COORDINATING RESEARCH COUNCIL, INC.
5755 NORTH POINT PARKWAY, SUITE 265
ALPHARETTA, GA 30022
TEL: 678/795-0506 FAX: 678/795-0509
WWW.CRCAO.ORG

November 27, 2023
In reply, refer to:
CRC Project No. E-144

Dear Prospective Bidder:

The Coordinating Research Council (CRC) invites you to submit a written proposal to provide services for "Impacts of Alternative Diesel Fuels on OBD Robustness" (CRC Project No. E-144). 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 15, 2023** 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 team requests that the test plan be quoted on a per vehicle, per fuel basis- for a program with 4 vehicles and 9 fuels. 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 considered 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
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 **January 5, 2024.**

Yours truly,

Amber B. Leland
Deputy Director

EXHIBIT A
STATEMENT OF WORK
CRC Project No. E-144

IMPACTS OF ALTERNATIVE DIESEL FUELS ON OBD ROBUSTNESS

Motivation

Availability of biofuels and renewable fuels is expected to increase, driven by federal and state policies like Federal Renewable Fuels Standards (RFS) and California Low Carbon Fuels Standard (LCFS) and other state mandates. While the impact of renewable fuels on engine and aftertreatment performance has been studied in other projects, the impact of fuel properties on OBD robustness is not well understood.

Goal

As renewable fuels become more widely available, this project seeks to understand the impact of renewable fuels on diagnostic robustness by investigating variation in key inputs to diagnostic strategies.

Description

Determine variation in engine and aftertreatment sensor measurements (including both test-to-test variation (repeatability) and variation with fuel type (fuel effect)) when tested with a range of diesel fuels across four vehicles and 6 to 8 fuels (work may be split into phases pending cost).

Hypothesis

Fuel properties such as oxygen content, cetane number, and heating value are expected to affect combustion performance such as air-fuel ratio and exhaust energy. If combustion performance is altered, engine and aftertreatment sensors will measure the change in response. Differences in air fuel ratio may lead to differences in fuel system diagnostic response. Fuels with different air-fuel ratios cause different oxygen concentrations in the exhaust stream for the same amount of fuel injected. The diesel propulsion system has monitors for oxygen and NOx sensors that implicitly rely on modeled O2 concentration. A larger difference between measured and modeled Oxygen concentration will decrease the separation between intact and faulty sensors and lead to increased Type 1 and type 2 errors.

Differences in heating value may lead to differences in exhaust temperature, affecting diagnostics based on exhaust energy, such as Diesel Oxidation Catalyst monitoring and Cold Start Emissions Reduction System monitoring. Because diagnostic thresholds are typically calibrated with standard fuel, a vehicle exposed to an alternative diesel fuel may false fail diagnostics due to the changed sensor response exceeding diagnostic thresholds. At this time, all of the interactions are not well understood among fuel properties and sensor response and how diagnostic system performance is affected.

Vehicles

The test plan will include the following vehicles for the program (Vehicle will be provided by OEMs):

OEM	MY	Make
Ford	2020MY or 2023MY	Diesel F250
GM	2020-2023MY	3.0L Diesel Sierra/Silverado 1500 or 6.6L Diesel Sierra/Silverado 2500
Stellantis	2023MY	Diesel Ram 2500
Mercedes Benz-**Tentative**		Van

Test Plan

The test plan will consist of the following cycles run for each vehicle and for each fuel, after some vehicle preparation before the test and in between each fuel blend with appropriate preconditioning cycles for each set of testing. OBD demonstration cycles will be used to assess variation in sensor response with test fuel, since either the FTP75 or LA92 cycle is required to be used for demonstration of diagnostic performance as part of OBD certification. Diesel Particulate Filter (DPF) regeneration cycles will be used to assess impact of test fuel on regeneration performance. Regeneration emissions and frequency are critical components of OBD demonstration. DPF regeneration will be manually triggered via calibration or scan tool.

