

CONTRACT REQUEST FORM (CRF)

CEC-94 (Revised 10/2015)

CALIFORNIA ENERGY COMMISSION

A) New Agreement 500-16-002 (To be completed by CGL Office)

| B) Division | Agreement Manager: | MS- | Phone |
|-------------|--------------------|-----|--------------|
| ERDD | Pilar Magana | 43 | 916-327-2216 |

| C) Contractor's Legal Name | Federal ID Number |
|---|-------------------|
| South Coast Air Quality Management District | 95-3099419 |

| D) Title of Project |
|---|
| Low NOx 12-Liter Natural Gas Engine Development |

| E) Term and Amount | Start Date | End Date | Amount |
|--------------------|------------|-----------|--------------|
| | 10/3/2016 | 10/5/2018 | \$ 1,000,000 |

| F) Business Meeting Information | | | |
|---|--------------|----------------------------------|--|
| <input type="checkbox"/> Operational agreement (see CAM Manual for list) to be approved by Executive Director | | | |
| <input type="checkbox"/> ARFVTP agreements under \$75K delegated to Executive Director. | | | |
| Proposed Business Meeting Date | 9/14/2016 | <input type="checkbox"/> Consent | <input checked="" type="checkbox"/> Discussion |
| Business Meeting Presenter | Pilar Magana | Time Needed: | 5 minutes |
| Please select one list serve. NaturalGas (NG Research Program) | | | |

| Agenda Item Subject and Description |
|---|
| Proposed resolution approving Agreement 500-16-002 with the South Coast Air Quality Management District, for a \$1,000,000 contract to develop commercially viable advanced 12-Liter natural gas engine with near zero NOx tailpipe emissions, and suitable for use in heavy-duty vehicles. |

| G) California Environmental Quality Act (CEQA) Compliance |
|--|
| 1. Is Agreement considered a "Project" under CEQA? <input checked="" type="checkbox"/> Yes (skip to question 2) <input type="checkbox"/> No (complete the following (PRC 21065 and 14 CCR 15378)): Explain why Agreement is not considered a "Project": Agreement will not cause direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment because |
| 2. If Agreement is considered a "Project" under CEQA: <input checked="" type="checkbox"/> a) Agreement IS exempt. (Attach draft NOE) <input type="checkbox"/> Statutory Exemption. List PRC and/or CCR section number: _____ <input checked="" type="checkbox"/> Categorical Exemption. List CCR section number: <u>14 CCR 15306 "Information Collection"</u> <input checked="" type="checkbox"/> Common Sense Exemption. 14 CCR 15061 (b) (3) Explain reason why Agreement is exempt under the above section: This work will primarily be completed in existing research facilities and consists of engine development work, dynamometer testing, and vehicle integration at local distributors. While some on-road demonstration will occur, the demonstration will not have a significant impact on the environment because the contractor will be utilizing existing fleets to conduct the demonstration and displacing traditional diesel based engines with natural gas near-zero NOx emission engines. No additional roadways will be built and the fleet will consist of the same number of trucks that are already in use. The activity is covered by the general rule that CEQA applies only to projects which have the potential for causing a significant effect on the environment. Where it can be seen with certainty that there is no possibility that the activity in question may have a significant effect on the environment, the activity is not subject to CEQA. <input type="checkbox"/> b) Agreement IS NOT exempt. (Consult with the legal office to determine next steps.) Check all that apply <input type="checkbox"/> Initial Study <input type="checkbox"/> Environmental Impact Report <input type="checkbox"/> Negative Declaration <input type="checkbox"/> Statement of Overriding Considerations <input type="checkbox"/> Mitigated Negative Declaration |

| H) List all subcontractors (major and minor) and equipment vendors: (attach additional sheets as necessary) | | | | |
|---|--------------|--------------------------|--------------------------|--------------------------|
| Legal Company Name: | Budget | SB | MB | DVBE |
| Cummins Westport, Inc. | \$ 1,000,000 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

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CALIFORNIA ENERGY COMMISSION



| |
|--|
| I) List all key partners: (attach additional sheets as necessary) |
| Legal Company Name: |
| Southern California Gas Company |
| Clean Energy |
| |
| |

| J) Budget Information | | | |
|-----------------------------------|-------------------------------|----------------------|-------------|
| Funding Source | Funding Year of Appropriation | Budget List No. | Amount |
| NG Subaccount, PIERDD | 15-16 | 501.001J | \$1,000,000 |
| | | | \$ |
| | | | \$ |
| | | | \$ |
| | | | \$ |
| | | | \$ |
| R&D Program Area: | EGRO: Transportation | TOTAL: | \$1,000,000 |
| Explanation for "Other" selection | | | |
| Reimbursement Contract #: | | Federal Agreement #: | |

| | | | | | | | |
|---|----------------------------|------|--------------|-------------------------------------|----------------------------|------|--------------|
| K) Contractor's Administrator/ Officer | | | | Contractor's Project Manager | | | |
| Name: | Richard Carlson | | | Name: | Richard Carlson | | |
| Address: | 21865 Copley Dr | | | Address: | 21865 Copley Dr | | |
| City, State, Zip: | Diamond Bar, CA 91765-4178 | | | City, State, Zip: | Diamond Bar, CA 91765-4178 | | |
| Phone: | 909-396-3996 | Fax: | 909-396-3324 | Phone: | 909-396-3996 | Fax: | 909-396-3324 |
| E-Mail: | rcarlson@aqmd.gov | | | E-Mail: | rcarlson@aqmd.gov | | |

| | | | |
|--|---------------------|-------------------------------------|--|
| L) Selection Process Used (For amendments, address amendment exemption or NCB, do not identify solicitation type of original agreement.) | | | |
| <input type="checkbox"/> | Solicitation | Select Type | Solicitation #: _____ # of Bids: _____ Low Bid? <input type="checkbox"/> No <input type="checkbox"/> Yes |
| <input checked="" type="checkbox"/> | Non Competitive Bid | (Attach CEC 96) | |
| <input type="checkbox"/> | Exempt | Select Exemption (see instructions) | |

| | |
|-------------------------------------|--|
| M) Contractor Entity Type | |
| <input type="checkbox"/> | Private Company (including non-profits) |
| <input type="checkbox"/> | CA State Agency (including UC and CSU) |
| <input checked="" type="checkbox"/> | Government Entity (i.e. city, county, federal government, air/water/school district, joint power authorities, university from another state) |

| | | |
|---|--|---|
| N) Is Contractor a certified Small Business (SB), Micro Business (MB) or DVBE? | <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes |
| If yes, check appropriate box: | <input type="checkbox"/> SB | <input type="checkbox"/> MB <input type="checkbox"/> DVBE |

| |
|--|
| O) Civil Service Considerations |
| <input type="checkbox"/> Not Applicable (Agreement is with a CA State Entity or a membership/co-sponsorship) |
| <input checked="" type="checkbox"/> Public Resources Code 25620, et seq., authorizes the Commission to contract for the subject work. (PIER) |
| <input checked="" type="checkbox"/> The Services Contracted: |
| <input type="checkbox"/> are not available within civil service |
| <input type="checkbox"/> cannot be performed satisfactorily by civil service employees |
| <input checked="" type="checkbox"/> are of such a highly specialized or technical nature that the expert knowledge, expertise, and ability are not available through the civil service system. |
| <input type="checkbox"/> The Services are of such an: |
| <input type="checkbox"/> urgent |
| <input type="checkbox"/> temporary, or |
| <input type="checkbox"/> occasional nature |
| that the delay to implement under civil service would frustrate their very purpose. |
| Justification: |
| Services performed under this agreement are highly specialized, and include Cummins Westport , Inc. as a subcontractor who is the only engine OEM with proven and commercialized natural gas engine technology certified to near-zero NOx level using a diesel based engine. |



P) Payment Method

A. Reimbursement in arrears based on:
 Itemized Monthly Itemized Quarterly Flat Rate One-time
 B. Advanced Payment
 C. Other, explain:

Q) Retention

1. Is Agreement subject to retention? No Yes
 If Yes, Will retention be released prior to Agreement termination? No Yes

R) Justification of Rates

The rates for this agreement is considered fair and reasonable because the total project cost is consistent with previously funded advanced natural gas engine development projects with this contractor. All previous engine development projects with Cummins Westport have been competitively bid and scoring criteria evaluates the cost effectiveness and reasonableness of the project with respect to the budget (i.e. Labor rate, overhead, etc.). The evaluation team in these competitively bid awards has included other funding partners such as U.S. Department of Energy, Air Resources Board, and South Coast Air Quality Management District. Labor rates for this agreement, including overhead rates are competitive and consistent with other engine development organizations.

