CHAPTER 3

SYSTEM SELECTION

3.1 Selection of Medium Capacity Metro

Traffic to be catered by metro services on East-West and North-South corridors of Ahmedabad Metro in the years 2010, 2025 and 2035 has been discussed in detail in Chapter 2 on 'Traffic Demand Analysis'. It can be seen from this Chapter that peak hour peak direction trips (phpdt) on these Corridors are 14000, 21000 and 34000 in the year of 2010, 2025 and 2035 respectively.

Road-based systems can optimally carry up to a maximum of 10,000 phpdt. Since the phpdt of the above corridors exceed 10,000, they qualify for a rail-based Mass Transit System. A rail-based system may be either Light Rail Transit System (LRTS), or Medium Capacity Metro System, or Heavy Capacity Metro System. While the Light Rail Transit System is suitable for corridors with phpdt in the range of 20,000 to 25,000, Medium Capacity and Heavy Capacity Metro Systems can optimally handle traffic densities ranging between 25,000 - 50,000 phpdt and between 50,000 – 75,000 phpdt respectively. For Delhi, a Heavy Capacity Metro system has been adopted due to high traffic demand.

As the phpdt in case of Ahmedabad Metro is more than 25,000 in the year of 2035 and is not likely to exceed 50,000 for many years, Medium Capacity Metro system is recommended to keep down the capital and operating costs.

3.2 Choice of Gauge

Standard Gauge (1435mm) is invariably used for metro railways world over. During the last decade, 20 new metros have been constructed in various cities of the world. All these metros have gone in for Standard Gauge even though the national gauge for mainline railways in some of these countries was different from Standard Gauge. In India the national gauge is Broad Gauge (1676mm). The question whether Ahmedabad Metro should go in for Broad Gauge or Standard Gauge has, therefore, been examined with following important parameters.

(i) Metro alignments in a city have to pass through heavily built-up areas for optimal passenger utilisation and this imposes severe restrictions on the selection of curves. As in most of the cities in India no 'right of way' has been reserved for metro systems, the alignments have to follow the major arterial roads. These roads may often have sharp curves and right-angle bends. In such a situation adoption of Standard Gauge is advantageous since it permits adoption of sharper curves compared to Broad Gauge to minimise property acquisition along the alignments.

(ii) In Standard Gauge 1 in 7 and 1 in 9 turn-outs, which occupy lesser length, are feasible compared to 1 in 8 ½ and 1 in 12 turn-outs required for Broad Gauge. Length of cross-overs for Standard Gauge is thus lesser than for Broad Gauge. Land requirement for depots where a large number of lines connected together in the shape of ladder is also reduced. Standard Gauge is, therefore, more suited for use in built up environment where land availability is scarce.

(iii) For Standard Gauge, optimised state-of-the-art rolling stock designs are available ‘off-the-shelf’. This is not so for Broad Gauge where new designs for rolling stock have to be specially developed which entails extra time and cost.

(iv) Because of the availability of a very large market, constant up-gradation of technology takes place for Standard Gauge coaches. Thus upgraded technology is available on a continued basis in case of Standard Gauge. This is not so in case of Broad Gauge.

(v) For the same capacity gross weight of a metro coach is lower for Standard Gauge than for Broad Gauge. Standard Gauge rolling stock thus results in recurring saving in energy consumption during operation.

(vi) Once technology for Standard Gauge coaches get absorbed and a manufacturing base for them is set up in India, there will be considerable export potential for the coaches, since almost all the countries use Standard Gauge for their metros. This is not so in case of Broad Gauge.

(vii) It is some time argued that adoption of Broad Gauge for metros would enable inter-running of metro trains with Indian Railways since the latter uses Broad Gauge. Inter-running is, however, technically and / or operationally not feasible as the two systems have different:

- Rolling Stock characteristics,
- Signalling Systems,
- Headways,
- Tariffs,
- Moving dimensions, and
- Loading standards.

(viii) Track gauge is not a technical parameter for any metro rail system. It is a planning parameter. This issue was also examined in January 2000 by the Ministry of Law and Justice who had opined that the choice of gauge is a matter which lies within the jurisdiction of the metro rail organisation entrusted with the responsibility of implementing and operating the metro systems.

(ix) With Standard Gauge, capital cost will be less by 2 to 4%

(x) Possibility of BOT route for financing the Metro will be feasible only with standard Gauge.

(xii) Presently Metro Coaches are not manufactured in the country. Delhi Metro rail Corporation has placed a contract for 240 Metro Coaches on a consortium of Mitsubishi Corporation/ Japan, Rotem/Korea & Mitsubishi Electric Corporation/Japan. 60 coaches are to be manufactured off-shore and 180 are to be manufactured in India with progressive indigenous content. The consortium has tied up with Bharat Earth Movers Limited, Bangalore for setting up facilities to manufacture 180 coaches for Delhi Metro out of which 96 coaches have already been supplied to DMRC. BEML/Bangalore being a public sector undertaking is to be developed as a centre for absorption of Metro Coach manufacturing Technology. Already their engineers and technicians have been trained in ROTEM/Korea. The machinery, Jigs/Fixture brought from Korea has been installed at BEML /Bangalore. As a result of collaboration with MRM, BEML would be able to develop as manufacturing base for supply of Metro Coaches with modern features to meet the requirement of future Metro Rail in India.

Since inter-running is not feasible, choice of Gauge for a metro system should be based solely on technical and economic considerations on which Standard Gauge turns out to be superior.

From the above, it is seen that Standard Gauge will be cost-effective and at the same time enable Ahmedabad Metro to be at par with world-class metros and enable it to remain technically up-dated in future. Standard Gauge will also enable setting up a manufacturing base for coaches required for metros in other cities of the country as well create an export potential for such coaches. Adoption of Standard Gauge is, therefore, recommended for Ahmedabad Metro. A wider gauge is not justified as coach width is small and axle loads are as low as 14 tonne for Standard Gauge Metro.

3.3 TRACK STRUCTURE

Track on Metro Systems is subjected to intensive usage with very little time for day-to-day maintenance. Thus it is imperative that the track structure selected for Metro Systems should be long lasting and should require minimum or no maintenance and at the same time, ensure highest level of safety, reliability and comfort, with minimum noise and vibrations. The track structure has been proposed keeping the above philosophy in view.

3.3.1 General

Two types of track structures are proposed for any Metro. The normal ballasted track is suitable for At-Grade (surface) portion of Main Lines and in Depot (except inside the Workshops, inspection lines and washing plant lines. The ballastless track is recommended on Viaducts and inside tunnels as the regular cleaning and replacement of ballast at such location will not be possible.

However for the depots, ballasted track is recommended as ballastless track on formation is not suitable due to settlement of formations. Ballastless track in depot is required inside the workshop and on inspection lines.

From considerations of maintainability, riding comfort and also to contain vibrations and noise levels, the complete track is proposed to be jointless and for this purpose even the turnouts will have to be incorporated in LWR/CWR.

