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Overview of DOE Alternative Fuels Utilization Program

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ABSTRACT

The Department of Energy Alternative Fuels Utilization Program encompasses a wide range of applied research activities and recently undertook implementation of the Federal Methanol Fleet Project. Research is conducted on various forms of synthetic fuels and alcohol fuels, examples of which are described in this paper. The Federal Methanol Fleet began operating its first group of vehicles in November 1985. The findings to date and future plans are summarized in the paper.

THE ALTERNATIVE FUELS UTILIZATION PROGRAM currently encompasses two significant projects in alternative transportation fuels: [1] the Alternative Fuels Utilization Project, a long range activity of applied research and development [2] The Federal Methanol Fleet Project, an effort initiated by Congress in FY 1985 to introduce methanol vehicles into the fleet of Federally-owned vehicles. The overall objectives and summaries of activities are described in this paper. The Oak Ridge National Laboratory serves as field project office for both projects.

ALTERNATIVE FUELS UTILIZATION R&D PROJECTS (AFUP)

GOALS, PURPOSE, SCOPE — Dependence on imported petroleum remains a significant threat to the nation's well-being. It is true that petroleum consumption in the United States decreased for a period from 1978 through 1983 but consumption is now increasing and has reached the same level as in 1975, a time when the "oil crisis" was fresh in mind. It is further true that imported petroleum now comes to the United States from more politically stable regions of the world, but international treaties would still make the United States susceptible to disruptions in the Middle East. When coupled with the recognition that proven domestic petroleum reserves have dropped by 30% since 1973, despite a doubling of exploratory drilling, the facts bear out that the oil problem, though temporarily dormant, is still with us. The primary goal of AFUP is to assure the availability of technology for, and eliminate barriers to, the use of viable alternative transportation fuel options, so industry can fill temporary and long-term gaps between petroleum supply and demand and reduce the nation's dependence on petroleum imports by using abundant indigenous resources.

Although arguments abound regarding when the price of oil will rise significantly or when the next supply disruption will occur, there is a clear consensus that price shocks and disruptions will occur with undesirable results. It follows that it is difficult to pinpoint a date by which it is essential that alternative fuels technology be ready for use, but it is clear that the need is inevitable and its readiness will lessen the impact of supply disruptions and may even help stabilize the world oil situation to avert disruptions.

The development of processing technologies for production of non-petroleum-derived fuels is certainly important in alleviating dependence on imports but indeed deficiencies in utilization technologies have stymied the adoption of alternative fuels as much as have the technical shortcomings in process technologies. For instance, most current transportation engines require a liquid hydrocarbon fuel with at least 11–12% hydrogen by weight. Hence a great void exists between fuel requirements and abundant resources such as coal, a solid with 4–5% hydrogen.

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Attempts to cross this void have typically placed the technical burden on the process technologies and have resulted in fuels that are perceived to be marginally economically viable for the most part. AFUP activities strive to determine if some of the burden could be shifted to the utilization side. As a further example, technical deficiencies on the utilization side have inhibited blanket substitution of methanol for gasoline due to a number of reasons such as the inability of engines to compensate for minor changes in fuel properties and materials incompatibility. Hence R&D under AFUP is considered to be nationally significant with potentially large payoff.

AFUP currently addresses six classes of fuels: (1) new hydrocarbon fuels, (2) synthetic gasoline and distillate fuel, (3) alcohol fuels, (4) advanced fuels, (5) emergency fuels, and (6) methane and related gaseous fuels. More detailed definitions of these classes are provided in Table 1. Work on advanced fuels (hydrogen) and emergency fuels (including heating oils, residual oils, vegetable oils) is essentially complete to the degree warranted by overall factors, leaving the existing emphasis on the remaining classes.

The evolution of research projects in New Hydrocarbon Fuels, the recent findings in those projects, and the identification of unsatisfied industry needs have led to redefining future work. The area of new emphasis, in essence, separates out the more generic fuel/combustion research from those aspects unique to a particular fuel. Thus, a new research area that cuts across practically all fuel types, Combustion Enhancement, is in the planning stage. It is noted that some activities already underway could be classed as representative of this new topical area.

