An Innovative People Mover For Low Capacity Transit Applications

John H. Stannard*

The low capacity transit market segment is defined as the approximate range 500 to 5000 pphpd, and is generally associated with typical station spacings in the range 200 to 800m. Applications can be broken down into Airports, Theme Parks, Major Activity Centres and Low Capacity Circulators/Feeders. This is a promising but cost sensitive market segment with near term opportunities identified at airports.

The Low Capacity Transit System (LCTS) being developed at UTDC is an innovative approach to this market which combines proven steel wheel and steel rail technology with an advanced light weight vehicle being developed jointly with Alcan International Ltd., and an advanced LIM in Track (LIT) propulsion system of UTDC design. Guidance, switching and fixed block overlay control system are entirely based on conventional, proven, low maintenance technology. The innovation lies in the combination of LIT propulsion with a light weight structurally efficient vehicle which allows relatively low guideway cost.

The vehicle consists of two, people carrying, modules mounted on a single articulated 4-axle undercarriage and is fully equipped with HVAC, lighting and safety systems powered by on-board 24V battery and a 220V single phase AC power rail.

A prototype vehicle has been manufactured and is under test at the UTDC Millhaven test site. Concepts are presented for future applications in combined operation with baggage and cargo movements.

----

* Manager, Mechanical Engineering Development, UTDC Inc., P.O. Box 70, Station "A", Kingston, Ontario, K7M 6P9.

activity centres like residential/commercial centers, universities, shopping malls, hospitals, and other similar installations about 1,000-5,000 pphpd. Examples are the AGT systems located in Morgantown and Duke University Hospital.

- Airports - The AGT requirements include connections between various activity centres within an airport complex, both landside and airside, about 2,000-5,000 pphpd. Examples are the AGT's located in Dallas Fort Worth Airport and Atlanta Airport.

- Amusement/Theme Park - The AGT connects various areas in recreational settings like theme parks, zoos and amusements parks. Examples are the AGT's in Busch Garden and King's Dominion. Applications are in the 500-2,000 pphpd range.

- Mass Transit - Under this segment are 2 types of needs, namely, the mass transit (low capacity circulator/connector of 4,000 to 10,000 pphpd) and the mass transit (medium/high capacity of 10,000 to 25,000 pphpd).

UTDC currently produces equipment such as the Vancouver Skytrain that meets market needs in the capacity ranges typical of the Mass Transit market segment. The LCTS therefore was aimed primarily at the capacity range of 500 to 5,000 pphpd.

A market survey indicated that this was a growing market segment and that the near term opportunities were primarily in Airports.

3.0 SYSTEM CONCEPT

The objectives of the system design were to achieve overall capital costs that were competitive with existing and projected people movers and also competitive with alternatives such as buses on dedicated guideway. A survey of the market place and discussions with transit officials, developers and people mover system operators also led to other design criteria which were necessarily difficult to precisely define but can be summed up as a need for "low intrusion". The components of this are:

- Small physical dimension in order to integrate well with existing and planned structures.

