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April 9, 2018
In reply, refer to:
CRC Project No. AV-25-16

Dear Prospective Bidder:

The Coordinating Research Council (CRC) invites you to submit a written proposal to provide services for "Fuel and Water Characterization in Support of the CRC Panel on Engine Component Deposits" (CRC Project No. AV-25-16). A description of the project is presented in Exhibit A, "Statement of Work."

Please indicate by letter, fax, or email by **April 23, 2018** 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 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 (not including resumes). The schedule / timeline information should be included in the technical proposal.

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:

Dr. Christopher J. Tennant
Coordinating Research Council
5755 North Point Parkway, Suite 265
Alpharetta, GA 30022

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

The deadline for receipt of your proposal is **May 9, 2018.**

Yours truly,

Dr. Christopher J. Tennant
Executive Director

EXHIBIT A
Statement of Work
Fuel and Water Characterization in Support of the CRC Panel on Engine Component Deposits

Relevant Strategic Objectives & Category (near, mid, long term impact): The CRC panel on Engine Component Deposits is interested in screening fuel and sump samples from selected airport locations, with a consistent approach, over a one year period.

Background: Over the past few years, several Airlines have been subjected to disruptive incidents (such as aborted takeoff, AOG from engine start faults, etc.) in North America, involving several Airframe and Engine OEMs. As a result, a large investigation was launched, and a root cause analysis determined that engine component water-soluble deposits was the likely cause. Part of the investigation focused on the evaluation of jet fuel quality and fuel handling equipment and procedures at limited airport locations. One of the most interesting findings was the discovery of water soluble deposits on engine hardware that do not appear to be related to byproducts of fuel thermal oxidation, a phenomenon commonly referred to as fuel lacquering (water insoluble). Although chemical characterization of the water-soluble deposits has been performed, the source and mechanism of deposition remains unknown.

Project Objectives/Project Approach:
Water soluble compounds (ammonium, sulfate, and other ionic compounds) as well as other contaminants found in aircraft fuel system are believed to be coming in with the fuel loaded at the airport. To understand their origin the Task Force will conduct collection of water and fuel samples at the airport locations listed in the table below. The selected laboratory will be tasked to perform chemical analysis of the collected samples. At the end of the program the laboratory will provide a report summarizing the findings.

Sample Collection Responsibilities
Sample collection from the airport locations listed below will be coordinated by the Task Force and will be performed by the participating airport personal. It will not be the responsibility of the selected laboratory to organize collection and shipment of the samples.

Sampling Schedule
Within a 12-month period, the Task Force will manage the collection and shipment of monthly 5-gallon airport samples to the selected laboratory.
Over a 12-month period there will be:

- 1 sample from 1 airport for the first 3 months (3 samples total),
- 1 sample from 10 airports for the remaining 9 months (90 samples total),
- A small possibility of several additional samples [realistically, no more than 5 additional samples – at any airport location under evaluation, if a fuel is known to be contaminated, or does not meet specifications, an extra sample would be requested at the time of failure].

The expectation is that collected samples will be composed of fuel and aqueous phases (preferred). However, cases when only one phase is collected are still acceptable (not preferred).

Sample Collection Guidelines to Be Performed by the Task Force:

TASK	Description
Sample water and fuel* from airport storage tank bottoms at several airports, doing monthly checks over a one year time frame. Collect a monthly 5-gallon sample from Airport Receiving Tank sump. **In some cases there might be a water/fuel interface (rag layer) that can be analyzed independently to provide additional valuable information. All phases should be collected.*	For obtaining a better picture of fuel contamination, sampling should not be limited to one particular area/location and should cover major US regions (i.e. East, West). The following locations are proposed: 1. SeaTac 2. Phoenix 3. Los Angeles 4. Las Vegas 5. San Diego 6. Miami 7. Chicago 8. Houston 9. Atlanta 10. New York In an unlikely event of fuel not meeting specification or if fuel farm becomes aware of contamination, additional fuel samples from such airport location will be collected immediately after the Task Force is notified of such event. The fuel sample will be sent to the participating laboratory in addition to the regular samples.
Use the same specified sample containers at all airport locations and store samples in a cool dark place (store at about 4°C to 20°C if possible) except where noted otherwise.	See EI 1530, page 38, §4.5.2. The Task Force will be supplying the same approved epoxy-lined sample containers to the participants.
Samples to be collected: **a. Both fuel and water phases* should be collected from "receiving" tank sump.** **b. Water should be collected from filter/water separator sump (see EI 1550, chapter 7, page 43)** **In some cases there might be a water/fuel interface (rag layer) that can be analyzed independently to provide additional valuable information. All phases should be collected.*	Samples should preferably be collected at airport storage receiving tank (sumps with water and fuel phases). If sumps from storage tanks are not available, other points in the system downstream of the depot where water draws can be made, might be considered (e.g. filter/water separators or haypack sumps, etc.). See EI 1550 Annex K, page 133 for recommended low point sampling/draining: a. Storage tanks b. Filter vessels (including strainers) c. Into-plane fueling equipment.
When collecting sump samples from airport storage tanks insure that a) pipe dead volume is discarded and b) adequate fuel flow is achieved in order to collect both fuel and water phases.	See JIG 2, §6.1.1
All samples must be collected at the same location (same tank, same filter sump, etc.) over the entire sampling timeframe of one year.	Ensure correct and accurate labeling (Airport name, sample location, date, time and other relevant information).

