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Report to the Chairman, Subcommittee on
Energy and Power, Committee on Energy
and Commerce, House of Representatives

May 1987

ALTERNATIVE FUELS

Information on DOD's Methanol Vehicle Program



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Resources, Community, and
Economic Development Division

B-226783

May 22, 1987

The Honorable Philip R. Sharp
Chairman, Subcommittee on
Energy and Power
Committee on Energy and Commerce
House of Representatives

Dear Mr. Chairman:

In response to your February 5, 1986, letter and subsequent discussions with your office, we evaluated the Department of the Army's progress toward achieving the goals of the Department of Defense's (DOD) methanol vehicle demonstration program. The Army initiated the program in February 1985, in response to White House and congressional interest, to establish the feasibility of using methanol as an alternative fuel for government vehicles. We reviewed Army efforts to accomplish the goals established in the authorizing legislation. These were to (1) procure new methanol vehicles, (2) establish the reliability and durability of such vehicles in laboratory and fleet tests, (3) test some of them in cold weather, and (4) resolve related support functions for the safe and efficient storage, distribution, and use of methanol fuel. Also, as you requested, we examined whether the program would contribute to the increased use of methanol fuel and vehicles.

To accomplish our objectives, we interviewed DOD and Army program managers; program operation personnel at fleet locations; and methanol vehicle experts at the Southwest Research Institute, the Jet Propulsion Laboratory (JPL), the California Energy Commission, Alcohol Energy Systems, Inc., and the Bank of America. We performed our review in accordance with generally accepted government auditing standards. Information for this report was gathered between March and November 1986. The objectives, scope, and methodology are described in more detail in appendix I.

The results of our review are summarized below and discussed more fully in the following sections. We found:

- The Army had difficulty obtaining new methanol vehicles because manufacturers were unwilling to provide the small number of vehicles needed for the program. The Army purchased 27 new vehicles, which it modified to operate on methanol; 25 used, factory-built methanol vehicles that were produced for California in 1983; and 4 factory-modified

methanol vehicles, which incorporated a third type of engine conversion technology.

- The Army developed data on the reliability and durability of methanol vehicles; however, budget limitations precluded the program from testing enough vehicles for a sufficient number of miles to decisively establish reliability and durability.
- The Army is examining methanol vehicle operation under cold, moderate, and hot climate conditions. Results of these operations will not be available until October 1987.
- In addressing support functions, the Army developed methanol fuel and lubricant specifications; methods for transporting, storing, and dispensing the fuel; and technical specifications for vehicle conversion.
- As a result of the demonstration program, the Army gained experience operating methanol vehicles at several locations and in a variety of climates. The Army program by itself contributed little to increasing the use of methanol fuel and vehicles because the number of vehicles used in the program was too limited to encourage methanol vehicle production or fuel distribution. The Army used its limited funding to gain as much experience as possible from the program.

The Army's Methanol Vehicle Demonstration

The Army's methanol vehicle program was initiated because of actions by the White House and the Congress. Methanol gained attention as an alternative to gasoline because it is a liquid fuel that can be produced with known technology from abundant nonpetroleum resources, be used in vehicles similar to gasoline vehicles, and produce acceptable emissions. In May 1984 the Vice President, as chairman of the Cabinet Council Working Group on Methanol, sent a letter to the Secretary of Defense suggesting that DOD purchase methanol-compatible vehicles. In October 1984 the Congress authorized a methanol vehicle demonstration in the Department of Defense Authorization Act of 1985 (Public Law 98-525).

The Army's Program Plan

The Army's June 1985 program plan called for a three-phased program to accomplish the goals set out in the authorizing legislation. The first phase tested five methanol-fueled vehicles to ensure that no fundamental flaws were associated with the technology. The second phase was to provide more detailed information on methanol vehicle technology using 22 additional methanol vehicles and 3 gasoline control vehicles to provide a source of comparison. The final phase was to include up to 1,000 methanol-fueled vehicles at various fleet locations.

