Transport for NSW

NSW GOVERNMENT

# MEMO

## SUBJECT: TRACKLESS TRAMS

### Introduction

The purpose of this briefing note is to present preliminary findings on a review of the suitability of trackless trams as a mobility technology for part or all of the second stage of the Parramatta Light Rail project. Specifically, the briefing note considers the following:

- A description of the key features and attributes of a trackless tram;
- A comparison of key features and attributes of the Parramatta Light Rail vehicle and trackless trams;
- A review of related and available mobility products;
- Operational interfaces with proposed light rail operations;
- A review of some of the key issues that would require resolution to implement a trackless tram technology within the Sydney Transport network.

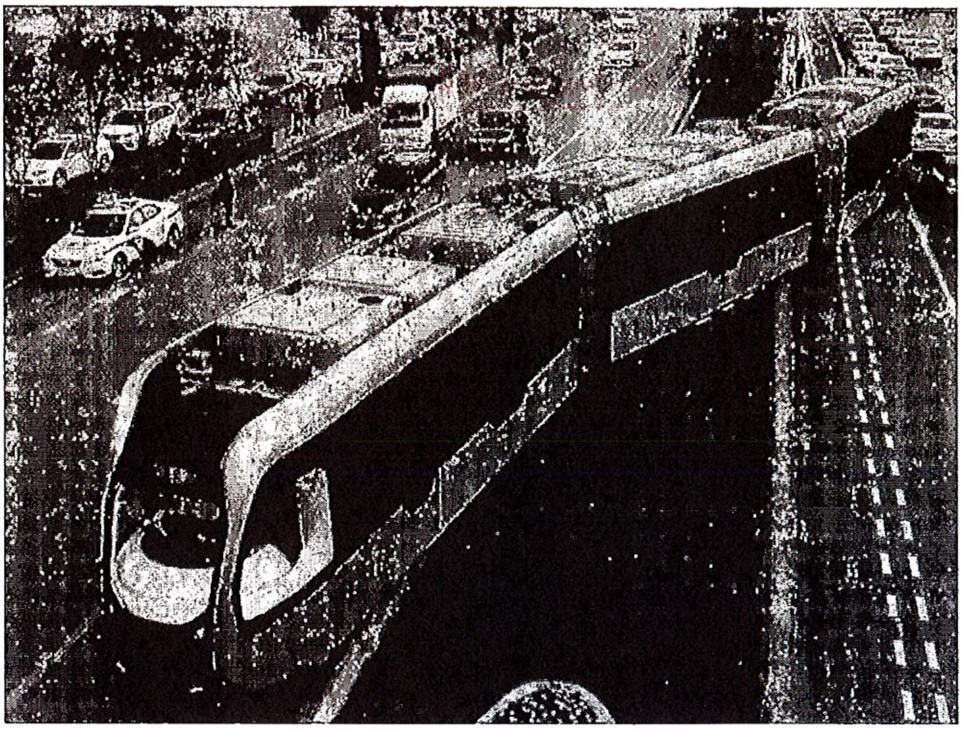
### Attributes of Trackless Trams

The trackless tram that is the subject of this briefing note is a passenger transport vehicle that has been developed by the Chinese organisation CRRC. It is an electrically powered road vehicle that consists of three vehicles. It is understood that the vehicle can operate autonomously requiring two white lines to be provided on a travelled roadway (without rails) to provide spatial guidance. Power supply is provided via a current collector arrangement.

It is envisaged the trackless tram would operate in the following environment:

- Dedicated corridor typical of a busway environment or reserved lanes;
- Stops of similar nature to that in application in light rail networks;
- Frequent services;
- Consideration of transport interchanges with other modes;
- Areas where high capacities are required;
- Similar ticketing and customer service interfaces as light rail;
- Dedicated maintenance and stabling facility.

A photo image of the vehicle (with driver) in operation is shown below.



More details on the CRRC trackless tram are given below with a comparison of similar attributes of the Parramatta Light Rail vehicle.