The track will be laid with 1 in 20 canted rails and the wheel profile of Rolling Stock should be compatible with the rail cant and rail profile.

3.3.2 Rail Section

Keeping in view the proposed axle load and the practices followed abroad, it is proposed to adopt UIC-54 (54 kg. /m) rail section (as shown in Fig.3.1). Since on main lines, sharp curves and steep gradients would be present, the grade of rail on main lines should be 1080 Head Hardened as per IRS-T- 12-96. As these rails are not manufactured in India at present, these are to be imported. For the Depot lines, the grade of rails should be 880, which can be easily manufactured indigenously.

3.3.3 Ballastless Track on Main Lines (Viaducts)

On the viaducts, it is proposed to adopt plinth type ballastless track structure with RCC derailment guards integrated with the plinths (shown in Fig.3.2). Further, it is proposed to adopt Vossloh-336 Fastenings System (shown in Fig.3.3) on both types of ballastless track structures, with a base-plate to base-plate spacing of 65 cm. on viaducts. Most of the components of Vossloh-336 fastening system are now indigenously available. The toe load design for the clips is to be finalised at the detail design stage.

3.3.4 Ballastless Track in Depot

The ballastless track in Depot may be of the following types:

- Discretely supported on concrete/steel pedestal for inspection lines.
- Embedded rail type inside the Workshop.
- Plinth type for Washing Plant line.

3.3.5 Turnouts

- From considerations of maintainability and riding comfort, it is proposed to lay the turnouts also with 1 in 20 cant. Further, it is proposed to adopt the following two types of turnouts:

  i) On main lines, 1 in 9 type turnout with a lead radius of 300 metres and permissible speed on divergent track as 40 km/h (shown in Fig.3.4).

  ii) On Depot lines, 1 in 7 type turnout with a lead radius of 140 metres and permissible speed on divergent track as 25 km/h (shown in Fig.3.5).

- The Scissors cross-overs on Main Lines (1 in 9 type) will be with a minimum track centre of 4.5 m (shown in Fig.3.6).

- The proposed specifications for turnouts are given below: -

  i) The turnouts should have fan-shaped layout throughout the turnout so as to have same sleepers/base-plates and slide chairs for both LH and RH turnouts.

  ii) The switches and crossings should be interchangeable between ballasted and ballastless turnouts (if required).

- The switch rail should be with thick web sections, having forged end near heel of switch for easy connection with lead rails, behind the heel of switch. The switches should have anti creep device at heel of switch for minimising the additional LWR forces transmitted from tongue rail to stock rail.

- The crossings should be made of cast manganese steel and with welded leg extensions. These crossings should be explosive hardened type for main lines and without surface hardening for Depot lines.

- The check rails should be with UIC-33 rail section without being directly connected to the running rails.

3.3.6 Buffer Stops

On main lines and Depot lines, friction buffer stops with mechanical impact absorption (non-hydraulic type) need to be provided. On elevated section the spans on which friction buffer stops are to be installed are to be designed for an additional longitudinal force of 85 T, which is likely to be transmitted in case of Rolling Stock impacting the friction Buffer Stops.

3.4 RAIL STRUCTURE INTERACTION

For continuing the LWR/CWR on Viaducts, the elevated structures are to be adequately designed for the additional longitudinal forces likely to be transmitted as a result of Rail-Structure interaction. Rail structure interaction study will determine the need and locations of Rail Expansion Joints (REJ) also. REJ in ballasted track will be for a maximum gap of 120 mm, whereas on ballastless track for a maximum gap of 180 mm.

3.5 WELDING

Flash Butt Welding Technique is to be used for welding of rails. Alumino-Thermic Welding is to be done only for those joints which cannot be welded by Flash Butt Welding Technique, such as joints at destressing locations and approach welds of switches & crossings. For minimising the population of Thermit welds, mobile (rail-cum-road or portable) Flash Butt Welding Plant will have to be deployed.

3.6 TRACTION SYSTEM

Traditionally, electric traction is used in Metro systems for requirement of high acceleration and pollution-free services in urban areas. There are three standard and proven systems of electric traction for use in suburban and metro lines, viz:- 750V dc third rail, 1500V dc overhead catenary and 25kV ac overhead catenary system. All these three systems are presently in use in India (750 V DC third rail in Kolkatta Metro, 1500V dc catenary in Mumbai suburban of Central & Western Railways and 25kV ac catenary in Delhi Metro & Indian Railways). However, conversion of 1500 V dc to 25kV ac is currently in progress in Mumbai suburban areas of Central and Western Railways.

750V dc third rail system has been extensively used in metros and more than 60% of existing metro systems in the world utilize 600-750V dc third rail system. The system does not negate the aesthetics of the city as it is laid alongside the track and also requires smaller tunnel diameter for underground section compared to other systems. This system has a technical limitation beyond a traffic level of 50,000 PHPDT on account of requirement of large number of traction sub-stations and difficulty in differentiation between over-current and short-circuit currents. Few recently commissioned Metro systems with 750V dc third rail are Bangkok Transit System (1999), Athens Metro (2000), Istanbul Metro (2001) and Tehran Metro (2000). All these are medium capacity Metro systems designed for a traffic level upto 45000 PHPDT.

1500V dc catenary system has been adopted by some of heavy metros to overcome the limitation imposed by 750V dc system for catering to traffic level of 60,000-80,000 PHPDT (e.g. Singapore, Hong Kong, Guangzhou etc.). This system requires use of catenary masts and messenger wires on elevated viaducts thereby affecting aesthetics of the city.

Stray current corrosion is often encountered in dc-electrified railways and therefore, suitable measures are required for protection against corrosion of metallic structures, reinforcement and utility pipes caused by dc stray current. Some of the old Metros are spending heavily on corrosion repairs caused by dc stray currents.

25kV ac traction has the economical advantages of minimal number of traction sub-stations and potential to carry large traffic (60,000-90,000 PHPDT). The system requires catenary masts on surface/elevated section, thereby affecting aesthetics and skyline of the city. Suitable measures are required for mitigation of electro-magnetic interference (EMI) caused by single-phase 25kV ac traction currents. EMI mitigation measures are simple and well known compared to dc stray current corrosion protection.

Typical 25kV AC Catenary Arrangement

Traffic requirements of the Ahmedabad Metro have been projected in the range of 40,000 PHPDT in horizon year 2035 and likely to be higher in future. The proposed Regional Railway System has to be operated on 25kV ac traction system as this will be integrated with Indian Railways. By adopting the same system for the Metro, the requirement of sub-stations can be optimised. The alignment of proposed corridors is on elevated viaducts and future extensions are also mostly on elevated sections. Keeping in view the ultimate traffic requirements, standardization, and other techno-economic considerations, 25kV ac overhead Catenary traction system is considered to be the best trade-off and hence, proposed for adoption on Ahmedabad Metro System. Since the route is on elevated viaducts with wide roads, it would not be prone to safety hazards to public and residents of nearby buildings as well. However, suitable measures will be required to be implemented for mitigation of Electro-Magnetic Interference (EMI) & Electro-Magnetic Compatibility (EMC) caused by 25 kV single phase traction currents.

