2007 GRANT PROPOSAL SOLICITATION
Alternative Fuel Incentive Program (AFIP)

Research and Testing

Grant Summary and Authorization Form

California Air Resources Board
June 2007

Grant Summary and Authorization Form
Alternative Fuel Incentive Program (AFIP) (Pursuant to AB1811)
Fiscal Year 2007-08

Project Title: Assessment of the Emissions from the Use of Biodiesel as a Motor Vehicle Fuel in California-Biodiesel Characterization and NOx Formation and Mitigation Study

Grant Recipient Name: University of California

Authorized Official: Charles Greer

Title: Principal Contract and Grant Officer

Address: Office of Research
200 University Office Building
University of California
Riverside, CA 92521

Phone # (951) 827-3093

AFIP Award: $1,280,000

Total Project Cost: $1,280,000

Time Period: 6/30/07–6/30/09

Tax ID #: 956006142W

Grant #: G06-AF38

The undersigned parties agree to the terms and conditions as set forth in this grant. The following documents are attached and incorporated as part of this grant and take precedence in the following order:

Exhibit A: Grant Provisions
Exhibit B: Work Statement incorporating the following attachments:

The undersigned parties agree to comply with the requirements and conditions contained herein. The undersigned parties certify under the penalty of perjury that they are duly authorized to bind the parties to this grant.

California Air Resources Board:

Signature of Authorized Official

Name: Marie Stephans
Title: Chief, Administrative Services Division
Date: 6/20/07

Grant Recipient:

Signature of Authorized Official

Name: **Charles E. Greer, Jr.**
Title: **Principal Contracts & Grants Officer**
Date: 6/22/07

EXHIBIT A

Alternative Fuel Incentive Program Grant

Air Resources Board
Mobile Source Control & Stationary Source Divisions

GRANT PROVISIONS

1. GRANT PARTIES AND CONTACT INFORMATION

1.1 This grant is from the California Air Resources Board (herein after referred to as ARB) to College of Engineering-Center for Environmental Research and Technology, University of California Riverside.

1.2 The ARB Grant Administrators are Ms. Rozanne McPhee. All administrative correspondence regarding this grant shall be directed to:

Ms. Rozanne McPhee
Administrative Services Division
Air Resources Board
P.O. Box 2815
Sacramento, California 95812
Phone: (916) 324-9907
Email: rmcphee@arb.ca.gov

1.3 The ARB grant manager is Robert Okamoto. All technical correspondence regarding this project shall be directed to:

Robert Okamoto
Air Resources Board
Stationary Source Division
P.O. Box 2815
Sacramento, California 95812
Phone: (916) 327-2953
E-mail: rokamoto@arb.ca.gov

2. TIME PERIOD

2.1 Performance of work or other expenses billable to ARB under this grant may commence after signing and awarding of this grant. However, this grant will not be considered valid, and expenses will not be payable, unless and until the grant is fully executed by ARB. The grant period shall end no later than June 30, 2009.

3. FINANCIAL MATTERS

Budget

3.1 The maximum amount of this grant is $1,280,000. Under no circumstance will ARB reimburse the grantee for more than this amount.

3.2 The budget for this project is shown in Exhibit B, Attachment A. Except as stated in 3.3, the cumulative grant disbursement for any line (cost) item for the entire project shall not exceed the corresponding figure therein under "AFIP Grant".

3.3 The total AFIP funding may be reallocated among cost items or tasks only with the prior approval of the ARB grant manager. The ARB will not unreasonably disapprove budget reallocations provided that they will allow the project to meet its stated goals.

Grant Disbursements

3.4 Requests for payment shall be made with the form "Grant Disbursement Request" (Exhibit B, Attachment E) and conform to the instructions therein. Grant payments shall be made only for reasonable costs incurred by the grantee and only when the tasks stipulated in Exhibit B, Attachment B, have been accomplished, documentation of accomplishment has been provided to ARB, and any associated deliverables have been provided to ARB. Payments shall not be made more frequently than monthly.

3.4 Grant payments are subject to ARB's approval of progress reports and any accompanying deliverables. (See Part 5 below.) A payment will not be made if the ARB grant manager deems that a task has not been accomplished or documented, that a deliverable meeting specifications has not been provided, that claimed expenses are not documented, not valid per the budget, or not reasonable, that the grantee has not met other terms of the grant.

The Chief of the Stationary Source Division of ARB may review the grant manager's approval or disapproval of a grant disbursement. No reimbursement will be made for expenses that, in the judgment of the Division Chief of the Stationary Source Division, are not reasonable or do not comply with the grant.

3.6 The grantee shall mail grant disbursement requests to the grant administrator.

3.7 The ARB shall withhold payment equal to ten percent of the total Agreement cost until completion of all work and submission to ARB by University of a final report (including computer diskette copy) approved by ARB. It is University's responsibility to submit a final grant disbursement form with the revised final report for ten percent withheld.

EXHIBIT B, Attachment A

Budget Summary

Grantee: CECERT-UCR **Grant No.: G06-AF38**

Project: Assessment of the Emissions from the Use of Biodiesel as a Motor Vehicle Fuel in California-Biodiesel Characterization and NOx Formation and Mitigation Study

Costs & Funding

Direct Costs	**Total**
1. Labor	78,734
2. Benefits	13,912
3. Materials & Supplies	77,003
4. Testing	524,020
5. Travel and Subsistence	4,102
6. Subcontractors and Consultants	274,987
Subtotal: 965,286	
7. Others	237,465
(Includes equipment: 70,000)	
Subtotal, Direct Costs:	1,210,223
Indirect Costs	
8. Other Indirect	
Subtotal, Indirect Costs:	69,777
Total	**1,280,000**

EXHIBIT B, Attachment B

Project Tasks

Grantee: CeCERT-UCR **Grant No.: G06-AF38**

Project Title: Assessment of the Emissions from the Use of Biodiesel as a Motor Vehicle Fuel in California-Biodiesel Characterization and NOx Formation and Mitigation Study

Task	Deliverable (in addition to bimonthly progress reports)	Duration[1]
1	Planning and Fuels	13 months
2	Chemical Samples	4 months
3	Chassis Dyno Testing	9 months
4	Engine Dyno Testing	9 months
5	Engine Dyno Testing	10 months
6	Off-Road Engines at Stockton	9 months
7	Speciation and Toxicity and Biological	11 months
8	Compilation of Chemical Data	8 months
9	Preparation of Final Report	Approved no later than June 30, 2009

[1]The tasks are not sequential and overlap. To see a more detailed description of the schedule see page 16 of the grant proposal in Exhibit C.