The scope of AFUP work covers alternative fuel distribution, utilization, and emissions, with the focus on utilization. However, the scope of interest, concern, and coordination covers the entire spectrum of topics in alternative fuels from resource through the effects (e.g., environmental) of their use.

DESCRIPTION OF TECHNICAL ACTIVITIES —

New Hydrocarbon Fuels — The long-term objective in this classification is to identify the optimum combination of resource/processing/engine technology in terms of efficiency, environmental acceptability, and marketability. The objective strives to reduce the void between the requirements for fuels usable

Table 1. AFUP activity areas, classified by fuel type

Fuel class	Description
(1) New hydrocarbon fuels	Non-petroleum hydrocarbon fuels which, though perhaps similar to conventional fuels do not meet current fuel specifications.
(2) Synthetic gasoline or distillate fuel	Non-petroleum gasoline or diesel fuel which essentially meet current fuel specifications.
(3) Alcohol fuels	Oxygenated fuels, in general, not limited to ethanol or methanol.
(4) Advanced Fuels	Fuels highly dissimilar to conventional fuels such as hydrogen and carbon slurry fuels.
(5) Emergency Fuels	Finished fuels and various liquid hydrocarbons which might be blended and utilized in an emergency fuel shortage where conventional fuels have become scarce.
(6) Methane and related gaseous fuels	Includes natural gas and liquefied petroleum gas (LPG), that can be substituted for conventional automotive fuels.

in modern engines and the characteristics of fuels that can be economically produced from domestic resources.

The work breakdown for new hydrocarbon fuels includes three major areas:

[1] Assessment and studies of synthetic fuel production and processing, and of social, market, and environmental constraints.

[2] Screening tests of available synfuels in combustion engines (both conventional and developmental engines)

[3] Combustion Enhancement Technology where research is conducted and applied toward problems and barriers identified in [1] and [2] above. Efforts are conducted in this area to examine and develop the best techniques for using new hydrocarbon fuels.

Assessments and Studies — Taking many prior investigations at face value, converting coal to current specification gasoline and diesel fuel is prohibitively expensive via practically any known process. While shale economics appear to be more favorable, there is still a sizeable disadvantage relative to purchased petroleum. Much of the cost in synfuel production is associated with producing a synthetic crude but a significant further cost (much the same as with petroleum) is incurred in processing the syncrude into specification fuels. Recently, AFUP sponsored the Engineering Societies Commission on Energy (ESCOE) to try to quantify [1] the amount of finished fuel processing that could be backed out of the conversion, [2] the resource savings resulting from this approach, and [3] the feasibility of developing transportation engines to use these relaxed specification fuels without compromising end-use efficiency. Economics were not considered in the study.

Through refinery analysis and review of synfuel processing experiments, the relative amounts of conversion and final processing energy were estimated (Fig. 1). A panel of industry and academic experts were assembled to review engine technology and its adaptability to minimally processed fuels. In summary, the conclusions were:

1. There is a notable, though not overwhelming, potential for coal and shale conservation by adopting use of fuels that have relaxed, but reasonable, specifications.

2. There is a similar, actually somewhat larger, conservation potential for petroleum if the minimally processed fuel is introduced in petroleum refining.

3. There are engine technologies that have potential for successfully using minimally processed fuels. Among the top candidates were the direct injection stratified charge (DISC) engine and low-heat-rejection diesel.

Although further study of the economics of processing new hydrocarbon, minimally processed fuels is needed, the potential for conservation of various resources appears sufficient for increased emphasis in this area.

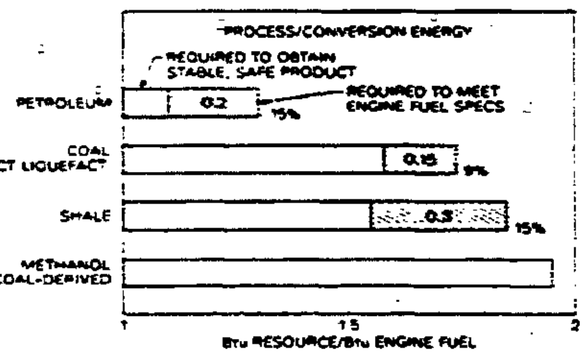

Fig. 1. Illustration of the resource energy requirements to produce transportation fuels.

