COORDINATING RESEARCH COUNCIL, INC.
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WWW.CRCAO.ORG

February 5, 2025
In reply, refer to:
CRC Project No. DP-05-22 (Phase 1)

Dear Prospective Bidder:

The Coordinating Research Council (CRC) invites you to submit a written proposal to provide services for ""Investigation of Solubility of Various Components in Renewable Diesel" CRC Project Number: DP-05-22 (Phase 1). 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 **February 19, 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:

Christopher J. Tennant
Coordinating Research Council
1 Concourse Parkway, Suite 800
Atlanta, GA 30328

Phone: 678-795-0506
E-mail: ctennant@crcao.org

The deadline for receipt of your proposal is **March 10, 2025.**

Yours truly,

Christopher J. Tennant
Executive Director

EXHIBIT A

CRC Project Statement of Work

"Investigation of Solubility of Various Components in Renewable Diesel"

CRC Project Number: DP-05-22 (Phase 1)

Background

Renewable diesel is a type of biofuel made from renewable resources like vegetable oils, animal fats, and waste cooking oils. Unlike biodiesel, which is produced through transesterification, renewable diesel is created through hydrotreating—a process that removes oxygen from the feedstock using hydrogen. Additional processes, such as isomerization, improve cold flow properties, while fractionation and/or distillation further separate renewable components. This results in a fuel that contains only hydrocarbons, allowing it to be used as a drop-in replacement for petroleum-derived Ultra-Low Sulfur Diesel (ULSD). Policies such as the Renewable Fuel Standard (RFS) and the California Low Carbon Fuel Standard (LCFS) encourage the use of low-lifecycle-carbon fuels, offering incentives for the production and use of renewable diesel. The increasing demand for sustainable and low-emission fuels is driving the market for renewable diesel.

Renewable diesel consists typically of aliphatic hydrocarbons in the C15 to C18 range, with minimal to no aromatics. Its bulk fuel properties are well understood; renewable diesel has a lower density, a higher flash point, reduced evaporation loss, and similar viscosity and water content to conventional diesel. The composition of renewable diesel can affect its miscibility with other fuels, such as biodiesel or polar fuel additives.

Objective

The proposed study aims to investigate the solubility impact of various components that may be blended with renewable diesels. Phase 1 of the study will evaluate renewable diesel solubility with biodiesel and its blends.

Scope of Work

Test Fuels Matrix:

The fuel matrix for the study includes three base fuels comprised of conventional marketplace #2 diesel fuel, two types of renewable diesels distinguished by their cloud points, and three types of biodiesels distinguished by their cold flow performances, as well as blends of these fuels as described below. Fuels may include additives to enhance typical performance aspects such as lubricity and stability, but they are not to contain cold flow improvers and drag reducing agents.

Note: All the base fuels procured shall be free of undissolved water, sediment, and suspended matter.

- Conventional #2 summer grade marketplace diesel (ULSD) with aromatics content ~25 to 35 volume % meeting the ASTM D975 standard. This fuel represents a typical U.S. market fuel quality with a higher aromatic content, which would accentuate its solubility behavior in contrast to aromatic-free renewable diesel.

  Renewable diesel with a high cloud point (RD1) as per ASTM D975 standard, ranging from 0°C to 5°C.Renewable diesel with a low cloud point (RD2) as per ASTM D975 standard, ranging from -7°C to -20°C.
- 50% blend of renewable diesel with a high cloud point (RD1) with conventional #2 summer grade marketplace diesel (ULSD).
  Biodiesel with a low cloud point (made from soybean oil or similar vegetable oil, see Note below) as per ASTM D6751 standard, approximately ranging from -5°C to +2°C. (Grade No. 1-B S15 LM)

- Biodiesel with a high cloud point (made from animal fat, palm oil or other highly saturated feedstock, see Note below) as per ASTM D6751 standard, ranging from +5°C to + 20°C. (Grade No. 1-B S15 LM)
- Biodiesel that has a performance value of > 200 seconds but < 360 seconds on the Cold Soak Filtration test as per ASTM D7501 and as per ASTM D6751 standard.
- Blends of biodiesels with conventional diesel and renewable diesels at B5, B20 and B50 levels, as well as RD50 blend with ULSD as described below:
    1. 5% Biodiesel (Low Cloud point) with ULSD
    2. 5% Biodiesel (Low Cloud point) with RD1
    3. 5% Biodiesel (Low Cloud point) with RD2
    4. 5% Biodiesel (High Cloud point) with ULSD
    5. 5% Biodiesel (High Cloud point) with RD1
    6. 5% Biodiesel (High Cloud point) with RD2
    7. 5% Biodiesel (CSFT > 200 to < 360 s) with ULSD
    8. 5% Biodiesel (CSFT > 200 to < 360 s) with RD1
    9. 5% Biodiesel (CSFT > 200 to < 360 s) with RD2
    10. 20% Biodiesel (Low Cloud point) with ULSD
    11. 20% Biodiesel (Low Cloud point) with RD1
    12. 20% Biodiesel (Low Cloud point) with RD2
    13. 20% Biodiesel (High Cloud point) with ULSD
    14. 20% Biodiesel (High Cloud point) with RD1
    15. 20% Biodiesel (High Cloud point) with RD2
    16. 20% Biodiesel (CSFT > 200 to < 360 s) with ULSD
    17. 20% Biodiesel (CSFT > 200 to < 360 s) with RD1
    18. 20% Biodiesel (CSFT > 200 to < 360 s) with RD2
    19. 30% Biodiesel (High Cloud Point) with RD1
    20. 30% Biodiesel (CSFT > 200 to < 360 s) with RD 1
    21. 50% Biodiesel (High Cloud Point) with RD1
    22. 50% Biodiesel (CSFT > 200 to < 360 s) with RD 1
    23. RD 50 with ULSD

