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ARB LPG Fuel Blends Evaluation Project September 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. Performance/Combustion tests were completed in January 1999 at Southwest Research Institute (SwRI). Durability tests at Bodycote ORTECH (Bodycote) continued. Project fundraising and management continued.

II. Test Program Work Performed

A. Fuel Composition Tests

One (1) LPG blend composition tests was received from Dixie Services, Inc. (see attached). Table 1 provides a summary of the results.

Fuel composition data from the Emissions, Performance/Combustion, and Durability tests can be accessed in prior monthly reports at ARB's website:

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

Table 1: Dixie Fuel Blend Composition Matrix

Components	4-Jun-99	17-Jun-99	21-Sep-99	Average	Standard Deviation
	(vol. %)	(vol. %)	(vol. %)	(vol. %)	
Methane	0.06	0.08	0.10	0.08	0.02
Ethane	3.96	4.20	4.15	4.10	0.13
Propane	80.87	81.32	80.94	81.04	0.24
Propylene	10.73	10.25	10.45	10.48	0.24
Isobutane	0.72	0.69	0.71	0.71	0.02
n-Butane	3.59	3.41	3.58	3.53	0.10
t-2-Butene	0.03	0.03	0.03	0.03	0.00
Isopentane	0.03	0.02	0.03	0.03	0.01
c-2-Butene	0.01	0.00	0.01	0.01	0.01

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

Tests were completed in August 1998. Final Report was submitted in November 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 were completed in September 1998. ARB's Final Report was posted on ARB's website in mid-July 1999. Prior monthly reports can also be accessed at ARB's website: <http://www.arb.ca.gov/altfuels/lpg/mvlpge/mvlpge.htm>.

D. Performance/Combustion Tests at SwRI

Tests were completed in January 1999. The Final Report was submitted in February 1999. 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

The test engine was shut down on September 12, 1999 due to a failed exhaust backpressure transducer. The component was replaced and durability tests restarted.

Due to high amounts of copper (79 ppm) found in the 200-hour oil analysis by Hertz Engineering (see attached), the durability tests were suspended on September 17, 1999. The tests were suspended until an interim maintenance oil analysis was received. Subsequent analysis indicated that the copper concentration decreased to 71 ppm¹, which signifies that the problem may have stabilized. Protocol specified oil and filter changes restored the oil's neutralization ability and removed the metallic debris along with other

¹ The drop in copper concentration is accounted for by the engine oil consumption. Approximately 1L of engine oil per day is added to the test engine.

impurities. Subsequent reference oil sample indicated acceptable levels of copper. Durability tests were restarted on September 21, 1999.

The Task Group approved and ADEPT signed one (1) contract amendment authorization (AA) for Durability tests at Bodycote (see attached). Total contract value with Bodycote is now at \$76,963.93. AA#1 (9/28/99) provided an additional fixed price amount for a project needed starter motor, flywheel housing, and diagnosis of mismatched parts.

AA#2 is still under review and negotiation.

III. Project Management Support and Administrative Work Performed

A. Project Fundraising

ADEPT continued attempts to process the TAFC awarded funds. The funding has not yet been received.

ADEPT met with NPGA and NRCAN to explore possible additional funding.

B. Project Expenditures

Table 2 shows September expenditures and total expenditures to date.² Table 3 shows total funds received to date, by respective funder.

Table 2: September Expenditures and Total Expenditures to Date

Item	Funds Expended In September	Funds Expended to Date
Fuel (Air Liquide, Phillips)	\$0.00	\$38,607.72
Emissions Tests (Bodycote)	\$0.00	\$176,351.07 ³
Perf./Comb. Tests (SwRI)	\$237.65	\$84,032.62
Fuel Properties (Dixie)	\$0.00	\$13,293.46
Engine	\$0.00	\$17,063.47
Raw Durability Tests (Bodycote, Hertz)	\$0.00	\$19,000.00
Project Management	\$13,155.96	\$117,612.73
Attorney Fees	\$0.00	\$2,250.00
Subcontractor	\$137.50	\$4,511.79
Miscellaneous	\$30.00	\$732.93
TOTAL	\$13,561.11	\$473,455.79

² All outlays above \$1,000 are pre-approved by the LPG Task Group and/or the TAC.

