5.1 Metrorail: User Requirement Specification

User Requirement Specification for the New Metrorail Rolling Stock

17 March 2011

Contents

ABBREVIATIONS

AC:	Alternating Current
ATC:	Automatic Train Control
ATP:	Automatic Train Protection
BITE:	Built-in Test Equipment
CTC:	Centralised Train Control
DC:	Direct Current
DVA:	Digitised Voice Announcement
EMU:	Electric Multiple Unit
kV:	Kilovolt
MC:	Motor Coach
PIDS:	Passenger Information Display Screen
PRASA:	Passenger Rail Agency of South Africa, previously SARCC
RSR:	Railway Safety Regulator
SARCC:	South African Rail Commuter Corporation of South Africa, now known as PRASA
Spoornet:	State-owned logistics provider, now known as TFR
TC:	Trailer Coach / Plain Trailer
TCO:	Train Control Officer
TFR:	Transnet Freight Rail, a division of Transnet, previously known as Spoornet

1 Background

1.1 Introduction

PRASA was established in April 2009 to house the operations of Metrorail, Shosholoza Meyl, Autopax and Intersite (Property Management). The consolidation was part of Government's key objective to achieve modal integration as well as to improve the performance of public transport services.

Coupled to the above, the Corporate Plan of PRASA 2009/10 – 2011/12 [i] highlights the following objectives:

- Sustainable passenger rail service delivery
- Improved performance of passenger rail services in terms of the quality and levels of services to passengers
- Improved efficiency in the delivery of services
- Improved effectiveness of asset management
- Effective targeting of subsidies to achieve desired socio-economic and transport objectives
- Improved oversight by Government
- Improved accountability to the users

Underpinning these objectives is the need to renew the existing rolling stock fleet. PRASA has committed to the replacement of the rolling stock fleet over the next 18 years.

1.2 Rolling Stock Replacement

Due to declining investment over the past three decades and as a result of poor condition of the existing rolling stock, which threatens the reliability and safety of the passenger rail service, PRASA has committed to the replacement of the entire Metrorail rolling stock fleet [ii]. Apart from the replacement of the existing fleet, this investment also includes the procurement of additional rolling stock to meet medium- and long term commuter demands.

Concurrent with the role out of new rolling stock, existing rolling stock will be phased out in a manner ensuring that commuter demand is met without undue disruptions to train services.

This User Requirements Specification has been produced prior to Market Engagement in relation to the replacement of the Metrorail fleet. The replacement of Shosoloza Meyl locomotives and coaches are subject to a separate high level Statement of User Requirements.

2 PRASA Commuter Regions and Corridors

PRASA provides commuter rail services in 6 Metropolitan regions being:

- Gauteng North (Tshwane)
- Gauteng South (Wits)
- Western Cape
- Durban
- East London
- Port Elizabeth

The commuter system comprises various rail networks in each region.

2.1 PRASA Rail Networks

Commuter trains operated in each region is broken down into networks, routes and corridors. Information regarding networks, routes and corridors can be found in the Network Information and Infrastructure Interface report [iii].

3 Estimated Rolling Stock Requirement

Based on the National Railplan Consolidated Report, August 2006 [iv], the estimated number of train sets and vehicles are indicated in **Tables 3.1 and 3.2.**

3.1 Indicative Sets Required per Region

Table 3.1: Estimated Trains Sets Required reflects the total number of sets allocated per region, estimated total requirement and estimated shortfall in terms of the current demand. Also shown is the estimated total new rolling stock requirement in terms of medium- to long term demand on the highest priority routes ("A" and "B" routes) - assuming that all existing sets are replaced. "A" routes carry >20,000 to 30,000 passengers per hour and "B" routes carry <20,000 passengers per hour.

