

California State Auditor

B U R E A U O F S T A T E A U D I T S

Los Angeles County Metropolitan Transportation Authority:

*Converting Its Poorly Performing
Alcohol-Fueled Buses to Diesel Is the
Most Cost-Effective Option Available*



February 1999
98120

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CALIFORNIA STATE AUDITOR

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February 18, 1999

98120

The Governor of California
President pro Tempore of the Senate
Speaker of the Assembly
State Capitol
Sacramento, California 95814

Dear Governor and Legislative Leaders:

As requested by the Joint Legislative Audit Committee, the Bureau of State Audits presents its audit report concerning the Los Angeles County Metropolitan Transportation Authority's (MTA) decision to convert its alcohol-fueled bus fleet to diesel fuel and to determine whether the use of public funds to convert these buses is justified. This report concludes that, based on the circumstances surrounding the purchase and the ongoing problems associated with its alcohol-fueled buses, the MTA's choice to convert these buses to diesel was the most cost-effective option that meets environmental standards.

Respectfully submitted,

A handwritten signature in cursive script, reading "Kurt Sjoberg".

KURT R. SJOBERG
State Auditor

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SUMMARY

Audit Highlights . . .

The MTA's decision to convert its alcohol-fueled buses to diesel was based on the following factors:

- ✓ Despite following maintenance requirements in the bus purchase agreements, the alcohol-fueled buses failed at inordinate rates.*
- ✓ By 1996, engine warranties covered at least \$16 million in repair costs, yet problems remained.*
- ✓ Converting the buses to diesel, rather than continuing to use ethanol, will save more than \$71 million.*

Therefore, we believe the MTA's solution is reasonable given the circumstances.

RESULTS IN BRIEF

The Los Angeles County Metropolitan Transportation Authority (MTA) coordinates all public transportation services in Los Angeles County, including long-range regional transportation, light and heavy commuter rail systems, and bus service. Our review focused on the financial aspects and current operational condition of the MTA's alcohol-fueled buses and on the MTA's decision to convert them to diesel-fueled buses. Based on the circumstances surrounding the purchase of the alcohol-fueled buses as well as the ongoing problems associated with them, we found that the MTA's choice to convert the buses to diesel is the most cost-effective option that also meets environmental standards.

Starting in 1989, the MTA anticipated changes in vehicle emissions standards and began experimenting with buses that ran on alcohol and compressed natural gas. The industry was just beginning to develop engines that operated on alternative fuels, and the MTA's choices for replacing and expanding its bus fleet with alternatively fueled buses were limited. By fiscal year 1992-93, it owned 333 alcohol-fueled buses, comprising 14 percent of its fleet and constituting one of the largest alternatively fueled fleets in the nation.

The MTA, along with other transit districts, encountered many problems with these alcohol-fueled buses, despite its reasonable efforts to follow the engine maintenance requirements in the purchase agreements. The MTA therefore pursued its rights under the warranty provisions included in the purchase agreements. By 1996, the warranties had covered at least \$16 million in repair costs.

By February 1998, the MTA had pulled 127 alcohol-fueled buses with failed engines and expired warranties out of service. By this action, the MTA risked losing the federal government's 80 percent share of the more than \$50 million it still owed on these buses. In response to this problem, its board of directors approved the MTA's recommendation to convert all 324 of its remaining alcohol-fueled engines to diesel engines that meet appropriate vehicle emissions standards, thus ensuring ongoing

service from this failing segment of its fleet. Under the plan, buses are not converted until their engines experience catastrophic failure and their warranties expire. As of January 1999, 42 buses have been converted to diesel while 234 of the remaining buses are nonoperational, leaving only 48 still in service.

Although converting all 324 of its remaining alcohol buses to diesel fuel is not the most environmentally sensitive option available to the MTA, the converted engines will meet both State and federal emissions standards for urban bus engine conversions. Converting the engines to cleaner compressed natural gas would cost the MTA an additional \$88,300 per bus, which includes both the incremental difference to convert to compressed natural gas as well as the extra operating costs over the remaining service life of the bus, estimated at six years. This would entail a total cost of \$85.7 million for converting all 324 buses, a considerably higher amount than the \$57.1 million it would cost to convert the buses to diesel.

AGENCY COMMENTS

The MTA was pleased that our findings support its decision to convert its alcohol-fueled buses to diesel fuel. ■

INTRODUCTION

BACKGROUND

State law created the Los Angeles County Metropolitan Transportation Authority (MTA) in 1993, merging the Los Angeles County Transportation Commission and the Southern California Rapid Transit District.¹ The MTA is governed by a 14-member board of directors consisting of 5 county supervisors, the mayor of Los Angeles, 3 members appointed by the mayor, 4 elected officials representing other cities in Los Angeles County, and a nonvoting member appointed by the governor. A chief executive officer manages the MTA.

To coordinate the operation of all public transportation services within Los Angeles County (county), the MTA is responsible for the following tasks:

- Overall long-range regional transportation planning.
- Planning, development, construction, and operation of light and heavy commuter rail systems.
- Operation of a bus system within its service area in the county and to portions of Orange and Ventura counties.

The MTA operates the main bus service for the county. In fiscal year 1997-98, its active fleet consisted of over 2,100 buses. This fleet covered a route system of approximately 3,200 miles to provide transportation for approximately 1,200,000 passengers each weekday.

