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July, 11, 2017
In reply, refer to:
CRC Project No. AV-25-16

Subject: CRC Request for Proposal AV-25-16, "CRC Panel on Engine Component Deposits"

Dear Prospective Bidder:

The Coordinating Research Council, Inc. (CRC) invites you to submit a written proposal on "CRC Panel on Engine Component Deposits**,**" as described in the attached Statement of Work, Exhibit A. Additional background information are also incorporated as Attachment A (Airport Fuel Sampling) and Attachment B (Supporting Information).

Please indicate via letter, fax, or email by **July 27, 2017** 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 will 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 including the proposed schedule of tasks and deliverables 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, Suite 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 **August 18, 2017**.

Sincerely,

Jan Tucker
Committee Coordinator

EXHIBIT A

CRC Panel on Engine Component Deposits – AV-25-16

Relevant Strategic Objectives & Category: 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. The initial investigation focused heavily on aircraft hardware and aircraft fuel samples, as well as an 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: To understand the formation of the observed water soluble deposits and understand the provenance of the chemicals participating in the formation of these deposits, the CRC Panel on Engine Component Deposits (the Panel) wants to focus on fuel delivered at airport fuel farms. There is already an extensive amount of data of aircraft hardware/fuel samples, and the next step was to focus on fuel delivered at the airport. Polar water soluble compounds (ammonium, sulfate, and other ionic compounds) are believed to be coming in with the fuel loaded at the airport. It is also possible that some chemical compounds might come in through the aircraft tank breathing and react with chemicals present in the fuel to form the deposits. Even though the Panel is now focusing on analysis of water and fuel samples from Airport Fuel Farms, away from the airplane, the goal of this study is still to understand the provenance and the mechanism of formation of these water soluble deposits on aircraft structures.

To encourage full participation, the samples will be anonymized to keep some of the information confidential (i.e. location). We will start with a 3-month ruggedness trial at one selected airport to ensure that all protocols and processes in place work as planned, before expending to the full list of airports for the reminder of the effort (9 months).

A. Evaluate ingress and solubility of dust through wing tank venting

TASK	Description
Look for an opportunity for an airline to remove flame arrestors from several different aircrafts that fly the western USA and also get a control from an aircraft flying eastern routes	Wash flame arrestors sequentially with 1) jet fuel and 2) distilled water and analyze the washed fluid. See the test protocol section below for guidance on analysis to perform on the various water/solvent washes.

B. Characterize chemicals in the water and fuel phases of airport draws

TASK	Description
Test 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) and/or particles that can be analyzed independently and can provide additional valuable information. All phases should be collected. If no water phase is present, the lab should perform an aqueous extraction.*	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). We propose the following locations: 1. SeaTac 2. Phoenix 3. Los Angeles 4. Las Vegas 5. San Diego 6. Miami 7. Chicago 8. Houston 9. Atlanta 10. New York
Use the same specified sample containers at all airport locations and store samples in a cool dark place (store at about 4°C if possible) except where noted otherwise.	See EI 1530, page 38, §4.5.2. The Panel 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. Additionally, water could 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) and/or particles that can be analyzed independently and can provide additional valuable information. All phases should be collected.*	Samples should be collected at airport storage receiving tank (sumps with water and fuel phases). 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).
Airlines will provide three (3) aircraft sump samples per month. When collecting sump samples from aircraft tanks (mains and center), ensure that the sumping tool is clean (to clean - perform sumping on another airplane until only fuel fills the tool and discard sump collected).	Follow AMM recommendations for sumping and combine the sump samples from each tank in a 1-gallon container. The Panel will be supplying the same approved epoxy-lined sample containers to the participants.
The suggested analysis for water, fuel and interface samples should include testing for microbial contamination, inorganics and organics.	Due to the specifics of each type of sample, each analysis requires a different approach and testing protocol to be finalized by the testing facility selected; e.g. use EPA modified test methods for aqueous samples (e.g. acidify sample only as needed, modify volume as needed, clean up fuel as needed). In case of suspected microbial contamination, microbial analysis can be performed using culture based techniques as in ASTM D6974 and/or using next generation DNA sequencing methods.