OBD Demonstration Cycles (Per OBD Certification) : FTP72 + soak + cold FTP75 + LA92, repeat 3 times

DPF Regeneration Cycles: back-to-back FTP72 in regeneration until Diesel Particulate Filter (DPF) regeneration completes

Tailpipe emissions will be measured for each fuel across the project even though previous studies have explored the impact of alternative diesel fuels on emissions. The main focus of this proposal is to measure the inputs to diagnostic strategies to assess diagnostic robustness. (Modal – second by second) Modal, or second by second, data should be collected.

Collect pre- and post- system MSS Micro Soot data (AVL 483 or other device) from the engine and aftertreatment. This should be collected by mass over time for further analysis of long term endpoints.

Sensors to Monitor

The following sensors will be monitored throughout the test. These sensors will be installed on the vehicles for the testing. The Project investigators will help to outline if these sensors are already part of the vehicle system or are additional sensors to be installed on the vehicle. Most of the sensors should be on-board and signals available through the data stream. If not, sensors should be added to the vehicle instrumentation and provisions made for external measurement of sensor feedback.

(If virtual sensors are utilized, they should be monitored and recorded, then compare with real sensors)

Exhaust gas temperature sensors pre- and post-DOC and DPF, NOx sensors, engine out O2 sensor, tailpipe NH3 sensor, PM sensor, exhaust manifold pressure (if so equipped), and engine manifold (boost pressure) pressure and temperature sensors. O2, NH3, and PM sensor may need to be added if not equipped.

Additional sensors to consider for evaluation: Liquid Pressure Sensor (On Chassis Fuel Bundle or Fuel Tank), Temperature Sensor (part of diesel filter), Water in fuel sensor.

Data from the sensors should be recorded continuously during each of the test cycles.

Fuels Matrix

The test plan will consist of the fuels shown in the table below, plus 2 more fuels planned for a total of 8 fuels. In addition, the ULSD fuel will be re-run a t the end of the project, giving a total of 9 fuels.

Fuel Property	ASTM Method	1	2	3	4	5	6
		EPA ULSD	B20 w EPA ULSD	B100	RD50 w EPA ULSD	RD80/B20	RD100
FAME Content, vol%	D-7371	0	18 to 22	99 to 100	0	18 to 22	0
Renewable Diesel Content, vol%	D-8368	0	0	0	48 to 50	78 to 82	> 98
Cetane Number, min	D-613	44 to 48	Report	>45	Report	>50	> 60
Aromatic content, total vol%	D-5186	> 27	Report	<1%	16 to 18	< 1%	<1 %
Paraffinic, vol%	D-2425	Report	Report	<1%	Report	Report	> 95
Distillation T90, max °C	D-975	282- 338	282 - 338	360	Report	Report	Report
Stability, hrs (Rancimat)	EN 14112	N/A	> 6	> 3	N/A	> 6	N/A
Density, kg/m3	D 4052	840 - 865	840 - 865	860 - 900	Report	Report	765 - 800
Kinematic viscosity, 40°C	D 445	To Report	To Report	To Report	To Report	To Report	To Report
Bulk Modulus	Experimental/SWRI Method	To Report	To Report	To Report	To Report	To Report	To Report

Note that for biodiesel blends (BXX fuels) aromatics content cannot be measured via this method and will be reported via calculation based on blend volume.

EPA ULSD =Tier 3 EPA Ultra-Low Sulfur Diesel for Certification
RD = Renewable Diesel
BXX = Blend containing XX volume % biodiesel and balance ULSD
B20/RD80 = blend containing 20 vol% biodiesel and 80 vol% renewable diesel (hydrotreated vegetable oil)

Each fuel will be provided with 6-x barrels (to be determined from test plan fuel approximation) of fuel so that there will be plenty of fuel to flush the tank between tests, and for enough repeats of the test conditions to gather enough data for statistical analysis.

The table below illustrates the priority for selection of test fuels based on their significance and the underlying reasoning.

