

GRANTS/CONTINGENT AWARD REQUEST



To: Grants and Loans Office

Date: 3/1/2013

Project Manager: Reynaldo Gonzalez

Phone Number: 916-327-1334

Office: Energy Generation Research Office

Division: Energy Research and Development

MS- 43

Project Title: Benefits of Dynamic Skip Fire for Improved Natural Gas Engine Performance

Type of Request: (check one)

[X] New Agreement: (include items A-F from below) Agreement Number: Assigned by G&L Office
Program: PIER NG / Transportation
Solicitation Name and/or Number: PON-12-504-10 (Research and Development of Advanced Natural Gas
Legal Name of Recipient: The Regents of the University of California on behalf of the Berkeley campus
Recipient's Full Mailing Address: 2195 HEARST AVE
BERKELEY, CA 94720-1083
Recipient's Project Officer: Robert Dibble Phone Number: 510-642-0215
Agreement Start Date: 7/1/2013 Agreement End Date: 6/30/2015

[] Amendment: (Check all that apply) Agreement Number:
[] Term Extension - New End Date:
[] Work Statement Revision (include Item A from below)
[] Budget Revision (include Item B from below)
[] Change of Scope (include Items A - F as applicable from below)
[] Other:

ITEMS TO ATTACH WITH REQUEST:

- A. Work Statement B. Budget C. Recipient Resolution, if applicable. (Resolution may be requested in Special Conditions if not currently available.) D. Special Conditions, if applicable. E. CEQA Compliance Form F. Other Documents as applicable
• Copy of Score Sheets
• Copy of Pre-Award Correspondence
• Copy of All Other Relevant Documents

California Environmental Quality Act (CEQA)

[X] CEC finds, based on recipient's documentation in compliance with CEQA:
[X] Project exempt: 14 CCR section 15061(b)(3) NOE filed:
[] Environmental Document prepared: NOD filed:
[] Other:
[X] CEC has made CEQA finding described in CEC-280, attached

Funding Information:

*Source #1: NG Amount: \$ 600,000.00 Statute: 11- FY: 12-13 Budget List #: 501.001F
*Source #2: Amount: \$ Statute: FY: Budget List #:
*Source #3: Amount: \$ Statute: FY: Budget List #:

If federally funded, specify federal agreement number:

* Source Examples include ERPA, PIER-E, PIER-NG, FED, GRDA, ARFVT, OTHER.

Business Meeting Approval: (refer to Business Meeting Schedule)

Proposed Business Meeting Date: 5/8/2013 [] Consent [X] Discussion
Business Meeting Participant: Reynaldo Gonzalez Time Needed: 5 minutes

Agenda Notice Statement: (state purpose in layperson terms)

Possible approval of a [X] Grant / [] Contingent Award to...
Possible approval of agreement PIR-xx-xxx in the amount of \$600,000.00 with The Regents of the University of California on behalf of the Berkeley campus to develop an advanced natural gas engine. The length of this agreement is 24 months.

Exhibit A WORK STATEMENT

TECHNICAL TASK LIST

Task #	CPR	Task Name
1		Administration
2		Fuel Economy with Skip Fire Technology
3	X	Boosted Operation with Skip Fire Technology
4		Data Collection and Analysis
5		Technology Transfer Activities
6		Production Readiness Plan

KEY NAME LIST

Task #	Key Personnel	Key Subcontractor(s)	Key Partner(s)
1	Robert Dibble, UC Berkeley		
2			
3			
4			
5			
6			

GLOSSARY

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

Term/ Acronym	Definition
CAFE	Corporate Average Fuel Economy
CPM	Commission Project Manager
CPR	Critical Project Review
DFS	Dynamic Skip Fire
ERDD	Energy Research and Development Division

Problem Statement:

The performance of existing spark-ignited natural gas engines can be greatly improved by removing losses incurred under part load and by increasing power density. Achieving part loads via a throttle valve presents a technical barrier because it causes significant loss in fuel economy. Among many potential technologies being researched, skip fire technologies have evolved and are proving to be effective. The basic concept of skip fire operation is to use firings or non-firings of engine cylinders to satisfy engine torque demand rather than throttling or other torque reduction mechanisms that degrade the overall thermal efficiency of the engine.