Table 3.1: Estimated Train Sets

Status Quo: Sets Allocated per Region			Sets Required to Provide Service on "A" and "B" Corridors		
Region	No. of Sets Allocated[1]	Sets Available for Service[2]	10 Minute Headways (Current to Short Term)		5 Minute Headways (Medium to Long Term)
			Estimated Total No. of Sets Req'd[3]	Shortfall (train sets)[4]	Estimated Total no. of Sets Req'd[5]
Gauteng North	56	32	60	28	89
Gauteng South	119	68	100	32	187
Western Cape	96	78	99	21	138
Durban	68	52	55	3	68
East London	6	6	8	2	13
Port Elizabeth	5	5	6	1	8
Sub-Total	**350**	**241**	**328**	**87**	**503**
Maintenance Requirement of %			33	9	50
TOTAL			**361**	**96**	**553**

Notes:

1) Based on original number of coaches allocated to regions

2) Based on current number of coaches available for service

3) To be confirmed when demand study has been completed

4) Number of sets required (new trains) to respond to the current demand established in 3 above (current trains remain in service)

5) Total number of sets required (old fleet replaced) to respond to future demand established in 3 above.

3.2 Indicative Number of Coaches Required

Table 3.2: Estimated Number of Coaches reflects the total number of coaches allocated per region, estimated total requirement and estimated shortfall in terms of the current demand. Also shown is the estimated total number of new coaches required in terms of medium- to long-term demand on the highest priority routes ("A" and "B" routes) - assuming that all existing coaches are replaced.

Table 3.2: Estimated Number of Coaches

Status Quo: Vehicles Allocated per Region			Vehicles Required to Provide Service on "A" and "B" Corridors		
Region	No. of Vehicles Allocated[1]	Vehicles Available for Service[2]	10 Minute Headways (Current to Short Term)		5 Minute Headways (Medium to Long Term)
			Estimated Total No. of Vehicles Req'd[3]	Shortfall (new vehicles)[4]	Estimated Total no. of Vehicles Req'd)[5]
Gauteng North	776	501	768	267	1139
Gauteng South	1600	963	1170	207	2188
Western Cape	1254	829	1049	220	1463
Durban	862	527	594	67	734
East London	88	60	80	20	130
Port Elizabeth	52	50	52	2	69
Sub-Total	**4632**	**2930**	**3713**	**783**	**5724**
Maintenance Requirement of %			371	78	572
TOTAL[6]			**4085**	**862**	**6296**

Notes:

1) Based on original number of coaches allocated to regions

2) Based on current number of coaches available for service (to be confirmed)

3) To be confirmed when demand study has been completed

4) Number of vehicles required (new trains) to respond to the current demand established in 3 above (current trains remain in service)

5) Total number of vehicles required (old fleet replaced) to respond to future demand established in 3 above

6) The total coach numbers are a function of the average actual number of coaches per train set; platform lengths is the limiting factor

4 Vehicle Principle Design and Performance

This section describes the general vehicle design and performance requirement for the new rolling stock.

4.1 Principle of Design

4.1.1 Design and Technology

Trains shall be of 3 kV DC Electrical Multiple Unit (EMU) design of up to 275m (nominal 12-car module). Where infrastructure constraints exist then modules may be of a smaller length. Consideration will be also given to solutions that allow for some off-peak services to be made of shorter length modules that can be built up into 12-car formation during the peak hours. All modules shall be fitted with automatic inter-modular coupling to cater for combination in service or rescue. See Technical Specification for further details [v].

All requirements are intended to be met by standard freely off-the-shelf rolling stock products as far as is practical rather than requiring a bespoke or custom-made design.

In addition to the above, a small number of modules will be required for the East London and Port Elizabeth regions (Eastern Cape). The fleet shall be based on the 3kV DC EMU design as far as is practical with suitable traction configuration for the mixture of 25kV AC/non-electrified infrastructure in this region e.g.

a) Non-motorized modules with diesel traction- or diesel/25kV hybrid locomotives
b) Diesel Multiple units
c) Diesel Electric Multiple unit/electric hybrid.

The supply of locomotives in (a) above falls outside the scope of this User Requirement Specification.

4.1.2 Standards and Quality

All such standards and specifications shall be internationally recognised and be motivated and demonstrated to be appropriate for the rolling stock required for this project. A full regime of standard specifications and standards shall be used, rather than applying only certain selected specifications of an ad hoc nature which might not be fully compatible. Any alternative and additional specifications shall be evaluated and, if deemed appropriate, approved by the client.

4.1.3 Durability

Rolling stock must be maintainable and up-gradable within acceptable limits of expenditure for a minimum of 40 years. Vehicles shall be constructed of corrosion resistant material consistent with the varied climate and regions of South Africa (manufacturer to demonstrate corrosion resistance). In light of recent PRASA experience, stainless steel piping shall be preferred.