Fuels	Key Properties	Rationale	Comments
B20 HA ULSD	High O2, High Cetane, High T90, High Density/viscosity	Most common biodiesel blend. Typical highest blend level approved by OEMs	Recommended
Low Cetane ULSD	Low Cetane ULSD	Worse Case Low Cetane US fuel	Recommended
B50 HA ULSD	Very high O2, High Cetane, Very high T90, Very high density/viscosity, Low energy content	Possible high biodiesel blend available in future	Might be considered for removal in the case of constrained funding, as this fuel expected to be less popular
High T 90 , HA ULSD	High T90 & High Aromatics	Fuel with high engine out emissions potential	Recommended
B20/RD80	High O2, Very High Cetane, Low density, Zero Aromatics	Popular 100% sustainable fuel mix in CA	Propose omitting it, as the spectrum of properties of this fuel is encompassed by other suggested fuel options.
RD50 HA ULSD	Very high Cetane, low density	Representative of mix of renewabel diesel fuel blend w ULSD	Propose omitting it, as the spectrum of properties of this fuel is encompassed by other suggested fuel options.
RD100	Very high Cetane, Zero Aromatics, Low Energy on volume basis	100% renewable fuel approved by many automakers	Recommended
EPA ULSD	Average Cetane, Distillation and Density/Viscosity	Representative of nominal ULSD fuel for US market	Recommended

Fuel Property List for Analysis (Member companies will be asked to volunteer to run the fuel properties for this study)

List of fuel analysis are in table below:

Test Properties for Fuel Analysis				
	ASTM		**Test Volume**	**Cost**
PROPERTY	**METHOD**	**UNITS**	**milliliters**	**$**
Flash Point (closed cup)	D 93	°C		
Water and Sediment	D2709	% volume		
Distillation	D 86	°C		
Kinematic viscosity, 40°C	D445	mm^2 / s		
Ash	D482	% mass		
Sulfur	D5453	ppm		
Copper Strip Corrosion	D130	-		
Cetane Number	D613	Value		
Cetane Index	D976	-		

IQT Ignition Quality Tests	D6890	Value		
Aromatics	D5186	Wt%		
Cloud Point	D2500	°C		
Carbon Residue (10% Bottoms)	D524	% mass		
Lubricity, HFRR @ 60C	D6079	micron		
Bulk Modulus @ various temperatures	SwRI Method	psi		
VUV-Diesel Composition	D8368	Vol%		
ICP-MS metals	D8110 or similar	ppm		
FAME Content	H-NMR & C-NMR tests	% mole of carbon types		
Elemental analysis	D5291			
Trace Nitrogen	D4629	Wt%		
Hydrocarbons by GM-MS	D2425	Wt%		
Net heat of combustion	D4809 & D3338	Btu		
Density	D4052	g/l		
CHN				
Oxygen Concentration				
AFR Calculation of the fuel				

In addition to the properties listed in the table above, along with LHV and CHNOS, sulfur content should be confirmed by ASTM D5453. Consider allowing D6890, D7168, and/or D8183 as alternatives to D613 for cetane measurement. Suggest including lubricity via D6079 or D7688. Confirm all fuels pass "workmanship" requirements - I.e., visually free of water, sediment, suspended solids, is bright & clear, etc.

Contractor Deliverables

The data collected will be compiled into an excel spreadsheet for the final report and captured as a separate file in addition to the final report. Conclusions on the robustness and variation of the sensors' measurement – with each fuel type should be explained in the final report by the contractor. Sensors should be assessed for test-to-test variation (repeatability) on repeated tests and for variation with fuel type (fuel effect).

The Final report is reviewed by the panel and revised by the contractors for final draft.

Contractor generated reports and deliverables will include:

- Status update presentations (bi-weekly)
- Written final report including but not limited to:
    - High level executive summary
    - Experimental setup
    - Data discussion
        - e.g. focus on exploring deltas in sensor, OBD, and vehicle performance
    - Analysis and hypothesis
        - e.g. focus on unusual sensor, OBD, or vehicle performance response due to fuel variations
    - Summary and Conclusions
- Excel sheet including
    - Raw data
    - processed data

Quote:

Bidders to provide the cost details on a per vehicle (total of four vehicles) and per fuel basis (total of 9 fuels). This will help the project team revise the project as needed.

Bidders should quote the project without providing the cost of the actual fuels. This will be handled separately by CRC.

Relevant Committees and/or Groups

Emissions Committee/ Real World Group

Performance Committee

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.