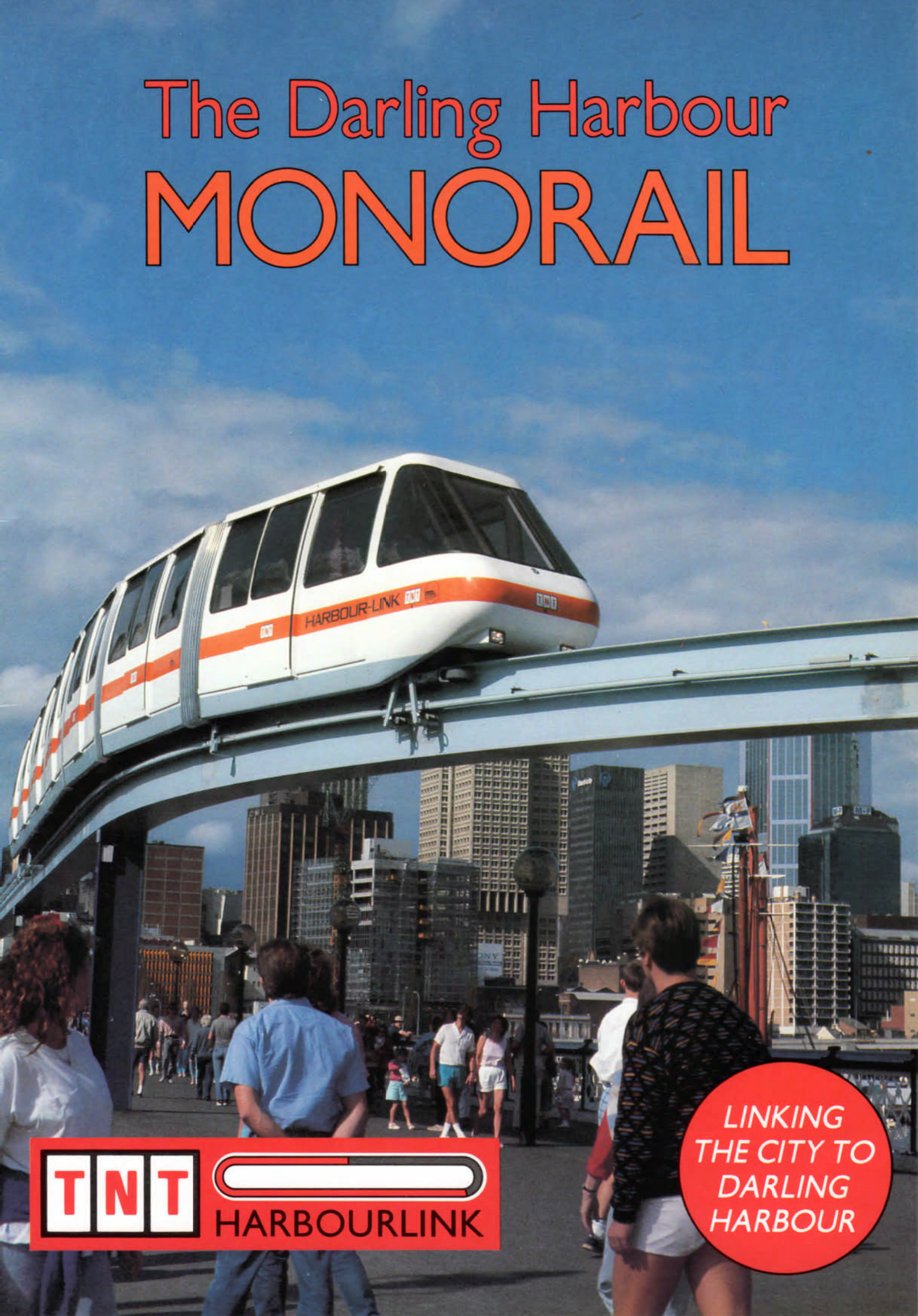
The Darling Harbour MONORAIL

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National Mutual
HARBOUR-LINK TNT

THE 21st CENTURY TRANSPORT SYSTEM

Sydney's TNT Harbourlink Monorail is a rapid, quiet conveyance for passengers moving between the central city area and Darling Harbour. Frequent services flowing around the loop join the entertainment, convention and cultural facilities of the Darling Harbour redevelopment to the transportation links and attractions of the central business district. The TNT Harbourlink monorail begins an exciting era in rapid transit as passengers glide above street congestion, avoiding crowded city thoroughfares on their way to the festive atmosphere of Darling Harbour.

