





## EXHIBIT A Scope of Work

### A. Task List

Task #	CPR <sup>1</sup>	Task Name
1		General Project Tasks
2		Integration, Testing, and Optimization
3	X	Engine Emissions Testing
4		Field Testing
5		Evaluation of Project Benefits
6		Technology/Knowledge Transfer Activities

### B. Acronym/Term List

	Meaning
ACIS	Advanced Corona Ignition System
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CARB	California Air Resources Board
CFR	Code of Federal Regulations
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO <sub>2</sub>	Carbon Dioxide
CPR	Critical Project Review
DF	Emissions Deterioration Factor
EGR	Exhaust Gas Recirculation
EPA	U.S. Environmental Protection Agency
FTP	Federal Testing Procedure
g/bhp-hr	Grams per Brake-Horsepower-hour
GHG	Greenhouse Gas
HD	Heavy-duty
NAR	North American Repower
NG	Natural Gas
NMOG	Non-methane Organic Gases
NO <sub>x</sub>	Nitrogen Oxides
OEM	Original Equipment Manager
PEMS	Portable Emissions Monitoring System
PM	Particulate Matter
PON	Program Opportunity Notice
TAC	Technical Advisory Committee
THC	Total Hydrocarbons
VOICE	Variable Output Ignition Coil with Electronics

<sup>1</sup> Please see subtask 1.3 in Part II of the Scope of Work (General Project Tasks) for a description of Critical Project Review (CPR) Meetings.

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#### **I. PURPOSE OF AGREEMENT, PROBLEM/SOLUTION STATEMENT, AND GOALS AND OBJECTIVES**

##### **A. Purpose of Agreement**

The purpose of this Agreement is to optimize, test and demonstrate two advanced ignition systems for heavy-duty (HD) natural gas (NG) engines. These unique systems will facilitate the stable and efficient ignition of NG fuel under conditions of high-boost pressure and elevated levels of Exhaust Gas Recirculation (EGR). The advanced ignition development for engines under this agreement will enable existing engines to improve fuel economy by up to 18 percent and attain or surpass the voluntary California Air Resources Board (CARB) nitrogen oxides (NO<sub>x</sub>) emissions goal of 0.02 grams/brake-horsepower-hour (g/bhp-hr), while demonstrating required levels of performance, drivability, and cost-effectiveness.

##### **B. Problem/ Solution Statement**

###### **Problem**

The ignition characteristics of NG fuel represent challenges to engine manufacturers working to reduce harmful emissions and achieve lower fuel consumption and higher engine performance, while responding to market pressure to reduce operating and maintenance costs. One of the most promising ways to reduce emissions and increase fuel economy is to increase the levels of EGR in an engine. While promising, this approach comes at the cost of reduced ignition stability with increased potential for misfire. Original Equipment Manufacturers (OEM) have tried to overcome this problem by increasing the spark energy, but this leads to rapid deterioration of the spark plug electrodes necessitating more frequent costly engine maintenance, increasing fleet downtime and costs. While advances in spark plug durability technology have helped, at the increased levels of EGR and boost required to meet the 0.02g/bhp-hr NO<sub>x</sub> emissions goal, traditional ignition systems can't reliably or economically provide the means to ignite NG fuel.

Both of the proposed advanced ignition systems have been shown to reliably ignite NG under high EGR and high boost conditions, but mostly under constant speed testing, and never with a standardized transient test cell durability run nor in an on road HD vehicle. Thus, the true durability and cost of ownership of these systems is unknown. Durability data as generated by this study design is the type used by OEM engine makers to decide if a product is market viable, and is the type of data required by the U.S. Environmental Protection Agency (EPA) and the CARB to determine if emissions are stable over the expected "useful life" of the engine. The "useful life" for class 8 engines is defined as 485,000 miles or 10 years, which underscores the need for durability and in-use testing of this type. It also underscores the fact that the existing in-use diesel fleet is a long-lived source of NO<sub>x</sub> emissions, and that an economically viable retrofit upgrade to natural gas operation for the legacy fleet is the most rapid means to achieve demonstrable reductions in harmful emissions. This study is designed to determine the economic viability of moving the legacy fleet, as well as new vehicles to this near-zero-emissions technology that uses a low-carbon fuel.