With the advantages of low cost and straightforward hardware implementation, various skip fire technologies have already been incorporated into commercial spark ignition gasoline engines. New skip fire technologies in combination with improved cylinder deactivation are being developed for gasoline-fuel spark ignition engines to achieve additional fuel savings, while meeting emissions standards with a 3-way catalyst. Due to the small market of natural gas engines, the potential benefits of these new technologies have not been fully explored. This project will involve the investigation of the benefits of a skip fire approach in natural gas spark-ignited engines.

Goals of the Agreement:

The goal of this Agreement is to improve natural gas engine fuel economy using advanced skip firing technologies in combination with cylinder deactivation under naturally aspirated and boosted intake.

Objectives of the Agreement:

The objectives of this Agreement are to: (1) demonstrate fuel economy savings of 20% on a General Motors V-8 6.2 Liter engine with skip fire technologies under a 2-cycle Corporate Average Fuel Economy (CAFE) formula without boost; (2) improve power density using boosted intake conditions; and (3) meet emissions standards with a 3-way catalyst.

TASK 1 ADMINISTRATION

Task 1.1 Attend Kick-off Meeting

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

The Recipient shall:

- Attend a “Kick-Off” meeting with the Commission Project Manager (CPM), the Grants Officer, and a representative of the Accounting Office. The Recipient shall bring its Project Manager, Agreement Administrator, Accounting Officer, and others designated by the CPM to this meeting. The administrative and technical aspects of this Agreement will be discussed at the meeting. Prior to the kick-off meeting, the CPM will provide an agenda to all potential meeting participants.

The administrative portion of the meeting shall include, but not be limited to, the following:

- Discussion of the terms and conditions of the Agreement
- Discussion of Critical Project Review (Task 1.2)
- Match fund documentation (Task 1.6) *No work may be done until this documentation is in place.*

- Permit documentation (Task 1.7)
- Discussion of subcontracts needed to carry out project (Task 1.8)

The technical portion of the meeting shall include, but not be limited to, the following:

- The CPM's expectations for accomplishing tasks described in the Scope of Work
- An updated Schedule of Products
- Discussion of Progress Reports (Task 1.4)
- Discussion of Technical Products (Product Guidelines located in Section 5 of the Terms and Conditions)
- Discussion of the Final Report (Task 1.5)

The CPM shall designate the date and location of this meeting.

- Submit an updated Schedule of Products, List of Match Funds, and List of Permits to the CPM.

Recipient Products:

- Updated Schedule of Products
- Updated List of Match Funds
- Updated List of Permits

Commission Project Manager Product:

- Kick-Off Meeting Agenda

Task 1.2 Critical Project Review (CPR) Meetings

The goal of this task is to determine if the project should continue to receive Energy Commission funding to complete this Agreement and to identify any needed modifications to the tasks, products, schedule or budget.

CPRs provide the opportunity for frank discussions between the CPM and the Recipient. The CPM may schedule CPRs as necessary, and CPR costs will be borne by the Recipient.

Participants include the CPM and the Recipient and may include the Commission Grants Officer, the Energy Research and Development Division (ERDD) technical lead, other Energy Commission staff and management, and any other individuals selected by the CPM to provide support to the Energy Commission.

The Commission Project Manager shall:

- Determine the location, date, and time of each CPR meeting with the Recipient. As determined by the CPM, these meetings may take place at the Energy Commission, another location, or via electronic conferencing such as WebEx.

- Send the Recipient the agenda and a list of expected participants in advance of each CPR. If applicable, the agenda shall include a discussion of both match funding and permits.
- Conduct and make a record of each CPR meeting. One of the outcomes of this meeting will be a schedule for providing the written determination described below.
- Determine whether to continue the project, and if so whether modifications are needed to the tasks, schedule, products, and/or budget for the remainder of the Agreement. Modifications to the Agreement may require a formal amendment (please see the Terms and Conditions). If the CPM concludes that satisfactory progress is not being made, he or she will refer the matter to the division management for concurrence.
- Provide the Recipient with a written determination in accordance with the schedule. The determination may include a requirement for the Recipient to revise one or more product(s) that were included in the CPR.

The Recipient shall:

- Prepare a CPR Report for each CPR 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 products identified in this Scope of Work. The Recipient shall submit these documents to the CPM 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.

Commission Project Manager Products:

- Agenda and a list of expected participants
- Schedule for written determination
- Written determination

Recipient Product:

- CPR Report(s)

Task 1.3 Final Meeting

The goal of this task is to close out 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, at a minimum, the Recipient, the Commission Grants Office Officer, and the CPM. The technical and

administrative aspects of Agreement closeout will be discussed at the meeting, which may be divided into two separate meetings at the discretion of the CPM.