In October 1996, the MTA agreed to the terms of a federal consent decree to settle its litigation with the Bus Riders Union and other bus riders in the county. In part, the consent decree required the MTA to improve service for county residents who

¹Throughout this report, we refer to actions taken by the MTA prior to 1993. These actions were taken by one of the two agencies that evolved into the MTA in 1993.

depend on its buses for transportation by providing additional stops and by expanding the bus fleet by 102 buses by June 30, 1997, to reduce overcrowding.

The MTA's operations and capital projects are funded from a variety of sources, including local, state, and federal governments. A major source of local funding comes from voter-approved Proposition A and Proposition C. Each proposition imposes a 0.5 percent sales and use tax on goods and services purchased in the county, which together accounted for approximately 40 percent of the MTA's budgeted annual revenues for fiscal year 1998-99. Bus riders and all other transit riders contribute about 10 percent of budgeted annual revenues through cash fares, passes, and tokens. The MTA also receives state funds, such as gasoline and sales taxes, for transportation planning purposes. Finally, the federal government funds transit operations and capital projects. For example, the federal government subsidizes approximately 80 percent of bus purchases.

THE MTA'S ACQUISITION OF ALTERNATIVELY FUELED BUSES

In response to impending changes in federal emissions standards, in 1984 the MTA decided to augment its fleet of diesel-powered buses with buses that used alternative fuels. Between 1989 and 1990, it began operating a demonstration fleet of 30 buses that ran on methanol and 10 that operated on compressed natural gas. By 1992, the MTA had agreed to purchase an additional 303 methanol-fueled buses to add to the approximately 2,000 buses in its diesel-powered fleet. To qualify for federal funds to subsidize its bus purchases, the MTA is required to keep buses in service for 12 years or 500,000 miles, whichever occurs first.

The MTA's alcohol-fueled buses originally ran on methanol, which is produced primarily from natural gas. As a result of methanol fuel price increases and problems with the methanol-fueled engines, in 1995 the MTA converted the buses to run on ethanol, which is derived from corn, sugar cane, grasses, trees, and agricultural waste. Because of problems we discuss in this report, the MTA decided to convert these buses to diesel power in 1998.

SCOPE AND METHODOLOGY

The Joint Legislative Audit Committee requested that the Bureau of State Audits evaluate the MTA's decision to convert its alcohol-fueled bus engines to diesel engines. Specifically, we were asked to determine whether the use of public funds to convert these buses is justified and if the costs related to the conversion are reasonable. While pursuing the answers to these questions, we examined whether the MTA had executed its rights under the warranty provisions of the purchase contracts for its alcohol-fueled buses and also assessed the MTA's compliance with the engine manufacturer's recommended preventive maintenance, which is required for the warranty to remain valid. Finally, we reviewed the MTA's conversion contract to determine whether its requirements for the conversion are in compliance with California's vehicle emissions standards.

First, to gain an understanding of urban bus procurements and establish a basis for our evaluation, we reviewed the laws, rules, and regulations relevant to the MTA and its transit bus program. We also interviewed MTA personnel.

Then, to determine whether the use of public funds to convert these buses was justifiable and if the costs related to the conversion were reasonable, we reviewed MTA board reports and board minutes. In addition, we examined the MTA's financial statements for fiscal year 1996-97 and its adopted budget for fiscal year 1998-99. We also investigated the costs of converting the alcohol-fueled bus fleet to diesel, as well as the costs of other options, such as converting the existing engines to compressed natural gas or installing new diesel engines.

To assess whether the MTA put a reasonable effort into obtaining its warranty rights for problems with its alcohol-fueled engines, we reviewed the purchase orders and contract specifications to determine possible recourse for defects. We also evaluated the MTA's warranty claims against the bus manufacturer, Transportation Manufacturing Corporation, and against the engine manufacturer, Detroit Diesel Corporation (Detroit Diesel), to determine whether the MTA took appropriate actions in a timely manner. Further, we interviewed MTA management, maintenance, and engineering staff regarding the repairs that had been completed under warranty. Finally, we reviewed informal agreements reached by the MTA and Detroit Diesel for correction of engine problems done at the expense of Detroit Diesel, including warranty extensions.

Further, to assess compliance with the engine manufacturer's recommended preventive maintenance schedule, we reviewed the planned maintenance program records and bus operator report cards for 10 of the MTA's 333 alcohol-fueled buses. Additionally, we determined if properly trained technicians had maintained the alcohol-fueled engines. We also compared the MTA's experiences with its alcohol-fueled engines to those of other transit agencies.

Finally, to determine whether converting the alcohol-fueled buses to diesel fuel is in compliance with legal and regulatory requirements, we reviewed laws and regulations at the federal and state level regarding vehicle emissions standards. Further, we examined correspondence to the MTA from the federal Environmental Protection Agency and the California Air Resources Board. Lastly, we evaluated the MTA's current and planned bus replacement purchases to determine if they include technologies that may not meet the vehicle emissions standards of the State. ■

AUDIT RESULTS

The MTA's Decision to Convert Its Alcohol-Fueled Buses to Diesel Complies With Emissions Standards and Is the Most Cost-Effective Use of Public Funds

SUMMARY

Changes in state and federal emissions standards and the limited availability of engines that met those standards contributed to the decision of the Los Angeles County Metropolitan Transportation Authority (MTA) to purchase 333 alcohol-fueled buses between 1989 and 1992. Despite following appropriate maintenance procedures and effectively using warranties, engine failures continue to plague the MTA's alcohol-fueled fleet. Faced with the extraordinary cost of keeping unreliable alcohol-fueled engines in service, the MTA decided in February 1998 to convert all of its alcohol engines to diesel. We believe that the MTA's decision is the most cost-effective option available and that, once converted, the diesel engines will comply with the appropriate California vehicle emissions standards.

