Clean Air PROGRAM

BRIEF 6 Summer 1993

Technical Assistance Brief

U.S. Department of Transportation

Federal Transit Administration

Office of Technical Assistance and Safety

IN THIS ISSUE

Alternative Fuels Initiative

Since the inception of the Federal Transit Administration' s (FTA) Alternative Fuels Initiative (API) Program in 1988, 61 grants have been awarded to purchase over 1000 alternative fueled vehicles. FTA' s AFI Program has provided over $185 million in Federal funds for this deployment of alternative fueled vehicles into transit revenue service operations.

The AFI Program approach has always been to allow the local transit decision-makers the choice of the technology and fuel that is best suited for their particular operation. As a result, a variety of technologies and fuels are being tested in diverse locations across the country.

This Technical Brief profiles four AFI project sites, each testing a different alternative fuel: Pierce Transit's compressed natural gas (CNG) buses, Houston Metro' s liquefied natural gas (LNG) buses, Los Angeles County Metropolitan Transportation Authority' s (LACMTA) methanol buses, and Greater Peoria Mass Transit District's (GP Transit) ethanol buses.

The case studies were selected in order to discuss four different alternative fuels that are under primary consideration in localities across the country. For the most part, each of the sites have significant operating experience with their fuel of choice.

Pierce Transit is currently operating 30 full sized CNG buses from Bus Industries of America and 21 small buses from El Dorado that have been converted to operate on CNG. The full sized Orion buses use the Cummins L10-240G natural gas engine.

Houston Metro is currently operating over 50 full sized buses using LNG with a diesel pilot ignition system. The Detroit Diesel 6V-92TA engine is being used.

The LACMTA (the new umbrella agency that absorbed SCRTD) is testing and evaluating a variety of alternative fuel technologies. The LACMTA operates the largest fleet of methanol buses in the country, over 300 by the end of 1993. These buses use the Detroit Diesel 6V-92TA methanol engine.

Greater Peoria Transit is conducting a demonstration and evaluation of 14 ethanol fueled buses, about 25 percent of their fleet. The engine used is the Detroit Diesel 6V-92TA ethanol engine.

By showcasing specific experiences with alternative fuels, other transit agencies should have a better understanding of the implications of operating their transit fleets with these alternative fuels.

Alternative Fuels Bus Program-Four Case Studies

Pierce Transit

Pierce Transit' s experience with alternative fueled buses began with a conference visit. In 1986, Director of Maintenance Ron Shipley attended an international conference in Vancouver, Canada and realized the U.S. was not experimenting with mass transit alternative fuel systems as much as other countries. Pierce Transit in Tacoma, Washington has been testing compressed natural gas (CNG) in buses ever since.

The transit district considered many fuels. It wanted a fuel that was more environmentally benign than diesel. The transit district was concerned about meeting the 1991 EPA emission standards for particulate matter. Also, it wanted a plentiful, domestically produced fuel so that costs could be stabilized. While many alternative fuels met these requirements, CNG provided the best solution for Pierce Transit, said Ed Harvill, Maintenance Technical Analyst. It was readily available. The infrastructure in the region was established (many houses depend on natural gas). The infrastructure only needed to be expanded, not developed. It provided energy independence and it was safe.

(Continues on page 4)

Houston METRO

Houston METRO serves 1,275 square miles and a population of 3.5 million people. METRO is organized as an independent authority responsible to a board of commissioners. It operates 1,160 buses. Fuel costs are approximately 4.5% of operating costs.

Houston METRO began considering an alternative fuels bus program in response to Texas clean air legislation which mandated that 30% of transit authority vehicles be clean-burning by September 1991. "We were looking for all the things we enjoyed with diesel that we didn' t want to give up," said Systems Assurance and Engineering Director Jim Patrick. LNG came the closest. The chart on page 3 shows the replacement criteria considered for alternative fuels.

The transit district investigated four fuels: methanol, propane, compressed natural gas and liquefied natural gas. Alternative fuels such as methanol and propane were considered to have too many handling hazards. The high maintenance costs of methanol were a major deterrent, as well as concerns regarding aldehyde

(Continues on page 5)

Greater Peoria Transit

Greater Peoria Mass Transit (GP Transit) serves a population of 230,000 people in a 56 square mile area with 49 buses. It has just started an Alternative Fuels Initiative project that will run 14 mass transit buses on ethanol fuel. Of the four case studies featured in this Technical Brief, the GP Transit ethanol bus program is the newest. As such, it is a six-year field test that intends to provide performance data on ethanol buses.

