**COORDINATING RESEARCH COUNCIL, INC.**
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ALPHARETTA, GA 30022
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**August 21, 2013**
In reply, refer to:
CRC Project No. AVFL-17c

Dear Prospective Bidder:

The Coordinating Research Council (CRC) invites you to submit a written proposal to provide services for "Thermal and Oxidative Instability in Biodiesel Blends During Vehicle Use and Onboard Fuel Storage" (CRC Project No. AVFL-17c). A description of the project is presented in Exhibit A, "Statement of Work."

Please indicate by letter, fax, or email by **September 6, 2013** 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 and government 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. Bidders are also advised that government funds may be used to support the research, and therefore certain government contract terms and conditions may apply.

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:

Brent K. Bailey
Coordinating Research Council
5755 North Point Parkway, Suite 265
Alpharetta, GA 30022
E-mail: bkbailey@crcao.org

Phone: 678-795-0506
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The deadline for receipt of your proposal is **September 18, 2013.**

Yours truly,

Brent K. Bailey
Executive Director

# EXHIBIT A

AVFL-17c Phase 1
Thermal and Oxidative Instability in Biodiesel Blends
During Vehicle Use and Onboard Fuel Storage
Statement of Work
8/20/13

## Background:

Diesel fuel stability was addressed a number of years ago for conventional diesel fuel. A thermal stability test method, ASTM D6468, was developed and acceptable levels to protect equipment were established and observed. Since the introduction of S15 in 2006 and its inherent ability to do well in D6468, further research and attempt to adopt stability specifications was not pursued. Two developments have surfaced:

- Common-rail systems with high pressure and high temperature have been introduced. Fuels are stressed more severely than before. Finer filters are required.
- New fuels such as biodiesel with different characteristics were introduced, and at the time accepted as stable if they met a certain induction period (IP) using an accelerated oxidation test.

It, therefore, is possible that the existing test methods, suggested levels, and practices may not be adequate in current and future equipment and may not be protective of the modern equipment.

It is our intent to test the hypothesis that currently stability levels and practices are not adequate for light-duty common rail systems, and to investigate the fundamental mechanisms responsible for diesel/biodiesel instability. We will apply existing test methods or ones that may be developed through this program, to determine what changes in stability test method and suggested levels are required for fuels that were perfectly fine for the existing equipment to perform equally as well for operation in the new high-pressure high-temperature common rail injection systems in modern vehicles.

Fuel stability in this program is limited to thermal, oxidative, and storage stability and excludes the more general stability performance areas such as cold temperature operability and microbial growth.

## Objectives:

The goals of Phase I in this study are to examine the impacts of various challenges to stability (temperature, pressure, oxidation, free radical formation, acid formation, etc.) on biodiesel blends during onboard vehicle use and storage conditions to:

1. more accurately capture and identify the environmental conditions and chemical processes which drive thermal and oxidative instability (literature search as it applies to onboard storage conditions)
2. develop relationship between such processes and a measurable attribute in the fuel such as the onset/presence of free radicals, peroxide formation, acid number, IP, etc.
3. develop a surrogate process or performance test to simulate those impacts and create oxidized biodiesel according to a given oxidation specification

4. determine the statistical uncertainty in reaching a selected degree of oxidation of such a simulated process in the laboratory (repeatability)
5. provide a project report with complete details of the project including the detailed final oxidation process and its repeatability analysis.

**Scope of Work:**

**Project Management**

CRC and its project technical panel will provide management and oversight for this project. These entities are hereafter referred to collectively as the project sponsor.

**Fuels**

High quality ASTM compliant B100 biodiesel will be procured. B100 will be blended with selected commercially available hydrocarbon diesel fuels comprised of high levels of hydrotreated and hydrocracked components, respectively. The hydrocarbon-only petroleum diesel fuels may also be evaluated separately for their stability performance. Sources of biodiesel may be soy and palm or other feedstocks that span the range of degree of saturation and initial stability. Fuel analyses must be conducted to determine test fuel properties, including cetane number and other compositional and performance characteristics to fully characterize the test fuels. The contractor may arrange for property inspections at an outside commercial laboratory. In summary, the following fuel sets will be considered for evaluation:

- High concentration hydrocracked & hydrotreated baseline diesel fuels respectively for a total of 2 hydrocarbon-only fuels
- 4 biodiesels at commercially approved blending levels representing 2 levels of saturation and 2 levels of stability as measured by induction times in a 2x2 matrix with selected diesel fuels from above (B100 containing no antioxidant may be selected as part of the stability-level matrix)
- 2 additional fuel blends from the above fuel sets with cetane number improver (2-ethylhexyl nitrate) added to explore the impact of this additive
- Additional fuel blends such as low-level or mid-level biodiesel blends may be proposed as options to the main research program scope

**Identification of Onboard Fuel Storage and In-use Conditions and Laboratory Simulations**
CRC may identify for the contractor some modern diesel vehicle technologies and generic fuel system conditions that will serve as a baseline to define in-use engine operation and onboard fuel storage conditions. These conditions can be explored in a literature search and, more directly, can be evaluated during vehicle onboard vehicle exposure testing operations. The baseline test conditions to be identified and evaluated in this study will include fuel tank breathing during diurnal storage, recirculation of fuel to the tank during operation, and exposure of fuel flowing in the pump/injection systems. Onboard vehicle conditions will also be simulated in the laboratory to duplicate conditions that may be observed in a vehicle operating on a dynamometer or on a test track.

**Fuel Stability Monitoring**

The contractor will propose analytical procedures to monitor fuel stability during simulated onboard vehicle storage and use to define any changes that may occur on fuel exposure to these conditions.

**Technical Approach:**

The following tasks are suggested to address the project objectives:

Task 1: Literature Search of potential oxidation and thermal stability impacts during onboard vehicle storage and in-use conditions and availability of potential screening tools

Task 2: Vehicle Technology Selection and Identification Onboard Fuel Exposure Conditions including fuel time, temperature, and pressure exposure conditions to bracket engine operating conditions

Task 3: Fuel Procurement (see list above) including full fuel characterizations of base fuels and blends

Task 4: Vehicle Dynamometer/Proving Ground/Test Track Evaluations (Baseline and Experimental Fuels)

Task 5: Bench Test Development to mimic an onboard fuel exposure history (thermal, oxidation, etc.) to develop potential screening tool(s). An Experimental Design for statistical analysis of all data generated will be prepared for review and approval by the Project Management Team.

Task 6: Repeatability testing will be conducted on the selected final test procedure. The design of experiments and analytic techniques should be suitable for use by ASTM to specify the test repeatability.

Task 7: Recommendations for Phase II on fuel effects testing

**Deliverables:**

The contractor should submit monthly reports in addition to the draft and final reports. Monthly reports should contain all data acquired during the report month. Depending on the final program schedule, the contractor may be requested to issue an interim report. This interim report would be structured in format of a final report, and would address any completed testing to that point. The final report must include a clearly marked, detailed, final procedure for simulated oxidation of fuel and a clearly stated and explained repeatability value or repeatability function for that procedure.

## 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 pdf-compatible 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).

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 an electronic copy in a pdf or pdf-convertible 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 of Contractor 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.