WORK STATEMENT

TECHNICAL TASK LIST

Task #	CPR	Task Name
1	N/A	Administration
2		Procurement of HPDI System
3	X	Combustion concept development
4		Exhaust aftertreatment
5	X	Implementation of Concept on Production Engine
6		Demonstration of Concept in Virtual Vehicle

KEY NAME LIST

Task #	Key Personnel	Key Subcontractor(s)	Key Partner(s)
1	Jan Hellaker - Volvo Technology North America		
2	Arne Andersson - Volvo Technology	Westport Innovations Inc.	
3	Ingemar Magnusson - Volvo Technology		
4	Peter Jozsa - Volvo Technology		
5	Peter Jozsa - Volvo Technology	Westport Innovations Inc.	
6	Ingemar Magnusson - Volvo Technology		

GLOSSARY

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

Term/ Acronym	Definition
ARB	(California) Air Resources Board
CPR	Critical Project Review
EATS	Exhaust After Treatment System
EGR	Exhaust Gas Recirculation
FTIR	Fourier Transform Infrared
FTP	Federal Test Procedure
GHG	Greenhouse Gas
HPDI	High Pressure Direct Injection
HC	Hydrocarbon

Term/ Acronym	Definition
HD	Heavy Duty
NOx	Nitrogen Oxides
OEM	Original Equipment Manufacturer
PAC	Project Advisory Committee
PIER	Public Interest Energy Research
RD&D	Research, Development and Demonstration

Problem Statement:
In the proposed project the High Pressure Direct Injection (HPDI) technology will be implemented in an US10 Volvo 13 L diesel engine. Previous demonstrations of the technology have been made in earlier generations of engines. The HPDI technology will be systematically evaluated using an overall engine system approach. The base engine and the exhaust after treatment system will be adapted and further developed to meet the special requirements of the new combustion technology with the objective to optimize the complete gas engine concept. In a subsequent step, using the experimental developments from the project, the gas engine concept will be implemented in a virtual demonstrator providing means for best possible estimates of the on the road vehicle performance in terms of drivability, efficiency and environmental impact.

In the proposed project the HPDI gas engine concept will be further improved in several aspects. Although hydrocarbon (HC) emissions are relatively low using the HPDI concept the engine will be equipped with an efficient methane oxidizing catalyst in order to avoid increasing GHG emissions. A key to efficient methane oxidizing is thermal management involving both the after treatment and the combustion system. Another means to decrease HC emissions is to improve in-cylinder oxidation by enhanced gas mixing. The fuel efficiency of the engine is also highly dependent on the in-cylinder mixing processes. In the project the effect of in-cylinder swirl on HC emissions as well as on efficiency will be investigated.

Direct involvement by an original equipment manufacturer (OEM) is needed to facilitate the optimization of the complete engine system(including taking the total system cost into account), and to bring the new gas engine technologies to market as quickly as possible.

Goals of the Agreement:
The goal of this Agreement is to evaluate and further improve new heavy duty (HD) gas engine technology with the objective to bring the technologies to market as quickly as possible.

Objectives of the Agreement:
The objectives of this Agreement are to demonstrate an HD gas engine concept characterized by:

- High fuel efficiency, above 45% brake efficiency.
- High gas/diesel ratio, above 90%.
- Exhaust emissions meeting US 10 and additional California Air Resources Board (ARB) regulations.
- Sustainable level of methane emissions.
- Performance in terms of drivability compared to diesel engine.
- Virtual demonstration of engine concept implemented in vehicle.
- Lowered greenhouse gas emissions by 20% compared to a diesel vehicle.

A successful project will accelerate the introduction of the technologies to market.

Product Guidelines:
For complete product guidelines, refer to Section 5 in the Terms and Conditions.

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, 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 Commission Project Manager to this meeting. The administrative and technical aspects of this Agreement will be discussed at the meeting. Prior to the kick-off meeting, the Commission Project Manager 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)
  - Permit documentation (Task 1.7)

  The technical portion of the meeting shall include, but not be limited to, the following:
  - The Commission Project Manager'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 Commission Project Manager shall:

- Designate the date and location of this meeting.

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 Energy Commission and the Recipient. CPRs generally take place at key, predetermined points in the Agreement, as determined by the Commission Project Manager and as shown in the Technical Task List above. However, the Commission Project Manager may schedule additional CPRs as necessary, and any additional costs will be borne by the Recipient.

Participants include the Commission Project Manager and the Recipient and may include the Commission Grants Officer, the Public Interest Energy Research (PIER) Program Team Lead, other Energy Commission staff and Management as well as other individuals selected by the Commission Project Manager 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. These meetings generally take place at the Energy Commission, but they may take place at another location.
- Send the Recipient the agenda and a list of expected participants in advance of each CPR. If applicable, the agenda shall include a discussion on 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 continuing, whether or not 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 Commission Project Manager concludes that satisfactory progress is not being made, this conclusion will be referred to the Energy Commission's Research, Development and Demonstration

(RD&D) Policy Committee for its concurrence.