4.2 Train Performance

4.2.1 Speed

Trains shall be able to achieve a maximum operating speed of 120 km/h. Train design should be sufficiently adaptable to allow future variants to be capable of operation at 160 km/h (see Technical Specification for further details).

4.2.2 Acceleration

Acceleration shall be consistent with international best practice and norms for metro-style rolling stock (see Technical Specification for further details).

4.2.3 Deceleration

Deceleration shall be consistent with international best practice and norms for metro-style rolling stock (see Technical Specification for further details).

4.2.4 On train ride comfort

On train comfort shall be consistent with international best practice and norms for metro-style rolling stock (see Technical Specification for further details).

4.2.5 Starting on maximum gradient

Trains will be expected to start from rest on all relevant routes (identified in section 2 above) consistent with international best practice and norms for metro-style rolling stock (see Technical Specification for further details). Trains should provide a hill-start mode to prevent roll-back.

4.3 Service Conditions

4.3.1 Train Loading

M1: Tare weight of the vehicle (mass per vehicle with equipment)
M2: M1 weight of the vehicle plus seated and standing passengers (6 persons standing per m^2 (saloon), 8 persons standing per m^2 (vestibules) and luggage
M3: M2 weight of the vehicle plus a crush passenger load (12 persons standing per m^2)

Trains shall be able to operate continuously at varying loading conditions for both the acceleration and deceleration rates up to maximum operating speed without equipment exceeding the design operating parameters.

4.3.2 Special Conditions

In the event of a failure of one traction package the train shall be able to continue to operate in service with minimal impact on performance and without damage to the equipment or an increased maintenance requirement on the operational equipment.

A M3 laden train shall be capable of starting from rest and moving uphill on1:40 track gradient with that traction package isolated without damage to the equipment.

A M3 laden train shall be able to rescue a M3 laden train of the same or shorter length to the next station from any point on the corridor. If on a 1:40 grade when rescue starts, the rescue train may have to reverse down the gradient, either to the previous station or to a more level section of track to allow the gradient to be climbed in the original direction of travel to the next station.

See Technical Specification for further details.

5 Service Level Parameters

Rolling Stock shall provide environments and levels of service standard comparable to international norms attracting commuters from other modes of transport. Specific requirements are set out below.

5.1 Classes of Accommodation

Current Metrorail services seek to meet three market segments known as Metro, Metro Plus and Business Express. It is a future intention that the second and third market segments be merged into a single new segment. This would mean that there would be two distinct market segments identifiable in the new rolling stock:

- A shorter distance, high volume commuter market ("Metro" configuration), servicing all stations
- A longer distance, premium commuter market ("Metro Express" configuration), servicing selected stations
- There are two further envisaged markets:
- Airport links
- Inter-region

The travel experience and service for all segments shall attract commuters from other modes of transport such as private vehicles and minibus taxis.

5.2 Seating Arrangement

Seating provision shall meet the requirements of each market segment. Each module shall comprise only one seating arrangement as below.

5.2.1 Metro Seating Arrangement

To optimise each vehicle's total capacity a longitudinal seating arrangement is required in Metro vehicles. Easy filling and emptying of vehicles should be taken into consideration with respect to seats adjacent to the doors.

The seats shall be designed according to ergonomic principles and provide a reasonable degree of comfort for sitting durations of up to two hours.

All standing passengers shall have access to passenger grab handles or poles.

5.2.2 Metro Express Seating Arrangement

A transversal 2+2 seating arrangement, with sufficient space to accommodate a drinks trolley, shall be required in Metro Express vehicles. Easy filling and emptying of vehicles should also be taken into consideration with respect to seats adjacent to the doors. However, the design shall not preclude future variants being fitted with 2+3 seating.

Seat design shall be according to ergonomic principles and shall be comfortable and stylish. Standing passengers shall have access to passenger grab handles.

5.3 Luggage Storage Facilities

Overhead parcel racks, with integrated grab rails, shall be provided on both classes.

Fastenings shall be accessible to facilitate easy removal of the racks by maintenance staff only.

5.4 Amenities

Passenger amenities shall be tailored to the market segments identified. Considering these market segments, the vehicle interior layout must be optimally utilised facilitating free flow of commuters.

5.4.1 Climatic Control

The base specification shall include both forced ventilation and heating equipment.

