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ALPHARETTA, GA 30022
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www.crcao.org

July 23, 2014
In reply, refer to: CRC Project No. AV-19-14

Dear Prospective Bidder:

The Coordinating Research Council, Inc. (CRC) invites you to submit a written proposal on "Alternative Aviation Fuels-Water Solubility and Demulsiblity Impact," as described in the attached Statement of Work, Exhibit A.

Please indicate via letter, fax, or email by **August 12, 2014** whether or not you or your organization intends to submit a written proposal for the project. 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.

The CRC technical group composed of equipment, petroleum, and government representatives will evaluate your proposal. CRC reserves the right to accept or reject any or all proposals.

The reporting requirement will be text, data and charts to CRC in accordance with Exhibit A Statement of Work. A Final Report documenting the results of the study will be published by CRC. The reporting requirement is described in more detail in the attachment entitled, "Reports" (Exhibit B).

The "Intellectual Property Rights Clause" (Exhibit C) and "Liability Clause" (Exhibit D) will be a part of the agreement, which may be executed as a result of this Request for Proposal solicitation.

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.

CRC expects to negotiate either a cost reimbursable or a fixed price contract. 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:

Mrs. Jan Tucker
Coordinating Research Council, Inc.
5755 North Point Parkway, Ste. 265
Alpharetta, GA 30022

Phone: 678-795-0506, Ext. 100
Fax: 678-795-0509
E-mail: jantucker@crcao.org

The deadline for receipt of your proposal is **September 1, 2014**.

Sincerely,

Jan Tucker
Committee Coordinator

EXHIBIT A

STATEMENT OF WORK

Alternative Aviation Fuels-Water Solubility and Demulsiblity Impact

1.0 Objective

The primary objective of this program is to determine the influence of alternative aviation fuels on the water solubility and coalescence characteristics of petroleum-derived product, both in mixture and on a stand-alone basis.

2.0 Background

Traditionally jet fuel has been derived from crude oil with the Aviation Industry developing appropriate handling methods and aircraft fuel systems for effective use. A key aspect of these procedures is the management of trace water which may be present in fuel either dissolved in solution or as free water drops. Alternative aviation fuels may have compositional differences relative to a conventional petroleum based product, being blends of controlled molecular families from diverse to single molecules. These have/are being developed as synthesized blending components to supplement aviation fuel supply and may have a subtle influence of the chemical composition of the pool after blending. This has raised questions regarding their potential impact on water solubility characteristics. While the water content of alternative fuels (i.e. per ASTM D7566) and blends with crude oil derived product have been measured at specific temperatures, their water solubility curves over a broader temperature range remains an area of interest. During the last revision of the CRC Aviation Fuel Handbook, it was recognized that the Industry water solubility data needs to be updated to include current alternative fuel chemistries for the benefit of system design and understanding.

In addition to water solubility, the Aviation Industry utilizes coalescer technology to reduce the amount of trace water in fuel to an acceptable level, typically below 30 or 15 ppm. Coalescer filter manufacturers have also expressed the need for a body of data to confirm that alternative aviation fuels separate from water in the same manner as conventional jet fuels. Experience has shown that trace impurities in other fuels, either from the source feed-stock or manufacturing process, have impacted coalescer performance through surface activity/disarming properties. Questions have been raised regarding the potential for greater quantities of water to be carried with the fuel through the entire combustion process, as a consequence of either lower water-fuel partitioning, or greater water solubility.

4.0 Experimental Approach

This research effort will be organized in two phases. In Phase I, the solubility of water in various fuels and blends will be determined as a function of temperature. This will provide an insight into the impact of alternative aviation fuels on water solubility. In Phase II, the surface tension and interfacial tension as a function of temperature will be developed for the fuel types and blends studied in Phase I. This will provide insight into the possible impact of alternative aviation fuels on water coalescer performance/disarming.

4.1 Test Fuels

A set of test fuels, consisting of a minimum of 10 fuel types will be assembled with support from the CRC. Then, the experimental methodologies for drying the fuel samples and preparing controlled water-fuel emulsions in airtight containers will be developed and verified. This will include at least one pure component for comparison versus literature data.

A set of aviation fuels that contains at a minimum, but not limited to the following fuel types:

- Suggested petroleum derived aviation fuels: Jet A, JP-5, JP-8. JP-8 is included in order to detect any possible impact from the JP-8 additive package on water solubility.
    - Other fuels that could be considered: Jet A-1, JPTS, TS-1
- Suggested alternative fuels:
    - hydrotreated depolymerized cellulosic jet (HDCJ)
    - hydrotreated esters and fatty acid jet (HEFA-HRJ)
    - Alcohol to jet (ATJ)
    - Fischer Tropsch synthetic paraffinic kerosene with aromatics (FT-SKA)
    - Fischer Tropsch synthetic paraffinic kerosene (FT-SPK)
    - Direct sugar to jet (DSH/SIP)
    - Synthetic Kerosene (Virent SK)
- Suggested pure chemical for verification of experimental technique: n-octane, o-xylene.

4.1.2 Fuel Test Matrix

Each petroleum fuel and each alternative fuel will be tested neat and each petroleum fuel will be tested after blending with each alternative fuel to produce 27 samples and blends as shown in Table

1.

		50%	50%	30%	10%	10%
Fuel Type	**Neat**	**HEFA HRJ**	**ATJ**	**HDCJ**	**SIP**	**Virent SK**
Jet A	X	X	X	X	X	X
JP-5	X	X	X	X	X	X
JP-8	X	X	X	X	X	X
TS-1	X					
HEFA-HRJ	X					
ATJ-SPA	X					
HDCJ	X					
FT-SPK	X					
FT-SPA	X					
DSH (SIP)	X					
Virent SK	X					
n-Octane or o-Xylene	X					

Table 1. Fuel test matrix of 27 samples, consisting of petroleum derived fuels, alternative fuels, blends and verification fluids.