**Comparison of key attributes with the Parramatta Light Rail rolling stock**

Outlined below is a comparison of some attributes of the CRRC trackless tram vehicle and the Parramatta Light Rail Vehicle. It should be noted that information regarding the CRRC vehicle is limited.

It is recommended that a briefing be sought from appropriate CRRC representatives to obtain relevant further information on this vehicle to enable it to be more fully assessed.

| Attribute | Parramatta Light Rail Light Rail Vehicle | CRRC trackless tram - Autonomous Rapid Transit (ART) |
|---|---|---|
| Length | 46m | 32m (3 vehicle consist), 53m (5 vehicle consist) |
| No of sub-vehicles | Seven modules | Three vehicles |
| No of axles | Eight (8) | Not known at this stage |
| Maximum axle load | Twelve (12) tonnes<br>60 tonnes total tare | Not known at this stage |
| Vehicle height | 3.6m | 3.4m |
| Vehicle width | 2.65m | 2.65m |
| Passenger capacity | Passenger Capacity – minimum 300 @ 4 passengers per m2 loading (min 75 seated) | 100 passengers per vehicle unit.<br>300 per three vehicle consist |
| Power requirement | 750 V DC | Not known at this stage |
| Fully charged range | LRVs in design – Supplier still to advise. | Fifteen kilometres with full air conditioning |
| Power unit charge time | Three minutes | Ten minutes |
| Maximum swept path width | TBD | 3.83m |
| Minimum curve radius that can be traversed | 25m | 15m |
| Maximum grade that can be travelled | 7 percent ASA standard | TBD It is likely that the maximum grade that can be traversed will be greater than 7%. |

A review of corporate information from large rolling stock suppliers from other countries, indicates that there are related passenger rail products available, which include:

Alstom – Aptis – This vehicle is an electrically operated single unit bus with enhanced manoeuvrability.

Siemens – Val – This vehicle is an automated people mover. It can consist of anywhere between two and nine vehicles. It requires a single central rail to provide electrical power for operation. This vehicle set has similar applications to a metro or light rail product (Also produced by French company, Matra).

Bombardier – TVR guided bus system – This system has been implemented and operated in Nancy, France as a guided light rail, rubber tyred transit system. The rolling stock for this system comprises three articulated vehicles. The vehicles use trolley poles to collect current from parallel overhead lines, and can also run independently without the central guide rail.

This system is planned for replacement. It has had challenges that relate to derailments and pavement wear and tear.

## Existing Light Rail Operations Interfaces

PLR Stage 2, in total, is a 12km service running from Parramatta Square to Sydney Olympic Park. The PLR Stage 2 project includes 9.9km of new track with 15 new stops which extends the Stage 1 project to provide direct connections between planned high-density residential precincts at Camellia, Ermington, Melrose Park, Wentworth Point and Carter Street with key employment and commercial hubs at Parramatta CBD and Sydney Olympic Park.

A staging strategy is currently being considered for project, which comprises the following stages (broad descriptions):

1) Melrose Park to Wentworth Point corridor including the bridge, development integration, active transport connections, and amended/new bus routes (**Stage 2A**).
2) Extension of PLR system from Camellia to Carter St via Melrose Park and Wentworth Point, which could be delivered as:
    a. Extend the existing PLR stage 1 from Camellia to Melrose Park (**Stage 2B**);
    b. Continue extension from Melrose Park to Carter Street via Sydney Olympic Park (**Stage 2C**).

The Stage 2A project could be considered as a candidate for trackless tram operations. As a standalone project, it does not interface with the stage 1 PLR project.

The application of trackless tram technology for the full stage 2 project would have the following implications:

- additional light rail vehicles would need to be procured for the stage 1 facility to achieve a 3 minute headway that is ultimately proposed when sufficient demand levels have been reached;

- passengers would need to interchange between the two transport types at Camelia to access light rail stops to travel to further destinations beyond Camelia. This would add travel time and inconvenience penalties for some trips.