Although converting its alcohol-fueled buses to diesel is not the most environmentally sensitive option the MTA has, the converted engines will meet both California vehicle emissions standards and federal requirements for urban bus conversions. Additionally, the remaining 324 alcohol-fueled buses that will be converted represent only 14 percent of the MTA's total fleet. By fiscal year 2003-04, when the alcohol-fueled buses can be pulled from service based on federal 12-year or 500,000-mile funding requirements, 96 percent of the MTA's fleet will use alternative fuels.

THE MTA'S PURCHASE OF ALCOHOL-FUELED BUSES WAS REASONABLE GIVEN THE CIRCUMSTANCES

Our review indicates that the MTA's decision to purchase 333 alcohol-fueled buses was a reasonable one, given the fluctuation of vehicle emissions standards and the state of alternative fuel technology at the time. The MTA was one of the first in the transit industry to use buses that ran on alternative fuels. In anticipation of impending changes in vehicle emissions standards, it purchased and began testing 30 buses fueled with alcohol in 1989 and 10 buses fueled with compressed natural gas in 1990. At the time, both alcohol- and natural gas-fueled engines were emerging technologies and, as such, were still being developed. However, the technology for alcohol-fueled engines was more mature than for engines fueled with natural gas. Nevertheless, the MTA reported significant problems with its alcohol-fueled engines.

As foreseen by the MTA and other transit organizations, the federal government established more stringent vehicle emissions standards under its Clean Air Act Amendment in 1990. This included new standards for urban buses. Perhaps more importantly, the amendment also allowed California to set its own, more restrictive, emissions standards. The California Air Resources Board (CARB), which has the primary responsibility for protecting air quality in California, established such regulations to become effective in 1991. For the first time, it set specific emissions standards for the heavy-duty engines used in urban buses. Before 1991, its emissions standards applied to all heavy-duty diesel engines, with no separate classification or standards directed at urban buses.

Once California adopted these specific standards for urban buses, the only bus engine certified by the CARB was an alcohol-fueled engine built by Detroit Diesel Corporation (Detroit Diesel). As a result, all new buses purchased in California during 1991 for use in urban transit fleets had to be powered by Detroit Diesel's alcohol-fueled engine.

To keep pace with its annual bus replacement schedule in 1991, the MTA had to buy at least 219 new buses every year. Pressed by this need and uncertain whether any other engines would soon pass the CARB emissions standards, the MTA had little choice but to overlook the problems it had experienced with the thirty alcohol-fueled buses it had already purchased. In 1992, the MTA

Because only Detroit Diesel's alcohol-fueled buses met state emissions standards, in 1992 the MTA had little choice but to buy these buses to keep pace with its replacement needs.

signed a contract with the Transportation Manufacturing Corporation for the purchase of 303 buses powered by Detroit Diesel's alcohol engines that burned methanol. Between 1992 and 1993, the MTA put into service all of the buses called for in the contract. When added to its demonstration fleet of 30 buses, this purchase increased the total number of the MTA's alcohol-fueled buses to 333, at a total cost of \$70.8 million, approximately 80 percent of which was subsidized by the Federal Transit Administration.

As it turned out, the exclusivity enjoyed by Detroit Diesel was short-lived. In 1992, the CARB began certifying additional engines as meeting California's urban bus emissions standards, including diesel engines and engines that burned compressed natural gas. Both Detroit Diesel and the Cummins Engine Company manufactured these engines.

THE MTA EXPERIENCED SIGNIFICANT MECHANICAL PROBLEMS WITH ITS ALCOHOL-FUELED BUSES

The MTA's problems with alcohol-fueled engines began with its 30-bus demonstration fleet and continued with the additional 303 methanol-fueled buses it purchased in 1992. Other transit districts using these same engines reported mechanical problems and engine failures similar to those experienced by the MTA. These mechanical problems continued despite the fact that the maintenance practices employed by the MTA on its fleet of alcohol-fueled buses conformed to those recommended by the manufacturer in the bus purchase agreements. Moreover, the MTA pursued the warranty rights included in the purchase agreements, thereby not only obtaining extensions to the engine's warranty period, but also avoiding an estimated \$16 million in repair costs between 1989 and 1996.

Engine failures plagued the demonstration fleet—30 buses with 30 major engine failures—and were common amongst the 303 buses procured in 1992.

The most common problems the MTA experienced with its original purchase of 30 alcohol-fueled buses included leaking fuel injectors, plugged fuel filters, and burned-out glow plugs. The leaking fuel injectors were of particular concern to the MTA. In a 1991 alternative fuel status report, the MTA concluded that even though fuel injector leaks do not noticeably affect engine performance, the raw fuel leaking into the bus crankcase could cause premature bearing or cylinder liner O-ring failure. Based on MTA statistics from the first quarter of 1991, the demonstration fleet of 30 alcohol-fueled buses sustained 30 major engine

failures, 8 of which were attributed to bearing failures due to leaking injectors. Engine failure occurs when the engine cannot operate sufficiently to allow a bus to remain in service without undergoing major engine repair. Furthermore, the MTA statistics from that quarter indicate that fuel injectors failed at an average of 22,300 miles when, according to the warranty, they should have lasted 100,000 miles. In addition, fuel filters averaged 4,700 miles when they should have lasted 6,000 to 10,000 miles, according to the engine manufacturer.