Note: Feed stocks mentioned above associated with Biodiesel with low and high Cloud Point (CP) are suggestions only, not requirements. In general, Biodiesel from soybean oil is expected to have lower CP than Biodiesel from animal fat or palm oil. But Biodiesel from any feed stock can be used if it meets CP targets.

Fuels Characterization:*

Conventional marketplace #2 diesel fuel and two types of renewable diesels are to be characterized as per the tests defined in ASTM D975 Table 1 requirements. The aromatic content of these fuels should be tested in accordance with ASTM D1319 or an equivalent method like D5186, D6591, or D8368. Biodiesels (B100s) should be characterized as per the tests defined in ASTM D6751 Table 1 requirements.

Also, Biodiesels (B100s) should be characterized for fatty acid profiles as per AOCS GC/MS method Ce 1c-89 and cold soak filter blocking tendency (CSFBT) as per CAN/CGSB-3.0 no. 142.0-2024. All fuels

should also be analyzed for cloud point as per ASTM D2500 or equivalent method (D5773, D7689) and for pour point as per ASTM D97 or equivalent method (D5949, D5950, D7346). All blends of biodiesel with conventional diesel and renewable diesel should also be tested for their distillation profile according to D86.

***The most recent version of applicable ASTM Test Methods will be used.**

Test Methodology:

Phase1 of the study aims to explore the solubility of biodiesel in renewable diesels, with cold ambient conditions being the most suitable for assessing these effects. The suggested test methodology involves exposing fuel samples in centrifuge test tubes or comparable containers, as shown in Figure 1, to various temperatures for 24 hours.

Fuel samples are soaked for 24 hours at varying temperatures and must include conventional #2 summer grade marketplace diesel (ULSD), renewable diesel with a high cloud point (RD1), renewable diesel with a low cloud point (RD2), RD50 blend with conventional #2 summer grade diesel and blends of biodiesels with conventional diesel and renewable diesels at B5, B20, B30 and B50 levels.

Note: Method to erase thermal history of fuels before soak tests based on the laboratory set up and this will be discussed by CRC panel for approval Example. The suggested approach would be to heat samples to 100F and stir for a period.

The proposed soak temperatures for the test will include a maximum of 20°C, 10°C, and a third soak temperature, which will be set at least 2°C above the measured cloud point of the base fuels and blended test fuels. For this third soak temperature, the fuels will be categorized into three groups based on their cloud points: "Low Cloud Point," "Medium Cloud Point," and "High Cloud Point." The third soak temperature for each group will be chosen as 2°C above the highest cloud point within that group, as shown in the hypothetical fuel matrix. The final decision on the third soak temperature for each fuel category will be based on the measured cloud points of the fuel samples and should be made in consultation with CRC panel members.

Please note that the cloud points provided are random hypothetical values, and the actual grouping will be determined by the measured cloud points.

Low Cloud Point Fuels (CP < -10C)	Cloud Point (deg C)	Soak Temperature(deg C)
5% Biodiesel (Low Cloud point) with ULSD	- 20 C	
5% Biodiesel (Low Cloud point) with RD2	- 18 C	
5% Biodiesel (CSFT > 200 to < 360 s) with RD2	- 22 C	- 14 C
20% Biodiesel (Low Cloud point) with ULSD	- 17 C	
20% Biodiesel (Low Cloud point) with RD2	- 16 C	
Medium Cloud Point Fuels (CP < -5 C TO >/= 10 C)		
5% Biodiesel (Low Cloud point) with RD1	- 10 C	
5% Biodiesel (High Cloud point) with ULSD	- 12 C	
5% Biodiesel (High Cloud point) with RD2	- 8 C	
5% Biodiesel (CSFT > 200 to < 360 s) with ULSD	- 10 C	
20% Biodiesel (Low Cloud point) with RD1	- 9 C	- 5 C
20% Biodiesel (High Cloud point) with RD2	- 7 C	
20% Biodiesel (CSFT > 200 to < 360 s) with ULSD	- 10 C	
20% Biodiesel (CSFT > 200 to < 360 s) with RD2	-9 C	
High Cloud Point Fuels (CP >/= - 5 C)		
5% Biodiesel (High Cloud point) with RD1	- 5 C	
5% Biodiesel (CSFT > 200 to < 360 s) with RD1	- 4 C	
20% Biodiesel (High Cloud point) with ULSD	-3 C	
20% Biodiesel (High Cloud point) with RD1	0 C	
20% Biodiesel (High Cloud point) with RD2	- 4 C	2 C
20% Biodiesel (High Cloud point) with RD2	- 4 C	
20% Biodiesel (CSFT > 200 to < 360 s) with RD1	- 3 C	
50% Biodiesel (Low Cloud point) with RD1	- 3 C	
50% Biodiesel (Low Cloud point) with ULSD	- 5 C	

