TRI-MET'S EXPERIENCE WITH ALTERNATIVE FUELS

Andrew Aebi
Portland Tri-Met Transit District

INTRODUCTION

Tri-Met is the regional transit district in the Portland area, which includes Multnomah, Washington, and Clackamas counties. Tri-Met operates 26 light rail vehicles, 591 buses, and 122 paratransit vehicles. Of the 591 fixed-route buses, 10 use alternative fuels. Four of the paratransit vehicles use alternative fuels, but this will soon be expanded to 17; it is still early in the test process. The fixed-route buses use liquefied natural gas (LNG), and the paratransit vehicles use compressed natural gas (CNG). Therefore, the approximately 700 vehicles, only 14 are powered by alternative fuel, although this will soon increase to 27 with the additional delivery of paratransit vehicles.

REASONS FOR USING ALTERNATIVE FUEL

Equipment operators are undoubtedly familiar with the Federal Clean Air Act Amendments of 1990 and its increasingly stringent tailpipe emissions, specifically, the particulate emissions standards. Operators are probably also aware of the National Energy Policy Act of 1992. This law aims for a 10 percent reduction in the use of petroleum-based motor fuels by the year 2000, and a 30 percent reduction by 2010. Both pieces of legislation played a role in Tri-Met's purchase of alternative fuel buses. A state of Oregon directive also played a large role. A proposal was made in the 1989 session of the Oregon Legislature for a mandate requiring that all of the vehicles Tri-Met purchased be powered by alternative fuel. Although this proposal did not get very far in the Legislature, another similar broad-based mandate was circulated two years later, in 1991. Federal mandates aside, many other states also have alternative fuel directives either in place or under discussion.

Given the reality of the political constituencies for alternative fuels, the pragmatic approach for Tri-Met was to compromise by trying a small test fleet of alternative fuel buses to minimize the risk. Tri-Met felt this to be prudent than to start with a very large fleet of alternative fuel fixed-route buses with which the agency had no operating experience. It should be noted that Tri-Met also sees the potential reward of alternative fuel buses. The environmental motif on two of the LNG-powered vehicles is part of a marketing appeal; it is designed to curry favor with the popular public perception that bus pollution needs to be reduced by using the latest available technology available.

ALTERNATIVE FUEL FLEETS AND VEHICLES

Tri-Met's 10 LNG buses comprise two fleets. The first alternative fuel fixed-route fleet Tri-Met purchased was manufactured by Gillig Corporation in Hayward, California. These buses are 40 feet long and 102 inches wide with a 279-inch wheel base. Gillig Phantoms are powered by a Cummins L10-G 6 cylinder engine with a Voith transmission. The fuel delivery system was manufactured by Cryogas. As mentioned earlier, these buses are painted with an environmental motif to maximize public visibility; they arrived in September of '92, when operational issues had to be worked out. Substantial preservice work was necessary. Therefore, they did not go into service until March of '93; Tri-Met has just over a year of experience with these buses.

The newer buses were manufactured by Flxible Corporation in Delaware, Ohio. These 10 buses are also 40 feet long, 102 inches wide, but with a 299-inch wheel base. They also have a Cummins L10-G 6 cylinder engine with Voith transmissions. The fuel delivery system was manufactured by CVI. These buses arrived in October of '93 and went into service January 1994.

As mentioned above, Tri-Met is expanding the paratransit fleet of alternative fuel vehicles, which currently consists solely of Ford Champions. These paratransit vehicles are "bifuel," so the cruising range is enhanced because the vehicle automatically switches its fuel source back to gasoline when the CNG runs out. This also allows these buses to be fueled once daily instead of twice daily, as was previously the case. Although CNG is used for paratransit vehicles, LNG was chosen for fixed-route operations.