The significant problems the MTA experienced with its demonstration fleet also plagued the 303 alcohol-fueled buses procured in 1992. Once again, the major problem was premature engine failure. Between 1992 and 1994, the MTA reported that methanol-fueled engines failed approximately every 40,000 miles when the warranty stated they should be free of defects for 100,000 miles. In other words, the engines failed more than twice as fast as they should have.

Major problems with the 303 new buses began around mid-1993. According to the MTA's records, its staff completed more than 10 engine repair projects between 1992 and 1994. Five of these projects were required for all 303 buses in an attempt to increase the engines' durability. In spite of these repairs, the alcohol-fueled engines continued to fail at intervals of approximately 45,000 miles.

Due to rising methanol fuel prices and the unreliability of the methanol engines, the MTA converted the engines to ethanol fuel in 1995. At the time, the MTA believed that the ethanol engines would need to be rebuilt only once every three years as opposed to once every twelve months using methanol. However, the ethanol engines failed at a much quicker rate, achieving only about half the life of methanol engines, or about 26,000 miles each.

MECHANICAL PROBLEMS WITH ALCOHOL-FUELED ENGINES ARE NOT UNCOMMON

The problems the MTA experienced with its alcohol-fueled bus engines are fairly common. We reviewed a study² of transit agencies that used the same type of alcohol-fueled engines in

²*Alternative Fuel Transit Bus Evaluation Results*, December 1996, by the National Renewable Energy Laboratory.

their fleets as the MTA. The report indicates that the maintenance costs for the alcohol-fueled buses belonging to a transit agency in New York were almost four times as high as they were for the diesel buses included in the study. Furthermore, the New York transit agency reported that its alcohol-fueled engines needed to be rebuilt or replaced after as few as 40,000 miles. The study concluded that the low-mileage engine problems came from degradation of the fuel injectors and the main bearings, which were prematurely wearing and failing. Corrosion and wear of the seals and metals in the fuel injectors were cited as a cause of reduced injector life.

The study also found that alcohol engine glow plugs, which warm the cylinders enough for the engine to start, were not reliable. Glow plug failure occurred between 2,600 and 4,700 miles, while the engine manufacturer, Detroit Diesel, recommended replacing them every 50,000 miles.

To more fully determine the status of alcohol-fueled urban bus fleets in use elsewhere, we contacted three transit agencies that had utilized this technology—New York City, New York; Peoria, Illinois; and Riverside, California. All three districts cited mechanical problems with their buses similar to those discussed in the study and experienced by the MTA. Two of these three agencies—New York and Peoria—have either converted their alcohol-fueled engines to diesel or are in the process of converting to compressed natural gas in order to avoid extraordinarily high maintenance costs. The Riverside transit agency sold all three of its alcohol buses at an auction to a used bus dealer because its operating costs were excessive. The dealer who bought the three buses stated that they are currently parked.

The engine maintenance schedule the MTA followed adhered to the manufacturer's requirements.

THE MTA'S MAINTENANCE PROGRAM DID NOT APPEAR TO CONTRIBUTE TO THE MECHANICAL PROBLEMS OF ITS ALCOHOL ENGINES

Based on our review of the relevant maintenance and training records for its alcohol-fueled buses, the MTA's maintenance procedures and practices were reasonable. According to the bus operator report cards, 6,000-mile checklists, the MTA's planned maintenance program, and other miscellaneous maintenance documents that we assessed, the MTA followed an established

maintenance schedule for its methanol-fueled buses that adhered to Detroit Diesel's maintenance requirements for such engines. Detroit Diesel's own actions also confirm that the MTA observed its contractual maintenance requirements for its engines.

The MTA mechanics received specialized training and assistance to enable them to properly service and maintain the alcohol-fueled buses. Specifically, after the delivery of the first demonstration and production buses, the manufacturer provided instruction and advice for eight weeks to MTA personnel on the proper operation and maintenance of the equipment. Furthermore, until the end of the warranty period, the manufacturer provided the MTA with a full-time, on-site service representative and, available on request, an engineer to assist the MTA in solving engineering and design problems. According to Detroit Diesel, the MTA had the only Detroit Diesel-certified trainer in the maintenance of alcohol-fueled engines in the nation. The MTA's training records indicate that 419 MTA staff received a combined total of 7,196 hours of specialized alcohol-fuel training from 1992 to 1997, which included three days of instruction in engine maintenance.

Because the MTA's alcohol-fueled buses had yet to perform satisfactorily, Detroit Diesel completed a review of issues concerning the performance levels of the ethanol engines in May 1997. The manufacturer's review concluded that both Detroit Diesel and the MTA were responsible for various issues related to the mechanical problems that caused the engines' unsatisfactory performance levels. However, we identified only two items in the review that we consider to be related to the MTA's routine maintenance practices; both appear to be minor. First, an oil analysis indicated that the MTA maintenance staff may have used diesel engine lubricant in the alcohol engines by mistake. Additionally, the review concluded that some of the glow plug problems could be remedied by the MTA ensuring that batteries were in good condition. As a result of Detroit Diesel's report, the MTA took action "to the extent of its capabilities" to address these issues by August 1997.

Detroit Diesel's continued completion of warranty work also suggests that the MTA's maintenance was satisfactory.