Screening Tests — These experiments are conducted to determine the general compatibility of new hydrocarbon fuels with various engine technologies. For the most part, such efforts are intended to identify problems. For example, a Deere heavy duty engine has been recently tested with a variety of fuels from coal, shale, and tar sands with cetane numbers as low as 33 (1).* With these fuels, the biggest challenges appear to be in controlling particulate emissions and cold-starting.

Combustion Enhancement — Since new hydrocarbon fuels represent significant departures from conventional fuels, impact studies and engine tolerance evaluations for conventional and advanced engines must be made to determine the overall tradeoff between processing efficiency and end-use efficiency. The large number of fuel/engine experiments that have been sponsored is indicative of a generic technical shortcoming in that

1. Fuel properties, as currently characterized, are not reliable indicators of engine performance and emissions which is the case largely because

2. The dominant fuel parameters and engine variables, and how they interact in combustion, remain poorly understood. Projects recently carried out in AFUP have confirmed the need for and elusiveness of this information. This problem, rather generic in nature, is seen to require expansion of the experiments on fuel/engine interaction that have thus far been carried out under the New Hydrocarbon Fuels area.

Generally, it appears that the deficiencies in technology and data in the combustion of many alternative fuels are the same that

*Numbers in parentheses designate references at end of paper.

exist regarding the combustion of conventional fuels. Indeed the decades of experience and empirical information available for engine combustion of petroleum fuels have generally been sufficient for industry's use but this wealth of information is only partially applicable to synthetic fuels. Furthermore, increasing demands for engine efficiency and low emissions, coupled with the changing composition of conventional fuels, is reinforcing the need for more data to improve combustion technologies even with conventional fuels. This expanded research area in AFUP, currently in the planning and evaluation stage, has been tentatively entitled Combustion Enhancement. The major activities in Combustion Enhancement are planned as:

1. Isolating fuel property effects on combustion from combustion system (engine) effects
2. Examining and developing combustion chamber technology to enhance use of new fuels
3. Investigating the extent that fuel composition, additives, etc. can be tailored to improve the use of new fuels, and
4. Integrating [2] and [3].

An example of projects in this classification was recently completed at the University of Wisconsin (2). Six specially blended diesel fuels were tested in an open-chamber TACOM-LABECO single-cylinder diesel engine at turbocharged conditions, to determine if the chemical composition of the volatile fraction of the fuels had a significant effect on performance and emissions. The tests show that for this engine, which has a moderately high swirl and a four hole nozzle, the effects are very small. Additional tests were run, with these same fuels, in a homogeneous autoigniting mode to determine if ignition trends were similar to those produced by the heterogeneous diesel ignition. The ignition delay trends were found to follow the same pattern, reinforcing the conclusion that the fuel combustion in the diesel was not significantly affected by distillation effects during the vaporization process. The planning of future activities in Combustion Enhancement is underway. Future project plans (published) will show this as a separate topic area.

An essential function in research of this nature is the supply and analysis of test fuels. This is currently performed at Southwest Research Institute who, under contract, operates the DOE Synthetic Fuel Center. More details of the operation can be found in Reference 3.

Synthetic Gasoline and Distillate Fuel — The principal objectives of the projects in this classification are to identify, study, and resolve problems of using non-petroleum-derived fuels that essentially meet current fuel specifications. Since fuel specifications can be met by fuels varying widely in chemical makeup, engine experiments are run to uncover fuel-related anomalies that may arise. Such anomalies may include hazardous, non-regulated emissions that historically have not appeared with use of petroleum-derived fuels.