4.2 Phase I: Dissolved water content as a function of temperature

A method for measuring water content of the fuel will be developed. It is envisioned that this will be a coulometric Karl Fischer (KF) titration performed in accordance with ASTM D6304, or equivalent, with particular focus on good experimental technique. Water emulsions will be prepared from each fuel sample, using a suitable high shear mixer at a minimum of 3 concentrations that encompass the range of soluble and free water. After mixing, the samples will be allowed to settle and the water content of the fuel phase will be measured at a minimum of 10 temperatures, ranging from -40°C to 50°C, in 10°C increments. A sufficient number of replicate analyses will be acquired as necessary to establish the precision of the KF titration measurements, including verification using the selected pure chemical sample.

Total number of fuel analyses = 27 samples x 3 conc. x 10 temperatures = **810 measurements**.

4.3 Phase II: Water settling times as a function of temperature

Using a high-shear contact mixer, prepare emulsions at 3 water concentrations in each sample using controlled agitation and a vessel of suitable, recorded, dimensions. After mixing, measure the water content of the fuel layer at a fixed point (e.g. center of vessel, at 30% of fuel height) by KF titration immediately after mixing and at a sufficient number of time periods to establish settling times. It is envisioned that this could be at a minimum of 1, 5, 15, 30, 60, minutes, then once every hour for an additional 7 hours (total = 12 times). Fuel will be held at a fixed temperature through the entire settling process, to aid in understanding the degree of emulsion formed with these fuels and water droplets size. Water content of the fuel layer will initially indicate total dissolved/free water, and should reach a saturation value over time based on solubility alone. If the KF water content is higher than saturation, this would serve as an indication that very small droplets remained emulsified.

Baseline data on settling times will be acquired from the 12 neat fuels and reference materials at 3 water levels (12 times x 12 fuels x 3 conc. = **432 measurements**). Settling times will be measured in the blends with the 5 alternative fuels shown in Table 1 and with JP-8 and Jet A fuels in order to assess the impact of the JP-8 additives (12 times x 2 fuels x 5 alt fuels x 3 conc = **360 measurements**). The number of fuel samples could be reduced if the baseline data indicate indistinguishable behavior with the alternative fuels.

4.4 Phase III: Surface and Interfacial Tension

The test fuels, water contents and temperatures as determined in Phase I will be used in this phase of the study to characterize interfacial and surface tension as a function of fuel composition and temperature. The fuel conditioning and water emulsion procedures developed in Phase I will be used to prepare a minimum of 78 samples consisting of a minimum of 11 neat fuels and the appropriate blends of the three petroleum fuels with the five alternative fuels as shown in Table 1, at 3 water concentrations, as determined in Phase I.

It has previously been established (CRC Aviation Fuel Handbook), that the surface tension of neat petroleum and FT aviation fuels tends to be linearly related to temperature. Measurements of interfacial tension and surface tension will be acquired from these fuel samples at a sufficient number and range of temperatures that adequately establishes their relationships to temperature and water content. Ideally, this would involve measurements at 5 - 10 temperatures over a range from approximately -15°C to +40°C for surface tension and approximately 4°C to +40°C for interfacial tension. Total number = 78 samples x 5 (minimum) temperatures = 390 for both IFT and ST for a total minimum of **780 determinations**.

5.0 Task Elements and Timeline

The two phases of this program can be conducted concurrently.

Phase I (6 months)
Water solubility data versus temperature and fuel type

- Obtain fuel samples
- Dry fuels and develop controlled water sample preparation procedure
- Measurement of water content versus temperature

Phase II (12 months)

- Measurement of water contents as a function of gravity settling times

Phase III (12 months)
Interfacial tension and surface tension data versus temperature

- Measure baseline surface tension of the fuels and fuel blends
- Measure interfacial tension of the fuel / water emulsions at room temperature

- Within the limits of the equipment, measure interfacial tension of the fuel/water with fuel at a defined set of temperatures (ambient temperature may be uncontrolled)

6.0 Deliverables

- Regular progress reports, documenting all significant instrumentation and progress, will be provided at required intervals as determined by CRC.
- Phase I: Report documenting all procedures, equipment and results.
- Phase II: Report documenting all procedures, equipment and results.
- Phase III: Final report documenting all procedures, equipment and results from Phase I + II. The final report should include an analysis of the anticipated impact of these fuels and blends with alternative fuels on the performance of current water coalescence technologies. It is envisioned that the results of this study will be incorporated in the next edition of the CRC Aviation Fuel Handbook

7.0 Funding Requirements

Phase I Water Solubility (6 months, 810 measurements)

- Water solubility vs temperature = 810 KF analyses

Phase II Water Settling Times (12 months, 792 measurements)

- Neat fuel settling times = 432 KF analyses
- Blend settling times = 360 KF analyses

Phase III Surface and Interfacial Tension (12 months, 780 measurements)

- Surface tension vs temperature = 390 determinations
- Interfacial tension vs temperature = 390 determinations

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 of the monthly technical progress report shall be submitted to CRC 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 in accordance with Exhibit A Statement of Work.

DRAFT AND FINAL REPORT

The contractor shall submit to CRC an electronic pdf-compatible copy of a draft final report after completion of the technical effort for each phase specified in the Statement of Work. The draft final 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 progress report(s).

The CRC Technical Committee and Steering Committee shall furnish comments regarding the draft report to the contractor within one (1) month after receipt the draft copy.

Within thirty (30) days after receipt of the approved draft copy of the phase reports, 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 Microsoft WORD and a pdf or pdf-convertible file format. The electronic copy will be made available for distribution by CRC.

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.

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.