In our opinion, Detroit Diesel's performing substantial warranty work also suggests that the MTA reasonably and adequately performed the recommended maintenance tasks it was responsible for under the contract. The contract for each alcohol-fueled bus purchase states that the warranty provisions are void if the MTA does not comply with the manufacturer's recommended

routine maintenance procedures. Detroit Diesel must have believed that the MTA's maintenance practices were reasonable; otherwise, it would not have agreed to perform the number of large and small repairs that it did under the warranty.

FUEL CONTAMINATION MAY HAVE AFFECTED ALCOHOL ENGINE PERFORMANCE

The 1997 Detroit Diesel review also found that many of the MTA's alcohol bus fuel tanks were severely contaminated, thus inhibiting the proper operation of the fuel filters and injectors. Detroit Diesel's report, however, did not cite fuel contamination as the cause of engine failures, nor did it stop fulfilling requests for warranty work because of the fuel contamination.

We did note that it took the MTA more than two years to address the fuel contamination problem first reported in February 1996 by a consultant hired by Detroit Diesel. The consultant stated that all of the dispensing hoses on the MTA's two main methanol-fueling depots were standard gasoline hoses. According to the Department of Energy's 1996 *Guidebook for Handling, Storing, and Dispensing Fuel Ethanol*, alcohol's corrosive impurities may degrade materials such as gasoline hoses, and this in turn could cause contamination of alcohol-fueled systems. The MTA did not install alcohol-compatible equipment until July 1998.

In explaining this delay, the equipment engineering supervisor stated that the MTA followed industry standards for the dispenser hoses used during the construction and initial operation of its alcohol fuel stations. The supervisor further stated that the industry had been debating whether alcohol can be safely used in conjunction with various components, including fuel dispensing hoses. In fact, according to the MTA supervisor, much of what the industry now knows about this fuel's compatibility is based on the MTA's experience. Finally, the supervisor stated that because the MTA was converting to ethanol in 1996, it thought incompatibility was no longer a problem, until 1998 when it switched some of its ethanol-powered buses back to methanol.

THE MTA PURSUED ITS RIGHTS UNDER CONTRACT WARRANTY PROVISIONS

The MTA took a variety of steps in pursuing its rights under the warranty provisions of both alcohol-fueled bus purchases. We found evidence that it filed warranty claims with the bus manufacturer, the Transportation Manufacturing Corporation, including claims for fleet defects, which occur when identical items fail in 20 percent or more of the buses included in the contract. After 1994, when the Transportation Manufacturing Corporation's assets related to its alcohol-fueled bus line were acquired by another company, the MTA began to work directly with Detroit Diesel, the manufacturer of the alcohol-fueled engines. As a result of its efforts, between 1989 and 1996, the MTA received at least \$16 million worth of warranty work on its methanol- and ethanol-fueled engines from Detroit Diesel.

Although the MTA was not able to provide us with any written warranty claims for the alcohol demonstration fleet between 1989 and 1992, it appears that it succeeded in convincing Detroit Diesel to fulfill its warranty obligations. The MTA met a

number of times with Detroit Diesel to discuss warranty issues and mechanical problems it was experiencing with the alcohol engines. Detroit Diesel absorbed the entire cost of more than 30 repair projects to enhance the durability and reliability of the alcohol engines and related fuel systems of the demonstration fleet. These repairs included overhauls and upgrades that

averaged three per bus during the first 100,000 miles. The MTA estimates that it saved over \$2 million in repair costs as a result of Detroit Diesel's honoring its warranty obligations for the demonstration fleet.

Detroit Diesel continued to cover the cost of various repairs and extended its warranty obligations in its efforts to rectify the engine failures on the MTA's additional 303 alcohol-fueled buses. In October 1993, Detroit Diesel agreed to overhaul cylinder heads; replace compression seals, gaskets, and rod bearings; and perform other necessary related repairs. It also agreed to extend the engine warranty period on these 303 buses for one additional year. While this warranty project was in progress, Detroit

The MTA's Estimates of Warranty Work Performed by Detroit Diesel*

1989-1992	\$2 Million	Demonstration fleet of 30 buses
1992-1996	\$10 Million	Production fleet of 303 buses
1996-1998	\$4 Million	Ethanol engines for 206 buses
Total	\$16 Million	

* Includes extended warranty work.

Diesel also redesigned the fuel injectors to reduce leakage and installed the new injectors on all 333 of the MTA's alcohol buses. Along with other engine repairs paid for by Detroit Diesel under the warranty provisions of the contract, the MTA estimates it saved \$10 million in repair costs between 1992 and 1996.

By 1996, the original warranties and their one-year extensions had expired. Therefore, the MTA decided it was more cost-effective to purchase 103 new ethanol-fueled engines from Detroit Diesel and have Detroit Diesel rebuild another 103 engines for a total cost of \$4.4 million than to spend an estimated \$10 million to repair the engines using its own mechanics. Detroit Diesel provided a one-year warranty on both the 103 new and 103 rebuilt engines. However, because of continued premature engine failures, Detroit Diesel extended some of these warranties for up to an additional year. The MTA estimates that by fulfilling its warranty obligations during this time, Detroit Diesel saved the MTA approximately \$4 million in engine rebuilding and other related costs. Detroit Diesel stopped producing alcohol-fueled engines in 1996. Since that time, no others have been produced anywhere in the nation.

By 1996, alcohol-fueled engines were no longer being produced in the United States, thus limiting the MTA's options.