GP Transit chose ethanol fuel for two primary reasons, said GP Transit General Manager Michael L. Brown. Due to its Midwestern location, ethanol fuel is produced nearby. Two major ethanol manufacturers are located close to the mass transit district. Illinois is a leading state in the production of ethanol from corn, and the project will assess the economic impact of using ethanol produced by locally grown and processed corn.

Second, ethanol needs to be evaluated as a viable alternative fuel. Brown said, "Several methanol projects are underway, and it was originally thought that those studies would provide information for ethanol as well, but the industry is realizing that there

(Continues on page 7)

PIERCE TRANSIT ACCELERATION TEST RESULTS

	0-10 mph	0-20 mph	0-30 mph
CNG	5.51 sec.	10.34 sec.	16.03 sec.
Diesel	5.6 sec.	9.15 sec.	12.82 sec.

LACMTA

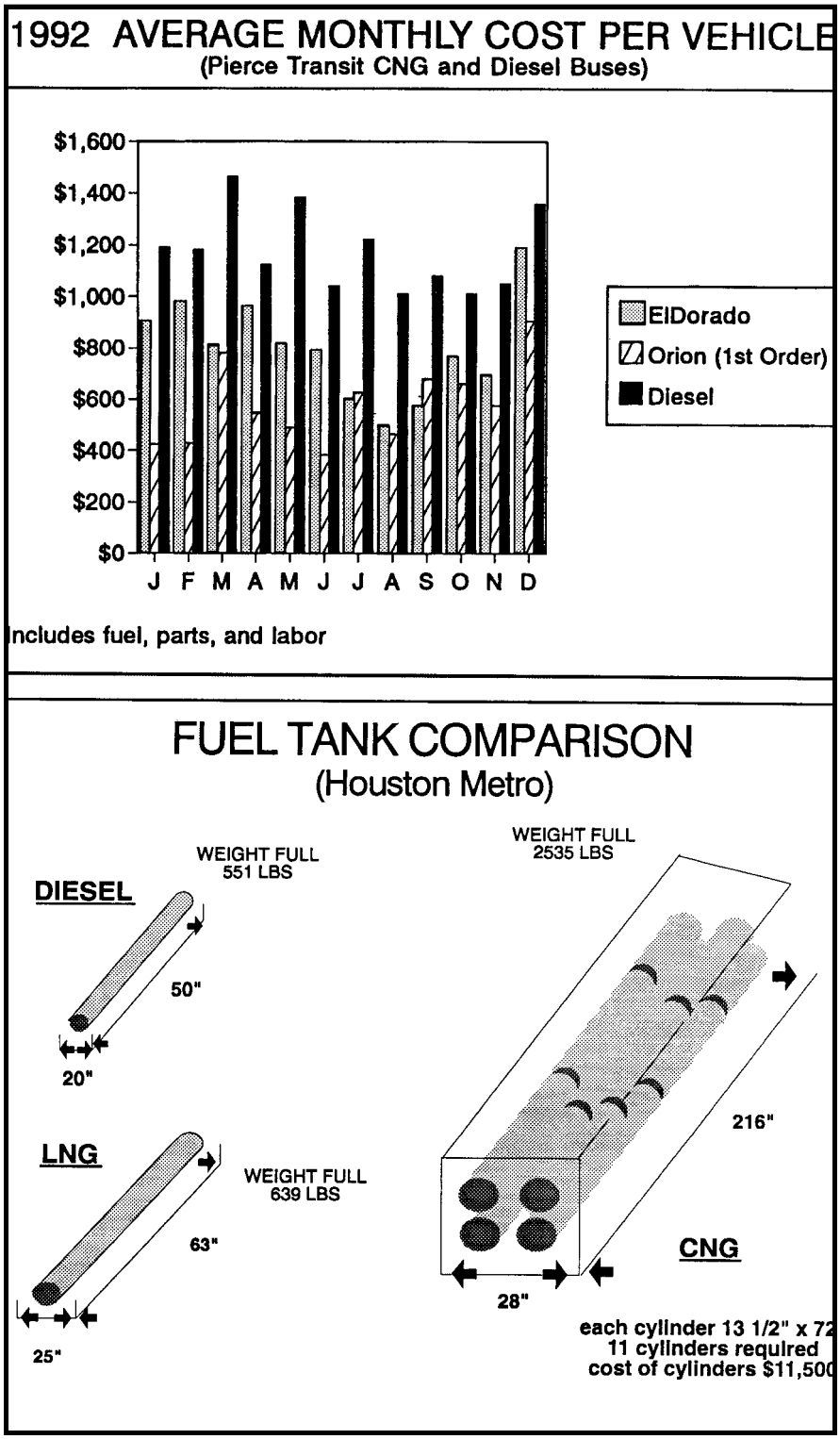
The Los Angeles County Metropolitan Transportation Authority (LACMTA) also became involved with alternative fueled buses due to state legislation. California commissioned a study on the use of alternative fuels (such as methanol) to promote United States energy security. LACMTA has a fleet of 2,632 buses and a services area of 1,442 square miles. This coupled with Southern California's notoriously poor air quality, made LACMTA a prime candidate for testing a new technology.