EXHIBIT B, Attachment C

Grantee's Project Schedule

Task #	Task Content	Scheduled Completion Date (weeks after project start)
1	Planning and Fuels	13
2	Chemical Samples	5
3	Chassis Dyno Testing	12
4	Engine Dyno Testing	12
5	Engine Dyno Testing	18
6	Off-Rod Engines at Stockton	20
7	Speciation and Toxicity and Biological	20
8	Compilation of Chemical Data	21
9	Preparation of Final Report	24

EXHIBIT B, Attachment D

Key Project Personnel

Name	Position	Duties
Dr. Tom Durbin	Co-Principal Investigator	Primary point of contact for CARB staff for all planning and execution project activities. He wil also be primarily responsible for communication, resolution, and overall coordination of activies
Dr. Wayne Miller	Co-Principal Investigator	Dr. Miller will assist with the oversight and development of the overall program, and assist in the preparation of reports/manuscripts documenting the results
Kent Johnson	HDD Mobile Lab Manager	Manage the engine dynamometer testing facilities
Davis Martis	Lab Manager	Manage the engine dynamometer testing facilities
Kathalena Martis	Chemist	Conduct VOC analyses that will be done at UC Riverside
Dr. Reiko Kobayashi	Principal Investigator	Responsible for sample preparation, sample collection, sample shipping, extraction of samples for biological and chemical tests, and analysis of chemical tests
Dr. Norman Kado	Co-Principal Investigator	Responsible for mutagenicity tests and for Comet assay and setup sampling
Dr. Mike Madden	Research Biologist	Responsible for Comet assay
Dr. Fumio Matsumura	Professor	Oversee human lung and macrophage cell assays and data analyses
Dr. Chris Vogel	Assistant Research Scientist	Responsible for selecting proper primers for each marker selected, guide the technical staff for the use of the lightcycler (RT-PCR) and oversee the actual human lung and macrophage cell assays and data anaylsis
Dr. Patrick Wong	Assistant Project Scientist	Responsible for culturing cells, characterization of markers, media selection, maintenance of low passage cultures for human cell and macrophage assays, and the quantitative RT-PCR
Dr. Thomas M. Cahill	Assistant Professor	Responsible for extracting and analyzing carbonyls and provide the sampling tem with the protocol for sampling carbonyls

EXHIBIT B, Attachment E

Grant Disbursement Request and Expenditures Summary

Grant No.: G06-AF38

Project Title: **Assessment of the Emissions from the Use of Biodiesel as a Motor Vehicle Fuel in California-Biodiesel Characterization and NOx Formation and Mitigation Study**

Period covered: Task # (or "summary"):

Please submit a separate form for each project task (defined in Exhibit B, Attachment C) that had expenses during the period, plus a summary form for total expenses in the period.

All expenses to be paid by AFIP must be assigned to a budget line item for which AFIP funds are allowed per Exhibit B, Attachment A (Budget Summary). Attach an itemization of labor charges, showing the numbers of hours spent by each professional member of the grantee's staff or in-kind partner's staff. Provide invoices from subcontractors and identification of goods and services from in-kind supporters.

Direct Costs	**Total**
1. Labor	
2. Benefits	
3. Materials & Supplies	
4. Testing	
5. Travel and Subsistence	
6. Subcontractors and Consultants	
Subtotal:	
7. Others	
(equipment:_____)	
Subtotal, Direct Costs:	
Indirect Costs	
8. Other Indirect	
Subtotal, Indirect Costs:	
Total	

I certify that, to the best of my knowledge and belief, the information contained in the attached progress report, including the accounting of expenditures on the project as summarized above, is correct and complete and is in accordance with the grant. In addition, I hereby authorize the California Air Resources Board to make any inquiries to confirm details in the progress report.

_____ _____
Grantee's Signature Date

_____ _____
ARB's Approval Signature Date

EXHIBIT B, Attachment F

Guidelines for Progress Report Form

Date
Grant No.:
Title:
Organization:
Report period:

List (by number) of all tasks that are completed or partially completed:

Work accomplished in this period (organized by task). For completed tasks, compare results to goals

For any planned work or scheduled task that did not occur:

- Reasons for non-occurrence:
- Will the problem persist?:
- Can the work be accomplished in the next work period?
- Will the nature of tasks or the overall project schedule be affected? (Propose a new schedule, if needed.):

Summarize any changes made during the period in the work plan, budget, or schedule
Please describe any other current or foreseeable problems and their possible mitigation
Work planned for the next reporting period (by task):

Provide narrative as needed to present accomplishments and findings of note.

EXHIBIT C

GUIDELINES FOR FINAL REPORT

Format. If all components of the final report are in a single Microsoft Word file or PDF file, the report may be delivered to ARB on an electronic medium. Otherwise, there should be one unbound, single-sided copy for photo-copying.

Font. Any commonly used font is acceptable if it is at least as large as Arial 12.

Binding. The final report may be either spiral bound or stapled.

Cover. The ARB will provide a standard cover.

Title. The title should duplicate the title of the grant unless a change is approved by the ARB's grant manager.

Page size. 8 1/2" x 11"

Large tables & figures. Do not include foldouts or highly reduced tables or figures. Large tables and figures should be presented on consecutive 8 1/2" x 11" pages, each page containing one portion of the table or graph

Color. Black on white, only.

Sections. The final report should contain the following sections, in this order:

Title page
Disclaimer
Acknowledgments
Table of Contents
List of Figures
List of Tables
Abstract
[body of report]
Appendices

Title page. The title page should include the grant number, grant title, grantee, date, and this statement: "Conducted under a grant by the California Air Resources Board of the California Environmental Protection Agency".

Disclaimer. (may be placed at the bottom of the title page)

"The statements and conclusions in this report are those of the grantee and not necessarily those of the California Air Resources Board. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such products."

Acknowledgments.

The last paragraph of this section should read as follows:

Abstract. The abstract should state the purpose and scope of the project, describe the work performed, and present the results obtained.

The body of the report should contain the following sections:

Introduction

This section should include the reason for the study, background information and literature on biodiesel emissions and NOx mitigation. Scope of study

Experimental

Experimental design
Test Facilities
Materials and Methods
Quality Control and Quality Assurance

Results and Discussion:

Provide narrative of results and present and summarize results of data in tables and figures. Discuss results.

Summary and Conclusions

Appendices Provide detailed data results for QA/QC, laboratory and emissions data, and support information and data in the appendices.

(Also, see page 15 of UCR proposal (Exhibit D) for description of what will be included in the final report.)

The ARB will not regard the final report as a confidential document. Do not include proprietary information.

EXHIBIT D

PROPOSAL

Grant No.: G06-AF38

Assessment of the Emissions from the Use of Biodiesel as a Motor Vehicle Fuel in California-Biodiesel Characterization and NOx Formation and Mitigation Study

Submitted to the
California Air Resources Board
05/18/07

Alternative Fuel Incentive Program (AFIP) (Pursuant to AB1811)
Fiscal Year 2007-08

Attach Proposal

Assessment of the Emissions from the Use of Biodiesel as a Motor Vehicle Fuel in California – Biodiesel Characterization and NO_x Formation and Mitigation Study

Revised June 2007

Official Authorized to Bind this Proposal:

Name: Charles E. Greer, Jr., Office of Research

Signature:

Prepared for:

Bob Okamoto
Stationary Source Division
California Air Resources Board
1001 I Street, 6th Floor
Sacramento, CA 95814

Principal Investigators, Thomas D. Durbin & J. Wayne Miller
College of Engineering-Center for Environmental Research and Technology
University of California
Riverside, CA 92521
(951) 781-5791
(951) 781-5790 fax

Authorized Representative
Charles E. Greer, Jr. Principal Contract and Grant Officer
Office of Research
200 University Office Building
University of California
Riverside, CA 92521
(951) 827-3093
(951) 827-4483 fax
charles.greer@ucr.edu

Table of Contents

Statement of Significance

Renewable fuels are one potentially important strategy to reduce petroleum dependency, air pollution, and greenhouse gases. California has established AB1007 to develop plans to increase the use of alternative fuels in California and has also established greenhouse gas reduction goals. Biodiesel provides potential benefits towards meeting all of these goals. There are a number of limitations in the currently available information about biodiesel, including the true impact on NO_x emissions, how to mitigate NO_x emissions, the potential impact relative to California in-use fuels, the effect of different feedstocks, and the effects for different operating conditions, such as chassis and engine dynamometer testing. CARB is conducting some preliminary work with CE-CERT to evaluate the differences in biodiesel effects for different blend levels and California and EPA fuels. The proposed work will expand on this preliminary study and to investigate the effects of biodiesel under different modes of operation including engine dynamometer, chassis dynamometer transient and steady state, and will a much broader range of biodiesel blended or derived fuels.