The technical portion of the meeting shall involve the presentation of an assessment of the degree to which project and task goals and objectives were achieved, in addition to findings, conclusions, recommended next steps (if any) for the Agreement, and recommendations for improvements. The CPM will determine the appropriate meeting participants.

The administrative portion of the meeting shall involve a discussion with the CPM and the Grants Officer about the following Agreement closeout items:

- Disposition of any equipment purchased with Energy Commission funds
- Energy Commission's request for specific "generated" data (not already provided in Agreement products)
- Need to document Recipient's disclosure of "subject inventions" developed under the Agreement
- "Surviving" Agreement provisions
- Final invoicing and release of retention
- Prepare written documentation of any agreements made between the Recipient and Commission staff during the meeting.
- Prepare a schedule for completing the closeout activities for this Agreement.

Products:

- Written documentation of meeting agreements
- Schedule for completing closeout activities

Task 1.4 Monthly Progress Reports

The goal of this task is to periodically verify that satisfactory and continued progress is made towards achieving the research objectives of this Agreement on time and within budget.

The objectives of this task are to summarize activities performed during the reporting period, to identify activities planned for the next reporting period, to identify issues that may affect performance and expenditures, and to form the basis for determining whether invoices are consistent with work performed.

The Recipient shall:

- Prepare a Monthly Progress Report that summarizes all Agreement activities conducted by the Recipient for the reporting period, including an assessment of the ability to complete the Agreement within the current budget and any anticipated cost overruns. Each progress report is due to

the CPM within 10 days of the end of the reporting period. The recommended specifications for each progress report are contained in the Terms and Conditions of this Agreement.

- In the first Monthly Progress Report and first invoice, document and verify match expenditures and provide a synopsis of project progress (including a discussion of whether match funds have been expended or work funded with match share has occurred after the notice of proposed award but before execution of the grant agreement). If no match funds have been expended or if no work funded with match share has occurred before execution, then state this in the report. All pre-execution match expenditures must conform to the requirements in the Terms and Conditions of this Agreement.
- In each Monthly Progress Report and invoice, document and verify:
 - Funds awarded to California-based entities
 - Funds spent in California
 - Match fund expenditures

Product:

- Quarterly Progress Reports

Task 1.5 Final Report

The goal of the Final Report is to assess the project's success in achieving its goals and objectives, advancing science and technology, and providing energy-related and other benefits to California.

The objectives of the Final Report are to clearly and completely describe the project's purpose, approach, activities performed, results, and advancements in science and technology; to present a public assessment of the success of the project as measured by the degree to which goals and objectives were achieved; to make insightful observations based on results obtained; to draw conclusions; and to make recommendations for further projects and improvements.

The Final Report shall be a public document. If the Recipient has obtained confidential status from the Energy Commission and will also prepare a confidential version of the Final Report, the Recipient shall perform the following activities for both the public and confidential versions of the Final Report.

The Recipient shall:

- Prepare an Outline of the Final Report.
- Prepare a Final Report following the approved outline and the latest version of the Final Report guidelines, which will be provided by the CPM. The CPM shall provide written comments on the Draft Final Report within 15 working days of receipt. The Final Report must be completed at least 90 days before the end of the Agreement Term.
- Submit one bound copy of the Final Report with the final invoice.

Products:

- Draft Outline of the Final Report
- Final Outline of the Final Report
- Draft Final Report
- Final Report

Task 1.6 Identify and Obtain Match Funds

The goal of this task is to ensure that the match funds planned for this Agreement are obtained and applied to this Agreement during the term of this Agreement.

