

Ann Arbor Transportation Authority

White Paper

Alternative Fuels,
Emissions, & Technology

July 2002

Throughout its history the Ann Arbor Transportation Authority (AATA) has placed a high priority on environmental issues. Whether it's been maximizing fuel efficiency or minimizing vehicle emissions, the AATA has demonstrated its commitment by investigating new and alternative technologies and materials, and incorporating them when they prove their worth.

This is consistent with the Authority's mission statement which calls for "providing options for safe, efficient, and reliable transportation." To accomplish that mission, AATA has identified "the challenges of traffic congestion, pollution, (and) energy conservation" as part of its vision. Throughout its current strategic plan, adopted in October 1999, AATA references its commitment to lowering emissions and/or implementing new technology no fewer than ten times.

This same theme was voiced throughout the community when comments were solicited for the strategic plan. Community members cited AATA's responsibility for "providing transportation... as well as offering an alternative to continued traffic congestion, parking problems, and pollution."

Consistent with AATA's mission and vision, as well as in response to community input, the strategic plan cites "stewardship of resources" as a primary AATA obligation. The plan also stipulates that AATA use innovation "to increase the efficiency and effectiveness of transportation services." Over time, AATA has consistently demonstrated this long-standing dedication.

INNOVATIONS

As new technologies and alternative fuels have been proven to be efficient and effective — both on an operations basis and from a budgetary standpoint — AATA has been quick to embrace them. AATA has compiled an impressive track record in this area and can cite specific examples of leadership in the area of alternative fuels — especially vehicle emissions.

In the early 1990s, AATA began investigating new technologies. In addition to inspecting alternative fuel vehicles in other cities, AATA staff conducted their own research and sought out professional resources through the American Public Transit Association (APTA).

As part of that process, AATA participated with Detroit Diesel in a test of a highly touted methanol fuel system. After three months of standard day-to-day operation, AATA determined that methanol was not cost effective at that time. The test showed that the fuel was more expensive and more difficult to acquire. Also, AATA found that buses using methanol could not deliver the 350-mile range to make it economical. Further investigation of methanol buses in California showed that, over time, the reliability of these vehicles could not be sustained.

Time has proven the decision to pass on methanol a wise one. Today, most transit authorities have abandoned methanol as an alternative fuel.

AATA has been a pioneer in introducing cleaner fuels. It first used an early formulation of low-sulfur diesel fuel in 1985. In the late 1980s, AATA voluntarily began converting its entire fleet to a “clean diesel” system using low-sulfur #1 diesel. The conversion was completed in 1995, years ahead of U.S. Environmental Protection Agency (EPA) directives for federal emissions standards that required buses to meet low-sulfur levels by 2004.

Taking the “clean diesel” approach one step further, in July 2002 AATA announced that it was converting its entire bus fleet to running on ultra low sulfur diesel. The timing made AATA the first transit agency in the Midwest to run its entire fleet on the specially-formulated fuel as well as putting AATA four years ahead of an EPA mandate.

At the same time, AATA began a program of installing a new generation of engines from Detroit Diesel that – according to the EPA and the California Air Resources Board (CARB) – would lower particulate matter, hydrocarbons and carbon monoxide by 90 percent. At that level, a CARB test and a Swedish study put the engine’s emissions as low as – or lower – than CNG vehicles.

Most recently AATA has become one of the first transit authorities nationwide to seriously consider purchasing hybrid (battery/electric-diesel) drive buses. As the technology establishes a track record, the hybrid-electric drive bus has begun to emerge as a viable technology for urban transit. For that reason, AATA is considering buying as many as four hybrid-electric drive buses in 2003. Featuring a combination of diesel and electric power, the hybrid-electric drive bus burns less fossil fuel, has lower emissions and, unlike other alternative fuels, does not require expensive building modifications.

INDUSTRY STANDARDS

In recent years, the concept of using low-sulfur fuel – or the “clean diesel” – has gained wide acceptance within the transit industry. The APTA has publicly stated that it “supports the use of low-sulfur diesel as one means of achieving clean air goals.”

For the foreseeable future, “clean diesel” is expected to remain on a par with alternative fuels and alternative propulsion systems when measuring emission controls. A study from the Environmental and Energy Study Institute (EESI) predicts that “transit authorities will have to convert buses to low-emission alternative-fuel buses or use clean diesel.”