The sheer magnitude of Darling Harbour, Australia's premier urban redevelopment project, may be appreciated from the scenic route along which the monorail passes. Transforming fifty hectares of derelict industrial sites and railway sidings, the appealing new structures and open space areas have become a focal point for the city's leisure activities. Darling Harbour is an important feature of Sydney and the nation, a world-class example of architectural vision and a demonstration of the commitment and dedication of industry and government. As part of this achievement, the monorail utilises innovative engineering to integrate the various components of the Darling Harbour project into the fabric and function of the city. The TNT Harbourlink monorail allows the Darling Harbour project, and the many events continually taking place there, to be readily accessible to the city's visitors, and workers.

In its three and a half kilometre length, the monorail route passes through both inner Sydney and Darling Harbour, passing by some of Australia's finest historical architecture. Flanking the Queen Victoria Building on Market Street and the majestic Town Hall beyond, the monorail continues west, down Market Street crossing Cockle Bay on the historic and refurbished Pyrmont Bridge towards the Harbourside Festival Markets. From Harbourside, passengers are carried along the perimeter of Darling Harbour by way of the hotels and convention facilities to the city's Entertainment Centre complex and fascinating Chinatown, with its abundant fine restaurants. Several museums, beautiful gardens and a wide array of modern shopping centres are also easily within reach of the strategically-sited stations.

It is not only the quietness of the monorail that contributes to the serenity of Darling Harbour; employing the TNT Harbourlink monorail as the primary method of moving people about the area has enabled planners to leave large sections of the project as open space. Surface roads have been kept to a minimum. Broad avenues of palms conduct visitors to the various Darling Harbour venues along the spacious, brick-paved walks. Pedestrians are freed from competing traffic and as a result a safe, pleasant environment has been created for children and adults alike.

DESIGN FEATURES

With safety the leading design criterion for efficient operation, the monorail incorporates a series of self-checking, automated control systems. These allow the unmanned trains to maintain set separation distances being distributed approximately the same distance from each other around the 3.6km track. The frequency of trains is determined by the number of trains operating on the loop at any time. Initially, the system will use up to six trains simultaneously, which provides a service for passengers at each station approximately every two minutes. However, the original design permits the number of trains to be increased to as many as nine, which will increase system capacity by fifty percent. In periods of low passenger demand, trains will be withdrawn from service.

The comfort of passengers has dictated the use of wide doorways and large tinted anti-glare windows. All the stations have elevator or ramp access, allowing those disabled in wheelchairs unimpeded access to the system. Train floor level is self adjusting according to load by means of an automatic suspension system allowing the train floor to always align with the platform level. Quiet, pollution-free electric motors propel the monorail along the continuously welded track and, in order to further reduce noise, rubber wheels have been used for the drive wheels of the trains. The track has been fitted with expansion joints specially designed with sliding steel components to maintain a continuous smooth running surface.

The normal operating speed of the monorail is 33 km/h. To slow down, stop at each platform and accelerate back to the travelling speed can take less than forty seconds. The wide doors close after a prescribed interval, provided no passenger movement is detected in doorways. The doors in fact operate similarly to lift doors. On average, a complete round trip of the monorail circuit

takes twelve minutes and the capacity of the system, with six trains operating is 5000 passengers per hour.

The monorail trains run along a steel box girder with the top plate extended to a 940mm width, allowing a wide running surface for the rubber tyred drive wheels. These wheels also bear the mass of the train and are located between each of the cars and at both ends. The extension of the top plate beyond each side of the girder also provides a running surface for the upthrust wheels which restrict any vertical movement, while the sidethrust wheels, which prevent any lateral movement, bear on the vertical face of the box girder. The monorail is therefore securely held to the track throughout its length.