The costs to obtain and document match fund commitments are not reimbursable through this Agreement. Although the Energy Commission budget for this task will be zero dollars, the Recipient may utilize match funds for this task. Match funds shall be spent concurrently or in advance of Energy Commission funds for each task during the term of this Agreement. Match funds must be identified in writing and the associated commitments obtained before the Recipient can incur any costs for which the Recipient

The Recipient shall:

- Prepare a letter documenting the match funding committed to this Agreement and submit it to the CPM at least 2 working days prior to the kick-off meeting. 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 such 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 each cash match fund, its source (including a contact name, address and telephone number), and the task(s) to which the match funds will be applied.
 - Amount of each in-kind contribution, a description, documented market or book value, its 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 shall identify its owner and provide a contact name, address, telephone number, and the address where the property is located.
- Provide a copy of the letter of commitment from an authorized representative of each source of cash match funding or in-kind contributions that these funds or contributions have been secured. For match funds provided by a grant a copy of the executed grant shall be submitted in place of a letter of commitment.
- Discuss match funds and the implications to the Agreement if they are reduced or not obtained as committed, at the kick-off meeting. 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 letter including the appropriate information to the CPM if during the course of the Agreement additional match funds are received.
- Provide a letter to the CPM within 10 days if during the course of the Agreement existing match funds are reduced. Reduction in match funds must be approved through a formal amendment to the Agreement and may trigger an additional CPR.

Products:

- A letter regarding match funds or stating that no match funds are provided
- Copy(ies) of each match fund commitment letter(s) (if applicable)
- Letter(s) for new match funds (if applicable)
- Letter that match funds were reduced (if applicable)

Task 1.7 Identify and Obtain Required Permits

The goal of this task 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. Although the Energy Commission budget for this task will be zero dollars, the Recipient shall budget match funds for any expected expenditures associated with obtaining permits. Permits must be identified in writing and obtained before the Recipient can make any expenditure for which a permit is required.

The Recipient shall:

- Prepare a letter documenting the permits required to conduct this Agreement and submit it to the CPM at least 2 working days prior to the kick-off meeting. If there are no permits required at the start of this Agreement, then state such in the letter. If it is known at the beginning of the Agreement that permits will be required during the course of the Agreement, provide in the letter:
 - A list of the permits that identifies the:
 - Type of permit
 - Name, address and telephone number of the permitting jurisdictions or lead agencies
 - The schedule the Recipient will follow in applying for and obtaining these permits.
- Discuss the list of permits and the schedule for obtaining them at the kick-off meeting and develop a timetable for submitting the updated list, schedule, and copies of the permits. The implications to the Agreement 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 the Progress Reports and will be a topic at CPR meetings.

- If during the course of the Agreement additional permits become necessary, provide an updated list of permits (including the appropriate information on each permit) and an updated schedule to the CPM.
- As permits are obtained, send a copy of each approved permit to the CPM.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the CPM within 5 working days. Either of these events may trigger an additional CPR.

Products:

- Letter documenting the permits or stating that no permits are required
- Updated list of permits as they change during the term of the Agreement (if applicable)
- Updated schedule for acquiring permits as changes occur during the term of the Agreement (if applicable)
- A copy of each approved permit (if applicable)

Task 1.8 Obtain and Execute Subcontracts

The goal of this task is to ensure quality products and to procure subcontracts required to carry out the tasks under this Agreement consistent with the terms and conditions of this Agreement and the Recipient's own procurement policies and procedures. This task will also provide the Energy Commission an opportunity to review the subcontracts to ensure that the tasks are consistent with this Agreement, and that the budgeted expenditures are reasonable and consistent with applicable cost principles.

The Recipient shall:

- Manage and coordinate subcontractor activities.
- Submit a draft of each subcontract required to conduct the work under this Agreement to the Commission Agreement Manager for review.
- Submit a final copy of the executed subcontract.
- If the Recipient decides to add new subcontractors, it shall notify the Commission Agreement Manager.

Products:

- Draft subcontracts
- Final subcontracts

TECHNICAL TASKS

TASK 2 FUEL ECONOMY WITH SKIP FIRE TECHNOLOGY

The goal of this task is to improve fuel economy on natural gas engines using advanced skip firing technologies guided by engine modeling using GTPower.

The Recipient shall:

- Install a General Motors V8 6.2 Liter engine retrofitted with an improved cylinder head in a test cell connecting to a dynamometer, emission analyzers, and equipment for measuring fuel flow rates and cylinder pressure.
- Convert the engine to run on natural gas. Modifications will include fuel injectors manufactured to use natural gas, control software, and a 3-way catalyst designed for natural gas engines.
- Install a natural gas fueling system for natural gas-fueled engines.
- Conduct tests on the V8 engine with natural gas and skip fire technologies.
- Develop/optimize skip fire strategies to improve fuel economy at low load when compared to traditional operation.
- Perform engine performance analysis using GTPower software to facilitate baseline performance analysis.
- Prepare a Skip Fire Fuel Economy Report that includes skip fire strategies to improve fuel economy and engine performance analysis.