Abstract

Increasing the use of biodiesel in the California fleet provides benefits for the enhanced use of alternative fuels and in meeting greenhouse gas reduction targets. This work will build on preliminary testing that is currently being planning to provide a more comprehensive test program for NO_x emissions, and studying different operating conditions, feedstocks, and blend levels. The program will involve engine dynamometer testing and chassis dynamometer testing under transient and steady state conditions. This study will also seek to better understand the mechanism via which NO_x emissions are formed and to find ways to mitigate NO_x emissions from biodiesel use. Testing will include at least 2 different biodiesel feedstocks to evaluate the effects of these differences on emissions and blend levels ranging from B5 to B100. Several potential strategies for reducing NO_x emissions will be investigated including the possibility of match blending or controlling fuel specifications for biodiesel blends, the use of fuel additives, and the new renewable diesel fuels that incorporate biodiesel feedstocks into the refinery process. Intercomparisons will also be made between similar operating conditions on the chassis and engine dynamometer.

Project Background and Objectives

Project Background

The legislature passed AB1007 that requires the ARB and CEC to develop a plan to increase alternative fuels use in California to reduce oil dependency and air pollution. Also, the governor has established aggressive greenhouse emission reduction targets for which the ARB has identified potential strategies such as biodiesel. Biodiesel is an alternative diesel fuel that has the potential to reduce greenhouse gas emissions, other pollutants, and can partially offset our use of petroleum-based fuels. However, knowledge gaps exist and further research is needed in characterizing the impact biodiesel has on NO_x emissions, the effects various feedstocks have on air emissions, and the effect biodiesel has on emissions from off road and post 1997 on road diesel engines. This research is needed to conduct lifecycle analyses and to determine the potential health and environmental benefits and disbenefits of biodiesel. Additionally, for the conditions under which NO_x is found to increase, it is important to identify methods which can mitigate the NO_x increases.

The US EPA published a draft technical report that evaluates the impact of biodiesel on pre 1997 engines. Most of the studies cited in the report were on soy-based biodiesel and its effect on criteria pollutants. A US EPA tier 1 emissions study on criteria and toxic emissions and a tier 2 health effects study were conducted as part of the US EPA fuel registration process. Again, these studies were limited to soy-based biodiesel. Also, a Montreal transit bus study evaluated both criteria and toxic emissions. NREL is currently conducting a study on newer engines. Most of these studies are limited in their direct application to CA because soy-based biodiesel may not be the major feedstock used in CA and or because exhaust emissions from diesel engines fueled with biodiesel were not compared to these engines fueled with CARB diesel. Additionally, most of the available literature has been obtained from engine dynamometer tests, whereas more recent studies have indicated that biodiesel fuels may behave differently in chassis dynamometer or types of tests.

Some studies have also examined mechanisms via which biodiesel might be impacting NO_x emissions. Researchers have suggested a number of explanations including chemical structure (McCormick et al., 2001; Ban Weiss et al., 2005), such as fatty chain length and number of double bonds, or an advancement in timing which could be related to bulk modulus (Szybist et al., 2003 a,b). Some research has also suggested that the impact of biodiesel on NO_x emissions can depend on operating conditions or engine configuration (McCormick et al., 2006). If biodiesel blends are determined to increase NO_x emissions then it is important to find mitigation strategies that make biodiesel NO_x neutral or better when compared to CARB diesel use. It is known that the properties of diesel fuel can affect the emissions of NO_x as well as other emission components (Miller, 2003). It is possible that the fuel specifications of diesel fuel can be altered such that any negative impacts of the biodiesel in the blend could be overcome or such that the properties of the biodiesel blend could be made such that the blend would have the same properties as a typical diesel fuel. Biodiesel could potentially even be incorporated into more traditional petroleum refinery processes as a feedstock. The use of additives and cetane improvers has also shown some potential for reducing NO_x emissions from biodiesel blends (McCormick et al., 2005; Sharp, 1994).

CARB and CE-CERT are conducting a preliminary study to better investigate biodiesel emissions with an emphasis on comparison of biodiesel fuels with CARB diesel fuels. Since much of the emphasis in previous studies has been comparisons with EPA diesel fuel formulations, it is important to better understand the benefits/liabilities relative to California diesel fuels, which tend to have more tightly constrained fuel properties. As part of this program, the emission effects of biodiesel relative to both a CARB diesel fuel and an EPA diesel fuel will be investigated. For this preliminary study, it is planned to test two biodiesel feedstocks with a variety of blend levels. The engine planned for this preliminary study is also expected to be used as one of the primary engines for the present study.

Under this proposed work, this preliminary study will be significantly expanded to investigate a wider range of issues relating to emissions from biodiesel fuels including differences in the effects of biodiesel under different operating conditions. Part of this effort will also focus on better understanding of the principle NOx formation mechanism in biodiesel blends. Research will also be conducted to find ways to mitigate NO_x emissions from biodiesel use including changes in fuel specifications, incorporating biodiesel as a feedstock in the petroleum refinery process, and using additives to reduce NO_x from biodiesel use. Testing will be conducted on an engine dynamometer and on a chassis dynamometer under transient and steady state conditions. Operating conditions will include the FTP, UDDS, and or other potential cycles where cross correlations between chassis and engine dynamometer conditions can be evaluated. For this testing, three biodiesel feedstocks will be utilized with blend levels ranging from B5/10 to B100. A total of up to 6 different engine configurations will be tested under this test program.

Project Objectives

The objective of this program is to provide a comprehensive program to study the effects of biodiesel as a function of type of feedstock, blend level, operating condition/test method, and engine type. A primary emphasis of this program will be understanding the effects of biodiesel on NO_x emissions. Methods by which NO_x emissions from biodiesel blends can be mitigated will also be investigated. Another important objective will be to better understand the effects of differences in operation on biodiesel emissions by comparisons between chassis, on-road, and engine dynamometer testing. Testing will be conducted on at least one engine in a vehicle that will be tested on a chassis dynamometer and have the engine removed for engine dynamometer test so that changes over the different dynamometer conditions. Operating conditions will include the FTP, UDDS, and or other potential cycles where cross correlations between chassis and engine dynamometer conditions can be evaluated. For this testing, at least biodiesel feedstocks will be utilized with blend levels ranging from B5/10 to B100, as well as other specialty blends with unique fuel blending, refinery processing, or the addition of additives. A total of up to 6 different engine configurations will be tested under this test program.