The track is raised to a minimum of 5.5m above the ground on steel columns set between 20m and 40m apart, with an average distance of 30m. The columns throughout the city area have been attractively designed with a reflective glass vertical insert. Planter boxes are located at the base of columns in traffic lanes to protect vehicle occupants in the event of accidental impact with the column.

Power is supplied to each train through sheathed conductor rails mounted below the running plate of the track. A control rail is also fitted which electronically informs each train of the separation distance to the train which preceded it. Each seven car monorail has six, 37kW DC, drive motors mounted above the drive wheels in the articulated section between each car. Each; DC motor is controlled through regulated conversion of the 500V AC supply, producing smooth, continuous acceleration and deceleration.

Central to the entire operation of the TNT Harbourlink monorail is the control and maintenance facility located between Convention and Haymarket stations on the western side of Darling Harbour. Here the trains are placed in and out of service from their storage tracks by a traverser — a special section of track which moves horizontally — bearing a whole train to the main track. At this facility the trains are cleaned and serviced. During inspection the train is placed on a track which supports the train on the vertical guide wheels, enabling the drive wheels to be examined. The trains are also stored when passenger demand declines during off-peak periods. In addition, the administrative offices and central control room, containing the computers and data communications equipment which supervises and monitors the functioning of the overall system, are located at this facility.

SYSTEM OPERATIONS

As trains are unmanned, the decisions regulating the normal safe operation of each train are carried out by a micro-processor based control system in the front car of each train. Unlike remote controlled craft, which are directly instructed by an operator, the monorail trains receive system status data which permits them to proceed as automatically programmed if safe operating conditions exist. The trains also have control panels which allow manual guidance of the trains when placing the trains in operation or during service maintenance.

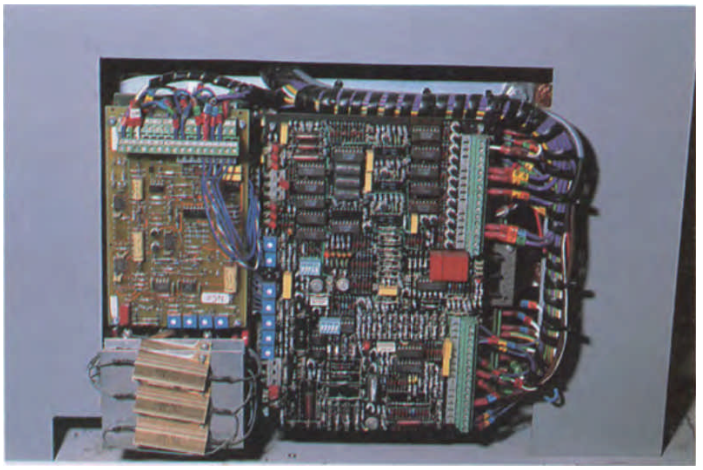
Under full computer control, the fail-safe needs of the monorail system require that every level of information collection, processing and communication is either duplicated or simultaneously checked by separate systems to ensure that safety is never compromised. At the central control room two main computers are linked in a master/standby relationship. Either machine may be started as master and while operating the standby stays in a back-up mode, its data base being regularly replenished by the master to ensure that it remains conversant with system conditions and able to assume full command within seconds, should any failure occur in the master computer.

Each monorail unit is able to carry out its own automatic control of speed, acceleration and deceleration and can also monitor and control its safety system. The equipment fitted consists of a series of computers and an autopilot controller. The two systems work together providing checks on each other and are fitted with standby systems in the event of failure of the working system.

The computer system comprises a main unit built into the nose cone which determines the monorail position by means of pulse counters. The system resets to zero at every station and is supplied with power from onboard batteries. Information on position is relayed to the central control room which in turn relays this information to other units on the loop so that each monorail is aware of its relative position. Further control computers are fitted to each carriage in the monorail unit to monitor and control drive motors, doors, lights and other systems. The main computer is preprogrammed with complete information on the position/distance/speed relationships of the loop.

The autopilot controller uses a control rail cut at intervals and joined by diodes to determine the monorail position by measuring the number of diode voltage drops between it and the unit in front. The autopilot can then regulate speed accordingly. Diode failure can be detected by the autopilot and in the event of a short circuit diode failures are detected by a station-to-station check circuit. Speed is monitored from a pulse generator fitted on the non-drive bogies at the front and rear of the monorail. Information is relayed back to the central control room. The autopilot will override the computer speed control if reference signals from the nondrive bogies indicate speed beyond tolerance.