Fresh air intakes shall be according to acceptable international norms and consideration shall be given to extreme climatic conditions.

Vehicle design shall permit future variants to be fitted with climatic control system without retrofitting any control systems or equipment.

Climatic control equipment shall maintain ambient conditions at comfortable temperature and humidity levels at varying heat load conditions. The climatic control system design shall take the following into consideration:

- Self contained
- Roof mounted
- Easy removal by maintenance personnel
- Vibration and shock resistant
- The coolant used in the air-conditioning unit shall be environmentally friendly to approved standards

See Technical Specification for further details.

5.4.2 Appliance Electrical Supply

220V power outlets shall be provided in Metro Express saloon areas for use by commuters (i.e. laptop computers).

5.4.3 Refreshments

Provision in Metro Express shall be made for the storing and powering of refreshment trolleys or cabinets to dimensions set out in the Technical Specification which shall serve hot and cold refreshments as well as snacks.

5.4.4 Ablution Facilities

Metro trains shall not include toilets. However, a costed option for the provision of toilets on every alternate vehicle in Metro Express shall be provided (one such toilet being accessible to people with Special Needs).

5.5 Special Needs Passengers

Universal train access compliant with South African legislation and policies shall be provided for Special Needs Passengers [vi]. Special care shall be given to the layout, without the need for specialised design or adaptation, of commuter areas and equipment with respect to the requirement of special needs passengers.

The following shall be incorporated:

- Access for passengers using wheelchairs (certain vehicles shall be fitted with a storable, lockable ramp to facilitate wheelchair access where vehicle floors and platform heights are not level. These vehicles are to be distinguishable from other vehicles)
- Features to aid people with difficulties in walking, gripping, reaching or balancing (including non-slip surfaces, handrails and handholds)
- Facilities to assist blind and partially sighted people
- Facilities for people who are deaf or hard of hearing.

6 Vehicle Capacity, Layout and Design

This section describes the minimum vehicle capacity, general layout and minimum design requirement of the rolling stock.

6.1 Vehicle Minimum Capacity

Train capacity shall be maximised, and provide a reasonable mix of seated and standing accommodation in accordance with industry best practice for both Metro and Metro Express trains (See Technical Specification for further details).

6.2 General Saloon Layout and Design

6.2.1 Sliding Doors

Three passenger sliding doors shall be provided on each side of the vehicle save for Metro express where the central of the three doors shall not be provided. Door design shall not allow a person to stand outside the doors when the doors are in the closed position. Each door should allow two people to join, alight or pass simultaneously.

Doors on the required side shall be opened and closed by the train guard when the train has stopped. Doors must incorporate an emergency egress device for use in the event of an accident or a power failure.

Obstruction detection shall be incorporated in the door system design. Door cycle times and forces shall be consistent with international best practice and norms for metro-style rolling stock.

Door apertures and arrangement shall be designed to suit the seating layout of the saloon area and shall cater for optimal passenger flow.

Door fittings shall be of robust construction. Door mechanisms shall only be accessible by maintenance personnel with required equipment.

The door exterior shall have a different appearance to that of the body exterior side cladding to facilitate the requirements of visually impaired commuters.

Sliding door windows shall be as large as possible to allow an unobstructed view of the outside.

See Technical Specification for further details.

6.2.2 Gangways

The purpose of gangways is to provide safe, free flow of passengers and train staff between the vehicles in a module during travel. Gangways shall be a full-width enclosed gangway with no inter-vehicle doors. No gangways shall be provided between modules coupled together.

Gangways are to be completely sealed off from outside elements with adequate insulation. No dangerous gaps shall be exposed. A gangway, including all its flexible elements, shall be stable under the dynamic and aerodynamic forces experienced up to maximum train speed. These forces include, but are not limited to, pressure transients created by other trains, by wayside structures, and by passage through tunnels.

The interior finish of gangways shall be similar to the interior finish of the saloon area.

6.2.3 Saloon Windows

The base specification shall include vandal proof opening windows. To meet the challenge of vandalism, PRASA has a preference for polycarbonate over glass windows – however, it would wish a solution that allows both its vandalism and fire rating requirements to be met. Hopper type windows are not permitted. A manually operated lock shall be fitted to each window. Fitment shall be tamper proof allowing removal by maintenance personnel only.