A revised program plan, issued in November 1986, incorporated new opportunities that had arisen and changes that occurred in the program. Phase II was expanded to include 25 methanol-powered, 1983 factory-modified Ford Escorts purchased from the state of California, which will be used primarily to assess cold-weather starting problems and operation at high elevations. Four factory-modified, methanol-fueled 1985 Chrysler K-cars were also added and will be used to obtain information on methanol vehicle operation in a hot climate.

Although a formal decision will not be made until the end of phase II, discussions with program officials and the revised program plan indicate that the 1,000-vehicle phase III anticipated in the original program plan is unlikely. Program officials indicated that the \$1.3 million funding authorized by Public Law 98-525 has already been expended. About \$1.4 million in additional funds was obligated to the program from the Army's fuels and lubricants research funds to continue operation through fiscal year 1987. These officials said that in light of other military programs more central to DOD's mission that require funding, they do not believe this program will be able to obtain further internal funding. Further, they said that DOD is not likely to request additional funds from the Congress to continue and expand the program because the technology is not militarily unique.

Implementation Problems Delayed Program

Phase I was initiated in April 1985. Since the Army was unable to obtain new methanol vehicles, program management officials decided to convert gasoline-fueled vehicles to operate on methanol using the conversion technology developed by the Bank of America. The bank has been operating methanol-fueled vehicles since 1979 and has about 275 in its fleet.

Phase II was initiated in August 1985. Vehicle conversion problems and slower-than-anticipated mileage accumulation caused the program to fall about 19 months behind schedule. Although the original program plan anticipated completing phase II by February 1986, the last of the 22 methanol-vehicle conversions for phase II was not completed until March 1986. The revised program plan calls for phase II to be completed by the end of September 1987.

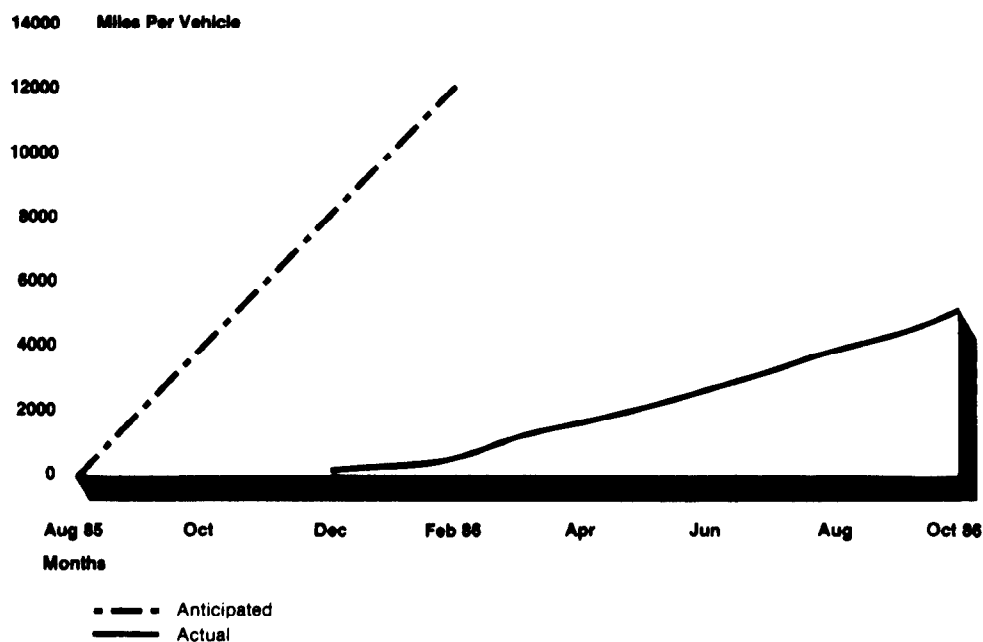
The vehicles operated on gasoline for at least 4,000 miles before being converted to operate on methanol. This gasoline-operating period was intended to break the vehicles in, make sure they were free of defects,

and provide a baseline for evaluating differences in operation and performance between methanol and gasoline. The June 1985 program plan estimated that vehicles would accumulate about 1,250 miles per month, completing the gasoline-operating period in 3 to 4 months. However, the vehicles averaged only 800 miles a month because they were operated on a consistent basis with the rest of the vehicles in the fleet, and were not given priority operation in order to accumulate mileage.