The eight fully enclosed stations around the monorail loop each have their own individual computer to regulate token vending dispensers, turnstiles and lighting and to inform the master computer if objects are on the track or passenger lifts are inoperative. The central control room operator maintains surveillance



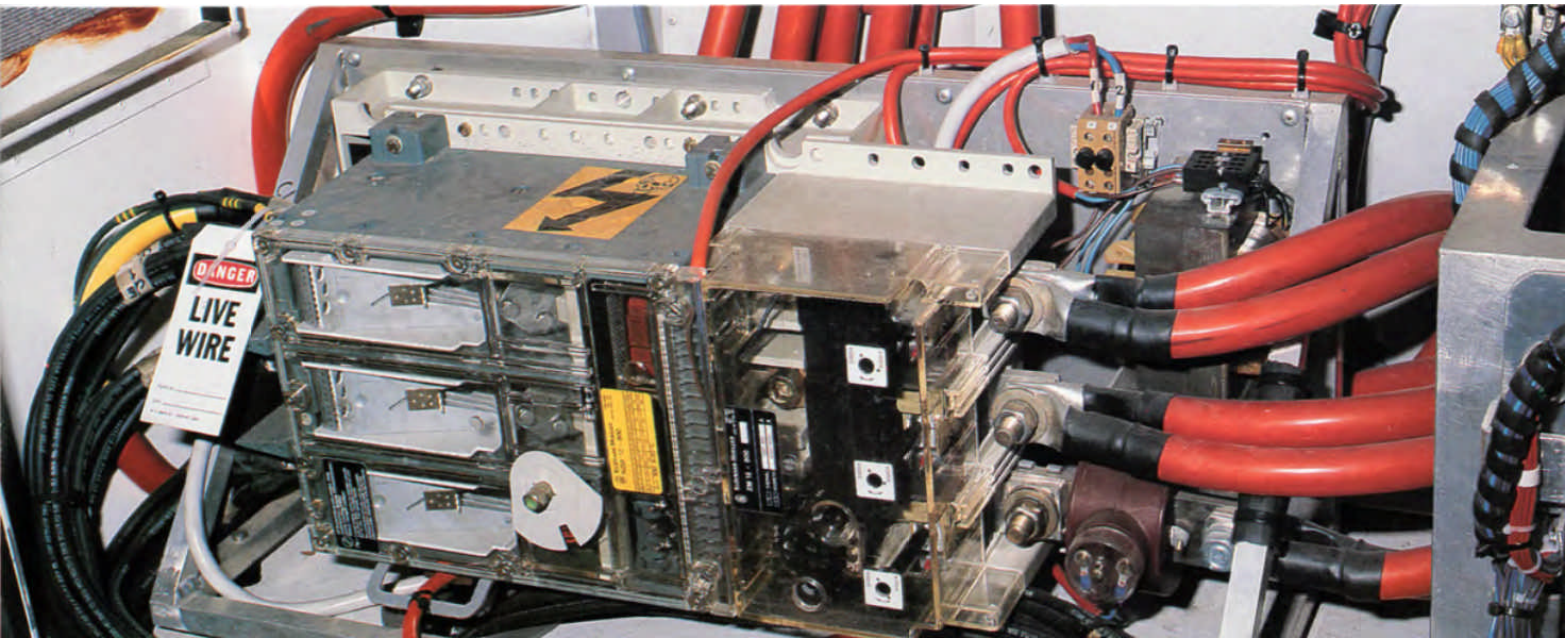
through closed circuit television cameras and may make public announcements.

A comprehensive closed circuit television surveillance system to all stations with monitoring from the central control room is installed. A multiplexed distortion-free voice communication is also fitted to all stations and monorail units with the intercom master provided in the central control room and submasters at each station.

A two way communication system is also provided to each carriage of the monorail unit.

Personnel will be allocated to conduct random security checks at stations, including ticket inspection.

The monorail system is planned to run from 6.00am to midnight, seven days a week although the hours may be extended in the future according to demand.