Methanol fueled engines were environmentally attractive because of their low NOx and particulate matter emissions. Methanol produces half as many nitrous oxides (NOx) as diesel fuel, with 80% less smoke and soot.

In 1989, FTA awarded a grant to LACMTA to convert 12 Detroit Diesel Corporation (DDC) 6V92 engines and 2 C~ L - 10 engines to run on methanol. These buses were operated for two years. South Coast Air Quality Management District and International Chemical Industries each contributed funds towards the differential cost in fuel. LACMTA currently has 180 methanol buses in service, and plans to have 340 buses in operation by ~e end of 1993.

The methanol bus demonstration project centered around the develop-

(Continues on page 6)



PIERCE TRANSIT (CONTINUED)

The original project began with two retrofitted TMC buses. The project went well and two years later, Pierce Transit officials decided they would like to move beyond the demonstration phase to a dedicated system. Unfortunately, in 1988 engine manufacturers were not ready to release engines that could be used in full-time revenue service provided for by the Alternative Fuels Initiative Program. Pierce Transit was forced to consider a bi-fuel system. It bought bi-fuel El Dorado coaches that could operate on either unleaded gasoline or CNG. These buses cost about $15,000 more per bus with the CNG conversion which included regulators, piping, and six CNG tanks.

"People have to realize that clean air costs money," Harvill said. "The federal grant covers 80% of the cost of the bus, and the district is depreciating the rest over 20 years. Also, as the chart below shows, the CNG buses run more cheaply than diesel buses. CNG is less expensive than diesel, and since it runs more cleanly, maintenance costs are lower."

Unfortunately these buses had trouble controlling the air-to-fuel ratio in the CNG system which led to several problems. The engines were difficult to start when cold. They tended to backfire, destroying cleaners and housings. The buses were slow to accelerate and were plagued with generally unreliable operation. As a result of the slow acceleration and unresponsiveness, operators were reluctant to drive the buses in the CNG mode.

Pierce Transit spent several months trying to resolve the problems, and finally decided to try another conversion system. The El Dorado buses were test driven for approximately 10,000 miles with a system produced by MOGAS Sales Inc. The tests went well and the El Dorado Bus Company agreed to pay for replacing the first conversion system.

The system allows the buses to go from idle through full throttle under load with good acceleration and no hesitation. Another advantage of the MOGAS conversion is the ability to switch between fuels (CNG and unleaded) while driving under load. The compressed natural gas supply can be run down to its lowest possible pressure before switching to unleaded without stopping. All of the El Dorados have been converted and are performing well on both CNG or unleaded gasoline.

In 1991, Pierce Transit received 15 dedicated CNG Orion buses from Bus Industries of America. The engines were the Cummins L-10. These inter-city transit buses were the first to cross the country fueled by a dedicated CNG system. It was a 3,100 mile trip with the farthest distance between fuelings being 360 miles and the shortest distance being 176 miles.

Except for the failure of one catalytic converter and one alternator, all of the buses made the trip successfully. The trip provided a chance to break in the buses and demonstrate to the staff and mechanics that the performance and reliability of the coaches were good. These buses cost approximately $41,500 more than their diesel counterpart in the same order. The cost of these buses was also partially covered by an Alternative Fuels Initiative grant.

Pierce Transit was required to lease the engines because it was illegal for Cummins to sell them until they had been certified. The arrangement worked out well for Pierce, because Cummins was responsible for repairs and provided an on-site mechanic. This also allowed Pierce mechanics to work with the Cummins mechanic in order to become familiar with the new system.

Initially, the buses had some problems, particularly a lack of power during acceleration on the hills of downtown Tacoma. A new shift pattern was able to alleviate this problem. As the table on page 2 shows, the modifications were able to bring the acceleration power of the Orion bus close to that of one powered by diesel.