3.7 SIGNALLING

3.7.1 Introduction

The signalling system shall provide the means for an efficient train control, ensuring safety in train movements. It assists in optimization of metro infrastructure investment and running of efficient train services on the network.

3.7.2 Signalling and Train Control

3.7.2.1 Overview

Metro carries large number of passengers at a very close headway requiring a very high level of safety enforcement and reliability. At the same time, heavy investment in infrastructure and rolling stock necessitates optimisation of its capacity to provide the best services to the public. These requirements are planned to be achieved by adopting CATC (Continuous Automatic Train Control) in the section consisting of ATO (Automatic Train Operation), ATP (Automatic Train Protection), and State of the Art ATS (Automatic Train Supervision) sub-systems. This will:

- Provide high level of safety with trains running at close headway (4 minutes), ensuring continuous safe train separation.
- Eliminate accidents due to driver passing Signal at Danger by continuous speed monitoring and automatic application of brake in case of disregard of signal/ warning by the driver. However, responsibility in degraded modes still lies with the driver.
- Provides safety and enforces speed limit on section having permanent and temporary speed restrictions.
- Improve capacity with safer and smoother operations. Driver will have continuous display of Target Speed / Distance to go status in his cab enabling him to optimise the speed potential of the track section. It provides signal / speed status in the cab even in bad weather.
- Increased productivity of rolling stock by increasing line capacity and train speeds, and enabling train to arrive at its destination sooner. Hence more trips will be possible with the same number of rolling stock.
- Improve maintenance of Signalling and telecommunication equipments by monitoring system status of trackside and train born equipments and enabling preventive maintenance.

Signalling system shall be provided on all running tracks of the metro except for the lines of the car shed used mainly for maintenance lines/ local shunting. At all stations with points and crossings, Computer Based Interlocking (CBI) will be provided for operation of points and crossings/ setting of routes including track of adjacent station. The control of train operation will be done from computer based operation control centre (OCC) and will be supervised by Traffic Controller. Facilities for setting of the route and clearing of the signals will also be provided from workstation or CCIP located at stations with points and crossings. The depot shall be interlocked and equipments with a workstation or CCIP to control and supervise the movements within its yards.

3.7.2.2 Selection of System

The Signalling and Train Control system shall be as below:

a. Interlocking System:

At all stations with points and crossings, Computer Based Interlocking (CBI) will be provided for operation of points and crossings and setting of routes.

The setting of the route and clearing of the signals will be done by work station which can be either locally (at station) operated or operated remotely from the Operation control Centre (OCC).

b. Train Depot: Signalling

In each depot, all lines except the ones used for shunting and in workshop shall be interlocked. A workstation each shall be provided in the Depot Control Centre for electrical operation of the points, signals and routes of the depot yard.

c. Automatic Train Protection

To ensure safety in train operation and to provide optimum train services on the main line, the train control on the metro shall be provided with Automatic Train Protection (ATP) System. For this, the transmission from track to train will be continuous preferably through audio frequency track circuits. Facilities for automatic enforcement of temporary/ permanent speed restrictions shall also be built in to enhance safety during maintenance work. ATP system will be provided on entire main line.

d. Train Supervision and Control Office

A train supervision system will be installed to facilitate the monitoring of train operation and also remote control of the stations. The train supervision will log each train movement and display it on the workstations with each Traffic Controller at the OCC and on one workstation placed in the Station Control room (SCR) with each Station Controller.

3.7.2.3 Standards

The following standards will be adopted with regard to the Signalling system.

Description	Standards
▪ Interlocking	Computer Based Interlocking adopted for station having switches and crossing. All related equipment as far as possible will be centralised in the equipment room at the station. The depot shall be interlocked except for lines mainly used for shunting, workshop/inspection shed areas.
▪ Operation of Points	With 110V D.C. point machines or 380 volts 3 phase, 50 Hz. AC point machines.
▪ Track Circuit	Audio frequency Track circuits on running section, test track and in depot.
▪ Signals at Stations	Line Side signals to protect the points (switches).
▪ UPS (uninterrupted power at stations as well as for OCC)	For Signalling and Telecommunications
▪ Train protection systems	Automatic train control with over speed protection and protection against signal passing at danger.
▪ Train Describer System	Movement of all trains to be logged on to a central computer and displayed on workstations in the Operational Control Centre and at the SCR. Remote control of stations from the OCC.
▪ Redundancy for TP/Train Describer.	Future space provision for redundancy for Train born equipments. Redundancy to be provided for ATS at OCC.
▪ Cables	Cables will be armoured, as far as possible.
▪ Fail Safe Principles	SIL-4 safety levels as per CENELEC standard for signal application.
▪ Immunity to External Interface.	All data transmission on telecom cables/ OFC/Radio. All Signalling and telecom cables will be separated from power cables. CENELEC standards to be implemented for EMC.
▪ Train Working in degraded modes	Running on site with line side signals protecting points
▪ Environmental Conditions	Air-conditioners for all equipment rooms
▪ Maintenance philosophy	Philosophy of continuous monitoring of system status and preventive & corrective maintenance of Signalling equipments shall be followed. Card / module / sub-system level replacement shall be done in the field and repairs under taken in the central laboratory/ manufacturer's premises.

3.7.3 Specifications

3.7.3.1 Automatic Train Protection

Automatic Train protection is the primary function of the train control systems. This sub-system will be inherently capable of achieving the following objectives in a fail-safe manner.

- Prevent rear-end or side collision resulting from one train trying to over-take the other.
- Prevent trains being routed on the conflicting routes.
- Prevent the possibility of points / switches moving just ahead of or under train.
- Not hindering the vehicles attaining maximum permissible speed.

Basic sub-system will include the following modules:-

i) Train detection
ii) Train Protection
iii) Computer Based Interlocking
iv) Signal and speed enforcement.
v) Brake assurance
vi) Interface with electrical sub-systems of the vehicle like brake control.

- Audio Frequency Track circuits will be used for vehicle detection as well as track to train communication.
- Preferably, Balise will be used for transmission of data from track to train
- Sub-system/components will conform to international standards like BS, IS, CENELEC, IEC, ITU-T etc.

3.7.3.2 The cab borne equipment

These will be of modular sub-assemblies for each function for easy maintenance and replacement. The ATP assemblers will be fitted in the vehicle integrated with other equipment of the rolling stock.

3.7.3.3 Train Supervision

Train supervision system will be installed in the Operation control center and will have a panoramic view of the sectional jurisdiction showing the status of tracks, points, signals and the vehicles operating in the relevant section/ whole system. The system shall provide train information in real time and in printouts for later analysis. It will be possible to set route of trains at terminals, mid-terminals and runback stations, etc. both locally from the stations with point and crossings and remotely from OCC. It shall have audio-visual alarms for deficiencies / malfunctioning.