Saloon windows shall provide good visibility for seated and standing passengers. The window size must provide adequate natural light in the saloon area. Glare and temperature fluctuations shall be maintained within acceptable levels without the need for blinds (see Technical Specification for further details).

Where Metro Express cars are fitted with air conditioning, window design shall also allow circulation of fresh air.

6.2.4 Interior Lighting

Ceiling mounted fluorescent lighting shall be provided and laid out to give an even illumination of the saloon interior to create a pleasant atmosphere without glares. Lighting shall be consistent with international best practice and norms for metro-style rolling stock (see Technical Specification for further details).

Battery operated emergency fluorescent lighting shall be provided at passenger doors. These lights shall remain energised in the event of electric traction power failure. Emergency lighting illumination levels shall be adequate to allow passengers to detrain safely in an emergency.

The light fittings shall be of robust construction, fully rustproof and designed for ease of inspection and maintenance by maintenance personnel.

Saloon lighting shall be operated from the driver's cab.

6.2.5 Head Room

Floor to ceiling headroom at any position within the passenger saloon shall provide adequate clearance according to ergonomic principles consistent with the vehicle gauge.

6.2.6 Floor Level

The train floor level shall be maintained, at various loading conditions, as described in the Technical Specification. Also, see Infrastructure Interface Report.

6.3 Driver's Cab

6.3.1 General

The driver's cab interior shall be designed to provide a pleasant working environment. All driver cabs shall be air conditioned.

The driver's cabs shall be designed for a centrally-positioned, single-person operation. The driver's control layout shall be arranged to accommodate all controls, switches/buttons, train information systems, monitors, radio equipment, intercom systems, etc. required for the safe operation of the train. The cab shall be fitted with viewing equipment providing the driver a view down the length of the train before departure without leaving the seat.

The cab shall be designed with due consideration of appropriate ergonomic principles.

Vandalism considerations shall be similar to the saloon area.

All cab equipment shall be easily accessible for maintenance and repair.

6.3.2 Driver's Seat

The driver's seat shall comply with ergonomic design principles. The seat shall provide sufficient support to enable the driver to sit for long periods without experiencing any discomfort.

Driver's seats shall, as a minimum, feature height adjustment, fore and aft adjustment, seat back angle adjustment. The seat shall be fitted with tilt-up armrests.

A second flip-up seat shall be provided for relevant railway personnel adjacent to but clear of the driver's seat.

6.3.3 Cab Doors

The driver's cab shall be equipped with inward opening or sliding side doors. The driver shall have a clear and unobstructed view through both the side door windows from a seated driving position. The driver's cab side windows shall slide fully down to allow a rearward view.

An access door from the cab to the saloon area shall be provided. The door shall be hinged, swinging toward the saloon area and lockable.

6.3.4 Windscreen

A single fixed windscreen shall be provided at each driving end of the module, providing a wide angle, unobstructed angle of view in both the horizontal and vertical planes from the seated position.

Windscreens shall be manufactured from impact-resistant material (see Technical Specification).

Windscreens shall be equipped with a washing and wiping mechanism and a spring-loaded, retractable roller blind for shielding against direct sun rays.

6.3.5 Cab Lighting

Ceiling mounted fluorescent lighting shall be designed and laid out to give even illumination of the cab interior. Lighting shall be consistent with international best practice and norms for metro-style rolling stock (see Technical Specification).

Driver's cab lighting shall be equipped with a dimming facility and an on / off switch. A time delay function shall be provided if train auxiliary power is switched off. In the case of a power failure, an emergency battery backup system shall be provided.

6.3.6 Instrumentation

Each cab shall be equipped with a driver's display unit. The display unit shall be an integral part of the train management system. The display unit shall be used for display of information to the driver, assistant or technical staff.

The positioning and design of the display unit shall be such as to prevent external glare making it difficult to read the display. The display unit shall be easily visible from the seated position with a wide viewing angle.

All instruments shall comply with internationally recognised norms and standards.

All instruments shall be securely and safely mounted in positions where they will not be vulnerable to damage, but at the same time being readily accessible for repair or replacement purposes.

The speed detection system shall be electronically operated. No calibration shall be required for varying wheel diametrical conditions due to wear.