中國城
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TNT


ASTER-GENERAL'S DEPT
RESTAURANT

MAINTENANCE & STORAGE

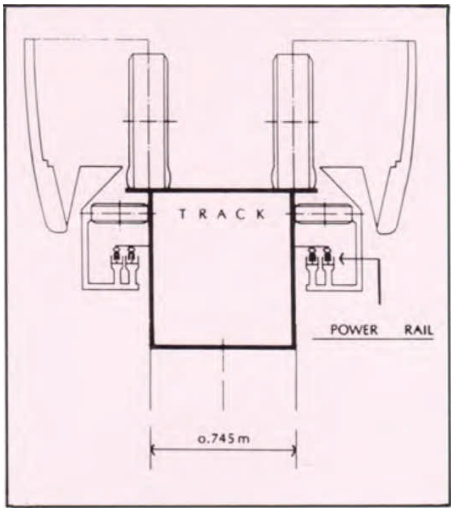
This facility is situated in Ultimo above the existing SRA railway alignment to Pyrmont. A traverser system is fitted to move monorails in and out of the main line, the traverser being able to align with five storage tracks, a car washing track and tracks for maintenance and inspection. Full workshops, administration and the central control room are located in this complex. The maintenance track is specially designed to allow the monorail to be run up and supported on the upthrust rollers, so allowing access to the drive bogies for maintenance purposes.

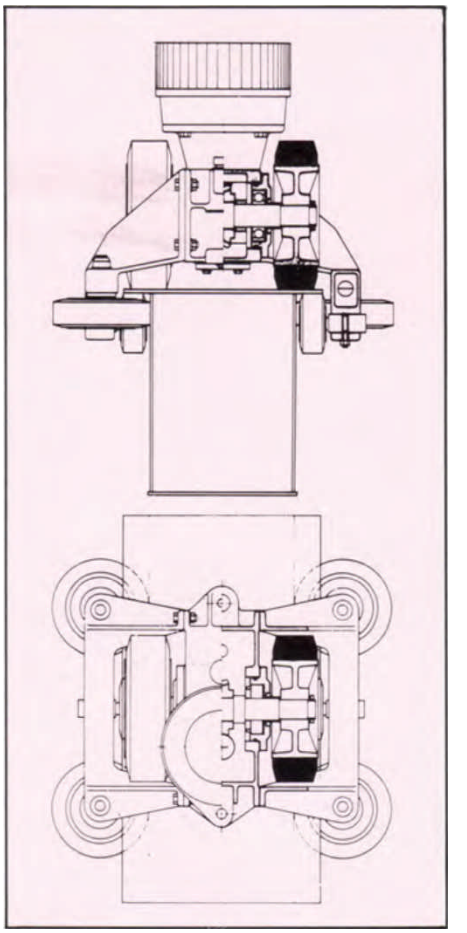
The traverser is, in fact, a double traverser; the working traverser described above delivers and retrieves the monorails from storage, whilst a through traverser maintains the main track allowing uninterrupted service.

Interlocking is provided to prevent a second monorail from entering the section incorporating the traverser until the traverser sequence is complete and all safety checks are satisfied.

General maintenance is carried out daily on each vehicle, checking such items as door operation, examination of lights and indicators, power supply controller, bogies and wheels and testing of automatic control systems and radio communications.

Every fourteen days vehicles will be subject to a more rigorous inspection where all drive motors, bogies and gear boxes will be checked, vehicles aligned, tyres and running gear inspected for wear as well as a detailed inspection of contactors, brushes and all electrical equipment and operation of emergency systems.