S) Disabled Veteran Business Enterprise Program (DVBE)

1. Exempt (Interagency/Other Government Entity)
 2. Meets DVBE Requirements DVBE Amount:\$ _____ DVBE %: _____
 Contractor is Certified DVBE
 Contractor is Subcontracting with a DVBE: _____
 3. Contractor selected through CMAS or MSA with no DVBE participation.
 4. Requesting DVBE Exemption (attach CEC 95)

T) Miscellaneous Contract Information

1. Will there be Work Authorizations? No Yes
 2. Is the Contractor providing confidential information? No Yes
 3. Is the Contractor going to purchase equipment? No Yes
 4. Check frequency of progress reports
 Monthly Quarterly _____
 5. Will a final report be required? No Yes
 6. Is the agreement, with amendments, longer than a year? If yes, why? No Yes

The Department of General Services has agreed to give the Commission blanket authority to execute multi-year contracts to support the Commission's RD&D Programs. This stems from the fact that RD&D projects do not neatly fit in a short timeframe and allowing longer timeframes supports projects (1) of greater complexity and (2) moving from testing to commercialization, both of which provide greater benefits to Californians.

U) The following items should be attached to this CRF (as applicable)

| | | |
|---|---|--|
| 1. Exhibit A, Scope of Work | <input type="checkbox"/> N/A | <input checked="" type="checkbox"/> Attached |
| 2. Exhibit B, Budget Detail | <input type="checkbox"/> N/A | <input checked="" type="checkbox"/> Attached |
| 3. CEC 96, NCB Request | <input type="checkbox"/> N/A | <input checked="" type="checkbox"/> Attached |
| 4. CEC 30, Survey of Prior Work | <input checked="" type="checkbox"/> N/A | <input type="checkbox"/> Attached |
| 5. CEC 95, DVBE Exemption Request | <input type="checkbox"/> N/A | <input checked="" type="checkbox"/> Attached |
| 6. CEQA Documentation | <input type="checkbox"/> N/A | <input checked="" type="checkbox"/> Attached |
| 7. Resumes | <input type="checkbox"/> N/A | <input checked="" type="checkbox"/> Attached |
| 8. CEC 105, Questionnaire for Identifying Conflicts | | <input checked="" type="checkbox"/> Attached |

 Agreement Manager Date Office Manager Date Deputy Director Date

To: Contracts Office, MS-18Date: 8/1/2016**REQUESTING STAFF INFORMATION**From Contract Manager: Pilar MaganaMS: 43Division: Energy Research and DevelopmentPhone Number: 916-327-2216**CONTRACT INFORMATION**Contractor Name: South Coast Air Quality Management DistrictContract Number: 500-16-002Amount: \$1,000,000.00Term: 10/3/2016 to 10/5/2018**PURPOSE OF CONTRACT**

The California Air Resources Board (CARB) 2010 emission standards for heavy-duty engines establish a limit for Nitrogen Oxides (NOx) emissions of 0.2 grams per brake horsepower hour (g/bhp-hr), and constitute a 90% reduction of emissions compared to the previous standard (CARB 2007) of 2.0 g/bhp-hr. Nevertheless, it is projected that even with the entire on-road fleet of heavy-duty vehicles compliant with the 2010 standards, upcoming National Ambient Air Quality Standards requirements for ozone attainment cannot be achieved in California's worst air basins without further significant reductions in NOx emissions from heavy-duty fleets.

Analysis of natural gas vehicle technology shows a high potential for greenhouse gas reductions on a well-to-wheels basis in heavy-duty vehicles (11-23%) using conventional natural gas, as well as an opportunity to substantially offset petroleum consumption. Original equipment manufacturers indicate that the near-zero emission target of 0.05 g/bhp-hr could be met or exceeded through research and development efforts. Even higher potential may exist, depending in large part on the removal of current obstacles through Research Development and Demonstration and deployment. Collaborative research efforts between federal, state, and local funding agencies and private technology developers are expected to produce key strategic breakthroughs in a broad range of natural gas vehicle technologies.

The purpose of this Agreement is to fund the integration and demonstration of an advanced 12-liter natural gas engine capable of achieving a 90% reduction in NOx emissions from California Air Resources Board 2010 emission standards, and with performance standards comparable to its diesel counterparts.

JUSTIFICATION FOR EXEMPTION

The South Coast Air Quality Management district is an other governmental agency that will be contracting 100 percent of the work to a subcontractor already identified as Cummins Westport, Inc. The work being completed under this agreement is of such a specialized nature, that to date, CWI is the only company able to achieve the technical requirements sought through this agreement.

APPROVED



 Sandra Raymos
 Contract Officer

Date



 Robert P. Oglesby
 Executive Director

Date

To: Contracts Office, MS-18Date: 8/18/2016**REQUESTING STAFF INFORMATION**From: Pilar MaganaMS: 43Division: Energy Research and DevelopmentPhone Number: 916-327-2216**CONTRACTOR INFORMATION**Contractor Name: South Coast Air QualityStreet Address: 21865 Copley DrTelephone: 909-396-3996Diamond Bar, CA 91765-4178Fax: (909) 396-3324Mailing Address: 21865 Copley DrE-mail: rcarlson@aqmd.govDiamond Bar, CA 91765-4178**Term:** 10/3/2016 to 10/5/2018**Amount:** \$1,000,000.00**A. THE GOOD/SERVICE REQUESTED IS RESTRICTED TO ONE SUPPLIER FOR THE REASONS STATED BELOW:****1. Why is the acquisition restricted to this good/service/supplier?**

(Explain why the acquisition cannot be competitively bid, or why the supplier is the only source.)

Services performed under this agreement are highly specialized, and include Cummins Westport, Inc. as a subcontractor who is the only engine OEM with proven and commercialized natural gas engine technology certified to near-zero NOx level using a diesel based engine.

2. Provide the background of events leading to this acquisition.

The SCAQMD has considerable experience working with entities to develop, demonstrate, and test engines and vehicles with emphasis on alternative fuels and emissions reduction technologies. Cummins Westport, Inc. has established a market consisting of three natural gas engines: the 6.7-liter, 8.9-liter and 11.9-liter engines. These engines can be integrated into vehicles from parcel delivery trucks and school buses, to transit buses and heavy-duty truck applications. In a previous competitively bid agreement, SCAQMD managed a engine development project that resulted in the certification and eventual commercialization of the CWI 8.9 Liter ISXNZ - the first production heavy-duty Low NOx engine to enter the market.

While the 8.9-liter engine is sufficient for bus and refuse truck applications, it does not meet the performance needs of larger vehicles such as port drayage and regional haul trucks. These larger vehicles carry heavier loads, consume greater volumes of fuel, and represent the largest leading source of emissions in California's worst air basins. Although other engine manufacturers are capable of developing a heavy-duty, on-road, near-zero natural gas engine, the Cummins Westport, Inc. 11.9-liter engine is the only heavy-duty natural gas engine in production that is currently certified by the U.S. Environmental Protection Agency and the California Air Resources Board (CARB).

3. Describe the uniqueness of the acquisition (why was the good/service/supplier chosen?)

SCAQMD is currently contracted with Cummins Westport, Inc. to develop and demonstrate a heavy-duty, near-zero natural gas engines. Cummins Westport, Inc. is a private company that designs and manufactures natural gas engines for heavy-duty vehicles. Cummins Westport, Inc. is the only engine manufacturer that has successfully developed a heavy-duty natural gas engine certified at near-zero NOx emissions. SCAQMD's ongoing collaboration with Cummins Westport, Inc. will enable the development of an advanced near-zero 11.9-liter engine with near term commercialization potential.