3.7.3.4 CBI at Stations

This sub-system is used for controlling vehicle movements into or out of stations automatically from a workstation. All stations having points and crossings will be provided with workstations for local control. Track occupancy, point position, etc. will be clearly indicated on the workstation. It will be possible to operate the workstation locally, if the central control hands over the operation to the local station. The system design will be on the basis of fail-safe principle.

The equipment will withstand tough environmental conditions encountered in a Mass Transit System. Control functions in external circuits will be proved both in the positive and negative wires. Suitable IS, IRS, BS standards or equivalent international standards will be followed in case wiring, installation, earthing, cabling, power supply and for material used in track circuits, relays, point operating machines, power supply etc.

3.7.4 Space Requirement for S & T Installations

Adequate space for proper installations of all Signalling equipment at each of the stations has to be provided keeping in view the case of maintenance and use of instrumentation set up for regular testing and line up of the equipment/system. The areas required at each of the stations for S & T equipment shall be generally 50 sq.m for UPS Room (common for signaling and telecom) and 50 sq.m at interlocked station with points & 20 sq.m at other stations for Signalling. The areas shall also cater to local storage and space for maintenance personnel to work. At the OCC and the Depot, the areas required shall be as per the final configuration of the equipments and network configuration keeping space for further expansion.

3.7.5 Maintenance Philosophy for Signalling systems

The philosophy of continuous monitoring of system status and preventive & corrective maintenance of Signalling and telecommunication equipments shall be followed. Card / module / sub-system level replacement shall be done in the field. Maintenance personnel shall be suitably placed at intervals and they shall be trained in multidisciplinary skills. Each team shall be equipped with a fully equipped transport vehicle for effectively carrying out the maintenance from station to station.

The defective card/ module / sub-system taken out from the section shall be sent for diagnostic and repair to a centralised S&T repair lab suitably located on the section. This lab will be equipped with appropriate diagnostic and test equipments to rectify the faults and undertake minor repairs. Cards / modules / equipments requiring major repairs as specified in suppliers documents shall be sent to manufacturer's workshop.

INTERLOCKING CUBICLE

3.8 TELECOMMUNICATION

3.8.1 Introduction

The telecommunication system acts as the communication backbone for Signalling systems and other systems such as SCADA, AFC etc and provides telecommunication services to meet operational and administrative requirements of metro network.

3.8.2 Telecommunication

3.8.2.1 Overview

The telecommunication facilities proposed are helpful in meeting the requirements for

1. Supplementing the Signalling system for efficient train operation.
2. Exchange of managerial information
3. Crisis management during emergencies
4. Passenger information system

The proposed telecom system will cater to the following requirements:

- Train Traffic Control
- Assistance to Train Traffic Control
- Maintenance Control
- Emergency Control
- Station to station dedicated communication
- Telephone Exchange
- Passenger Announcement System and Passenger Information and Display System within the station and from Central Control to each station.
- Centralised Clock System
- Train Destination Indicator
- Instant on line Radio Communication between Central Control and Moving Cars and maintenance personnel.

- Data Channels for Signalling, SCADA, Automatic Fare Collection etc.
- Non Power SCADA for TVS, ECS and other Electrical Systems

3.8.2.2 Telecommunication System and Transmission Media

i) Optical Fibre Cable - Main Telecommunication Bearer

The main bearer of the bulk of the telecommunication network is proposed with optical fibre cable system. Considering the channel requirement and keeping in view the future expansion requirements a optical fiber cable is proposed to be laid in ring configuration with path diversity.

SDH STM-4 155 Mbps based system shall be adopted with SDH nodes at every station, OCC and depot. Access 2MB multiplexing system will be adopted for the lower level at each node, equipped for channel cards depending on the requirement of channels in the network. Further small routers and switches shall be provided for LAN network at station.

ii) Telephone Exchange

For a optimised cost effective solution a mix of medium and small exchanges are planned. Three EPABX of 512 ports will be provided at four locations preferably one at the OCC, one at an intermediate station and other at the depot. Small exchanges of 30 port each shall be at each station. These are to be connected together through optical fiber, which will provide communication at each stations and depots. The Exchanges will serve the subscribers at all the stations, OCC and depot. The exchanges will be interconnected at multiple 2 MB level through optical fibre cable. The Exchanges shall be software partitioned for EPABX and Direct Line Communication from which the phones shall be extended to the stations. Interface required with existing EPABX network of North-South Line shall be done through standard 2 MB links at the OCC level.

iii) Mobile Radio Communication

Mobile Radio communication system having 8 channels is proposed for on-line emergency communication between Motorman (Front end and Rear end) of moving train and the Central Control. The system shall be based on Trunk Radio Technology to TETRA International standard/ APCO25 Standard. This system now is widely adopted for mobile radio communication in metro / rapid transit services abroad. All the stations and Car Depot will be provided with fixed radio sets. Mobile communication facility for maintenance parties and Security Personnel will be provided with handheld sets.

These persons will be able to communicate with each other as well as with central control. To provide adequate coverage, based on the RF site survey to be carried out, base stations for the system will be located at a site conveniently selected after detailed survey. Preliminarily it is anticipated that minimum seven Radio Base stations shall be required, interlinked to the Central Radio Equipment at the OCC through channels on the optical fibre system.

The frequency band for operation of the system will be that for Trunk Radio in 400/800 MHz band depending upon availability of frequency. Instant mobile radio communication between the motorman of the moving cars from any place and the Central Control can be established. The motorman can also contact any station in the network through the central control, besides intimating the approaching trains about any emergency like accident, fire, line blocked etc., thus improving safety performance.

Radio Tower

iv) Passenger Announcement System

The system shall be capable of announcements from the local station as well as from OCC. Announcements from OCC will have over-riding priority in all announcements.

v) Centralized Clock System

This will ensure an accurate display of time through a synchronization system of slave clocks driven from a Master Clock at the operation control center. The Master Clock signal shall also be required for synchronization of SDH and Exchanges. The System will ensure identical display of time at all locations. Clocks are to be provided at platforms, concourse, Station Master's Room and other service establishments etc.

vi) Passenger Information Display System

These shall be located at convenient locations at all stations to provide bilingual visual indication of the status of the running trains and will typically indicate information such as destination, arrival/departure time, and also special messages in emergencies. The boards shall be provided at all platforms and concourses of terminal & junction stations.

vii) Network Monitoring and Management

For efficient and cost effective maintenance of the entire communication network, it is proposed to provide a network management systems (NMS), which will help in diagnosing faults immediately from a central location and attending the same with least possible delay, thus increasing the operational efficiency and reduction in manpower requirement for maintenance.

The proposed NMS system will be covering radio communication, Optical Fiber Transmission system and Telephone Exchange.

viii) NP SCADA System for underground portion

Non Power SCADA will be used for monitoring from OCC Tunnel Ventilation system, Environmental Control system, Electrical & Hydraulic systems, Lift & Escalators and Seismic system for the underground section. Besides, NP SCADA will facilitate controlling of TVS system from OCC. This system will also be used for monitoring of Telecommunication system.