The engines have a more frequent tune-up requirement than diesel. The spark plugs have to be replaced two, perhaps three times more often than maintenance performed on diesel engine fuel injectors. (The CNG engine uses spark plugs; the diesel engine uses a fuel injection system.) Harvill said the durability of the engine may be greater than in a diesel engine. "The jury is still out, but there's a feeling that since it is a cleaner fuel the engine should last longer."

The California Air Resources Board certified the Cummins CNG engine in August, 1992 and Pierce took ownership of the engines in their buses in November, 1992.

In 1992, Pierce Transit received a second order of 15 dedicated CNG Orion buses. Modifications had been made to increase fuel capacity. Three additional CNG cylinders were added to the roof of each vehicle, giving a total carrying capacity of

(continued on page 5)

16,000 SCF at 3000 psi, which allows the buses to travel 400 miles and assures operators that the bus they are driving will not run out of fuel. These tanks are mounted in three banks of four tanks, parallel to the length of the bus.

Initially, the operators were somewhat resistant to the CNG for perceived safety reasons. Harvill said Pierce Transit provided extensive information sessions demonstrating the safety of the fuel tanks. "We showed videos of the tanks being dropped and being shot at without explosion." The public has reacted positively to the buses. Harvill said that Pierce has viewed the project as a technical field test but has posted "Clean Machine" on the buses as part of the public awareness demonstration.

Fueling is a critical issue. The last bus completes its run at 1 :00 a.m. and the first bus departs at 4:00 a.m. Pierce Transit evaluated both slow and fast fill technologies. They needed a system able to fuel 19 CNG buses back-to-back, in line, to an operating pressure of 3,000 psi, in 10 minutes or less. It decided to go with a fast fill technology because the slow fill would have taken too much space and time.

The fueling station is experiencing some problems. For example, the compressors have shut down due to high gas temperatures and during colder weather the lines have frozen due to a heater breakdown. The station is currently operating on conditional acceptance from the contractor until the station is dependable.

Harvill has several words of advice for other transit districts. He recommends using dedicated fuel engines. He said a vehicle operates more smoothly if it does not require conversion of an engine that is really meant to operate on another fuel. The size of the vehicle more easily accommodates the fuel system because it is designed with one system in mind. If a district decides to retrofit, he suggests thoroughly researching the company and system that would be installed. He also said that having a supportive Board of Governors is very important.

For additional information, contact Ed Harvill, Maintenance Technical Analyst, Pierce Transit, (206) 581-8047.

Houston Metro **(Continued)**

emissions. METRO felt they would have problems with price and domestic supply fluctuations if it switched to propane.

METRO considered both forms of natural gas: compressed and liquefied. There is an anticipated 60 year domestic supply of natural gas available, 28% of which is in Texas. The cost is low, it has low particulate emissions, and it has demonstrated success in gasoline engine conversions. CNG posed many problems for METRO. The weight, volume and range changes were unacceptable, said Patrick. The structural and component changes required to enable CNG tanks to give the buses a 350 mile range would have displaced 19 passengers per bus. Liquid natural gas offered significant advantages, Patrick said. The chart on page 3 shows the space and weight requirements of diesel, LNG and CNG fuel tanks.

METRO has had more than two years of operating experience with LNG. Preliminary indications are that engine wear and maintenance will be less for the LNG fueled buses compared to diesel. While the lower fuel density of natural gas can result in lower power output for the same engine displacement, METRO was able to recover this power loss through engine modifications. The engines will require catalytic converters to meet emissions requirements.

Another issue involved with the switch to LNG is its tendency to "weather" due to evaporation. The change in composition causes unacceptable engine performance. METRO uses LNG with a methane content of 94% to assure acceptable engine performance. To avoid a build-up of flammable fumes, several safeguard procedures have been instituted.

A methane detection and fire suppression system is built into every bus, and into the garages. The systems work automatically, 24 hours a day. Also, the buses are parked outside both overnight and for longer term storage. Special procedures are used when maintenance or storage occurs inside, such as depressurizing the tanks and venting gases to the outside.

METRO' s LNG buses, including fuel, safety equipment and engine hardware, are about $50,000 more than a diesel powered vehicle. METRO expects the price to drop as production increases. Patrick said they have seen a dramatic drop in prices.

For additional information, contact Jim Patrick, Director of Systems Assurance/Engineering, Metropolitan Transit Authority, (713) 653 -0265.

LACMTA (Continued)

ment of DDC' s 6V92 methanol bus engine. It was the first heavy duty engine to be federally certified and California Air Resources Board (CARB) certified to meet state and federal emission regulations for buses. It was designed with special features to accommodate the use of methanol. For example, it uses a glow plug system to make ignition more efficient.