Products:

- Skip Fire Fuel Economy Report

TASK 3 BOOSTED OPERATION WITH SKIP FIRE TECHNOLOGY

The goal of this task is to demonstrate that the power density of a natural-gas fueled spark-ignited engine can be increased by the application of boosted intake pressures while maintaining efficient operation at low loads through the use of skip fire technology.

The Recipient shall:

- Install a supercharger and an intercooler on the V8 engine installed in Task 2.
- Perform a test and analyze test results to demonstrate that power density can be increased through the use of boosted intake pressures.
- Perform analysis to show that fuel economy gains through the use of skip fire technology is still applicable (see Task 2).
- Demonstrate that emissions meet California standards with a 3-way catalyst.
- Guide optimization of skip fire technology with GTPower for spark-ignited natural gas engines.
- Prepare Skip Fire Performance Report that includes power density tests, fuel economy analysis, emissions analysis, and optimization analysis.
- Prepare a CPR Report.

Products:

- Skip Fire Performance Report
- CPR Report

TASK 4 DATA COLLECTION AND ANALYSIS

The goals of this task are to collect operational data, analyze the data for economic and environmental impacts, and include the data and analysis in the Final Report.

The Recipient shall:

- Develop a data collection test plan based on input from the CPM. The plan will include but not limited to a discussion of the following:
 - Energy savings and estimated cost savings
 - Greenhouse gas reductions
 - Other non-energy benefits
- Provide data on potential job creation, market potential, economic development, and increased state revenue as a result of expected future expansion.
- Provide an estimate of the project's energy savings and other benefits and potential statewide energy savings once market potential has been realized.
- Compare project performance and expectations provided in the proposal with actual project performance and accomplishments.
- Prepare a Data Analysis Report that includes a data collection test plan, data analysis for economic and environmental impacts, and comparisons of proposed expectations with actual project performance.

Products:

- Draft Data Analysis Report
- Final Data Analysis Report

TASK 5 TECHNOLOGY TRANSFER ACTIVITIES

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

The Recipient shall:

- Prepare a Technology Transfer Plan that explains how the knowledge gained in this project will be made available to the public. The level of detail expected is least for research-related projects and highest for demonstration projects. Key elements from this report will be included in the Final Report.
- Conduct technology transfer activities in accordance with the Technology

Transfer Plan. These activities will be reported in the Monthly Progress Reports.

- Indicate the intended use(s) for and users of the project results.

Products:

- Draft Technology Transfer Plan
- Final Technology Transfer Plan

TASK 6 PRODUCTION READINESS PLAN

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

The Recipient 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 its state of development. As appropriate, the plan will include but not be limited to a discussion of 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"
 - A projected "should cost" for the product when in production
 - The expected investment threshold to launch the commercial product
 - An implementation plan to ramp up to full production

Products:

- Draft Production Readiness Plan
- Final Production Readiness Plan



Award Number: PON-12-504

Date: 3 / 1 / 2013

Note: The Energy Commission Project Managers Manual includes detailed instructions on how to complete this section, with examples of grants that are “Projects” and are not “Projects”. When the Project Manager is completing this section, if questions arise as to the appropriate answers to the questions below, please consult with the Energy Commission attorney assigned to review grants or loans for your division.

1. Is grant/loan considered a “Project” under CEQA? Yes (skip to question #2) No (continue with question #1)

Please complete the following: *[Public Resources Code (PRC) 21065 and 14 California Code of Regulations (CCR) 15378]:*

Explain why the grant/loan is **not** considered a “Project”? The grant/loan will not cause a direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment because grant/loan involves:

2. If grant/loan is considered a “Project” under CEQA: (choose either **IS** or **IS NOT**)

Grant/loan **IS** exempt:

Statutory Exemption: (List PRC and/or CCR section numbers) _____

Categorical Exemption: (List CCR section number) _____

Common Sense Exemption. (14 CCR 15061(b)(3))

Explain reason why the grant/loan is exempt under the above section:

The project involves engine installation, testing, and analysis activities that will not have a significant effect on the environment.

Please attach draft Notice of Exemption (NOE). Consult with the Energy Commission attorney assigned to your division for instructions on how to complete the NOE.

Grant/loan **IS NOT** exempt. The Project Manager needs to consult with the Energy Commission attorney assigned to your division and the Siting Office regarding a possible initial study.