Critics point to some industry reports and studies that have cited emissions problems with diesel-powered buses. Typically, these results do not involve ultra-low sulfur diesel. (See Appendix A.)

ALTERNATIVES & CHOICES

With EPA emissions mandates looming and taxpayers clamoring for judicious use of public funds, transit authorities across the country – including the AATA – are faced with difficult choices. Among these challenges are determining which vehicles will be reliable, cost effective, fuel efficient and environmentally friendly – while costing the taxpayer the least amount of money to purchase, operate and maintain.

Other factors that must be considered when deciding which fuel system(s) to use include: fuel delivery systems, emission levels, availability of replacement parts and vehicle life expectancy.

Which vehicles are best for the mass transit constituents? Which vehicles provide the best value? Which vehicles provide the best return on investment? Which vehicles deliver the best, most reliable, overall transportation service? The choices are many. There are:

- conventional diesel systems,
- low-sulfur “clean diesel” systems,
- biodiesel systems,
- compressed natural gas (CNG),
- liquified natural gas (LNG),

- fuel cell-based systems, and
- the hybrid-electric drive bus.

PURCHASING ISSUES

When the AATA considers purchasing new buses for its fleet, many factors must be weighed before investing tax dollars. There are practical issues such as seating capacity and delivery times. There are comfort factors including the seats, hip and knee room, aisle width, climate controls and other passenger amenities. Then, there are the mechanical and technological issues which include drive train, axles, brakes, vehicle weight, fuel type, etc.

A typical request-for-proposal (RFP) from AATA for a new bus purchase may be as long as 250 pages. Issues relating to the manufacturers will include company financials (such as financial strength of the company and payment schedule), delivery times, warranties, content requirements and more. The entire RFP process may take as long as 18 months or more which demands that fuel and drive train decisions be made long before delivery is accepted.

Understandably, each option and each variable has its advantages and disadvantages and are weighted differently on each RFP. Especially when deciding on fuel and drive train, a multitude of factors must be critically evaluated. (See Appendix B)

Purchase prices. Not surprisingly, the vehicles with the best records for emissions and fuel efficiency also carry higher purchase prices. For example, the price for a CNG bus typically runs \$35,000-\$50,000 more than the price of a diesel bus, and a hybrid-electric drive bus can cost as much as \$125,000 more per vehicle. The purchase price of buses that operate on fuel-cell technology can run as much as four times the cost of today's conventional diesel-powered bus.

Fuel costs. With its proven record of lower emissions, low-sulfur diesel fuel can cost as much as 4-12 cents more per gallon than conventional #2 diesel fuel. Cost estimates for biodiesel fuel range from 30-40 cents, to as much as 80 cents more per gallon than conventional diesel.

On the other hand, CNG can cost as much as 25 cents less per gallon than diesel fuel. However, converting fuel depots to handle CNG can be prohibitively costly. According to a report from the Environmental and Energy Study Institute, "New York City DOT estimates that it will cost \$7 million to (convert) each of (its) four remaining (CNG) depots in the city."

Fuel efficiency. In addition to emissions and fuel cost, fuel efficiency is also a determining factor. Hybrid-electric drive buses have proven to be quite fuel efficient. However, their operating experience is limited, and their service reliability as well as the replacement costs for batteries have come into question. Although they are also efficient, low-sulfur diesel and CNG vehicles usually are chosen more for their emission records.

Maintenance. Another consideration is how fuel affects engine wear and maintenance. For example, according to APTA, when compared to diesels, methanol/ethanol engines accelerate engine wear “resulting in premature engine failure.”

Fueling systems. Most transit systems – including AATA – already are well equipped to handle any kind of diesel vehicle fueling system. As noted earlier, one of the major drawbacks to CNG buses is the cost of installing new fuel depots and retrofitting garages to be explosion proof.

Air quality. As for air quality, fuel cells, low-sulfur diesel buses, CNG buses, and hybrid-electric drive buses all have demonstrated the ability to significantly lower emissions. These approaches vary mainly by degree and by the types of emissions. Only the conventional diesel vehicles using high sulfur fuels stand out in poor emission performance.

Among other approaches, CNG and LNG produce lower emissions but require substantial, expensive infrastructure investments in fuel depots. Biodiesel systems generally have lower emissions, but using biodiesel actually increases the amount of nitrogen oxide (NO_x) emissions which the EPA is trying to eliminate.

