



**COORDINATING RESEARCH COUNCIL, INC.**

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**December 5, 2023**

In reply, refer to:

CRC Project No. E-143

Dear Prospective Bidder:

The Coordinating Research Council (CRC) invites you to submit a written proposal to provide services for “Brake, Tire, and Road Wear– Literature Review” (CRC Project No. E-143). A description of the project is presented in Exhibit A, “Statement of Work.”

Please indicate your intention to bid at [this link](#) on or before **December 20, 2023** 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 here: [Q & A Link](#). 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:

Amber Leland  
Coordinating Research Council  
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The deadline for receipt of your proposal is **January 12, 2024**.

Yours truly,

Amber B. Leland  
Deputy Director

## **EXHIBIT A STATEMENT OF WORK**

### **CRC Project E-143 Brake, Tire and Road Wear – Literature Review**

#### **Background**

As tailpipe Particulate Matter (PM) emissions from Light Duty (LD) vehicles declined, other types of PM emissions became more important. LD vehicles emit at least five types of PM; tailpipe, brake wear, tire wear, road wear, and resuspended road dust. Although measurement methods are still in development, total combined PM emissions for brake, tire, and road wear are estimated at about 30 mg/mi (ref. 1, 2 and 5). This is an order of magnitude greater than the tailpipe PM regulatory limit of 3 mg/mi. Battery Electric Vehicles (BEV) emit four of the five types of PM, all except tailpipe PM. Government regulatory agencies including EPA and California Dept. of Transportation have studied certain types of non-tailpipe PM including PM from brake and tire wear (ref. 3 and 4). Although it is unclear when or if U.S. regulatory limits may be proposed for vehicle non-tailpipe PM emissions, this is a topic we want to better understand (ref. 6, 7, 8 and 9).

#### **Objective**

Perform a literature review of vehicle emissions of non-tailpipe PM. Topics of interest include:

- Magnitude of non-tailpipe PM emissions, preferably expressed in units like mg/mi to allow comparison with tailpipe PM emissions levels and regulatory standards.
- Source apportionment of non-tailpipe PM emissions including brake wear, tire wear, road wear, resuspended road dust, etc.
- Test methods to generate non-tailpipe PM. Compare and contrast test methods (if possible) to identify possible influence of method on measurement results.
- Test methods to measure non-tailpipe PM emissions, including methods to discriminate PM from various sources. Test methods would include, but not limited to, component bench tests, full vehicle laboratory tests, and on-road tests.
- Characterization of non-tailpipe PM, including chemical composition, morphology, particle density, and particle size distribution.
- Test methods to characterize non-tailpipe PM emissions.
- Strengths or weaknesses of particular test or measurement methods, especially affecting their ability to accurately estimate emissions from real-world on-road vehicles.
- Information about distribution of non-tailpipe PM from the point source. For example, residence time, half-life, dispersion distance or other metrics characterizing how long non-tailpipe PM stays suspended in the atmosphere and dispersion characteristics from the source of origin. Mine safety and health agencies worked on this topic in the 1990s.
- Although the focus of this review is LD vehicles, information on Heavy Duty on-road or off-road vehicle non-tailpipe PM emissions is also welcome, especially if it fills an information gap unavailable for LD vehicles.

- Factors known to control or affect magnitude or type of non-tailpipe PM emissions. For example, vehicle weight may affect tire wear magnitude, and brake pad material may affect brake wear magnitude and chemical composition. Electric vehicles have been reported to produce faster tire wear than comparable conventional ICE vehicles, possibly caused by a combination of higher vehicle weight and higher launch torque.
- Methods proposed to control or reduce LD vehicle non-tailpipe PM emissions.
- Scope should be focused on literature published within the last 15 years (since 2008). But include seminal literature or literature addressing knowledge gaps from references published before 2008.
- Analysis of xEV and BEV vehicles should be considered which use regenerative braking when available and capable to minimize use of friction brake however for tire wear xEV and BEV vehicles add significantly more vehicle mass which may increase PM for tire wear.
- Literature used to justify/support the new Euro 7 brake particulate emissions standard and the downselection of the chosen test method. Also, assessment of potential impacts on overall air quality will be of interest.
- List researchers (individuals and organizations) known to be working in this topical area of testing, measuring, or estimating vehicle non-tailpipe PM emissions, regardless of whether they have published results publicly. Include the researcher's known capabilities and topical focus (for example, they have a brake test bench rig and focus on effect of LD brake pad materials composition on brake wear PM)
- Data gaps not adequately addressed in literature.
- Recommendations for non-tailpipe PM emissions topics for future study by CRC. Studies to fill data gaps listed above may be included in these recommendations.