6.3.7 Exterior Lighting

Train driving- and end-of train lighting shall be consistent with international norms and standards (see Technical Specification).

6.3.8 Train Number Indication

Train number and destination indication shall be consistent with international norms and standards (see Technical Specification).

6.4 Cleaning and Presentation

6.4.1 Cleanability

The rolling stock must be designed and manufactured to be easily cleaned, internally and externally (using automated external washing plants). There should be no crevices, dirt traps, gaps or horizontal surfaces which can attract litter and sharp corners or joints will be avoided.

6.4.2 Resistance to Vandalism

The rolling stock must be designed and manufactured to be vandal resistant and minimise the effect and repair costs of any vandalism incidents. Internal and external surfaces should not show signs of staining or shadowing after the removal of graffiti. All exposed fasteners in the passenger area must be of a tamper proof design.

6.4.3 Vermin

The rolling stock must be designed to prevent damage arising from vermin.

6.4.4 Access for Cleaners

Daily cleaning of the rolling stock will take place in dedicated cleaning facilities ate depots or at other dedicated facilities. Additionally the rolling stock must incorporate a “cleaning mode or isolation state” that immobilises the rolling stock and provides the necessary access, power, lighting and HVAC for cleaners to undertake their duties.

6.4.5 Fire and Emergency Equipment

The design of the coaches shall incorporate provision for the operator to mount fire extinguishing equipment in each coach. The type and accessibility of this equipment shall be risk assessed taking into account the propensity for misuse and any impacts/hazards this may present.

7 Minimum Engineering Requirement

This section describes the minimum design requirement of the rolling stock.

7.1 Crash Safety

Rolling stock shall be of adequate design and construction to:

- Withstand in-service collisions associated with rough shunting without any damage
- Ensure the integrity of the passenger compartment in the case of a collision with a diesel locomotive or goods vehicle.
- Be in line with accepted European or American norms and guidelines.

For further information see Technical Specification.

7.2 Fire Safety Requirements

All rolling stock should:

- Have a low fire load
- Provide early warning smoke detection and alarm systems
- Be low heat release with the minimum amount of combustible materials and use inherently fire resistant materials
- Be made of low smoke – low toxicity materials

For further information see Technical Specification.

7.3 Noise Levels

The external and internal noise generated by the rolling stock under all conditions must comply with noise levels specified by South African standards or in the absence thereof, relevant International standards [vii].

7.4 Train Management System

Each train module shall have a train management system that monitors the performance of the train and individual vehicles upon it. Service critical and emergency data and fault information shall be displayed on the driver's display unit.

Train operational, control and fault data shall be digitally stored and the information accessed and downloaded via a wireless/downloadable system at maintenance depots or other specified points to the computerised maintenance management system. The downloaded information shall, as a minimum, include the following:

- Train performance
- Component performance
- Operational data
- Fault and failure data
- History
- Communications

The train management systems shall only be available to the train driver and maintenance staff. Train assistants shall have access to information, safety and security and communication systems only.

7.5 Deadman's / driver's vigilance

The train master controller shall incorporate a "deadman's / vigilance feature", which on release shall disconnect power from the motors and apply an "emergency" train brake.

7.6 Couplers and Drawgear

7.6.1 Couplers

Vehicles shall be configured into modules. Within each module, inter-vehicle coupling shall be by means of semi-permanent couplers. Inter-module coupling shall be automatic

7.6.2 Drawgear

The drawgear shall be able to absorb the maximum buffing and pulling forces that will be imposed under all conditions throughout a train, including being hauled by a locomotive.

7.6.3 Train Rescue

PRASA's and Transnet Freight Rail's existing vehicles are fitted with an emergency coupling bracket as detailed in the Technical Specification.

7.7 Braking System

A blended dynamic / pneumatic brake system shall be provided. The brake system shall firstly automatically switch into dynamic braking, proportional to the brake demand, to fulfil all or part of the braking demand to ensure that the pneumatic brake system is used to the absolute minimum.

7.7.1 Dynamic Brakes

The dynamic brake system shall incorporate both regenerative and rheostatic braking systems. If the overhead power supply system is incapable of absorbing the generated current, the system will default to rheostatic mode in order to provide the braking effect.

Proven designs shall be used incorporating simplicity of design, reliability and ease of maintenance. Proposals shall be considered for the alternative storage and application of regenerated power.

