COORDINATING RESEARCH COUNCIL, INC.
5755 NORTH POINT PARKWAY, SUITE 265
ALPHARETTA, GA 30022
TEL: 678/795-0506 FAX: 678/795-0509
WWW.CRCAO.ORG

January 2, 2019
In reply, refer to:
CRC Project No. RW-108

Dear Prospective Bidder:

The Coordinating Research Council (CRC) invites you to submit a written proposal to provide services for "Effect of Lead in Gasoline on Tier3 / LEVIII Catalyst Technology" (CRC Project No. RW-18). A description of the project is presented in Exhibit A, "Statement of Work."

Please indicate by letter, fax, or email by **January 16, 2019** 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 confirmed 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 B. Leland
Coordinating Research Council
5755 North Point Parkway, Suite 265
Alpharetta, GA 30022

Phone: 678-795-0506
Fax: 678-795-0509
E-mail: aleland@crcao.org

The deadline for receipt of your proposal is **January 31, 2019.**

Yours truly,

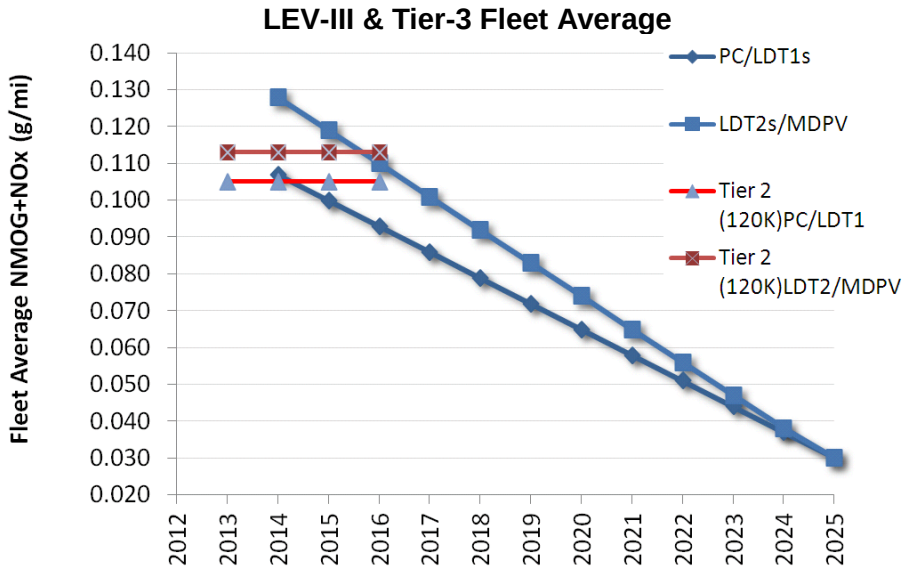
Amber B. Leland
Deputy Director

EXHIBIT A: STATEMENT OF WORK

CRC Real World Group Project RW-108
Effect of Pb in Gasoline on Tier3 / LEVIII Catalyst Technology

Background

Vehicle emission standards in the U.S. market continue to increase in severity. By 2025, EPA Tier-3 and CARB LEV-III regulations will require passenger vehicles and light trucks to meet emission standards less than one-third of the 2015 levels. These "SULEV30" levels will need to be maintained throughout the vehicle's useful life, defined as 15 years or 150,000 miles. Therefore, the vehicle's aftertreatment system must operate at peak efficiency throughout this period.



It has been known since the early days of catalytic converter development that lead (Pb) in gasoline adversely affects automotive catalyst efficiency.[1] Leaded gasoline has generally been phased out worldwide, and is currently allowed in only three countries. In the U.S. market, the lead limit for unleaded gasoline stands at 13 mg/L; intentional addition is not permitted. The lead limit in many other countries is at 5 mg/L, and some fuel grades in the EU are already at 2 mg/L. However, the effects of lead in gasoline at levels of 13 mg/L and below upon automotive catalysts have not been studied or reported in recent literature; the effect on catalysts designed to meet SULEV30 standards is unknown.

Objectives

The goal of this project is to determine an appropriate limit for Pb in gasoline that would ensure that vehicles and light trucks can meet 2025 Tier-3/LEV-III emission standards throughout their useful life.

Scope of Work

Overview

The project will consist of two phases: (1) Engine-bench aging of full-sized catalysts and oxygen sensors using gasoline blends containing various concentrations of Pb, and (2) performance assessment of the devices.
Although this project will focus on Pb, the methods developed above should have sufficient flexibility such that other metals can be investigated in the future.
Note that this phase of the project will focus on engine-bench aging and assessment of aftertreatment devices. A potential subsequent phase could confirm the Phase 1 findings at a full-vehicle scale, using on-road mileage accumulation followed by assessment on a chassis dynamometer.