3.8.2.3 Standards

The standards proposed to be adopted for telecommunication systems are shown in Table below:

System	Standards
• Transmission System	**SDH based** for the entire telecom network.
• Transmission Media	**Optical Fibre system** as the main bearer for bulk of the telecommunication network,
• Telephone Exchange	EPABX of 512 ports is to be provided at four locations preferably one at OCC, one at an intermediate station and other at both depots. Further small exchanges shall be at each station.
• Train Radio System	**Train radio (TETRA/APCO25)** communication between motorman of moving cars, stations, maintenance personnel and central control**.**
• Train Destination Indicator System	**LED/LCD based boards** with adequate visibility to be provided at convenient location at all stations to provide bilingual visual indication of the status of the running trains, and also special messages in emergencies.
• Centralized clock system	Accurate display of time through a synchronisation system of slave clocks driven from a master clock at the OCC and sub – master clock in station. This shall also be used for synchronisation other systems.
• Passenger Announcement System	**Passenger Announcement System** covering all platform concourse areas with local as well as Central Announcement.

System	Standards
• Redundancy (Major System)	Redundancy on Radio base station equipment. Path Redundancy for Optical Fibre Cable by provisioning in ring configuration.
• Environmental Conditions	All equipment rooms to be air-conditioned
• Maintenance Philosophy	System to have, as far as possible, automatic switching facility to alternate routes/circuits in the event of failure. Philosophy of preventive checks of maintenance to be followed. System networked with NMS for diagnosing faults and co-ordination. Card/module level replacement shall be done in the field and repairs undertaken in the central laboratory/manufacture's premises.

3.8.3 Car Depot

Car Depot will be provided with a Mobile Radio Dispatcher System for Depot/Yard communication connected from the central infrastructure at the OCC, to provide communication from the Depot Control Room to Mobile sets in the Cabs of the cars and hand held sets with the maintenance personnel of the depot.

All the offices and the Maintenance installations at Car Depot will be connected with EPABX telephones and will be fed from the nearest Exchange.

3.8.4 Space Requirement for Telecom Installations

Adequate space for proper installations of all Telecommunication equipment at each of the stations has to be provided keeping in view the case of maintenance and use of instrumentation set up for regular testing and line up of the equipment/system. The areas required at each of the stations for S & T equipment shall be generally 40 sq.m each for Telecomm Room and 50 sq.m. for UPS Room (common for signal and telecom). These areas shall also cater to local storage and space for maintenance personnel to work. Radio tower shall be located at approximately 5 km interval along the section. The tower may be placed as near to Base Station Equipment Rooms as possible but not more than 40 - 50 m away from it. Necessary land/ space acquisition (8mX8m) for the same should be planned. However at detailed design stage it can be checked whether these can be provided over the station. At the OCC and the Depot, the areas required shall be as per the final configuration of the equipments and network configuration keeping space for further expansion.

3.8.5 Maintenance Philosophy for S & T systems

The philosophy of continuous monitoring of system status and preventive & corrective maintenance of Signalling and telecommunication equipments shall be followed. Card / module / sub-system level replacement shall be done in the field. Maintenance personnel shall be suitably placed at intervals and they shall be trained in multidisciplinary skills. Each team shall be equipped with a fully equipped transport vehicle for effectively carrying out the maintenance from station to station.

The defective card/ module / sub-system taken out from the section shall be sent for diagnostic and repair to a centralized S&T repair lab suitably located on the section. This lab will be equipped with appropriate diagnostic and test equipments to rectify the faults and undertake minor repairs. Cards / modules / equipments requiring major repairs as specified in suppliers documents shall be sent to manufacturer's workshop.

3.9 AUTOMATIC FARE COLLECTION

3.9.1 Introduction

Mass Rapid Transit Systems handle large number of passengers. Ticket issue and fare collection play a vital role in the efficient and proper operation of the system. To achieve this objective, ticketing system shall be simple, easy to use/operate and maintain, easy on accounting facilities, capable of issuing single/multiple journey tickets, amenable for quick fare changes and require overall lesser manpower. In view of above, computer based automatic fare collection system is proposed.

AFC system proves to be cheaper than semi-automatic (manual system) in long run due to reduced manpower cost for ticketing staff, reduced maintenance in comparison to paper ticket machines, overall less cost of Smart Card in comparison to paper tickets and prevention of leakage of revenue.
Relative advantages of automatic fare collection system over manual system are as follows:

A) Manual fare collection systems have the following inherent disadvantages:

1. Large number of staff is required for issue and checking of tickets.
2. Change of fare structure is time consuming as has to be done at each station.
3. Manipulation possible by jamming of mechanical parts.
4. Staff and passenger interaction leading to more chances of confrontation.
5. 100% ticket checking at entry / exit is not possible.

B) Automatic fare collection systems have the following advantages:

1. Less number of staff required.

2. Less possibility of leakage of revenue due to 100% ticket check by control gates.
3. Recycling of ticket fraudulently by staff avoided.
4. Efficient and easy to operate, faster evacuation both in normal and emergency.
5. System is amenable for quick fare changes.
6. Management information reports generation easy.
7. System has multi-operator capabilities. Same Smart Card can be used for other applications also,
8. AFC systems are the worldwide accepted systems for Metro environment.
9. Integration with revenue collection regime is possible.

The proposed ticketing system shall be of Contactless Smart Token/ Card type. The equipments for the same shall be provided at each station Counter/Booking office and at convenient locations and will be connected to a local area network with a computer in the Station Master's room. Equipment and installation cost of Contactless Smart Card /Token based AFC system is similar to magnetic ticket based AFC system, but Contactless system proves cheaper due to reduced maintenance, less wear and tear and less prove to dusty environment.

C) Choice of Control Gates

Retractable flap types Control Gates are proposed which offer high throughput (45 passengers per minute), require less maintenance and are latest in modern metros internationally. Tripod turnstile type or pneumatic flap type gates offer less throughput and require more maintenance. Bi-parting flap gates though offer good throughput but require more discipline from patrons.

D) Passenger Operated Machine

Space for provision of Passenger Operated Machines (Automatic Ticket Dispensing Machines) for future, shall be provided at stations.

3.9.2 Standards

The standard proposed for AFC systems are as under:

Standards	Description
• Fare media	a) **Contactless smart token** – For single journey. They shall have stored value amount for a particular journey. Tokens are captured at the exit gate. b) **Contactless smart card** – For multiple journeys.