Detailed Work Plan

Overview of Approach

The primary focus of this program will be the testing of different biodiesel feedstocks and blend levels over different operating conditions on an engine dynamometer and a chassis dynamometer under transient and steady state conditions and for different engine types. The scope of work will essentially be divided into nine tasks: Task 1 – program planning and fuel and engine acquisition;

Task 2 – sample media organization and storage; Task 3 – chassis dynamometer testing; Task 4 – engine dynamometer testing for biodiesel characterization; Task 5 – engine dynamometer testing for NO_x mitigaton; Task 6 – Testing of off-road engines at the CARB Stockton facility; Task 7 – Toxicity and Biological Testing; Task 8- Compilation of Speciation, Toxicity, and Biological Testing data; and Task 9 – Reporting

Task 1 Program Planning and Fuel and Engine Acquisition

CE-CERT will work in conjunction with the ARB and appropriate stakeholders to identify test fuels for the program. The test fuels will include a CARB ultralow sulfur diesel (ULSD) and two biodiesel feedstocks. The specific biodiesel feedstocks will be determined as part of the planning process, but will likely include a soy-based biodiesel and a yellow-grease biodiesel. Additionally, a number of different blend stocks will be formulated to evaluate the potential for NO_x mitigation. A summary of the expected approaches for NO_x mitigation is as follows:

Fuel specifications: Fuel specifications will be evaluated to determine if specifications such as distillation and density can be adjusted to result in a NO_x neutral biodiesel fuel. Match blending will be evaluated as part of this effort. Match blending is where the diesel portion is adjusted so that the biodiesel blend has the same physical properties as diesel.

Refinery Processing: The potential of developing a new generation of renewable fuels will be evaluated. These fuels would incorporate biodiesel feedstocks into the refinery process to produce non-oxygenated feedstocks that can be used to produce diesel fuel.

Fuel Additives: The potential impact of fuel additives on reducing NO_x emissions will be evaluated. Promising fuel additives will be utilized in various biodiesel fuels against CARB ULSD fuel.

Funds for the purchase of all fuels are included in the budget. If it is found that fuels can be obtained through in-kind contributions, the monies will be redirected to the testing effort.

Fuel analyses will be conducted on the CARB ULSD (D975) and each of the neat biodiesels (D6751). Fuel analyses will also be conducted on the finished blends at levels of B5, B20, B50, and B100 to ensure/evaluate the quality of the blending.

Several options will be examined for acquisition of testing engines include the Engine Manufacturers Association (EMA) and other interested stakeholders. The costs associated with engine acquisition are planned to be covered under separate funding of $50,000 from the South Coast Air Quality Management District, and as such are not included in the budget for this program.

For the purposes of this study, a technical advisory board will be convened. The technical advisory panel will consist of experts from government, industry, and academia. This could include, but will not be limited to, representatives from the Coordinating Research Council and the National Renewable Energy Laboratory. CE-CERT will work in conjunction with ARB and appropriate stakeholders to review the relevant literature with respect to the impacts of biodiesel on NO_x emissions. CE-CERT will work in conjunction with the ARB and the technical advisory

board to develop a test matrix and matrix of fuel properties, blends, or additives for testing. It is expected that experts from the petroleum industry will provide significant input into this process. A test plan will be developed for the test program and will be provided for CARB approval prior to the initiation of testing. In particular, it is recognized that the technical advisory will provide considerable expertise in the development of a test plan and in the various formulation strategies for the NO_x mitigation portion of the study.

Task 2 Sample Media Organization and Storage

CE-CERT will work in conjunction with the ARB to organize the sample media for collection of samples for subsequent chemical analyses of 1,3 butadiene, VOCs, carbonyls, PAHs, elements, OC/EC, as well as a range of other species. CE-CERT will provide for sample storage and shipping to appropriate laboratories for analysis and to CARB for their use.

Task 3. Chassis Dynamometer Testing at the CARB LA Test Facility

Testing at the CARB chassis dynamometer facility in Los Angeles will be conducted on several vehicles on a CARB base fuel and various blends of the biodiesel feedstocks. The test matrix for a single vehicle is provided in the table below and is expected to be the same or very similar for all vehicles. The blends will range from B5/10 to B100. Test cycles will include the UDDS and another transient test cycle or steady state conditions to be determined. To the extent possible, all testing on a particular vehicle will be conducted over the same period to ensure the most consistent and repeatable data set.

Table 1. Los Angeles CARB Chassis Dynamometer Test Matrix
For each Test Vehicle

	UDDS	Cycle TBD
CARB	3	3
Soy 5	3	3
Soy 20	3	3
Soy [illegible]	3	3
Soy [illegible]	3	3
YG [illegible]	3	3
YG [illegible]	3	3
YG [illegible]	3	3
YG [illegible]	3	3
SU [illegible]	24	24
Total		**48**

A total of three vehicles is anticipated for this program. Each will repeat the same test matrix. For one of the three vehicles, it is planned to have the vehicle equipped with a diesel particulate filter. For this vehicle, the test matrix will be repeated with and without the DPF. The option to test up to two more vehicles on the chassis dynamometer will be considered during the planning process depending on test cell availability and costs.

For at least one vehicle tested on the chassis dynamometer, the engine will be utilized for cross comparisons on an engine dynamometer. This engine will be removed from the vehicle and then utilized in task 4 below. This same engine will also be utilized as part of a pilot project that will be conducted at UC Riverside prior to the chassis dynamometer testing. In conjunction with the chassis dynamometer testing, data on the engine load and rpm will be collected during the ARB transient cycle. These data will be used for subsequently developing an engine dynamometer test cycle to provide operating conditions as similar as possible to those found on the chassis dynamometer.

Task 4. Engine Dynamometer Testing – Biodiesel Characterization Test Matrix

Two engines will be tested over a test matrix that includes blends ranging from B5/10 to B100 for three biodiesel feedstocks. Engine tests will be performed in CE-CERT's Engine Dynamometer Test Laboratory. At least one of the engines will be the same as that being used for chassis dynamometer testing at CARB's chassis dynamometer test facility in Los Angeles. The engine removal will be performed by a local outside repair facility that CE-CERT works with on a regular basis.

Test cycles will include the FTP and a UDDS cycle performed at two different loads. The UDDS cycles will be based on the engine parameters gather during the chassis dynamometer testing at the CARB facility. The UDDS cycles will be programmed into the engine dynamometer computer program. The software for the dynamometer computer will be upgraded to allow the addition of different cycles with different transient conditions.

A proposed sample test matrix that will be used for both engines is provided in the table below. The test matrix includes replicates for the CARB diesel fuel to provide a measure of long-term repeatability. The engine tests will be performed over the same testing period to the extent possible, to allow the best comparability over the set of fuels to be tested. For each test matrix point, 6 test cycle iterations will be performed in a single test day.

Table 2. Engine Dynamometer Test Matrix for each Engine

	Engine 1		
	FTP	UDDS (Load 1)	UDDS (Load 2)
CARB	6	6	6
SoyB5/10	6	6	6
SoyB20	6	6	6
SoyB50	6	6	6
SoyB100	6	6	6
CARB	6	6	6
YGB5/10	6	6	6
YGB20	6	6	6
YGB50	6	6	6
YGB100	6	6	6
Sub total	**60**	**60**	**60**
Total			**180**

Samples for chemical analysis for assays, PAHs, and nitroPAHs will be collected for tests number in parentheses for the FTP test cycle iteration, but only for a single engine. This represents a total of 27 samples. Samples for detailed hydrocarbons C_1-C_{12} and carbonyls will be collected for the tests noted in parentheses and shaded in turquoise, but for both engines. This represents a total of 48 samples.

Since it is planned that one of the two test engines planned for this portion of the testing will be utilized, a portion of the testing shown in this test matrix could potentially be performed during the preliminary study. This could include, for example, the testing associated with the FTP test cycles for the base fuel and the different blend levels on the Soy-based biodiesel fuel. If such cost saving are realized, the test matrix could potentially be expanded to evaluate other test parameters of interest.