Modifications were made to bus component systems. The fuel tank is constructed from stain-less steel for compatibility with methanol. The methanol bus fuel tank is also larger than its counterpart on a diesel bus to account for the lower energy content in methanol: to go the same distance, more fuel is required.

The complexity of LACMTA operations required that methanol buses have the same distance capabilities as diesel buses. The methanol buses can travel roughly 240 miles on one tank of fuel. Freeway and minimum-stop-per-mile operation could extend this range to more than 300 miles, due to fuel economy. The table on page 6 shows the transit district' s criteria for replacing diesel with an alternative fuel.

Several modifications were made to account for the volatility, corrosiveness and toxicity of methanol. Senior Engineer Vince Pellegrin stressed that methanol is less volatile than gasoline, and with proper safety procedures, the corrosiveness and toxicity can be accommodated easily.

Several modifications were made to the fueling systems to reduce the possibility of ignition. The buses were equipped with systems that shut

off fuel flow at low pressure levels. (Low-pressure levels could indicate a leak.) The buses also have an automatic fire suppression system. Mechanics are required to wear methanol compatible gloves, and a closed drainage system for fuel filter changes was developed in order to minimize potentially hazardous spills. Testing has shown that exposure levels were well below regulated levels in all areas, according to a NIOSH report.

The buses use 100% methanol. Early in the project it was discovered that water in the fuel degraded engine reliability. (The fuel injectors would become clogged.) Random samples are taken of fuel deliveries to ensure purity and water content. To date, fuel contamination has been negligible.

Pellegrin said that methanol buses are about 75% as durable as the diesel buses. They require more servicing and it takes nearly twice as long to fuel them. Also, methanol buses are more expensive than diesel buses. One methanol bus costs approximately $40,000 more than a diesel bus. Fuel costs are approximately 50% higher than for diesel buses. But emissions are lower. Based on two years of data, LACMTA estimates that the clean fuel buses are reducing emissions of bus pollutants by as much as 54% as compared to diesel engines. The power of the methanol buses is the same as diesel buses, and the drivers like the driveability of the methanol buses.

Training has been critical to the success of LACMTA's methanol bus program. Training is provided to bus operators, supervisors, radio dispatchers and storeroom personnel when they begin employment and on a yearly basis thereafter. Mechanics receive this training, as well as in-depth technical training. In addition to training LACMTA personnel, a series of programs were offered to outside interest groups to promote technology exchange. Custom tailored technology training was provided to the California Highway Patrol, as well as the Los Angeles County and LA City Fire Departments. According to an LACMTA report, the extensive training programs have been one of the major reasons for the smooth transition from a research and development project to application in the real world transit environment.

The LACMTA methanol buses are prominently identified by decals on all four sides to introduce the technology to the public, as well as to alert fire or safety personnel should an incident occur.

Pellegrin said that the dedication of the people involved has been the most important factor in seeing the program through the development phase. The support of the mechanics, as well as the board of governors has been critical.

For information, contact Vince Pellegrin, Senior Engineer - Altemative Fuels, LACMTA,(213)972-5844.

LACMTA REPLACEMENT CRITERIA FOR ALTERNATIVE FUEL

- Safety
- Similar Range
- Similar Weight
- Fast Fill Fueling
- Performance
- Dependability
- Similar Maintainability
- Reduced Emissions
- Similar Economics
- Domestic Availability

are significant differences between the fuels."

The alternative fuels project began when the current fleet was up for replacement, enabling GP Transit to purchase up to 27 coaches for testing with the latest technology available. The Alternative Fuels Initiative grant provided funding for 14 ethanol buses. In addition, the transit duty cycle used by GP Transit mirrors the industry standard averages, and Peoria' s geographical and climatic conditions are reflective of many regions in the U.S.

Peoria has an ozone problem due to community growth, limited highway expansion and increased use of automobiles and trucks within the urban area. The project will address the serious air quality problems associated with diesel engines in urban areas by testing, demonstrating and evaluating the use of ethanol as an alternative fuel.

These emissions, which include carbon monoxide, carbon dioxide, nitrous oxides, particulates, and other organic compounds, play a major role in increasing ozone levels. EPA has set standards that diesel engines may have difficulty meeting. Ethanol is one of the alternative fuels that appears capable of meeting the proposed standards.

Cost is a consideration, however, with ethanol. Currently, the price of ethanol is running $0.50 more per gallon than diesel for GP Transit. Brown said that the project is working with Pokin Energy to establish a contract to bring this price down. He also said the higher per gallon cost overtime worked better for GP Transit rather than the high, up-front cost of other alternative fuels, such as CNG.

