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September 12, 2017
In reply, refer to:
CRC Project No. AV-26-17

Subject: CRC Request for Proposal AV-26-17, "Development of Industry Reference Fluids for ASTM D3241 Testing"

Dear Prospective Bidder:

The Coordinating Research Council, Inc. (CRC) invites you to submit a written proposal on "Development of Industry Reference Fluids for ASTM D3241 Testing**,**" as described in the attached Statement of Work, Exhibit A.

Please indicate via letter, fax, or email by **September 29, 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
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E-mail: jantucker@crcao.org

The deadline for receipt of your proposal is **October 30, 2017**.

Sincerely,

Jan Tucker
Committee Coordinator

EXHIBIT A

Development of Industry Reference Fluids for ASTM D3241 Testing

Relevant Strategic Objectives: Develop accepted reference fluid for standardization of ASTM D3241 testing - Standard Test Method for Thermal Oxidation Stability of Aviation Turbine Fuels. Impact of project success would be immediate due to significant variations in ASTM D3241 testing experienced across labs using different equipment and test consumables currently available in the field. Benefits would extend to the long-term by improving D3241 calibration and provide future standardization of new D3241 testing equipment and consumables.

Background: The lack of appropriate D3241 reference standards is becoming a more acute problem as new equipment and processes for manufacturing consumables enter the market. Assuring consistency in test performance between different instruments and consumables, as well as consistency in production of consumables within a single manufacturer, is needed.

Over the past few years several batches of jet fuel in the US distribution system have failed to meet the D3241 requirement. Repeat testing of some of the fuels at different labs highlighted the poor precision of the test as results varied significantly lab-to-lab. The variability is believed to be related to the use of different equipment and test consumables. In addition, results from a recent ASTM Interlaboratory Crosscheck Program further highlighted the lack of consistency in D3241 testing from the same sample over many labs. Current equivalence testing for consumables requires a comparison of a new consumable to currently supplied approved consumable. Unfortunately there is no assurance that the approved consumables are not varying over time creating a moving target for any new manufactures of consumables which is highly undesirable.

Resolution of this issue requires appropriate reference fluids to be designed so that labs can verify if their testing equipment is providing the expected response today and into the future. In addition, it is good lab practice to verify at regular intervals if a test is properly operating and under control which can be achieved using reference fluids.

Project Objectives: This project requires a contractor that understands the nuances associated with developing reliable reference fluids that respond to trace level components. The contractor will initiate and develop 2 reference fluids for the D3241 test to enable standardized interpretation of D3241 results.

A first reference fluid will be designed to generate consistent D3241 tube deposit. This fluid shall undergo a known thermal oxidative chemistry pathway leading to consistent deposit thickness and profile on a D3241 heater tube at a test temperature falling within 250 to 300 °C (preferable 260 or 275 °C).

A second reference fluid designed to generate consistent D3241 differential pressure response. This reference fluid shall undergo a known thermal oxidative chemistry pathway leading to consistent particulates and a differential pressure of 100 mm Hg within a 60 to 90 minutes time frame in a similar test temperature range as the deposit reference fluid.

Alternatively, one fluid that can achieve both objectives would be highly desired but likely very challenging to develop.

Visual tube ratings and metrology (ellipsometry/interferometry) shall be used to evaluate the consistency of deposits produced by the fluids on a single JFTOT instrument (designated as the project standard instrument) using batch equivalent consumables (single production batch of tubes). The consistent performance of the fluid(s) over time on the project standard instrument is an important requirement that needs to be demonstrated.

Project Approach: Hire a qualified jet fuel thermal stability subject matter expert with the laboratory facilities to develop JFTOT reference fluids. Use stage gates to provide clear demonstrations of progress and to avoid committing funds to an approach that may not prove feasible.

Phase 1 – Scope out potential fluids/components and their supply

- Literature review of possible pathways to achieve the desired objective.
- Purchase chemicals and conduct scoping tests to demonstrate feasibility of different pathways. All testing should be conducted on the project standard equipment to allow for side-by-side comparison of the different approaches.
- Assemble feasibility data for review by industry experts and relevant CRC Groups to choose leading 2 pathways (2 types, 4 total) to pursue further. Data shall include a comparison of the complexity (blending requirements, purification steps, stability…), component supply reliability and deployability of each approach.