###### **Solution**

The Recipient and Project Team will optimize, durability- and emissions-test, and demonstrate the Federal-Mogul Advanced Corona Ignition System (ACIS) Plasma Ignition and the Delphi

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Variable Output Ignition Coil with Electronics (VOICE) systems for NG engines in a test cell and in an on-road HD Class 8 vehicle. When integrated into an existing spark-ignited Class 3 to Class 8 HD NG engine, these systems will provide unique energy discharges known to facilitate the ignition of NG fuel under high-boost pressures and greatly increase the levels of EGR that an engine can tolerate. Ignition component life can also be extended through careful integrated control of the energy delivered by the ignition system that traditional spark delivery systems are unable to perform.

After retrofit integration, testing, and optimization of the ignition systems, EGR, and boost levels, the Team anticipates that both ignition systems will enable these spark-ignited HD NG engines to attain or surpass the voluntary CARB goal of Federal Testing Procedure (FTP) verified NO<sub>x</sub> emissions of 0.02g/bhp-hr while demonstrating required levels of performance, drivability, and cost-effectiveness in comparison with standard diesel engines. Upon completion of transient test-cell-based emissions and extensive durability testing, the Project Team will conclude the project with the integration of the proposed systems into heavy-duty Freightliner trucks and perform standardized Portable Emissions Measuring System (PEMS) testing to verify real-world performance and emissions. PEMS tests will be done at installation and again after a substantial in use interval. In this manner, both unique ignition systems can be directly compared for emissions savings, fuel efficiency, maintenance schedules and operating costs to determine suitability for use by OEM and small volume manufacturers of HD on-road, spark-ignited NG engines in California.

#### **C. Goals and Objectives of the Agreement**

##### **Agreement Goals**

The goals of this Agreement are to:

- Enhance the ignition systems of existing spark-ignited NG engines in order to improve performance and reduce emissions through improved EGR and boost pressure use;
- Facilitate the adaptability of developed advanced ignition systems into existing or future heavy-duty natural gas engines;
- Document the durability of ignition and engine components to allow a life time cost analysis as compared to each other and to existing HD engine technologies.

Ratepayer Benefits:<sup>2</sup> This Agreement will result in the ratepayer benefits of 1) increasing natural gas end-use efficiency, 2) potentially dramatically reducing the emissions of particulate matter and NO<sub>x</sub> from the largest source of these emissions on California's roads, and 2) advancing the science and technology of advanced, high-energy ignition systems for spark-ignited, HD NG engines. Specifically, by increasing the level of EGR in a stable and consistent manner, the Project Team will increase the fuel efficiency of spark-ignited, HD NG engines. This will allow for more efficient use of NG as a low-carbon transportation fuel. By optimizing the energy delivery levels of the ignition components and the EGR level and boost levels during transient

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<sup>2</sup> California Public Resources Code, Section 25711.5(a) requires projects funded by the Electric Program Investment Charge (EPIC) to result in ratepayer benefits. The California Public Utilities Commission, which established the EPIC in 2011, defines ratepayer benefits as greater reliability, lower costs, and increased safety (See CPUC "Phase 2" Decision 12-05-037 at page 19, May 24, 2012, [http://docs.cpuc.ca.gov/PublishedDocs/WORD\\_PDF/FINAL\\_DECISION/167664.PDF](http://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/FINAL_DECISION/167664.PDF)).

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operations, the Project Team will advance the science and technology of advanced, high-energy ignition systems for spark-ignited, HD NG engines.

Both the ACIS and VOICE ignition systems have advanced electronic control capable of nanosecond variations in the energy delivered to the cylinder. This allows many opportunities to adjust the ignition event to more efficiently match the in cylinder requirements for stable combustion under emissions optimized conditions. Using advanced engine control strategies to exploit this capability will lead to a more fuel-efficient NG engine while also dramatically reducing NO<sub>x</sub> and particulate matter (PM) emissions.

Technological Advancement and Breakthroughs:<sup>3</sup> This Agreement will lead to technological advancement and breakthroughs to overcome barriers to the achievement of the State of California's statutory energy goals by providing a means for the legacy diesel fleet, as well as new fleet vehicles to reduce their greenhouse gas (GHG) emissions and move to a lower carbon fuel source in alignment with the goals of AB32 and the Low Carbon Fuel Standard in an economically viable manner. CARB created the retroactive Truck and Bus regulations as they recognized that the greatest gains in emissions reductions were to be made by modernization of the legacy diesel fleet, but that turnover rates for HD fleets are too low to allow new technology penetration to have much of an effect if only available on new HD vehicles. While directed at PM reduction, this also holds true for all GHG emissions.

