

**StateRail**

**State Rail Authority of New South Wales**



**Contract N°: C03005**  
**Design and Build**  
**New Outer Suburban Cars**

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**Part D – Technical Specification**  
**(Appendices)**

**Volume 4 of 4**

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# Design and Build New Outer Suburban Cars

Contract C03005

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Design and Build New  
Outer Suburban Cars

Contract C03005

Part D  
Technical Specification  
(Appendices)  
Volume 4 of 4

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## **TECHNICAL SPECIFICATION (APPENDICES)**

### **APPENDIX A - SIGNAL SYSTEM**

#### **1 General**

The OSC must operate satisfactorily with the RIC signaling infrastructure. The Contractor must develop compatibility parameters to ensure satisfactory operation of existing signalling systems as used by the Principal. These parameters must be submitted for review by the Principal.

#### **2 Signalling Systems**

Operation of the OSC must not under any circumstances disrupt the normal operation of the existing signalling systems used by the RIC on electrified lines. The existing signalling systems are:

- a) 50 Hz a.c. double and single rail track circuits.
- b) CSEE modulated audio frequency track circuits operating at 1700 Hz, 2000 Hz, 2300 Hz and 2600 Hz.
- c) Jeumont - Schneider impulse track circuits.
- d) Audio frequency track circuits complying with British Railways Board Specifications and operating at identical frequencies to the CSEE circuits above.
- e) The Contractor must prove to the satisfaction of the Principal and RIC that the OSC fully comply with the compatibility requirements of the above signalling equipment, as determined by them in consultation with the manufacturers of the equipment.

#### **3 Interference Tests**

Type tests must be conducted using one and two OSC sets to measure vehicle generated disturbance effects in signalling track circuits, telecommunication cables and lineside telecommunications systems.

The tests indicated below are the minimum required for acceptance testing and may be varied at the discretion of the Principal.

The Contractor must provide a detailed test specification and programme for the interference testing including method of analysis, track possessions required etc. It must be noted that in order to eliminate the possibility of unsafe working and unknown variables, testing shall require full possession of large sections of track at times which cause the minimum disruption to normal services.

The locations and operating methods for the tests will be chosen to produce the worst case interference levels. Those indicated below may be used as a guide.

##### **3.1 Tests on Vehicles**

Tests must be carried out to confirm the nature of the harmonic spectrum associated with the traction unit and auxiliary power supply and other onboard systems.

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This refers to vehicle generated a.c. components, rectifier equipment, a.c. components and low frequency surges associated with input filter charging and discharging.

The ripple current and voltage will be recorded as the OSC operates in motoring and braking through typically supplied power sections. A.C. ripple measurements will be made as the OSC is operated close to each type of substation used by the Principal. The following sites are suggested:

- a) Blacktown - Emu Plains
- b) Hornsby - St Leonards
- c) Hurstville - Meeks Road
- d) Caringbah

The results of the above tests will be processed by an FFT analyser such that the harmonic spectrum is made available, for a complete power-brake run, for each type of substation.

### **3.2 Tests on Jeumont-Schneider Track Circuit**

Tests will be carried out to establish whether the Jeumont-Schneider (J-S) track circuit can be disturbed, in either a right-side or a wrong-side sense, by the operation of the OSC. In particular tests will be undertaken to investigate the effect of:

- a) steady-state conductive interference in an occupied track circuit,
- b) steady-state conductive interference in a track circuit which is not occupied,
- c) transient interference effects and direct magnetic coupling in occupied track circuit, and
- d) transient interference effects in a track circuit which is not occupied.

For all tests the voltage at the track circuit receiver connections will be recorded. In addition a relay movement detector will be set up using the 'up' and 'down' contacts of the relay. The electrical signals from this circuit, which correspond to 'up' and 'down' will also be recorded.

Recordings will be processed using an FFT analyser to confirm that the in-band spectrum produced by the OSC could not cause a false operation of the track relay.

### **3.3 Tests on Westinghouse Double Rail Track Circuit**

Tests will be carried out to establish whether the AC track relay can be disturbed, in either a right-side or a wrong-side sense, by the operation of the OSC.

Tests will be undertaken with normal balanced conditions and the following broken rail conditions:

- a) A Broken rail condition that isolates one rail, but leaves the relay connected across the complete bond.
- b) A broken rail condition where the relay coil connections were taken to the rails, whilst one of the bond to rail connections becomes disconnected.

For all tests the magnitude and phase with respect to the relay local supply of the current in the coil of the track relay which is connected to the track, will be measured. In addition signals representing the state of the 'back' and 'front' contacts will be measured.

Recordings will be processed using an FFT analyser to confirm that the in-band spectrum produced by the OSC could not cause a false operation of the track relay.

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### **3.4 Tests on Single Rail Track Circuits**

Tests will be conducted to establish whether the VTI relay operating in a single rail track circuit can be disturbed by the operation of the OSC, generally as described for the double rail track circuit in Clause 3.3.

### **3.5 Tests on CSEE Rail Track Circuit**

Tests must be carried out to confirm that the UM71 track circuit cannot be disturbed by the OSC in either a wrong-side or a right-side sense.

For all tests the voltage at the track receiver will be measured. In addition, the relay contacts will be monitored as specified in Clause 3.3 above.

The results will be processed using a frequency sensitive voltmeter for each particular carrier frequency. A general assessment will be processed using an FFT analyser.

A check will be made to ensure that the in-band traction generated signals are generally smaller than the minimum to operate levels for the appropriate carrier. If the carrier levels exceed the minimum to operate levels, then further processing will be required to check the possible generation of frequency modulated coding.

## **4 Signalling And Communications Equipment**

A brief description of the relevant features of the RIC signalling and communications infrastructure system follows.

### **4.1 Power Cables (Parallel to Track)**

Signalling power distribution is generally at 120V a.c. nominal with some 50V d.c. mains. Cable sizes vary from 4 mm<sup>2</sup> to 70 mm<sup>2</sup> depending on loading and voltage drop and the feeders may be open wire line, or cable installed in ducting or troughing, or buried. Cable runs are generally parallel to the lines, at any convenient position between the railway boundaries.

Power distribution cables are generally not screened, and where a metallic termite barrier is provided, this is not normally connected to earth.

### **4.2 Signalling Circuits (Parallel to Track)**

Signalling circuits may be run in multicore cable installed in ducting or troughing, aerial or buried; in individual conductors installed in ducting or troughing; or in open wire line.

Circuits in multicore cable operate generally at 50V d.c., double switched, not a.c. immunised. Conductors are normally 1/.064" or 7/0.50 mm singles (not balanced pairs or quads). On the suburban lines, audio frequency tract transmitters and receivers are connected to trackside equipment by up to 1500 m or single pair 7/0.50 mm aluminium foil screened cable, laid in trackside ducts and troughing.

Circuits in individual conductors operate generally at 120V 50 Hz, single switched with common return, over distances up to 1000 m. Conductor size is 1/.064" or 1/1.70 mm.

The relatively few remaining open-wire signalling circuits in electrical traction areas may operate at various voltages between 10V and 120V DC, or 120V 50 Hz.

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Cable and linewire routes run generally parallel to the tracks, at any convenient position between the railway boundaries. Signalling cables are not screened, although a metallic tape termite barrier is incorporated.

### **4.3 Communications Circuits**

Frequencies in use range from DC to 300 kHz.

#### **4.3.1 Cables**

- (a) Trunk, Junction and Local type cables Quad construction, with system screening factors of between 0.04 and 1 at 800 Hz with most cables having a system screen factor of 1.

For use mainly in DC to VF range. Balance of cable and equipment generally 40 dB, however in older cables and plastic non-gassed cables that have been subject to the ingress of moisture, the balance may be worse.

- (b) Carrier and Coaxial Cable

Carrier cable is of quad construction for use in the frequency range 6 kHz - 150 kHz. Screening factor is similar to above.

Coaxial cable is used with systems operating in the range 60 kHz - 1500 kHz. In most cases no electromagnetic screening is applied to this cable.

All types of cable can be located anywhere within the Railway easement and often located in troughing close to the rails.

In the metropolitan area of Sydney, many of the cable routes are above ground in troughing and drawings are not available. Cable route plans of buried cables are available if required. However, these are not necessarily typical. Locations of routes vary in all respects possible, from routes parallel to six line suburban tract at the boundary fence line or between tracks, buried and elevated and at times on both sides of the railway easement.

Cable types vary from lead sheathed tape and wire armoured to solid polythene insulated and sheathed with copper tape. A large percentage of cables have a screening factor close to unity due to inadequate earthing or screening material. The critical case is related to cable installations in which a reduction of screening factor cannot be achieved due to inadequate screening materials. This type of cable exists on a number of main line routes.

### **4.4 Railway Telephone and Radio Systems**

The frequency spectrum from V.F. to 108 kHz is used on all routes. There is also an increase in digital data on most routes. Train working and emergency telephones are used in tunnels e.g. City Circle and Eastern Suburbs and the transmission circuit is single twisted pairs in trough or conduit.

Present planning on new works adopts CCITT standards. Specifications for equipment are similar to Telecom Specifications.

### **4.5 Telemetry and Remote Control**

A variety of signalling remote control and indication systems are in use in lines around Sydney currently electrified or proposed for electrification; their uses, types and details are listed below:

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Application	Location	Mode	Manufacturer	Model	Frequencies	Module
Indication	Erskineville - Strathfield	FDM	RFL	6850	400-3500AM	AM
Indication	Liverpool - Campbelltown	TDM	Teknis16/32	TRCS/	3000	FSK
Control and Indication	Sutherland - Gymea	TDM	Teknis*	1500,2220 2940,3660		FSK
Control and Indication	Riverwood - Revesby	TDM	Teknis*	1500,2220 2940,3660		FSK
Control and Indication	Blacktown - Quakers Hill	TDM	Cutler-Hammer	2460,3060	Phase	
Indication	Lithgow - Zig Zag	TDM	Cutler-Hammer	4800,7200	Phase	
Indication	Mt Victoria - Hartley Vale	TDM	Cutler-Hammer	3600,6000		FSK
Indication	Hornsby - Thornleigh	TDM	Cutler-Hammer	4200,6000		FSK
Indication	Hornsby - Berowra	TDM	Cutler-Hammer	4200,2400		FSK
Indication	Eastern Suburbs Railway	TDM	Ericsson	JSA700	1200	FSK
Indication	Awaba - Broadmeadow	TDM	Ericsson	JSA700		
Indication	City Circle - Redfern	TDM	Westinghouse	S1		FSK
Substation supervisory control	Full electrified area	TDM	Leeds and Northrup	1200,2200		FSK
* These are to CCITT Specification						

**Table 4.5**  
**Signalling Remote Control And Indication Systems.**

Information is transmitted through both communications type cable and aerial lines located at various distances from and running parallel to the overhead traction wires and the track.

## APPENDIX B - WASHPLANT FACILITIES

### Washplant Facility Details.

CityRail operates a washplant facility at each of its three Maintenance Centres to clean the car exterior sides and part of the roof area.. Details of the washplant facilities are as follows:

Propulsion Method	Remote towed, Train towed or Driven
Maximum Track Grade	1.961%(Refer drawings: 160-615, 153-455, 157-740)
<b>WASH PARAMETERS:</b>	
Train Washing Speed	3km/hr
Detergent application arch	
Spray Nozzle Brand	Spraying Systems Company
Nozzle Type/Size	H 1/4 U.SS.4008
Nozzle angle	40 degree V - jet
Nozzle flow	4 to 5 litres per minute
Nozzle quantity	9 per side (Total 18)
Spray Pressure	7 bar (100 psi)
Brush Diameter	833 mm
Brush Material	Polypropylene
Detergent Active ingredient	Oxalic Acid
Current Supplier ( March 1998)	Applied Chemicals No. 2-544,
Concentration Target	Between 5% and 15%
<b>RINSE PARAMETERS:</b>	
Train Rinsing Speed	3 km/hr
Spray Nozzle Brand	Spraying Systems Company
Nozzle Type/Size	H 1/4 U.SS.5030 to H 1/4 U.SS.5050
Nozzle angle	40 degrees
Nozzle flow (total arch)	1250 to 1600 litres per minute
Nozzle quantity	26 per side (Total 52)
Spray Pressure	7 bar (100 psi)
Rinse agent	Fresh tap water

The SRA also use a foam acid application method having the following characteristics

Nozzle angle	80 degree V - Jet
Operating pressure	25 to 30 psi
Flow to foam arch	30 to 40 litres/min

## APPENDIX C - LIGHTNING STRIKES

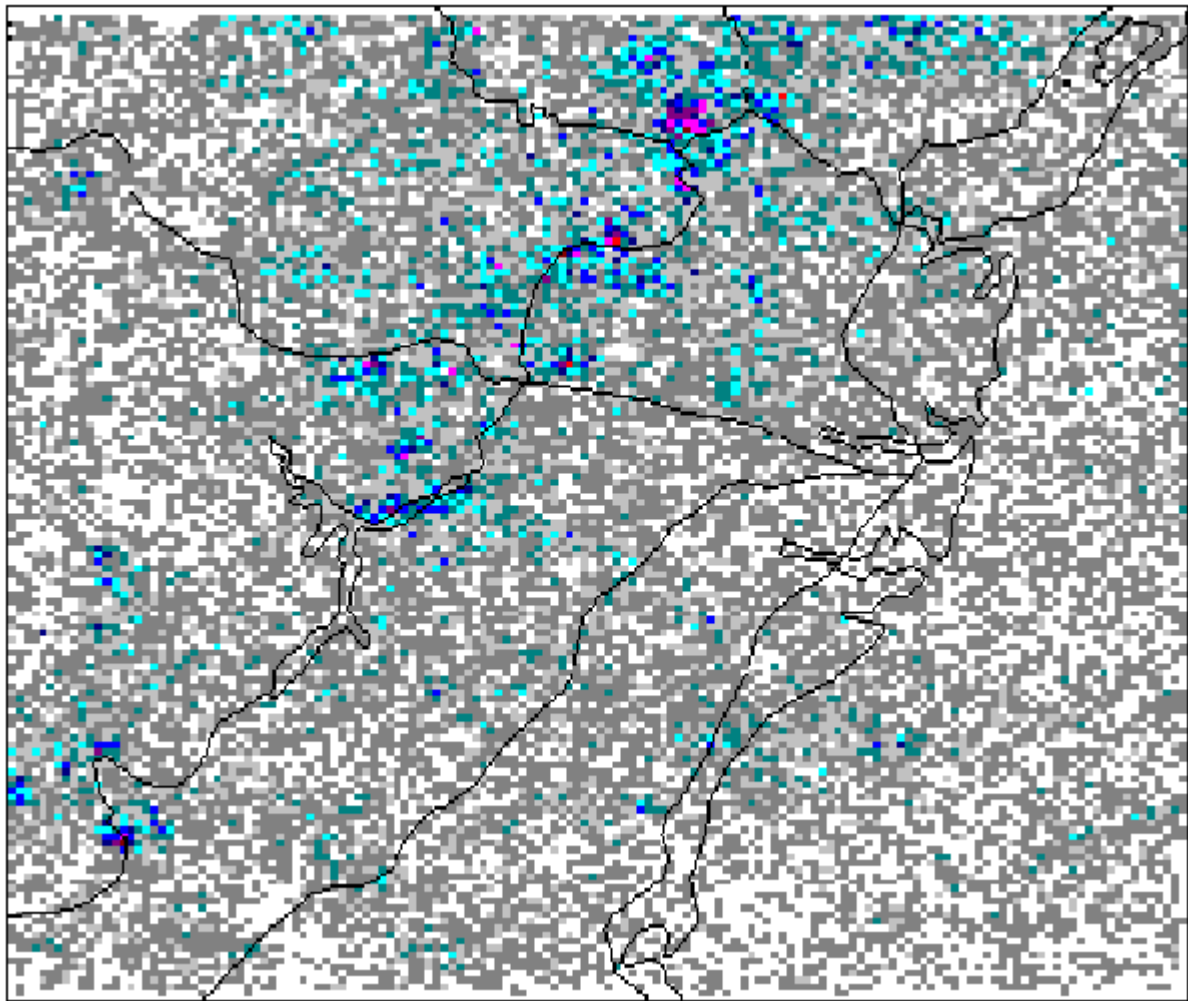
The following data applies to the Sydney Metropolitan area bounded by Bondi Junction; Wyong; Springwood and Port Kembla (Latitude S33.2541 to S34.039 and Longitude E149.9491 to E151.5889) a 150 km square area. The period for the data is from 01 January, 1992 to 28 February, 1997. The data was provided by Katron Lightning Data Service, P.O. Box 109 Ourimbah, NSW 2258.

Graphs 1, 2 and 3 provide geographical distribution verses frequency for ground strokes of amplitude exceeding 0 kAmps. Each box point represents a 1 km square area. The reference key provides the colour corresponding to each frequency of occurrence within each box point. The three graphs cover Positive, Negative and All ground strokes respectively.

Graph 4 provides frequency of occurrence (No. of Strokes) verses amplitude (kAmps) for the entire area. The four plots are Negative First, Negative Subsequent, Positive First and Positive Subsequent. The criteria for selection of a Subsequent Stroke was based on a stroke which occurred within 500 milliseconds of the First Stroke and in a 10 km square area around the First Stroke. Table 1 provides the data used to generate Graph 4.