Phase II vehicle conversions began in September 1985. The conversions took longer than expected because of problems with one of the conversion parts. Soon after the first few vehicles were converted, a problem developed with the fuel-sending unit, a device that determines the amount of fuel in the fuel tank for display on the fuel gauge. The remaining conversions were delayed while awaiting a solution to this problem. Although the problem was not solved, program management officials decided to use the converted vehicles without functioning fuel gauges in order to avoid further delays.

As of October 1986, no vehicle had accumulated more than 7,500 of the 12,000 to 15,000 methanol miles established as the target for February 1986. As shown in figure 1, the average methanol mileage for the fleet was about 4,400 per vehicle. In order to reach the methanol mileage target as quickly as originally anticipated, it would have been necessary to accumulate 2,000 miles per month. However, after conversion to methanol, the vehicles averaged 524 miles per month. The rate of mileage accumulation decreased from the preconversion level because the vehicles were used primarily for short, local trips. Program management officials told us that in October 1986 they requested the fleet managers to accelerate mileage accumulation.

Figure 1: Phase II Average Mileage Accumulation



Source: Department of the Army.

Program Accomplishments and Limitations

The Army's demonstration program will meet some of the goals specified in the authorizing legislation, including testing vehicles in a variety of climates and resolving support functions for the vehicles. However, the Army had difficulty in obtaining new methanol-fueled vehicles, and the Army program alone does not appear sufficient to decisively establish the reliability and durability of methanol vehicles. The demonstration program did little to encourage increased use of methanol fuel and vehicles because the number of vehicles used in the program was too limited to encourage methanol vehicle production or fuel distribution.

Army Had Difficulty Purchasing New Methanol Vehicles

The authorizing legislation directed DOD to buy new methanol cars. Army officials said that they contacted the domestic automobile manufacturers in an attempt to obtain new methanol vehicles at the beginning of the program. However, at the time, the manufacturers were unwilling to provide the small number of vehicles requested for the program in part because they said it would not be economically feasible.

In order to get the program underway and accomplish the remaining objectives of the authorizing legislation, program management officials decided to modify gasoline vehicles to operate on methanol. The officials decided to use the methanol conversion technology designed by the

Bank of America because it is a relatively inexpensive conversion that was being used successfully in a fleet of 275 Bank of America vehicles. A total of 27 vehicles for the Army's program were converted using the Bank of America technology.

The revised program plan also included two additional fleets of vehicles. Chrysler provided four factory-modified methanol engines and fuel systems for DOD to evaluate. Although the engine and fuel system will be installed in existing cars, the methanol-related components, such as the fuel tank and fuel lines, will be new. The Army also purchased 25 factory-built, methanol-powered Ford Escorts from the state of California. These vehicles were previously used in the California Energy Commission's methanol vehicle demonstration program. Table 1 shows the composition and location of vehicles in the Army's methanol vehicle demonstration program.

Army Program Experience Alone Insufficient to Establish Reliability and Durability

Researchers and Army officials indicated that the Army program alone did not include enough vehicles or operate them for a sufficient number of miles to decisively establish reliability and durability. A researcher at JPL noted that car manufacturers generally test 500 vehicles to establish durability. A Southwest Research Institute researcher said that maintenance data are not being analyzed to compare the type or cost of repairs for gasoline and methanol vehicles because in a fleet this small, even one "lemon" would skew the results.

Table 1: DOD Methanol Vehicle Fleet^a

Location	Type of vehicle	Methanol vehicles	Gasoline vehicles ^a
California			
Presidio Army Base	1984 Chevrolet Citation	4	2
JPL	1984 Chevrolet Citation	1	•
	1985 Chevrolet S-10 Pickup	1	•
Fort Ord	1985 Chevrolet S-10 Pickup	21	3
	1983 Ford Escort	5	•
Sierra Army Depot	1983 Ford Escort	20	•
Texas			
Randolph Air Force Base	1985 Chrysler K-car	4	3
Total		56	8

^aThe gasoline vehicles were used as controls to provide a source of comparison with the methanol vehicles.

Source: Department of the Army.