The technology that will be documented here will allow highly fuel-efficient and low-GHG-emitting engines to be built and retrofitted into existing high fuel use vehicles through an already established market pathway, the diesel engine remanufacturing process. By introducing the technology demonstrated here into the remanufacturing process, California can achieve rapid reductions in emissions of PM, NO<sub>x</sub> and carbon dioxide (CO<sub>2</sub>), move fleets to a lower-carbon fuel source, create green jobs in California, and create the lowest-carbon-footprint fleet through reuse of high-carbon-cost materials rather than importing newly forged engines and vehicles. Nearly 2 million trucks are subject to the CARB retroactive emission regulations. This technology and the pathway it enables addresses these vehicles directly and will have a much greater impact than only equipping new vehicles with new technology.

#### **Agreement Objectives**

The objectives of this Agreement are to:

- Integrate a Federal-Mogul ACIS Plasma Ignition system into an existing NG engine from Daimler Trucks North America-Detroit Diesel Corporation (Remanufacturing Division).
- Integrate a Delphi VOICE ignition system into an existing NG engine from Daimler Trucks North America-Detroit Diesel Corporation (Remanufacturing Division).
- Optimize both ignition systems (EGR rates, turbo boost levels, and ignition energy input).
- Achieve NO<sub>x</sub> emissions at or below CARB's voluntary goal of 0.02g/hph for the integrated ACIS ignition/engine system as demonstrated by FTP testing.

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<sup>3</sup> California Public Resources Code, Section 25711.5(a) also requires EPIC-funded projects to lead to technological advancement and breakthroughs to overcome barriers that prevent the achievement of the state's statutory and energy goals.

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- Achieve NO<sub>x</sub> emissions at or below 0.02g/bhp-hr for the integrated VOICE ignition/engine system as demonstrated by FTP testing.
- Durability-test each integrated ignition/engine system for 500 hours in a rapid-aging, high-stress test cycle.
- Integrate an ACIS- and a VOICE-optimized engine into an on-road Class 8 vehicle for on-road PEMS, drivability, and serviceability testing at initial installation and after a substantial time in service to document real-world emissions and durability.

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### II. TASK 1 GENERAL PROJECT TASKS

#### PRODUCTS

##### Subtask 1.1 Products

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

##### The Recipient shall:

###### For products that require a draft version

- Submit all draft products to the CAM for review and comment in accordance with the Project Schedule (Part V). The CAM will provide written comments to the Recipient on the draft product within 15 days of receipt, unless otherwise specified in the task/subtask for which the product is required.
- Submit the final product to the CAM once agreement has been reached on the draft. The CAM will provide written approval of the final product within 15 days of receipt, unless otherwise specified in the task/subtask for which the product is required.
- If the CAM determines that the final product does not sufficiently incorporate his/her comments, submit the revised product to the CAM within 10 days of notice by the CAM, unless the CAM specifies a longer time period.

###### For products that require a final version only

- Submit the product to the CAM for approval.
- If the CAM determines that the product requires revision, submit the revised product to the CAM within 10 days of notice by the CAM, unless the CAM specifies a longer time period.

###### For all products

- Submit all data and documents required as products in accordance with the following Instructions for Submitting Electronic Files and Developing Software:

- **Electronic File Format**

Submit all data and documents required as products 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 products under this Agreement, and establishes the software versions that will be required to review and approve all software products:

- Data sets will be in MS Access or MS Excel file format

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- (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 Recipient 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.

#### **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 Recipient 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 Recipient 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;
- Administrative products (subtask 1.1);

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- 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;
  - Technical products (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.
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- Provide an *Updated Project Schedule*, *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 Recipient a *Kick-off Meeting Agenda*.

#### **Recipient Products:**

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

#### **CAM Product:**

- 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, products, schedule, or budget. CPR meetings provide the opportunity for frank discussions between the Energy Commission and the Recipient. 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 Recipient, 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 Recipient, 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.

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#### **The Recipient 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 Products* 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 products 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 Recipient's input.
- Send the Recipient 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 Recipient 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, products, 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 Recipient with a *Progress Determination* on continuation of the project, in accordance with the schedule. The Progress Determination may include a requirement that the Recipient revise one or more products.