Peak current (kA)	Negative First	Negative Subsequent	Positive First	Positive Subsequent
1000				
1300				
1600				
2000				
2600	7			
3200				
4000	676	374	1047	157
5000	959	742	1945	320
6300	1241	1273	2726	389
8000	3777	4245	7259	1031
10000	9592	11107	9509	1295
12600	10610	12621	5189	657
15900	12317	14106	3051	409
20000	13905	15588	1659	212
25100	9437	9582	753	96
31600	8067	6919	604	51
39900	6072	4098	562	50
50200	3403	1716	387	35
63100	1806	615	341	33
79400	847	187	249	20
100000	286	56	116	13
125900	78	8	67	6
158500	29	8	17	
199500	12	1	8	
Totals	83121	83246	35489	4774

**Table 1**  
**Amplitude Statistics**



Latitude - 33.2541 to -34.6039,

Longitude 151.5889 to 149.9491

Box size: 1 x 1

Total: 39592

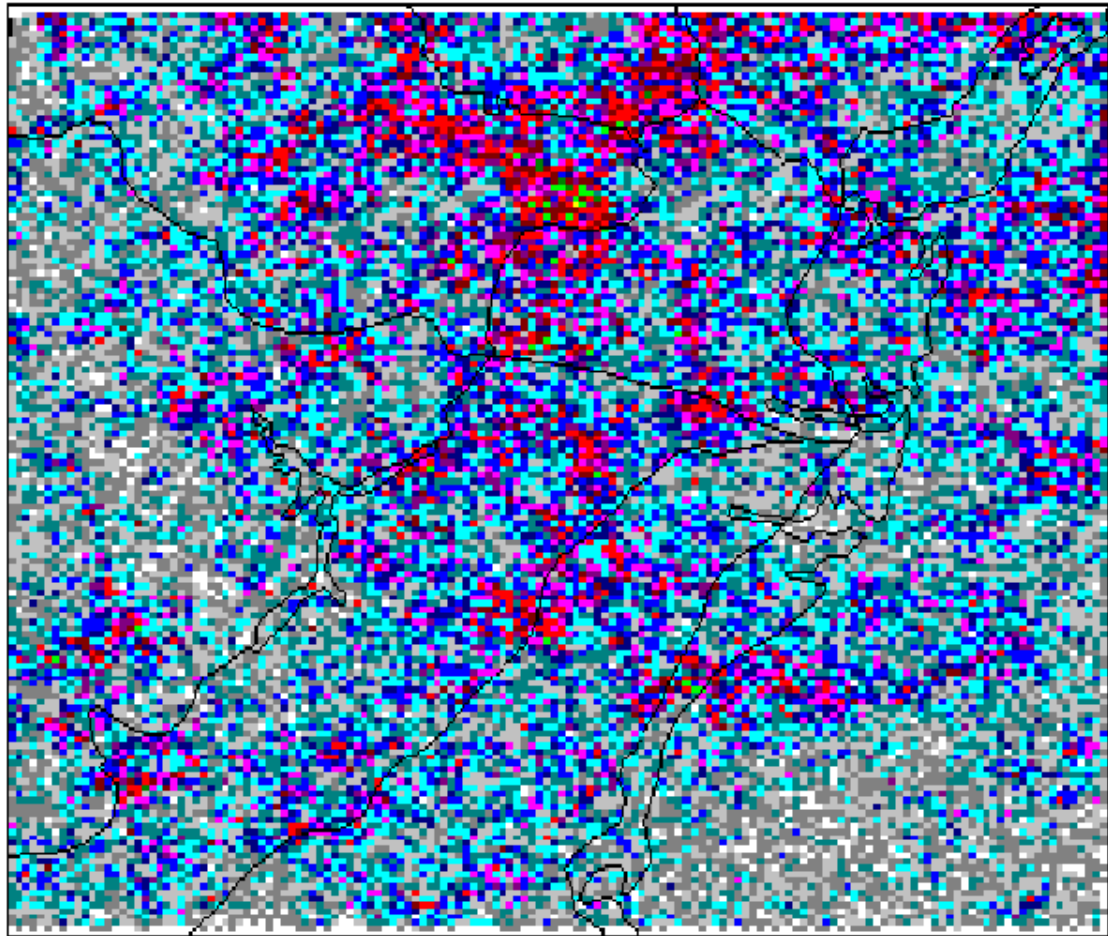
Stroke Type: Positive

Current Limit: Above 0 kAmp

Period: 1/1/92 to 20/2/97



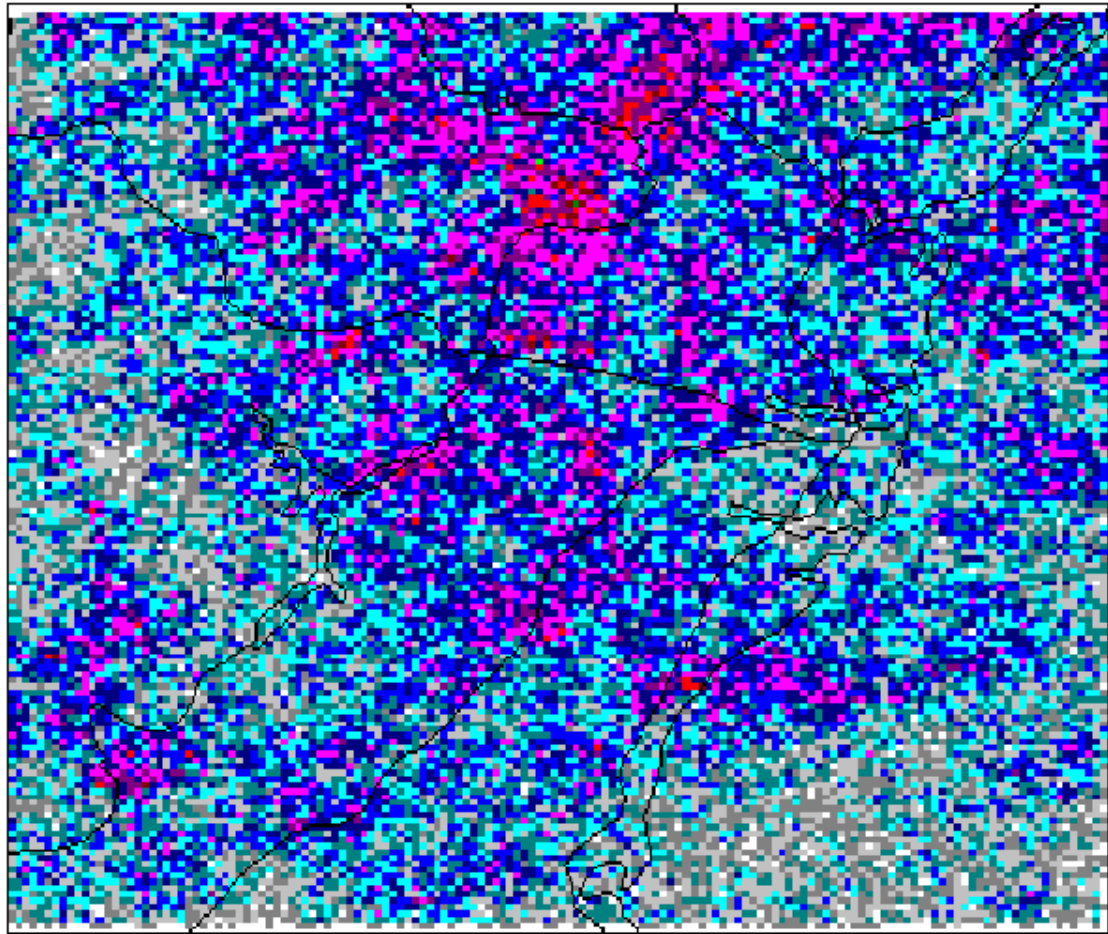
**Figure 1.**  
**Positive Strikes in the Period 1 January 1992 to 20 February 1997.**



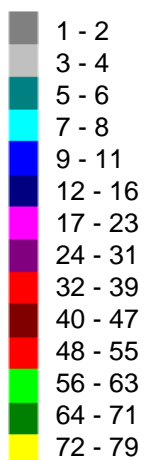
Latitude - 33.2541 to -34.6039, Longitude 151.5889 to 149.9491  
Box size: 1 x 1 Total: 163962  
Stroke Type: Negative Current Limit: Above 0 kAmp  
Period: 1/1/92 to 20/2/97



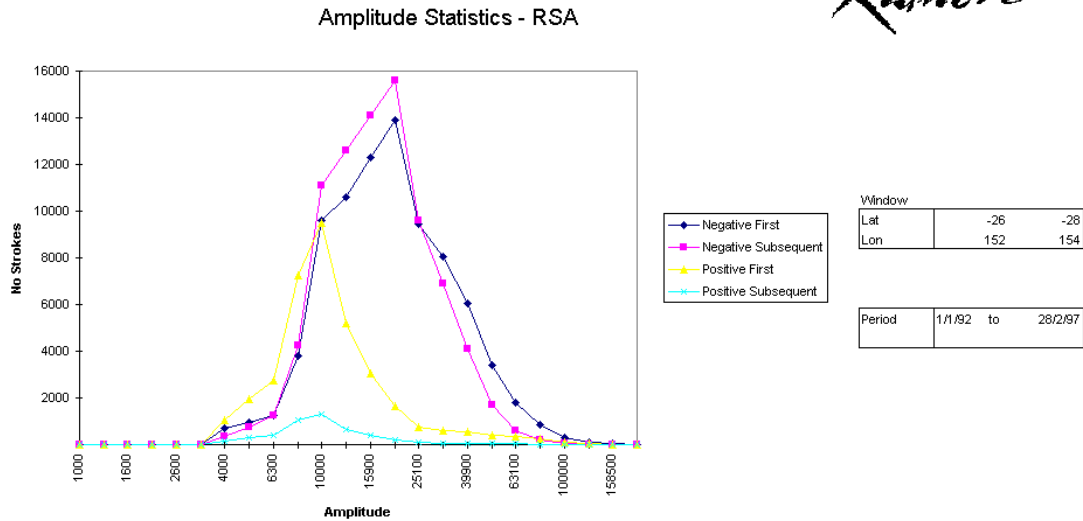
**Figure 2.**  
**Negative Strikes in the Period 1 January 1992 to 20 February 1997.**



Latitude - 33.2541 to -34.6039, Longitude 151.5889 to 149.9491  
Box size: 1 x 1 Total: 203554  
Stroke Type: All Ground Current Limit: Above 0 kAmp  
Period: 1/1/92 to 20/2/97



**Figure 3.**  
**All Ground Strikes in the Period 1 January 1992 to 20 February 1997.**



NOTE: The Lightning Data is copyright and the property of Katron and may not be copied or distributed in any form without the express permission of Katron.  
 Katron Lightning Data P.O. Box 109 OURIMBAH N.S.W. 2258 Phone/Fax 043 89 2024

RSA-amp.XLS

**Figure 4.**  
**Frequency Distribution of Strike Amplitude, for the Period 1 January 1992 to 20 February 1997.**

**APPENDIX D - STATION LIGHTING AND SIGNAGE**

**1. Recommended Lighting Levels**

Location	Basic Access LIGHTING LEVEL (Lux)	Easy Access LIGHTING LEVEL (Lux)
External Approaches Arrival and Departure (Covered Areas)	85	85
Commuter Car Parking Car Parks (CityRail, Council & Others)	min. average 3.5 min. illuminance 10	min. average 5.0 min. illuminance 1.0
Entrance Halls Covered Halls, Entrance Doorways	15-75	100-150
Vertical Transport Lift Cars Lift Control		150 min. 400 (illuminated buttons)
Stairs/Ramps uncovered covered	50 50	50 100
Ticket Sales Areas	200	200
Platform Underground Open Covered (awning) Blue Light Zone	80-100 30 50 40-85	80-150 see note 3 85 85
Passenger Facilities Waiting Room Telephones	200 as per Telecom Standards	200 accessible phone 200
Toilets	200	200

Note: These recommended light levels are to be read in conjunction with Notes 1, 2 & 3

**NOTE:**

- (1) The above minimum levels may be varied to cater for specific locations and operational requirements.
- (2) The following underground stations are not included as Easy Access Stations: Central, Town Hall, Wynyard, St James, Museum, Bondi Junction, Edgecliff, Kings Cross, Martin Place, Redfern ESR.
- (3) The normally open platform lighting level is to be increased by 25-50 lux when required for special purposes, e.g. the area for a wheel chair ramp.

## 2. Station Signage

There are nine types of fixed station signs in usage and one type of electronic destination indicator, defined by the drawings listed in the following table and included overleaf:

ITEM	TITLE	DRAWING NUMBER
2.1	Station Seat with station name	A89C81
2.2	Station Sign type 'C' Graphics	A89C61
2.3	Station Sign type 'H', bracketed Platform No.	A89C72(A)
2.4	Station Sign type B(i), General Face to approach end	A89C57
2.5	Station Sign type B(i), General Face to departure end	A89C58
2.6	Station Sign type 'B' sizes	A89C52
2.7	Station Sign type 'B' General	A89C53
2.8	Station Sign type 'A' General	A89C47
2.9	Station Sign type 'A' sizes	A89C48
2.10	T4 Platform Indicator Face Plate Graphics Dimensions	D0120

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## APPENDIX E - ENERGY CONSUMPTION

### 1. Time-based Energy Consumption/ Regeneration

Equipment	Energy consumption / regeneration (kWh/Set/h)	Comments	Reference
Traction			
Electric brake			
Mechanical brake			
Mechanical Auxiliary Supply			
Electrical Auxiliary Supply			
Climate Control Subsystem			
NET TOTAL			

### 2. Distance-based Energy Consumption/ Regeneration

Equipment	Energy consumption / regeneration (kWh/Set/km)	Comments	Reference
Traction			
Electric brake			
Mechanical brake			
Mechanical Auxiliary Supply			
Electrical Auxiliary Supply			
Climate Control Subsystem			
TOTAL			

The runs to be used in the calculation of energy consumption must be the Bankstown circle all stations both directions and the Central-Penrith return.

The energy consumption must include the net traction energy and the auxiliary energy consumption based on the stated duty cycle in Clause 3.1.6.

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**APPENDIX F - SUNRISE AND SUNSET TIMES**

The following table provides the Eastern Summer Time (shaded) or Eastern Standard Time (unshaded) of sunrise/sunset and civil twilight for Sydney at 14 day intervals. The data is provided for 1997; times for other years are similar within one or two minutes. Eastern Standard Time is based on the 150th meridian. During daylight saving (shaded) Eastern Summer Time is 1 hour ahead of Eastern Standard Time though the start and finish dates may vary.

Month	Day	Sun		Twilight	
		Rise	Set	Starts	Ends
January	1	05 48	20 09	05 19	20 38
	15	06 00	20 09	05 31	20 37
	29	06 13	20 03	05 46	20 30
February	5	06 20	19 57	05 53	20 24
	19	06 34	19 44	06 08	20 10
March	5	06 46	19 27	06 21	19 52
	19	06 57	19 08	06 32	19 33
April	2	06 08	17 49	05 43	18 14
	16	06 18	17 31	05 53	17 57
	30	06 29	17 16	06 03	17 41
May	14	06 39	17 03	06 13	17 30
	28	06 49	16 56	06 22	17 23
June	11	06 57	16 53	06 29	17 20
	25	07 01	16 55	06 33	17 22
July	9	07 00	17 01	06 33	17 28
	23	06 54	17 09	06 27	17 36
August	6	06 44	17 19	06 17	17 45
	20	06 29	17 29	06 03	17 54
September	3	06 11	17 38	05 46	18 03
	17	05 52	17 48	05 27	18 13
October	1	05 33	17 58	05 08	18 23
	15	05 14	18 08	04 49	18 34
	29	05 58	19 20	05 32	19 46

## **APPENDIX G - FINITE ELEMENT AND FATIGUE LIFE ANALYSES**

1. For the component to be analysed, a computer-based Finite Element Analysis (FEA) must use beam, plate, brick elements and contact elements where appropriate to accurately model the physical structure of the component and appropriately model details such as welds.
  2. For all FEA software used in design analysis, benchmarking information must be provided.
  3. For each component analysed, a FEA Report must contain data to fully define the model used for analysis.
  4. The FEA report must include model definition data, such as:-
    - Solution options
    - Units definition
    - Material property tables
    - Element properties for the types of elements used (ie beam, plate, brick etc)
    - Load case data
    - Load combination data
    - General solution data
    - Process warning reports
  5. The FEA report must include calculations for the following:-
    - Beam element properties
    - Equivalent nodal loads
    - Pressure loads: Normal
    - Tangential (friction)
    - Inertia reactions
  6. The report must also contain verification calculations, using engineering equations in a manual checking area of the model to verify model stresses due to various loading conditions.
  7. The report must include full isometric plots of the mesh used, covering:-
    - Plot of elements
    - Plot of elements, loads and constrained nodes
  8. The report must contain a comparison of calculated loads and the summation of all loads case/combination nodal reactions (ie sum of model global forces and moments).
  9. The report must contain deformed shape plots of the whole model at an appropriate exaggeration factor.
  10. Convergence testing must be carried out in high stress areas to confirm model accuracy.
-

11. Evidence of convergence testing must be provided. The model is deemed to have converged if maximum stress difference is less than or equal to 5% between convergence iterations.
  12. All stress contour plots must identify the stress concentrations and the levels of stress at the location.
  13. Stress concentrations must not be obscured by other elements and contours must be generated for all elements and nodes. Masking is not permitted, unless agreed that the area is unimportant.
  14. All stress concentrations must be identified and reasons for non consideration of these as part of the analysis must be provided.
  15. Information provided on stress analysis regions must be in addition to all other information requested.
  16. The report must contain the following full model stress contour plots. Plots are to be isometric with top and bottom fibre surfaces identified. Plots are to be A4 minimum.
    - Von Mises stresses top fibre: all load cases/combinations analysed.
    - Von Mises stresses bottom fibre: all load cases/combinations analysed.
    - Detailed stress contour plots must be provided for areas to be analysed for fatigue.
    - Von Mises stresses: all load cases/combinations analysed.
    - Major and minor principal stresses: all load cases/combinations analysed.
  17. Apart from linear elastic analysis, other analysis requirements, due to the nature of the car body structure, must include:-
    - Non-linear elastic analysis (to be confirmed prior to the CDR).
    - Buckling, including non-linear geometry
    - Crash worthiness
    - Simulation of missile penetration to onset of material failure
  18. The FEA analysis for car bodies must follow the procedure shown in figure 1.
  19. The FEA analysis for car bogies including the static test for correlation purposes must follow the procedure shown in figure 2.
  20. The Contractor must conduct the bogie life testing to UIC 615 - 4 or equivalent. If the bogie fails as a result of this test the Contractor must submit a proposal and undertake the process as described in Figure 2 as appropriate.
-