7.7.2 Pneumatic Brakes

Trains shall be fitted with pneumatic brake equipment of service proven design providing optimum braking performance in respect of:

- Failure or decrease of dynamic braking shall result in pneumatic braking being automatically applied or increased in order to keep the total braking demand the same as existed prior to the failure and/or decrease.
- Simplicity, reliability and maintainability.
- Flexibility for blending with electric braking.

The pneumatic brake system shall be capable of satisfactory operation when the train is being hauled by a diesel-electric locomotive.

7.7.3 Parking brakes

A spring-applied automatic parking brake shall be provided which shall be capable of holding a crush-laden train on a 1:40 gradient.

7.8 Wheel Slip/ Slide Detection

Train control equipment shall be designed to detect wheel slip and slide and perform the necessary corrective action to re-establish adhesion between the wheel and the rail effectively and efficiently.

An automatic method of wheel slip and slide protection shall be applied in a manner to prevent any damage to equipment.

Fitment of sanding equipment is not permitted.

7.9 Wheel Flange Lubrication

No provision shall be made for wheel flange lubrication. Track-mounted lubrication systems are provided.

7.10 Bogies

Bogies shall be fabricated to internationally accepted standards and service proven designs. Self-levelling air suspension bogies shall be provided. Motorised and non-motorised bogies shall be of similar design.

Dimensions and suspension design shall ensure that the vehicle body and equipment remain within the permanent way structure gauge at all times.

Adequate provision shall be made to facilitate maintenance activities.

Provision shall be made to prevent bogie / body separation in the event of a derailment.

Bogies shall provide optimal performance in respect of tangent track stability at operating speed, curving, crush loading conditions and ride quality.

7.11 Exterior fittings

All exterior fittings shall be of suitable vandal proof design and only removable by maintenance personnel. All external fittings shall be within the moving structure gauge.

7.11.1 Cowcatcher

Modules shall be fitted with a removable cowcatcher with vertical adjustable plates at each driving end to afford adequate protection to all under frame mounted equipment.

7.11.2 Side Steps

Steps with non-skid treads shall be provided at each driving cab side door to enable train personnel to enter the cab from ground level.

7.12 Maintainability

The modules shall be designed to be capable of running without attention from maintenance staff for a distance of not less than 20,000 km or a period of two months, which ever comes first.

7.12.1 Component Change-Out and Inter-changeability

All key components must be modularised and be capable of being exchanged, and the train tested and returned to service, within defined times (four hours maximum). All

components that may be reasonably expected to require replacement at the depot must be designed for replacement including, where appropriate, the use of quick release fasteners, electrical connectors and other couplings.

7.12.2 Built-In Test Equipment

All major systems and sub-systems must have Built-In Test Equipment, including faults and failure logs. In addition to wireless downloading of data, this data must be downloadable during routine maintenance via portable devices. It must also be remotely downloadable. Built-In Test Equipment should also include a fault finding guide to guide maintainers as to the likely cause or source of any identified faults.

7.12.3 Access to Equipment for Maintenance

The rolling stock must be designed with ease of maintenance in mind. All equipment that has a maintenance requirement must be readily accessible and clearly labelled in English. All covers within the passenger area that are required to be opened during routine maintenance must be fitted with security locks that visually indicate their locked status.

7.12.4 Sharp Edges

Care should be taken during the design and construction of the rolling stock to ensure that there are no sharp edges, corners or protrusions that could cause personal injury. This includes those instances when panels are removed for maintenance purposes thereby exposing components or features that would not normally create a hazard.

7.12.5 Equipment Marking and Labelling

All equipment locations must be marked to identify the function, type and model of equipment installed. Major components must be marked with the year and month of manufacture and fitted with an equipment identification plate that shows the manufacturers name, equipment designation, revision code, serial number and a bar code to allow tracking of components. All separable items of equipment must be clearly and permanently labelled in English in a suitable location that is clearly visible and legible when the equipment is installed. Nameplates for equipment must be securely and permanently attached to a non-removable part of the component or major sub-assembly. Nameplates and markings must be indelible and vandal resistant. They must not be adversely affected by cleaning agents, graffiti or graffiti removal chemicals.

7.12.6 Discharging of Electrical Equipment

It must be safe to work on any electrical equipment within 30 seconds after it has been isolated from its supply. Energy storage devices such as capacitors must be discharged.