Alcohol Fuels — Alcohol fuels must necessarily be divided into two subclasses: (1) extenders in the form of blends, and (2) neat fuels for essentially total substitution. In the AFUP, interest lies in the broad classification of oxygenated hydrocarbons (including ethers), although activities are focused on methanol and ethanol as the principal candidates in this class. AFUP objectives related to alcohol fuels are:

Near-Term Objective — The near-term objective of testing and evaluating alcohol/gasoline blends in commercial and government fleets has been met. Solutions to problems have been verified, and the practicality and reliability of blends in this country have been demonstrated. Commercial blends of ethanol, methanol, higher-order alcohols, and ethers have been tested in the market place. Although concrete data from the use of alcohol blends in the current vehicle population are scarce, the recent downturn in the marketability of alcohol blends indicates widespread public skepticism regarding the compatibility of current vehicles and alcohol/gasoline blends.

Longer Term Objective — The longer term objective of defining and evaluating new systems has largely been completed. These efforts focused on optimizing resource/engine/fuel systems based on alcohols, confirming emissions and efficiency improvements in various engines, and discovering and solving problems associated with the use of alcohol fuels.

Presently funded projects are, for the most part, directed toward the longer term objective. Resolution of the cold-start issue is not entirely in hand as yet, but concepts should be approaching readiness for demonstration within a year. Experimental data on the ultimate efficiency of an engine optimized for methanol (as opposed to tests with modified conventional engines) are not complete, but funds are currently unavailable for a significant effort here. Emissions regulations for methanol vehicles are being developed by EPA. Aldehyde emissions for alcohol fuels are significantly higher than with gasoline, but they appear to be controllable by catalytic converters. The extent to which emissions regulations will require new control technology is unclear at this time, but does not seem to be extensive.

METHANE AND RELATED GASEOUS FUELS — The AFUP objectives for gaseous fuels are:

1. To test and evaluate gaseous fuels as substitutes or extenders in current gasoline and diesel engines, permitting determination of performance and emissions characteristics

and of the potential for improving engine thermal efficiency.

2. To assess institutional and safety-related issues associated with the use of gaseous fuels.

Since the technology for using gaseous fuels in automotive heat engine/vehicles is well established, DOE's role is focused on studies and/or specific R&D projects which industry could not be expected to accomplish.

Gaseous fuels were added to the AFUP in Fiscal Year 1981 because the Congress of the United States expressed interest in the use of methane (natural gas) as a transportation fuel. The Methane Transportation Research, Development, and Demonstration Act of 1980 (PL 96-512), enacted 12 December 1980, focuses on the expanded use of methane as a fuel for fleet-operated vehicles. Implementation of the Act is the responsibility of DOE's Office of Transportation Systems, though no funds were ever appropriated.

ORNL is co-sponsoring a project with other industry and State groups to determine the contaminant levels of pipeline natural gas, including hydrogen sulfide, carbon dioxide, water, oxygen, and other water-soluble sulfides, to assess the need for research into the role of contaminants in corrosion of on-board vehicle storage systems.

A single methane utilization project is under way, dealing with methane as a diesel engine fuel. This is being conducted on a railroad engine thereby extending the applicability beyond that for highway transportation. Over four billion gallons of diesel fuel are used annually for rail transportation. Natural gas offers potential as a less costly, more abundant alternative and its storage and refueling requirements, which hinder methane's acceptance for highway transportation, should present few problems for rail application. The unique aspect of the project is the investigation of high-pressure direct methane injection which should allow more efficient operation of the engine than currently found in conventional dual-fuel engines.

AFUP PROJECT PLAN — ORNL publishes project plans which provide detailed descriptions of each task. The first such document was published in January 1986 (4) and an updated version is currently being prepared. Interested readers should refer to that document for expanded descriptions of individual tasks.

FEDERAL METHANOL FLEET

LEGISLATIVE ORIGIN AND BACKGROUND — In the fiscal year (FY) 1985 Continuing Resolution, there was an appropriation of $980,000 to DOE for initiation of a Federal Methanol Fleet with the requirement that the demonstration be closely coordinated with a similar one begun by the Department of Defense (DOD). The Continuing Resolution referenced a section of a bill that had been introduced, but not passed by Congress, and instructed DOE to implement the Federal Methanol Fleet in accordance with the provisions of one of the sections of that bill. Section 105 of H.R. 5048 provides the congressional guidelines for the Federal Methanol Fleet. Those guidelines are summarized as follows:

1. Funds provided are for incremental costs associated with methanol only.
2. At least one of the sites at which methanol-fueled vehicles will be assigned must be in a cold climate.
3. Performance including fuel economy, emissions, and vehicle safety must be assessed.
4. Costs of operation and maintenance must be assessed in comparison to those costs for gasoline vehicles.

