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November 8, 2011
In reply, refer to:
CRC Project No. AV-14-11

Subject: CRC Request for Proposal AV-14-11, "Low-Sulfur (< 100 ppm) Aviation Turbine Fuel Lubricant Functionality"

Dear Prospective Bidder:

The Coordinating Research Council, Inc. (CRC) invites you to submit a written proposal on "Low-Sulfur (< 100 ppm) Aviation Turbine Fuel Lubricant Functionality", as described in the attached Statement of Work, Exhibit A.

Please indicate via letter, fax, or email by **November 15, 2011** 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 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.
3650 Mansell Road, Suite 140
Alpharetta, GA 30022

Phone: 678-795-0506, Ext. 100
Fax: 678-795-0509
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The deadline for receipt of your proposal is **December 7, 2011**.

Sincerely,

Jan Tucker
Committee Coordinator

Exhibit A

Low-Sulfur (< 100 ppm) Aviation Turbine Fuel Lubricant Functionality
(CRC Project No. AV-14-11)

Background

Ultra-low sulfur (ULS) distillate fuels continue to penetrate the market place at higher percentages and are the future. Lubricity impacts from ULS fuels are known and have been dealt with for ground transportation. The world's conversion to ULS distillates seemingly has to impact future aviation turbine fuels by also lowering their sulfur content, since all these fuels often come out of the same processing facilities. It is proactively time to start addressing reduced aviation fuel lubricity, before it becomes an issue further impacting equipment performance in the field.

In the effort to continuously improve jet fuel quality, refiners can turn to the option of hydrotreating. This method of processing can significantly improve the consistency of jet fuel quality as defined in ASTM D1655 (for example: thermal stability, msep, acidity, and existent gum). Hydrotreating can also remove sulfur, nitrogen, and oxygen-bearing organics. In doing so, the lubricity property of the jet fuel will almost certainly be impacted to some degree. Lubricity is not a "Table 1" mandatory specification for D1655 aviation turbine fuels, not even as a "report". However, lubricity is discussed in the "non-mandatory information" appendix to D1655, in Section X1.10 and one can read that:

- "Aircraft/engine fuel system components and fuel control units rely on the fuel to lubricate their sliding parts." . . .
- "In-service problems experienced have ranged in severity from reductions in pump flow to unexpected mechanical failure leading to in-flight engine shutdown." . . .
- "Most modern aircraft fuel system components have been designed to operate on low lubricity fuel [Test Method D5001 (BOCLE) wear scar diameter up to 0.85 mm]. Other aircraft may have fuel system components that are more sensitive to fuel lubricity." . . .
- "Problems have occurred when severely hydroprocessed fuel from a single source was the primary supply for sensitive aircraft." . . .
- "Because the BOCLE may not accurately model all types of wear that cause in-service problems, other methods may be developed to better simulate the type of wear most commonly found in the field."

Because lubricity is a property that will change with handling, jet fuel lubricity is not a producer specification or requirement. Therefore it may not be tested or monitored at the time of fuel certification. But, diesel fuels must meet a lubricity specification, so producers regularly test diesel products for lubricity to ensure compliance with D975. However, this testing is by the D6079 HFRR method, which is thought to be a more common laboratory method. Aviation turbine fuel hydrocarbon composition is very similar to No. 1 diesel fuel, even in the "ULS" versions. Applicability of the HFRR test for providing some guidance for jet lubricity is not well known.

In summary:

- Processes for the improvement of D1655 jet fuel quality, or for the removal of sulfur in diesel fuels, can result in jet fuel with decreased lubricity characteristics.

- Such circumstances may become more common and occur regionally, where a "ULS-jet" producer happens to be the primary supplier for major US airports.

- The testing and reporting of jet fuel lubricity is presently not required [not a certificate of analysis (COA) property] in the US.

Project Objectives

The primary objective of this project is to collect data and assess the trends and magnitude of changes of jet fuel in commerce to answer the following questions:

1. Should "lubricity" be considered as a required property in Table 1 of ASTM D1655, even if only as a "report?" (Including considerations of how to handle such a requirement given potential changes in the property with handling.)

2. Jet fuels blended with synthetic hydrocarbons have to meet a lubricity specification in Table 1 of ASTM D7566. However, is this testing for naught if a final blended D1655 jet fuel that is shipped to the user goes untested for lubricity?