4. What are the consequences of not purchasing the good/service or contracting with the proposed supplier?

The development and deployment of low NOx, advanced, and efficient natural gas engine for heavy-duty vehicles will lower greenhouse gas emissions and benefit natural gas ratepayers by improving air quality and reducing health and environmental risks associated with emissions from heavy-duty vehicles. By not contracting with the proposed supplier, the deployment of an advanced near-zero NOx heavy-duty engine will be significantly delayed. The couple year delay in making this product commercial available will result in the loss of an opportunity to reduce emissions by as much as 2 tons per day in critical non-attainment regions such as the South Coast and the San Joaquin Valley Air Basins.

5. What market research was conducted to substantiate no competition, including evaluation of other items considered?

(Provide a narrative of your efforts to identify other similar or appropriate goods/services, including a summary of how the Division concluded that such alternatives are either inappropriate or unavailable. The names and addresses of suppliers contacted and the reasons for not considering them must be included OR an explanation of why the survey or effort to identify other goods/services was not performed.)

Staff compiled a list of natural gas engines that are suitable for heavy-duty vehicles that range between Class 3 and Class 8, and that achieves the California Air Resources Board's optional low NOx standard. There are several natural gas engines available, however only one other engine, the Cummins Westport, Inc's. 8.9-liter ISX-G NZ is certified at the CARB optional low NOx standard and capable of meeting the performance needs of some heavy-duty vehicles. However, while this engine is suitable for smaller applications such as transit buses and refuse trucks, it does not meet the performance needs of larger engine applications such as drayage and cement trucks. Developing a 12-liter near-zero natural gas engine option for heavier vehicle applications serves as a critical step in achieving California's emission reduction goals, particularly in the South Coast Air Basin where many of these vehicles operate.

B. PRICE CONSIDERATION

1. How was the price offered determined to be fair and reasonable?

(Explain what the basis was for comparison and include cost analyses as applicable.)

The price for this agreement is considered fair and reasonable because the total project cost is consistent with previously funded advanced natural gas engine development projects with this contractor. All previous engine development projects with Cummins Westport have been competitively bid and scoring criteria evaluates the cost effectiveness and reasonableness of the project with respect to the budget (i.e. Labor rate, overhead, etc.). The evaluation team in these competitively bid awards has included other funding partners such as U.S. Department of Energy, Air Resources Board, and South Coast Air Quality Management District. Labor rates for this agreement, including overhead rates are competitive and consistent with other engine development organizations.

Historically, the Energy Commission Research and Development funding for engine development projects has averaged about 3:1 in match contributions to CEC awarded funds. This healthy match amount helps offset much of the total project costs.

Approximately \$3,375,915 in match contributions are being included in this agreement, with contributions from the South Coast Air Quality Management District (\$1,875,915), Southern California Gas Company (\$1,000,000), and Clean Energy (\$500,000). This project contribution



estimate is comparable to the amount of funding being provided for a similar, but separate project for natural gas engine development.

2. Describe any cost savings realized or costs avoided by acquiring the goods/services from this supplier.

CWI has already had success in developing this advanced technology for a smaller engine. While the funding is needed for integration and demonstration for a larger engine displacement, costs savings are realized through the utilization of an existing technology that has already been proven to be successful and capable of being certified at the optional low-NOx emission standard issued by the California Air Resources Board.

| APPROVED | |
|---|---------------|
|  _____ Sandra Raymos Contract Officer | _____ Date |

**EXHIBIT A
SCOPE OF WORK**

I. TASK ACRONYM/TERM LISTS

TASK LIST

| Task # | CPR | Task Name |
|---------------|------------|--------------------------------|
| 1 | n/a | General Project Tasks |
| 2 | X | 12-Liter Engine Development |
| 3 | | 12-Liter Vehicle Integration |
| 4 | | 12-Liter Vehicle Demonstration |
| 5 | | Evaluation of Project Benefits |
| 6 | | Technology Transfer Activities |
| 7 | | Production Readiness Plan |

ACRONYMS/GLOSSARY

Specific acronyms and terms used throughout this scope of work are defined as follows:

| Term/ Acronym | Definition |
|----------------------|--|
| CARB | California Air Resources Board |
| CCM | Commission Contract Manager |
| CO | Carbon Monoxide |
| CPR | Critical Project Review |
| EFTO | Emerging Fuels and Technology Office |
| Energy Commission | California Energy Commission |
| EPA | U.S. Environmental Protection Agency |
| ERDD | Energy Research and Development Division |
| FTP | Federal Test Procedure |
| g/bhp-hr | Grams per brake horsepower hour |
| HC | Hydrocarbon |
| NH ₃ | Ammonia |
| NMHC | Non-Methane Hydrocarbons |
| NO _x | Nitrogen Oxides |
| PM | Particulate Matter |

II. PURPOSE OF AGREEMENT, PROBLEM/SOLUTION STATEMENT, AND GOALS AND OBJECTIVES

A. Purpose of Agreement

The purpose of this Agreement is to fund the development of an advanced 12-liter natural gas engine capable of achieving a 90% reduction in NO_x emissions from California Air Resources Board 2010 emission standards, and with performance standards comparable to its diesel counterparts.

EXHIBIT A SCOPE OF WORK

B. Problem/ Solution Statement

Problem

The California Air Resources Board (CARB) 2010 emission standards for heavy-duty engines establish a limit for Nitrogen Oxides (NOx) emissions of 0.2 grams per brake horsepower hour (g/bhp-hr), and constitute a 90% reduction of emissions compared to the previous standard (CARB 2007) of 2.0 g/bhp-hr. Nevertheless, it is projected that even with the entire on-road fleet of heavy-duty vehicles compliant with the 2010 standards, upcoming National Ambient Air Quality Standards requirements for ozone attainment cannot be achieved in California's worst air basins without further significant reductions in NOx emissions from heavy-duty fleets.

Analysis of natural gas vehicle technology shows a high potential for greenhouse gas reductions on a well-to-wheels basis in heavy-duty vehicles (11-23%) using conventional natural gas, as well as an opportunity to substantially offset petroleum consumption. Original equipment manufacturers indicate that the near-zero emission target of 0.05 g/bhp-hr could be met or exceeded through research and development efforts. Even higher potential may exist, depending in large part on the removal of current obstacles through research development and demonstration and deployment. Collaborative research efforts between federal, state, and local funding agencies and private technology developers are expected to produce key strategic breakthroughs in a broad range of natural gas vehicle technologies.

Solution

The development and deployment of low NOx, advanced, and efficient natural gas engine for heavy-duty vehicles will lower greenhouse gas emissions and benefit natural gas ratepayers by improving air quality and reducing health and environmental risks associated with emissions from heavy-duty vehicles. Research, development and demonstration of the low-NOx 12-liter natural gas engine is needed to adopt innovative technologies into various heavy-duty vehicle applications or vocations.

C. Goals and Objectives of the Agreement

Agreement Goals

The goal of this agreement is to fund an engine development project that focuses on the advancement of an ultra clean burning natural gas engine suitable for use in various heavy-duty vehicle applications. The engines and associated exhaust after-treatment technologies should be capable of:

- Achieving emissions targets of 0.02 g/bhp-hr NOx, 0.01 g/bhp-hr particulate matter (PM), 0.14 g/bhp-hr non-methane hydrocarbons (NMHC), and 15.5 g/bhp-hr Carbon Monoxide (CO) or lower as determined by the heavy-duty engine federal test procedure (FTP).
- Keeping exhaust Ammonia (NH3) emissions as low as achievable. Projects that address methods to maintain NH3 emission at 10 parts per million or lower.
- Being thermally and fuel efficient. Developed engines that achieve 20% or lower engine thermal efficiency penalty or fuel economy penalty when compared to 2010 U.S. Environmental Protection Agency (EPA) and CARB certified diesel engines in similar duty cycle.

Joint Funding

The Energy Commission's Energy Research and Development Division (ERDD) and Emerging Fuels and Technology Office (EFTO) are funding this project through two separate agreements.