#### **Recipient Products:**

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

#### **CAM Products:**

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

#### **Subtask 1.4 Final Meeting**

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

#### **The Recipient 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 Recipient 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,

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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 products).
  - Need to document the Recipient's disclosure of "subject inventions" developed under the Agreement.
  - "Surviving" Agreement provisions such as repayment provisions and confidential products.
  - Final invoicing and release of retention.
  
- Prepare a *Final Meeting Agreement Summary* that documents any agreement made between the Recipient and Commission staff during the meeting.
- Prepare a *Schedule for Completing Agreement Closeout Activities*.
- Provide *All Draft and Final Written Products* on a CD-ROM or USB memory stick, organized by the tasks in the Agreement.

### Products:

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

## 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 Recipient shall:

- Submit a monthly *Progress Report* to the CAM. Each progress report must:
  - Summarize all Agreement activities conducted by the Recipient for the preceding month, including an assessment of the ability to complete the Agreement within the current budget and any anticipated cost overruns. See the Progress Report Format Attachment for the recommended specifications.
  - Provide a synopsis of the project progress, including accomplishments, problems, milestones, products, schedule, fiscal status, and any evidence of progress such as photographs.
- Submit a monthly or quarterly *Invoice* that follows the instructions in the "Payment of Funds" section of the terms and conditions. In addition, each invoice must document and verify:
  - Energy Commission funds received by California-based entities;
  - Energy Commission funds spent in California (*if applicable*); and

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- Match fund expenditures.

#### **Products:**

- 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 and approve 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 Recipient must use a Style Manual provided by the CAM.

#### **Subtask 1.6.1 Final Report Outline**

##### **The Recipient shall:**

- Prepare a *Final Report Outline* in accordance with the *Style Manual* provided by the CAM.
- Submit a draft of the outline to the CAM for review and comment.
- Once agreement has been reached on the draft, submit the final outline to the CAM. The CAM will provide written approval of the final outline within 10 days of receipt.

##### **Recipient Products:**

- Final Report Outline (draft and final)

##### **CAM Products:**

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

#### **Subtask 1.6.2 Final Report**

##### **The Recipient shall:**

- Prepare a *Final Report* for this Agreement in accordance with the approved Final Report Outline and the Style Manual provided by the CAM.
- Submit a draft of the report to the CAM for review and comment. Once agreement on the draft report has been reached, the CAM will forward the electronic version for Energy Commission internal approval. Once the CAM receives approval, he/she will provide written approval to the Recipient.
- Submit one bound copy of the Final Report to the CAM.

##### **Products:**

- Final Report (draft and final)

##### **CAM Product:**

- Comments on Draft Final Report

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### MATCH FUNDS, PERMITS, AND SUBCONTRACTS

#### **Subtask 1.7 Match Funds**

The goal of this subtask is to ensure that the Recipient 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 Recipient may spend match funds for this task. The Recipient 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 Recipient must obtain any associated commitments before incurring any costs for which the Recipient will request reimbursement.

#### **The Recipient shall:**

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

#### **Products:**

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

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#### **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 Recipient may incur any costs related to the use of the permit(s) for which the Recipient will request reimbursement.

#### **The Recipient 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 Recipient will follow in applying for and obtaining the permits.

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.

#### **Products:**

- 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 Recipient 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.

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- 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).

#### **Products:**

- 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;
  - 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 products and provide recommendations for needed product 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 products.

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.

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#### **The Recipient 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.

#### **Products:**

- 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.

#### **The Recipient 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.

#### **Products:**

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

## EXHIBIT A Scope of Work

### III. TECHNICAL TASKS

*Products that require a draft version are indicated by marking “(draft and final)” after the product name in the “Products” section of the task/subtask. If “(draft and final)” does not appear after the product name, only a final version of the product is required. **Subtask 1.1 (Products)** describes the procedure for submitting products to the CAM.*

#### **TASK 2 INTEGRATION, TESTING, AND OPTIMIZATION**

The goals of this task are to procure all necessary equipment and materials, to integrate the ignition systems with the engines, to test and optimize the resulting systems, and to durability-test the optimized engines/systems.

##### **Subtask 2.1 Pre-Integration Activities**

The goals of this subtask are to: 1) procure all necessary equipment and materials and 2) complete all activities that must be finished before the integration process can begin.