THE MTA'S DECISION TO CONVERT TO DIESEL ENGINES IS A VIABLE APPROACH GIVEN THE CIRCUMSTANCES

The MTA considered its options before deciding to convert its alcohol-fueled fleet to diesel-fueled engines, and we believe it chose the most cost-effective, emission-compliant alternative. In 1995, as the alcohol engines continued to fail and their warranties started to expire, the MTA began to consider converting its alcohol-fueled fleet. It first tested conversions to both diesel and compressed natural gas in 1996. According to the MTA, the converted compressed natural gas bus had problems, but the converted diesel buses performed well. The MTA considered other alternatives as well, such as converting the ethanol engines back to methanol or to a combination of methanol and diesel. Of all the options considered, the most cost-effective was the conversion to diesel.

THE MTA HAD FIVE OPTIONS FOR ITS ALCOHOL FLEET

The MTA considered the following options for resolving its problems with its alcohol-fueled fleet:

- Continue to operate the buses on alcohol fuel.
- Sell the buses and buy new buses with compressed natural gas engines.
- Convert the alcohol engines to compressed natural gas engines.
- Replace the alcohol engines with new 1996 diesel engines that meet 1996 emissions standards.
- Convert the alcohol engines to 1992 diesel engine technology that meets 1992-era emissions standards.

The first option, continuing to operate the buses on alcohol, was not viable because of the expense and the amount of time it takes to maintain the engines. For example, the MTA's records indicate that by 1998, alcohol engines needed to be rebuilt about every 73,000 miles, while diesel engines last 135,000 miles between rebuilds. The following table provides a comparison of the various costs associated with the different types of engines.

TABLE

Total Costs Per Fuel Type for the Remaining Life of the Buses

	Ethanol ^a	Methanol ^a	Compressed Natural Gas ^b	1992 Converted Diesel ^b	New 1996 Diesel Engines ^b
One-Time Cost					
Conversion Price			\$75,000	\$15,513	
Replacement Price					\$60,000
Annual Costs					
Rebuilds	\$10,000	\$10,000	3,333	2,500	2,500
Maintenance	24,506	20,278	21,970	15,279	15,279
Fuel	31,685	21,412	6,257	8,983	8,983
Total Annual Costs	\$66,191	\$51,690	\$31,560	\$26,762	\$26,762
Costs for Remaining 6 Years (1998-2003)					
Total Cost per Bus	397,146	310,140	264,360	176,085	220,572
Fleet Cost for 324 buses	\$128,675,304	\$100,485,360	\$85,652,640	\$57,051,540	\$71,465,328

^a Based on the MTA's records, rebuilds are done approximately once every 1.5 years on average.

^b Based on the MTA's records, rebuilds are done approximately once every three years on average.

Because of the high incidence of alcohol engine failures, the MTA relies heavily on its contingency fleet of 17-year-old diesel buses to meet service demands.

An additional factor against continuing to operate the alcohol engines was durability. According to the MTA, ethanol engines fail at more than five times the rate of diesel engines. This increased rate of engine failure forced the MTA to rely heavily on its contingency and spare fleets. For instance, about one-third of the alcohol fleet was out of service in September 1997 for engine-related problems. Since December 1997, the MTA has been using 17-year-old diesel buses from its contingency fleet to meet service demand when the alcohol buses fail. This contingency fleet is intended for emergency use only.

The second option, to sell the alcohol buses and buy new buses that operated on compressed natural gas, posed three problems. Perhaps most importantly, no market exists for used alcohol-fueled buses. Alcohol engines have not been manufactured since 1996, a fact that both indicates the lack of a market and also perpetuates it, since potential buyers would find engine replacement and repair difficult. Industry-wide problems with alcohol engines, such as the performance issues cited earlier, suggest that the MTA's experience was not unique. It appears that running buses on alcohol is a failed technology.

The second problem with selling and replacing the buses related to financing issues. As of January 1, 1999, the MTA owed \$50 million for the purchase of its alcohol buses, 80 percent of which was to be paid by the federal government. The MTA would have lost this funding if it had sold the buses, since the buses had to be in service to be eligible for the federal contribution. The Federal Transit Administration could have also required the MTA to return the funding it had already received for these buses since funding provisions require that buses remain in service for 12 years or 500,000 miles, whichever occurs first. In addition, the MTA might have been required to pay costs, possibly as much as \$10 million, for terminating the bus financing arrangements early.

The third problem with selling the buses and buying new ones was that new compressed natural gas buses are expensive. The MTA estimates that its share of this cost would have been \$72,126 per bus, or more than \$23 million to replace the 324 remaining alcohol buses. The MTA used the other nine of its 333 alcohol buses to test its options by converting three of the alcohol engines to diesel and one to compressed natural gas in 1996 and another five to diesel in 1998.

Converting each alcohol engine bus to run on compressed natural gas costs \$75,000 whereas conversion to diesel is \$15,513.

Another option was to convert the alcohol engines to compressed natural gas. While the new compressed natural gas buses emit fewer contaminants than diesel engines and have proven reliable, converting alcohol engines to compressed natural gas may not be feasible. For example, according to the MTA, the existing bus frames on the alcohol-fueled buses may not be structurally strong enough to hold the added weight of fuel tanks and other hardware necessary for compressed natural gas. The conversion is also very expensive. A proposal submitted to the MTA quoted \$75,000 for converting each alcohol engine to compressed natural gas, whereas Detroit Diesel proposed converting each alcohol engine to diesel for \$15,513. In addition, although new production line buses with compressed natural gas engines are successful, existing buses with converted engines have not proven as reliable. Therefore, the risk of reduced durability and reliability, coupled with the high cost, made the option of converting the alcohol engines to compressed natural gas less attractive.

