On the negative side, there have been and will continue to be productivity inefficiencies until the two distinctly separate requirements of the motor coach suburban and trolley coach urban systems unite in a balanced, integrated transit system. Again, knowledgeable transit people recognize that it takes more than just 2 years for that to occur.

What happens when the power goes off has been the most significant effectiveness problem for our industry. In cooperation with UMTA and the Garrett Corporation, we recently completed a test of off-wire propulsion through the use of batteries. The test results are promising.

RTA is also looking forward to a demonstration project in cooperation with UMTA and Renault/Mack Truck to test the feasibility of dual-mode battery trolley.

As I mentioned earlier, we are looking to an expansion of our trolley system as well as some efficiency modifications that require costly overhead work.

If the off-wire capability can approximate standard operating speeds at reasonable operating costs, the technology can allow the trolley to better emulate the flexibility that motor buses enjoy.

Another technological change we are investigating is solid-state substations.

RTA is in the process of acquiring about 14 miles of railroad right-of-way from Penn Central and Conrail. It extends from the southeast corner of the county to the Dayton central business district through the most traveled traffic corridor in the region. It may become an exclusive right-of-way for a trolley rapid transit system--if not on a permanent basis, at least as an interim step toward light rail.

I also envision that technological advances will soon give us off-wire flexibility at full operating level, which can significantly reduce construction and maintenance costs on the catenary system while increasing on-street schedule dependability.

Vancouver and the Trolley Bus

Tom E. Parkinson

Transit in British Columbia and Vancouver is unusual in that the city and other municipalities have never been involved. It started out with B.C. Electric Railway Company running streetcars and generating power. Power became the bigger part of the operation and this private company elected to convert from streetcars to a trolley bus system in the late 1940s. The company did this with no public funds partly because the streetcar system had few new vehicles and needed major capital improvements. Vancouver has a large trolley bus system and has never had any route cutbacks. The province purchased B.C. Electric in 1964, and transit and the then freight rail operation came with it into the transportation division of B.C. Hydro and Power Authority. B.C Hydro never wanted transit, but it was 15 years before it was able to hand it over to a newly created provincewide transit authority. Transit never extended into the suburbs under B.C. Hydro. Only in 1972 did a new agency, the Bureau of Transit, instruct B.C. Hydro to start serving the neighboring municipalities, leading to the present system.

The Bureau of Transit initiated serious thoughts on the retention and expansion of the trolley bus system by purchasing 50 new Flyers in 1976 using reconditioned electrical equipment. The Bureau of Transit became the Urban Transit Authority in 1979, with a subsequent name change in 1982 to BC Transit (BCT). BCT is a provincial crown corporation. It owns and purchases all transit assets in the Province of British Columbia and contracts out for the operation of service in a tripartite agreement between the regional district or the municipality and an operator. BCT has 27 transit systems under its jurisdiction. In Vancouver the system is too big to put out to public tender; another crown corporation, Metro Transit Operating Company, was created solely to operate transit in Vancouver and Victoria.

Under the auspices of the Urban Transit Authority, economic studies were done with B.C. Hydro Transportation Division in 1978 and 1979 to determine the future of trolley buses in Vancouver.

There are three main indices that affect a decision to retain trolley buses or to introduce trolley buses and all of them have significant hazards. There have been enough recent bids to know the price of vehicles, substations, and overheads. Five years ago this was not the case. The price of diesel fuel and electricity throughout the future life of the coach is difficult to project. The most significant factor and important advantage of the trolley bus is the maintenance cost. The trolley is (and in Vancouver has proven to have much lower maintenance cost than diesels) fully offsetting any differentials in fuel and cost of maintaining and renewing the overhead and the substations. There have been much conflicting data on the relatively different maintenance cost of electric vehicles versus diesel vehicles. In Vancouver we were fortunate in having diesel and trolley buses of the same make, model, and vintage running out of the same garage to allow a reasonably accurate comparison.

The BCT analysis demonstrated that with modern electrical equipment on a trolley bus, a maintenance savings of 30 to 40 percent below that of a diesel coach could be achieved. When the decision was made to renew the trolley bus fleet in 1980, procurement of a new fleet was started using a two-stage process. Vancouver was at a turning point between old but reliable electrical equipment being retrofitted in diesel coaches and the new generation of trolley buses using 1980 electronics.

BCT tried to take a fresh look at the need of drivers and passengers to evolve an urban transit vehicle for heavy-duty service, not for use on suburban routes. BCT wanted to retain the double front doors not available on buses in North America since 1955. This was the biggest battle. It is regrettable that manufacturers have resisted the desires of transit authorities (and authorities with much higher density routes than Vancouver) by insisting that a double front door bus was not necessary or possible. BCT fought hard and now has the first two-axle North American double front door bus in 15 years. This is an urban bus; it has two-one seating with stanchions on every seat, double exit doors, and windows that open.

In the two-stage procurement BCT was prepared, given the resistance of the North American suppliers to provide double front doors, to go to a European vehicle. A technical specification was widely circulated to solicit the world for responses and opinions. BCT was prepared to change specifications in order to open the bidding process. There was extensive feedback with visits to 11 electrical manufacturers, indicating a view that the trolley coach or the dual-mode coach is here to stay and may even increase in numbers.