##### **The Recipient shall:**

- Prepare and provide an *Integration Equipment and Materials List*. This document will include all equipment and materials necessary for all Subtask 2.2 and Subtask 2.3 activities.
- Purchase or otherwise procure all items on *Integration Equipment and Materials List*.
- Prepare and provide *Engine Specifications* for Daimler Trucks North America-Detroit Diesel Corporation (Remanufacturing Division).
  - (a) NAR compressed natural gas CNG Specific Head with valves and valve seals for CNG use
  - (b) NAR CNG Specific Pistons
  - (c) Intake and exhaust manifolds per NAR
- Order four 12.7-liter NAR spec CNG Series 60 engines from Daimler Trucks North America-Detroit Diesel Corporation (Remanufacturing Division).
- Order/purchase all other required equipment and materials, including:
  - Spark plugs for VOICE
  - Spares as needed for ACIS and VOICE systems
  - CNG specific oil and other consumables
- Develop and provide a *Data Collection Test Plan*. This plan will include:
  - Economic data
    - Integration costs
    - System component costs
    - System maintenance costs
    - Fuel costs/economy
  - Emissions data, including:
    - NO<sub>x</sub>
    - Particulate matter
    - Non-methane Organic Gases (NMOG)
    - Carbon Monoxide (CO)
    - Total Hydrocarbons (THC)
    - All other criteria pollutants as detailed in the Code of Federal Regulations (CFR) for the FTP.
    - Emissions Deterioration Factor (DF)
    - Total GHG emissions per mile

## EXHIBIT A Scope of Work

- Performance data, including;
  - Horsepower
  - Torque
  - Drivability
  - Drive-cycle-specific fuel economy
- Install engines on dynamometers
- Confirm functionality of engines and base calibration
- Prepare and provide a *Engine Optimization Test Plan* describing test objectives, procedures, conditions, facilities, and equipment.
- Execute *Engine Optimization Test Plan*.

### Products:

- Integration Equipment and Materials List
- Engine Specifications
- Data Collection Test Plan
- Engine Optimization Test Plan

### Subtask 2.2 Integration and Optimization

The goals of this task are to integrate the ACIS and VOICE ignition systems with the engines and to test and optimize the resulting systems.

### The Recipient shall:

- Prepare and provide an *Integration Activities Plan*. This plan will include a summary of all activities necessary for integration of the ACIS and VOICE ignition systems with the engines from Daimler, including:
  - Alteration of heads and/or pistons to accommodate ignition components as needed
  - Design of any brackets or component bracing needed to mount components to engine
  - Computer analysis of mounting for vibrational tolerance
  - EGR system design for high flow, tight control
- Prepare *Integration Test Plan* describing test objectives, procedures, conditions, facilities, and equipment. The goals of this test are to:
  - Optimize EGR use for stable, reliable maximum reductions in NO<sub>x</sub>
  - Optimize turbo sizing and control for greatest turbo efficiency
  - Optimize Ignition System parameters for maximal life without compromising above goals
- Execute *Integration Activities Plan*.
- Execute *Integration Test Plan*.
- Collect data in accordance with the *Data Collection Test Plan*.

### Products:

- Integration Activities Plan
- Integration Test Plan

### Subtask 2.3 Durability Testing

The goal of this task is to perform 500 hours of durability testing on the integrated ACIS and VOICE ignition/engine systems.

## EXHIBIT A Scope of Work

### The Recipient shall:

- Prepare and provide a *Durability Test Plan* describing test objectives, procedures, conditions, facilities, and equipment. Test will include:
  - Operation of the integrated ACIS ignition/engine system for a total of 500 hours under the following operational conditions:
    - McLaren Standardized HD engine rapid aging/high stress protocol utilizing pump quality CNG fuel
    - Fully instrumented and monitored to document in cylinder performance
  - Operation of the integrated VOICE ignition/engine system for a total of 500 hours under the following operational conditions:
    - McLaren Standardized HD engine rapid aging/high stress protocol utilizing pump quality CNG fuel
    - Fully instrumented and monitored to document in cylinder performance
  - Each engine's cylinders will be boroscoped and ignition components inspected every 20 hours.
  - At every 100 hours the heads will be removed and CMM inspected. At a minimum the following will be done:
    - Document valve wear
    - Cylinder bore and piston wear evaluated
    - EGR components inspected
    - Examination of both integrated ignition systems' components for wear or abnormality.
    - Oil Analysis
    - Coolant Analysis
  - At 500 hours the entire engine will be disassembled and all components examined for wear.
  - Barring significant wear issues being identified, the engines will be reassembled with these same components.
- Execute *Durability Test Plan*.
- Collect data in accordance with the *Data Collection Test Plan*.
- Prepare and provide *Durability Test Results* to report the test results from durability testing.