Phase 1: Catalyst Aging

Catalysts designed to achieve SULEV30 emission levels should be used for this project. The preferred aging device will consist of a dynamometer-mounted engine fitted with the catalyst and oxygen sensor. The engine should be representative of the modern "down-sized," turbocharged, direct-injected variety. It should be operated over an appropriate rapid aging cycle over a period simulating 150,000 miles of real-world mileage accumulation. The cycle must be pre-approved by the CRC. Examples of such cycles: SBC, RAT-A, RAT-T, or an OEM-developed cycle.[2,3,4,5,6] Four sets of catalyst/sensors are to be aged in this manner, each using a specific Pb-doped test fuel. A fifth set should be set aside as a control, and not aged.

Test fuel: The base fuel should be an E10 gasoline meeting the specifications for CARB Phase-3 or EPA Tier-3 certification fuel. The fuel should be doped with tetraethyl lead (or similar) to produce four test fuels with Pb concentrations representing exposure to 0, 2, 5, and 13 mg/L Pb over 150,000 miles of real-world driving. The resulting elevated Pb concentrations, however, should affect neither engine operation nor the poisoning mechanism. The proposal should clearly state how this will be accomplished.

Phase 2: Catalyst and Oxygen Sensor Performance Assessment

The performance of the catalyst and oxygen sensor can be assessed using the same engine as that used for aging, or a separate but similar engine can be used. The performance should be assessed both before and after the aging, with the control catalyst/sensor set also evaluated in both instances. Test gasoline in all cases will be the base E10 fuel.
Suggested evaluations are listed below. The CRC is open to suggestions for additional tests.

- Time to catalyst light-off; the temperature needed to achieve 50% conversion of NO_X, CO, and THC.

- Oxygen storage capacity; the ability to store and release oxygen. Note that it may be possible to evaluate oxygen sensor performance concurrently, by monitoring the output voltage during the OSC testing.

- Efficiency. This should be assessed at various steady-state engine load points. Test points should include exhaust gas temperature extremes – high and low – that can be expected from the latest high-efficiency engines.[7] Efficiency should also be measured using a range of air/fuel ratios around the stoichiometric ratio.

- Emission performance over traditional test cycles. Ideally, cycles such as the FTP and US06 should be simulated on the engine bench also. However, it is recognized that emulating a chassis dynamometer test on an engine bench is challenging.

Option: Catalyst Postmortem

After completion of all testing listed above, the catalyst can be sectioned axially to investigate chemical effects at various depths. Examples of potential analytical procedures would include XRD (for crystalline phases) and EDXRF or EPMA (for spatial elemental analysis).[8]
The CRC will also accept proposals for additional postmortem procedures, such as flow-reactor testing of catalyst sections.
Cost proposals for optional tasks should be submitted separately from the main proposal, and should be listed on a per catalyst basis.

Project Deliverables

- Monthly status reports, including project timeline.
- Final report.

References

1. Yarrington, R., Bambrick, W., "Deactivation of Automobile Exhaust Control Catalyst," Journal of the Air Pollution Control Association, 20:6, 398-401, 1970.
2. Ball, D. et al., "Application of Accelerated Rapid Aging test (RAT) Schedules with Poisons: The Effects of Oil Derived Poisons, Thermal Degradation and Catalyst Volume on FTP Emissions," SAE Technical Paper 972846, 1997.
3. Ball, D. et al., "A Survey of Automotive Catalyst Technologies Using Rapid Aging Test Schedules Which Incorporate Engine Oil Derived Poisons," SAE Technical Paper 973050, 1997.
4. California Air Resources Board, "California Evaluation Procedures for New Aftermarket Catalytic Converters," adopted October 25, 2007.
5. Ramanathan, K., Oh, S., "Modeling and Analysis of Rapid Catalyst Aging Cycles," Chemical Engineering Research and Design 92, 350-361, 2014.

6. Wallin, F. et al., “Thermal and Chemical Deactivation of Three-Way Catalysts: Comparison of Road-, Fuel-Cut and SAI- Aged Catalysts,” SAE Technical Paper 2015-01-1000, 2015.
7. Pischinger, S., “Current and Future Challenges for Automotive Catalysis: Engine Technology Trends and Their Impact,” Topics in Catalysis 59, 834-844, 2016
8. Williams, A. et al., “Impact of Fuel Metal Impurities on the Durability of a Light-Duty Diesel Aftertreatment System,” SAE Technical Paper No. 2013-01-0513, 2013.

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.