TECHNICAL DATA

Number of cars per vehicle	7
Total length of vehicle	32.12 metres
Overall width of vehicle	2.06 metres
Overall height of vehicle	2.6 metres
Height of door entrance	2 metres
Length of front and end car	5.55 metres
Length of middle car	4.12 metres
Vehicle capacity (normal)	130 passengers approx
Vehicle capacity (maximum)	170 passengers approx
Maximum seated per vehicle	56 passengers
Capacity per hour with 6 vehicles	3878 approx normal 5030 approx maximum
Capacity per hour with 9 vehicles	5817 approx normal 7500 approx maximum
Hours of operation	6.00am to midnight 7 days a week
Number of vehicles	6
Design maximum no. of vehicles	9
Maximum number of circuits per hour of one vehicle	5.05 approx
Average headway time (6 vehicles)	1.98 minutes
Average headway time (9 vehicles)	1.5 minutes
Rated speed	9.16 metres (second)
Assumed stopping time at stations	40 seconds (including acceleration and deceleration)
Security/communication	Full audio communication from each car to control room
No. of drive units per vehicle	6, located between cars
No. of bogies	total 8, (6 drive bogies and 2 lazy bogies). Each bogie is equipped with 2 riding wheels, 4 side thrust and 4 up-thrust wheels. The riding wheels are special 750mm diameter heavy duty pneumatic tyres fitted with a patented flat tyre protection rim.
No. of stations	8 (ultimately)
Platform length	27 metres

Ticketing	Fully automatic (under surveillance by central controller)
Entry to system	Via automatic turnstiles with separate provision for wheelchair and stroller access
Security	Closed circuit TV.System patrolled by Field Supervisors.
Track	
Rail type	Box girder fabricated steel
Rail size	832mm x 700mm (height x width) 940mm top flange
Spans	30m on straights (nominal) 23m in curves (nominal)
Support columns	690 x 125 UB (typical) rolled steel (i.e. 690mm flange to flange, 250mm wide, Universal Beam section weighing 125 kg/m)
Minimum radius of curves	20m (reduced speed 5.5 m/sec)
Maximum gradients	4.4% up 6.6% down.
Track security	Sensors on selected columns to detect any column misalignment
Maintenance Facilities	Include vehicle storage washing and cleaning, full maintenance facilities, administration and control room.
No. of traversers	1 with 2 beams to install and remove vehicles from service
Power Supply	
Supply	500 V AC 3 wire/50 Hertz
No. of feeding points	8
No. of conductor rails	2+1 earth using up-thrust collectors
Feeder capacity	each 700 KVA approx.
Emergency generator	Used in the event of a power failure to clear vehicles from the track—400 kVA located at Maintenance Facilities