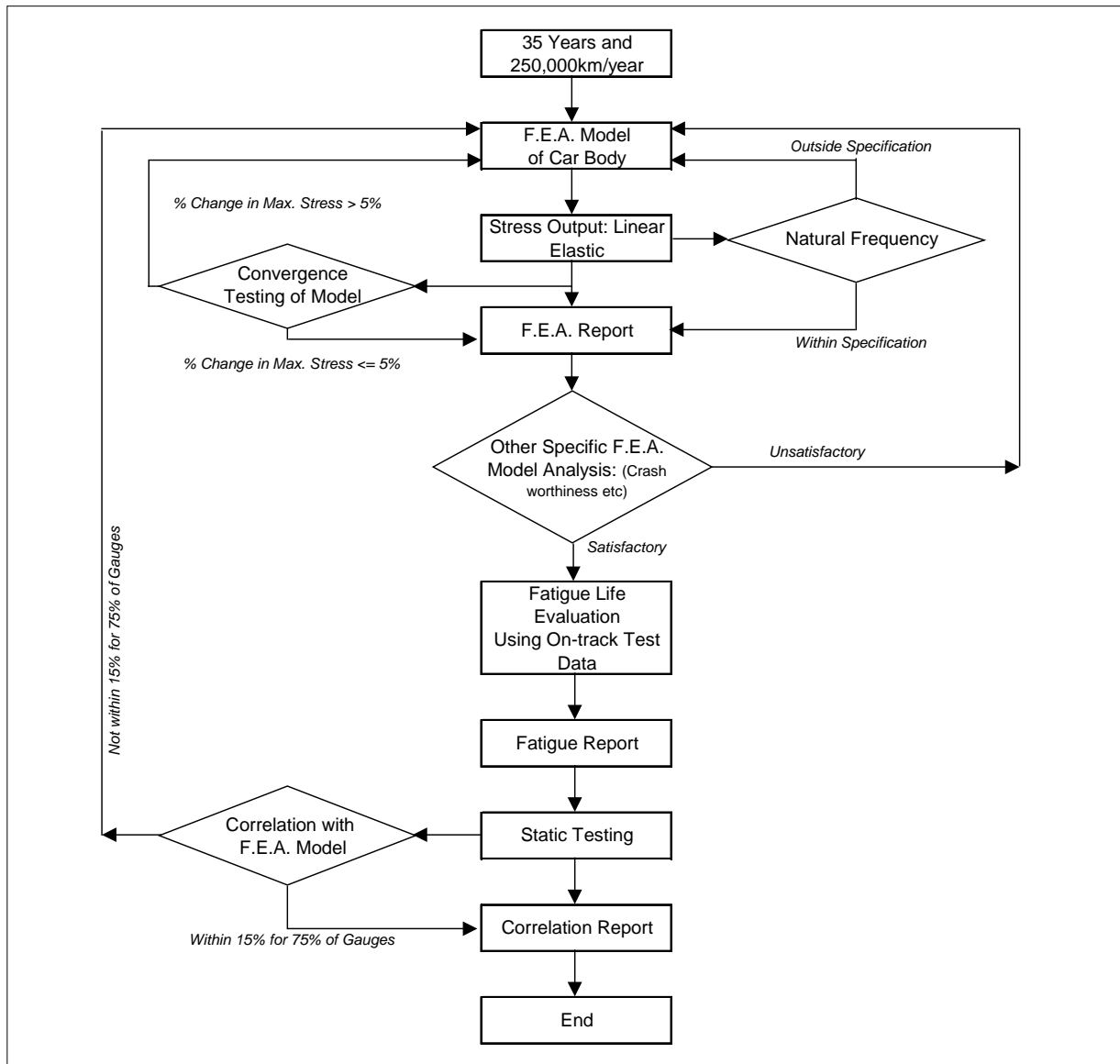
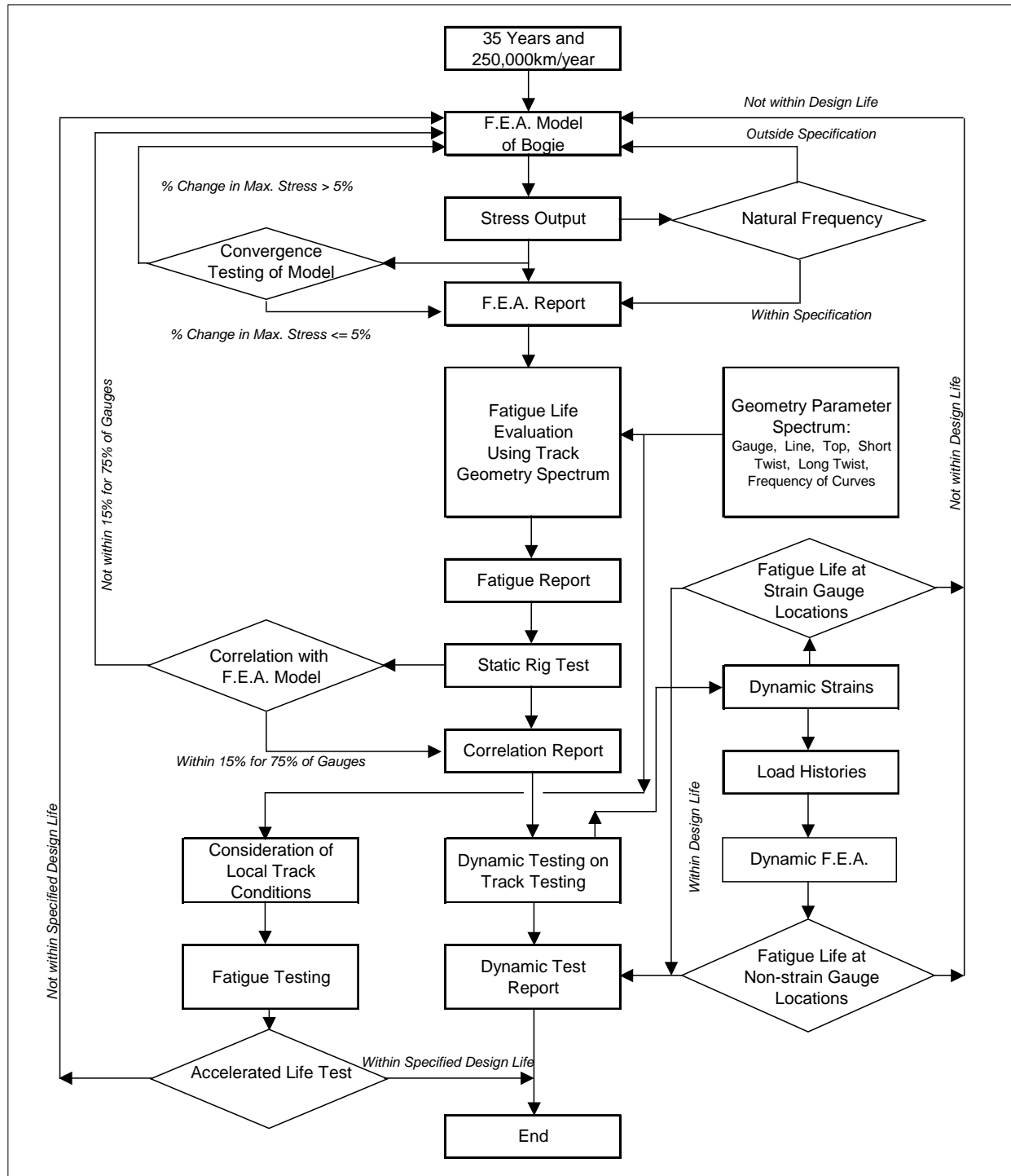


Figure 1.

**Car Body - Design and Test Procedure for Structure and Fatigue.**



**Figure 2.**

**Car Bogies - Design and Test Procedure for Structure and Fatigue.**

## APPENDIX H - TRACK DATA

### 1. Track Data

The track data consists of information collected by RIC's Track Evaluation Vehicle - (Recording Car), MM039 (RVX4). In addition to the data provided in the Technical Specification, the following are provided for information.

### 2. Table of Tolerances

The levels of various defect parameters at construction/upgrading and at the point at which they are registered as defects is given in the table below:-

Parameter	Upgrading /Construction	Defect Tolerance (mm)	Typical Worst Case: Mainline	and Storage Yards
Gauge	1435 mm, +12 mm, -4 mm	+25 (RVX4 Priority 1) -13	+35 mm -19 mm	+35 mm -19 mm
Line	± 5 mm versine in 20m chord	± 50 (RVX4 Priority 1)	± 67 mm	± 100 mm
Top	±10 mm over 20 m chord	± 35 (RVX4 Priority 1)	± 37 mm	± 42 mm
Long Twist	N/A	± 50 (RVX4 Priority 1)	± 67 mm	± 80 mm
Short Twist	1 in 600	± 25 (RVX4 Priority 1)	± 34 mm	± 42 mm
Superelevation	± 5 mm	N/A	± 30 mm	± 30 mm

**Table 1.  
Table Of Tolerances**

### 3. Track Geometry Defects and Track Condition

Recent track geometry recording data including defects and track condition index (TCI) data is appended in electronic form as text files. These have not been filtered, and isolated cases of electronic glitches may be present, which are normally recognisable as unrealistically high values.

A spreadsheet of track permanent speedboards (speedbrd.xls) is appended in an electronic format. The only sections of the operating environment currently speedboarded for operation at 110 mm superelevation deficiency are those sections over which the XPT currently operates. In addition compiled and filtered defect spectra charts are appended. Details of the trackcodes for the geometry data files are attached.

### 4. Sample Track

Sample files containing detailed track geometry measured by RVX4 are available from the Principal in electronic form as Excel spreadsheets.

*NB: These files were previously issues to tenderers on CD as part of the tender documents.*

These cover Sydney Yard (sydneyyd.xls) which is slow speed (15 km/h) with poor alignment, twist and top defects and some track which has recently been renewed; as well as high speed track at Heathcote (heathcot.xls) on the Illawarra Line and high speed track (145 plus km/h) at St Mary's (stmarys.xls) on the Western Line. Note: currently there are no XPT speedboards on the Illawarra Line, the Heathcote area currently having 110 and 115 km/h speedboards for 75 mm superelevation deficiency.

An explanation of how track geometry is measured is contained in Clause 7 "Track Data Description". Further detail can be found in the Track Evaluation Vehicle - MM039 (RVX4).

Detailed track data will be provided progressively through the design stage of the Contract and according to the Contractor's schedule and will preferably be the location where the ride tests may be conducted. These locations are outlined in Section 1 of Appendix I.

## 5. Mainline Track

Cars must be capable of safely negotiating all defects at track speed.

Testing by instrumented wheelset for the leading axle should be carried out over nominal worst case main line track including typical maximum defects with a review of critical parameters including:

- body roll,
- the ratio of instantaneous lateral to vertical wheel forces (L/V), and
- wheel unloading.

Where an instrumented wheelset is not used, then the Contractor must propose alternative methods to validate the design. The alternative methods must be approved by the Principal.

In addition testing for rail panel shift shall be required, with the following limits:

For each axle, the ratio of the instantaneous net lateral force to vertical force must be not greater than 0.5.

Nadal's equation must also be used to calculate the theoretical worst L/V, assuming the worst case for rail angle at the wheel rail interface is 26 degrees to the vertical, (ie. 64 degrees to the axis of the axle) and for the range of friction coefficients experienced in the operating environment.

Nadal's equation:

$$L/V = [\tan (a) - u] / [1 + u * \tan (a)]$$

where a = angle of wheel flange face to axis of the axle, new wheel profile  
u = coefficient of friction

## 6. Sidings

Siding track structure is made up of short rails with fish plated joints. The track has low maintenance and therefore has dipped joints, poor subgrade and sleeper condition and a lack of ballast support. Due to the poor track condition the speed of train operations are no more than 20 km/h.

Testing by instrumented wheelset should be carried out over nominal worst case siding track and yards including typical maximum defects with a review of critical parameters including:-

- body roll,
-

- the ratio of instantaneous lateral to vertical wheel forces (L/V), and
- wheel unloading.

Where an instrumented wheelset is not used, then the Contractor must propose alternative methods to validate the design. The alternative methods must be approved by the Principal.

## 7. Track Data Description

Track Geometry information is collected by RVX4 Track Recording Car, processed using TESS Software, and is in the following form:

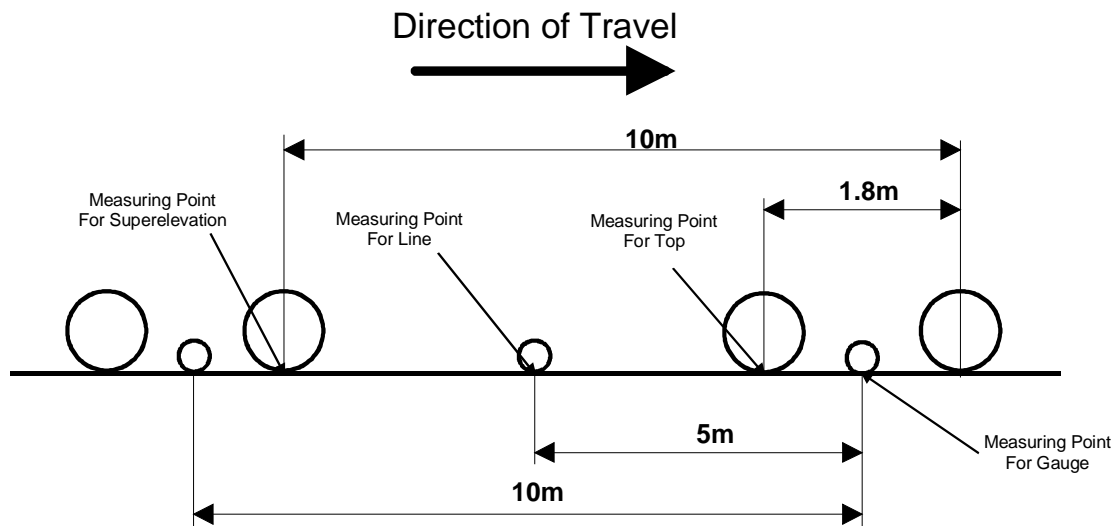
1. Fixed Width ASCII Text file.
2. Header contains location, recording and report generation information.
3. Body contains one row of data for each point on the track, at approximately 1 metre intervals, however this interval may vary due to calibration changes.
4. Each row is broken into columns containing the following data:
  - METRAGE Location of point along track [km].
  - GAUGE Distance between rails measured at a point 16 mm below the top of the rail [mm].
  - SUPER-EV Superelevation or Cant of the track [mm].
  - LINE DN Horizontal alignment of the Down rail expressed as a versine measured halfway along a 10m chord [mm].
  - LINE UP Horizontal alignment of the Up rail expressed as a versine measured halfway along a 10m chord [mm].
  - TOP DN Vertical alignment of the Down rail expressed as a versine measured at 1.8m along a 10m chord [mm].
  - TOP UP Vertical alignment of the Up rail expressed as a versine measured at 1.8m along a 10m chord [mm].
  - TWIST (SHORT) Difference in superelevation between its current location and a location 2.7m previous [mm].

The interpretation of the Up and Down rails follows the standard naming convention for rails which is as follows. When facing in the Down direction (away from Sydney, or in the direction of increasing kilometrage), the Down Rail is on the Left.

Occasionally locations appear to be repeated or skipped, this is due to the location measuring system of the track recording car. Consider the "METRAGE" column to be a label only, with each row being an individual record of points approximately 1 metre apart. These files contain all locations. Points on the track are neither skipped nor repeated, only the labels attached to them.

The following diagram representing the RVX4 Track recording car and describes the layout and locations of the measuring points.

---



Twist is not measured directly and is derived from Superelevation by calculating the difference between the superelevation at the current location, and that measured at a location 2.7 m previous.

During recording, all the above data is offset and referenced to a single point on the vehicle so that the reported values of Gauge, Superelevation, Versine (Line), and Top, are all referring to the same point on the track. Twist is the difference between the superelevation at this point on the track, and the superelevation of the point 2.7 m previous.

## 8. Defect Spectra

The RVX4 track geometry inspection car runs every 4 months in the CityRail area. For each of the track geometry defects recorded by RVX4 a defect spectrum has been produced for the main line track in the CityRail system over which electric trains run. In each case the number of defects to be expected greater than a particular size in mm is plotted; refer attached graphs:

Tight Gauge and Wide Gauge Defect Spectra

Top Defect Spectra

Line Defect Spectra

Long Twist and Short Twist Defect Spectra

Long Twist refers to the difference in superelevation between its current location and a location 13.2m previous.

In each case the dark line is to be used which has been adjusted to remove the known anomalies and to reduce the frequency of the larger defects because they would be in track for a much smaller proportion of the time. The horizontal scale shows the defect size and the vertical scale the frequency using a log scale. For example there would be expected to be 10 wide gauge defects greater than 31 mm in the 1300 km of the CityRail system. The occurrence of the larger defects would be expected to be less for higher track speeds, depending on the type of defects. Table 2 shows the nominal maximum speed at which defects of a certain size would be expected. Note that no speed based relationship is expected for tight gauge.

Current maintenance defect limits for which repair is mandatory are given in table 1. For Priority 1 defects, inspection is required in 7 days, and removal within 30 days. These defects

are not dependent on speed under the present regime. However, the need for a speed restriction is assessed at the time of inspection. There are additional requirements for identification of defects that cause rough riding based on on-train inspections which generally remove lesser defects which affect trains travelling at higher speed. A speed-based regime is being prepared for operation in the CityRail system. The new regime sets appropriate limits for defects dependent on track speed and sets mandatory repair in a timescale dependent on the degree of variation from the acceptable speed level.

SPEED (km/h)	Wide Gauge	Short Twist	Top	Line	Long Twist
15	40	35	35	65	80
25	35	35	35	60	80
30	35	35	35	60	60
35	35	35	35	60	60
40	35	35	35	60	60
45	35	35	35	50	60
50	35	35	35	50	60
55	35	35	35	40	60
60	35	35	35	40	60
65	35	35	35	40	50
70	30	35	35	40	50
75	30	35	35	40	50
80	30	35	30	40	50
85	25	30	30	30	50
90	25	30	30	30	50
95	20	30	30	30	50
100	20	30	30	30	50
105	20	25	30	30	45
110	20	25	30	25	40
115	20	25	30	25	40
120	20	25	25	25	35
125	20	20	20	25	35

**Table 2.**  
**Defect Maxima vs Speed**

## 9. Sample Track Data

Track data is provided in electronic form only, consisting of the following text and spreadsheet files:

G_110410 TXT	7,349 16-04-97 10:05a	G_509633 TXT	5,486 15-04-97 1:23p
G_111021 TXT	20,112 08-04-97 1:31a	G_521074 TXT	5,230 08-04-97 12:08a
G_111022 TXT	12,792 08-04-97 1:16a	G_532611 TXT	8,597 10-04-97 2:04p
G_111031 TXT	19,483 08-04-97 1:53a	G_532630 TXT	4,881 10-04-97 1:50p
G_111032 TXT	13,725 08-04-97 2:02a	G_532810 TXT	5,589 10-04-97 1:16p
G_112120 TXT	5,473 09-04-97 2:10a	G_532920 TXT	4,094 10-04-97 2:14p
G_112130 TXT	6,259 09-04-97 1:29a	G_532930 TXT	4,485 10-04-97 2:08p
G_114020 TXT	5,139 20-04-97 12:19p	HEATHCOT XLS	117,760 16-05-97 12:44p
G_114030 TXT	4,183 20-04-97 9:15a	STMARYS XLS	120,832 20-05-97 8:48a
G_124021 TXT	12,380 20-04-97 12:16p	SYDNEYXD XLS	163,840 16-05-97 1:52p
G_124022 TXT	26,518 20-04-97 12:02p	G_312021 TXT	18,845 09-04-97 2:06a
G_124031 TXT	13,587 20-04-97 9:30a	G_312022 TXT	25,785 11-04-97 2:11p
G_124032 TXT	26,145 20-04-97 10:02a	G_312031 TXT	17,677 09-04-97 1:44a
G_124120 TXT	8,312 20-04-97 1:53p	G_312032 TXT	27,828 10-04-97 11:51a
G_124130 TXT	8,096 20-04-97 1:11p	G_322010 TXT	46,102 11-04-97 9:55a
G_211011 TXT	6,836 08-04-97 12:24a	G_322020 TXT	39,083 11-04-97 1:04p
G_211021 TXT	9,922 08-04-97 1:07a	G_322030 TXT	40,136 10-04-97 12:52p
G_211022 TXT	9,567 08-04-97 3:13a	G_322081 TXT	5,252 11-04-97 10:30a
G_211023 TXT	17,782 08-04-97 3:06a	G_322082 TXT	5,059 11-04-97 10:44a
G_211031 TXT	9,077 07-04-97 11:19p	G_322083 TXT	5,579 11-04-97 11:03a
G_211032 TXT	9,620 08-04-97 2:15a	G_322084 TXT	4,891 11-04-97 11:14a
G_211033 TXT	16,228 08-04-97 2:41a	G_322085 TXT	4,915 11-04-97 11:37a
G_211034 TXT	11,309 17-03-97 11:29a	G_322086 TXT	4,065 11-04-97 11:47a
G_211042 TXT	7,076 08-04-97 12:56a	G_322087 TXT	5,387 11-04-97 11:55a
G_211043 TXT	16,066 08-04-97 12:50a	G_322088 TXT	5,497 11-04-97 11:58a
G_211052 TXT	7,835 07-04-97 11:26p	G_322089 TXT	4,834 11-04-97 11:06a
G_211053 TXT	15,395 07-04-97 11:59p	G_322720 TXT	8,076 10-04-97 1:46p
G_213980 TXT	5,096 09-04-97 12:41a	G_322730 TXT	13,927 10-04-97 1:02p
G_213990 TXT	5,297 09-04-97 12:06a	G_322760 TXT	5,666 10-04-97 1:09p
G_214120 TXT	5,672 20-04-97 2:02p	G_509021 TXT	22,166 07-04-97 10:32a
G_214130 TXT	5,485 20-04-97 12:59p	G_509022 TXT	6,098 11-04-97 2:36p
G_221024 TXT	13,657 26-03-97 11:05a	G_509023 TXT	5,478 07-04-97 10:57a
G_509321 TXT	4,583 16-04-97 9:52a	G_509024 TXT	4,751 07-04-97 10:37a
G_509331 TXT	5,639 16-04-97 12:30p	G_509031 TXT	22,021 07-04-97 11:47a
G_509412 TXT	8,925 16-04-97 10:52a	G_509032 TXT	7,486 10-04-97 10:28a

G_509420 TXT	6,159 16-04-97 12:16p	G_509033 TXT	4,980 07-04-97 10:59a
G_509430 TXT	4,486 16-04-97 10:46a	G_509034 TXT	5,979 07-04-97 10:48a
G_509520 TXT	12,753 16-04-97 12:11p	G_509110 TXT	14,305 15-04-97 12:25p
G_509530 TXT	9,459 16-04-97 11:30a	G_509180 TXT	4,212 15-04-97 1:19p
G_509621 TXT	9,799 15-04-97 10:56a	G_5091L0 TXT	3,301 15-04-97 1:02p
G_509623 TXT	4,123 15-04-97 11:12a	G_509220 TXT	10,184 16-04-97 12:24p
G_509631 TXT	10,357 15-04-97 1:54p	G_509230 TXT	8,796 16-04-97 10:16a

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## **APPENDIX I - OSC RIDE QUALITY**

### **Requirements & Testing, including Kinematic Outline**

#### **1. General**

Ride quality must be measured over extended running of at least 200 km throughout the operating environment at speeds corresponding up to 110 per cent of the design operating speed, unless otherwise specified, and as applicable to the OSC's operating condition (with respect to air spring condition, if supplied). This running would be compiled from such runs as follows: Berowra to Penrith via the North Shore (~92 km); Berowra to Berowra via the North Shore and Main North (~81 km); Penrith to Campbelltown via Harris Park Y Link (~67 km); Campbelltown to Central via East Hills and Circular Quay (~52 km) or via Granville (~55 km); all in either direction, with no duplication of runs.