Standards	Description
• Gates	Computer controlled retractable flap type automatic gates at entry and exit. There will be following **types of gates**: • **Entry** • **Exit** • **Reversible – can be set to entry or exit** Automatic Gates for disabled are not proposed. For disabled people, manual swing gates will be used as in existing Line.
• Station computer, Central computer and AFC Net work	All the **fare collection equipments** shall be connected in a **local area network** with a station server controlling the activities of all the machines. These station servers will be linked to the central computer situated in the operational control centre through the optic fibre communication channels. The centralised control of the system shall provide real time data of earnings, passenger flow analysis, blacklisting of specified cards etc. Central Computer will interface with the existing server of North-South Line for common reporting and security.
• Ticket office machine (TOM/EFO)	Manned **Ticket office machine** shall be installed in the stations for selling smart cards/ tickets to the passengers. Provision will be there to issue magnetic tickets for stations of North-South Line.
• Ticket reader and portable ticket decoder.	**Ticket reader** shall be installed near EFO for passengers to check information stored in the smart cards.
• UPS (uninterrupted power at stations as well as for OCC).	**Common UPS of S&T system will be utilised.**
• Maintenance philosophy	Being fully Contactless systems, manpower requirement for maintenance is much less compared to system with magnetic tickets. However, adequate facilities to be provided similar to that of S&T systems.

3.9.3 Integration of AFC with Suburban/Bus System

Common Smart Card based ticketing for both Suburban and Bus systems is not proposed at this stage as this will require installation of AFC system at all suburban stations and in buses also. A Clearing House system will also be required for separation of revenue among various operators. However, the proposed system shall have multi operator capability and in future this will be possible to integrate various transport providers and other agencies.

Entry/Exit Gates

Ticket Office Machine

3.9.4 GSM and CDMA services along the Metro Route

It is envisaged to integrate GSM and CDMA services along the metro route to enable availability of quality communication services to metro passengers. This will require the following provisions to be made in the building structures.

- Around 25 sqm air-conditioned space each for GSM equipment and CDMA equipment at each of the metro stations.
- Space for leady coaxial cable or other communication media along the route for GSM and CDMA services.

It is envisaged that the GSM/CDMA operators will form joint consortia for setting up the communication services by sharing these provisions."

3.10 ROLLING STOCK

The required transport demand forecast is the governing factor for the choice of the Rolling Stock. In a metro city like Ahmedabad, the forecasted Peak Hour Peak Direction Traffic (PHPDT) precludes use of Light Rail Vehicle.

3.10.1 OPTIMISATION OF COACH SIZE

The East West corridor and North South corridor in Ahmedabad are completely on elevated track i.e. 8-10 m above ground level. The sharpest horizontal curve will be of 120 m radius. The maximum gradient on main line will be 3%. The vertical curve will have a minimum radius of 1500 m. Considering the above and clearances and space required for the service etc., the following optimum size of the coach has been arrived at Table 3.1

Table 3.1
Size of the coach

	Length	Width	Height
Driver Motor Car	20.9 m	2.88 m	3.9 m
Trailer car	20.5 m	2.88 m	3.9 m

Principal dimensions are shown in **figure 3.7 & 3.8**.

3.10.2 PASSENGER CARRYING CAPACITY

In order to maximize the passenger carrying capacity, longitudinal seating arrangement shall be adopted. The whole train shall be vestibuled to distribute the passenger evenly in all the coaches and for evacuation from ends in emergency. Criteria for the calculation of standing passengers are 3 persons per square meter of standing floor area in normal state and 6 persons in crush state of peak hour.

Therefore the Mass Rail Vehicle with 20.9 m carbody length with 2.88 m width and longitudinal seating arrangement conceptually have the capacity of 43 seated, 210 standing thus a total of 253 passengers for a Driving motor car, and 50 seated, 230 standing thus a total of 280 for a one trailer car is envisaged. Table 2 shows these figures.

Table 3.2

Carrying Capacity of Metro Rail Vehicles

	Driving Motor car		**Trailer car / Non-driving motor car**		**3 carTrain**	**6 car Train**
	Normal	Crush	Normal	Crush	Crush	Crush
Seated	43	43	50	50	136	286
Standing	105	210	115	230	650	1340
Total	148	253	165	280	786	1626

NORMAL-3 Per/sqm of standee area
CRUSH -6 Per/sqm of standee area

3.10.3 WEIGHT

The weights of motor cars and trailers was estimated as in Table 3.3, referring to the experiences in Delhi Metro. The average passenger weight has been taken as 60 kg .

Table 3.3
Weight of Metro Rail Vehicles (TONNE)

	DMC	**TC**	**MC**	**3 car train**	**6 car train**
TARE	40	37	38	117	230
Passenger					
(Normal)	8.88	9.9	9.9	27.66	57.36
(Crush)	15.18	16.8	16.8	47.16	97.56
Gross					
(Normal)	48.88	46.9	47.9	144.66	287.36
(Crush)	55.18	53.8	54.8	164.16	327.56

Heavy rush of passenger, having 8 standees per sq. meter can be experienced occasionally. As done in DMRC, it will be advisable to design the coach with sufficient strength so that even with this overload, the design will not result in overstresses in the coach and the bogie should therefore be designed for **15 t axle load**.

3.10.4 Required Power

It would be necessary for the trains to have rather higher acceleration and deceleration, considering the short distance between stations along the line.

To estimate the tractive force required by the three-car train, the following preconditions were assumed in consideration of riding comfort and adhesion.

Acceleration : 1.0 m/s^2
Deceleration 1.1 m/s^2 (Normal brake)
More than 1.3 m/s^2 (Emergency brake)

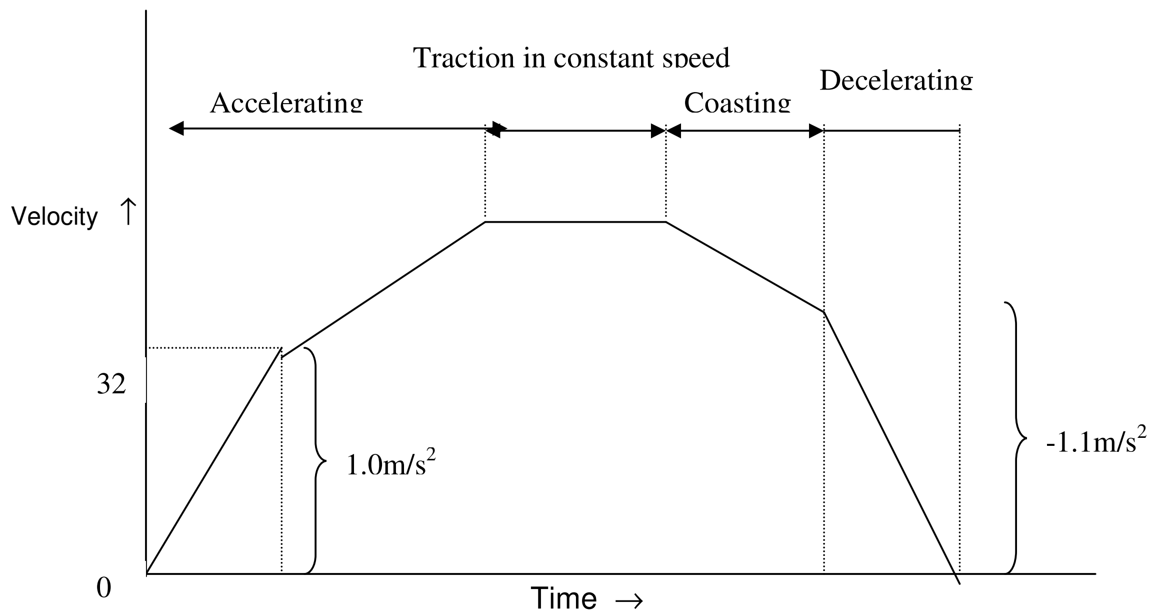

Fig 1 - Simplified velocity – time operation curve

Necessary power for a train of about 164 t in gross weight to accelerate in 1.0 m/s^2 , at schedule speed of 35 Km/h, on a level and straight track would be about 1,520 KW.