Under the project, GP Transit is cooperating with DDC to test a new diesel engine which has been developed to operate on ethanol. DDC tested their first methanol engine in an urban bus over six years ago. Since then, the DDC methanol engine has become a commercial production engine.

In 1989 the same basic methanol engine was modified to run on ethanol. The primary changes occurred in the adjustment of the injectors and the electronic control strategy to optimize fuel input and air input for more efficient operation. A key benefit of the ethanol engine is that ethanol is less toxic than methanol. It also has lower emissions.

The project will also provide information to other transit districts and bus manufacturers on the performance, costs, and benefits of ethanol fuels for reducing emission levels and reducing national dependence on foreign oil.

The first stage of the test will have operators, passengers and the general public evaluate the driveability, comfort, and noise of the engines, as well as the smell of the buses over time. These evaluations are being done with survey forms, and possibly interviews. The second level of monitoring will be with on-board computers and data logs which can record fuel use, miles driven, average speeds and duty cycles to help determine performance.

A standard data logging system will be used on all of the buses. After every 200 to 300 hours of engine operation, a lubricant analysis will be conducted of all engines involved in the test. This will determine' if further inspection is required and if there are any unusual wear problems.

At the end of one year of operation, a total engine tear-down will be performed on 12 engines, six of which will be randomly selected ethanol engines. The tear-down will provide extensive performance data on the engines.

The project will assess local, regional and national economic impacts of the alternative fuels program using ethanol. This analysis will include a quantifiable assessment of the reduction of pollutants by type through a program such as this using ethanol fuel. The information from this assessment should be transferable to other communities and programs, helping to justify the investment in funds for clean fuels.

Unique to the Alternative Fuels Initiative bus program is an effort to make people aware of the benefits of alternative fuels, especially the State of Illinois, the farming community, and engine manufacturers who are seeking to develop new engines and fuels which will reduce harmful emissions and increase the use of renewable fuels indigenous to the area.

For more information, contact Michael Brown, General Manager, GP Transit, (309) 676-8015.

Health Properties	Methanol	Ethanol
Odor threshold, ppm	2000	10
TLV-TWA, ppm	200	1000
TLV-STEL, ppm	250	None Est.
Vapor Hazard Ratio	820	76

Clean Air Program

• Seattle Metro plans to purchase 360 natural gas buses for delivery in 1995 after refueling and maintenance facilities have been modified to safely handle natural gas.

Industrial hygiene surveys were completed for CNG transit operations at Pierce Transit and Cleveland RTA.

• An alternative fuels training course is being offered by the Transportation Safety Institute. Call (405) 954-3682 for information.

Electric Vehicle Program

• Initial program reviews have been conducted of the Chesapeake Consortium and the CALSTART Consortium projects. Similar program reviews are being scheduled for the New York State Consortium and the Advanced Lead Acid Battery Consortium.

• A $50,000 challenge grant awarded to the Electric Transit Vehicle Institute to promote the design, production and use of electric vehicles in transit. ETVI will serve as a facilitator and resource center for electric vehicle development for the transit industry.

Federal Activities

❑ DOE

• In September 1992, DOE awarded 10 grants for alternative school bus projects. Another grant program is scheduled to be announced in the Federal Register. Ten awards to develop 40 to 50 alternative-fuel original equipment manufacturer school buses will be granted by DOE. Louise Urgo of the DOE Boston Support Office is the contact person for the new program. She can be reached at (617) 565-9709.

• The National Alternative Fuels Hotline for Transportation Technologies has responded to well over 1,000 calls on a variety of fuels and vehicle technologies. The general public may reach the hotline between 10 a.m. and 6 p.m., EST, Monday through Friday (except federal holidays) at 1-800423-lDOE, or by calling (202) 554-5047 in the Washington, DC area. The hotline helps the public access Alternative Fuels Data Center information.

• Most of the questions involve vehicle conversions, with more than 30% of all callers asking about conversions to CNG, and more than 15% requesting information on LPG conversions.

• The hotline has also assisted numerous fleet managers and fleet consultants with questions regarding the economics of alternative fuels, regulatory guidelines, and other market considerations.

❑ EPA

In February 1993, the EPA issued an advisory circular discussing the proposed in-use urban bus annual testing program for cities with populations greater than 750,000. The testing program will establish a "pass/fail" rate which will determine if a low-polluting fuels program must be instituted by cities that fail to meet the 1994 urban bus emission standards.