The trackless tram technology provides the opportunity for operational flexibility subject to availability of suitable corridors. In Sydney Olympic Park this may have application due to the changes that occur between event and non – event mode particularly along Australia Avenue. The avenue closes for approximately one month a year with the Royal Agricultural Show hence allowing services to continue by travelling a different corridor through the precinct till broader changes in the area occur.

**Issue requiring resolution for the implementation of trackless trams**

There are a number of issues that would require resolution to enable the implementation of the operation of a trackless tram. These include:

- Capacity of industry to supply this market;
- Regulatory requirements;

- Structural impacts on pavements;
- Structural impacts on bridges;
- Power supply;
- Infrastructure geometry;
- Operation at traffic signal controls.

Each of these issues has been considered below.

Capacity of industry to supply this market

There currently do not appear to be any other suppliers of this vehicle type other than CRRC, which would mean that procuring on a competitive basis may present challenges for other mobility technology suppliers to be able to offer a similar product.

Future procurement strategies for trackless tram vehicles would need to promote new suppliers into the market.

Regulatory requirements

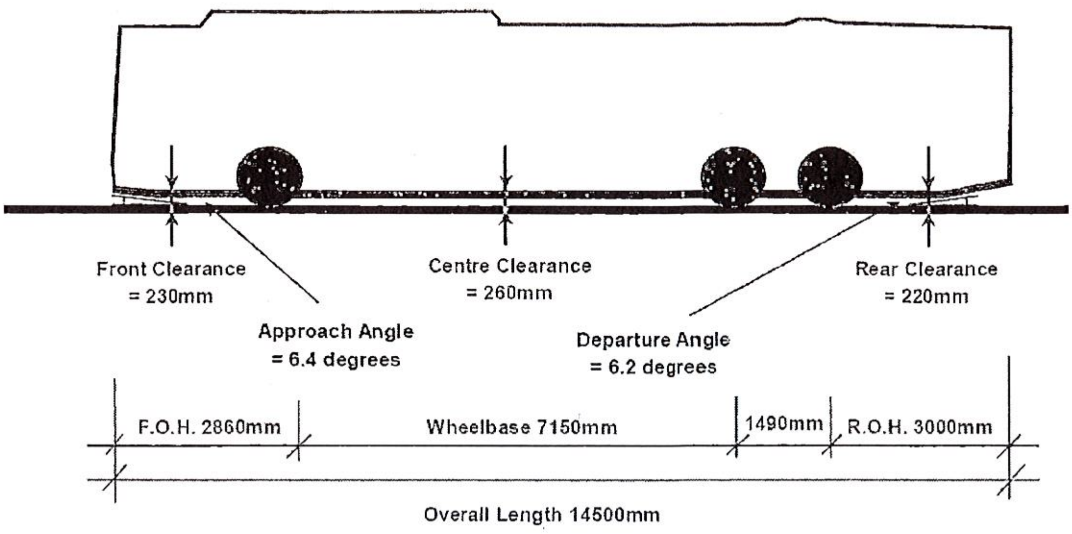
The use of heavy motorised vehicles on the public road network is regulated. The National Heavy Vehicle Regulator (NHVR) is Australia's dedicated independent regulator for heavy vehicles over 4.5 tonnes gross vehicle mass. The NHVR would be the appropriate regulator for trackless trams.

A trackless tram is likely to be considered to be included in the NHVR category of buses.