## **Work Plan**

Perform a review of publicly available literature based on the topics outlined above. Hold interactive monthly project review calls with the CRC project panel. The purpose of the calls is to update CRC panel members on project status and allow feedback on what topics are of greatest interest to better focus the results. Document results of the literature review in a written final report consistent with CRC guidelines. The final report should include a list of literature references responsive to each topic of interest listed above, as well as a summary of findings related to each topic.

Also included in the final report will be an analysis of the literature. The analysis will culminate in figures or tables with a breakdown summary of PM sources (tailpipe and all non-tailpipe types) from ICE, BEV, HEV platforms for LD and HD (on road and off road). Further, if the literature has gaps, they are to be indicated.

The CRC reporting process includes submitting a draft final report, review period for CRC panel members to review and comment on the draft, resolution of comments, and submission of the final report to CRC for publication on the CRC website.

## Deliverables

Project kickoff call with the contractor and CRC project panel. Monthly project review calls with the contractor and CRC project panel. Other project calls as needed by the contractor or CRC panel leadership. Written final report consistent with CRC guidelines.

## References

- 1) M. Maricq, Engine, Aftertreatment, and Fuel Quality Achievements to Lower Gasoline Vehicle PM Emissions: Literature Review and Future Prospects, Coordinating Research Council (CRC) Project E-136, Sep. 2022, draft executive summary and draft journal article. (types of non-tailpipe PM emissions from LD vehicles and estimated magnitude compared to tailpipe PM emissions)
- 2) Y. Zheng, Xiaoyi He, H. Wang, M. Wang, S. Zhang, D. Ma, B. Wang, Y. Wu, Well-To-Wheels Greenhouse Gas and Air Pollutant Emissions from Battery Electric Vehicles in China, *Mitigation and Adaptation Strategies for Global Change (Springer)*, 25, 355-370 (2020). (magnitude of PM 2.5 emissions of BEV vs. gasoline cars)
- 3) EPA 2014. Brake and Tire Wear Emissions from On-Road Vehicles in MOVES 2014, EPA Report EPA-420-R-14-013, Dec. 2014
- 4) J. Koupal, A. DenBleyker, Y. Zhao, A. Stanard, S. Kishan, R. Vedula, C. Agudelo, Brake Wear in Particulate Matter Emission Modeling, report by Eastern Research Group, Inc. and LINK Engineering Co. for California Dept. of Transportation, report # CA21-3232, May 18, 2021
- 5) The Light-Duty Vehicle to Nowhere, When Will the Battery Electric Vehicle Consensus Break?, *Emissions Analytics Newsletter*, Sep. 13, 2022 (estimated PM emissions from tire wear)
- 6) The Septillion Particle Problem, *Emissions Analytics Newsletter*, Mar. 31, 2022. (vehicle PM sources and comparison of regulatory schemes in US and Europe)
- 7) The Even More Hidden Life of Tyres, *Emissions Analytics Newsletter*, Dec. 2, 2021. (methods for source apportionment of tire wear PM based on chemical composition)
- 8) B. Bienkowski, Soot Success: Clean Air Within Reach Nationwide - But Not for Long, *Environmental Health News*, Mar. 6, 2014. (Los Angeles is considering regulation of brake and tire wear and home fireplaces)
- 9) Bill Visnic, Europe's Dust Buster (Pending Euro 7 brake particulate emissions), *SAE News*, May 19, 2023, [SAE article on Euro 7 Brake PM Regulations](#)

## **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.