Task 5. Engine Dynamometer Testing – NO_x Mitigation Test Matrix

The test matrix for the engine testing is designed around testing two engines over a range of different potential feedstock/additive combinations. The different biodiesel blend formulations or additive combinations are generically termed blend formulations 1-6 in the test matrix below. The specific combinations of blend or additive formulations will be determined in conjunction with the technical advisory committee. This also provides flexibility in the number of biodiesel blends that will be specified in either the fuel specification, match blend, refinery blend, or additive categories. For each blend formulation, two variations are included in the test matrix, as denoted as "a" and "b". This will allow for the testing of two applications of a formulation that shows promise, be it two levels of biodiesel blend or two levels of an additive. The test matrix includes replicates for the CARB diesel fuel to provide a measure of long-term repeatability. For each test matrix point, 6 test cycle iterations will be performed in a single test day.

The two engines to be utilized for testing will be the same engines utilized for a companion project with CARB for the characterization of biodiesel. The will provide synergies and costs savings between the two programs in terms of replication and engine set-up. One of these engines will also be utilized in testing at the CARB LA chassis dynamometer test facility, as part of the companion biodiesel characterization project. Test cycles will include the FTP and a UDDS cycle similar to the cycles used in the biodiesel characterization project. The UDDS cycle will be performed at only a single load point, however.

Samples for chemical analysis for assays, PAHs, and nitroPAHs, detailed hydrocarbons C_1-C_{12} and carbonyls will be collected for tests number in parentheses for the FTP test cycle iteration on a single engine. This represents a total of 12 samples.

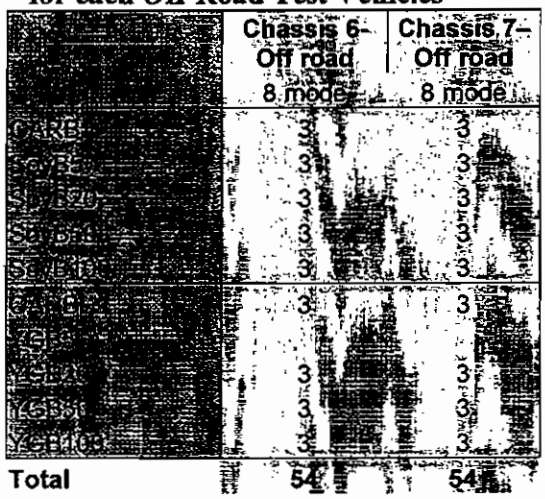
Table 3. Engine Dynamometer Test Matrix for each Engine

	Engine 1	
	FTP	UDDS
CARB	6 (3)	6
Blend formulation #1a	6 (3)	6
Blend formulation #1b	6	6
Blend formulation #2a	6 (3)	6
Blend formulation #2b	6	6
Blend formulation #3a	6 (3)	6
Blend formulation #3b	6	6
CARB	6	6
Blend formulation #4a	6	6
Blend formulation #4b	6	6
Blend formulation #5a	6	6
Blend formulation #5b	6	6
Blend formulation #6a	6	6
Blend formulation #6b	6	6
CARB	6	6
Sub total	**90**	**90**
Total		**180**

Task 6. Testing of Off-Road Engines at the CARB Stockton Facility

Testing is planned for two off-road engines at the Stockton facility. CE-CERT will provide oversight for this testing, but the actual testing and sampling will be conducted by CARB representatives. At the Stockton chassis dynamometer facility, tests will be conducted on the CARB base fuel and various blends with two biodiesel feedstocks. The blends will range from B5/10 to B100. The steady state 8 mode test will be used for the test cycle. A sample test matrix is provided below. Samples for chemical analysis will be collected at the test points denoted in pink.

Table 4. Stockton CARB Chassis Dynamometer Test Matrix for each Off-Road Test Vehicles



	Chassis 6-Off road 8 mode	Chassis 7-Off road 8 mode
CARB	3	3
[illegible]	3	3
[illegible]	3	3
[illegible]	3	3
[illegible]	3	3
[illegible]	3	3
[illegible]	3	3
[illegible]	3	3
[illegible]	3	3
Total	54	54

Task 7 Detailed Speciation, Toxicity and Biological Analyses

Speciation of toxics and biological testing of the biodiesel exhaust will primarily be carried out by researchers at UC Davis including PAH/nitro-PAHs, carbonyls, and biological tests. In conjunction with this, researchers at CE-CERT will make some measurements of volatile organic compounds.

From the test matrix provided above, 36 carbonyl and C_1-C_{12} VOC samples will be collected during the biological characterization portion of the engine testing, with an additional 12 carbonyl and C_1-C_{12} VOC samples collected during the NO_x mitigation portion of the engine testing. Provisions are provided for an additional 9 carbonyl and C_1-C_{12} VOC samples, which will be used for some combination of tunnel or trip blanks or repeat tests, however there is limited knowledge on the concentration of some of these carbonyls because some of these carbonyls have not been previously measured in diesel exhaust, some of the carbonyl samples may need to be used for range finding to ensure the amount of carbonyls collected in the samples are not outside the range of the sample collection media.

From the test matrix provided above, 24 samples for biological assays, PAH and nitroPAH analyses will be collected during the biological characterization portion of the engine testing, with an additional 12 samples for biological assays, PAH and nitroPAH analyses will be collected during the NO_x mitigation portion of the engine testing. Provisions are provided for an additional 9 biological assays, PAH and nitroPAH samples, which will be used for some combination of tunnel or trip blanks or repeat tests.

(A) Sample Preparation

UCD personnel will prepare media used for sampling. Media includes filters to collect PM, and XAD to collect volatile/semivolatile compounds for PAH/nitro-PAH analyses and biological tests, and aqueous solution to collect carbonyls. Filters and XAD will be pre-cleaned by solvents

(hexane, acetone, and/or dichloromethane). Filters will be pre-weighed and sampling cartridges will be assembled. Mist chambers and collection tubes for carbonyl analysis will be prepared.

(B) Sample collection

UCD personnel will setup high volume air sampling system with filter+XAD for PAH/nitro-PAH analyses and biological tests, and mist chambers for carbonyl analysis, and conduct sampling. After sampling, post-sampling weight of filters will be determined in a temperature and humidity controlled weighing room, Filter and XAD samples will be shipped to the UCD lab. Trapping and derivatizing solution for carbonyls will be transferred to vials and shipped to the lab in Arizona State University (ASU). Blue ice and insulated shipping containers will be used for shipping samples.

In conjunction with each test for which a carbonyl sample is collected, CE-CERT researchers will collect a sample for C_1-C_{12} detailed hydrocarbons in Tedlar bags.

(C) Sample analysis

UCD lab staff will extract filter and XAD samples for biological tests and PAH/nitro-PAH analyses. Human lung and macrophage cell assays will be conducted for filter samples by UCD, and the Comet assay will be conducted for filter samples by UCD in collaboration with USEPA. Mutagenicity test (Salmonella/microsome microsuspension assay) and PAH/nitro-PAH analyses will be conducted for filter and XAD samples at UCD. Extraction of mist chamber solutions and analysis of carbonyls will be conducted at ASU. The target compound list for the carbonyl and PAH analyses is provided in Table 5.

At CE-CERT, Tedlar bag samples for C_1-C_{12} hydrocarbons will be analyzed using a GC-FID and protocols consistent with those used in earlier Auto-Oil related programs, with some additional provisions for the sampling of diesel exhaust.