EXHIBIT A SCOPE OF WORK

This agreement is funded by the ERDD, and focuses primarily on engine development and vehicle integration. The EFTO-funded agreement will focus primarily on vehicle demonstration including preparation and installation of parts and the operation and monitoring of vehicles. Task 4 of this agreement (Vehicle Demonstration) funds only a report on the vehicle demonstration activities funded by the EFTO.

Agreement Objectives

The objective of this agreement is to promote the development of advanced natural gas engines and after-treatment technologies with near-zero NO_x emissions that can be used in heavy-duty vehicle applications. The Energy Commission will work with the contractor and other funding partners to support efforts for the effective development of a 12-liter natural gas engine with after-treatment technologies that is commercially viable and capable of being certified to CARB Optional Low NO_x Emission Standards.

The proposed research aims to optimize after-treatment technology designs, after-treatment configurations, engine tuning, and engine management practices for heavy-duty natural gas engines. The objective is to obtain the maximum NO_x reductions possible while continuing to meet or exceed all applicable standards for hydrocarbons, non-methane hydrocarbons, carbon monoxide, and PM, and without incurring a fuel economy penalty. A NO_x emission rate of 0.02 g/bhp-hr (a 90% reduction from the 2010 standard) is the target for the proposed research.

III. TASK 1 GENERAL PROJECT TASKS

DELIVERABLES

Subtask 1.1 Deliverables

The goal of this subtask is to establish the requirements for submitting project deliverables (e.g., reports, summaries, plans, and presentation materials). Unless otherwise specified by the Commission Agreement Manager (CAM), the Contractor must provide deliverables as required below by the dates listed in the **Schedule of Deliverables (Part V)**. Deliverables that require a draft version are indicated by marking “**(draft and final)**” after the deliverable name in the “Deliverables” section of the task/subtask. If “(draft and final)” does not appear after the deliverable name, only a final version of the deliverable is required. With respect to due dates within this Scope of Work, “**days**” means working days.

The Contractor shall:

For deliverables that require a draft version, including the Final Report Outline and Final Report

- Submit all draft deliverables to the CAM for review and comment in accordance with the Schedule of Deliverables (Part V). The CAM will provide written comments to the Contractor on the draft deliverable within 15 days of receipt, unless otherwise specified in the task/subtask for which the deliverable is required.
- Consider incorporating all CAM comments into the final deliverable. If the Recipient disagrees with any comment, provide a written response explaining why the comment was not incorporated into the final deliverable.
- Submit the revised deliverable with responses and comments within 10 days of notice by the CAM, unless the CAM specifies a longer time period, or approves a request for additional time.

For deliverables that require a final version only

EXHIBIT A SCOPE OF WORK

- Submit the deliverable to the CAM for acceptance. The CAM may request minor revisions or explanations prior to acceptance.

For all deliverables

- Submit all data and documents required as deliverables in accordance with the following:

Instructions for Submitting Electronic Files and Developing Software:

- **Electronic File Format**

Submit all data and documents required as deliverables under this Agreement in an electronic file format that is fully editable and compatible with the Energy Commission's software and Microsoft (MS)-operating computing platforms, or with any other format approved by the CAM. Deliver an electronic copy of the full text of any Agreement data and documents in a format specified by the CAM, such as memory stick or CD-ROM.

The following describes the accepted formats for electronic data and documents provided to the Energy Commission as deliverables under this Agreement, and establishes the software versions that will be required to review and approve all software deliverables:

- Data sets will be in MS Access or MS Excel file format (version 2007 or later), or any other format approved by the CAM.
- Text documents will be in MS Word file format, version 2007 or later.
- Documents intended for public distribution will be in PDF file format.
- The Contractor must also provide the native Microsoft file format.
- Project management documents will be in Microsoft Project file format, version 2007 or later.

- **Software Application Development**

Use the following standard Application Architecture components in compatible versions for any software application development required by this Agreement (e.g., databases, models, modeling tools), unless the CAM approves other software applications such as open source programs:

- Microsoft ASP.NET framework (version 3.5 and up). Recommend 4.0.
- Microsoft Internet Information Services (IIS), (version 6 and up) Recommend 7.5.
- Visual Studio.NET (version 2008 and up). Recommend 2010.
- C# Programming Language with Presentation (UI), Business Object and Data Layers.
- SQL (Structured Query Language).
- Microsoft SQL Server 2008, Stored Procedures. Recommend 2008 R2.
- Microsoft SQL Reporting Services. Recommend 2008 R2.
- XML (external interfaces).

Any exceptions to the Electronic File Format requirements above must be approved in writing by the CAM. The CAM will consult with the Energy Commission's Information Technology Services Branch to determine whether the exceptions are allowable.

EXHIBIT A SCOPE OF WORK

MEETINGS

Subtask 1.2 Kick-off Meeting

The goal of this *subtask* is to establish the lines of communication and procedures for implementing this Agreement.

The Contractor shall:

- Attend a “*Kick-off*” meeting with the CAM, the Commission Agreement Officer (CAO), and any other Energy Commission staff relevant to the Agreement. The Contractor will bring its Project Manager and any other individuals designated by the CAM to this meeting. The administrative and technical aspects of the Agreement will be discussed at the meeting. Prior to the meeting, the CAM will provide an agenda to all potential meeting participants. The meeting may take place in person or by electronic conferencing (e.g., WebEx), with approval of the CAM.

The administrative portion of the meeting will include discussion of the following:

- Terms and conditions of the Agreement;
- Deliverables (subtask 1.1);
- CPR meetings (subtask 1.3);
- Match fund documentation (subtask 1.7);
- Permit documentation (subtask 1.8);
- Subcontracts (subtask 1.9); and
- Any other relevant topics.

The technical portion of the meeting will include discussion of the following:

- The CAM’s expectations for accomplishing tasks described in the Scope of Work;
 - An updated Project Schedule;
 - Deliverables (subtask 1.1);
 - Progress reports and invoices (subtask 1.5);
 - Final Report (subtask 1.6);
 - Technical Advisory Committee meetings (subtasks 1.10 and 1.11); and
 - Any other relevant topics.
- Provide an *Updated Schedule of Deliverables, List of Match Funds, and List of Permits*, as needed to reflect any changes in the documents.

The CAM shall:

- Designate the date and location of the meeting.
- Send the Contractor a *Kick-off Meeting Agenda*.

Contractor Deliverables:

- Updated Schedule of Deliverables (*if applicable*)
- Updated List of Match Funds (*if applicable*)
- Updated List of Permits (*if applicable*)

CAM Deliverable:

- Kick-off Meeting Agenda

Subtask 1.3 Critical Project Review (CPR) Meetings

The goal of this *subtask* is to determine if the project should continue to receive Energy Commission funding, and if so whether any modifications must be made to the tasks,

EXHIBIT A SCOPE OF WORK

deliverables, schedule, or budget. CPR meetings provide the opportunity for frank discussions between the Energy Commission and the Contractor. As determined by the CAM, discussions may include project status, challenges, successes, advisory group findings and recommendations, final report preparation, and progress on technical transfer and production readiness activities (if applicable). Participants will include the CAM and the Contractor, and may include the CAO and any other individuals selected by the CAM to provide support to the Energy Commission.

CPR meetings generally take place at key, predetermined points in the Agreement, as determined by the CAM and as shown in the Task List on page 1 of this Exhibit. However, the CAM may schedule additional CPR meetings as necessary. The budget will be reallocated to cover the additional costs borne by the Contractor, but the overall Agreement amount will not increase. CPR meetings generally take place at the Energy Commission, but they may take place at another location, or may be conducted via electronic conferencing (e.g., WebEx) as determined by the CAM.

The Contractor shall:

- Prepare a *CPR Report* for each CPR meeting that: (1) discusses the progress of the Agreement toward achieving its goals and objectives; and (2) includes recommendations and conclusions regarding continued work on the project.
- Submit the CPR Report along with any other *Task Deliverables* that correspond to the technical task for which the CPR meeting is required (i.e., if a CPR meeting is required for Task 2, submit the Task 2 deliverables along with the CPR Report).
- Attend the CPR meeting.
- Present the CPR Report and any other required information at each CPR meeting.