Testing may be performed at the discretion of the Principal on any or all track locations within the operating environment.

Unless otherwise specified, testing must be performed in both the tare and crush loaded conditions. For the latter, the cars must be weighted to simulate passenger crush loading, including the centre of gravity.

Testing must be performed with the OSC in the new condition with the suspension in the normal condition unless otherwise specified, and at the service limits nominated by the Contractor and agreed by the Principal, for the bogie and any other running gear without exceeding the criteria below.

The design and the agreed maintenance scope and frequency must ensure that the required performance is achieved at all times.

The ride quality of the OSC, as measured by the criteria described below, must be equivalent to or better than the V-set cars as follows: overall for each run, the value of each parameter measured on each OSC car must be better than the value of the corresponding selected parameter for the selected position of the selected V-set car when back-to back testing is performed at normal V-set speeds (corresponding to 75 mm superelevation deficiency). When the OSC is tested at speeds corresponding to 110mm superelevation deficiency up to and including maximum design speed (unless otherwise specified), the OSC must not exceed the V-set values measured at 75mm superelevation deficiency. Values for the various criteria are provided only as a guide to the performance of the V-set.

The ride quality criteria must be reported overall for each trip, for major sections of track length (eg. Central to Hornsby), and where appropriate (such as for Ride Index) continuously over short sections of track. The Contractor must provide any further data requested by the Principal .

The criteria used to evaluate ride quality are derived from:

- a) accelerations measured in the three mutually perpendicular directions: vertical, lateral and longitudinal, at the nominated locations;
  - b) body roll angle;
  - c) suspension displacements;
  - d) time; and
  - e) distance and/or location.
-

The acceleration data must be filtered according to the specified criteria. Filter attenuation rates must be a minimum of 24 dB/octave, unless otherwise specified.

The jerk values must be derived from accelerometer output.

## 2. Maximum Accelerations and Jerk

Acceleration data for the extended running must be filtered at 20 Hz low pass for determining maximum acceleration, and approximately 5 Hz low pass for jerk.

Longitudinal acceleration must also be high pass filtered at approximately 0.5 Hz to remove normal train handling and gradient influences.

The measurements must be made on the floor above bogie centres and in the upper saloon on the floor and/or seating level. Measurements must be made over the trailing bogie centre of the OSC. Measurements may also be taken on the ceiling of the upper saloon or on the ceiling above bogie centres.

The following values apply to measurements taken on the car floor above bogie centres, including the trailing bogie. Values are included for deflated air springs.

Criteria (Absolute value)	Normal suspension condition Direction (Orientation)			Deflated Airsprings Direction (Orientation)		
	Vertical	Lateral	Longi- tudinal	Vertical	Lateral	Longi- tudinal
Maximum acceleration, peak (g)	0.40	0.30	0.025	0.50	0.35	0.05
Maximum jerk, peak (g/s)	Same as V-set car			Same as V-set car		

## 3. Acceleration Histograms

Acceleration data for the extended running, filtered at 20 Hz low pass, must be used for the acceleration histograms. The histograms must be based on zero-crossing analysis. The class intervals for the acceleration levels must not exceed 0.05g. The two-sided (positive and negative) zero-crossing output of lateral acceleration must be checked for instrumentation offset and correction if required, prior to converting to one-sided (ie. absolute value) counts. The two-sided zero-crossing output must also be supplied by the Contractor.

The following maximum values for percentage of occurrences of the stated acceleration levels for the vertical and lateral directions are provided and relate to the suspension in the normal operating condition. For deflated airsprings, the limit shall be that of the end of the V-set car nominated by the Principal.

Table of maximum cumulative counts of occurrences of peak acceleration levels as a percentage of the total number of counts.

Orientation	Acceleration levels, peak (g)							
	remainder	>=0.15	>=0.20	>=0.25	>=0.30	>=0.35	>=0.40	>=0.45
Vertical	100	20	6.0	4.5	3.0	0.07	0.035	0
Lateral	100	4	1.0	0.07	0.035	0	0	0

#### 4. Acceleration verses Speed Histograms

An analysis, which outputs two-sided (positive and negative) histograms of acceleration (peaks and averages) verses speed, must also be performed for the extended running. The averages are separately, the arithmetic mean of the positive peaks and, the arithmetic mean of the negative peaks. The acceleration data must be bandpass filtered between 0.1 and 20 Hz. The class intervals must not exceed 5km/h for speed and 0.05g for acceleration. The table below provides maximum values relating to the suspension in the normal operating condition.

Parameter	Vertical limits	Lateral limits
Maximum acceleration, peak (g)	+/- 0.40	+/- 0.30
Average (mean peak) acceleration (g)	+/- 0.03	+/- 0.02

#### 5. Jerk Histograms

Jerk histograms must be used, as a criteria for comparison of the ride of the OSC and the selected V-set car / end, using the accelerations from the extended running filtered at approximately 5 Hz low pass.

#### 6. Kinematic Outline

The theoretical maximum kinematic outline of each car type under the stated operating conditions, including the calculations and assumptions, must be provided by the Contractor prior to System Definition Review.

The actual kinematic outline of the OSC must be determined by measuring the maximum roll angle relative to the track plane and the maximum lateral and vertical displacements of the suspension system. The individual maximums must be combined with the roll centres for the suspension elements, the bogie centres, and the car body and pantograph outlines to determine the kinematic outline of each car type for the tare and crush loaded conditions. Testing must be performed through curves with the OSC operating at the superelevation deficiency nominated in RSU 289, excluding the transient roll effects. For the purposes of this test all vertical suspension points on the car must be measured to obtain the average angular displacement of the car with respect to the rail plane. This is to negate the influence of transient track irregularities.

The cars must remain within the kinematic rolling stock outline at all times under all conditions of loading, dynamic behaviour and wear, when tested at the required superelevation deficiency.

The crush loaded OSC must remain within the kinematic rolling stock outline under all conditions of wear nominated by the Contractor to the satisfaction of the Principal when body roll and lateral displacements are measured with the OSC standing on the superelevation nominated in RSU 289.

#### 7. Car body Roll and Sway Frequencies

The roll and sway frequency must be such that they do not cause a feeling of motion sickness to the passengers and crew. The roll and sway frequencies must be determined from lateral accelerations and displacements.

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## 8. Ride Index

The ride index of the OSC must be equal to or better than a V-set when tested in a back-to-back situation under the conditions described in Section 1. This must be achieved up to any track speed that corresponds to 110 mm superelevation deficiency and up to the maximum service speed of the OSC over any track complying with the minimum standard.

### Method Overview

The acceleration data is subjected to a Fast Fourier Transform (FFT) analysis over the required frequency range. An intermediate value,  $V_i$ , based on the frequency-weighted peak acceleration levels derived from the FFT, is then calculated for each line of the FFT. A ride index ( $RI_i$ ) is then calculated for each intermediate value. These are then combined to give the overall ride index value ( $RI_{total}$ , or just  $RI$ ).

### Details

Accelerometer data for analysis must come from testing at substantially constant speed (nominally  $\pm 5$  km/h). Analysis may also be performed over a run, for example, Hornsby to Penrith, providing the OSC track speed is maintained.

The FFT frequency analysis must be a minimum of 400 lines of equal bandwidth covering the frequency range of 0-100 Hz with a minimum resolution of 0.25 Hz. A minimum of 16 averages must be used, but 32 is preferred to minimise statistical error.

The intermediate values,  $V_i$  must be calculated for each line of the FFT according to the appropriate frequency-dependent formula, according to the following table. The formulae include frequency and peak acceleration components

ie.  $V_i = \text{function}(F, A)$ .

Table of Weightings for Calculation of  $V_i$ .

Frequency (Hz)	Vertical	Lateral
0 - 6	$0.325 FA^3$	$4.32 A^3$
6 - 20	$400 A^3/F^3$	$650 A^3/F^3$
20 - 100	$A^3/F$	$A^3/F$

where  $F = \text{Frequency (Hz)}$

$A = \text{Amplitude, peak (g)}$

The ride index for each line,  $RI_i$  is calculated using:

$$RI_i = 7.07(V_i)^{0.1}$$

Over the frequency range from 0.1 Hz to 50 Hz inclusive, the overall ride index must be calculated using the following summation of the i-th values of  $RI_i$  :

$$RI_{total} = [ \sum_{i=1}^n (RI_i)^{10} ]^{0.1}$$

## 9. V-set Ride Information

Following is V-set car ride information for guidance for the back-to-back testing. Note that for gathering this information, the V-set cars were only operated up to a maximum of 75 mm superelevation deficiency.

Attached are:

- (a) RI values measure on the floor above bogie centre
- (b) Table of RI measurement locations
- (c) Acceleration verses Speed histograms
- (d) Raw two-sided histograms
- (e) Acceleration histograms (cumulative count). Note: the data has been analysed using 0.1 g class intervals. The OSC must be analysed using a maximum class interval of 0.05 g.

Should the Contractor require additional ride quality information or confirmation of supplied data, a 4-car V-set can be made available to the Contractor on one occasion between the hours of 2200 Friday and 0200 the following Monday, which shall include the equipment setup and removal time.

Track Location Number <sup>(2)</sup>	Direction	Track	Location km <sup>(1)</sup>	Speed (km/h)
1	Down	Main North	17	90
2	Down	Main North	43	85
3	Up	Main North	40	105
4	Up	Shore	24	70
5	Down	West Suburban	2	70
6	Up	Bankstown	22	60
7	Down	East Hills	8	70
8	Down	East Hills	10	72
9	Down	East Hills	17	85
10	Down	East Hills	26	100
11	Down	Main South	45	80
12	Up	Main South	50	110
13	Up	Main South	47.5	105
14	Up	East Hills	30	105
15	Up	East Hills	15	80

Track Location Number <sup>(2)</sup>	Direction	Track	Location km <sup>(1)</sup>	Speed (km/h)
16	Down	West Main	6	100
17	Down	West Suburban	36	100
18	Up	West Main	51	105
19	Up	West Suburban	41	110
20	Up	West Main	21	70

(1) at start of test

(2) If required by the Contractor, the Principal will provide track data relating to the track locations. This data was recorded around the same time as the recording of the RI Values shown in the Chart appearing later in this Appendix.

## 10. V-set General Information

Train sets targeted and referred to as 'V' sets consist of Double Deck Interurban/Intercity Motor, Control Trailer and Trailer Cabs.

These cars operate as 'V' Sets as 2, 4, 6 and 8 car trains on the CityRail electrified system.

The nominal dimensions and masses of the different car types are as follows.

	Motor Car	Control Trailer Car	Trailer Car
Coupled Length (mm)	23,968	23,968	23,828
Over Body Length (mm)	23,530	23,530	23,232
Bogie Centres (mm)	16,160	16,160	16,160
Over Headstocks (mm)	23,130	23,130	22,990
Bogie Wheel Base (mm)	2,440	2,440	2,440
Wheel Diameter (nominal)	940	940	940
Vehicle Mass Complete with Bogies (Tonnes)	61 to 62	40 to 46	46

The Bogies are a 'J' type with two traction motors fitted to each motor car bogie.

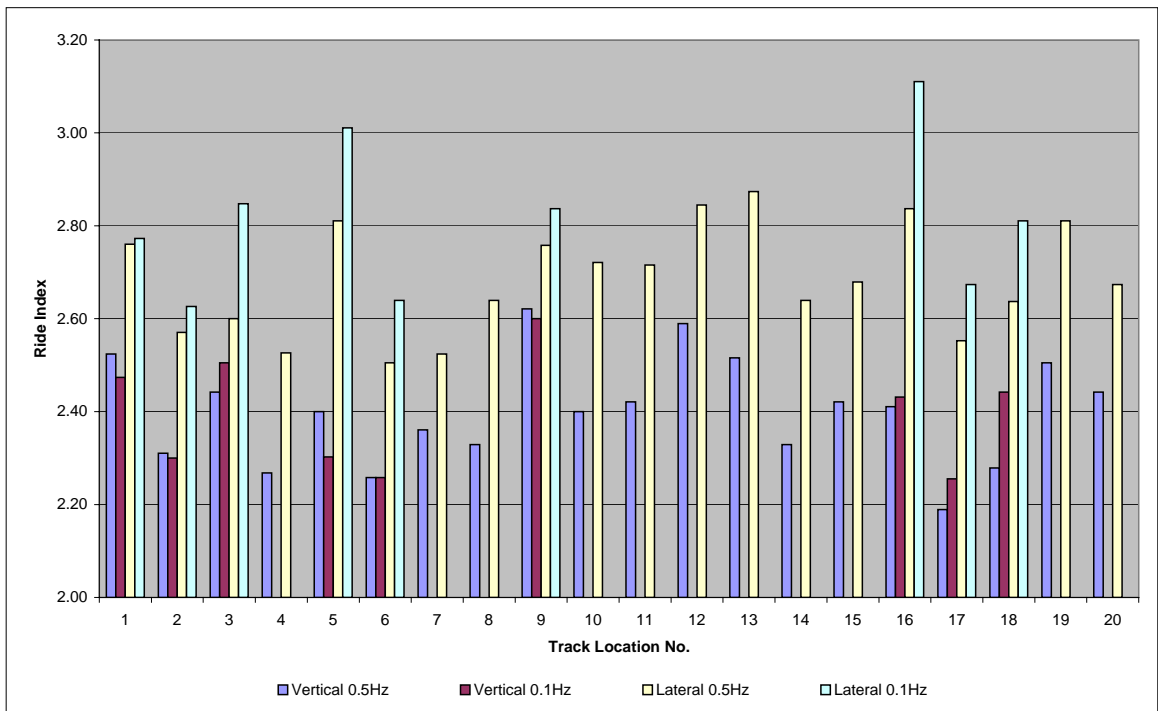
The primary suspension has coil springs fitted between the axleboxes and the bogie frame.

The secondary suspension has air bellows fitted between the spreader beam and the car underframe/body.

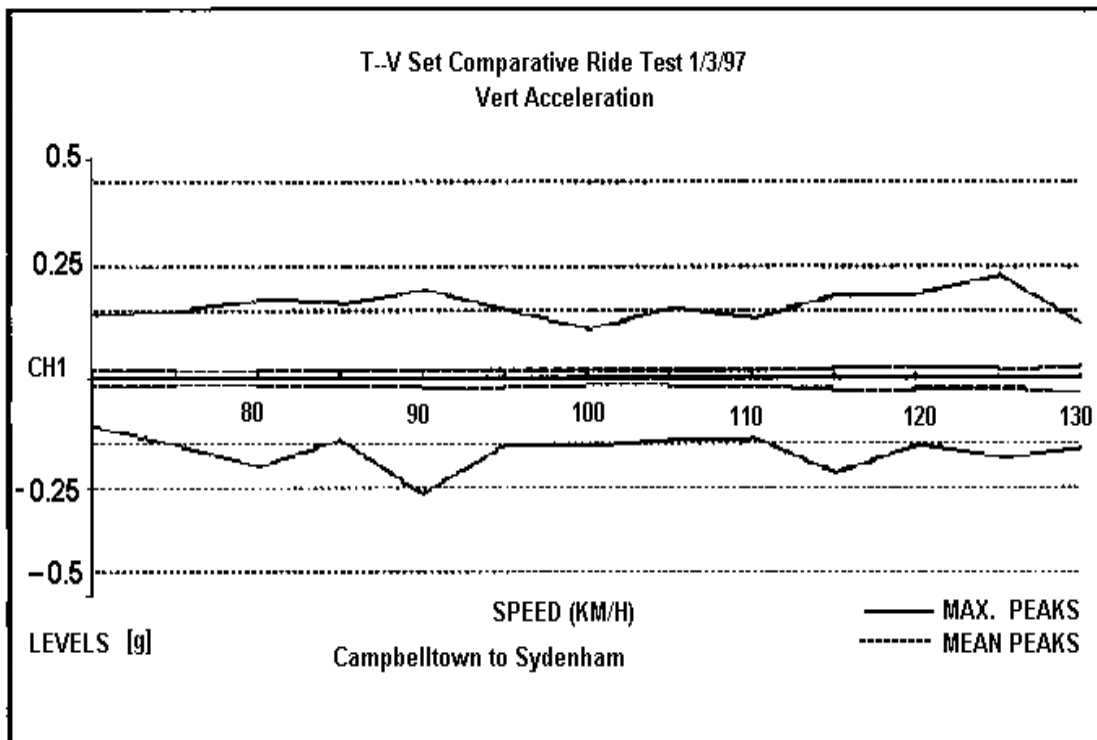
Levelling valves are fitted to control the vehicle/bellow height for various passenger loadings.

All bogies are fitted with Brake Cylinders and Tread Brakes.

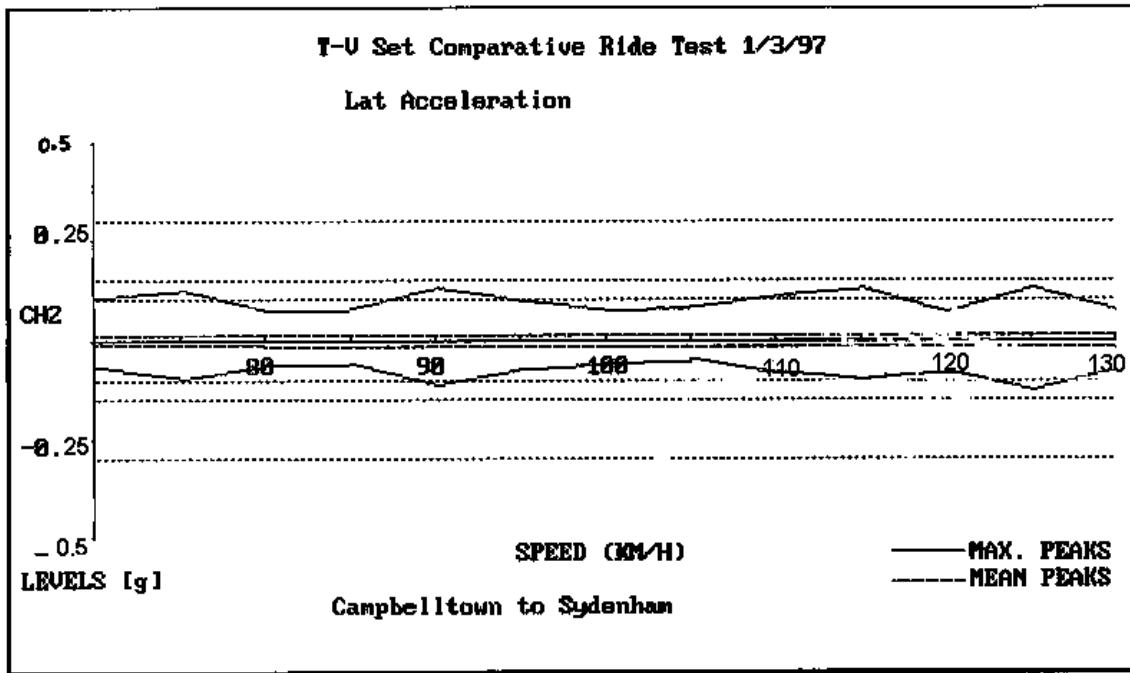
For car diagrams please refer to the CityRail diagram book.