PROJECT STRATEGY AND APPROACH — The philosophy for operation adopted by DOE in this project is that methanol-fueled vehicles should be introduced into the Federal fleet in a manner common to and consistent with the present use of gasoline-fueled vehicles. It seemed relevant that private industry should be involved in the commercial aspects of the project, including both the fuel and the vehicle aspects, while Federal agencies would be involved in the acquisition and operation of the vehicles.

It was recognized early that this project is characterized by neither established specifications for, nor commercial availability of, the products themselves, i.e. methanol-fueled vehicles and fuel methanol. Furthermore, there is no methanol fuel distribution experience on a national or regional basis nor dedicated dispensing equipment, except for limited facilities in California.

Based on these observations, it was determined that a two-phase fleet project was appropriate. In Phase I, limited quantities of late-model vehicles modified for fuel methanol according to state-of-the art preproduction technology would be operated. The objectives of Phase I are as follows

1. Establish initial fleet operations and fueling sites.
2. Conduct operations with counterpart gasoline-powered comparison vehicles on a one-to-one basis.
3. Structure test controls, monitoring, vehicle operation and testing, data collection, and analysis activities.
4. Augment current information pertaining to user-agency benefits of methanol-fueled vehicles.
5. Provide the mechanism and framework for operator purchase of appropriate methanol fuel.
6. Provide inputs for Phase II operations.

In Phase II, at least 1000 vehicles will be acquired from U.S. automakers and integrated into Federal fleets. Operations will incorporate the following procedures and objectives:

1. Utilize Phase I data to establish or upgrade vehicle and fuel specifications.
2. Procure vehicles using General Services Administration (GSA)* purchase and allocation policies.
3. Expand the number and/or size of operational sites in conformance with purchases.
4. Verify operational results on a representative fleet cross section.
5. Provide appropriate prepurchase and operational support to ensure convenient operations by user agencies in a routine manner.

During both phases of the project, close communication will be maintained among industry participants, the program and project Managers, and the fleet operators. In addition to industry liaison, cooperative ties will be established with other Federal and State agencies, although DOE and DOD activities will be emphasized.

Strategy for Phase I Vehicles — It was planned that the Phase I test fleets would consist of the following types of vehicles: (1) gasoline-fueled vehicles converted to methanol use without increasing engine compression ratio (CR), (2) the same as (1) but with increased CR, and (3) unmodified gasoline-fueled cars to serve as control vehicles. Some of these vehicles would be specially adapted for cold weather operation.

Even though it was recognized that Phase I vehicles would not come from one of the U.S. auto manufacturers as original equipment, nevertheless it was desirable that conversion be done either by a manufacturer or by a suppliers with proven experience in converting gasoline vehicles to methanol vehicles. In the latter case, it is required that the supplier have some close ties with the appropriate auto manufacturer(s).

Strategy for Phase I Data Acquisition — Phase I data acquisition should serve to clarify perceptions and help to focus the direction of Phase II. At the same time, any data collection should have minimum impact on a fleet's operations in order to ensure reliable data without burdening an agency with too much.

Therefore, it was decided that only minimal data would be required of any participating fleet. Those requirements would include the following for both the methanol cars as well as the comparable gasoline control cars:

1. Refueling data including odometer readings and amount of fuel.
2. Driver reactions to the operation of the vehicle including ease of starting and driveability.
3. Vehicle maintenance records for both routine maintenance as well as extraordinary maintenance.

Special testing and data reporting at certain intervals in the vehicle's operation would also be required. The lubricating oil should be tested at regular intervals for each vehicle to determine such parameters as concentration of wear metals, total base number, viscosity, fuel dilution, etc. It also was planned to test each participating vehicle on the U.S. Federal Test Procedure both before and after conversion to methanol. Furthermore, emissions tests would be conducted on approximately one-year intervals, after the initial test.