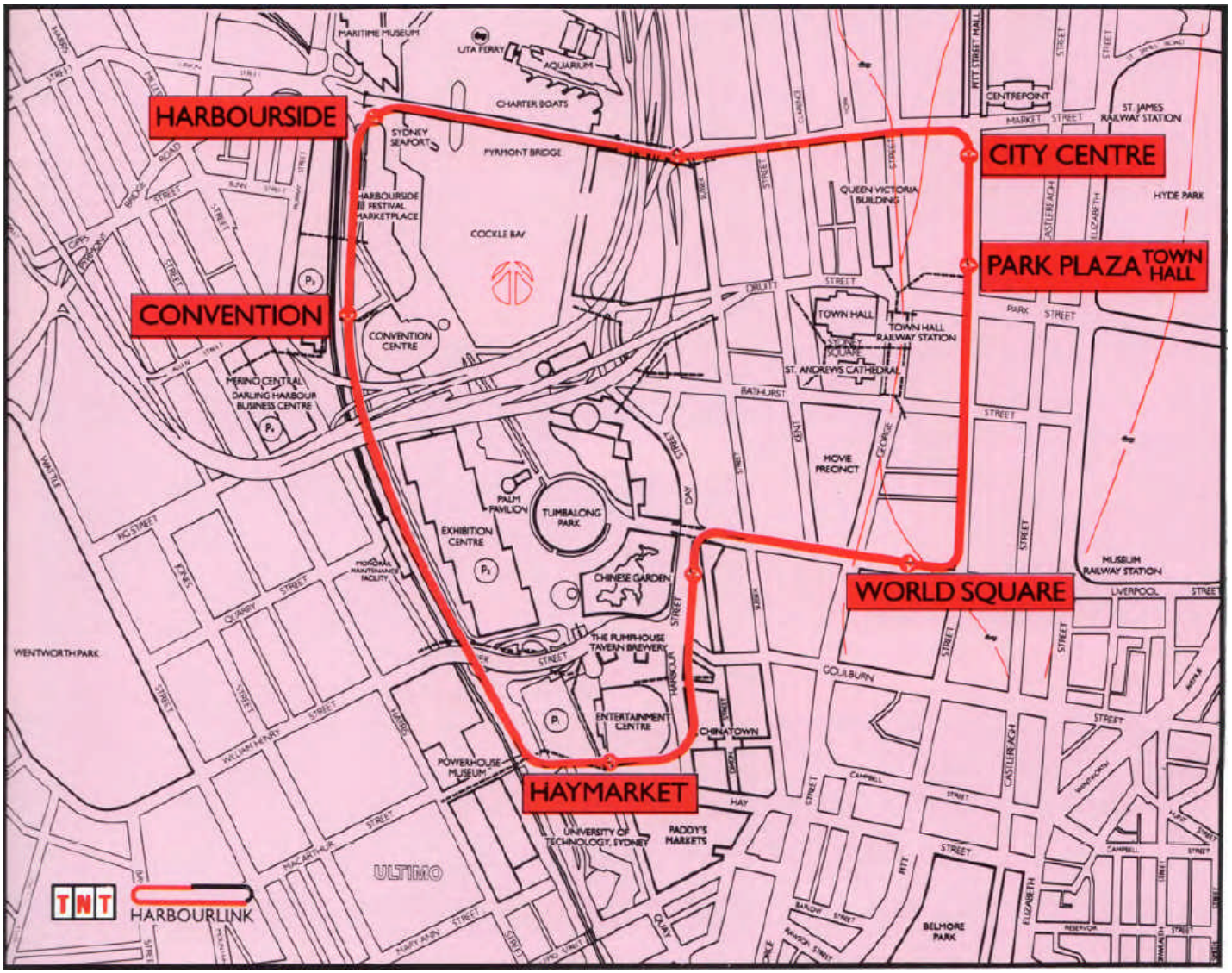
CROSSING PYRMONT BRIDGE

One of the unique features of Sydney's monorail system is that the track passes over the historic Pyrmont Bridge, the track structure utilizing the unique span feature of the bridge, which has been restored to its 19th Century splendour as part of the Darling Harbour redevelopment.

The central pivoting section of the bridge will still be operable to allow the passage of vessels into and out of the section of Darling Harbour south of the bridge. For the passage of small vessels up to 15m mast height, the monorail track will remain unbroken by the provision of a specially designed pivot column located in the centre of the bridge swing span. For the passage of larger vessels the monorail track will swing with the bridge swing span, thus temporarily interrupting the service.

An interlocking system is provided within the control system which closes and stops all monorails after various safety checks are made, including bringing all monorails into stations, isolating power from the monorail track and unlocking the swinging section of the monorail beam.

TNT HARBOURLINK MONORAIL ROUTE



AROUND THE TRACK

Joining the heart of Sydney with the Darling Harbour complex of exhibition halls, museums, hotels, shopping and entertainment facilities stretching from historic Chinatown along the shores of Darling Harbour, the TNT Harbourlink plays a vital role in maintaining a pleasant ambience — an urban environment uncluttered by road traffic and congestion in Darling Harbour.

Sydney's central retail blocks, public trains and buses, major car parks and all the happenings at Darling Harbour are only a few minutes apart by monorail. Passengers generated by the significant attractions are an important part of the flow of people moving about the city and in servicing this need the monorail provides Sydney's visitors and locals with a fast, modern transportation system.

The frequent monorail service offers a scenic, unhindered ride through the city and Darling Harbour and the inner areas that surround Darling Harbour. Each of the eight station has its own points of interest. The map shows the route of the monorail and the places of interest served by each station.