Performance. A downside for alternative fuel vehicles is the absence of solid performance service records. In most cases, transit buses are subjected to extreme operating conditions that severely strain vehicle reliability and vehicle life expectancy. The American Society for Testing Materials (ASTM) doesn’t even have tests for biodiesel systems. Without a proven record of operational service, life-cycle cost and vehicle reliability become unknowns that could jeopardize an authority’s ability to serve its customers if increased resources must be diverted to accelerated vehicle replacements or higher operating costs.

SUMMARY

Given the size of the investment and the direct impact that investment has on the entire system, when purchasing a new bus is a long, arduous task. While AATA is committed to running the most environmentally favorable vehicles available, emissions are one piece of larger puzzle. It's been AATA practice to weigh *all* factors affecting vehicle performance – including emissions, fuel efficiency, maintenance and reliability – and to base its decisions on the total package.

AATA's primary goal is to provide safe, clean and reliable transportation for the citizens in the Ann Arbor area. This must be accomplished with the most efficient use of the taxpayer funds that have been entrusted to it.

Appendix A

EMISSIONS CHART

San Francisco Muni 15-Year Emission Totals for Fleet Scenarios (in tons)
Emissions Using CARB* In-Use Emission Factors

	HYDRO-CARBONS	CARBON MONOXIDE	NITROGEN OXIDES	PARTICULATE MATTER
Diesel fleet	529	2,388	5,329	156
Alternate fuel fleet	577	7,622	4,686	121
Diesel fleet + Ultra-Low Sulfur Fuel & Particulate Traps	206	1,359	5,288	57

* California Air Resources Board

Appendix B

COMPARATIVE OVERVIEW

BUS TYPE	ADVANTAGES	DISADVANTAGES
Advanced diesel bus using low-sulfur fuel	<ul style="list-style-type: none"> ■ Can use existing fuel infrastructure ■ Lower purchase price ■ Proven service record 	<ul style="list-style-type: none"> ■ Higher fuel costs ■ Higher emissions than alternative fuels
Biodiesel bus	<ul style="list-style-type: none"> ■ Domestic availability ■ Engine and fueling technology similar to conventional one ■ Lower on some emissions 	<ul style="list-style-type: none"> ■ Higher fuel costs ■ Higher levels of nitrogen oxide (NO_x) emissions ■ Unknown long-term reliability ■ No standard tests for quality or performance ■ Limited availability ■ Performs poorly in cold weather
CNG bus	<ul style="list-style-type: none"> ■ Reduced emissions ■ Lower fuel costs ■ Domestic availability 	<ul style="list-style-type: none"> ■ Lower energy efficiency ■ Higher capital costs – purchase price, new fuel infrastructure, replacement parts ■ Limited range
LPG bus	<ul style="list-style-type: none"> ■ Reduced emissions ■ Lower operating costs ■ Domestic availability 	<ul style="list-style-type: none"> ■ Limited range ■ Higher capital costs
Methanol bus	<ul style="list-style-type: none"> ■ Reduced emissions ■ Engine technology similar to conventional one 	<ul style="list-style-type: none"> ■ Lack of infrastructure ■ Higher capital costs ■ Limited range ■ Accelerated engine wear

BUS TYPE	ADVANTAGES	DISADVANTAGES
Battery electric bus	<ul style="list-style-type: none"> ■ Local zero emission vehicle ■ Little noise ■ Domestic availability 	<ul style="list-style-type: none"> ■ Higher capital costs ■ Limited performance in cold weather and in mountainous regions ■ Limited range ■ Time to recharge and access to recharging outlets
Hybrid-electric drive buses	<ul style="list-style-type: none"> ■ Flexibility due to dual power system ■ Greater energy efficiency ■ Lower emissions ■ Can use existing fuel infrastructure 	<ul style="list-style-type: none"> ■ Higher capital cost ■ New propulsion system technology ■ Unknown durability and performance
Fuel cell bus	<ul style="list-style-type: none"> ■ High fuel efficiency ■ Low emissions ■ Water is the only tailpipe emission ■ Less noise 	<ul style="list-style-type: none"> ■ Significantly higher capital cost ■ Lack of fuel infrastructure ■ Technological barriers still to be overcome ■ Unknown durability

Source: "Clean Heavy-Duty Vehicles: Analyzing Trends in Advanced Technologies and Fuels,"
WestStart/CALSTART; Pasadena, California
National Association of Fleet Administrators (NAFA)
U.S. Department of Energy, Clean Cities – Alternative Information Series