The MTA's fourth option was to replace the alcohol engines with new 1996 diesel engines, which are required to emit fewer pollutants than the rebuilt diesel engines. The MTA considered this feasible, but the alternative of converting to diesel engines with 1992 emissions standards was far more cost-effective. Since both alternatives meet applicable state and federal emissions requirements, cost was the deciding factor. As shown in the table, replacing each alcohol engine with a 1996 diesel engine would have cost \$60,000, as opposed to \$15,513 for the diesel conversion.

Given the list of options, converting the alcohol engines to diesel was the most cost-effective alternative for the MTA while still meeting appropriate emissions standards. The MTA's contract with Detroit Diesel to convert each alcohol engine for a discounted price of \$15,513 rather than the full price of \$24,450 contributed to the low conversion cost. Detroit Diesel also provides full engine warranties for 100,000 miles for each engine converted. Finally, the ongoing maintenance and engine rebuild costs for these diesel engines are less expensive than for compressed natural gas or alcohol engines. The buses will all be retired from service by fiscal year 2003-04.

Considering the circumstances surrounding the purchase of the alcohol buses and the ongoing problems associated with them, the MTA's choice to convert to diesel is the most cost-effective, emissions-compliant option.

THE MTA IS ALREADY IN THE PROCESS OF CONVERTING ITS ALCOHOL FLEET

As discussed, the MTA has had serious problems with its alcohol fleet since it began operating the buses in June 1989. In July 1997, the MTA's board of directors approved a recommendation by the MTA to park alcohol buses with failed engines that were no longer under warranty until a decision was made concerning how best to reduce the operating cost of these buses. By February 1998, the MTA had pulled 127 alcohol buses out of service. This action posed two major problems. First, because it used the majority of buses in its 17-year-old contingency fleet of diesel buses to replace the alcohol-fueled buses, the MTA may not have had a sufficient number of spare buses to guarantee uninterrupted service. Second, the Federal Transit Administration had already issued a warning to the MTA to return the alcohol buses to revenue service or risk losing the federal portion of the cost of purchasing these vehicles. Therefore, the MTA needed to make a decision.

The MTA's board approved the diesel conversion in February 1998.

In February 1998, the MTA's board approved converting the alcohol engines to diesel engines that meet appropriate vehicle emissions standards. In April 1998, the MTA contracted with Detroit Diesel to convert the remaining 324 alcohol buses when the engines catastrophically failed and their warranties expired. Of the 333 alcohol-fueled buses the MTA had originally purchased, three had had their engines converted to diesel and one to compressed natural gas in 1996 and another five to diesel in 1998 when the MTA was testing the viability of its options.

By June 1998, 224 of the MTA's alcohol-fueled buses were out of service. Detroit Diesel was converting 16 of the bus engines to diesel and repairing the ethanol engines of 8 others because their warranty provisions were still in effect. The other 100 alcohol buses were still in service; 15 of these had warranty coverage as late as December 1998. As of January 1999, Detroit Diesel had increased the number of engines converted to diesel to 42, while the number of alcohol buses still in service dropped to 48. Since all warranties had expired by this time, the remaining buses, which were parked and out of service, were waiting to be converted.

WHILE THE MTA HAD MORE ENVIRONMENTALLY SENSITIVE OPTIONS, ITS DIESEL ENGINE CONVERSIONS COMPLY WITH STATE AND FEDERAL REGULATIONS

Although the CARB certified the 1992 diesel conversion kits chosen by the MTA, stating that they meet California's vehicle emissions standards, it expressed concern with the MTA's conversion solution. It would have preferred that the MTA had chosen a lower-emissions option and continued to use alternative fuel. The diesel conversion kits meet emissions standards but are not as clean as 1996 diesel kits, which emit fewer pollutants, or the compressed natural gas engines, which are the most environmentally safe. However, the MTA's decision to convert to diesel conforms to both federal regulations and California's current emissions standards.

Further, even though the 1992 diesel conversion kits meet California's vehicle emissions standards, the CARB recently determined that diesel is a toxic air contaminant and may pose adverse health effects. However, the CARB has yet to determine what, if any, additional regulations it should place on diesel emissions due to its recent determination. Therefore, the CARB's finding has no bearing on the MTA's conversion plan.