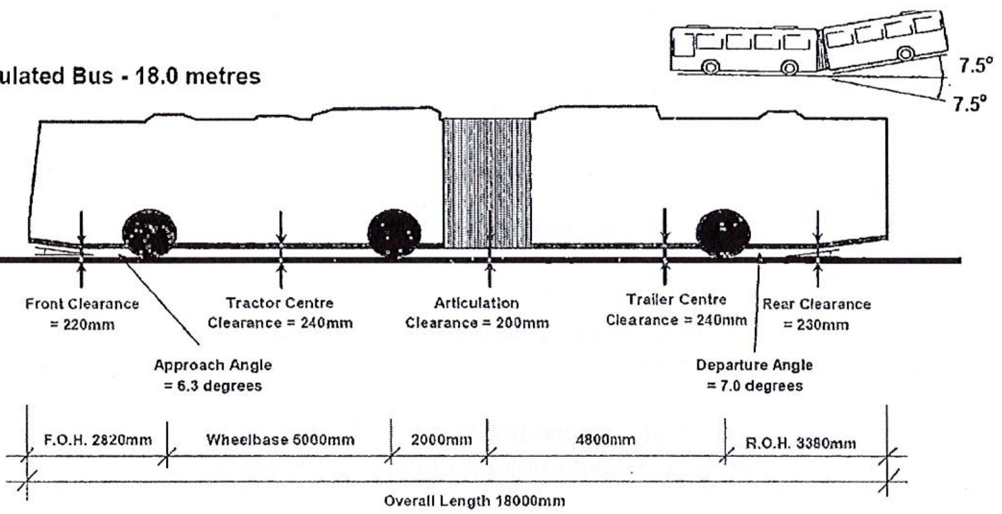
The current length of the CRRC trackless tram is 32m for a three vehicle consist and 53m for a five vehicle consist.

Current state transit authority maximum bus lengths are 14.5m for a single unit and 18m for an articulated bus. These configurations are shown below.

### Long Rigid Bus - 14.5 metres




### Articulated Bus - 18.0 metres

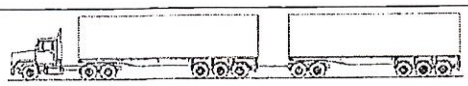
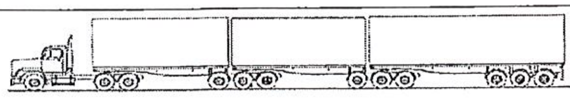
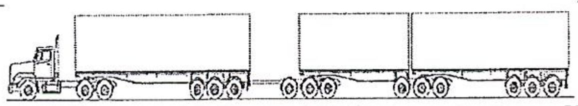
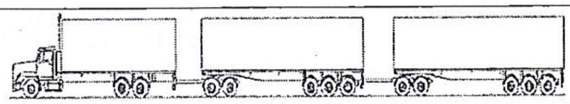
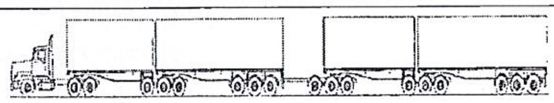
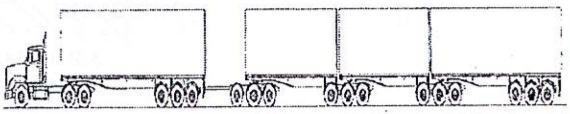
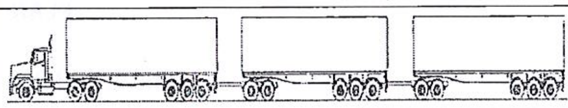



The maximum length of heavy vehicles that can operate on the Sydney road network with general access is 19m. Vehicles in excess of this length operate and up to 36.5m length operate on restricted access routes within Sydney. If a trackless tram length was approximately 32m, then some form of special access declaration is likely to be required.

In relation to heavy road vehicles greater than 36.5m in length, the maximum length of these vehicle that is approved for use in NSW on some routes are road trains which are 53.5m in length.

The lengths and configurations of heavy road vehicles permissible for use in NSW are shown in the figure below.