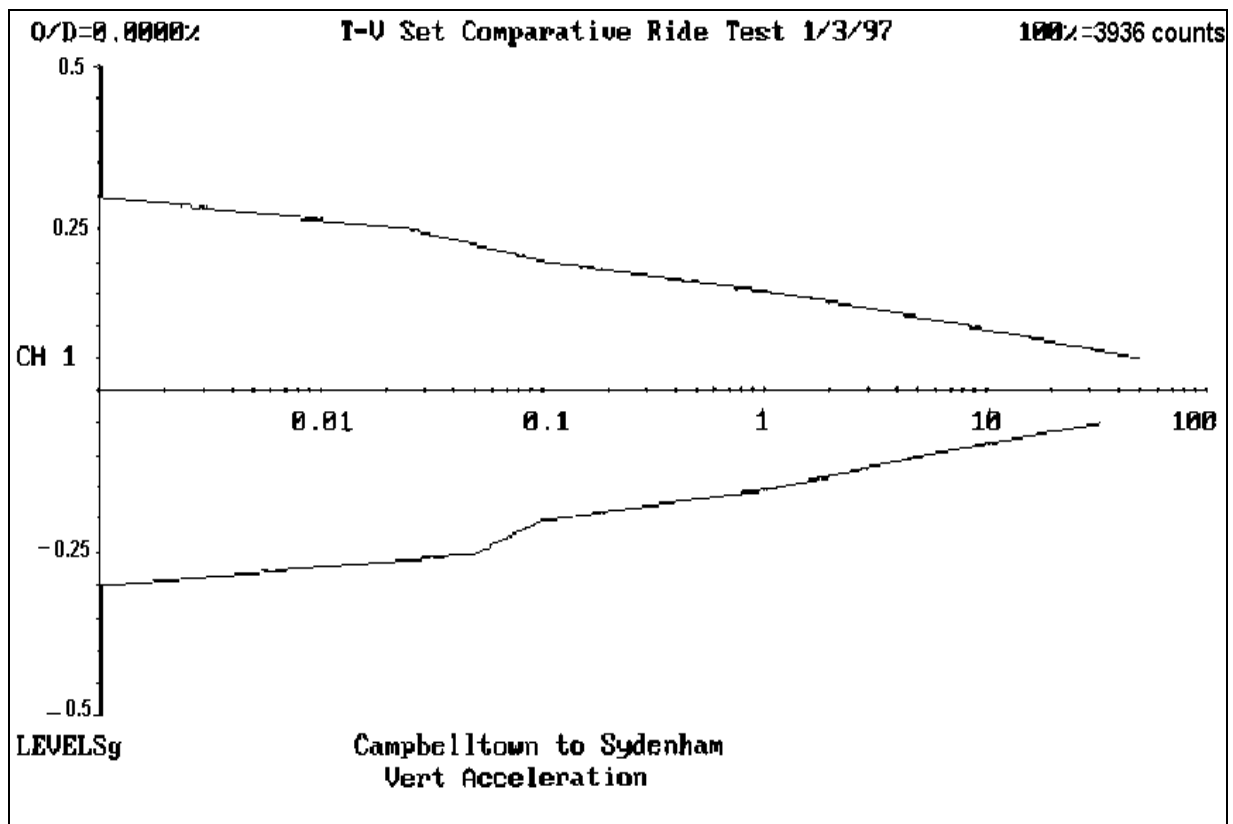
RI Values Measured on the Floor Above Bogie Centres (refer 9a)



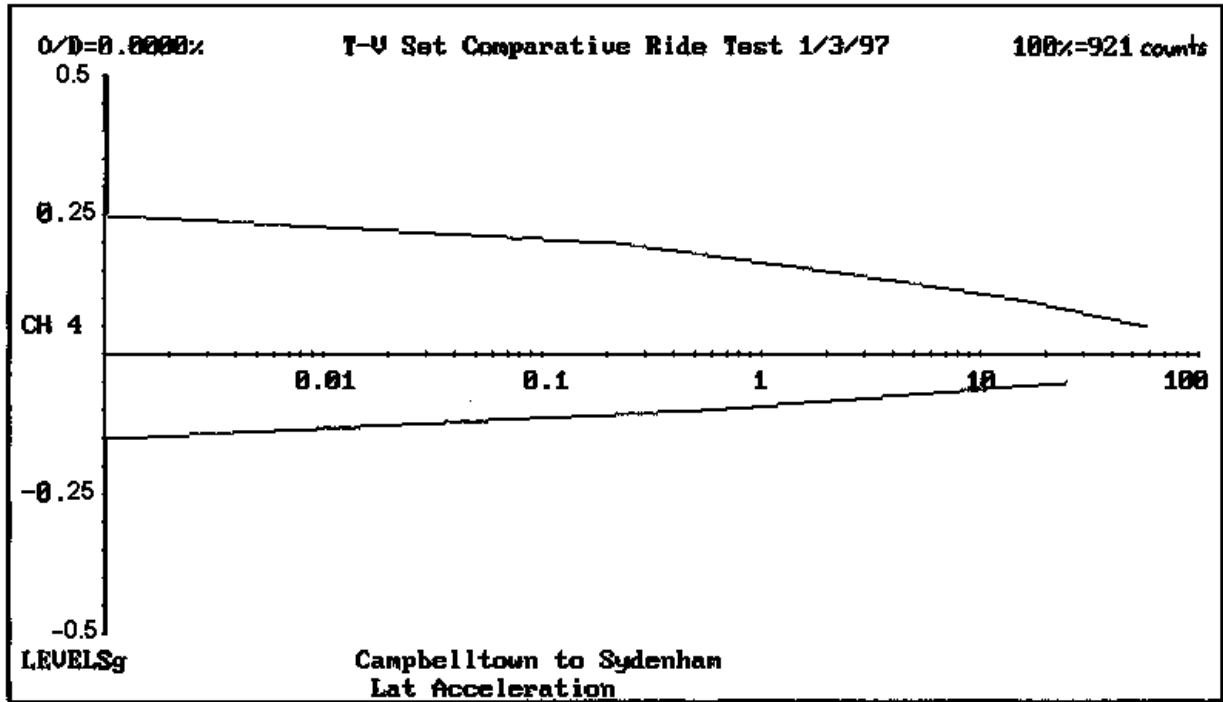
Vertical Acceleration Versus Speed Graph (refer 9c)



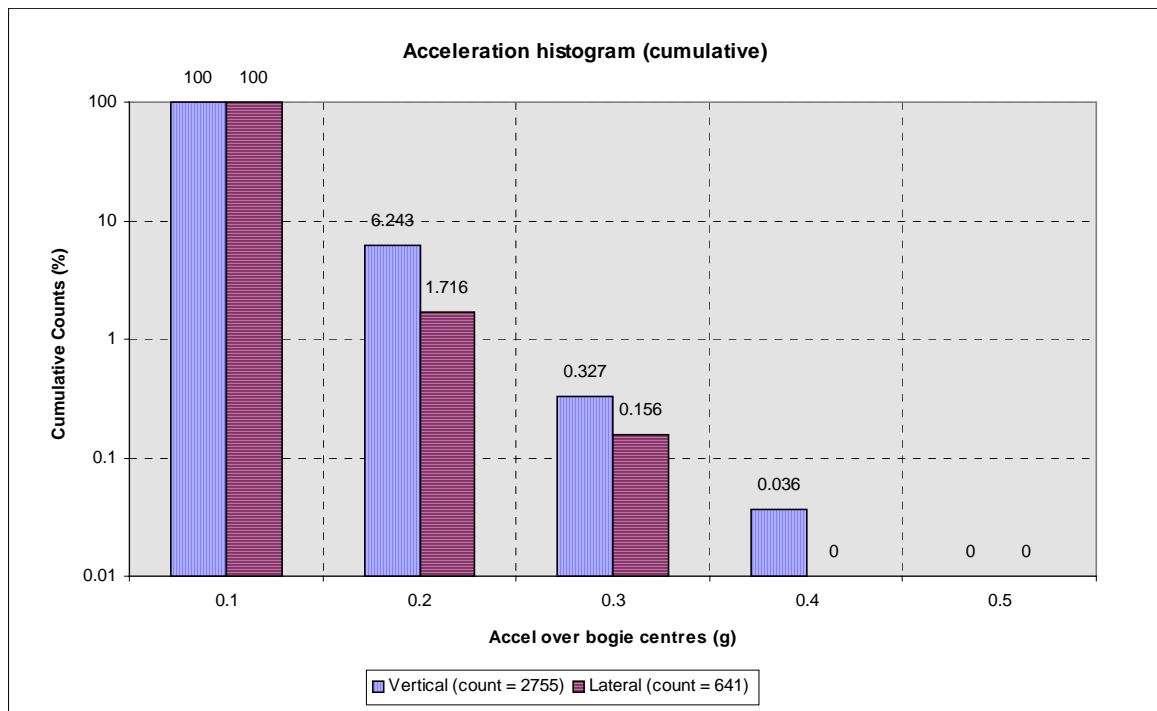
Lateral Acceleration Versus Speed Graph (refer 9c)



Two-Sided Vertical Acceleration Versus Occurrence Graphs (refer 9d)



Two-Sided Lateral Acceleration Versus Occurrence Graphs (refer 9d)



Acceleration Histogram (Cumulative Count) (refer 9e)

## APPENDIX J - JUNCTION STATIONS

Junction stations are trigger points for “Junction” or “Journey” announcements on the DVA and changes to the Destination Indicator’s “via” destination. Junction stations lists for the DVA and DI are subject to change due to changes to the network and timetables.

The DVA and DI Junction stations are not necessarily the same.

Where two DVA Junction stations occur consecutively within the same route/trip then the second Junction station should not generally be utilised as a Junction station.

<b>DVA Junction Stations include, but are not limited to, the following:</b>	<b>DI Junction Stations include, but are not limited to, the following:</b>
Blacktown	Blacktown
Broadmeadow	Broadmeadow
Cabramatta	Cabramatta
Central	Central
Chatswood	Clyde
Clyde	Coniston
	Dapto
Coniston	Glenfield
Dapto	Granville
Domestic	East Hills
Epping	Flemington
Glenfield	Hamilton
Gosford	Hornsby
Granville	Hurstville
Flemington	Kogarah
Hamilton	Lidcombe
Hornsby	Liverpool
Hurstville	Merrylands
International	North Sydney
Kogarah	Parramatta
Lidcombe	Port Kembla
Merrylands	Redfern
North Sydney	Regents Park
Parramatta	Rockdale
Penrith	Springwood
Redfern	Strathfield
Regents Park	Sutherland
Rockdale	Sydenham
Strathfield	Tempe
Sutherland	Thirroul
Springwood	Turrella
Sydenham	Wollongong
Tempe	Wolli Creek
Thirroul	Wyong
Turrella	
Wollongong	
Wyong	

### APPENDIX K - TYPICAL DESTINATION INDICATOR DISPLAYS

The following are typical external destination indicator displays used by the Principal. The list is not exhaustive and is included to show the typical information required.

The Destination Indicator must normally show the End Of Trip as the main destination and the next DI junction station as the via destination. Special displays (non stations) must also be provided as shown and shall be generated by the crew entering a special run or code number.

Destination	Destination	Destination
AIRPORT	HORNSBY	WYONG
ASHFIELD	HORNSBY Via North Sydney	WYONG Via North Sydney
BANKSTOWN Via Auburn	HORNSBY Via Strathfield	WYONG Via Strathfield
BANKSTOWN Via Lidcombe	HURSTVILLE	
BANKSTOWN Via Olympic Park	INGLEBURN	
BANKSTOWN Via Sefton	KATOOMBA	
BANKSTOWN Via Sydenham	LIDCOMBE	
BEROWRA Via North Sydney	LIDCOMBE Via Bankstown	
BEROWRA Via Strathfield	LIDCOMBE Via Olympic Park	
BLACKTOWN	LIDCOMBE Via Strathfield	
BLACKTOWN Via Olympic Park	LINDFIELD	
BONDI JUNCTION	LITHGOW	
BROADMEADOW	LIVERPOOL	
CAMPBELLTOWN	LIVERPOOL Via Bankstown	
CAMPBELLTOWN Via Airport	LIVERPOOL Via Granville	
CAMPBELLTOWN Via Bankstown	LIVERPOOL Via Regents Park	
CAMPBELLTOWN Via East Hills	MACARTHUR	

CAMPBELLTOWN Via Olympic Park	MACARTHUR Via Airport
CAMPBELLTOWN Via Regents Park	MACARTHUR Via Bankstown
CAMPBELLTOWN Via Granville	MACARTHUR Via East Hills
CARLINGFORD	MACARTHUR Via Granville
CENTRAL	MACARTHUR Via Regents Park
CENTRAL Via Olympic Park	MARTIN PLACE
CHARTER	MORISSET
CHATSWOOD Via Epping	
CITY Via Airport	MORTDALE
CITY Via Bankstown	MT. VICTORIA
CITY Via East Hills	NEWCASTLE
CITY Via Granville	NORTH SYDNEY
CITY Via Olympic Park	NORTH SYDNEY Via Central
	OUT OF SERVICE
CITY Via Regents Park	OLYMPIC PARK
CITY Via Strathfield	PARRAMATTA Via Epping
CITY CIRCLE Via Museum	PARRAMATTA Via Olympic Park
CITY CIRCLE Via Town Hall	PENRITH
CITYRAIL	PENRITH Via Olympic Park
CLYDE	PIPPITA
COAL CLIFF	PORT KEMBLA
CRONULLA	PT KEMBLA NTH

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DAPTO	REDFERN
EAST HILLS	RICHMOND
EAST HILLS Via Airport	RICHMOND Via Olympic Park
EMPTY TRAIN	RIVERSTONE
EMU PLAINS	ROSEHILL
EPPING	ROSEHILL GARDENS RACE COURSE
FAIRFIELD	SEVEN HILLS
GLENFIELD	SPECIAL
GLENFIELD Via Airport	SPRINGWOOD
GLENFIELD Via Bankstown	ST MARYS
GLENFIELD Via East Hills	ST MARYS Via Olympic Park
GLENFIELD Via Granville	STRATHFIELD
GLENFIELD Via Regents Park	SUTHERLAND
GORDON	SYDNEY TERMINAL
GOSFORD	TERMINATES
GOSFORD Via North Sydney	THIRROUL
GOSFORD Via Strathfield	TRAIN UNDER TEST
GOSFORD Via Olympic Park	VALLEY HEIGHTS
GRANVILLE	WATERFALL
HELENSBURGH	WOLLONGONG
HOME BUSH	

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**APPENDIX L – MULTIFUNCTION COUPLER ELECTRICAL PINOUT  
ALLOCATION**

(Deleted)

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## APPENDIX M - DOOR TESTS

This Appendix outlines tests to indicate the susceptibility of the OSC doors to vandalism. The door tests are not limited to those listed and compliance with them does not relieve the Contractor of their responsibilities with respect to vandal resistance. Tests must be performed on each type of powered door and the Contractor must submit the full testing program including the test criteria at the CDR stage. Some tests will need to be repeated or operated as cyclic tests in order to simulate actual in-service operation. These tests are to be conducted at or near the completion of the door cycle life tests.

### 1. Door lateral Load Test.

- 1.1 A horizontal force representing 2 persons (500 N) exerted on each door leaf of a door pair during the same test cycle, at any point 1.5 m or shoulder height above the vestibule car floor level.
- 1.2 The same test as in Clause 1.1, except that the forces to act in the opposite direction.
- 1.3 Pass criteria:-
  - a) The door may temporarily slow down or stop during the test.
  - b) The door must operate normally after the test.
  - c) No permanent deformation or mechanical failure.
  - d) No long term effect on the door operation.

### 2, Door Longitudinal Load Test.

- 2.1 Force applied to the edge of each door leaf under the conditions of 1.1 causing each door leaf to open 40% faster than the programmed speed.
- 2.2 The same test as in Clause 2.1 except that the forces must cause the door leaves to close 40% faster than the programmed speed.
- 2.3 Pass criteria:-
  - a) The door may temporarily slow down or stop during the same test cycle.
  - b) The door may do one calibration movement after the close command is given.
  - c) The door must operate normally after the test.
  - d) No permanent deformation or mechanical failure.
  - e) No long term effect on the door operation.

### 3. Door Vertical Loading Test.

- 3.1 A vertical downward force of 1000 N or equivalent to a 100 kg person, to be applied at the top of the door, 200 mm from the edge of each door leaf of a door pair on the same test cycle.
  - 3.2 Pass criteria.
    - a) The door must open and close as appropriate. A maximum increase of 50% of the normal “door failure” threshold times to be allowed.
-

- b) The door must operate normally after the test.
- c) No permanent deformation or mechanical failure.
- d) No long term effect on the door operation.

#### **4. Surface Tests.**

- 4.1 Cross cut adhesion. When tested to BS3900 Part E6 1974 (10), using a 2 mm spacer, the surface must achieve a performance level of Class 1.
- 4.2 Scratch resistance. When tested to BS3900 Part E2 1974 (8), using a 2 kg load, the surface must achieve a performance level of no penetration.
- 4.3 Stone chip resistance. When tested to ASTM D3170 - 74 (2), using 16 mm mesh on 9.5 mm mesh, no damage greater than the limits stated in each of 4a, 5b, 10c and 10d. shall be allowed.
- 4.4 Bend test. When subjected to a Type 1 bend test to BS3900 Part E1 1970 (7), no cracks or detachment of the surface must occur.

#### **5. Chemical Resistance Test.**

- 5.1 The typical range of paints and inks must be individually applied to the surface and allowed to fully dry and cure.
- 5.2 Each of the various graffiti cleaners used by State Rail shall be used on each type of paint and ink, according to the manufacturer's instructions.
- 5.3 The graffiti removal must be complete. No damage must occur to the original surface and there must be no staining or "shadowing" after the removal of the graffiti. Test shall be repeated five times to ensure that no "shadowing" occurs.

#### **6. Obstruction and Detection Test**

- 6.1 The compliance of the door to the specification for obstruction detection to be established including at the floor level simulating a child's foot obstructing the door.
- 6.2 A test must be conducted to validate the minimum sized object able to be detected by the obstruction and detection system.

#### **7. Closing Force Test.**

- 7.1 With the obstruction detection system deactivated and the train stationary, the door closing cycle is to meet the requirements of the Contract for maximum closing force, through to the plugging and final closing of the door. The door must not permanently deform or deflect.
- 7.2 The test in Clause 7.1 is to be repeated with the door control system instrumented to simulate the OSC moving greater than 10 km/h. The door must meet the requirements of this Technical Specification; Part D. The door must not permanently deform or deflect.

#### **8. Indentation Test**

A 4 mm diameter hardened steel pin is to be forced into any location on an actual sample door panel (not the glass), in incremental steps of force of 100 N, commencing at 300 N. The door is to be inspected between each force application. No permanent deformation or damage shall be allowed at forces

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below 600 N. The force is to be stepped up until permanent deformation or damage occurs. The force at which damage occurs, and the type and extent of damage is to be noted.

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## **APPENDIX N - PRINCIPAL'S MAINTENANCE FACILITIES AND EMERGENCY EQUIPMENT**

### **1.0 Introduction**

This Appendix outlines the equipment used by the Principal within its Maintenance Centres and by the Emergency Response Group (break down gang).

This information has been prepared to support the Operating and Maintenance concept as detailed in Statement of Works; Part C, with the Principal undertaking maintenance under its existing regime to the Technical Maintenance Plan provided under the Contract.

The support documents, drawings and references are provided for the Contractor to be taken into consideration during the development of the Technical Maintenance Plan, the facilities, equipment, spare parts etc. which are available under the existing maintenance system, in meeting its obligations under the Contract.

While the Contractor should adopt a "Whole of Life" asset management approach, the documentation is not intended to restrict the Contractor in considering innovative approaches that will provide better value to the Principal.

If during the course of the Contract, the Contractor becomes aware of equipment that will provide a lower Whole of Life costing, details should be provided to the Principal.

