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ARB LPG Fuel Blends Evaluation Project March 1999 Progress Report

submitted to:

LPG Fuel Blends Evaluation Project Task Group and Co-Sponsors

American Automobile Manufacturers Association, ARCO Products Co., California Air Resources Board, Cummins Engine Co., Engine Manufacturers Association, Equilon, Ford Motor Co., GFI, IMPCO, National Propane Gas Association, National Renewable Energy Laboratory, Natural Resources Canada, Propane Education and Research Council, Railroad Commission of Texas Alternative Fuels Research & Education Division, South Coast Air Quality Management District, Tosco Refining Co., and Western Propane Gas Association

I. Executive Summary

Medium and Light-duty emissions tests were completed in 1998. Southwest Research Institute (SwRI) submitted the Final Report for Performance/Combustion tests. Preparations continued for Durability tests at Bodycote ORTECH (ORTECH). Project fundraising and management continued.

II. Test Program Work Performed

A. Fuel Properties and Octane Tests

The fuel composition test results from Phillips 66 on their three cylinders used in Medium-Duty Emissions tests are in Table 1.

**Table 1: Fuel Compositions by Percent Volume of Phillips 66
Cylinders (from ORTECH)**

Fuel	Propylene (C ₃ H ₆)	Propane (C ₃ H ₈)	n-Butane (C ₄ H ₁₀)
Certification Fuel	2.99	95.01	2.00
Fuel #2	14.94	80.06	5.00
Fuel #5	21.32	77.08	1.6

Other fuel composition test data for Emissions and Performance/Combustion tests can be accessed in prior monthly reports at ARB's website:

<http://www.arb.ca.gov/altfuels/lpg/mvlpge/mvlpge.htm>

B. Medium-Duty Engine (Cummins B5.9LPG) Emissions Tests at Bodycote ORTECH.

Tests were completed in August 1998. Final Report was submitted on November 18, 1998. Prior monthly reports and the Final Report can be accessed on ARB's website: <http://www.arb.ca.gov/altfuels/lpg/mvlpge/mvlpge.htm>.

C. Light-Duty Truck (F150 Bi-Fuel) Emissions Tests at ARB Haagen Smit Laboratory.

Tests ended in September 1998. ARB's final report is not yet available.

D. Performance/Combustion Tests at Southwest Research Institute.

Tests were completed in January. Final Report was submitted in late March.

Test program protocol and previous reports can be accessed at ARB's website: <http://www.arb.ca.gov/altfuels/lpg/mvlpge/mvlpge.htm>.

E. Durability Tests at Bodycote ORTECH.

Project Agreement negotiations continued.

ADEPT explored the possibility of using the Performance/Combustion engine for Durability tests. To prepare the engine, ADEPT authorized SwRI to seal the engine's pressure sensor tap with an appropriate plug. This repair makes the engine usable for Durability tests or for use in other applications.

Discussions continued regarding the optimum durability test cycle. One of the proposed test cycles is based on "hot box" conditions suggested by Cummins. "Hot box" refers to testing the engine under the following conditions:

- Constant 100% load,
- Water out temperature @ 100°C,
- Intake manifold temperature @ 150°F,
- Air inlet restriction at 20" H₂O,
- At rated rpm speed.

Running the engine at full load will use considerably more fuel than was initially estimated. The cost of the extra fuel may exceed the current budget.

There will be no baseline data for comparison. Cummins' Certification Fuel durability test data is not available to compare with Fuel #1 and the project budget does not allow testing on both Certification Fuel and Fuel #1.

Cummins offered to review final results. Wear data on Fuel #1 will be supplemented by

tribological oil analysis at Hertz Engineering. This extensive oil analysis will act as a safety measure against catastrophic failure as well as a reliable scientific back up to the anticipated Cummins review.

III. Project Management Support and Administrative Work Performed

A. Project Fundraising

ARB completed its internal funding contract approval and award of \$85,000 to the project. These funds were transferred in full to the project account. SCAQMD reimbursed the project for the Performance/Combustion engine. California Energy Commission (CEC) funding is still being solicited and subject to CEC Committee approval. The AFRED/T AFC funding approval meeting scheduled for March 19th was postponed indefinitely due to an emergency audit by the Texas Appropriations Committee of all Texas Energy Commission funding.