- Provide the Recipient with a written determination in accordance with the schedule. The written response 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 Commission Project 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.

Commission Project Manager Products:

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

Recipient Products:

- CPR Report(s)

Task 1.3 Final Meeting

The goal of this task is to closeout this Agreement.

The Recipient shall:

- Meet with Energy Commission staff to present the 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 Commission Project Manager. The technical and administrative aspects of Agreement closeout will be discussed at the meeting, which may be two separate meetings at the discretion of the Commission Project Manager.

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

  The administrative portion of the meeting shall be a discussion with the

Commission Project Manager and the Grants Officer about the following Agreement closeout items:

- What to do with any equipment purchased with Energy Commission funds (Options).
- 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, such as repayment provisions and confidential Products.
- Final invoicing and release of retention.
- 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 Quarterly 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 Quarterly Progress Report which 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 Commission Project Manager 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.

Products:

- 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 RD&D projects and improvements to the PIER project management processes.

The Final Report shall be a public document. If the Recipient has obtained confidential status from the Energy Commission and will be preparing a confidential version of the Final Report as well, 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 PIER Final Report guidelines published on the Energy Commission's website at **http://www.energy.ca.gov/contracts/pier/contractors/index.html** at the time the Recipient begins performing this task, unless otherwise instructed in writing by the Commission Project Manager. Instead of the timeframe listed in the Product Guidelines located in Section 5 of the Terms and Conditions, the Commission Project Manager shall provide written comments on the Draft Final Report within fifteen (15) working days of receipt. The Final Report must be completed on or 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 Matching Funds

The goal of this task is to ensure that the match funds planned for this Agreement are obtained for 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 PIER 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 PIER 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 will request reimbursement.

The Recipient shall:

- Prepare a letter documenting the match funding committed to this

Agreement and submit it to the Commission Project Manager 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, and 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 and 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.
- 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 the appropriate information to the Commission Project Manager if during the course of the Agreement additional match funds are received.
- Notify the Commission Project Manager 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 PIER 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 Commission Project Manager 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 the 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 the appropriate information on each permit and an updated schedule to the Commission Project Manager.
- As permits are obtained, send a copy of each approved permit to the Commission Project Manager.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the Commission Project Manager within 10 days. Either of these events may trigger an additional CPR.

Products:

- Letter documenting the permits or stating that no permits are required
- A copy of each approved permit (if applicable)
- 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)

TECHNICAL TASKS

TASK 2 PROCUREMENT OF HPDI SYSTEM

The goal of this task is to procure necessary HPDI components prior to engine tests.

The Recipient shall:

- Procure HPDI system:

- Rail control module.
- Injectors for different configurations.
- Common rail pump suitable for 1-cyl engine fuel flow.
- Harness.

- Provide necessary engineering support:
  - Nozzle configurations.
  - Multi injection.
  - 1-cyl adaptation.
- Prepare an HPDI report of procured components and system status.

Products:

- Draft Report on all HPDI components to be installed
- Final Report on all HPDI components to be installed
- Draft HPDI report on procured components
- Final HPDI report on procured components

TASK 3 COMBUSTION CONCEPT DEVELOPMENT

The goal of this task is to evaluate and improve the overall HPDI gas engine combustion concept with a low cost perspective.

Previous investigations of the HPDI combustion concept indicate a potential to reduce the combustion duration by enhancing the in-cylinder mixing process, especially when operating the engine with high levels of EGR. Reducing the combustion duration is generally believed to be beneficial to reduce engine out HC emissions. Reducing the combustion duration also provides opportunities to improve the efficiency of the engine. The main procedure to influence the in-cylinder mixing will be variation of the swirl level, i.e. the degree of rotational motion of the in-cylinder charge. A method to accomplish such swirl variations has previously been developed for the single cylinder research engine that will be used in this task, allowing a continuous variation of the swirl number from 0 to 6.

A main objective is to explore the latest US10 diesel engine technology in form of flexible EGR control, highly efficient NOx after treatment and low cost particle trap technology to optimize the overall performance of engine concept focusing on meeting emission and efficiency performance at lowest total cost of the system.

Another main objective is to adapt the combustion process to the requirements put by the novel methane oxidation catalyst system developed in Task 4 and to perform engine tests for the evaluation of the methane oxidation technique.

Task 3.1 Reference testing

The goal for this task is to perform initial tests with software parameter variations that will guide the recipient in setting up a test plan for subsequent hard ware variations.

The Recipient shall:

- Plan and prepare engine lab for gas engine tests.
- Prepare test plan for hardware variations.
- Install and check the functioning of the HPDI system.
- Perform reference state-of-art HPDI engine tests.
- Perform parameter variations of injection timing and EGR.
- Prepare report on reference state-of-art HPDI engine performance.