Methanol fuel researchers we interviewed said the 12,000-to-15,000-mile targets set for phase II vehicles are insufficient to establish reliability and durability. A methanol fuel expert at the California Energy Commission said that vehicles should be driven at least 50,000 miles to establish durability. In addition, Army officials told us that some problems may not be evident until the vehicles have been driven at least 20,000 miles on methanol.

The Army plans to evaluate the durability of methanol engines through engine oil wear metal analysis, and by disassembling some of the engines at the end of the program to measure critical parts and clearances for comparison with factory specifications or, in the case of the Chrysler and Ford engines, pre-test measurements.

The Army's program management officials agreed that DOD's methanol vehicles alone would be inadequate to establish reliability and durability. In order to make the best use of the information available, program management officials said they intend to use data from the Department of Energy, state of California, and Bank of America demonstrations to augment the Army's data for the purpose of assessing reliability and durability. The state's and bank's methanol fleets are larger than the Army's and have been in operation longer. We did not review the records of these other groups to assess whether the data are comparable and could be used for this purpose.

Vehicles Tested in a Variety of Climates

The program demonstrated methanol vehicle operation in the temperate San Francisco Bay and Monterey, California, areas. Additional fleet locations have been added, which will assess methanol vehicle operation in a cold-weather/high-altitude environment and a hot climate. Low-temperature laboratory testing is also being done on methanol engines at the Southwest Research Institute. Results for the additional fleet locations added late in 1986 are not expected to be available until October 1987.

Support Functions Addressed

The authorizing legislation also called upon DOD to resolve support functions for methanol vehicle use. During the program, Army officials developed specifications for methanol fuel and technical guidance for providing both permanent and temporary methanol refueling facilities. They established a source for methanol engine lubricants and fuel, and developed the know-how for transporting, storing, and distributing

methanol fuel. They also developed technical specifications for the vehicle and engine conversion process.

The Army has been evaluating several different engine lubricants specially formulated for use in methanol engines in an attempt to determine which is most effective. A special lubricant is needed because methanol fuel is incompatible with gasoline-type lubricants. This evaluation is still underway and results are not available.

Some Fuel Consumption Data Unreliable

Part of the program was to compare methanol and gasoline fuel economy. Problems occurred at one of the fleet locations with gasoline fuel consumption data collection. Program officials noted that some fuel consumption data have been distorted by record-keeping errors. They believe that some drivers neglected to record gasoline that was added to the vehicles. Our analysis shows that 10 percent of the gasoline consumption data was in error.

In order to improve the accuracy of fuel consumption data, program officials told us they were modifying fuel use data collection. The filling station attendant will check the figures recorded by the driver. Officials believe this system will lead to more consistent recording of fuel consumption. Furthermore, the program manager told us that for their final report, the data will be analyzed prior to estimating fuel economy in order to remove any erroneous data.

Impact on the Increased Use of Methanol Vehicles

We examined whether the program would contribute to the increased use and potential commercial production of methanol fuel and vehicles. Some analysts believe that private fleets of methanol vehicles could be used as a catalyst to initiate a more general market for methanol fuel and vehicles. In addition, fleet vehicles could be used to determine economic viability and identify any potential technical or environmental problems. A previous GAO report concluded that converting the federal fleet to operate on methanol was unlikely to provide sufficient demand for vehicles or fuel to promote commercial production and distribution.¹

The DOD methanol vehicle demonstration program tends to support the findings in our 1983 report. Although the Army's methanol vehicle demonstration program will provide some data on the technical and environmental aspects of methanol vehicle operation, it was too limited in size

¹Removing Barriers to the Market Penetration of Methanol Fuels (GAO/RCED-84-36, Oct. 27, 1983).

and duration to encourage the production of methanol vehicles or the availability of methanol fuel. Vehicle manufacturers were unwilling to produce the small number of methanol vehicles required for the demonstration in part because they said it was not economically feasible. In addition, because the vehicles used private refueling facilities at the fleet installations, the demonstration did not help establish commercial fuel distribution.