The CAM shall:

- Determine the location, date, and time of each CPR meeting with the Contractor's input.
- Send the Contractor a *CPR Agenda* and a *List of Expected CPR Participants* in advance of the CPR meeting. If applicable, the agenda will include a discussion of match funding and permits.
- Conduct and make a record of each CPR meeting. Provide the Contractor with a *Schedule for Providing a Progress Determination* on continuation of the project.
- Determine whether to continue the project, and if so whether modifications are needed to the tasks, schedule, deliverables, or budget for the remainder of the Agreement. If the CAM concludes that satisfactory progress is not being made, this conclusion will be referred to the Deputy Director of the Energy Research and Development Division.
- Provide the Contractor with a *Progress Determination* on continuation of the project, in accordance with the schedule. The Progress Determination may include a requirement that the Contractor revise one or more deliverables.

Contractor Deliverables:

- CPR Report(s)
- Task Deliverables (draft and/or final as specified in the task)

CAM Deliverables:

- CPR Agenda
- List of Expected CPR Participants
- Schedule for Providing a Progress Determination
- Progress Determination

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Subtask 1.4 Final Meeting

The goal of this subtask is to complete the closeout of this Agreement.

The Contractor shall:

- Meet with Energy Commission staff to present project findings, conclusions, and recommendations. The final meeting must be completed during the closeout of this Agreement. This meeting will be attended by the Contractor and CAM, at a minimum. The meeting may occur in person or by electronic conferencing (e.g., WebEx), with approval of the CAM.

The technical and administrative aspects of Agreement closeout will be discussed at the meeting, which may be divided into two separate meetings at the CAM's discretion.

- The technical portion of the meeting will involve the presentation of findings, conclusions, and recommended next steps (if any) for the Agreement. The CAM will determine the appropriate meeting participants.
- The administrative portion of the meeting will involve a discussion with the CAM and the CAO of the following Agreement closeout items:
 - Disposition of any state-owned equipment.
 - Need to file a Uniform Commercial Code Financing Statement (Form UCC-1) regarding the Energy Commission's interest in patented technology.
 - The Energy Commission's request for specific "generated" data (not already provided in Agreement deliverables).
 - Need to document the Contractor's disclosure of "subject inventions" developed under the Agreement.
 - "Surviving" Agreement provisions such as repayment provisions and confidential deliverables.
 - Final invoicing and release of retention.
 - Prepare a *Final Meeting Agreement Summary* that documents any agreement made between the Contractor and Commission staff during the meeting.
 - Prepare a *Schedule for Completing Agreement Closeout Activities*.
 - Provide *All Draft and Final Written Deliverables* on a CD-ROM or USB memory stick, organized by the tasks in the Agreement.

Deliverables:

- Final Meeting Agreement Summary (*if applicable*)
- Schedule for Completing Agreement Closeout Activities
- All Draft and Final Written Deliverables

REPORTS AND INVOICES

Subtask 1.5 Progress Reports and Invoices

The goals of this subtask are to: (1) periodically verify that satisfactory and continued progress is made towards achieving the project objectives of this Agreement; and (2) ensure that invoices contain all required information and are submitted in the appropriate format.

The Contractor shall:

- Submit a quarterly *Progress Report* to the CAM. Each progress report must:
 - Summarize progress made on all Agreement activities as specified in the scope of work for the preceding 3 months, including accomplishments, problems, milestones, deliverables, schedule, fiscal status, and an assessment of the ability to complete the

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Agreement within the current budget and any anticipated cost overruns. See the Progress Report Format Attachment for the recommended specifications.

- Submit a monthly or quarterly *Invoice* that follows the instructions in the “Payment of Funds” section of the terms and conditions, including a financial report on Match Fund and in-state expenditures.

Deliverables:

- Progress Reports
- Invoices

Subtask 1.6 Final Report

The goal of this subtask is to prepare a comprehensive Final Report that describes the original purpose, approach, results, and conclusions of the work performed under this Agreement. The CAM will review the Final Report, which will be due at least **two months** before the Agreement end date. When creating the Final Report Outline and the Final Report, the Contractor must use the Style Manual provided by the CAM.

Subtask 1.6.1 Final Report Outline

The Contractor shall:

- Prepare a *Final Report Outline* in accordance with the *Style Manual* provided by the CAM. (See *Task 1.1* for requirements for draft and final deliverables.)

Contractor Deliverables:

- Final Report Outline (draft and final)

CAM Deliverables:

- Style Manual
- Comments on Draft Final Report Outline
- Approval of Final Report Outline

Subtask 1.6.2 Final Report

The Contractor shall:

- Prepare a *Final Report* for this Agreement in accordance with the approved Final Report Outline, Style Manual, and Final Report Template provided by the CAM with the following considerations:
 - Ensure that the report includes the following items, in the following order:
 - Cover page (required)
 - Credits page on the reverse side of cover with legal disclaimer (required)
 - Acknowledgements page (optional)
 - Preface (required)
 - Abstract, keywords, and citation page (required)
 - Table of Contents (required, followed by List of Figures and List of Tables, if needed)
 - Executive summary (required)
 - Body of the report (required)
 - References (if applicable)
 - Glossary/Acronyms (If more than 10 acronyms or abbreviations are used, it is required.)
 - Bibliography (if applicable)

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- Appendices (if applicable) (Create a separate volume if very large.)
- Attachments (if applicable)
- Ensure that the document is written in the third person.
- Ensure that the Executive Summary is understandable to the lay public.
 - Briefly summarize the completed work. Succinctly describe the project results and whether or not the project goals were accomplished.
 - Identify which specific ratepayers can benefit from the project results and how they can achieve the benefits.
 - If it's necessary to use a technical term in the Executive Summary, provide a brief definition or explanation when the technical term is first used.
- Follow the Style Guide format requirements for headings, figures/tables, citations, and acronyms/abbreviations.
- Ensure that the document omits subjective comments and opinions. However, recommendations in the conclusion of the report are allowed.
- Include a brief description of the project results in the Abstract.

- Submit a draft of the report to the CAM for review and comment. The CAM will provide written comments to the Recipient on the draft deliverable within 15 days of receipt.
- Consider incorporating all CAM comments into the Final Report. If the Recipient disagrees with any comment, provide a written response explaining why the comment was not incorporated into the final deliverable.
- Submit the revised Final Report and responses to comments within 10 days of notice by the CAM, unless the CAM specifies a longer time period or approves a request for additional time.
- Submit one bound copy of the *Final Report* to the CAM along with *Written Responses to Comments on the Draft Final Report*.

Deliverables:

- Final Report (draft and final)
- Written Responses to Comments on the Draft Final Report

CAM Deliverable:

- Written Comments on the Draft Final Report

MATCH FUNDS, PERMITS, AND SUBCONTRACTS

Subtask 1.7 Match Funds

The goal of this subtask is to ensure that the Contractor obtains any match funds planned for this Agreement and applies them to the Agreement during the Agreement term.

While the costs to obtain and document match funds are not reimbursable under this Agreement, the Contractor may spend match funds for this task. The Contractor may only spend match funds during the Agreement term, either concurrently or prior to the use of Energy Commission funds. Match funds must be identified in writing, and the Contractor must obtain any associated commitments before incurring any costs for which the Contractor will request reimbursement.

The Contractor shall:

- Prepare a *Match Funds Status Letter* that documents the match funds committed to this

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Agreement.

- If no match funds were part of the proposal that led to the Energy Commission awarding this Agreement and none have been identified at the time this Agreement starts, then state this in the letter.

If match funds were a part of the proposal that led to the Energy Commission awarding this Agreement, then provide in the letter:

- A list of the match funds that identifies:
 - The amount of cash match funds, their source(s) (including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied.
 - The amount of each in-kind contribution, a description of the contribution type (e.g., property, services), the documented market or book value, the source (including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied. If the in-kind contribution is equipment or other tangible or real property, the Contractor must identify its owner and provide a contact name, address, telephone number, and the address where the property is located.
- A copy of a letter of commitment from an authorized representative of each source of match funding that the funds or contributions have been secured.
- At the Kick-off meeting, discuss match funds and the impact on the project if they are significantly reduced or not obtained as committed. If applicable, match funds will be included as a line item in the progress reports and will be a topic at CPR meetings.
- Provide a *Supplemental Match Funds Notification Letter* to the CAM of receipt of additional match funds.
- Provide a *Match Funds Reduction Notification Letter* to the CAM if existing match funds are reduced during the course of the Agreement. Reduction of match funds may trigger a CPR meeting.