Table 1. Target compounds for chemical analyses (PAHs requested by ARB are highlighted)

Carbonyls	PAHs
Saturated aldehydes	NitroPAHs
acetaldehyde	1-nitronaphthalene
propanal	5-nitroacenaphthene
butanal	2-nitrofluorene
pentanal	9-nitroanthracene
3-methylbutanal	3-nitrofluoranthene
hexanal	1-nitropyrene
heptanal	6-nitrochrysene
octanal	7-nitrobenz(a)anthracene
2-methylpropanal	6-nitrobenzo(a)pyrene
Unsaturated aldehydes	Alkylated PAHs
acrolein	1-methylnaphthalene
crotonaldehyde	2-methylnaphthalene
3-methyl-2-butenal	2,6-dimethylnaphthalene
2-hexenal	2,3,5-trimethylnaphthalene
2-heptenal	1-methylphenanthrene
	3-methylcholanthrene
Aromatic aldehydes	2-methylfluoranthene
benzaldehyde	5-methylchrysene
o,m-tolualdehyde	7,12-dimethylbenz(a)anthracene
p-tolualdehyde	
2-ethylbenzaldehyde	Unsubstituted PAHs
3,4-dimethylbenzaldehyde	naphthalene
4-methoxybenzaldehyde	acenaphthylene
1-naphthaldehyde	acenaphthene
	fluorene
Diones	phenanthrene
2,3-butanedione	anthracene
2,3-pentanedione	fluoranthene
3,4-hexanedione	pyrene
2,4-pentanedione	chrysene
2,3-hexanedione	benz[a]anthracene
	benzo[b]fluoranthene
Other compounds	benzo[j]fluoranthene
glyoxal	benzo[k]fluoranthene
methyl glyoxal	benzo[e]pyrene
2-furaldehyde	benzo[a]pyrene
nopinone	perylene
pinonaldehyde	indeno[1,2,3-cd]pyrene
	dibenz[a,h]anthracene
	dibenzo[a,e]pyrene
	dibenzo[a,h]pyrene
	dibenzo[a,l]pyrene
	dibenzo(a,*i*)pyrene

Task 8 –Compilation of the Chemical Analysis Data

Samples collected and analyzed by researchers from UC Davis will be analyzed and confirmed by UC Davis using established QA/QC criteria. The data will be reduced to chemical mass per cycle. Statistical analysis including ANOVA, Student's t-tests and regression analysis will be conducted by UC Davis for biological data to compare biological response among samples, blank, positive and negative controls, and to correlate response to concentrations. CE-CERT will compile these results into a single file to provide a comprehensive database for the program. Additional statistical analyses will be conducted by CE-CERT to compare the results for chemical analyses between the different biodiesel feedstocks and blend levels to be used in the test matrix.

Task 9 –Reporting and the Final Report

A final report will be prepared for CARB incorporating the results from the engine dynamometer testing. The final report will include a description of the experimental procedures used, all relevant test data for PM and regulated emissions, and analysis of the test results. All reduced data will be made available to CARB investigators in an appropriate format. Summary plots will be prepared for the primary emissions results. The results will also be compared to previous studies and assessed in that context.

The draft report will be provided to CARB for review. The schedule incorporates 1 month for CARB to provide comments on the draft final report and 1 month for CE-CERT to incorporate any changes based on the CARB comments. Upon approval by CARB, the findings will be jointly reported for peer-review and publication.

In addition to the comprehensive final report, summary reports will be provided for the results of different tasks or subtasks. In particular, separate summary reports for the regulated and unregulated emissions for the biodiesel emissions study and the NO_x mitigation study.

Bimonthly progress reports will also be prepared throughout the course of the program. CE-CERT and UC Davis researchers will also be available as needed for conference calls relating to program planning or results presentations. The budget also includes travel for 4 trips to Sacramento for data presentation/planning, as needed.

Deliverables

The results will be summarized in a final report prepared under task 9. Data from the emissions testing for regulated and speciated emissions, as well as biological and toxicity testing will be compiled and put into an electronic format. Electronic copies of all data collected, pictures, data logs, and any other appropriate information shall be provided to CARB in a suitable format.

Project Schedule

A project schedule is provided below for the major tasks. The schedule is based on number of months based from the point of authority to proceed. It is anticipated that this project will be completed within a 24 month period.

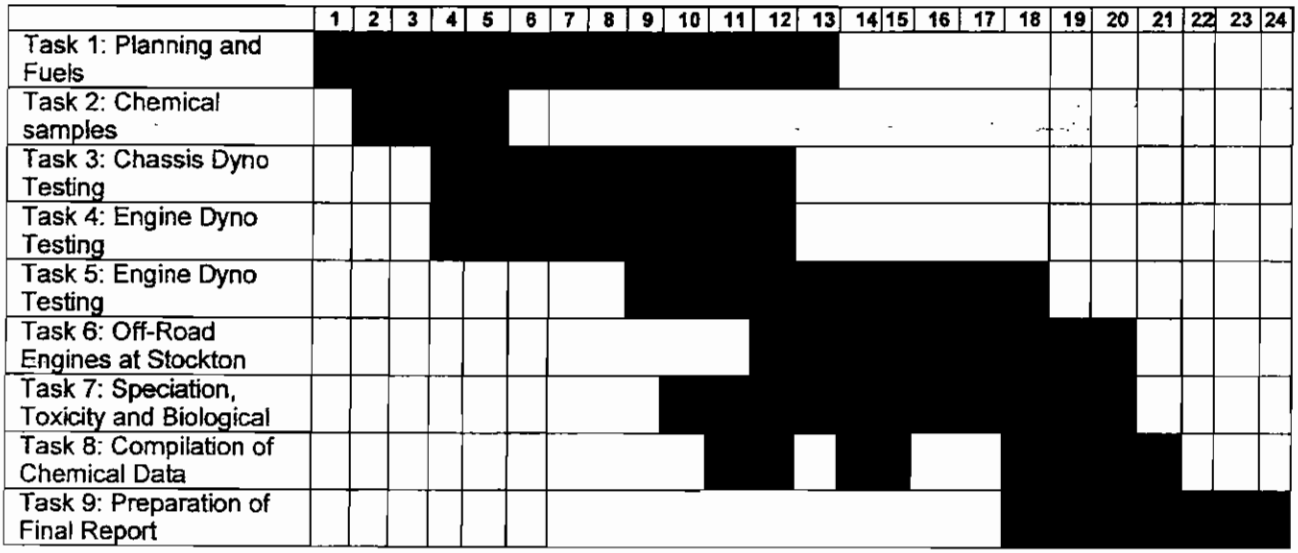


Table 1 Schedule of major milestones for the project.

Project Management Plan

The figure below is an organizational chart for this project. Drs. Tom Durbin and Wayne Miller will serve as the co-Principal Investigators. Dr. Durbin will be the primary point of contact for CARB staff for all planning and execution of project activities. He will also be primarily responsible for communication, resolution, and overall coordination of activities. Dr. Miller will assist with the oversight and development of the overall program, and assist in the preparation of reports/manuscripts documenting the results. The PIs will be assisted by Kent Johnson and Dave Martis who manage the engine dynamometer testing facilities at CE-CERT. Mrs. Kathalena Cocker will also assist Dr. Durbin with the VOC analyses that will be done at UC Riverside.