Since the track on a viaduct could possibly be constructed on a level and the traction motors could be operated with overload for a short time, 8 traction motors with about 190 KW installed on a three car train would be enough, even if the equivalent gradients on a curved section of track are considered. It was also assessed that failure of one motor car in a train running on a 4% grade having a R-120 curvature will still be giving sufficient acceleration to the train to clear the section.

3.10.5 Coach design and basic parameters

The important criteria for selection of rolling stock are as under:

(i) Proven equipment with high reliability
(ii) Passenger safety feature
(iii) Energy efficiency
(iv) Light weight equipment and coach body

(v) Optimised scheduled speed
(vi) Aesthetically pleasing Interior and Exterior
(vii) Low Life cycle cost
(viii) Flexibility to meet increase in traffic demand
(ix) Anti-telescopic

The controlling criteria are reliability, low energy consumption, light weight and high efficiency leading to lower annualized cost of service. The coach should have high rate of acceleration and deceleration.

3.10.6 Selection of Technology

Low life cycle cost

The low life cycle cost is achieved by the way of reduced scheduled and unscheduled maintenance and high reliability of the sub-systems. It is possible to achieve these objectives by adopting suitable proven technologies. The selection of following Technologies has been adopted to ensure low life cycle cost -.

(i) Car body

In the past carbon high tensile steel was invariably used for car bodies. In-fact almost all the coaches built by Indian Railways are of this type. These steel bodied coaches need frequent painting as well corrosion repairs which may have to be carried out up to 4-5 times during the service life of these coaches. It is now standard practice to adopt stainless steel or aluminum .The car bodies with aluminum requires long and complex extruded sections which are still not manufactured in India. Therefore aluminum car body has not been considered for use. Stainless steel sections are available in India and therefore Stainless steel car bodies have been specified. No corrosion repair is necessary on stainless steel cars during the service life of the cars.

The stainless steel car body leads to energy saving due to lightweight. It also results in cost saving due to easy maintenance and reduction of repair cost from excellent anti corrosive properties as well as an improvement of riding comfort and safety in case of crash or fire .A design life of 30 years for coach has been recommended.

(ii) Bogies

Bolster less lightweight bogies with rubber springs are now universally adopted in metro cars. These bogies require less maintenance and overhaul interval is also of the order of 4,20,000km. The use of air spring at secondary stage is considered with a view to keep the floor level of the cars constant irrespective of passenger loading unlike those with coil spring. The per turbration from the track are also dampened inside the car body on account of the secondary air spring. The primary suspension system improve the curve running performance by reducing lateral forces through application of conical rubber spring. A smooth curving performance with better ride index is being ensured by provision of above type of bogies.

(iii) Braking System

The brake system shall consist of –

(i) An electro-pneumatic (EP) service friction brake
(ii) A fail safe, pneumatic friction emergency brake
(iii) A spring applied air-release parking brake
(iv) An electric regenerative service brake
(v) Provision of smooth and continuous blending of EP and regenerative braking

The regenerative braking will be the main brake power of the train and will regain the maximum possible energy and pump it back to the system and thus fully utilize the advantage of 3 phase technology .The regenerative braking should have air supplement control to bear the load of trailer car. In addition, speed sensors mounted on each axle control the braking force of the axles with anti skid valves, prompting re-adhesion in case of a skid .The brake actuator shall operate either a tread brake or a wheel disc brake.

(iv) Propulsion System Technology

In the field of Electric Rolling Stock, DC series traction motors have been widely used due to its ideal characteristics and good controllability for traction applications. These motors were adopted because of its high starting tractive effort and simple speed regulation by connecting them in series and series paralled and sequentially short-circuiting the starting resistors on DCEMU/Metro systems and the tap changer contacts in case of ACEMUS. But these required intensive maintenance because of commutators and electro-mechanical contactors, resistors etc. With the advent of solid state devices like thyristors/GTOS (Gate Turn off), in power circuits and micro processor based control electronics, the propulsion technology has undergone a significant improvement. Thyristor chopper controls on DC traction system were adopted leading to elimination of starting resistors contactors, camshaft controller, tap changer etc. This enabled provision of step less controls resulting in better riding qualities, reduced energy consumption, easy adoption of electrical re-generative braking etc, but the traction motor continued to be direct current series motor.

The idea of adopting a simple three phase induction motor for traction remained more or less like a concept and almost in development stage till seventies. But brush less 3 phase induction motors have now replaced the d.c. series motors in traction applications. The induction motor, for the same power output, is smaller and lighter in weight and ideally suited for rail based Mass Rapid Transit applications. The motor tractive effort and speed is regulated by ‘Variable Voltage and Variable frequency’ control and can be programmed to suit the track profile and operating requirements. Another advantage of 3 phase a.c. drive and VVVF control is that regenerative braking can be introduced by lowering the frequency and the voltage to reverse the power flow and to allow braking to very low speed. The regenerative braking is rather essential in tunnel alignment otherwise heat generated by friction brakes will increase the heat load inside the tunnel and the air-conditioning plant size will go up.

For Ahmedabad Mass Rapid Transit System, three phase AC traction drive that are self ventilated, highly reliable, robust construction and back up by slip/slid control have been recommended for adoption.

The AC Catenary voltage is stepped down through a transformer and converted to DC voltage through converter and supply voltage to DC link which feeds Inverter operated with Pulse Width Modulation (PWM) control technology and using insulated Gate Bipolar Transistors (IGBT). Thus three phase variable voltage variable frequency output drives the traction motors for propulsion.

Recently advanced IGBT has been developed for inverter units. The advanced IGBT contains an Insulated Gate Bipolar Transistor (IGBT) and gate drive circuit and protection. The advanced IGBT incorporates its own over current protection, short circuit protection, over temperature protection and low power supply detection. The IGBT has internal protection from over current, short circuit, over temperature and low control voltage.

The inverter unit uses optical fibre cable to connect the control unit to the gate interface. This optical fiber cable transmits the gate signals to drive the advanced IGBT via the gate interface. This optical fibre cable provide electrical isolation between the advanced IGBT and the control unit and are impervious to electrical interference. These are recommended for adoption in Trains of MRTS.