### **2.0 Maintenance Facilities**

Refer Section 2 of the enclosed documentation for details of the Principal's Maintenance Facilities:

- Mortdale Maintenance Centre
- Hornsby Maintenance Centre
- Flemington Maintenance Centre
- Maintrain Auburn Service Facility

### **3.0 Emergency Response Unit**

Refer Section 3 of the enclosed documentation for details of the Principal's Emergency Response Unit.

### **4.0 Spare Parts**

Refer Section 4 of the enclosed documentation for details of the Principal's typical inventory of spare parts.

### **5.0 Additional Information on Facilities**

Refer Section 4 of the enclosed documentation for additional details of the Principal's Maintenance Facilities.

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## **Further Attachments**

- Attachment 1: Procedure – Removing and Replacing Vehicles from Tracks
- Attachment 2: Procedure – Using Pony Bogies to Support Defective Wheel Sets
- Attachment 3: Procedure – Replacing Bogies Back onto Their Kingpins
- Attachment 4: Procedure – Attending an Incident/Derailment Involving Dangerous Goods
- Attachment 5: Annual Usage of Common Items and Stores Where Held

Drawing Index

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## 2.0 MAINTENANCE FACILITIES

### 2.1 Mortdale Maintenance Centre

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Wash Roads	√	7	Rds 5, 6, and 7-10	All roads 2x163m/rd	Sydney end not elevated, depot end elevated for cleaning: all roads have dead end.	8.30am - 3.00pm, 9.00pm - 5.00am	Wet/dry vacuum, major internal clean, graffiti removal.
Automatic Car Wash Facility	√	1	Car wash road	1x163m set; 8 cars - transfer to/from shed and wash total time 15 minutes.	Wash bug awaiting funds for repair: drivers drive sets through: road is dead end, must reverse set back via wash rd.	M-F 7.30am - 4.00pm & 6.00pm - 12.00am, Weekends 6.00pm - 12.00am	Detergent wash.
High level access platforms	√	4	Rds 1,2,3 (includes lift shop)	Rds 1,2 - 1x163m/rd: rd 3 - 1x200m/rd	High level access (1&2 rds both sides, 3 rd one side only): height from rail head to platform typically 3530mm: car access between platforms typically 3350mm: stable 4 car set behind 1, 2 rds: both roads have dead end.	Rds 1,2 (PR) - 9.00am - 1.00pm and 9.00pm - 1.00am, 7 days: rd 3 (GI) - 7.00am - 3.00pm (M-F)	1,2 rds - PR's and out of course maintenance performed: 3 rd - general inspections performed.
Pit Roads	√	4	Rds 1,2,3 (includes lift shop)		Rd 3 (GI) if traction motor change required set has to be moved to 1 or 2 rd for forklift access: pit depth typically 1220mm, pit width typically 1100mm.		

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Lift Shop	√	1	Rds 1,2	Two cars/rd fit in lift shop.	High level access both sides of 1 & 2 rds: no overhead supply in lift shop: lifting of car requires two lifting operations, one end at a time: rds can be used simultaneously eg. car on rd 2 may undergo wheelset or bogie change, while car on rd 1 may undergo camshaft change - type of work dependent on crane access and clearances for removal of modules and undercar equipment:: rear exits are 5 metres wide and 6100mm high.		
Lift Shop Crane	√	2	Rds 1,2	Main hoist 25 Tonnes, auxiliary hoist 5 Tonnes.	Combined width of 1&2 rds and about 2 car lengths: high road access – 1 rd high level platform diagonally opposes 2 rd high level platform to allow crane access: top of rail to auxiliary hoist hook height 6100mm.		Detachable lifting beam attached to main hoist for lifting of cars and removal of bogies: auxiliary hoist for removal/insertion of roof items.
Jigs (lifting beams)	√	1 each	Lift shop	Approx. SWL's T/G sets only: A/C unit - 800 Kg, SIV module - 2500 Kg, Chopper module - 3500 Kg.	Made for T/G sets only. (Masses; AC 940kg, chopper 2150kg, SIV 2085kg): AC unit weight unbalanced, jig designed to keep unit level once in jig, specially designed and certified.		Modular replacement.

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
AC Trolley	√	1		Approx. 1000Kg	Has wheels for mobility - pushed by forklift: fits T & G AC units only.		
Trolley (station master)	√				General manual movement of small/light items.		
Drop Table	x						
Brake Roads	√	2	Rds 11,12	2x163m /rd	Access ramps at Sydney end, depot end and at 4 car length positions: elevated rd insufficient for undercar access: exposed to weather: 1080 width, length 345m:dead end at depot end.	9.00am -1.00pm and 9.00pm -1.00am, 7 days	Changing brake pads only, regulation of brakes.
Brake shoe trolley	x						
Brake road hoist	x						
Fork Lift	√	3		Road tractor - SWL 5 Tonnes: store f/l 1500kg, lift height 3 metres: manual f/l 1400kg lift height 3 metres	Road tractor is modified with a permanent jib.		Road tractor - lifts traction motors, wheelsets and one end of bogie: store f/l - moves items to/from store, moves all sets except T and G into/out of lift shop: manual f/l moves small items over small distances.

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Elevators	√	2	Shared by 2 and 3 rds	SWL 320Kg each	Located at about 1 and 4 car mark, interlocked with Annette system.		Bring glass to high level access rds.
Road Truck	√	1		6.030 Tonnes tare, 13.000 tonnes Gross	Items have to be lifted to and from truck via forklift or hoist.	7.00am - 3.30pm (M-F)	Road deliveries via gate 2 and 3, able to back up to rear of lift shop for loading/unloading.
Multifunction Roads	x						
Non-raised roads	√	6	Sydney end of 5 to 10.				
Shunting Vehicle (tractor)	√	1	Used mainly on 1,2,3 rds.		Emergency Tangara coupler head at front and sharon coupler at rear. On board compressor allows brake control (West) of up to 4 car set, can charge up air system on 4 car set.		Moves sets into/out of lift shop.

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Stores	√	2	Beside rd 1	Main store (general use items for day work only), rotatable store; ordering is by the min/max system.	Insufficient area to sustain new items, available interior and exterior areas are utilised for seating, glass, wheelsets, batteries etc.	Main via restricted access 7.00am - 3.00pm: rotatable store includes contingency for commonly used items on day and night shift - 24hrs unrestricted access.	
Car Weighing Facilities	√	1	2 rd in lift shop	At least one T/G trailer car	Bogie centre distance and wheel base must be equal to a T/G set, will not be able to fit onto load cells otherwise.		
Test Facilities	x						
Welding Facilities	√	1 each	Beside lift shop, external to shed.	Able to perform Mig, Tig, oxyacetylene and stick: oxyacetylene unit portable and has own generator.	Secured workshop: only one person qualified to weld.		
Gassing/degassing facility	x						

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
AC workshop crane	x						
AC workshop hydraulic hoist	x						
Jacking Road	x						
Component assembly/overhaul facility	x						
Wheel lathe	x						
Wheel lathe hoist	x						
Progression system	x						
Machining Facilities	√				General lathe only.		
Wet and Dry Vacuum	√	1	Platform between 6 & 7 rds	1x163m set /rd shared outlets.	9 points of attachment: flexible hoses about 1/2 car length long.		To vacuum up water etc after walls, floors and ceilings sprayed: to vacuum dry seats after shampooing.
Water (sinks, taps)	√		Rds 1, 2, 3 and between 6 & 7.				

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Stabling Roads	√	3	loop and adjoining two dividing rds	Loop rd 1x163m up to 2nd set of points: 2 dividing rds 1x163m/rd: buffer stop end of 1/2 rds 1x85m.	Access to lift shop restricted if 8 car set placed on Sydney end of loop: Dead end at loop and dividing rds: wash rd can be used but no cars can be washed.		
Shore supply (415VAC)	√		Rds 1,2,3 excluding lift shop.		Plug fits T and G set jumper connection only.		Only occasionally used, outlets may not be operational.
415VAC (welding )	√		Rds 1,2,3 including lift shop.				
240VAC	√		Rds 1,2,3 including high level access platforms and lift shop, between rds 6 & 7.				
120VDC	√		Rds 1,2,3 including high level access platforms, pits and lift shop.				

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Compressed Air Supply	√	2 (1 duty and 1 standby)	Beside rd 1	163 cfm, max discharge psig	Approx. 750kPa max.: connections - 1/2" BSP male thread & same with CJEN quick connect fitting fitted (fits 8mm bayonet): filter drier dries air output from compressor.	24 hrs	Supplies all shop air.
Compressed Air Supply Connections	√		Rds 1,2,3 including high level access platforms, pits and lift shop.		Threaded connections in pit as well as on stanchions, extendable air hoses mounting on underneath of high rds - length 15m, only Rd 3 has reel on high rd access, other roads have connections.		
Roof Lighting (fluoro)	√		Rds 1-10				
Pit Lighting (fluoro)	√		Rds 1,2,3 including lift shop.				
Effluent Decanting	x				Decanted at Port Kembla: Public Works plumber under fitter's instruction replaces toilets - fitters do not work on toilets.		
Road Isolation	√		All roads except wash road		Knife switch with Annette key system.		

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Heavy vehicle access (all weather)	√	2	No2 gate (main) and no3 gate (secondary).		Gate 2 off Boundary Rd, gravelled parking/turning/loading/discharge area, access to area behind lift shop requires traversing 2 to 4 tracks: loading/unloading materials requires forklift to traverse large distance to main store and rotatable store.		
Mobile Stairs	√	4	Rds 1,2,3	SWL 300kg/m2	Set to height of train floor.		Platform with stairs allows access to drivers and side doors, wheels lock for stability.
Working Platforms	√	4	Rds 1,2,3	SWL 300kg/m2	Set to height of train floor.		Platform with built in ladder on side allows access to drivers and side doors, wheels lock for stability.
	√	1	Lift shop	SIV working platform unknown.	Made to fit Mortdale lift shop dimensions only.		Allows access to front area of train for ease of removal.
Scaffolding (with platform)	√	1	Rds 1,2,3	Not stated	Adjustable.		Painting, car building.

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Scissor Lift with platform	√	1	workbay	226kg	Heights are in two stages (1.2m and 3m), 2nd stage requires security key.		Has own power supply and is rechargeable (240VAC), has separate GPO for external power supply for tools.
Lifting trolley	√	1	workbay	750Kg			
Hydraulic Car Jacks	√	2	workbay	approx. 12 tonnes each			Have forklift attachment for mobility, positioning aided by two mobile trolleys.
Car Stands	√	4	lift shop	SWL 10 000kg each	Non adjustable.		Used under one or both ends of car during lift shop maintenance.
Workbay	√	1	Behind 3 rd			24hrs	Lindishing grinder (small), drilling m/c, cleaning bath, 2 large pedestal grinders (2 wheels per grinder), 1 gap bed lathe, Parker Hannifin door motor test bench.
Work benches	√	3	Rd 3				Bench vice on each bench.
Remote mapper (oracle) access on work roads	√	1	Rd 3 and lift shop		Exposure to external working environment (dirty hands).		PC to access oracle for car history and failure information, updating of repairs.

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Ultrasonic Test Equipment	√	1					
Pumps (oil)	√	10	Rds 1,2,3		Pneumatic pumps and rotary pumps for attachment onto standard oil drums.		
Mobile drum supports	√	10	Rds 1,2,3	Supports full 44 gallon drum of oil	Three wheels for mobility.		
Double Deck Suburban Car Jumper Tester	√	1		Mobile trolley required power.			
Battery Tester	√	1			Battery and circuit tester - mobile unit requires power.		
Battery Charger	√	1	Battery store				
Greasing points	x						

## 2.2 Hornsby Maintenance Centre

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Wash Roads	√	4	Rds 4-7	Each road - 2x163m, depot end 8 cars, Sydney end 8 cars	Sydney end not elevated, depot end elevated for cleaning: road has a dead end.	Day, afternoon, night shifts	Wet/dry vacuum, major internal clean, graffiti removal; door glass replacement.
Automatic Car Wash Facility	√	1	16	1x163m set; 8 cars - transfer to/from shed and wash total time 15 minutes.	Wash bug awaiting funds for repair; towing vehicle used to drive sets through wash; washed sets leave via rd 15 (joined); road is a dead end; wash plant operating tower removed.	Monday to Friday day and afternoon shift (up to about 11pm)	
High level access platforms	√		Rds 1,2,3,8,9 (includes lift shop)		Roof items such as gate control (T/G) must be carried down stairs or forklift used to max height to lift down from high road level; car access between platforms typically 3350mm, height from rail head to platform typically 3530mm.		Rds 1,3 - GI, PR; rd 3 - roof washing; rd 2 - general repair, storage; rds 8,9 - brake regulation/inspections, PR, roof repairs, has driver access platforms, has drop down stairs.
Pit Roads	√		Rds 1,2,3,8,9 (includes lift shop)		Rds 1,2,3 are below ground level; rds 8,9 raised for access: pit depth typically 1200mm (brake roads are 1420mm), pit width typically 1100mm.		

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Lift Shop	√		fits 1x20.3m car, one road only, pit extends outside lift shop by about 2 car lengths		High level access at ends of lift shop only (both sides); max size of replacement items equivalent to an AC - restricted by lift shop width and side access doorway width; SIV and choppers - cars need to be removed, items removed from lift shop, replacement items lifted into position and cars brought back in for item installation.		
Crane - Lift shop	√			20 tonne SWL	Estimated to be equivalent to MMC hook height (floor to hook) - 6100mm.		Detachable lifting beam attached to hoist for lifting of cars and removal of bogies.
Car Jacks (drop table)	√	2		15 tonne SWL each	Jacks are located using a trolley.		
Jigs (lifting beams)	√						
AC trolley	√	1	AC bay	Unknown - approx. 1000kg.	Fits all AC units; portable.		
Trolley (station master)	√						
Drop Table	√	1	Lift shop	31 tonne			Changing bogies and alternators.

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Crane - Service Road (beside drop table)	√			15 tonne SWL	Hook height (floor to hook) - 5500mm, total lift height (hook to below floor level) - 7500mm.		
Brake Roads	√	4	Rds 8,9,12,13	Each road - 2x163m	Access ramps at Sydney end, depot end and at 4 car length positions: elevated rds insufficient for undercar access and exposed to weather: typically 1100mm wide, length 345m:dead end at depot end.	Day, afternoon, night shifts	Brake shoe changes/regulation; can do PR's.
Brake shoe trolley	x						
Brake road hoist	√		Depot end of brake roads.	Unknown.			Lifts GTO stacks.
Fork Lift	√			Road tractor - SWL 5000kg; forklift with extended forks - SWL 5000kg; forklift - 1000kg; store forklift - 1180kg	Road tractor is modified with a semi-permanent jib.		Road tractor - lifts traction motors, compressors, AC's, wheelsets, used as a backup for the lift shop; other 5000kg forklift lifts AC, chopper, SIV, wheelset; 1000kg forklift - lifts traction motors, compressors and for general purpose use; store forklift dedicated to store area, lifting pallets etc.

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Elevators	x						
Road Trucks	√	1		T 10560kg A 20400kg L 9840kg	Has crane - lifting capacity of 3650kg at 2.65m & 450kg at 13.35m.		
Multifunction Roads	√	2	Rds 8,9	roof /side /underframe access	> 2x163metres length; extra width between roads for forklift access; depot end of wide area has hoist.		Hoist for lifting small loads (GTO stacks).
Non-raised roads	√	11	Sydney end of Rds 4, 5, 6, 7; 2 car lengths at Sydney end of rds 1, 2, 3; rds 11, 14, 15, 16.		Roads 1-3 fit 1x163m, roads 4-7 fit 2x163m; rd 2 has pit at Sydney end for 1 car length.		2 rd used for traction motor change with forklift (jib) and 2 car jacks, road must be isolated; compressor changes done also.
Shunting vehicle (tractor)	√	1			Emergency Tangara coupler head at front and sharon coupler at rear. On board compressor allows brake control (West) of up to 4 car set, can charge up air system on 4 car set.		Moves sets into/out of lift shop.

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Stores	√	2	Main store back of 1, 2, 3 rds; running store beside 1 rd.	Main - top level has 1500kg crane, 1100kg forklift, and hand trolleys; ordering is by the min/max system.	Main store on two levels - lower level houses small rotables and general use items, top level houses larger rotables and glass (not TM etc).	Main store 7.00am - 3.00pm, restricted access, two man operation; running store 3.00pm - 7.00am, unrestricted access.	
Car Weighing Facilities	√	1	loop road of lift shop		Bogie centre distance and wheel base (2400mm) must be equal to a T/G set, will not be able to fit onto load cells otherwise.		
Test Facilities	√	1	Beside rd 1		Must have AC on AC trolley for support and access.		AC - after repair can set up unit for test run.
Welding Facilities	√	1	beside lift shop	Able to perform Mig (2 sets), oxyacetylene (2 sets) and stick: oxyacetylene and stick unit portable			

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Gassing/degassing facility	√	1	Beside rd 1	Can handle all types of AC's.	During operation of AC unit, ducting for removal of hot air obstructs the access to the top part of the unit, therefore this ducting is disconnected or not used. In order to gain access the units must be positioned away from these ducts. Testing units have automotive quick connect connections on hoses (industry standard) - low pressure hose (up to 300psi) and high pressure hose (up to 1800psi); set up only suitable for 134A gas.		
AC workshop crane	x						
AC workshop hydraulic hoist	x						
Jacking Road	x						
Component assembly/overhaul facility	√				For AC units only, all parts are repaired except the evaporator, compressor, motor.		
Wheel lathe	x						
Wheel lathe hoist	x						

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Progression system	x						
Machining Facilities	√				General lathe only.		
Wet and Dry Vacuum	√	1	Platform between 4 & 5 rds	1x163m set /rd shared outlets.	9 points of attachment: flexible hoses about 1/2 car length long.		To vacuum up water etc after walls, floors and ceilings sprayed: to vacuum dry seats after shampooing.
Water	√		Rd 3 high access platform, between rds 7/8	Water hose reel (3 rd); hot water (7/8)			
Stabling Roads	√		Rds 2,11,12,13,14,15	Rd 2 - 1x163m, rds 11 to 15 - 2x163m.	All roads dead end.		
Shore supply (415VAC)	√		Lift shop, rds 1,2,3,8,9		Plug fits T and G set jumper connection only.		Only occasionally used, outlets may not be operational.
415VAC (welding)	√		Lift shop, rds 1,2,3,8,9		Lift shop also has outlets inside the pit at the buffer stop end.		

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
240VDC	√		Lift shop, rds 1,8,9		Two pin outlet in pits not generally used.		
120VDC	x						
24V	x						
Compressed Air Supply	√		Beside rd 1				Supplies all shop air.
Compressed Air Supply Connections	√		Rds 1,2,3,8,9,16 & lift shop.		Rds 1,2,3 - 1/2" BSP male connection; rds 8,9 - 1/2" BSP male connection in pit; lift shop - 1/2" BSP male connection at floor level, air hoses on reels with bayonet fitting (4).		16 rd supply for charging towing vehicle.
Roof Lighting (fluoro)	√						
Pit Lighting	√						
Effluent Decanting	x						
Road Isolation	√		All roads except wash road		Knife switch with Annette key system.		
Heavy vehicle access (all weather)					All weather road access from lift shop, passed stores and along behind wash road.		