Products:

- Draft Report on reference state-of-art HPDI engine performance
- Final Report on reference state-of-art HPDI engine performance
- Draft test plan for hardware variations
- Final Test plan for hardware variations

Task 3.2 Engine test with hardware variations

The goal for this task is to perform engine tests involving hardware variations. The sensitivity of swirl on the HPDI combustion process will be tested in a range of swirl numbers from 0 to 6. Also, different injector nozzles will be investigated.

The Recipient shall:

Perform engine tests with first improved HPDI combustion concept.

- Tests at different swirl levels.
- Perform parameter variation with different nozzle configurations.
- Prepare report on HPDI engine performance with optimized hard ware.

Products:

- Draft Report on HPDI engine performance with optimized hard ware
- Final Report on HPDI engine performance with optimized hard ware

Task 3.3 Report on HPDI Engine Performance with optimized hardware

The goal for this task is to perform engine tests in combination with the methane oxidation catalyst and to provide data for a numerical description of the combustion concept including emission. Also, at the completion of this task, the Grant Recipient will submit a CPR report to the Commission and attend a CPR meeting to review the progress.

The Recipient shall:

- Perform engine tests with final improved HPDI combustion concept
- Attend a CPR Meeting.
- Prepare report on HPDI engine performance including methane oxidation catalyst.

Products:

- Draft Report on HPDI engine performance including methane oxidation

catalyst
- Final Report on HPDI engine performance including methane oxidation catalyst
- CPR Report

TASK 4 EXHAUST AFTERTREATMENT

The goal of this task is to develop a low cost aftertreatment system that together with combustion system optimization reduces GHG emissions while complying with US 10 and additional ARB emission regulations.

Research and development in this task will enhance understanding of the exhaust aftertreatment performance in combination of advanced heavy duty gas engine. The main challenge will be the hydrocarbon oxidation of the lean exhaust due to challenges of oxidizing methane. The task consists of three subtasks: simulations, gas bench test and engine tests. Simulations provide the opportunity to identify potential obstacles and to find solutions prior to the experimental work. The Recipient will suggest hardware designs and test prototypes in small scale aftertreatment laboratory. Hardware will be evaluated based on criteria such as conversion efficiency, cost, and durability. The most promising hardware will further be evaluated in engine tests. Important parameters such as temperatures of the exhaust and space velocities in the single-cylinder research engine are varied by using adjustable damper on the inlet of the catalyst and heat exchangers, to be able to simulate multi-cylinder conditions. Final assessment of the Exhaust Aftertreatment System (EATS) concept will be performed in a multi-cylinder engine in Task 5.

Task 4.1 Simulations of exhaust aftertreatment system

The goal of this task is to simulate and map temperatures from exhaust. Simulation will be performed to understand the chemical behavior of the reduction of emissions and thermal/chemical deactivation of aftertreatment system, with focus on cost-efficient aftertreatment configuration. There will also be a special investigation of methane oxidation behavior in order to design a catalytic system. Heat management procedures will be evaluated by calculation and the possibilities to reach ultra-low emission will be investigated.

The Recipient shall:

- Investigate methane oxidation behavior to design a catalytic converter.
- Evaluate heat management procedures.
- Investigate possibilities to reach ultra-low emissions.
- Perform simulations to understand the chemical behavior of the reduction of emissions, thermal/chemical deactivation of aftertreatment system.
- Prepare report on methods and hardware design for cost-efficient aftertreatment system to reach ultra-low emission for advanced heavy duty natural gas engine.

Products:

- Draft Report on methods and hardware design for cost-efficient

aftertreatment system to reach ultra-low emission for advanced heavy duty gas engine

- Final Report on methods and hardware design for cost-efficient aftertreatment system to reach ultra-low emission for advanced heavy duty gas engine

Task 4.2 Synthetic gas bench evaluation of exhaust aftertreatment system
The goal of this task is to identify the most interesting EATS prototypes using a synthetic exhaust gas rig. Different hardware configuration will be examined with the goal to identify the most interesting prototypes for engine bench development. The test will focus on thermal stability, reduced cost and wide operation region of the catalytic system, especially for low temperature activity

The Recipient shall:

- Perform evaluation of different hardware in a synthetic exhaust gas rig.
- Prepare report on hardware selected for further evaluation and development in engine test.

Products:

- Draft report on hardware selected for further evaluation and development in engine test
- Final Report on hardware selected for further evaluation and development in engine test

Task 4.3 Evaluation and development in engine tests
The goal of this task is to evaluate and develop a new, innovative method for heat management including new catalytic materials for low temperature activity of hydrocarbon reduction in order to achieve efficient methane oxidation techniques.