³ Total includes \$23,422.55 (CAN\$35,931.02), paid directly to Bodycote by PGAC.

Table 3: Total Funds Received to Date

Funder	Amount
ARB (ULTRAMAR)	\$100,000.00
ARCO	\$50,000.00
Cummins Engine Co.	\$6,155.57
EMA	\$1,000.00
NPGA	\$8,920.00
NRCan	\$126,033.95 ⁴
PERC	\$25,000.00 ⁵
SCAQMD	\$82,876.64
Shell/Equilon	\$40,000.00
Tosco	\$25,000.00
WPGA	\$12,000.00
TOTAL	\$476,986.16

Project Account Balance at month's end: **\$3,530.37**

Table 4 summarizes the in-kind services received to date, by respective funder.

Table 4: In-Kind Services Received to Date

Funder	Item	Estimated Value
ARB	ARB-El Monte Light-Duty Emissions Tests	\$90,000
Cummins	Test Support	\$8,000
Ford	Vehicle and Test Support	\$23,500
NREL	Cummins B5.9LPG Engine	\$15,000
TOTAL		\$136,500

C. Project Contracts and Other Documents

The final August 1999 Progress Report was distributed to the Task Group.

Travel associated with effort described:

September 16, 1999: ADEPT travel to Providence, Rhode Island, to give project update and seek additional funding from NPGA.

September 18, 1999: ADEPT travel to Mississauga, Ontario, CANADA, to settle test engine mismatched parts issue and deal with other outstanding matters.

September 20, 1999: ADEPT travel to Ottawa, Ontario, CANADA, to give project update and seek additional funding from NRCan.

⁴ 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). This figure was incorrectly reported in prior monthly reports due to an ADEPT accounting error.

⁵ Total PERC award was \$30,000. \$5,000 was allotted to PVC for its project costs.

IV. Work planned for the next reporting period (October 1-31, 1999)

Project Management-ADEPT

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

Test Program

Bodycote to continue Durability tests.

V. Attachments:

1. Dixie fuel composition test results (9/22/99);
2. Fluid Life Oil Analysis Alert (9/15/99);
3. Fluid Life Tribological ICP Oil Analysis Wear Rates report (9/20/99);
4. Bodycote AA# 1 (9/28/99).

VI. Disclaimer

This report was prepared by ADEPT as result of work co-sponsored by the SCAQMD and Task Group members. Opinions, findings, conclusions, and recommendations within are those of the author and do not necessarily represent SCAQMD's views. SCAQMD, their officers, employees, contractors, and subcontractors make no warranty, expressed or implied, and assumes no legal liability for the information in this report. SCAQMD has not approved or disapproved this report, nor have they passed upon the accuracy or adequacy of the information contained herein.

VII. Glossary of Acronyms

AA	amendment authorization
ARB	California Air Resources Board
ARCO	ARCO Products Co.
Bodycote	Bodycote ORTECH
Cummins	Cummins Engine Co.
Dixie	Dixie Services Inc.
EMA	Engine Manufacturers Association
Ford	Ford Motor Co.
GFI	GFI Control Systems, Inc.
Hertz	Hertz Engineering
ICP	Inductively Coupled Plasma Spectrometry
IMPCO	IMPCO Technologies Inc.
LPG	liquefied petroleum gases
NPGA	National Propane Gas Association
NRCan	Natural Resources Canada
PGAC	Propane Gas Association of Canada
PERC	Propane Education and Research Council
Phillips	Phillips 66 Propane Co.
PVC	Propane Vehicle Council
SCAQMD	South Coast Air Quality Management District
SwRI	Southwest Research Institute
TAC	Technical Assessment Committee
TAFC	Texas Alternative Fuels Commission
Tosco	Tosco Refining Co.
WPGA	Western Propane Gas Association