Deliverables:

- Match Funds Status Letter
- Supplemental Match Funds Notification Letter (*if applicable*)
- Match Funds Reduction Notification Letter (*if applicable*)

Subtask 1.8 Permits

The goal of this subtask is to obtain all permits required for work completed under this Agreement in advance of the date they are needed to keep the Agreement schedule on track. Permit costs and the expenses associated with obtaining permits are not reimbursable under this Agreement, with the exception of costs incurred by University of California recipients. Permits must be identified and obtained before the Contractor may incur any costs related to the use of the permit(s) for which the Contractor will request reimbursement.

The Contractor shall:

- Prepare a *Permit Status Letter* that documents the permits required to conduct this Agreement. If no permits are required at the start of this Agreement, then state this in the letter. If permits will be required during the course of the Agreement, provide in the letter:
 - A list of the permits that identifies: (1) the type of permit; and (2) the name, address, and telephone number of the permitting jurisdictions or lead agencies.
 - The schedule the Contractor will follow in applying for and obtaining the permits.

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The list of permits and the schedule for obtaining them will be discussed at the Kick-off meeting (subtask 1.2), and a timetable for submitting the updated list, schedule, and copies of the permits will be developed. The impact on the project if the permits are not obtained in a timely fashion or are denied will also be discussed. If applicable, permits will be included as a line item in progress reports and will be a topic at CPR meetings.

- If during the course of the Agreement additional permits become necessary, then provide the CAM with an *Updated List of Permits* (including the appropriate information on each permit) and an *Updated Schedule for Acquiring Permits*.
- Send the CAM a *Copy of Each Approved Permit*.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the CAM within 5 days. Either of these events may trigger a CPR meeting.

Deliverables:

- Permit Status Letter
- Updated List of Permits (*if applicable*)
- Updated Schedule for Acquiring Permits (*if applicable*)
- Copy of each Approved Permit (*if applicable*)

Subtask 1.9 Subcontracts

The goals of this subtask are to: (1) procure subcontracts required to carry out the tasks under this Agreement; and (2) ensure that the subcontracts are consistent with the terms and conditions of this Agreement.

The Contractor shall:

- Manage and coordinate subcontractor activities in accordance with the requirements of this Agreement.
- Incorporate this Agreement by reference into each subcontract.
- Include any required Energy Commission flow-down provisions in each subcontract, in addition to a statement that the terms of this Agreement will prevail if they conflict with the subcontract terms.
- If required by the CAM, submit a draft of each *Subcontract* required to conduct the work under this Agreement.
- Submit a final copy of the executed subcontract.
- Notify and receive written approval from the CAM prior to adding any new subcontractors (see the discussion of subcontractor additions in the terms and conditions).

Deliverables:

- Subcontracts (*draft if required by the CAM*)

TECHNICAL ADVISORY COMMITTEE

Subtask 1.10 Technical Advisory Committee (TAC)

The goal of this subtask is to create an advisory committee for this Agreement. The TAC should be composed of diverse professionals. The composition will vary depending on interest, availability, and need. TAC members will serve at the CAM's discretion. The purpose of the TAC is to:

- Provide guidance in project direction. The guidance may include scope and methodologies, timing, and coordination with other projects. The guidance may be based on:
 - Technical area expertise;

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- Knowledge of market applications; or
- Linkages between the agreement work and other past, present, or future projects (both public and private sectors) that TAC members are aware of in a particular area.
- Review deliverables and provide recommendations for needed deliverable adjustments, refinements, or enhancements.
 - Evaluate the tangible benefits of the project to the state of California, and provide recommendations as needed to enhance the benefits.
 - Provide recommendations regarding information dissemination, market pathways, or commercialization strategies relevant to the project deliverables.

The TAC may be composed of qualified professionals spanning the following types of disciplines:

- Researchers knowledgeable about the project subject matter;
- Members of trades that will apply the results of the project (e.g., designers, engineers, architects, contractors, and trade representatives);
- Public interest market transformation implementers;
- Product developers relevant to the project;
- U.S. Department of Energy research managers, or experts from other federal or state agencies relevant to the project;
- Public interest environmental groups;
- Utility representatives;
- Air district staff; and
- Members of relevant technical society committees.

The Contractor shall:

- Prepare a *List of Potential TAC Members* that includes the names, companies, physical and electronic addresses, and phone numbers of potential members. The list will be discussed at the Kick-off meeting, and a schedule for recruiting members and holding the first TAC meeting will be developed.
- Recruit TAC members. Ensure that each individual understands member obligations and the TAC meeting schedule developed in subtask 1.11.
- Prepare a *List of TAC Members* once all TAC members have committed to serving on the TAC.
- Submit *Documentation of TAC Member Commitment* (such as Letters of Acceptance) from each TAC member.

Deliverables:

- List of Potential TAC Members
- List of TAC Members
- Documentation of TAC Member Commitment

Subtask 1.11 TAC Meetings

The goal of this subtask is for the TAC to provide strategic guidance for the project by participating in regular meetings, which may be held via teleconference.

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The Contractor shall:

- Discuss the TAC meeting schedule with the CAM at the Kick-off meeting. Determine the number and location of meetings (in-person and via teleconference) in consultation with the CAM.
- Prepare a *TAC Meeting Schedule* that will be presented to the TAC members during recruiting. Revise the schedule after the first TAC meeting to incorporate meeting comments.
- Prepare a *TAC Meeting Agenda* and *TAC Meeting Back-up Materials* for each TAC meeting.
- Organize and lead TAC meetings in accordance with the TAC Meeting Schedule. Changes to the schedule must be pre-approved in writing by the CAM.
- Prepare *TAC Meeting Summaries* that include any recommended resolutions of major TAC issues.

Deliverables:

- TAC Meeting Schedule (draft and final)
- TAC Meeting Agendas (draft and final)
- TAC Meeting Back-up Materials
- TAC Meeting Summaries

IV. TECHNICAL TASKS

TECHNICAL TASKS

TASK 2 12-LITER ENGINE DEVELOPMENT

The goal of this task is to develop a commercially viable 12-liter natural gas engine and after-treatment technologies suitable for various heavy-duty vehicle applications that meets the CARB Optional Low NOx on-road emissions regulations. Information will also be collected on the specifications of the natural gas that will be used for the engine testing and on-road vehicle demonstration described in Task 4.

Task 2.1 Fuel Specification

The Contractor shall:

- Work with the subcontractor to collect natural gas fuel specification information indicating that the fuel being used for emissions testing meets specifications for natural gas engine certification.
- Work with the subcontractor to prepare a *Natural Gas Fuel Specification Report* that includes fuel specification information including but not limited to:
 - Methane, ethane, propane, I-butane, nitrogen gas (N₂), and carbon dioxide (CO₂) levels
 - Methane number (MN) determined via CARB calculations
 - Wobbe Number/Index
 - Higher Heating Value
 - H/C (hydrogen to carbon) ratio

Contractor Deliverables:

- Natural Gas Fuel Specification Report

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Task 2.2 Engine Development

The Contractor shall:

- Obtain a detailed *12-Liter Engine Work Plan* from the subcontractor for the design, analysis, and development of the proposed natural gas engine and after-treatment technologies. The Work Plan, at a minimum, should include:
 - Specifications and conceptual design strategy of the proposed heavy-duty natural gas engine and associated exhaust after-treatment technologies suitable for heavy-duty vehicle chassis and powertrain strategies in refuse, goods movement, drayage, and transit and school buses' market fleets.
 - A detailed feasibility and risk analysis of the design strategy addressing, at a minimum, the development strategies for:
 - Engine mechanical components including base engine components, power cylinder components (pistons, rings, bores, liners, etc), intake/exhaust manifolds, cylinder heads, turbo machinery, fuel system components, exhaust gas recirculation subsystem, etc.
 - Engine control system including electronic, hardware, and software controls, sensors, valves, actuators, ignition system, on-board diagnostics and the interface with various mechanical engine systems, after-treatment technology, vehicle electronics and any application-specific interface requirements or control system performance features.
 - Exhaust after-treatment technology and associated subsystems components.
 - Engine mechanical components and vehicle interface and packaging requirements.
 - Emissions certification to ensure that the proposed heavy-duty natural gas engine and associated exhaust after-treatment technology are thermally and fuel efficient, and certified by the EPA and CARB to meet the emissions targets of 0.02 g/bhp-hr NO_x, 0.01 g/bhp-hr PM, 0.14 g/bhp-hr HC, and 15.5 g/bhp-hr CO or lower as determined by the heavy-duty engine FTP while keeping exhaust NH₃ emissions as low as achievable.
- Build a minimum of one (1) prototype engine and exhaust after-treatment technology for initial laboratory testing and evaluation.
- Work with the subcontractor to implement modifications and refinements to the engine, engine subsystem, and exhaust after-treatment technology to meet the product specifications as needed. In cases where product specifications must be updated during the development process, the subcontractor shall identify the changes, evaluate the impact of the change, and review them with the Contractor for approval before proceeding.
- Upon completion of the detailed design and the initial prototype engine and associated exhaust after-treatment system evaluation, the Contractor shall require the subcontractor to:
 - Build a minimum of one (1) production-intent or production engine and exhaust after-treatment technology for final performance and emissions validation.
 - Perform transient dynamometer tests per the heavy-duty on-highway FTP to determine brake specific fuel consumption and NMHC, NO_x, CO, PM, NH₃, N₂O, NO₂, CO₂, and ultrafine emissions from the production-intent or production engine and after-treatment system. The testing shall be conducted using natural gas that is laboratory tested to comply with CCR Title 13, Section 2292.5.
 - Utilize their internal product development and validation procedures to establish minimum quantities and specific validation requirements, but at a minimum, the subcontractor must perform a full validation of the product specifications and document the results. The subcontractor should conduct an initial engine durability

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testing program for a minimum of 250 hours, or as defined by the subcontractor and approved by the Contractor.

- Obtain from the subcontractor production or production-intent engine available for independent dynamometer emissions and performance testing during this project, as directed by the Contractor. In addition, the subcontractor shall provide a complete engines system and any required appurtenance necessary to conduct the testing and arrange for on-site engineering support to facilitate the testing, if requested by the Contractor.
- Obtain from the subcontractor *12-Liter Prototype Engine Performance Specifications and Photos* for the completed engine prototype. Engine specifications should include, but will not be limited to: brake horsepower and torque ratings, engine displacement, compression ratio, and bore and stroke.
- Require the subcontractor to submit a draft and final *12-Liter Certification Pathway Report* identifying the proposed path towards eventual emissions certification of the engine and exhaust after-treatment technology and commercialization of the product. This report shall include specific high-level activities and a proposed timeline for the commercialization of the engine.
- Prepare a *CPR Report* that discusses the progress of the Agreement toward achieving its goals and objectives. This report shall include recommendations and conclusions regarding continued work of the projects. This report shall be submitted along with any other deliverables identified in this Scope of Work. Submit these documents to the Commission Contract Manager and any other designated reviewers at least 15 working days in advance of each CPR meeting.
- Present the required information at each CPR meeting and participate in a discussion about the Agreement per subtask 1.3.

Contractor Deliverables:

- 12-Liter Engine Work Plan
- Prototype 12-Liter Engine Performance Specifications and Photos
- 12-Liter Certification Pathway Report (Draft and Final)
- CPR Report

TASK 3 12-LITER VEHICLE INTEGRATION

The goal of this task is to integrate the developed natural gas engine into multiple heavy-duty vehicle applications.

The Contractor shall:

- Obtain a detailed *12-Liter Integration Work Plan* from the subcontractor for the design, feasibility and risk analysis, assemblage, and validation of prototype and production vehicle for heavy-duty vehicle applications. Specifically, the work-plan shall include, at a minimum:
 - Vehicle specifications and a conceptual design strategy suitable for heavy-duty vehicle chassis and powertrain strategies in refuse, goods movement, drayage, and transit and school bus market fleets.
 - A detailed feasibility and risk analysis of the design strategy in Task 3 addressing, at a minimum, the integration strategies for:
 - Mechanical components including engine mounting requirement, transmission interface, driveline requirements, cooling and air interface, cooling system requirements, fan drive requirements, air conditioning

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- compressor interface, axle ratio, transmission ratios, and other mechanical systems.
- Fuel system including fuel storage strategy (CNG/LNG). storage capacity requirements, storage tank installation requirements (mounting, crash protection and shielding, weight accommodation, National Fire Protection Association and Federal Motor Vehicle Safety Standard applicability), fuel control, and other fuel related systems.
 - Electrical systems including vehicle communication protocols, on-board diagnostics requirements, diagnostic connector locations, engine and control system power/grounding, Electromagnetic Interference/Electromagnetic Compatibility, wiring interface requirements and design, electrical component installation, fuel level display, electronic foot pedal, remote throttle, Anti-lock Braking System or traction control interface, charging system, exhaust after-treatment system control and diagnostics.
 - Exhaust after-treatment and associated sub-system requirements, diesel exhaust fluid freeze protection if required, heat protection, piping material requirements, packaging and mounting, etc.
- Work with the subcontractor to conduct detailed design of the vehicle to integrate the production-intent or production engines and exhaust after-treatment systems built in Task 3, update product specifications as required and as design details are solidified, and build a minimum of one (1) prototype vehicle for initial testing and evaluation.
 - As needed, work with the subcontractor to implement modifications and refinements to the vehicle integration to meet the product specifications and comply with engine and exhaust after-treatment technology manufacturers' requirements and other design requirements including codes and standards. In cases where product specifications must be updated during the integration process, the subcontractor shall identify the changes, evaluate the impact of the change, and review them with the Contractor for approval before proceeding. Upon completion of the detailed design and the initial prototype vehicle evaluation, require each subcontractor to:
 - Build a minimum of one (1) production-intent or production vehicle for final performance and emissions validation (total quantity shall be defined by the Contractor based upon the Contractor's internal product validation requirements). The prototype vehicle may also serve as the production-intent or production vehicle should it be sufficiently refined.
 - Utilize their internal product development and validation procedures to establish minimum quantities and specific validation requirements. At a minimum, the subcontractor must perform a full validation of the product specifications and document the results in the compliance matrix. The subcontractor is encouraged to conduct an initial vehicle emissions tests to confirm performance and emissions expectations.
 - Obtain a production or production-intent vehicle from subcontractor available for independent chassis dynamometer emissions and performance testing during this project, as directed by the Contractor. In addition, each subcontractor shall provide a complete vehicle system and any required appurtenance necessary to conduct the testing and arrange for on-site engineering support to facilitate the testing, if requested by the Contractor.
 - Obtain a *12-Liter Commercialization Pathway Report* identifying proposed path towards commercialization of the engine. This report shall include specific high-level activities and a proposed timeline for the commercialization of the engine.

Contractor Deliverables:

- 12-Liter Integration Work Plan (Draft and Final)

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- 12-Liter Commercialization Pathway Report (Draft and Final)

TASK 4 12-LITER VEHICLE DEMONSTRATION (Co-funded by the Energy Commission's EFTO)

The goal of this task is to prepare a report that describes the deployment of developed engines in multiple vehicle applications for on-road demonstration and testing. At least one vehicle should be deployed in the South Coast Air District. This agreement funds only the development of the report. The Energy Commission's EFTO will fund the deployment activities described below in a separate agreement.

The Contractor shall:

EFTO-Funded Activities under Agreement 600-13-008

- Deploy to the field up to three (3) vehicles for the 12-liter engine developed, preferably in multiple applications, in the South Coast Air Basin.
- Conduct at least six (6) months of field demonstration for each vehicle, including monitoring and support.
- Identify, characterize, and resolve operational and/or performance issues prior to commercial product launch.
- Document the in-service performance of the demonstration fleet, including mileage accumulation, vehicle downtime, maintenance and repair frequency, and operating costs.
- Validate vehicle fuel efficiency for each vehicle to within 20% or lower of comparable diesel vehicles over comparable duty cycles.