PROJECT STATUS — At this time, one fleet has been fully operational since November 1, 1985, at Lawrence Berkeley Laboratory, a DOE facility in Berkeley, California. Two other DOE laboratories have made commitments to participate in the project; Argonne National Laboratory, near Chicago, Illinois, has agreed to be the site for the cold-weather fleet; and Oak Ridge National Laboratory, in Oak Ridge, Tennessee, has agreed to participate. Nearly all civilian departments of the U.S. Government have been contacted and briefed about the project. Out of these contacts a number of departments and/or agencies have indicated an interest and willingness to participate, but in most cases, circumstances have precluded their participation in Phase I of the project.

In addition to the three DOE laboratory sites for fleets mentioned above, it is expected that there will be perhaps, one methanol car prepared for use in the Washington, D.C. area as a means of promoting the project. The remainder of this section will deal separately with the status of the fleets at the three DOE laboratories.

Lawrence Berkeley Laboratory Fleet

Fleet Description and Methanol Conversion Details — This fleet has been operating at Lawrence Berkeley Laboratory (LBL) since November 1, 1985. The ten cars involved in the project are 1984 Chevrolet Citations with carburetted 2.8 liter V-6 engines and automatic transmissions. Five of the Citations were converted to operate on methanol by the Bank of America (BoA). Major elements of the BoA conversion include replacing some fuel lines and carburetor materials; electroless nickel plating of the carburetor; enlarging the fuel metering jets; replacing the head gaskets; and a larger fuel tank. No change was made in compression ratio.

Initial Emissions and Fuel Economy Results — Emissions and fuel economy tests of the five methanol Citations were performed both before and after conversion according to

*GSA is the procuring agency for all Federal vehicles.

the U.S. Federal Emissions Test Procedure (FTP) at the University of Santa Clara. Results of those tests are presented in Table 2. Notable in Table 2 is the fact that, for the five-car average, emissions of carbon monoxide and oxides of nitrogen are reduced considerably while emissions of hydrocarbons are increased after converting to methanol operation. The comparisons of fuel economy on an energy content basis before and after conversion are rather interesting also, showing the efficiency with methanol to be slightly lower than with gasoline in every case. Please note that the emissions tests on the cars after conversion to methanol were performed with BoA fuel which consisted of 88% methanol by volume and 12% unleaded gasoline.

Table 2. Emissions and fuel economy of five Citations before and after conversion

Vehicle ID (License #)	Emissions (g/mile)			Fuel economy	
	CO	HC	NO_x	ℓ/100 km	km/GJ
E-36753					
(g)[a]	2.23	0.39	0.79	12.3	252.1
(m)[b]	1.87	0.98	0.66	24.1	233.9
E-36754					
(g)	7.86	0.21	1.15	12.3	252.9
(m)	2.38	0.59	1.06	23.0	245.0
E-36755					
(g)	2.32	0.19	0.94	12.3	252.6
(m)	2.27	0.75	0.80	24.6	229.2
E-36756					
(g)	2.89	0.20	1.01	11.9	261.3
(m)	3.28	1.27	0.53	24.5	230.2
E-36757					
(g)	15.91	0.44	0.96	12.5	249.2
(m)	1.55	0.74	0.29	23.6	238.4
Five-car average					
(g)	6.24	0.36	0.97	12.3	253.6
(m)	2.27	0.87	0.67	23.9	235.3

[a]Unleaded gasoline (per FTP requirements).

[b]88% methanol plus 12% unleaded gasoline.

Data Acquisition Requirements at LBL — Copies of all maintenance records for all ten cars, whether the maintenance is routine or unscheduled, are sent to ORNL. Logs of all refueling transactions for the ten cars are maintained. Oil sample analysis is being handled by the Belvoir Fuels and Lubricants Research Laboratory located at the Southwest Research Institute in San Antonio, Texas; and they keep all records as well as forwarding copies to ORNL.