The new technique will lead to high methane oxidation performance from the exhaust aftertreatment system. Special focus will be to develop a cost efficient system with less precious metal without sacrificing high efficiency.

The Recipient shall:

- Evaluate and develop an efficient methane oxidation technique during engine tests.
- Prepare report on methane oxidation technique utilizing a new innovative heat management method.

Products:

- Draft report on methane oxidation technique utilizing a new innovative heat management method
- Final report on methane oxidation technique utilizing a new innovative heat management method

TASK 5 IMPLEMENTATION OF CONCEPT ON PRODUCTION ENGINE

The goal of this task is to assess **the effect of EGR and** the new aftertreatment system, including heat management, on a multi cylinder production engine **and an empirical model simulating real on-the-road driving conditions**.

This task will be accomplished by using a combination of:

1. **test data from a multi-cylinder production-type engine without EGR,**
2. **test data from a single-cylinder engine with EGR,**
3. **test data of methane in engine exhaust using Fourier Transform Infrared(FTIR) spectroscopy,**
4. **data from engine tests with an optimized methane catalyst and**
5. **engine data utilizing advanced heat management procedures.**

The test data from 1-5 above will be processed and refined to form an empirical model representing a multi-cylinder production-type engine with EGR, methane catalyst and advanced heat management procedures. Output from the model in terms of fuel consumption and climate gas emissions will be compared to corresponding data from a reference diesel engine (both engines meeting the US10 emissions regulations) and for real on-the-road driving conditions. ~~It is of greatest importance to be able to evaluate the concept on an engine bench. A production engine will give the necessary properties for an efficient evaluation of the advanced aftertreatment system, the heat management procedure and technologies. The gas engine will be a 6-cylinder production engine equipped with aftertreatment system and heat management technologies, especially for boosting the low temperature activity. The work will be based on the developments made in Tasks 3 and 4.~~

~~A baseline test without EATS will be performed in the engine rig. Additional tests will focus on wide operation region of the catalytic system, designed for low temperature activity. Heat management technology and procedure will be a very important part of the work for the development of a low-cost, robust methane oxidizing aftertreatment system. The heat management procedure can be performed by modifying engine parameters or by using hardware such as counter flow heat exchanger. The engine will then be tested against several test protocols to evaluate the performance of the system. Both stationary test and transient behavior will be evaluated. Final evaluation of the engine performance will be based on FTP (Federal Test Procedure). The FTP heavy-duty transient cycle is currently used for emission testing of heavy-duty on-road engines in the USA [CFR Title 40, Part 86.1333]. The transient test was developed to take into account the variety of heavy-duty truck and buses in American cities, including traffic in and around the cities on roads and expressways. The Federal Test Procedure will be used to evaluate the performance for reaching the project targets within the application. The Fourier Transform Infrared (FTIR) measurement will give more information concerning unregulated emission and identify hydrocarbon species in the exhaust. Also, at the completion of this task, the Grant Recipient will submit a CPR report to the Commission and attend a CPR meeting to review the progress.~~

The Recipient shall:

- **Collect data from a multi-cylinder production-type engine without EGR,**
- **Perform complementary tests with single-cylinder engine with EGR,**
- **Measure methane in engine exhaust using Fourier Transform Infrared (FTIR) spectroscopy,**
- **Collect data from engine tests with an optimized methane catalyst performed in Task 4**
- **Collect data from engine tests utilizing advanced heat management produces performed in Task 4**
- **Process and refine data to form an empirical model representing a multi-cylinder production-type engine with EGR**
- **Evaluated the complete engine concept for real on-the-road driving conditions**
- ~~Install proper equipment on the engine and check the functioning of the system.~~
- ~~Perform engine test to evaluate EATS with heat management procedures.~~
- ~~Perform engine test to evaluate EATS in emission legislation cycles.~~
- ~~Attend a CPR Meeting.~~
- Prepare report on evaluation of the combustion system performance in engine bench both in stationary and transient cycles.

Products

- Draft report on evaluation of the combustion system performance ~~in engine bench both in stationary and transient cycles~~ **for real driving cycle conditions**
- Final report on evaluation of the combustion system performance ~~in engine bench both in stationary and transient cycles~~ **for real driving cycle conditions**
- ~~CPR Report.~~

TASK 6 DEMONSTRATION OF CONCEPT IN VIRTUAL VEHICLE

The goal of this task is to build a virtual demonstrator and to estimate on-the-road performance of the complete vehicle incorporating the new gas engine concept.

The Recipient shall:

- Implement gas engine models in existing vehicle model.
- Perform calculations for a selection of driving cycles primarily focusing on harbor trucks, refuse trucks and long haul within California.
- Prepare report on complete gas engine vehicle performance.

Products:

- Draft report on complete gas engine vehicle performance
- Final report on complete gas engine vehicle performance