DOD officials agreed that the demonstration would probably do little to promote methanol fuel or vehicle availability. They told us that promoting the commercial production of methanol fuel and vehicles is beyond the scope of DOD's mission, especially because the technology has no unique military value. In addition, they told us that methanol is incompatible with engines, fuel handling, storage, and distribution systems that would be used on the battlefield. They said DOD is interested in methanol fuel as a potential consumer, not as a market leader.

DOD provided official comments on a draft of this report. They concurred with its content with the exception of several technical comments, which have been incorporated where appropriate.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of this letter. At that time we will send copies to the Secretaries of Defense and the Army, and make copies available to others upon request. This work was done under the direction of Flora H. Milans, Associate Director. Major contributors are listed in appendix II.

Sincerely yours,

A handwritten signature in black ink, reading "J. Dexter Peach". The signature is fluid and cursive, with the first name "J." and last name "Peach" clearly legible.

J. Dexter Peach
Assistant Comptroller General

Objectives, Scope, and Methodology

Our objective was to evaluate the Army's progress toward achieving the goals established in the authorizing legislation and determine whether the program would have an impact on the commercial development of methanol fuel and vehicles. The program objectives and rationale are described in the authorizing legislation and expanded on in several basic program documents. The legislative objectives included purchasing new methanol vehicles; establishing their reliability and durability in laboratory and fleet environments; testing a percentage of the vehicles in cold weather; and resolving related support functions for the safe and efficient storage, distribution, and use of methanol fuel. As requested, we also examined whether the program would contribute to the increased use of methanol fuel and vehicles.

In order to evaluate the adequacy of the program plan for achieving the legislative objectives, we compared the objectives laid out in the Army's program plan with the original authorizing legislation and supporting documents. We interviewed program management officials to determine what factors, aside from the goals established in the authorizing legislation, were considered during program design, such as budget and technology availability. We spoke with program management officials and operations personnel to determine how the program was implemented and to learn program management's perception of its intended purpose and DOD's mission as it relates to methanol vehicles.

We reviewed pertinent DOD documents and interviewed DOD officials to determine the program status. We compared the program status with the DOD program plan to determine how well the two coincided and where problems occurred. We used the June 1985 plan as the primary basis for comparison; however, the Army issued a revised program plan in November 1986. We therefore reevaluated our results in light of the revision.

We interviewed methanol vehicle experts and program management officials to address the issue of whether vehicle testing should be conducted in a wider variety of climates. We asked methanol vehicle experts to better define climate-related methanol vehicle issues, and asked program management officials how they made vehicle-siting decisions and whether climate was an issue.

In order to address the adequacy of the current test fleet size and assess what it could accomplish in terms of reliability and durability testing, we examined the size and composition of the total methanol vehicle test fleet and compared it with the size and composition of the DOD fleet

overall. We also spoke with program management officials to determine what type of statistical analysis was conducted prior to program implementation.

To evaluate the accuracy of data entry and the results to date, we reviewed documentation and data regarding the vehicles' operation, mileage accumulation, fuel economy, maintenance records, emissions, and fuel and oil samples. We verified that a random sample of the computer-generated data agreed with the raw data that were input. We also conducted a computerized analysis of the fuel economy and mileage data to assess the reliability of the data, and compared the progress of the program with the established goals.

To assess whether the DOD methanol vehicle fleet might contribute to the commercialization of methanol fuel and vehicles, we used the findings of an earlier GAO report that examined the potential of methanol vehicle fleets to expand methanol fuel and vehicle use.¹ We compared these findings with what we learned about the DOD fleet. We also spoke with DOD officials to determine their perception of the potential for the fleet program to increase methanol fuel and vehicle use.

To accomplish our objectives, we interviewed officials at the following locations:

- U.S. Army Laboratory Command in Adelphi, Maryland;
- U.S. Army Belvoir Research and Development Center in Fort Belvoir, Virginia;
- Jet Propulsion Laboratory in Pasadena, California;
- Southwest Research Institute in San Antonio, Texas;
- Presidio of San Francisco, California;
- Fort Ord, California;
- California Energy Commission in Sacramento, California; and
- Bank of America in San Francisco, California.

We performed our review in accordance with generally accepted government auditing standards. Information for this report was gathered between March and November 1986.

¹GAO/RCED-84-36, Oct. 27, 1983.

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