The program will differ from other heavy-duty engine testing programs developed by EPA because it requires testing of a representative sample drawn from a heterogeneous population of engines. The population will be stratified, or divided into subpopulations, by engine family and model year. The number of engines tested in each segment will generally be proportional to the population of buses in that segment relative to the total population of buses subject to testing.

In March 1993, EPA announced a 1994 particulate emission standard for urban transit buses of 0.07 g/bhp.hr. In 1996, that standard becomes 0.05 g/bhp.hr.

In April 1993, EPA announced the final rule establishing provisions for an urban bus retrofilter build program. The rule applies to 1993 and earlier model year buses whose engines are rebuilt or replaced after January 1, 1995. The program only applies to those buses operating in metropolitan areas with a 1980 population of 750,000 or greater.

State and Local Activities

• As of January 1995, the California Air Resources Board will require fleet operators to measure the density of their vehicle's emissions, which must meet the standards imposed by California's random roadside testing program. The rule applies to fleet owners of two or more diesel trucks or buses. The program' s goal is to reduce particulate emission by 10% each year and is expected to affect up to 120,000 vehicles annually.

• Pennsylvania has passed legislation that will provide $3.5 million for an alternative fuels grant program. The energy office will make grants to school districts, municipal authorities, corporations and others to assist with the conversion of conventional vehicles to operate on alternative fuels or the purchasing of vehicles specifically designed to use alternative fuels.

• For the last several months, the Kansas Corporation Commission has been sponsoring a series of alternative fuel seminars around the state. The purpose of the seminars is to educate fleet owners on the various alternative fuel options available to them. By promoting and coordinating the use of alternative fuels among fleet owners and operators, the State hopes to increase the use of such fuels produced in Kansas. Participation in the seminars is open to officials from all levels of government and the private sector.

Technology Development

Detroit Diesel Corporation (DDC) plans to have a dedicated natural gas bus engine on the market by the end of 1993, according to a presentation given at the 1992 International Gas Research Conference held in Orlando, Florida in November 1992. Five different combustion system concepts were evaluated for the conversion of a heavyduty, two-stroke diesel to dedicated operation with natural gas. The most promising concept in terms of high efficiency and low exhaust emissions is the conventional compression ignition engine in which high pressure gas is injected into the cylinder near top dead center and a glow plug is used to increase starting efficiency. The engine being developed by DDC is similar to 80% of the new transit buses in North America, but it runs on alternative fuel.

Two research groups have developed separate methods to efficiently convert natural gas to a form that is easily and safely transported long distances to market centers. According to researchers, methane may become competitive with petroleum for fuel and feedstock purposes. Until now, it has not been economical to convert methane, the principal component of the gas, to other kinds of fuel meaning that much of the gas found naturally is unusable. The University of Minnesota and Dow Chemical Company have been collaborating to develop a method to combine oxygen and methane to quickly create a usable "syngas" of hydrogen and carbon monoxide. The other method, being developed by Catalytica Inc. is using sulfuric acid and mercury to convert methane to the easily transportable, liquid fuel methanol.

CUMMINS L10-240G NATURAL GAS ENGINE

Engine Specifications:	Powerplant	In-line 6 cylinder
	Engine Displacement	10.0 liters
	Maximum Horsepower	240 hp
	Peak Torque	850 lb. - ft.
	Rated Speed	1400 rpm
	Aspiration	Turbocharged/aftercooled
	Turbocharger	Holset WH2-D, wastegated
	Compression Ratio	10.5:1
Key Modifications from Diesel L10:	Altonic D.I.S. spark ignition system "Lean-burn" technology (37% thermal efficiency) Impco 200 carburetor Woodward electronic governor	
L10-240G Emissions Certification:	Particulates	.02 g/bhp-hr
	NOx	2.0 g/bhp-hr
	Non-methane hydrocarbons	0.6 g/bhp-hr
	Carbon monoxide	0.4 g/bhp-hr

FTA Technical Reports

FTA has limited copies of the following technical reports about alternative fuels in transit. To obtain a copy, just check the reports you want, fill in your name and address and mail to FTA at the address below.

❑ Properties of Alternative Fuels

A brief comparison of many physical factors of alternative fuels; contains data items such as cost, heat content, density, electrical conductivity, vapor pressure, boiling points, etc.

❑ Technical Advisory on CNG Fuel Measurement

A brief paper explaining the intricacies of measuring CNG fuel use with accuracy; contains recommended strategies and a worksheet for doing useful calculations.

❑ Status of Particulate Trap Developments Related to Transit

A report summarizing the status of particulate traps in transit buses; contains recent experiences at transit agencies and explains the technology of particulate traps.