The main portion of the toxics and biological testing will be performed by researchers from UC Davis. Dr. Reiko Kobayashi will serve as PI for this portion of the work. She will be responsible for sample preparation, sample collection, sample shipping, extraction of filter and XAD samples for biological tests and PAH/nitro-PAH analyses, and quantitative chemical analyses of PAH/nitro-PAHs. Dr. Norman Kado (UCD) will serve as the Co-PI and will be responsible for mutagenicity tests and for Comet assay in collaboration with Dr. Mike Madden (USEPA). He will also help sampling setup and sample collection. Dr. Fumio Matsumura (UCD) will oversee studies using human cell and macrophage cell assays. Dr. Chris Vogel (UCD), will be responsible for selecting proper primers for each marker selected, guide the technical staff for the use of the lightcycler (RT-PCR) and oversee the actual human lung and macrophage cell assays and data analyses. Dr. Patrick Wong (UCD) will be responsible for culturing cells, characterization of markers, media selection, maintenance of low passage cultures for human cell and macrophage assays, and the quantitative RT-PCR. Dr. Thomas M. Cahill (ASU) will be responsible for extracting and analyzing carbonyls. He also will provide the sampling team with the protocol for sampling method (using mist chambers) for carbonyl analyses.

Biographies of all key personnel are presented after the figure.

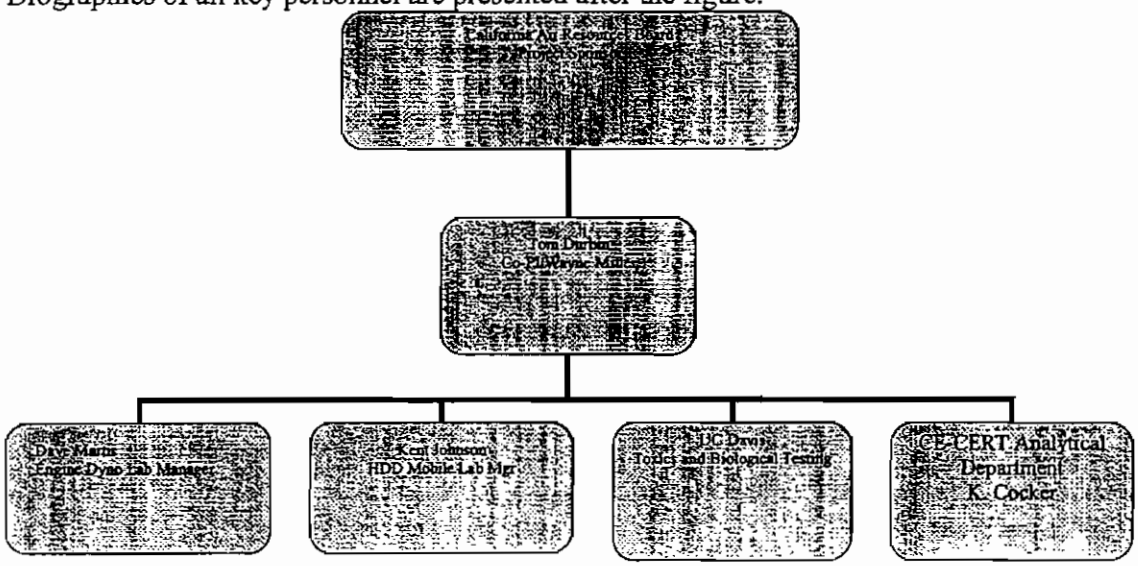


Figure 1 Organization Chart for the Key People Involved in the project

Budget

The total cost of this proposal is $1,280,000 including all tasks. A breakdown of the total budget expenses is provided below. A total of 120 engine testing days are allocated for emissions testing under this program as well as two engine installations. The University of California at Davis will be provided a subcontract in the amount of $274,987 for toxics and biological testing. A total of 10.2 full-time equivalent (FTE) months are budgeted for this project.

A total of $77,003 is allocated for supplies and expenses for fuel procurement, fuel analysis, miscellaneous materials needed for installation of the test engines, engine removal/installation into a test vehicle, and sample media, storage and shipping. Total also includes cost for engine change at MTA.

A total of $70,000 is included in the budget for this contract for the purchase of one of the test vehicles for use in the program. It is intended that additional engines and vehicles will be purchased through a separate funding sources or through in-kind contributions. Co-funding in the amount of $50,000 has been obtained from the South Coast Air Quality Management District (SCAQMD), of which approximately $15,000 will be needed for the installation of a new engine and engine removal and replacement for the preliminary program. As the remaining $35,000 represents a relatively small amount of money relative to the costs of purchasing vehicles/engines, these funds would like only be sufficient to support purchases of engines/vehicles in the late 1990/early 2000 model year period. A broader mix with new technologies would require in-kind contributions to maintain the same level of testing effort. If the costs of engine and vehicle purchase exceed those of the funds provided by SCAQMD, the number of testing days will need to correspondingly be reduced to stay within the program budget. On the other hand, if in-kind contributions can be obtained from fuel suppliers, the biodiesel industry, or engine manufacturers, the corresponding cost saving can be utilized to augment other activities, beyond that originally budgeted for. Preliminary discussions with industry have indicated that some in-kind contributions will likely be obtained, although no formal commitments have been obtained as of the time this proposal is being prepared.

It is important to note that the combination and biodiesel characterization and the NO_x mitigation portions of this project into a single program provides many synergies and cost savings between the test programs. There will be considerable saving in time and resources in the set up of engines and in the procurement of engines/vehicle that can be used across both test program. It is anticipated that it might be possible to reduce the number of replicates on the baseline CARB fuel and reallocate these tests to additional feedstocks or testing conditions. Alternatively, the combined test programs will have a much more robust set of testing results from which to conduct statistical analyses from.

The combination of the separate testing elements into a single program also has significant efficiency and costs saving in terms of program logistics and program planning, and the personnel resources required for those tasks. The proximity of the CE-CERT facility to the CARB Los Angeles chassis dynamometer test facility will also provide considerable saving in travel and logistical costs in coordinating the various different tasks of the overall program

Additionally, there will also be program synergies with a pilot program that CE-CERT is already under contract with CARB to conduct. It is anticipated that at least 6 test days from this preliminary test program will be utilized to cover some of the elements in the test matrices in tasks 4 and 5. This could allow the test matrix for this program to be expanded to examine additional test conditions that may be of interest.

Several other items are not included in the test program that may be either of interest to CARB or may become of more importance as the test program evolves. Size-distributions for PM mass emissions may be of interest to CARB. CE-CERT has various instruments capable of providing size distribution data and anticipate the costs of this activity to be approximately $100-$150 per test. No funds are allocated for statistical analysis at a level beyond that typically done at the spreadsheet level. Provision can be made for more sophisticated modeling using SAS or other similar programming. We anticipate the cost for this activity will be approximately $5,000 to $10,000 depending on the detail of the required analysis. This program also does not include provisions for the installation or remove of the DPF that may be required in conjunction with the chassis dynamometer testing at CARB's Los Angeles test facility. We anticipate such charges could run in the $5,000 range.

With regards to the proposed test matrix consisting of test cycles, replicates, samples, engines, and fuels may be modified based on input of the technical advisory committee and input from ARB, however the changes made shall not effect the total number of emission test days allocated for testing, total cost, sample types and number.

Finally, the ARB may elect through the contract amendment process reallocate some of the funding to include additional subcontracting.