LNG CHOSEN FOR FIXED-ROUTE SERVICE

LNG is preferred because it provides more energy for the same volume as CNG. The primary factor is weight. A bus powered by CNG weighs about 3,000 pounds

more than a similar diesel-powered vehicle because of the heavier fuel tanks. In contrast, a LNG-powered coach only weighs about 300 pounds more than a similar diesel-powered coach. The heavy weight of CNG on a fixed-route bus would result in a larger reduction in passenger capacity, which would also preclude standees. In contrast, the reduction with LNG is not nearly as severe. This reduced capacity is an undesirable limitation for Tri-Met, because the schedules are written with the assumption that some trips carry more than 100 percent of capacity (i.e., standees). This factor will probably become even more important to Tri-Met because a decision has been made to retire 60-foot long articulated buses and to replace them with standard coaches. For these reasons, if Tri-Met were to adopt an all alternative fuel fixed-route fleet, a substantial increase in fleet size would be necessary.

There have been some recent improvements in composite materials that might allow fuel tanks to be made of materials other than steel. This would reduce the weight of the fuel tanks and would, therefore, allow passenger capacity to be increased. Until this becomes a reality, passenger weight capacity limitations will remain a major concern. Another factor in choosing LNG buses is the operating range; the maximum range of the CNG-powered buses is somewhere around 250 miles, whereas an LNG coach can cruise 300 to 350 miles. Several other factors gave LNG the nod over CNG. Unlike CNG, LNG is not stored under pressure at the rate of 3500 psi but is instead chilled to minus 260 degrees Fahrenheit. This allows special handling procedures to be avoided which would otherwise be necessary to minimize the danger from these high pressures. While special handling procedures are required because of the cold temperatures, Tri-Met feels the danger is greater from the pressure than from the temperature. Another major factor is Northwest Natural Gas already has the infrastructure for LNG, so Tri-Met saved the capital cost of building its own fueling facility. Finally, LNG coaches cost less than similar CNG coaches.

Despite these apparent advantages of LNG, CNG is being tried with paratransit vehicles. The main reason is simply to have some operating experience with CNG. The paratransit vehicles are smaller, so the fuel tanks are smaller than on the regular transit bus, so there is not as great of a weight increase. Consequently, it was assumed that CNG would pose a smaller limitation for paratransit vehicles than for fixed-route buses.

FUELING PROCEDURE CHANGES

The LNG and the CNG fuels are supplied by the local natural gas provider, Northwest Natural Gas Company. The vehicles are fueled at NNG's facilities; no CNG or LNG fueling facilities exist at Tri-Met. This off-site fueling does add time to the fueling and servicing process. Once at the fueling site, the actual fueling time is longer because gas is not dispensed as quickly as diesel and because a cooldown process is required. This is necessary to allow the LNG coach fueling system pressure to drop below the pressure of the fueling station. Pressure on the Gillig coach does not need to drop very far as it is at 40 psi and the fueling station is also 40 psi. However, pressure on the Flxible coach must drop from 100 psi to below 40 psi.

Northwest Natural Gas' fueling station is roughly 40 to 50 years old, so it does not have the latest in equipment and technology. Obviously the cold temperature of the fuel does require some safety precautions. The fuel tanks have to be drained when heavy maintenance is performed. They are drained at an off-site facility located 13 miles away. Both factors obviously result in additional inconvenience.

DYNAMICS OF SOLE ALTERNATIVE FUEL SUPPLIER

Because alternative fuels are so new, Northwest Natural Gas and many equipment suppliers are still adjusting to Tri-Met's needs as a customer. It is a new experience for them to get used to the transit market as opposed to their traditional industrial gas customer. Getting the gas from their tanks to our buses quickly and safely is still an issue to be resolved.

The supplier has run out of LNG fuel several times, which is a challenge to transit operations. Tri-Met obviously does not want to miss a pullout because of lack of fuel. This operational issue will be taken into account before a decision is made to go to alternative fuels on a fleetwide basis.

As equipment operators are aware, the alternative fuel market is still in its infancy, so few suppliers exist. In Tri-Met's case, only one exists in town, so the distribution channels are not well established. Obviously, if LNG fueling stations existed on every corner, the dynamics of competition would be much different. The supply would be greater, and the costs would be lower. The critical mass would reduce the likelihood of supply problems. Obviously we are currently nowhere near this scenario yet. For the most part, Tri-Met has not been hit by any major or nasty surprises with the experience so far; it is about as expected.