### Products:

- Durability Test Plan
- Durability Test Results

### TASK 3 ENGINE EMISSIONS TESTING

The goals of this task are to demonstrate tailpipe emissions of the optimized and durability tested ACIS- and VOICE-equipped engines via the EPA-defined FTP for on-road HD engines in a CFR 1065 compliant emissions test cell.

### The Recipient shall:

- Prepare and provide an *Engine Emissions Testing Plan*. This plan to include a list of all critical activities, procedures, conditions, facilities, and equipment. The basic sequence of activities follows:
  - Installation into a 1065 compliant Emissions Dynamometer test cell
  - Documentation of correct CNG fuel for testing
  - Running of the engines per the EPA FTP protocol as for on road HD engines

## **EXHIBIT A**

### **Scope of Work**

- Execute the *Engine Emissions Testing Plan*.
- Collect data in accordance with the *Data Collection Test Plan*.
- Prepare and provide an *Engine Emissions Testing Report*.
- Attend Critical Project Review (CPR) Meeting as per task 1.3. and prepare a *CPR Report*.

#### **Products**

- Engine Emissions Testing Plan
- Engine Emissions Testing Report (draft and final)
- CPR Report

#### **TASK 4 FIELD TESTING**

The goals of this task are to integrate each of the optimized and durability- and emissions-tested ACIS- and VOICE-equipped engines into a Freightliner heavy-duty truck and to perform on-road field-testing. Field testing for the emissions portion (PEMS) will be done under the standards and guidelines established by EPA, CARB and the Engine Manufacturers Association for in use testing of heavy-duty vehicles. Other on-road testing for drivability and durability will be under a variety of environmental extremes and duty cycles (urban, highway, heavy load) to document performance.

#### **The Recipient shall:**

- Prepare and provide a *Freightliner Integration Plan*. This plan to include a list of all critical integration activities, procedures, conditions, facilities, and equipment. The basic sequence of activities follows:
  - Conversion of the Truck fuel system to CNG to National Highway Transportation Safety Administration/National Fire Protection Association 52 standards
  - Installation of the ACIS and VOICE equipped engines
  - Address any serviceability access issues to components
  - Design and creation of an engine and vehicle wiring harness
  - Integration of the vehicle chassis electronics and controller area network bus with the NAR engine management system
  - Test driving and debugging of any vehicle integration issues
- Execute the *Freightliner Integration Plan*.
- Prepare and provide a *Freightliner Test Plan*. This plan to include a list of all critical field testing activities, procedures, conditions, facilities, equipment, and operating conditions. The basic sequence of activities follows:
  - Drivability testing include cold and hot starts, variable driving conditions and loads
  - Fuel Economy Documentation
  - PEMS as currently mandated for in-use engine certified heavy-duty diesel vehicles.
- Execute the *Freightliner Test Plan*.
- Collect data in accordance with the *Data Collection Test Plan*.
- Prepare and provide a *Field Testing Report* which will include the results of the execution of the *Freightliner Test Plan*.

#### **Products**

- Freightliner Integration Plan
- Freightliner Test Plan

## EXHIBIT A Scope of Work

- Field Testing Report (draft and final)

### **TASK 5 EVALUATION OF PROJECT BENEFITS**

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

#### **The Recipient 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.

## **EXHIBIT A**

### **Scope of Work**

- 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.
- An estimate of how the project information has affected energy use and cost, or have 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 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.
- Respond to CAM questions regarding responses to the questionnaires.

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

#### **Products:**

- 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 Recipient 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

## **EXHIBIT A**

### **Scope of Work**

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

#### ***Products:***

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

#### **IV. PROJECT SCHEDULE**

Please see the attached Excel spreadsheet.

STATE OF CALIFORNIA

STATE ENERGY RESOURCES  
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION - RE: NORTH AMERICAN REPOWER, LLC

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

**RESOLVED**, that the Energy Commission approves Agreement PIR-14-009 from PON-14-501 with **North American Repower, LLC** for a **\$750,000** grant to optimize, test and demonstrate two advanced ignition systems for heavy-duty natural gas engines; 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 April 8, 2015

AYE: [List of Commissioners]

NAY: [List of Commissioners]

ABSENT: [List of Commissioners]

ABSTAIN: [List of Commissioners]

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Harriet Kallemeyn,  
Secretariat