**Table 1 - Maximum Lengths of Road Trains**

| Vehicle combinations | Length (m) | Type | Combination diagram |
|---|---|---|---|
| A prime mover towing two semitrailers connected by a drawbar. | 36.5 | Type 1 |  |
| B-triple | 36.5 | Type 1 |  |
| AB-triple | 36.5 | Type 1 |  |
| Longer AB-triple (as described above) | 44.0 | Type 2 | (as depicted above) |
| A rigid truck towing two semitrailers connected by a drawbar. | 47.5 | Type 2 |  |
| BAB-quad. | 53.5 | Type 2 |  |
| ABB-quad. | 53.5 | Type 2 |  |
| A prime mover towing three semitrailers connected by drawbars. | 53.5 | Type 2 |  |

The current permissible axle loadings for Sydney are 11 tonnes for a single axle on a low floor bus without multiple axle combinations and 20 tonnes in total in a three axle combination.

In addition to complying with vehicle use regulations, the manufacturer would need to seek certification via the National Vehicle Certification Scheme to ensure that the vehicle complies with Australian Design Rules.

Structural impacts on pavements

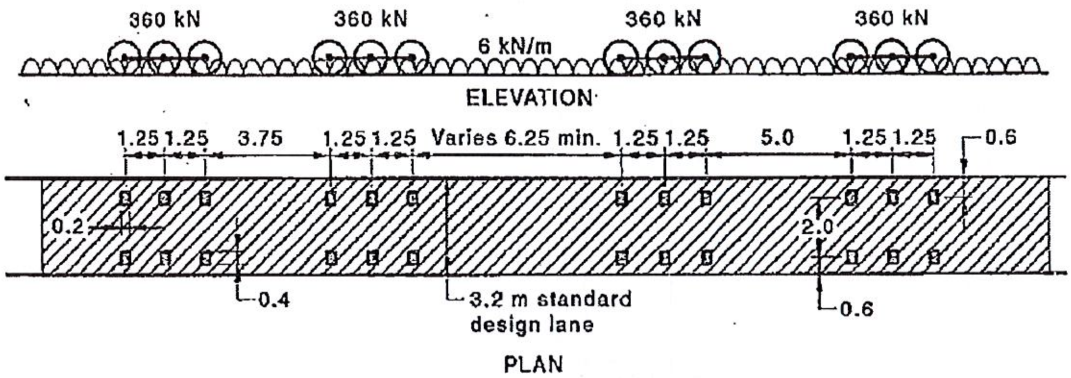
The relevant standard for the design of road pavements is the Austroads, Guide to Pavement Design, Part Two, Pavement Structural Design. This standard assumes that an equivalent standard axle with dual tyres for the design of a flexible pavement is 80KN. This guide makes provision for the estimation of traffic loadings for non – standard vehicles. Tyre pressures are also a factor that would need to be considered in the design of pavements. Notwithstanding, the design of pavements for trackless trams is likely to require a specialist approach assuming a non-standard axle configuration, axle loading and tyre pressures.

Structural impacts on bridges and structures

Bridges for the NSW road network are designed in accordance with Australian Standard AS 5100. This code allows for both road and rail vehicle configurations.

The code would need to be applied on the basis that this is a road based vehicle. AS 5100 makes allowance for the following loading types:

- A single wheel load, W80, applied anywhere on the bridge road surface which is a single 80KN wheel load;
- A single axle load, A160, which is applied in a fixed location within a 3.2m width design lane;
- A moving load, M1600, which is applied as a distributed load and moving axle loads within a 3.2m width design lane as shown in the diagram 7.2.4 below. The loading is applied to provide the most adverse effect;
- A heavy platform load platform, HLP320 or HLP400, as shown in the figure 7.3 below. Two loads are applied on adjacent lanes to create the most adverse effects.