Note: The Task Force will provide a detailed sampling protocol to each airport location.

Statement of Work for the Selected Analytical Laboratory
Suggested Sample Preparation Guidelines

The selected laboratory will check fuel samples for presence of aqueous phase by drawing liquid from the bottom of the container using a long pipette. The fuel container should be tilted slightly to one side before checking for water. The pipette should be able to reach the lowest part of the container.

Samples consisting of fuel and aqueous phase

1) Draw enough fuel sample to perform analysis of the fuel phase.
2) Draw enough water to perform analysis as described for the aqueous phase.

Samples consisting of fuel phase only or fuel phase with very little water

If too little or no water is present perform the following:

1) Draw enough fuel sample and perform analysis of the fuel phase.
2) Pipette all water from the original fuel sample (if any present) and measure the volume.
3) Add 150 ml of distilled water to the fuel, agitate the container for 5 minutes to induce efficient mixing, wait for 10 minutes, pipette all the water out.
4) Add another 150 ml of distilled water to the fuel, agitate the container for 5 minutes to induce efficient mixing, wait for 10 minutes, pipette all the water out.
5) Combine original water and water extracts, record the total volume.
6) Perform water analysis as described for the aqueous phase.

Samples consisting of aqueous phase only

Samples consisting of aqueous phase only should be analyzed directly following the steps described for the aqueous phase.

Sample Analysis

The finalized testing protocol will be agreed between the Task Force and the lab based on the lab analytical capabilities and the available funding. The testing protocol will be finalized prior to the beginning of the program. The lab is expected to perform, at a minimum, the following tests:

Fuel Phase

1) *Measure total sulfur, nitrogen and oxygen content*

   The lab is to propose a suitable method for measuring total concentrations of nitrogen, sulfur and oxygen. Existing ASTM, EPA test methods are acceptable. Semi-quantitative measurements based on gas chromatographic methods are also acceptable. The selected test methods will be approved by the Task Force prior to the beginning of the testing. Semi-quantitative measurements are acceptable.

2) *Perform speciation and measure concentration of nitrogen, sulfur and oxygen containing species.*

   - Methods where polar phase is separated from the fuel matrix based on solid phase extraction, solvent extraction (e.g. methanol with subsequent concentration), etc… are preferred. Semi-quantitative measurements based on gas chromatographic methods with MS detector are preferred.

- If the lab has an in-house method for separating polars from the fuel matrix with subsequent analysis the method will be considered after its efficiency is demonstrated to the Task Force.
- Existing ASTM, EPA test methods are also acceptable.

Aqueous Phase

1) *Measure sample pH*
   pH digital meter is preferred over pH paper.

2) *Measure total nitrogen concentration*
   Lab is to propose a suitable method for measuring total nitrogen concentrations. The selected analytical method will be approved by the Task Force prior to beginning the testing. Semi-quantitative measurements are acceptable.

3) *Perform IC analysis*
   Concentrations of the following ions should be measured: NH_4^+, Na^+, K^+, SO_4^{2-}. In case if laboratory equipment is calibrated to detect other ions it is encouraged to report those as well. Semi-quantitative measurements are acceptable.

4) *Perform ICP by ASTM D7111*
   Concentration of the following elements should be measured: Cu, Mg, Fe, S, Si, P.

5) *ESI-TOFMS in both positive and negative modes*
   ESI-TOFSM will be used for detection of easily ionizable compounds and hot cations/anions that are not typical of jet fuel environment (atypical amines, benzalkonium cation (M/Z 304), oxygen containing species). Protonating agents in case of (+) ESI-TOFMS and basic agents in case of (-) ESI-TOFMS are recommended to assist ionization. Cone voltage should be varied in order to adjust sensitivity/fragmentation. Where possible MS/MS should be run to help identify compounds of interest.

Communication/Data Reporting

- Feedback from the laboratory regarding analytical methods is encouraged.
- The lab is expected to deliver testing results to the Task Force on a monthly basis. The expectation is that testing results are reported 3 weeks after sample receiving.
- At the end of this testing program the lab will provide a final report with all analytical data. A draft of the final report is required within two months after the last sample is collected and analyzed.
- The lab is encouraged to perform data analysis and to provide ideas on the observed trends.
- The raw data should be archived in a digital form and provided to CRC.

Other Information:

- The list of tests provided here is intended to generate a consistent screening of the samples over time.
- If an outlier sample is identified, the lab might be asked to provide additional techniques/analysis that can be performed to better characterize the sample.
- For any outlier sample, shipment of sub-samples to other labs may be requested by the Task Force.
- The lab is expected to store all samples in a temperature controlled environment until all data is reviewed and accepted by the Task Force. The acceptable temperature for sample storage is between 4°C and 20°C.

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 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.