3. What alternatives are there both in options for lubricity test methods and in fuel production and handling to monitor and control jet fuel lubricity? There is some impetus for ASTM to develop an alternative lubricity test method for jet fuel (for example, a modification of the HFRR method that laboratories could take advantage of with existing equipment and resources). Also jet fuel consumers, who have historically bought "neat" fuel, may simply want to move to additized jet fuel to have more comfort that their fuel meets desired lubricity properties.

4. Where in the fuel system and engine are wear problems the worst and which test is more likely to resemble these critical areas and conditions considering existing test methods examine different lubricity regimes (HFRR and BOCLE)?

Project Approach

The investigator will develop an approach in their proposal for answering the objective questions of the project. Approaches to consider include the following. Other approaches may also be proposed.

OEMs will be consulted regarding their view of the fuel system lubricity design parameter of 0.85 mm BOCLE wear scar currently called out in D1655. OEM consultation will be used to request OEM determinations of the appropriateness of the 0.85 mm BOCLE design parameter and to seek recommendations on any adjustments needed including alternate metrics and test methods.

In addition the investigators should also approach the UK Ministry of Defence (MoD) for related information. Defence Standard 91-91 turbine fuel specifications include a BOCLE lubricity requirement if a large proportion of the fuel is severely hydro-processed. The background to this specification should be reviewed. Indications are that the MoD standard may have related to a New Zealand routing where a single source of supply was used. Documents may be available to assist with understanding the engine technology effected (for comparison with the current fleet) on fuel types, testing, and technical premise. It will be important to fully understand the experiences and requirements of the component manufacturers including fuel pump, fuel control unit, and any component using "fuel actuation of components" in its operation.

In addition to the above, the investigators should link with the ASTM D02J002 Jet-Diesel Task Force. This Task Force is currently examining worst-case fuel lubricity quality (HFRR and BOCLE) on a world-wide basis with relation to piston diesel engines for General Aviation. Useful information may be available from this group.

The CRC Aviation Committee currently has a project to update the Jet Fuel Sulfur Survey, and the Update or other database information may be used to make an assessment of current status of products in the field. The aviation community will also need data for turbine fuel "lubricity versus sulfur content" to understand the potential limiting lubricating functionality of the lower-sulfur turbine fuels going into the market place. These data along with associated test method information should also be collected from suppliers or other sources if available.

Along with OEM input and findings from the CRC Sulfur Survey Update there still may be some additional information available on lubricity impacts from fuel purchasers. Most customers expect operational issues to have been resolved by the OEM/fuel supplier/regulator group and simply wish to have fit-for-purpose materials for reliable operations. In addition to OEM consultation and CRC sulfur survey data, fuel purchasers may also be approached to determine their perception of lubricity on product performance, notably those using both ASTM D1655 and Defence Standard 91-91 products.

Project Deliverables & Schedule

Phase 1 of the study will attempt to reach consensus on answering the objective questions and develop a research approach for a Phase 2 effort by end of CY2012. A Phase 2 effort to fill in data gaps will be conducted separately if needed. To avoid a conflict-of-interest, the Phase 2 effort, if needed, will be conducted by a third party.

The final report will present an assessment of current aviation fuel lubricity standards to determine if any changes are indicated or appear to be required. As a minimum, the final report

shall include consulting information gathered from turbine engine, aircraft fuel pump, fuel control units and other OEM manufacturers where fuel is used to actuate hardware components.

The final report will also indicate if a new measurement technique is required to monitor and control fuel lubricity. If so, an evaluation will be made on whether the diesel HFRR or other method option is a viable replacement for the BOCLE (D5001). This evaluation will need to include impacts to design philosophies of the OEMs and how the different methods predict target behaviors differently. For example, experience has shown that that some components wear in a consistent manner with BOCLE predictions and some wear more like the HFRR may predict.

Also, the final report will include recommendations to CRC on testing requirements, test methods, and data gaps needing further research based on findings for the study.

Utilization of Deliverables:

If there is industry agreement that no changes to the current system are indicated or necessary, the project will end at Phase 1. Otherwise, a Phase 2 plan will be used to create additional laboratory data to attempt to achieve industry agreement on how lubricity is addressed within the D1655 Turbine Fuel Specification. Changes might be brought about through a new monitoring/control procedure or, if there is general industry agreement, through establishing a firm lubricity specification. A possible outcome might involve a requirement for additization of Turbine Fuels for lubricity improvement as a standard operating procedure, similar to current diesel fuel requirements.

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 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.

2) Previous performance on related research studies.

3) Personnel available for proposed study – related experience.

4) Timeliness of study completion.

5) Cost.