DIMENSIONS IN METRES

FIGURE 7.2.4 M1600 MOVING TRAFFIC LOAD

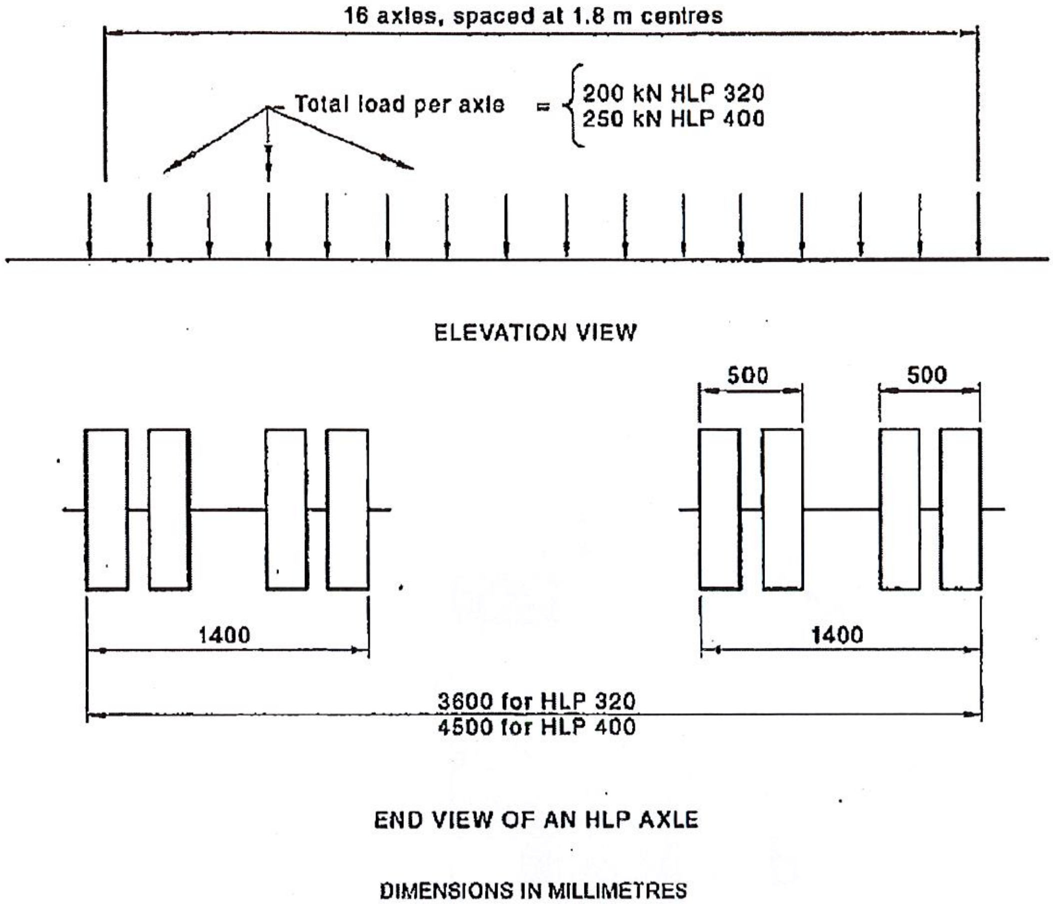



FIGURE 7.3 LATERAL SPACING OF DUAL WHEELS ALONG AN AXLE FOR HLP LOADS

If a trackless tram loading is not consistent with loadings specified in AS 5100, then a purpose developed loading requirement set would need to be developed for the design of bridges and any other crossing structures.

Similarly, the interaction of trackless trams with roadside barriers will also require further investigation, as the current standard designs of barriers within NSW may not cater for the dynamic behaviour of trackless tram in an impact situation.

Power supply

Power supply for trackless trams would be provided via a current collector arrangement, which would be located at terminal stops or depots.

The vehicles are proposed to be "wire free" and would use on board energy storage systems for operation.

Infrastructure geometry

The geometric design of transitway infrastructure for trackless trams will require the preparation of purpose developed guidelines as the vehicle consist is: greater in length than existing public transport vehicles; has different turning characteristics; is articulated and has low clearances. It is anticipated that existing guidelines for light rail stop infrastructure could be readily adapted for this case.

Operating at traffic signal control

Trackless trams could operate at intersections and crossings with traffic signal control using similar principles as are currently used for buses, albeit that trackless trams are almost twice as long as buses that currently use the NSW bus network. Tram jump priority measures could be adopted in accordance with the operating approach shown in the diagram below.