Phase 2 – Progress ruggedness testing around the leading industry agreed pathways (2 types, 4 total).

- Ruggedness and sensitivity testing of each approach in the contracted lab on the project standard instrument to evaluate material component supply variations, sample preparation variations and shipping/storage variation. This should resolve question such as; is component inerting required? does glassware cleaning need to be specified? is the purity chosen adequate? is an expiration date required? does the fluid need to be provided as a multicomponent rather than a single sample to assure stability? Chemical purity of each component needs to be defined to minimize reference fluid variation and insure consistency. This might come from requiring a certain ACS purity designation or limits the contractor demonstrates is necessary.
    - Reference fluid testing after accelerated aging (0, 6 and 12 weeks using 43 °C to simulate 0, 6 and 12 month storage).
    - Investigate consistency of the base fluids and deposit instigating components by purchasing ingredients from different suppliers.
- Connect with commercial suppliers to understand the reality of commercializing leading reference fluids.
- Assemble ruggedness data of the 2 approaches to review by industry experts and relevant CRC Groups to choose leading pathway by providing a comparison of each approach.

Phase 3 – Finalize commercial application of the leading approach and conduct a preliminary ILS using a variety of JFTOT instruments and consumables. Intent of ILS is to highlight the JFTOT precision and to instigate a full ILS if the data reveals an issue which will be pursued in a

volunteer forum such as EI or ASTM which is outside of the contractor's responsibility. This will help determine if there is a systematic issue that may have been overlooked in previous studies that need to be resolved.

- Finalize details with commercial supplier of components with desired quality, packaging and volumes if not currently available. Obtain pricing estimates, ideally from multiple potential suppliers if existing commercial option are not available.

- Organize an ILS with 5 volunteer labs that provide a breath of instrument types and consumables. Have participants follow any reference fluid preparation procedure.

If it becomes apparent as we progress through the initial stage that the goal is unachievable the request reverts to writing a research report on the efforts to familiarize the industry with the challenges and support any future effort along the same lines.

Considerations and constraints to designing fluids

- Reference or reference fluid component sets should be single use (minimum 600 ml total combined volume) to avoid autoxidation of the sample between use.

- Base fluids, deposit instigating components, formulations need to be commercially available and of high quality so that they provide the same result for years to come, regardless of when and where they are purchased. If a hydrocarbon is used as the base fluid without prior purification the deposit instigating component(s) needs to dominate over minor trace component impacts that might arise over time in the base fluid. If purification is required, the details need to be robust and explicitly outlined in the reference fluid preparation procedure.

- A multiple component approach that requires mixing prior to testing shall be taken if the components react with each other. The agitation during aeration provides sufficient mixing so blending directly in the D3241 beaker is possible. This procedure minimizes glassware use and potential cross contamination (if glassware is used the details of cleanliness need to be outlined).

- If blending is required the reference fluid preparation procedure should avoid meticulous dilutions and blending to ppm levels. Components should be easily mixed in a lab with limited glassware.

Some potential deposit instigating components include cetane improver (nitrate type), low MW PIPSI (See SEA 2013-01-2682), Zinc neodecanoate (see SAE 2016-01-2247), mixtures of nitrogen and sulfur containing materials at ppm levels in base fuels (See Steve Zabarnick CRC 2016 and 2017 thermal stability presentation), 2-Methylindole and/or Copper (Spence Taylor BP summary to be provided to contractor). For differential pressure there is evidence that aliphatic amines in reactive sulfur base fluids cause differential pressure failures. Copper additives are also a possibility.

Project Deliverables & Schedule: Within 24 months (8 months per stage), deliver data and information requested in this proposal.

Utilization of Deliverables: Update D3241 with reference fluid information and testing requirements. Reference fluids to be used for quality control of the D3241 test.

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).