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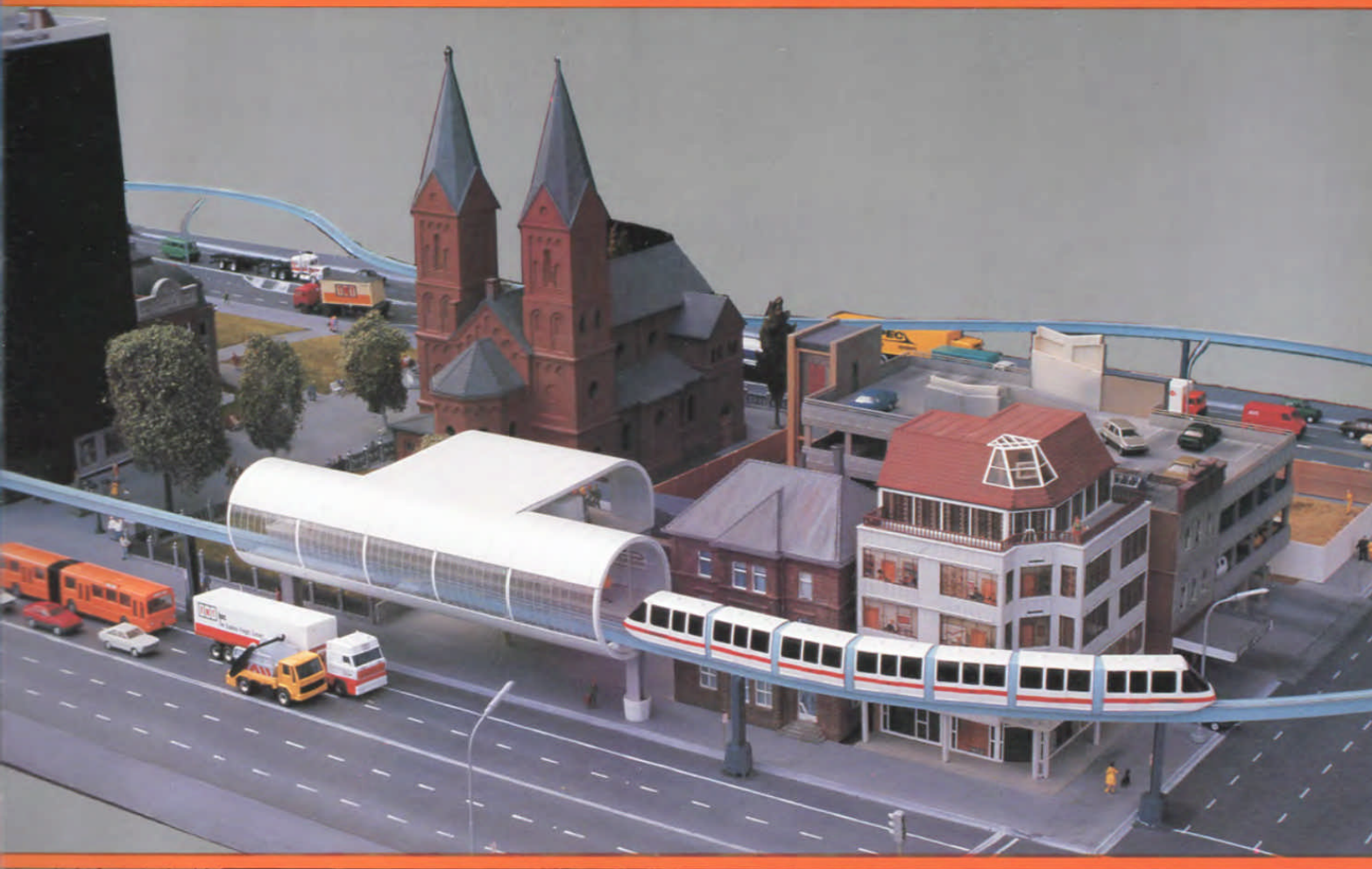
YOU'VE SEEN THE REAL THING.

NOW YOU CAN TAKE ONE HOME!

TNT HarbourLink have released an HO scale model of the Sydney Darling Harbour Monorail. The model has been designed and manufactured in Australia by A R Kit Co.

This is the only commercially available model of a monorail in the world. A first for Australia!



THE MODEL SHOWN RUNNING AT THE 1988 INTERNATIONAL TOY, HOBBY AND LEISURE FAIR IN SYDNEY.

The model in quality ABS injection moulded plastic is offered in a packaged set consisting of a fully assembled 12V DC electrically powered 7 car set, modelled faithfully on the type running on the Sydney Darling Harbour System. The packaged set also contains an oval of elevated track, again modelled on the Sydney Darling Harbour type, together with a transformer and basic accessories.

The monorail set is produced in limited quantities available from Harbourlink Kiosks at a recommended retail selling price of $189.95.

TNT HARBOURLINK

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