❑ CNG Bus Demonstration Program Data Analysis Report

A report summarizing experience to date with CNG bus operations in transit; contains test track performance results.

❑ Extent of Indoor Flammable Pulumes Resulting from CNG Bus Fuel System Leaks

Validated three dimensional mathematical model that was used to examine the extent of flammable plumes resulting from CNG leaks inside a typical transit maintenance facility.

❑ Proving Ground Comparison of M.A.N.. Methanol and Diesel Transit Buses

A detailed report on tests of performance and driveability conducted on M.A.N. methanol and diesel buses.

❑ Methanol Use Training Manual

A manual designed to help inform employees about the proper use and handling of methanol fuel; an audio visual and videotape training materials are available.

❑ Industrial Hygiene Survey Reports

Three reports from NIOSH on the occupational health and safety issues associated with the fueling, maintenance, and operation of methanol transit buses at Triboro Coach in New York, Seattle Metro, and SCRTD in Los Angeles.

❑ Compressed Natural Gas Fuel Use Training Manual

A manual designed to help inform employees about the proper use and handling of CNG fuel.

❑ Alternative Fuel Price Summary

Compilation of alternative fuel costs that includes both current and historical cost information.

❑ Methanol Status Report

A detailed report on the operating experience of the methanol buses in a number of transit systems.

Mail this completed form to:

Vincent R. DeMarco
Federal Transit Administration
Office of Technical Assistance and Safety/TTS-21
400 Seventh Street, S.W., Room 6431
Washington, D.C. 20590

Name: _____
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PTI Publications

❑ Alternative Fuel Vehicles: A Demonstration Project. *Albuquerque, New Mexico DG 90-316*

❑ Dual Fuel Conversion Demonstration. *Broward County, Florida DG 89-323*

❑ An Alternative Fuels Evaluation System for Fleet Vehicles. *Denver, Colorado DG 89-325*

❑ A Regulatory Framework for Alternative Fuels and Transportation Management Services. *Denver, Colorado DG 90-318*

❑ Fleet Assessment for Opportunities to Effectively Deploy Light Duty Alternative Fuel Vehicles. *Detroit, Michigan DG 89-326*

❑ Analysis of Programmatic Fleet Conversion to Ethanol Blends (1989). *Phoenix, Arizona DG 89330*

❑ A Guidebook for Alternatively Fueled Vehicles. *Science Applications International Corporation, PTI DG 91-401*

❑ Alternative Transportation Fuels: Infrastructure Issues. *New York New York DG 89-327*

❑ Economic Evaluation Guide for Alternative Transportation Fuels. *PTI DG 91-501*

❑ Insurance Issues and Natural Gas Vehicles. *New York New York DG 91-338* (Published through Gas Research Institute. Limited quantities available from PTI otherwise available through NTIS.)

❑ Analysis of Operational, Institutional and International Limitations for Alternative Fuel Vehicles and Technologies. *Detroit DG 91-311*

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❑ "Alternative Fuel Vehicles: A Demonstration Project."

❑"Dual Fuel Conversion Demonstration"

❑ "An Alternative Fuels Evaluation System for Fleet Vehicles"

❑ "A Regulatory Framework for Alternative Fuels and Transportation Management Services"

❑"Fleet Assessment for Opportunities to Effectively Deploy Light Duty Alternative Fuel Vehicles"

❑"Analysis of Programmatic Fleet Conversion to Ethanol Blends (1989)"

❑"A Guidebook for Alternatively Fueled Vehicles"

❑"Alternative Transportation Fuels: Infrastructure Issues"

❑ "Economic Evaluation Guide for Alternative Transportation Fuels"

❑"Insurance Issues and Natural Gas Vehicles"

❑"Analysis of Operational, Institutional and International Limitations for Alternative Fuel Vehicles and Technologies"

Clean Air Calendar of Events

Future Transportation Technology Conference .....August 9-12, 1993
San Antonio, Texas

Natural Gas Vehicle Conference; American Gas Association .....Sept. 12-15, 1993
Denver, Colorado

23rd International Electric Propulsion Conference .....Sept. 13-16, 1993
Seattle, Washington

Alternative Fuels, Engine Performance and Emissions;
American Society of Mechanical Engineers .....Sept. 26-29, 1993
Morgantown, West Virginia

Electric Vehicle Infrastructure Conference
Electric Power Research Institute .....October 19-21, 1993
Scottsdale, Arizona

1993 SAE International Truck and Bus Meeting.....November 1-4, 1993
Detriot, Michigan