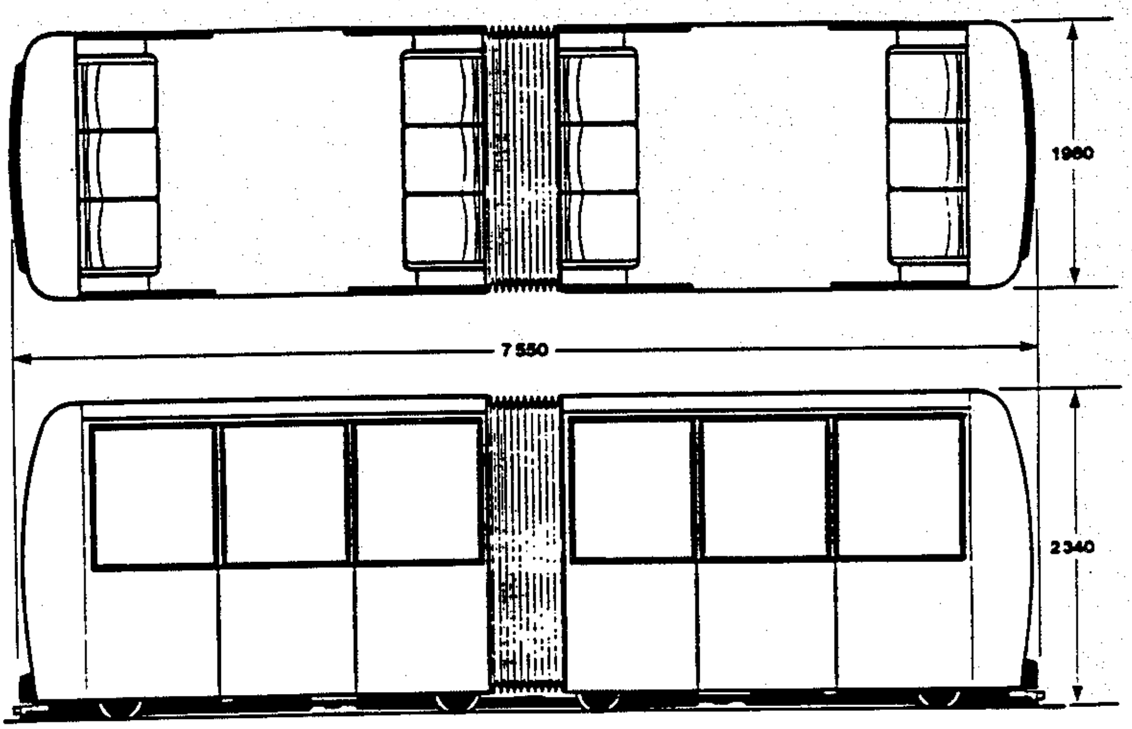

FIGURE 1 SIDE AND PLAN VIEW OF LCTS VEHICLE

Fibrefax insulation. This floor assembly has been tested and meets ASTM E119 fire test criteria as required by NFPA 130 for AGT systems.

Sidewalls are a combination of bonded sheet and extrusion with fibreglass insulation. Doors are of foam core construction, like the roof. The side and end windows are of molded Lexan. The vehicle presents an attractive appearance as can be seen in Figure 2.

5.0 PROPULSION AND CONTROL

The LIT propulsion and control system consists of a series of Linear motors fixed between the running rails of varying spacing and design depending on the particular location and operating conditions. The LIMs and their associated power controllers can be optimised to some extent for a given position but must of course also meet any demands imposed by failure cases and restart after a power failure. For the LCTS typical LIM thrusts for station areas are of order 6 KN (1350 lbf) with typical cruise section LIMs having 2 KN (450 lbf) thrust. The LIM design is challenging as design duty cycles are usually very low, of order 2 to 5%. It is also necessary to optimise the power distribution system along with the LIMs as they can be of equivalent magnitude in terms of cost.

A currently installed LIT system in a Material Handling applications at the Continental Car plant in Toronto uses a dedicated voltage controller for every LIM. Other configurations tested at UTDC include a central voltage controller with power distributed to the individual LIMs by means of solid state switches, and combinations of the above schemes. Central control has been performed by both PLCs and off-the-shelf PCs such as the Compaq 386. A certain amount of decision making and control is performed locally at the LIMs, giving rise to the term "distributed intelligence". The INTEL BITBUS system is used to communicate between the central Host computer and the distributed command and control elements. The overall feature of interest is that from a propulsion and braking point of view the vehicle is passive although a single power rail is used to provide single phase 220 V A.C. power for auxiliary purposes. The net result is a simple, low-cost, low-maintenance vehicle.

6.0 GUIDEWAY

As previously noted the guideway is a large element in the overall capital cost. In the effort to reduce this element a study was carried out of guideway design, and particularly the effect of the live load in terms of vehicle mass per unit length. It was found that for a given column spacing there was a point beyond which costs began to increase rapidly with live loading for a particular crossing frequency. The LCTS guideway design proved to have a relatively low cost and to be insensitive to live load until a value close to 900 kg/m (600 lbf/ft) was reached. Thus the design target for the vehicle was to keep below this level, which was achieved. The optimum column spacing in good soil conditions proved to be about 20 m (66 ft).

For at-grade track a tie-and-ballast system will be sufficiently accurate for LIM-In-Track propulsion as long as continuously welded rail is used to minimize rail-joint impact on the small wheels.

The tunnel diameter can be minimized to 3.05 m (10 ft) because the already low vehicle has its propulsive elements in the track, thus maximizing use of a circular tunnel crossection. The objective here was to reduce tunnel cost, which is virtually proportional to tunnel diameter squared in the range of interest for subway tunnels between 3.0 m (10 ft) and 6.0 m (20 ft). In good soil conditions this might result in a cost reduction from 10,000 US$/m for 6.0 m (20 ft) tunnel to 3,000 US$/m for a 3.0 m (10 ft) tunnel. The tunnel crossection is compared for ALRT and LCTS in Figure 3. Passenger walkways in the guideway can easily be provided, again in conformance with NFPA 130 AGT requirement.

7.0 DEVELOPMENT SUMMARY

The prototype was constructed in 1987 and testing of the structure and auxiliaries carried out in that year with satisfactory results. In 1988 the vehicle was dynamically tested on the 2 km test loop at UTDC while being towed by diesel engined tug. The dynamic performance and curving behaviour were satisfactory up to 10 m/s. The vehicle was also tested in fixed and moving frog switches and behaved normally despite the small wheels and novel undercarriage layout. A short (100 m) test section was fitted with Linear