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Mobile Stairs	√			Unknown	Set to height of train floor.		
Working Platforms							
Scaffolding (with platform)	√	1		Unknown	Platform height alterable, portable, approx. max height 12ft.		Access to front end of train, top middle and lower glass.
Scissor Lift with platform	√	1		300kg	Lifting height unknown.		
Lifting trolley	x						
Car Jacks (screw type)	√	4		2x 30 tonne, 2x 15 tonne SWL	Portable.		
Car Stands	x						
Workbay	√	1	Beside rd 1		Drilling machine, grinder, sandblaster, workbenches with vices, lathe, linisher.		
Work benches	√	2	Workbay				
Remote mapper (oracle) access on work roads	√	1	Back of rd 1				

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Ultrasonic Test Equipment	√						
Pumps (oil)	√						
Mobile drum supports	√				Greasing trolley with drums on board.		
Double Deck Suburban Car Jumper Tester	x						
Battery Tester	√						
Battery Charger	√						
Truck (Kubota)	√						Shunting, detachable blade for ballasting inside depot.
Greasing points	√		1/2 & 2/3, rd 1		Greasing points attached to hose on reel (1/2 & 2/3); grease supply/removal piping.		Greasing of axle boxes, changing oil on traction motors and compressors.

### 2.3 Flemington Maintenance Centre

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Wash Roads	√	4	Rds 5, 6, 7 & 8	Raised end (depot end) 1x163m, non-raised end (SE) 4 car length/rd.	Sydney end not elevated, depot end elevated for cleaning: Dead end.		Wet/dry vacuum, major internal clean, graffiti removal, window replacement.
Automatic Car Wash Facility	√	1	Wash road	1x163m set; 8 cars - transfer to/from shed and wash total time 15 minutes.	Wash bug awaiting funds for repair: drivers use 4 or 6 car set for towing vehicle: alternate road available for movement of set back into yard.		
High level access platforms	√	5	Rds; A,B,C,4,F (rd 8 - only for 1 car length)	Rds A,B,C,4 - 1x163m;rd F - 2 car lengths	Height from rail head to platform typically 3530mm: car access between platforms typically 3350mm: rd F - efficient replacement of AC unit (using hoist) as AC workshop attached to side of F road.		Rds A & B - GI and PR inspections (includes compressor and brake cylinder changes), roof inspection (unit replacements done on F road); rd C - out of course repairs and running repairs; Rd F - roof gear requiring lifting help, includes AC changes; rd 4 - out of course work.

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Pit Roads	√	12	Rds 1,2,3,4,9,10, 21, 22, A,B,C,F	Rds 1 to 4, 9,10,A,B,C - 1x163m car set/rd: rds 21, 22 - pit is 1 car length; Rd F - 2 car lengths;	Forklift restricted to roads A & B (width); fluorescent lights approx. every 1500mm, both sides: pit depth typically 1220mm, pit width typically 1100mm.		Rd F used for under car inspection (traction motors etc).
Lift Shop	√	3	Rds 21,22,23	Rds 21,22 - 2 cars/rd; rd 23 - 4 car set.	Only 22 road can be used for working, forklift used to push set into and out of road.	Day and afternoon shift.	Rd 21 for bogie storage; rd 22 - changeouts on couplers, traction motors, alternators, bogies, brake cylinders, bellows, crown springs and wheelsets, after wheel machining do - brake change, regulation and balance bogie height; rd 23 has non-operational wheel mill.
Lift Shop Pits	√	2	Rds 21,22		Depth est:1500mm, Width est:1000mm.		Pit used on rd 22 only, pit in rd 21 has no services.
Lift Shop Crane	√	1	Rds 21,22 (can also traverse the Sydney end of 23 road)	Main hoist 25 ton, class 3 (hook load 23 tonne SWL); 4 tonne auxiliary hoist	Estimated to be equivalent to MMC hook height (floor to hook) - 6100mm.		Main hoist lifts half car, bogies etc, small hoist lifts light bogies etc. Lighter items (couplers etc.) are lifted by forklift.

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Jigs (lifting beams)	x						
AC Trolley	√	3 (two types)	AC workshop	Unknown	One type adjustable, the other fixed; both types portable.		
Trolley (station master)	x						
Drop Table	x						
Brake Roads	√	2	Rds 9,10	2x163m length/rd	Access platform to train doors between rds 9 &10; rail level raised, pits accessible from the side and deep. No electrical or pneumatic services.		Changing brake pads, regulation of brakes; internal clean; PR's.
Brake shoe trolley	√	2	Rds 9,10		Able to store inside buffer stop base, must have track empty to load shoes onto ground below track and to pick up shoes after shoe changes.		Carries brake shoes along track, able to load brake shoes onto trolley by hoist.
Brake road hoist	√	1	Rds 9,10	Hoist 2 tonne class 3, forklift arm attachment is 2 tonne SWL.			Forklift attachment allows pallets of brake shoes to be loaded.

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Fork Lift	√			Lift shop - 2700kg lifting height 3700mm; AC workshop - 1660kg lifting height 2590mm; store - forklift cap 2 tonne lifting height 240mm, f/l cap 1 tonne lifting height 3 metres, f/l cap 1 tonne lifting height 1970mm.			
Elevators	x						
Road Trucks	√	2		One equipped with crane.			
Multifunction Roads	x						
Non-raised roads	√	16	Rds 1,2,3,12 to 20,21,22,23,24				Rds 12 to 20 – storage.
Shunting vehicle (tractor)	√	2			Tractor currently used has an attachment for pushing against the buffer beams.		Road /rail tractor available but not used, alternative tractor used without road/rail capacity.

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Stores	√	2	Beside rd 1	Main store - scissor lift capacity 250kg lifting height 0.5 metre; ordering is by the min/max system; flammable store floor lowers for road access, capacity 1400kg; upper level has hoist and enclosed platform cap 2 tonnes SWL class 2; 2 unmotorised hand trolleys cap 2 tonnes.	Separated into main store (includes flammable store) and after hours store. Main store is on two levels - lower level houses shelvable items (small rotables), 2nd level houses items stored more easily in crates (glass, rubber etc.). After hours store houses general use small items (overnight contingency).	Main store 7.00am - 3.30pm manned, after hours store 24hr access, unmanned.	Scissor lift - small rotables, 2 tonne f/l - lifting pallets of batteries, 1 tonne f/l loading/unloading glass etc onto hoist, 1 tonne f/l (upstairs) loading/unloading crates from hoist.
Car Weighing Facilities	√	5 pairs	Rd 22		Bogie centre distance and wheel base must be equal to a T/G set, will not be able to fit onto load cells otherwise.		(1 set of 3 pairs - locos, 1 set of 2 pairs pass).
Test Facilities	√			For AC units only.			
Welding Facilities	√	1	Beside rd 1	Able to perform Mig, Tig, oxyacetylene and stick: workbay has grinder, saw, extraction system.			

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Gassing/degassing facility	√	1	Beside rd 1	Can handle R22 and R134A gases (separate reclaiming units)	Testing units have automotive quick connect connections on hoses (industry standard) - low pressure hose (up to 300psi) and high pressure hose (up to 1800psi).		
AC workshop crane	√	1	AC workshop and F road	3 tonne SWL	Has crab attachment to move onto separate running rail.		All roof components.
AC workshop hydraulic hoist	√	1	AC workshop, beside rd 1	Operating range 200kg - 1250kg.	Portable, foot operated.		Lifting compressors.
Jacking Road	x						
Component assembly/overhaul facility	√				For AC units only, all parts are repaired except the evaporator, compressor, motor.		
Wheel mill	√	1	Rd 23	5 min. to set up using installed cutters, 40 minutes to machine wheelset, 1.5 hrs to change cutters (currently set to TP2 and TP2 7/8).	Machines one wheelset per time.		

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Wheel mill hoist	√	1	Rd 23	250 kg class 3			Lifts cutting tools into/out of wheel mill.
Progression system	√	1	Rd 23	Able to pull 4 car V set			
Machining Facilities	√			Wheel lathe and general lathe.			
Wet and dry vacuum	√	Rds 5/6 & 7/8			9 points of attachment: flexible hoses about 1/2 car length long.		To vacuum up water etc after walls, floors and ceilings sprayed: to vacuum dry seats after shampooing.
Water (sinks and taps)	√						
Stabling Roads	√	9	Rds 12 to 20	2x163m length/rd			
Shore supply (415VAC)	√		A,B,C				
415VAC (welding)	√		Rds 1,2,3,21,23, F				
240VDC	√		Rds 22,A,B,C				
120VDC	√		Rds A,B,C,F				
24V	x						
Compressed Air Supply	√						

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Compressed Air Supply connections	√		Lift shop, rds A,B,C,		1/2" BSP male and 1/2" Snap-On; hose reel with dummy coupling connection (rd B only).		
Roof lighting	√						
Pit lighting	√						
Effluent Decanting	x						
Road Isolation	√				Knife switch with Annette key system.		
Heavy vehicle access (all weather)	√						
Mobile Stairs	√	4	Rds A,B,C	SWL 300kg/m2	Set to height of train floor.		Platform with stairs allows access to drivers and side doors, wheels lock for stability.
Working Platforms	√			Unknown	Set to height of train floor.		Platform with built in ladder on side allows access to drivers and side doors, wheels lock for stability.
Scaffolding (with platform)	√			Not stated	Adjustable.		Painting, car building.

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Scissor Lift with platform	√	1	Rd 22	Unknown	Specifically for use on rd 22.		Both rails are split and hinged on track to allow platform to hook into wall of pit, platform has set of rails and generator is supported and removed by manoeuvring the platform (up/down/side to side).
Lifting trolley	x						
Hydraulic Car Jacks	x						
Car Stands	√	4	Rd 22	Unknown	Non adjustable.		Used under one or both ends of car during lift shop maintenance.
Car Building Workshop	√	1			Band saw, 2 cutting work benches, drilling machine, grinder, workbenches with vices.	24hrs	
Work benches	√		Work bays	Bench vice on each bench.			
Remote mapper (oracle) access on work roads	x						
Ultrasonic Test Equipment	x						

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Pumps (oil)	√				Pneumatic pumps and rotary pumps for attachment onto standard oil drums.		
Mobile drum supports	x						
Double Deck Suburban Car Jumper Tester	√			Mobile trolley required power.			
Battery Tester	√				Battery and circuit tester - mobile unit requires power.		
Battery Charger	x						
Greasing points	x						

## 2.4 Maintrain Auburn Service Centre

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Wash Roads	√				Non existent currently. Presentation rds planned for internal and external fit-out and cleaning.		Planned for future - internal and external wash. System will not be automated as in the depot.
Automatic Car Wash Facility	x						
Bogie wash facility	√	2	Back of jacking rd.		One is automated and the other is for manual light cleaning. Traction motors must be removed before cleaning bogie.		
High level access platforms	√	1	Commissioning road	4 car length	High level access both sides, dead end.		
Pit Roads	√	2	Commissioning road, out of course repair road, bogie wash rd.	4 car length	OOO has non-raised area for 1 car length for car jacking, bogie wash rd pit allows access for removal of traction motor.		

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Lift Shop (jacking road)	√	1	Jacking road	4 car length	Able to lift 4 cars simultaneously. Will take 4 suburban cars or two intercity cars (due to length of cars and jacking locations). No pits, high roads or overhead supply.		Replacement of bogies, compressors, air reservoirs, couplers, repair/replacement of pipework and underframe support work; NDT of critical weld areas (MPT).
Lift Shop Crane (jacking road)	√	1	Extends across commissioning road and jacking road	10 tonnes SWL	Crane not used for raising/supporting cars.		Detachable lifting beam attached to main hoist for lifting of cars and removal of bogies; auxiliary hoist for removal/insertion of roof items.
Jigs (lifting beams)	√		Lift Shop (jacking road)	Approx. SWL's T/G sets only: A/C unit - 800 Kg, SIV module - 2500 Kg, Chopper module - 3500 Kg.	T/G sets - lifting jigs; AC, SIV, chopper units, AC support pallet; other sets - camshaft and high tension group, curtain/diaphragm support (used with forklift for T/G & I/C sets).		Modular replacement.
AC Trolley	√						
Trolley (station master)	x						

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Drop Table	x						
Brake Roads	x						
Brake shoe trolley	x						
Brake road hoist	x						
Fork Lift	√	Many		Average about 2-3 tonnes.			
Elevators	x						
Road Truck	√						
Multifunction Roads	x						
Non-raised roads	√						
Shunting Vehicle (tractor)	√	2			Detachable couplers at front and rear, takes sharon coupler (on all sets except T/G) and Emergency Tangara coupler. Can pull 4 car set.		Normal mode for movement of sets onto and out of the premises as there is no overhead wire.
Stores	√	2	Beside rd 1	Main store (general use items) and rotatable store.	Rotatable store is to be expanded for increase in capacity, currently items are in racks external to building.		

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Car Weighing Facilities	√	1	Weighing road.	Can weigh all wheels on a car simultaneously	Can weigh all suburban and interurban vehicles. Design of vehicle needs to be considered so packing of suspension system is simplified as in the T/G sets.		Balancing the load on a car, allocates packing to correct load.
Test Facilities	√		Air brake shop, bogie suspension springs.		Air brake shop - system is currently set up for Westinghouse and Davies and Metcalf equipment. If other manufacturer used would require some modification of existing equipment (change manifolds/interface to testing equipment) or new equipment. Bogie springs - able to do all springs including T/G sets, requires base and top retaining housings for testing. New type of springs would require new housings. Would require adjustment to computer program to incorporate any new variations of springs. "A dimension" jig - checks the height between the axle box and the bogie frame.		All pneumatic equipment, including solenoids are tested. Each item is tested separately. Testing facilities are - drivers console for suburban and T/G set testing, T/G test bench, Westinghouse test bench, D&M test bench, brake cylinder test bench (not T/G sets). Brake cylinders for T/G sets contracted out, other sets are stripped, rebuilt and tested on site.

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Welding Facilities	√		Besides jacking road and inside bogie workshop.	Straighten bogie frame in 40 - 60 hrs.	Able to perform Mig, Tig, oxyacetylene and stick. Includes a turn over jig and a turn around jig for easier welding access to bogie frame; rocking jig for checking distortion after welding etc., coupler rotator.		
Gassing/degassing facility	x						
AC workshop crane	x						
AC workshop hydraulic hoist	x						
Jacking Road	√		Can support at least the weight of an intercity car (61 tonnes tare).		Comprises of both jacks (platforms) and stands. Able to raise both to a height of about two metres. The stands are adjustable - able to adjust horizontal distance along track, lateral distance from support point and height. These jacks are integrated into the jacking road.		The jacks support the car by lifting the bogies and the stands lift the car at the underframe.

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Component assembly / overhaul facility	√		Bogie workshop, air brake shop, pneumatic shop.	Bogie o/haul - 45 hrs with 2 men, rebuild telescope & door motor (T/G) - 4hrs.			Includes wheel and axle machining, disc removal/machining/installation from T/G wheelset, gear box overhaul, axlebox overhaul (cleaning and dimensional checking contracted out), brake rigging and bogie frame overhaul, DC and AC drive traction motors contracted out. All air brake components overhauled including reservoirs, pantographs and door motors, except the T/G brake cylinders.
Wheel lathe	√		Trailer wheel sets only	18 wheel sets / day	Motor wheelsets have to be done on another lathe in a separate workshop (these wheelsets are generally infrequently turned due to their low wear rate).		
Wheel lathe hoist	√						

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Wheel Press (removal)	√	1 each	Bogie workshop		Trailer press can only take trailer w/sets. Motor/trailer press will take either but motor w/s requires jockey wheel to support gearbox. Jockey wheel track would require adjustment for non-standard position of gearbox. Removal of axlebox is via a puller - has different horse shoes for different sizes, new type of axle boxes would require new horse shoes. Current snap gauges are for diameters between 125/150mm and 150/175mm, any other axle diameters would require new gauges.		
Wheel Press (wheel installation)	√	1					
Traverser	√	2	Between bogie workshop and collision repair workshop; back of bogie workshop.	8 bogies or 1 locomotive.			
Progression system	x						

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Machining Facilities	√						
Wet and Dry Vacuum	x						
Water (sinks, taps)	x						
Stabling Roads	x						
Shore supply (415VAC)	√						
415VAC (welding )	√						
240VAC	√						
120VDC	x						
Compressed Air Supply	√						
Compressed Air Supply Connections	√		Jacking road, CCO road		1/2" quick connect fitting adaptable for rattle guns etc.		
Roof Lighting (fluoro)	√						
Pit Lighting (fluoro)	√						

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Effluent Decanting	x				Decanted at Port Kembla: Public Works plumber under fitter's instruction replaces toilets - fitters do not work on toilets.		
Road Isolation	x				Knife switch with Annette key system.		
Heavy vehicle access (all weather)	√						
Mobile Stairs	√						
Working Platforms	√				Set to three heights - train roof, floor and windscreen.		Platform with built in ladder on side allows access to drivers and side doors, wheels lock for stability.
Scaffolding (with platform)	x						
Scissor Lift with platform	√						
Lifting trolley	√	1					
Hydraulic Car Jacks	√		Jacking road, OOC rd, collision repair workshop.	SWL 30 Tonne each	Portable car jacks.		Have forklift attachment for mobility, positioning aided by two mobile trolleys.

Facility	Facility in Place	Num.	Location	Capacity	Operational area/limitation	Operation Hours	Function
Car Stands	√						
Hydraulic platforms (jacks)	√		Jacking road		Hydraulic platform in pit area between jacking points can lower to ground level or raise to do work under vehicle.		
Workbay	√						
Work benches	√						
Remote mapper (oracle) access on work roads	x						
NDT Equipment	√			MPT, ultrasonic. 30 minutes / wheelset for MPT.	Magnetic particle testing on axle shaft and journals, underframe welding. Ultrasonic testing on axle area covered by gearbox.		
Pumps (oil)	√						
Mobile drum supports	x						
Double Deck Suburban Car Jumper Tester	x						

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<b>Facility</b>	<b>Facility in Place</b>	<b>Num.</b>	<b>Location</b>	<b>Capacity</b>	<b>Operational area/limitation</b>	<b>Operation Hours</b>	<b>Function</b>
Battery Tester	x						
Battery Charger	x						
Greasing points	x						

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### 3.0 EMERGENCY RESPONSE UNIT

**Contact - Earl Wilson 0419 418172 (7.15am – 15.15pm+)**

#### 3.1 Overview

- Work on passenger vehicles primarily in the metropolitan area but have previously worked the entirety of N.S.W.
  - Operations involve; derailments, collisions, any time where a pony bogie may be required, exchange of wheelsets and bogies
  - Core crew of 10 people, with additional assistance normally drawn from the XPT Centre and from Flemington and Mortdale Maintenance Centres.
  - On Call 24 hours a day, 7 days a week (normal working hours 7.15am – 3.15pm).
  - Skill level of personnel – 2 with trade based background (fitters trained in welding) and on the job training, non-trade based have on the job training only.
  - Equipment:
    - Possess rail recovery train with a 110 tonne crane. Restricted to major work only, as can not operate normally where overhead wiring in close proximity to work area. Requires OHW to be isolated and possibly disconnected.
    - Various capacity jacks
    - Two reticulated vehicles with a single axle trailer for ease of manoeuvrability
    - Crew van to carry work personnel and ancillary equipment
    - Ancillary equipment including hand tools and enerpacs (capacity up to 50 tonne each, height restriction)
    - Three carriages used as accommodation on major work, capacity for 16 people.
  - Re-railing – generally use jacking equipment and items carried in one of the two emergency response vehicles.
  - Righting a vehicle – generally use the rail crane where they are asked to attend, or contractor may be contacted instead to use a road crane. Where rail crane or contractor's road crane can not gain access, specialised ladder and jacking system carried by the two emergency response vehicles. All items transportable.
  - Change outs – where equipment needs, or has been arranged to be changed out, crew can change item such as bogie. They do not have the capacity to return the item to a workplace, therefore normally separate crew (FreightCorp) will supply item such as bogie, and they will also take the item for repair back to a workshop. Emergency response unit can cut up the item possibly and dispose of it as scrap.
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- Under major work conditions will have a work crew and a relief crew.
- Procedures – there are sixteen documented work procedures that apply to the core processes used and the maintenance of some of the equipment. Due to the enormous variation in the work, there are no procedures that can be applied beyond the core processes. These procedures have been validated by on the job experience. There is training and induction before staff are allowed to go on the job, but most training is learnt on the job. They have videos for training.
- Safety apparel – 3M 8714 acid gas respirator suitable for use with chlorine, hydrogen chloride and sulphur dioxide; rubber boots with steel toecaps, full face shield and gloves. (Refer to procedure numbers; 013B “Wearing the 8714 acid gas respirator” and 013A “Attending an incident /derailment involving dangerous goods”.