BCT had 19 bids, probably the largest and most

extensive bid for any trolley bus procurement in North America. Some of these were permutations of different electrical manufacturers with the same body builder, making evaluation difficult.

One distressing aspect was that all the vehicles offered were heavier than the buses being replaced. The low bid with Japanese electrical equipment had to be disqualified because, with a passenger load, it exceeded the rear-axle highway loading limit. Some of the vehicles offered had a power-to-weight ratio inferior to the buses being replaced because of their weight. There was some difficulty in evaluating technical risk. On the premise that complexity is the enemy of reliablility, there was a desire for simple proven equipment, which was in conflict with energy efficiency and lower bids. Given an opportunity to move into the future, BCT selected the bid from Flyer Industries and Westinghouse Electric Corporation for a propulsion system that previously had never been used on a trolley bus. It uses a fourth-generation chopper, which was working well on the light rail vehicles in Philadelphia.

BCT also looked closely at off-wire operation. Records were sketchy on the number of delays and incidents that occurred on the extensive trolley bus system in Vancouver, but it appeared clear the 90 plus percent of all incidents were minor. They involved a coach being stuck on an insulator, a defective switch, a span wire or an intersection down--the sort of things that do not need a lot of stored energy to correct. For a small incremental cost in the procurement, battery capability of about a kilometer at low speed was provided. This is limited by how much air for braking can be stored and permits somewhere between six and eight stops. It is enough to get over almost all these minor problems. In some cases--for example, stuck on an insulator--the driver does not have to touch the poles, he just presses the button and moves away. It adds weight to an already heavy coach, but new battery developments should reduce this.

BCT was aware that there would be problems in introducing a bus with so much complexity. The first prototype was due in 1981 and was delayed for manufacturer's reasons. It came in April and had, with three counterparts, undergone about 400 vehicle-days of testing. There have been many problems; most have been corrected but a few are still outstanding. Transients are a big problem on trolley coaches and some of the transient problems on this bus were solved by the simple expedient of reprogramming the microprocessor (putting in different timing constants). There are additional problems with transients that appear to internally generated, and debugging is continuing. Initial "hot coach" problems were resolved by increasing insulating grommets on the resistors.

BCT is proud of having pioneered a new-generation trolley bus with microprocessor control, full regenerative brake, off-wire battery operation, and double front doors, and is looking forward to having the full fleet in service over an expanded network.

Trolley Coach Applications in the 1980s: Toronto Update

Paul A. Wenning

The eight existing Toronto Transit Commission (TTC) trolley coach routes are centrally located in metropolitan Toronto, contained for the most part in the city of Toronto. These trolley coaches were introduced in the late 1940s to the early 1950s and replaced streetcars that formerly operated on these routes. Figure 1 shows the geographic location of these trolley coach routes within the TTC system.

The trolley coach has a rather limited, albeit important, share in the public transit make-up in Toronto. In 1981, trolley coaches constituted 3.7 percent of the total annual TTC system mileage (3,938,374 miles). This compares with 48.1 percent for diesel buses, 39.6 percent for subways, and 8.6 percent for streetcars. In terms of passenger use, 4.9 percent of system ridership--representing 19,204,000 revenue passengers--traveled on trolley coach routes.

As the TTC system has expanded over the years since its official formation in 1955, the relative role of the trolley coach has diminished. This trend reflects the general stability of the central-core trolley coach and streetcar routes in relation to steady suburban growth and resulting bus and subway system expansion.

HISTORICAL PROFILE

The presence of trolley coaches on Toronto streets dates back to the 1920s, when "trackless trolleys" replaced gasoline buses on the Mt. Pleasant route on June 18, 1922. Mt. Pleasant trolley coach service was later replaced by streetcars on September 1, 1925. This first type of trolley coach is shown in Figure 2.

A fleet of second-generation trolley coaches was acquired by the then Toronto Transportation Commission over the period 1947-1951. Engaged in a postwar system modernization program, the Commission decided to purchase new and used trolley coaches on economic grounds. These trolley coaches were used to replace certain sections of streetcar lines that would otherwise have required extensive track rehabilitation and replacement work.

The spring of 1967 marked a major milestone in Toronto trolley coach history, when the TTC decided to study the feasibility of refurbishing its aging trolley coach fleet. Coach No. 9020 was rebuilt as a prototype and underwent 1 year of successful operational testing in revenue service. By mid-1972, the remainder of the 151-vehicle fleet had been overhauled, resulting in a third-generation trolley coach fleet. The catalyst behind the rebuild program was economics.

In March 1981, the TTC considered a staff report (1) recommending greater use of existing trolley coaches through a two-phase route electrification program. The TTC granted approval in principle to this undertaking and to date has authorized its staff to proceed with initial design work for a phase 1 conversion only. However, TTC staff are reevaluating the conversion program in light of public concern over visual pollution from overhead lines and the more recent diesel-electricity cost scenario.

TROLLEY COACH EXPANSION REVIEW

The March 1981 staff report to the TTC advocated a two-step trolley coach expansion program for the 1980s. The two-step process recognized the economic limitations of conversion at that time, and was recommended as a means of staging electrification of routes to be compatible with the present and future economic circumstances. Essentially, the phase 1 conversion of three proposed routes (Wellesley-Parliament-Sherbourne) would take immediate advantage of capital deferment of 20 peak-period buses, and