Budget Justification

1. Labor Charges

Dr. Durbin will serve as Principal Investigator for the project. Dr. Miller will serve as the Co-Principal Investigator. Mr. Pacocha will assist in various aspects of the program such as transporting truck and other miscellaneous tasks. The University charges for benefits as a direct cost. Benefit rates are 17% for faculty, 23% for research staff.

2. Subcontractors

The University of California at Davis will serve as a subcontract to UCR in this program for the toxics and biological testing including carbonyls, PAHs, nitro-PAHs, and biological assays. A breakdown of the costs for the UC Davis subcontract is as follows:

(I.) Labor and Supplies

Labor and supplies are estimated for the following tasks.

(a) Preparation of sampling, conducting sampling

- For 45 samples for biological tests and PAH/nitro-PAH analyses which include biodiesel and diesel emission samples and QA/QC samples such as tunnel and trip blanks.
- For 69 samples for carbonyl analyses which include biodiesel and diesel emission samples, range finding samples, and QA/QC samples such as tunnel and trip blanks.
- (b) Extraction of 95 filter samples and 95 XAD samples.

(c) Conducting human lung and macrophage cell assays for 45 filter samples

(d) Conducting Comet assay for 45 filter samples

(e) Conducting Salmonella/microsome microsuspension assay for 45 filter and 45 XAD samples

(f) Analyses of PAH and nitroPAH for 45 filter and 45 XAD samples

(g) Extraction and analyses for 69 Carbonyl samples (trapped in aqueous solution)

(II) Equipment

The purchase of a mass spectrometer (5973 MSD with negative chemical ionization (NCI) made by Agilent Technologies) is proposed for this study since the NCI-MSD will increase the sensitivity by 100 fold and also increase the efficiency of the analysis. Because of the increased sensitivity of the new instrument and higher throughput, there can be a net savings by reducing the sample collection time, the amount of preparative work for analysis, and analysis time for nitroPAHs. Also, UCD has negotiated with the manufacturer for the purchase of the NCI-MSD at a substantial price discount. These three factors will result in no increase in cost to the proposal.

Estimated cost

Direct Costs		
Labor & Employee Fringe Benefits	$ 133,601	
Travel & Subsistence	$ 4,100	
Materials & Supplies	$ 55,000	
Analyses	$ 30,015	
Equipment	$ 30,000	
Total Direct Cost		$ 252,716
Indirect Costs (10% direct excluding equipment)		$ 22,272
Total Direct and Indirect Cost		**$ 274,987**

3. Equipment

The purchase of several engines/vehicles will be required for this program. A total of $70,000 is being allocated for the purchase of one test vehicle in this proposal. Other engines/vehicles are anticipated to be acquired through other sources of funds from the South Coast Air Quality Management District or through in-kind contributions.

4. Travel

Travel will be necessary to coordinate with the portions of the testing being conducted at the CARB's chassis dynamometer testing facility in Los Angeles and the chassis dynamometer facility in Stockton, CA. Given the significance of the program, it is anticipated that a limited amount of travel to Sacramento for meetings or presentations may be required. Travel charges include airplane flights, hotel, per diem, and rental cars. Mileage is at the University's standard reimbursement rate of $0.48 per mile.

5. Electronic Data Processing

No costs are planned in this area.

6. Photocopying and Printing

No costs are planned in this area.

7. Mail, telephone, and fax.

No costs are planned in this area.

8. Materials and Supplies.

Costs in this area include test fuels and test fuel preparation, fuel analysis, sample media and shipping and storage, and miscellaneous materials and supplies used in the installation of the test engine. Also included is a software upgrade that will be needed in order to perform engine dynamometer tests on cycles with variations in engine parameters different from those used in the FTP. Approximately $21,400 is also allocated for fuel blending for the more specialized fuels that will be needed in the NO_x mitigation study.

9. Analyses.

Emissions measurements are a major portion of this project. The University has established fixed "sale for service" rates for a variety of emissions measurement activities that cover the cost of personnel, facilities, materials, and maintenance.

10. Miscellaneous.

Because CE-CERT is a permanent off-campus facility, federal regulations require us to account for facilities rental as a direct cost. Facilities rental is charged based on 24% of Modified Total Direct Costs (MTDC). MTDC consists of total direct costs minus equipment, facilities rental, graduate student partial fee remission/health insurance (included in benefits), and the UC Davis subcontract.

11. Overhead.

This project was budgeted on the assumption that it will be undertaken under the existing interagency agreement between the California Air Resources Board and the University of California. The indirect cost rate for that agreement was 10% of Modified Total Direct Costs, which excludes the off-campus facility fee and the UC Davis subcontract.

The 10% indirect cost rate applies only if the ARB does not apply federal funds to this project. If federal funds are used, the standard indirect cost rate of 26% must be applied.

Attachment A. Quality Assurance and Quality Control Procedures for CE-CERT Mobile Emissions Laboratory

Internal calibration and verification procedures are performed regularly in accordance with the CFR. A partial summary of routine calibrations performed by the MEL as part of the data quality assurance/quality control program is listed in Table 10. The MEL uses precision gas blending to obtain required calibration gas concentrations. Calibration gas cylinders, certified to 1 %, are obtained from Scott-Marrin Inc. (Riverside, CA). By using precision blending, the number of calibration gas cylinders in the lab was reduced to 5 and cylinders need to be replaced less frequently. The gas divider contains a series of mass flow controllers that are calibrated regularly with a Bios Flow Calibrator (Butler, New Jersey) and produces the required calibration gas concentrations within the required ±1.5 percent accuracy.

In addition to weekly propane recovery checks which yield >98% recovery, CO_2 recovery checks are also performed. A calibrated mass of CO_2 is injected into the primary dilution tunnel and is measured downstream by the CO_2 analyzer. These tests also yield >98% recovery. The results of each recovery check are all stored in an internal QA/QC graph that allows for the immediate identification of problems and/or sampling bias.

Table 2 Verification and Calibration Table

EQUIPMENT	FREQUENCY	VERIFICATION PERFORMED	CALIBRATION PERFORMED
	Daily		Throat Pressure Absolute Pressure
CVS	Weekly	Propane Injection CO_2 Injection	
	Per Set-up	CVS Leak Check	
	Second by second	Back pressure tolerance ±5 inH_20	
Calibration System	Semi-Annual	Primary Standard 1% Bottle Check	MFCs: Drycal Bios Meter
Analyzers	Pre/Post Test		Zero Span
	Daily	Zero span drifts	
	Monthly	Linearity Check	
Secondary System	Daily	Leak Check	

	Per Test	CO_2: Secondary vs. Primary	
	Weekly	Propane Injection: 6 point primary vs secondary check	
	Semi-Annual		MFC: Drycal Bios Meter & TSI Mass Meter
Data Validation	Per Test	CO_2 Balance Modal vs Integrated Bag Mass Standard Check all sensors limits/mode	
PM Sample Media	Per Test	Static, tunnel & dynamic blanks	
Temperature Barometric Pressure & Dewpoint Sensors	Daily	Checks w/ ATIS; Psychrometer	Performed when verification fails

Contingency Provision

Supplemental projects have been scored and are approved conditioned upon the availability of funds as determined by the Air Resources Board (ARB). The ARB Executive Officer shall make funding determinations based on whether funds for granted projects have been expended by grant agreement specified schedules or dates, or by June 30, 2009, whichever is earlier. Funds for projects failing to satisfy provisions of the grant award may be redirected to the next highest scored project(s) on the list of supplemental projects.