B. Project Expenditures

Table 2 shows March expenditures and total expenditures to date.¹

Table 2: March Expenditures and Total Expenditures to Date

Item	Funds Expended In March	Funds Expended to Date
Fuel (Air Liquide, Phillips)	\$109.00	\$23,736.99
Emissions Tests (ORTECH)	\$0.00	\$176,351.07 ²
Perf./Comb. Tests (SwRI)	\$56,119.70	\$78,619.70
Fuel Properties (Dixie)	\$488.79	\$12,107.25
Engine	\$0.00	\$17,063.47
Project Management	\$481.36	\$54,928.61
Attorney Fees	\$0.00	\$2,250.00
Subcontractor	\$0.00	\$2,273.29
Miscellaneous	\$0.00	\$687.66
Total	\$57,198.85	\$368,018.04

Project Account Balance at month's end: **\$68,579.95**

Table 3 shows total funds received to date, by respective funder.

¹ All outlays above \$1,000 are pre-approved by the LPG Task Group and/or the TAC.
² Total includes \$23,422.55 (CAN\$35,931.02), paid directly to ORTECH by PGAC.

Table 3: Total Funds Received to Date

Funder	Amount
ARB (ULTRAMAR)	\$85,000.00
ARCO	\$45,000.00
EMA	\$1,000.00
NPGA	\$8,920.00
NRCan	\$119,500.95 ³
PERC	\$25,000.00 ⁴
SCAQMD	\$82,876.64
Shell/Equilon	\$36,000.00
Tosco	\$22,500.00
WPGA	\$10,800.00
Total	\$436,597.59

C. Project Contracts and Other Documents

1. The draft October 1998 Progress Report was submitted to Task Group.
2. ADEPT followed up with Tosco regarding their MOU signature.

Travel associated with effort described:

- March 18, 1999: ADEPT travel to San Antonio, TX, for project review meeting with SwRI and to meet with AFRED/TAFC. (TAFC cancelled this meeting.)
- March 27, 1999: ADEPT travel to Atlanta, GA, for project review update at PVC Board Meeting.

IV. Work planned for the next reporting period (April 1 - 30, 1999)

Project Management-ADEPT

1. Continue general project management.
2. Prepare and complete funding contracts for co-sponsors.
3. Continue fundraising.
4. Prepare for Durability tests.

Test Program

1. ARB-EI Monte will finalize results and submit a draft Final Report.
2. ORTECH will prepare for durability tests.

³ Total of three payments: one at US\$61,356.48 (conversion ratio of 0.6817), one at US\$34,721.92 (conversion ratio of 0.6518), and one at US\$23,422.55 (conversion ratio of 0.6519). Please note that this figure was incorrectly reported in prior monthly reports due to an ADEPT accounting error.

⁴ The total PERC award was for \$30,000. Five thousand was directly allotted to PVC for their costs associated with the project.

V. Attachments:

Phillips 66 Certificates of Analysis

VI. Disclaimer

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VII. Glossary of Acronyms

AFRED	Alternative Fuels Research and Education Division
ARB	California Air Resources Board
ARB-El Monte	ARB Haagen Smit Laboratory in El Monte, CA
°C	Celsius
CEC	California Energy Commission
EMA	Engine Manufacturers Association
°F	Fahrenheit
H ₂ O	Water
LPG	liquefied petroleum gases
NPGA	National Propane Gas Association
NRCan	Natural Resources Canada
ORTECH	Bodycote ORTECH
PERC	Propane Education and Research Council
PGAC	Propane Gas Association of Canada
PVC	Propane Vehicle Council
rpm	revolutions per minute
SCAQMD	South Coast Air Quality Management District
SwRI	Southwest Research Institute
TAFC	Texas Alternative Fuels Commission
WPGA	Western Propane Gas Association