## 3.2 Equipment Audit

### 3.2.1 Support vehicles:

This includes a road/rail vehicle and a 4 wheel drive vehicle

### 3.2.2 Road Trucks:

There are two road trucks, one set up for water jacks, the other set up for oil jacking. Both trucks carry essentially the same items except for items specific for the type of jacking.

### 3.2.3 Water Jacks (the numbers represent those carried in one truck only)

Type	Capacity (tonnes)		Lifting height (mm)		Number
	1 <sup>st</sup> stage	2 <sup>nd</sup> stage	1 <sup>st</sup> stage	2 <sup>nd</sup> stage	
Two stage 60/30	60	30	230	460	4
Two stage 120/60	120	60	230	460	3
Two stage 150/75	150	75	230	460	1
Telescoping	35	-	1000	-	2
Squats 60/30	60	30	130	-	3
Squats 120/60	120	60	130	-	1
Squats 10	10	-	130	-	4
Pushing jack	12	6			2

### 3.2.4 Oil jacks

Exactly the same except the 150/75 tonne two-stage jack is replaced by a 90/45 tonne two-stage jack.

Workshop in depot at Clyde has maintenance facilities and manufacturing facilities. It has; lathe, forklift, hand tools, enerpac 50 ton press, power hacksaw, grinder, oxyacetylene for oxy cutting, drilling machine and cleaning bath.

### 3.2.4.1 Equipment Carried by Emergency Response Truck Fitted-out for Water Jacks

Item	Function	Capacity	No.
Traversing Beams	Used in conjunction with trolley, telescoping jacks and other jacks in re-railing operation.	80 tonnes each	2
Trolleys	As above.	120 tonne approx.	
Pony bogie (type A & B)	Used under two conditions, transportation of a car when; wheels in place but defective (type A), and secondly for when wheels removed (type B). Can only do one bogie in this way per car.	20 tonne axle load	1 each
Wire rope ladder	Used to right a vehicle on its side.		1
Air hoist	Permanently attached to truck, lifts items in/out of truck. Able to traverse entire length of truck by manually moving the hoist along its tracks.	0.5 tonnes (main body), 0.3 tonnes (jib)	1 as a unit
Compressor	Permanently stays with truck, provides air to air hoist and able to detach lines to provide air pressure to rail vehicle.	100 p.s.i.	1
Transformer	Petrol driven motor attached to a pump used to provide fluid under pressure for jacking (mobile, includes lifting bracket). Duty and standby pumps.		2
Control stand	Used in conjunction with transformer and jack for controlling operation of jack.		1
Pump	Used for removal/filling of fluids		1
Oxyacetylene cutting equipment	Freeing items.	200 p.s.i., extendable hose length 25 ft.	1
Pollution Gear	Same gear as supplied to police and fire brigade, booms.		1 set
Fire fighting equipment	Various extinguishers, water tank, pump and hose		1 set
Rail tongs	Manually shifting rails.		
Packing	Various sizes and lengths, commonly 900x150xx300mm hardwood		
Locomotive jacking brackets	Used for lifting locomotives by the rail crane.		4
Winch gear	Located at front of truck		1
XPT jacking/lifting bkt	Used for jacking/lifting with the rail crane, has eyelet to accept crane hook.		2
Emergency Response Truck	Road access vehicle only, consists of prime mover and single axled trailer.	7 960 kg (T) 900 kg (A) 5940 kg (L) 21 000 kg (PM & T approx.)	2

### 3.2.6 Equipment Carried by Emergency Response Truck fitted out for Oil Jacks (additional or different from water jack truck set up)

Item	Function	Capacity	No.
Transformer	Petrol driven motor attached to a pump used to provide oil under pressure for jacking (mobile, includes lifting bracket). Duty and standby pumps.		2
German Pusher Bracket			
Turfer	General purpose winch.	3 tonne (SWL)	1
Ladder (wooden)			

### 3.2.7 Equipment Carried by Crew Transport Truck

Item	Function	Capacity	No.
Portable generator	Used to provide power for lights external to truck.		1
Manual trolleys	Used for moving small items , 3 wheeled		2
External lighting	Telescopic stands allow balloon lights to lift up to about 20 feet		2
Ladder			
Pneumatic mats	Air driven mats for attachment around perforations on vehicles to contain payload, lifting small distances where jacking not possible.	50 tonnes each, lifting height 6 in. approx.	3
Jaws of life	Gain access to items in a damaged condition.		
Oxy cutting equipment	Includes an oxy lance – able to cut through all materials normally associated with rail		
Petrol driven cutter	Cuts through rails etc		1
Towing connections			
Rail trolley (folds out flat)	Transportation of materials along the rail		1
Small porta power jacks		10 – 50 tonnes	
Run around hoses	Each hose of sufficient length to hook up to a vehicle either end of a stranded vehicle with no air, used for brake pipe air.		Approx. 4

### 3.2.8 Pony Bogie

This item is adjustable and is able to carry all vehicle loads currently used within both the passenger and freight fleet with the exception of the 90 class locomotive. In order to place the bogie under the cars, brake gear has to be removed with the exception of the Tangara and G set fleet. The time taken to position the pony bogie is about 1 hour for a T/G set and other sets about 1- 2 hours. To allow for differences in wheel diameters, slippers are applied within the wheel cradle to secure the wheel.

### 3.2.9 Rail Crane

- Capacity – 110 tone SWL at 11metres.
- Travels on rail only.
- Used coupled to a match truck (cap. 66 tonnes, Tare 31 tonnes, length 14.8 metres).
- Normally loco hauled (all classes OK), but can be self - propelled within the worksite.
- Normal speed 115kphr (jib trailing or leading).
- Carries counterweights that must be connected to the rear of the crane when in use and stowed when not in use.
- Jib extends 24 metres in two stages.
- Normal operation uses loco, crane, match truck and support car carrying equipment. Crew would travel by road in road vehicle.
- Has three support vehicles (ex Southern Aurora Cars) – one carries basically the same items as the emergency response trucks, the second is the sleeping and dining car and the third is the power van required to power the sleeping car.
- Out riggers on crane at both sides and at each end, extend to allow balance to lift loads of about 20 tonne (will cope with bogie change). Rams only extend short distance and must be supported by packing, which may be substantial depending on the site.
- Generally will have to stop traffic on adjacent lines.
- Overhead wiring must be removed for crane use.
- Crew required would be loco driver and observer, and about 8 people to set up and operate crane (need at least 4 crew to operate crane). During re-railing would normally use about 7/8 people.
- Set up time about 1.5 hrs.
- Time taken to place pony bogie under a vehicle about 0.75hrs.
- Time taken to do a bogie change on a T/G set about 4hrs.
- Can get back up in most country areas therefore may send just core crew of say 4, and support crew from remote location such as FreightCorp.
- **Krup** crane available owned by FreighCorp and kept at Lithgow. 120 tonne SWL, able to lift 120 tonne at about 7 metres with pin jib (fixed jib). Draw back as it was designed for steam locos and lifting from the buffer beams.

### 3.3 Issues

Where transponder is located under the T and G sets, this is a possible jacking point. This can be used when other jacking points are not accessible. However transponder must either be removed or destroyed in order to jack here. Emergency Response Unit has been in discussions with George Roumanos about this topic. No resolution yet.

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When righting a rolled vehicle such as Tangara with a thin shell, difficulties arise due to bending and distortion.

Pony bogie type A can not be used under the Explorer or Endeavour cars in wheel positions 5 and 6 due to obstruction from the fuel tank. Obstructions surrounding the bogie area may interfere or prevent the use of either or both types of pony bogie. All other suburban and interurban cars are able to fit into pony bogie.

#### 4.0 Spare Parts

ITEM	MANUF.	ANNUAL USAGE MMC	ANNUAL USAGE HBY	ANNUAL USAGE FMC	TOTAL ANNUAL USAGE
Disc pads (black)	ABL	576	64		640
Disc pads (yellow)	ABL	896	567		1472
Wheels MC MKA wheelset	Nippon	13	18		31
Wheels TC TKA wheelset	Nippon	3	16		19
Main Compressor	Mitsubishi				
Main Compressor brushes	Mitsubishi	598	354		952
Main Compressor air filter	Mitsubishi	303	398	104	805
Main Compressor oil filter		114	60		174
Pantograph					
Pantograph end & centre carbons	Fanstan	875 1010	624 1470	1222 1340	2622 3830
Trip mechanism assy	Westinghouse Brakes	32	58	151	241
Air conditioning filters		16500	16731		33231

## 5.0 Additional Information on Facilities

### 5.1 Mortdale Maintenance Centre

- Loop road – this follows the inspection shed the entire length splitting at two sets of points. The first set of points joins the loop road with the dead end of roads 1 and 2. There is insufficient room for an eight car set to stable at this dead end as it would block the first set of points. Cars from 1 and 2 road are unable to reverse up this road and join the loop due to the short distance to the buffer stop. The second set of points split the loop road into two. One eight car set may fit on each road if there is sufficient clearance from the points and between the cars.
  - The sets currently maintained are G, T, S, R and L.
  - The normal operations undertaken in the lift shop are exchange of bogies, wheelsets, air conditioning units, static inverters and pantographs.
  - Bogie exchange procedure :
    1. Car is separated from the set
    2. Tractor pulls car into lift shop
    3. Bogie connections are separated between car and bogie, crane lifts one end of car, 4 people push bogie outside lift shop, jacks placed under lifted car end, crane removed and brings replacement bogie from adjacent track onto track in front of lifted car
    4. Four people push bogie under car into position
    5. Crane now supports lifted car end
    6. Jacks are removed
    7. Car lowered slightly
    8. Connections reconnected
    9. Crane lowers car onto bogie
    10. Tractor pulls or pushes car out of liftshop (bogie would have to be pushed a long way to allow car to be stabled on loop road)
    11. Car reconnected to set.
  - The shunting tractor is used to move all sets into and out of the lift shop.
  - Access road – the road truck has to enter/leave via Boundary road. All stores deliveries are via this entry. The secondary gate (for wash road supplies) is near the depot end of brake roads. Access rail – via the Sydney end of the centre. All traffic must enter and leave this way, there is no turning loops.
  - TMP time allowed for T and G sets is 8 hours.
  - The maintenance normally performed at this depot is General Inspections, Pantograph and Reservoir inspections, brake inspections and modifications.
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- Lifting jigs for T and G sets – all jigs were supplied originally by Goninan. Mortdale had them all certified.
    1. AC – the jig had to be modified as the eyebolts on the jig were permanently attached and have to be checked for cracks annually. The eyebolts are now removable. The jig design allows for the crane lifting point to be offset from the jig centre to counterbalance the uneven weight distribution of the AC unit. There are four lifting points on the AC unit. The eyebolts attached to the underneath of the jig attach to the AC unit. The D bolt is attached to the upper jig and is held in the auxiliary hoist.
    2. SIV – There are four lifting points on the SIV. The eyebolts from lifting frame attach to the SIV. The four chains are attached to the lugs on the top of the frame. The chains are held and lifted by the auxiliary hoist.
    3. Chopper unit –There are six lifting points on the chopper unit. Open hooks are attached to the underneath of the jig and lift the chopper at the lifting points. Four chains with shackles at each end attach to the jig's upper lifting points. The chains are held and lifted by the auxiliary hoist.
    4. The bogies are lifted with car lifting hooks placed diagonally across the bogie or by using four specialised lifting hooks attached to chains coming into a D ring which is lifted by the main hoist.
  - Changing the window glass on T and G sets – this is normally done on a GI, it can be done on the running but with restrictions. When on running, the scissor lift platform is raised to a height of 1.2 metres (maximum unrestricted height). This is convenient for changing glass on the lower deck. For changing glass on the upper deck, as it is rounded, the only way the glass can be changed is to lower it down from above window opening. This necessitates the use of the high road or the scissor lift to be used to its maximum height of 3 metres. If the scissor lift is used to this height, a key must be obtained from the foreman or supervisor to unlock the scissor lift. This necessitates the 1500V overhead to be isolated, hence the road must be cut out. This can interfere with the running status of the shed. The glass must be removed when it is cracked or broken. This involves the removal of the key rubber, followed by the replacement of the glass and finally the reinsertion of the key rubber with the use of the back of a hammer. The total time taken to replace one pane of glass on the upper deck of a T or G set is approximately 30 minutes. Due to the weight of the glass, two car builders utilising suction caps, are required to perform window glass replacement.
  - Filling the supply water tanks on a G set - both water tanks for toilet and drinking water are filled by using a hose fitted with a 25mm female kamlock fitting. Care has to be taken during the filling operation. If the tanks are filled with an ordinary hose fitting, it dislodges the rubber seal in the kamlock fitting and allows the escape of water.
  - The removal of the traction motors – this can only be done at the lift shop as the car must be separated from the bogie. The relevant end of the car is
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lifted by hoist, supported on stands, the bogie connections removed and the bogie moved clear of the car by hand. A forklift with a flat plate over the forklift arms is used to support the traction motor while the bolts are removed. The traction motor is then lifted free.

- The depot caters for modulated replacement only, not component overhaul. It is able to perform modular change outs on the following items; main air compressor, pantograph, traction motor, air conditioner, bogie, wheelset, No.s 1,2 & 3 high tension groups, chopper module, draw gear, filter drier, pantograph compressor, smoothing reactors, filter reactor and high speed circuit breakers 1 & 2.

## **5.2 Hornsby Maintenance Centre**

- The lift shop has under pit access to allow personnel to travel from one side of the road to the other, being only suitable for people and small cartable items.
- The lift shop has no problem lifting out items from the roof with respect to clearance, however, where the AC is concerned this item has to be considered as the largest item that can be lifted out of the car and down beside the car. Side access from the welding bay side is limited, and again the AC has to be considered the largest item that can be moved through this opening except where the item can be rotated. Any items larger than this are lifted out, the car or set is removed, the item is lifted down to the floor level then removed, the replacement item is then lifted into position above the roof height, the car is moved back into the lift shop and the item placed into the car roof.
- The weighing facilities accommodate all cars except the Tulloch cars (48xx R and S sets).
- The commissioning road – the best road would appear to be 1 road. Roads 8 and 9 have all services, but they carry 16 cars and the entire road would have to be isolated during commissioning. Road 3 is the roof washing road and it has water at the high access platform. If road 1 was used, GI's could be performed on 3 road, and roof washes suspended during commissioning. These roads are only 10 car lengths long and there would be less disruption to operations. One road has all services and the Sydney end is flat enabling easy forklift access to the underneath of the car if required.
- Presentation details. Graffiti cleaning – there is no time limit, the cleaning is done as required. Major cleans are performed during day, night and afternoon shifts. For all shifts each person has up to 4 hours allocated to clean a four car set, there are four people working on a four car set. The roof wash is done on the afternoon shift and only on 3 road as it has the available water supply to the roof.

## **5.3 Flemington Maintenance Centre**

- The proposed new AC workshop (to be located within the old wheel lathe road) will maintain the existing crane (3 ton max. load) but raise it 2 metres. High level platforms will be installed on both sides of the road, but with no overhead supply.
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- The lift shop does a bogie change in 4 hrs.
- Maintenance on T/G sets can be performed in the AC workbay.
- The sets maintained at the depot are C, S, V – 240 interurban, 296 suburban.
- The main store upper level shelving has been removed for the permanent placement of crates. This allows for less handling, but with enormous loss of storage capacity. There is enough room to hold more items, but this would require the shelving to be reinstalled.
- Only the depot engineers are trained in ultrasonic testing, no ultrasonic equipment is held by FMC.
- There is a general use lathe beside rd A.
- Road B has drop down stairs, these tend to be a waste of time and not used.
- The electrical services are actually located on roads A and C but by utilising electrical extension leads, these services are available on road B as well.
- Cleaning details – all types of cleans are performed on the roads between the loop road and road 20. There is no vacuuming done on suburban sets. Major cleans are performed Monday to Friday on day and night shift allowing 1 person 4 hrs per car (8 people on 8 car set). Daily cleans are performed Monday to Friday on day and night shift allowing 1 hr per car per person (interurban) and 45 minutes per car per person (suburban). A group of 3 cleaners work on a 4 car set. The turn around clean is done on weekends, public holidays and special events allowing 10 minutes per car.
- Rd 23 has automatic swarf removal from the wheel mill.

#### **5.4 Maintrain Auburn Service Centre**

- The bogie wash facility encompasses two roads, one for a mechanised detailed clean, the other for a manual spray clean. Before entry into the wash, the traction motors are removed via a hoist, and the bogies are allowed to queue at the back of the jacking road.
  - There are two main traversers, one is located at the rear of the bogie workshop and the other is located between the bogie workshop and the crash repair workshop. The first traverser moves bogies from the washing facility to the rear of the workshop, where they can be rolled into the repair/overhaul progression system. The other traverser moves cars to and from the crash repair workshop. A small traverser exists underneath the bogie workshop for the movement of bogies into and out of the paint shop and for bogie storage control.
  - Bogies once painted can be lifted from the paint shop to the workshop floor via a hoist and loaded straight onto waiting trucks. Separate holding bays exist for freight and passenger bogies.
  - The bogie paint shop is a mechanised shop for the fast spraying of all types of bogies.
  - There are numerous cranes and hoists with varying capacities, as they have been used for the current rolling stock within their safe working loads, it is
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assumed that the loads are sufficient to carry similar rolling stock subject to the scrutiny of the operator. As such these hoists and their capacities are not listed.

- Due to the large number of jigs in use at the Auburn facility, data on this equipment is not listed.
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## **ATTACHMENT 1**

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### **Procedure:** Removing and Replacing Vehicles From Tracks

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## **ATTACHMENT 2**

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### **Procedure:** Using Pony Bogies to Support Defective Wheel Sets

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## **ATTACHMENT 3**

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### **Procedure:** Replacing Bogies Back on Their Kingpins

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## **ATTACHMENT 4**

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**Procedure:**  
Attending an Incident/Derailment Involving  
Dangerous Goods

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## **ATTACHMENT 5**

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**Annual Usage of Common Items and Stores  
Where Held**

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## **APPENDIX O - INTERPRETATION OF COMPLIANCE WITH THE DISABILITY STANDARDS FOR ACCESSIBLE PUBLIC TRANSPORT (DDS)**

The Sets must comply with the Disability Standards for Accessible Public Transport issued by the Commonwealth Attorney-General's Department ("DDS") and to assist with this the following interpretation of specific requirements is provided:

### **1. Toilet**

The Sets must comply with the layout being adopted on other SRA rollingstock projects that facilitates internal use by various user groups and external access. This layout is indicated on the Drawing B59394.

### **2. Allocated Spaces and Priority Seats**

The Sets must comply with the requirements for Allocated Spaces and Priority Seats. Drawings B59392, B59393 and B59394 indicate the proposed locations of these provisions.

### **3. Access to Toilets**

Access from allocated spaces and priority seating to the toilets must be provided on the train, either by:

- a) an access path from the nearest end saloon of the adjoining car; or
- b) equivalent access by provision of appropriate facilities such as call buttons and direct assistance from SRA personnel for those not in the adjoining end saloon.

### **4. Access Paths**

Allocated spaces and priority seating must be provided in the end saloons of Cars but not necessarily within the double deck component of the Cars.

Access paths of 850 mm width and maneuverability space must be provided in these end saloon and vestibule areas.

Where stairs are provided, compliance with the DDS is to be maximised whilst also maximising seating numbers.

### **5. Hearing Augmentation**

The Sets must, if required by the Principal, provide hearing augmentation.

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