ERDD-Funded Activity

- Prepare an *On-Road Demonstration Vehicle Report* discussing the following for each vehicle:
 - Duty cycle selection, estimated mileage accumulation, and range and geographic location of vehicles selected for on-road demonstration, including photographs of vehicles.
 - Performance specifications of the engine for each of the vehicles used in the demonstration. Performance specifications should include the torque and brake horsepower rating of the engine used in each vehicle.
 - Operational and/or performance issues with on-road demonstration, including downtime, actual mileage accumulation, and operating costs over the full demonstration period.
 - Chassis dynamometer testing of vehicle level tailpipe emissions and fuel economy for a representative vehicle.
 - Compatibility results of the on-board fuel storage and delivery system with a variety of operating and ambient conditions, including lessons learned and recommendations for future designs.

Contractor Deliverables:

- On-Road Demonstration Vehicle Report (Draft and Final)

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TASK 5 EVALUATION OF PROJECT BENEFITS

The goal of this task is to report the benefits resulting from this project.

The Contractor shall:

- Complete three Project Benefits Questionnaires that correspond to three main intervals in the Agreement: (1) *Kick-off Meeting Benefits Questionnaire*; (2) *Mid-term Benefits Questionnaire*; and (3) *Final Meeting Benefits Questionnaire*.
- Provide all key assumptions used to estimate projected benefits, including targeted market sector (e.g., population and geographic location), projected market penetration, baseline and projected energy use and cost, operating conditions, and emission reduction calculations. Examples of information that may be requested in the questionnaires include:
 - For Product Development Projects and Project Demonstrations:
 - Published documents, including date, title, and periodical name.
 - Estimated or actual energy and cost savings, and estimated statewide energy savings once market potential has been realized. Identify all assumptions used in the estimates.
 - Greenhouse gas and criteria emissions reductions.
 - Other non-energy benefits such as reliability, public safety, lower operational cost, environmental improvement, indoor environmental quality, and societal benefits.
 - Data on potential job creation, market potential, economic development, and increased state revenue as a result of the project.
 - A discussion of project product downloads from websites, and publications in technical journals.
 - A comparison of project expectations and performance. Discuss whether the goals and objectives of the Agreement have been met and what improvements are needed, if any.
 - Additional Information for Product Development Projects:
 - Outcome of product development efforts, such copyrights and license agreements.
 - Units sold or projected to be sold in California and outside of California.
 - Total annual sales or projected annual sales (in dollars) of products developed under the Agreement.
 - Investment dollars/follow-on private funding as a result of Energy Commission funding.
 - Patent numbers and applications, along with dates and brief descriptions.
 - Additional Information for Product Demonstrations:
 - Outcome of demonstrations and status of technology.
 - Number of similar installations.
 - Jobs created/retained as a result of the Agreement.
 - For Information/Tools and Other Research Studies:
 - Outcome of project.
 - Published documents, including date, title, and periodical name.
 - A discussion of policy development. State if the project has been cited in government policy publications or technical journals, or has been used to inform regulatory bodies.
 - The number of website downloads.

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- An estimate of how the project information has affected energy use and cost, or has resulted in other non-energy benefits.
- An estimate of energy and non-energy benefits.
- Data on potential job creation, market potential, economic development, and increased state revenue as a result of project.
- A discussion of project deliverable downloads from websites, and publications in technical journals.
- A comparison of project expectations and performance. Discuss whether the goals and objectives of the Agreement have been met and what improvements are needed, if any.
- Respond to CAM questions regarding responses to the questionnaires.

The Energy Commission may send the Contractor similar questionnaires after the Agreement term ends. Responses to these questionnaires will be voluntary.

Deliverables:

- Kick-off Meeting Benefits Questionnaire
- Mid-term Benefits Questionnaire
- Final Meeting Benefits Questionnaire

TASK 6 TECHNOLOGY/KNOWLEDGE TRANSFER ACTIVITIES

The goal of this task is to develop a plan to make the knowledge gained, experimental results, and lessons learned available to the public and key decision makers.

The Contractor shall:

- Prepare an *Initial Fact Sheet* at start of the project that describes the project. Use the format provided by the CAM.
- Prepare a *Final Project Fact Sheet* at the project's conclusion that discusses results. Use the format provided by the CAM.
- Prepare a *Technology/Knowledge Transfer Plan* that includes:
 - An explanation of how the knowledge gained from the project will be made available to the public, including the targeted market sector and potential outreach to end users, utilities, regulatory agencies, and others.
 - A description of the intended use(s) for and users of the project results.
 - Published documents, including date, title, and periodical name.
 - Copies of documents, fact sheets, journal articles, press releases, and other documents prepared for public dissemination. These documents must include the Legal Notice required in the terms and conditions. Indicate where and when the documents were disseminated.
 - A discussion of policy development. State if project has been or will be cited in government policy publications, or used to inform regulatory bodies.
 - The number of website downloads or public requests for project results.
 - Additional areas as determined by the CAM.
- Conduct technology transfer activities in accordance with the Technology/Knowledge Transfer Plan. These activities will be reported in the Progress Reports.
- When directed by the CAM, develop *Presentation Materials* for an Energy Commission-sponsored conference/workshop(s) on the project.
- When directed by the CAM, participate in annual EPIC symposium(s) sponsored by the California Energy Commission.
- Provide at least (6) six *High Quality Digital Photographs* (minimum resolution of

EXHIBIT A SCOPE OF WORK

1300x500 pixels in landscape ratio) of pre and post technology installation at the project sites or related project photographs.

- Prepare a *Technology/Knowledge Transfer Report* on technology transfer activities conducted during the project.

Deliverables:

- Initial Fact Sheet (draft and final)
- Final Project Fact Sheet (draft and final)
- Presentation Materials (draft and final)
- High Quality Digital Photographs
- Technology/Knowledge Transfer Plan (draft and final)
- Technology/Knowledge Transfer Report (draft and final)

TASK 7 PRODUCTION READINESS PLAN

The goal of this task is to determine the steps that will lead to the manufacturing of technologies developed in this project or to the commercialization of the project's results.

The Contractor shall:

- Prepare a *Production Readiness Plan*. The degree of detail in the plan should be proportional to the complexity of producing or commercializing the proposed product, and to its state of development. As appropriate, the plan will discuss the following:
 - Critical production processes, equipment, facilities, personnel resources, and support systems needed to produce a commercially viable product.
 - Internal manufacturing facilities, supplier technologies, capacity constraints imposed by the design under consideration, design-critical elements, and the use of hazardous or non-recyclable materials. The product manufacturing effort may include "proof of production processes."
 - The estimated cost of production.
 - The expected investment threshold needed to launch the commercial product.
 - An implementation plan to ramp up to full production.
 - The outcome of product development efforts, such as copyrights and license agreements.
 - Patent numbers and applications, along with dates and brief descriptions.
 - Other areas as determined by the CAM.

Deliverables:

- Production Readiness Plan (draft and final)

V. PROJECT SCHEDULE

Please see the attached Excel spreadsheet.

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION - RE: SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

RESOLVED, that the State Energy Resources Conservation and Development Commission (Energy Commission) adopts the staff CEQA findings contained in the Agreement or Amendment Request Form (as applicable); and

RESOLVED, that the Energy Commission approves Agreement 500-16-002 with the South Coast Air Quality Management District for a \$1,000,000 contract to develop a commercially viable, advanced 12-liter natural gas engine with near zero NOx tailpipe emissions suitable for use in heavy-duty vehicles; and

FURTHER BE IT RESOLVED, that the Executive Director or his/her designee shall execute the same on behalf of the Energy Commission.

CERTIFICATION

The undersigned Secretariat to the Commission does hereby certify that the foregoing is a full, true, and correct copy of a Resolution duly and regularly adopted at a meeting of the California Energy Commission held on September 14, 2016.

AYE: [List of Commissioners]

NAY: [List of Commissioners]

ABSENT: [List of Commissioners]

ABSTAIN: [List of Commissioners]

Cody Goldthrite,
Secretariat