It was deemed appropriate to obtain drivers' perceptions of the methanol cars as compared to their perception of the gasoline cars. The data requested each time a driver checks out a car follows: date, driver name, time out, time in, destination, odometer out, and odometer in, plus the driver's assessment of ease of starting and driveability. This assessment is done by requesting that each driver rate starting and driveability merely by placing a check mark under either "Good," "Average," or "Poor" after the trip has been completed.

Results to Date from LBL Fleet — Table 3 and Figs. 2 and 3 summarize the primary results from the LBL fleet to date. In Table 3 the gross data in terms of numbers of trips, total miles, average miles per trip, and average fuel economy is presented for each of the ten cars as well as aggregate totals for the five cars in each category — methanol or gasoline. It can be noted that there is not much variation in fuel economy among the methanol cars or among the gasoline cars. The difference in fuel economy between the gasoline cars and the methanol cars is in about the same ratio as that for the methanol cars when compared before and after conversion, as was presented in Table 2. The total miles and average miles per trip for the gasoline cars will probably always be higher than the methanol cars since only the gasoline cars have been used for the longer, overnight trips.

Figures 2 and 3 show graphically the average of the drivers' responses to the questions of "Ease of Starting" and "Driveability." In both of these figures there is no appreciable trend of difference between the methanol and the gasoline cars. Basically, the drivers appear to like both types of cars since the average response is better than "average." Occasionally, the methanol cars have been rated "Poor" by some drivers; but, this is usually because they just do not like the car or some feature of it. It has nothing to do, usually, with the fact that the fuel is methanol.

The analyses of the oil samples so far have revealed higher levels of iron, lead, and tin wear debris in the crankcase oils of the methanol cars than in the gasoline cars. This is inconclusive, though, because the methanol cars' oils also have higher levels of silicone (dirt contamination) resulting, probably, from the difference in operational service (shorter trip lengths).

Argonne National Laboratory Fleet — Argonne National Laboratory (ANL), located in the western suburbs of Chicago, Illinois, will be the site of the cold-weather fleet for Phase I. At ANL a typical winter season will include numerous days of temperatures below freezing and a fair number of days when the low temperature is below 0°F (-18°C).

Plans for the ANL fleet are to use 10 Chevrolet S-10 pickup trucks with throttle-body-injected, 2.5 ℓ, four-cylinder engines and automatic transmission. Five of the S-10s will be methanol- and five will be gasoline-fueled. Also, nine Ford Crown Victorias with 5.0 ℓ, sequentially-timed, port fuel-injected V-8 engines and automatic transmission will be

Table 3. Lawrence Berkeley Laboratory Fleet Data
November 1, 1985 to March 31, 1986

Vehicle ID	Total trips	Total miles	(km)	Average miles/ trip	(km)	Average fuel economy mpg	(ℓ/100 km)
			Methanol cars				
E-36753	82	3,426	(5,512)	41.8	(67.3)	11.4	(20.6)
E-36754	72	3,074	(4,946)	42.7	(68.7)	12.1	(19.4)
E-36755	101	3,070	(4,940)	30.4	(48.9)	12.0	(19.6)
E-36756	61	2,493	(4,011)	40.9	(65.8)	11.3	(20.8)
E-36757	89	1,963	(3,158)	22.1	(35.6)	10.9	(21.6)
FIVE-CAR TOTALS	405	14,026	(22,567)	34.6	(55.7)	11.5	(20.5)
			Gasoline cars				
G-92563	133	4,085	(6,573)	30.7	(49.4)	21.7	(10.8)
G-92580	120	7,006	(11,273)	58.4	(94.0)	22.0	(10.7)
G-92611	101	5,478	(8,814)	54.2	(87.2)	25.5	(9.2)
G-92709	51	5,324	(8,566)	104.4	(168.0)	24.2	(9.7)
G-92771	130	5,380	(8,656)	41.4	(66.6)	23.6	(10.0)
FIVE-CAR TOTALS	535	27,273	(43,882)	51.0	(82.1)	23.3	(10.1)