FUEL COST OF LNG

As far as the LNG buses are concerned, clearly their benefits are environmental, not financial. The fuel cost

per mile for diesel buses is less than half the cost for LNG buses; this is explored below. Although quantifying these costs is subjective and difficult, the maintenance cost per mile is clearly higher on the LNG buses as well. The roughest of estimates suggest it is more than double the cost of diesel. The technology of alternative fuel is new, which does result in more frequent breakdowns (road calls). Parts for LNG buses are sometimes difficult to find and take awhile to get.

For fuel cost experience, Tri-Met has been spending about 37 cents per mile for the LNGs versus to 14 cents a mile on the diesel buses. If Tri-Met were to go to an all-LNG fleet tomorrow, Tri-Met would need to spend an additional $5.4 million a year on fuel costs, based on today's price per therm of about 74 cents. This figure could and will likely change; some price reductions are expected as time progresses, particularly if the volume of LNG usage were to increase. Even so, using current technology, the price per therm would have to decline from about 74 cents to about 28 cents for this to be a "break-even" proposition in fuel costs.

MAINTENANCE COSTS AND PERFORMANCE

Meanwhile, maintenance costs, which are not included in the above figures, are much higher. Tri-Met is not certain as to exactly how much higher. First, these costs are difficult to trace; second, the case can be made that over time this disparity could decrease as technology improves and the mechanics progress on the learning curve. However, so far the crudest of estimates suggest the fixed-route LNG buses are over twice as maintenance intensive as a similar diesel-powered fleet.

We know we have had our share of problems, but we feel a strong need to acquaint ourselves with this fuel delivery technology sooner or later. While the worst was expected, the engine problems are less significant than expected. It is too early to render judgment on the LNG vehicles, but the initial operating experience has clearly shown the higher cost of alternative fuels. While the decision to procure alternative fuel buses may not ultimately rest with Tri-Met, the verdict on alternative fuel buses probably rests on whether the environmental benefits of alternative fuels are worth the extra cost.

OPPORTUNITY COST OF ALTERNATIVE FUELS

A neighbor to the north, Seattle, Washington, was once looking at going to an all LNG fleet. They actually signed a contract to do this. A critic of the move said, "Natural gas will not get people out of cars; more convenient transit service will." This speaks to the opportunity costs inherent in any major decision. The $96 million cost of alternative fuels might instead in Tri-Met's case be spent to increase service by perhaps some 845,000 hours a year with diesel buses. Although this is probably on the high side, the opportunity cost of alternative fuels must be considered. One question Tri-Met has is to what extent "clean diesel" might eventually approach the same environmental benefits at a lower cost as LNG.

TECHNICAL CONSIDERATIONS

A brief note on the technical side of what the experience has been. As mentioned earlier, Tri-Met deals with many contractors and small companies. As such, it can be a little difficult coordinating all of them. Many of these suppliers are oriented to traditional customers; transit agencies are a relatively new application for them. There have been some first stage regulator problems with the buses, some cracked engine cylinder heads, and many fuel pumps have had to be replaced, which are quite expensive. The fuel line blockage problems have largely been solved by placing an in-line fuel filter in the fuel line just before the first stage regulator. In addition, the seals in the fuel pumps have been replaced, which has greatly reduced leakage problems. Tri-Met is satisfied with the improvements in maintaining LNG buses, but is disappointed with the fuel costs of LNG vehicles.

CONCLUSION

Alternative fuels are an issue that is increasingly being raised in the public arena. Tri-Met's experiment in alternative fuels will continue. Overall the performance has been close to initial expectations, but Tri-Met is disappointed in the initial disparities in fuel costs and in maintenance intensiveness. The $5.4 million estimate of increased annual fuel costs may decrease over time, but questions remain as to the additional capital, maintenance and servicing costs. Are these additional costs worth it for cleaner air? Tri-Met and the Portland region will soon have to answer this question.