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

Project Deliverables & Schedule: Within a 12-month period, the Panel will manage the collection and shipment of monthly airport and aircrafts samples to the selected laboratory. The lab is expected to perform, at a minimum, the tests listed below. It is encouraged that the selected lab provides feedback and suggestions regarding the proposed testing based on the lab experience and analytical capabilities. This study is intended to be a collaboration between the CRC Panel and the selected laboratory.

Fuel Phase:

- GCxGC-ESI-MS in both positive and negative modes; mass spectrometer with ability to perform MS/MS is preferred.
  Sample analysis should include: (a) neat jet fuel and (b) polar species after solid phase extraction (SPE). The lab can also perform acid/base aqueous extraction or extraction with different polarity solvents (e.g. methanol) for separating polar species from the fuel matrix with the subsequent analysis of the polars by mass spectrometry.
- GC-MS of the neat fuel samples and polars extracted using techniques suggested above can also be done.
- GC-SCD and GC-NCD for total sulfur and nitrogen content.
- Total Sulfur by ASTM D5453.
- ICP by ASTM D7111.
- Thermal stability per ASTM D3241.
- Analysis for presence of MDA (can the lab provide a proposal for detection method?).

Water phase:

- GCxGC-ESI-MS in both positive and negative modes; mass spectrometer with ability to perform MS/MS is preferred. Derivatization might be needed for certain classes of compounds.
- IC (ammonium, sodium, potassium, sulfate, etc…).
- ICP (Cu, Na, K, Mg, Ca, Fe, S, Si, P).
- pH.

Interface:

Use chemical separation/extraction techniques to characterize the interface.
The following methods are recommended for characterization: GCxGC-ESI-MS, GC-MS, FT-IR, ESEM/EDXRF (particulate).

Summary of Sampling:

Over a 12-month period there will be:

- First 3 months (1 airport) - Each month: one (1) x 5-gallon sample from airport tank sumps and three (3) x 1-gallon samples from Aircraft sumps. Total samples per month: 4.
- The following 9 months (10 airports) - Each month: ten (10) x 5-gallon samples from airport tank sumps and three (3) x 1-gallon samples from Aircraft sumps. Total samples per month: 13.
- Five (5) flame arrestors from different airplanes.

- At a few specific airports, water may be collected directly from filter/water separator sumps and sent for analysis. These samples may be substituted for water extractions from fuel (i.e. total number of samples to analyze would not be greatly impacted).

Other Information:

- The list of tests provided here is intended to generate a consistent screening of the various samples over time.
- Feedback from the lab is welcome.
- If an outlier sample is identified, please provide additional technique/analysis the lab can perform to better characterize the sample (e.g. microbial contamination, etc.)
- For any outlier sample, shipment of sub-samples to other labs may be requested by the Panel.
- The lab is expected to store all samples in a temperature controlled environment until all data are reviewed and accepted by the Panel.
- The lab is expected to deliver the data at regular intervals and to provide a final report. The raw data should be archived in a digital form and provided to CRC.

Utilization of Deliverables:

Information and data collected will increase understanding of variations in jet fuel composition by location (various airports across the US fed by different pipelines) and potentially identify the source of the chemicals making up the water soluble deposits. Other unwanted chemicals could also be identified.

EXHIBIT B

REPORTS

DRAFT AND FINAL REPORT

The contractor shall distribute for the CRC an electronic pdf-compatible copy of a draft final report after completion of the technical effort specified in the contract. 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 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.

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

Within thirty (30) days after receipt of the approved draft copy of the annual 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 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 (Part One).

2) Previous performance on related research studies (Part One).

3) Personnel available for proposed study – related experience (Part One).

4) Timeliness of study completion (Part One).

5) Cost (Part Two).