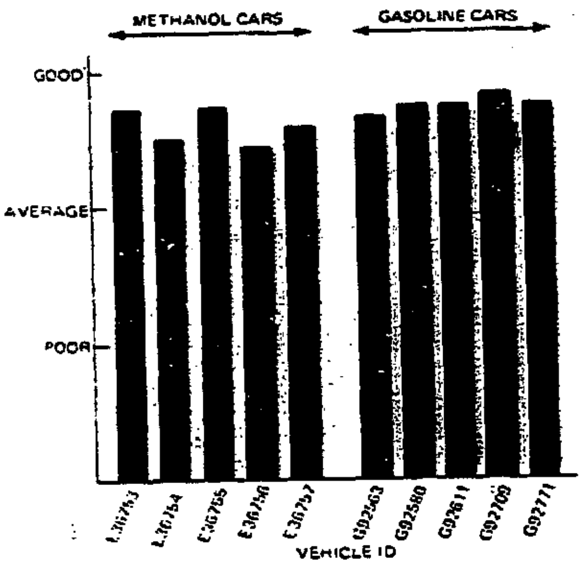

Fig. 2. Average Drivers' assessments of ease of starting.

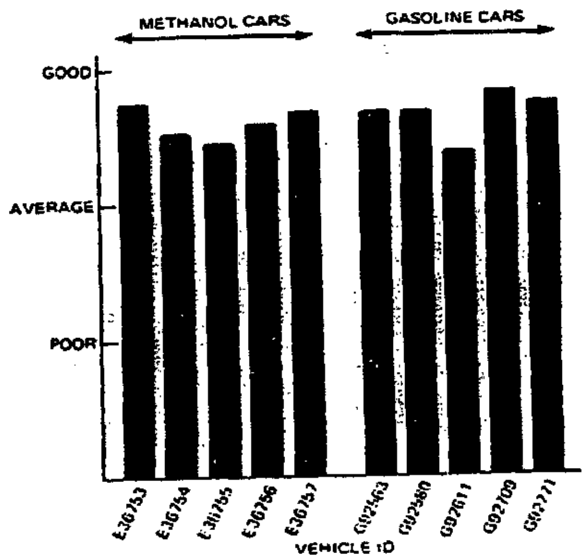

Fig. 3. Average Drivers' assessments of "Driveability."

included, five of which will be methanol-fueled and four of which will be gasoline. For the cold-weather conditions the supplier of these vehicles must demonstrate reliable starting and drive-away down to 5°F (-15°C) using only the primary fuel, i.e. 85% methanol and 15% unleaded gasoline. For "emergency" starting below 5°F (-15°C) down to -20°F (-29°C), the use of an on-board, auxiliary fuel system such as gasoline or propane will be allowed, if necessary. Delivery of the methanol vehicles to ANL can be expected before the next winter; the gasoline vehicles could be delivered a few months earlier.

The nine Fords will be placed into service at ANL as security patrol vehicles and, as such, will be used, most likely, on a 24-h basis. The ten Chevrolet S-10s will be used by ANL maintenance personnel as they are dispatched to various jobs on the site. Thus, these vehicles will be used mostly during the day for relatively short trips around the site.

An underground fuel tank with associated pump equipment is being installed at ANL to service the ten methanol vehicles. Data requirements will be very much like those at Berkeley with the possible addition of some questions about weather conditions.

Oak Ridge National Laboratory — Tentative plans have been made to locate a fleet at Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee. It is anticipated that the cars to be located at ORNL will be the Buick Regals, again five methanol and five gasoline. The Buicks feature a 3.8 ℓ, turbocharged, fuel-injected V-6 engine which represents a high level of technology in terms of utilizing the high-octane feature of methanol. These cars will be placed in service with various divisions of ORNL and will probably be rotated periodically among divisions so that duty cycles and mileage accumulation can be equalized.

Winters in Oak Ridge are moderate, but occasionally, severely cold weather can occur. However, the cars for Oak Ridge will have no extraordinary features for cold weather. Such an approach will be successful for the vast majority of the year. Nevertheless, during the cold periods that do occur, this will be a good test of the regular methanol-fuel system to operate in less than ideal conditions.

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