7.12.7 Shore Supply

The rolling stock must interface with the dedicated depot “Shore Supply” system.

7.12.8 Venting of Pneumatic Equipment

Pneumatic components must vent outside the passenger area. Exhausts from vented components must not present an OH&S hazard to maintenance staff [vi].

7.12.9 Lifting and Jacking Points

All lifting and jacking points must be clearly marked and accessible without the need to remove other equipment.

7.13 Future Installations

Reasonable and cost-effective provision shall be made within the vehicles for the future installation of:

- Automatic Train Control (ATC)
- Automatic Train Protection (ATP)
- In-cab signalling

8 Communication & Information Systems

8.1 Passenger Information Displays

On board Passenger Information Display screens (PIDS) shall be fitted to provide passenger information on train movements and next station indication and shall comply with requirements for Special Needs Passengers. The technical specification and functionality for the display screens will be determined during the detailed design phase.

8.2 Public Address

A public address (PA) system shall be provided to complement the PIDS. The on-board PA system will generally operate in automatic mode (Digitised Voice Announcements) providing information for the next stop (station), and 'doors closing', delays, safety and security announcements at pre-determined intervals and general information to enhance the travel experience for all users but more especially the visually impaired.

The system shall have the capability for:

- Automatic announcements for safety and security and general announcements at predetermined intervals
- Automatic announcements for 'next station' arrivals, destination, direction of travel and 'doors closing'
- Manual announcements on the train by train staff
- Manual announcements from the CTC
- Automatic and manual emergency announcements for evacuation instructions
- Use of clear and understandable English voice recordings
- Clear sound quality
- A test and failure indication facility

8.3 Help Points

Help Points provide customers with the ability to contact a person of authority in an emergency situation e.g. security, passenger illness, etc.

The Help Point system will be the Emergency Only contact for passengers to contact either the on train attendant or security officer for assistance and / or attendance.

The Help Point facility on the train will have clear and concise operating instructions displayed for the passenger and also there will be a warning displayed stating the

"Emergency Only" use only of the Help Point. The system is not to be utilised for general enquiries.

8.4 Communication Systems

The following train communication systems shall be provided:

- Inter-communication system between all driving cabs
- A train radio system for communication between train and the CTC to the current standard

All electronic equipment shall be designed in accordance with recognised international standards and norms and compliant with relevant South African standards.

The Communication System shall allow the CTC to make PA announcements on trains.

9 Safety & Security

9.1 Closed Circuit Television

A costed option for the provision of a closed circuit television system (CCTV) shall be provided whereby:

CCTV is installed in commuter saloon areas.

Modules are equipped with forward- and rear facing CCTV cameras.

The CCTV system monitors the saloon areas in all coaches, and sends the video data to the drivers cab when a passenger presses the help button (Section 8.3; Help Points).

The CCTV system records all cameras on a robust recordable medium for rolling window of 336 hours before over-writing.

10 Legislation and Standards

10.1 Safety Regulation

All design, construction and commissioning life cycle requirements for engineering and operating systems shall be done in accordance with the National Railway Safety Regulator Act 16 of 2002 (as amended) [viii] and relevant standards as well as the Occupational Health and Safety Act 85 of 1996 [ix].

10.2 Quality

Preference shall be given to manufacturers whom have implemented a recognised quality management system. The accepted quality system in South Africa is with ISO 9001:2000, ISO 9001:2008 and ISO 14000.

11 References

i. PRASA Corporate Plan, 25/02/2010
ii. Funding Motivation for the Acquisition of New Rolling Stock for Metrorail Operations, July 2010
iii. Network Information and Infrastructure Interface Report, March 2011
iv. SARCC National Railplan Consolidated Report, August 2006
v. Procurement of New Rolling Stock for Metrorail Services, Technical Specification, March 2011
vi. Design Guidelines to Improve Accessibility of Commuter Rail in South Africa, SARCC, April 2008
vii. Noise Control Regulations in Terms of Section 25 of the Environment Conservation Act, Act 73 of 1989, Department of Environmental Affairs, GNR 154 of January 1992
viii. Occupational Health and Safety Act, No. 85 of 1993
ix. National Safety Regulator Act, No. 16 of 2002 (as amended)