



**COORDINATING RESEARCH COUNCIL, INC.**

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**April 7, 2020**

In reply, refer to:

CRC Project No. AVFL-37

Dear Prospective Bidder:

The Coordinating Research Council (CRC) invites you to submit a written proposal to provide services for “Thermal and Electrical Properties of Lubricants for HEV/EV Applications” (CRC Project No. AVFL-37). A description of the project is presented in Exhibit A, “Statement of Work.”

Please indicate by letter, fax, or email by **April 21, 2020** 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 at least one week before the proposal submission deadline. CRC will then return written answers to all of the bidders, along with a copy of the original questions. Questions submitted within a week of the deadline may not be answered before the proposal submission deadline.

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.

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  
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The deadline for receipt of your proposal is **May 7, 2020**.

Yours truly,

Dr. Christopher J. Tennant  
Executive Director

**EXHIBIT A: STATEMENT OF WORK**  
**CRC Project AVFL-37 Statement of Work**  
**Thermal and Electrical Properties of Lubricants for HEV/EV Applications**

**Background**

The sales volume of hybrid and pure electric vehicles is expected to increase significantly in the near future. According to one estimate, the growth of this segment of vehicles will increase from 4% in 2018 to 38% in 2025 in North America. Dedicated hybrid transmissions often known as PowerSplit transmissions are widely used in hybrid application where two electric motors (one as a starter generator and the other as a traction device to power the wheels) are inside the transmission housing. The electric motors are cooled by dripping transmission fluid on copper windings. All PowerSplit transmissions use automatic transmission fluid because the fluid has adequate electrical resistivity, although not optimized for this application. The next generation transmission fluid should perform as a lubricant as well as an effective motor coolant. Electric motors operate more efficiently at lower temperatures. Therefore, the fluid should have high thermal conductivity and specific heat, enabling faster heat removal from copper windings. The thermal properties of this fluid is controlled by base oil chemistry. The same requirement applies to other transmissions with torque converters, used for bigger hybrid electric vehicles (larger sport utility vehicles and light duty trucks) requiring higher torque capability. Also, the gear box in an electric vehicle has the same design concept where the electric motor resides inside the gear box and requires cooling. High thermal conductivity fluid will allow more torque generation and/or enable motor size reduction or both and will also enable high-end performance improvement of vehicles. All are very important attributes for future hybrid and electric vehicles, which would require fluids with vastly improved thermal properties than the current automatic transmission fluid. The electrical resistivity is another important fluid property to ensure non-conductance of electricity to prevent short circuiting. However, the thermal and electrical properties of lubricants are scarce in the literature.

**Objectives**

The objective of the project is to develop a database of thermal and electrical properties of base oils from Group I to Group V for selection of appropriate base oil chemistry to meet the performance requirements of next generation automatic transmission fluid for future hybrid and pure electric vehicles.

**Experimental Plan**

The plan is to select several different base oils from Group I to Group V. The base oils will be selected upon recommendation from oil/additives companies based on their knowledge and experience in formulation and availability. The contractor is requested to propose a draft list of base oils for testing, then collaborate with the CRC project panel to finalize the list. The project will emphasize Group V oils including monoesters, diesters, polyol esters, aromatic esters, phosphate esters, polyalkylene glycols, silicones, synthetics and variants thereof, etc. The project emphasizes Group V oils because there is a wide variety of chemical types comprising Group V oils, this variety produces greater differences in measured properties of interest, and they are not as well characterized as other Groups. Also, different slates of base oils like Motiva, Yubase,

Excel, GrIII+, Group III GTL can be included. For each base oil type, Include various viscosity cuts as appropriate. The properties to be measured are

- viscosity
- density
- thermal conductivity
- specific heat
- electrical resistivity

at temperatures at -25°C, 25°C, 40°C, 60°C, 80°C, 100°C, and if possible, extend to 120°C and 140°C. We want to measure sufficient temperature data points to enable interpolation to any temperature of interest within the range of measured temperatures. Therefore, the contractor is requested to make recommendations about temperatures at which each property is measured in order to accomplish this goal. For example:

- Is it necessary to measure additional temperatures beyond those listed in Table I below in order to capture changes in measured properties? This may include additional temperatures between those listed in Table I and/or temperatures hotter or colder than those listed.
- Feasibility of measuring at hot and cold temperatures using available standard test equipment.

The measurements will be conducted at an accredited test lab.

Table I. Oil Properties to be Measured

Property	Test Method	Measurement Temperature (°C)
Density	ASTM D4052	40, 60, 80, 95
Kinematic Viscosity	ASTM D445	40, 100
Thermal Conductivity	ASTM D7896	-25, 40, 70, 100, 130
Specific Heat	ASTM E1269	-25, 40, 70, 100, 130
Electrical Resistivity	ASTM D1169	25, 40, 70, 100, 130

In real-world practice, observed variability for several test methods (especially thermal conductivity, specific heat, and electrical resistivity) has been significantly higher than values listed in the ASTM test methods. The contractor is requested to explain the measures they plan to take to minimize variability of measured test results in this project.

### Oil samples

The proposed oil samples would include Group I, Group II, and Group III mineral oils, Group IV, and Group V oils. However, there could be different variants in each category and therefore, one needs to select formulations carefully not to make the list too long. I would propose including more samples from Group V oils as several different molecular structures are available. Limited data available in open literature shows that thermal conductivity and specific heat of Group I-IV oils are not vastly different. CRC members would be solicited for suggestion of the type of oils (25) to be included in this investigation and their supply.

### Project Duration

Expected to be 6-8 months

## **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 (Microsoft Word) 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).

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.

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 ten (10) hardcopies including a reproducible master copy of the final report. The final report shall also be submitted as electronic copies in a pdf and Microsoft Word 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.