THE MTA'S FUTURE BUS PURCHASES SHOULD SIGNIFICANTLY REDUCE ITS CONTRIBUTION TO AIR POLLUTION

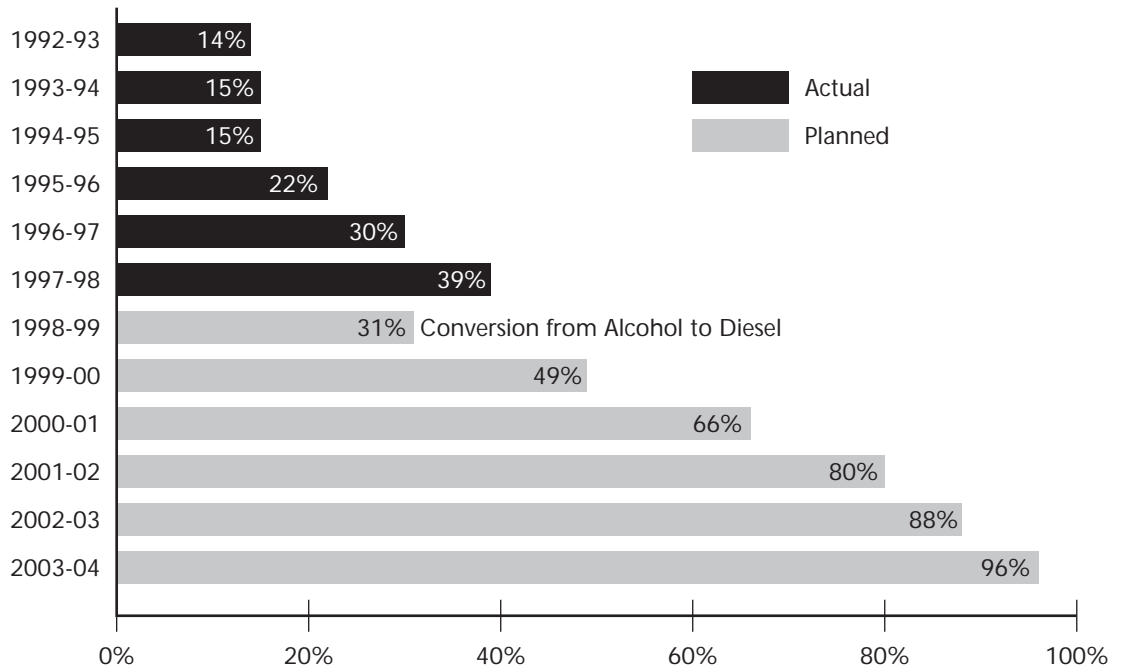
The MTA has shown a commitment to improving the quality of the environment by using buses that run on alternative fuels. Currently, 31 percent of the MTA's active bus fleet is made up of buses that use alternative fuel. As the figure shows, by fiscal year 2003-04, the MTA plans to increase the proportion of its buses that use alternative fuels to 96 percent. Although the MTA is converting 324 buses from alcohol-fueled engines to diesel-fueled engines, the conversion involves only 14 percent of its active fleet. Moreover, all such buses will be replaced by fiscal year 2003-04 at the latest, as they will have reached the end of their useful lives.

By fiscal year 2003-04, 96 percent of the MTA's planned bus fleet will run on compressed natural gas.

The MTA's board adopted a policy in 1993 to purchase only buses that use alternative fuels. Since the MTA's purchase of the 333 alcohol-fueled buses, it has put 502 compressed natural gas buses into service. The MTA's board has approved its plan to purchase another 1,838 compressed natural gas buses between

FIGURE

Alternative Fuel Buses as a Percentage of the MTA's Active Fleet



Source: Based on the MTA's records and board-approved purchases through fiscal year 2003-04.

fiscal years 1998-99 and 2003-04. The MTA estimates that its total investment for these 1,838 compressed natural gas buses will be \$726.8 million, or about \$43 million more than the cost for the same number of diesel buses. Most of the additional cost is for necessary facilities upgrades, such as compressed natural gas fueling stations.

Of the current engine choices available for transit buses, compressed natural gas buses are the most environmentally sound and should significantly improve air quality over time. Furthermore, compressed natural gas buses have proven to be reliable. Currently, compressed natural gas buses are being used successfully in other transit districts such as the Sacramento Regional Transit District, as well as in the MTA's own fleet.

CONCLUSION

We found that the MTA maintained its alcohol engines in a reasonable manner that adhered to the engine manufacturer's recommendations. When these efforts did not prevent the alcohol engines from continuing to fail prematurely, the MTA effectively pursued its warranty rights.

After considering the alternatives, we believe that the MTA made the appropriate choice concerning the conversion of its alcohol-fueled fleet. Using public funds to convert the bus engines from alcohol to diesel is both cost-effective and compliant with emissions standards. By the time the converted diesel buses are removed from service in fiscal year 2003-04, the MTA will have saved over \$14.4 million by converting their alcohol engines rather than choosing the next most cost-effective alternative, installing new diesel engines. Moreover, given its current plans for bus purchases and for the retirement of the converted diesels, approximately 96 percent of the MTA's bus fleet should run on compressed natural gas, the more environmentally sensitive fuel, by fiscal year 2003-04.

We conducted this review under the authority vested in the California State Auditor by Section 8543 et seq. of the California Government Code and according to generally accepted governmental auditing standards. We limited our review to those areas specified in the audit scope section of this report.

Respectfully submitted,



KURT R. SJOBERG
State Auditor

Date: February 18, 1999

Staff: Doug Cordiner, Audit Principal
Jerry A. Lewis
Kimberly J. Bootman

Agency's response provided as text only:

Metropolitan Transportation Authority
One Gateway Plaza
Los Angeles, CA 90012-2932

Mr. Kurt R. Sjoberg
State Auditor
Bureau of State Audits
555 Capitol Mall, Suite 300
Sacramento, California 95814

Dear Mr. Sjoberg:

The MTA has reviewed the report entitled "Los Angeles County Metropolitan Transportation Authority: Converting Its Poorly Performing Alcohol-Fueled Buses to Diesel Is The Most Cost-Effective Option Available" prepared by your office. We have no comments, and are very pleased that the findings detailed in the report support the MTA's decision for this conversation.

We truly appreciate the effort expended by Mr. Jerry Lewis and Ms. Kim Bootman of your office.

Sincerely,

Signed by Allan Lipsky, Deputy CEO for:

*Julian Burke
Chief Executive Officer*