After soak period at each test temperature, the samples will be inspected for solubility concerns through visual observations and characterization of biodiesel content and any precipitates. Visible signs of precipitation or haze will be documented and photographed.
Visual inspections will be performed by two methods per ASTM D4176 Haze by Visual, Procedure 2 and by the Haze Clarity Index (HCI) by Spectroscopy test method, as outlined in ASTM D8148. Haze analysis should be performed both immediately after cold soak and then also after the soak period when the sample warms up to room temperature 20 to 28 hours later based on discussion with CRC panel.
Besides visual inspection, biodiesel content will be measured at the top and bottom phases of the test samples. Appropriate test methods include EN14078 FAME in Diesel by FTIR, D7371 FAME in Diesel by FTIR-ATR-PLS, D7861 FAME in Diesel by LVF Mid-IR, and EN14103 FAME in Diesel by GC.
Subsequently, any fuel sample exhibiting haziness or precipitate will be centrifuged. The separation of the precipitate from the sample and amount of precipitate (preferably quantified by mass) will be documented and photographed. This will be followed by a composition analysis of the solid or semi-solid precipitate using GC-MS or another suitable method.

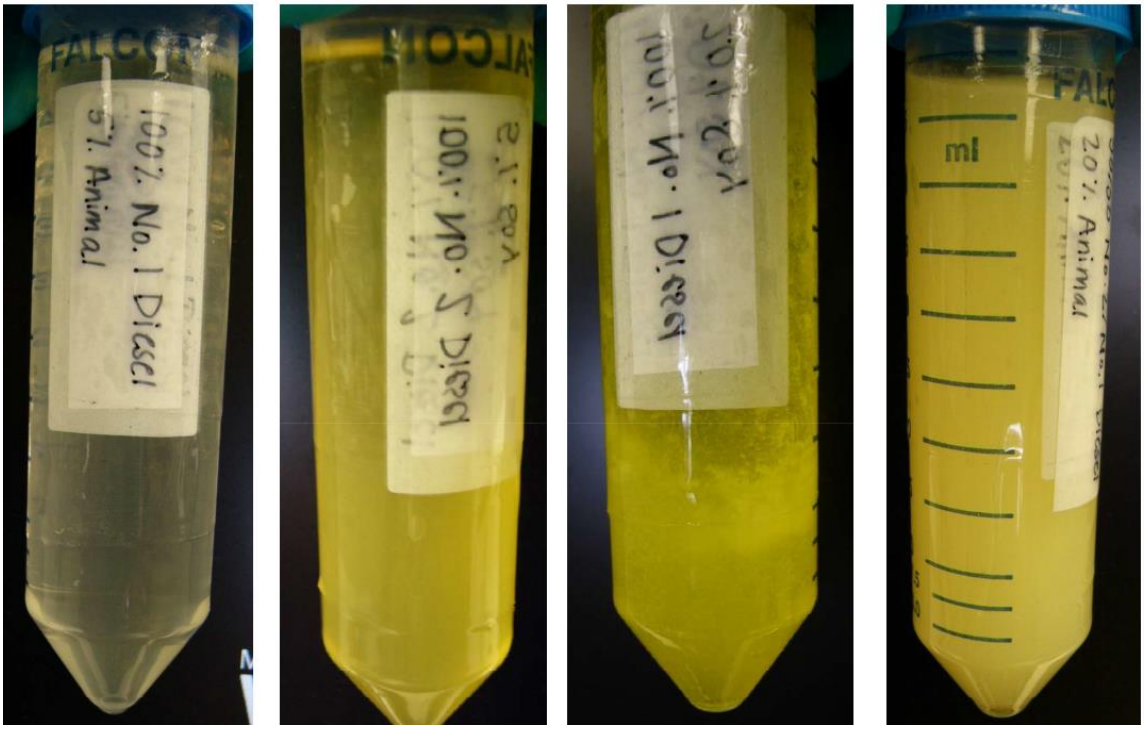

Figure 1. Depiction of precipitate formation in fuels

Schedule
Because of the limited experimental scope, this project is expected to take 3-6 months to complete from contracting to draft final report.

Deliverables
Deliverables include monthly reports, a stand-alone final report (not dependent upon or referring to other documents such as monthly reports or interim reports), and related project data in a readily accessible format like Excel spreadsheet and Word or PDF document. Project status calls will be scheduled as appropriate (about monthly) to support dialog between the CRC project panel to the contractor during project execution.

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.