(v) Interior and gang ways

The passenger capacity of a car is maximized in a Metro System by providing longitudinal seats for seating and utilizing the remaining space for standing passenger. Therefore all the equipments are mounted on the under frame for maximum space utilization .The layout of interior panel is blended in such a way that they provide structural integrity to avoid distortion or damage and last the same as the expected life of the train.

The gangways are designed to give a wider comfortable standing space during peak hours along with easy and faster passenger movement especially in case of emergency.

(vi) Passenger Doors

For swift evacuation of the passenger in short dwell period, four doors of adequate width, on each side of the coach have been considered. These doors shall be of such dimensions and location that all the passenger inside the train are able to evacuate with in least possible time without conflicting movement .As the alignment passes through elevated section at 10 to 12 meters above ground, automatic door closing mechanism is envisaged from consideration of passenger safety. Passenger doors are controlled electrically by a switch in Driver cab. Electrically controlled door operating mechanism has been preferred over pneumatically operated door to avoid cases of air leakage and sluggish operation of doors.

The door shall be of Plug Swing Type as this has the advantage of being flush with coach body when closed giving it a stream line look apart from increasing the available space along width inside the coach.

(vii) Air –conditioning

With heavy passenger loading of 6 persons/m^2 for standee area and doors being closed from consideration of safety and with windows being sealed type to avoid transmission of noise, the air conditioning of coaches has been considered essential. Each coach shall be provided with two air conditioning units capable of automatically controlling interior temperature throughout the passenger area at 278 C with 65% RH at all times under varying ambient condition up to full load. For emergency situations such as power failure or AC failure both ventilation provision supplied from battery will be made. . Provision shall be made to shut off the fresh air intake and re-circulate the internal air of the coach, during an emergency condition, such as fire outside the train causing excessive heat and smoke to be drawn in to the coach.

(viii) Cab Layout and Emergency detrainment door

The modern stylish driver panel shall be FRP moulded which give maximum comfort and easy accessibility of different monitoring equipment to the driver along with clear visibility .The driver seat has been provided at the left side of the cabin.

An emergency door for easy detainment of the passenger on the track has been provided at the center of the front side of the each cabin, which has a easy operation with one handle type master controller.

(ix) Communication

The driving cab of the cars are provided with continuous communication with base Operational Control Center and station control for easy monitoring of the individual train in all sections at all the time.

Public Address and Passenger Information Display System is provided in the car so that passengers are continuously advised of the next stoppage station, final destination station, interchange station, emergency situations if any, and other messages. The rolling stock is provided with Talk Back Units inside the cars, which permit conversation between passengers and the drivers in case of any emergency.

(x) Noise and Vibration

The train passes through heavily populated urban area .The noise and vibrations for a metro railway become an important criteria from public acceptance view point. The source of noise are (i) rail-wheel interaction (ii) noise generated from equipment like Blower, Compressor, air conditioner, door, Inverter etc. (iii) traction motor in running train .For elimination and reduction of noise following feature are incorporated: -

- Provision of anti drumming floor and noise absorption material
- Low speed compressor, blower and air conditioner
- Mounting of under frame equipments on anti-vibration pad
- Smooth and gradual control of door
- Provision of GRP baffle on the via-duct for elimination of noise transmission
- Provision of sound absorbing material in the supply duct and return grill of air conditioner
- Sealing design to reduce the aspiration of noise through the gap in he sliding doors and piping holes

The lower vibration level has been achieved by provision of bolster less type bogies having secondary air spring.

(xi) Passenger Safety Features

(a) ATP

The rolling stock is provided with Continues Automatic Train Protection to ensure absolute safety in the train operation. It is an accepted fact that the 60-70% of accidents take place on account of human error. Adoption of this system ensures freedom from human error. The on board computerized ATC system compare and verify the continuous data like speed etc .for safest train control

(b) Fire

The rolling stock is provided with fire retarding materials having low fire load, low heat release rate, low smoke and toxicity inside the cars. The electric cables used are also normally low smoke zero halogen type which ensures passenger safety in case of fire.

Fire Extinguishers are provided in passenger accommodation and driving cabin.

(c) Emergency door

The rolling stock is provided with emergency doors at both ends of the cab to ensure well directed evacuation of passengers in case of any emergency including fire in the train.

(d) Crash worthiness features

The rolling stock is provided with inter car couplers having crashworthiness feature which reduces the severity of injury to the passengers in case of accidents.

(e) Gangways

Broad gangways are provided in between the cars to ensure free passenger movement between cars in case of any emergency.

(f) **Potential source for Design, Manufacturing and Supply of Metro Coaches**

Presently Metro Coaches with above mentioned features are not manufactured in the country. Delhi Metro rail Corporation has placed a contract for 240 Metro Coaches on a consortium of Mitsubishi Corporation/ Japan, Rotem/Korea & Mitsubishi Electric Corporation/Japan 60 coaches are to be manufactured off-shore and 180 are to be manufactured in India with progressive indigenous content out of which 96 coaches have already been supplied to DMRC. The consortium has tied up with Bharat Earth Movers Limited, Bangalore for setting up facilities to manufacture 180 coaches for Delhi Metro. BEML/Bangalore being a public sector undertaking is to be developed as a center for absorption of Metro Coaches manufacturing Technology. Already their engineers and technicians have been trained in ROTEM/Korea. The machinery, Jigs/Fixture brought from Korea has been installed at BEML /Bangalore. As a result of collaboration with MRM, BEML would be able to develop as manufacturing base for supply of Metro Coaches with modern features to meet the requirement of future Metro Rail in India.

Salient Features of Ahmedabad Metro Rolling Stock

S.No.	Parameter	Ahmedabad Metro
1	**Gauge** (Nominal)	1435mm
2	**Traction system**	
a.	Voltage	25 KV AC
b	Method of current collection	OHE
3	Train composition	3 coach (2DMC + 1TC) 6 coach (2DMC+2TC+2MC)
4	Maximum speed Scheduled speed	80 kmph 35 kmph
5	**Vehicle dimensions**	
a.	Length over body DMC TC MC	 20900mm 20500mm 20500mm
b.	Length over body with fairing DMC TC MC	 21,050mm 20,800mm 20,800mm
c	Max. width over body	2880mm
d.	Height of coach from Rail Level Panto lock down Ht from Rail Level	3900mm 4118 mm
e	Train length 3 car train 6 car train	 64100 mm 128300mm
f	Bogie wheel base	2300mm
g	Distance between bogie centers	14700mm
h	Wheel diameter (new) Wheel diameter (fully worn)	860mm 780mm
I	Door opening width	1400mm
j	Cab length	2200mm
k	Gangway Width Clear Width Length	 1400mm 1200mm 450mm
l	Coupler Height	810mm

Salient Features of Ahmedabad Metro Rolling Stock

S.No.	Parameter	Ahmedabad Metro
6	**Carrying capacity- @ 6 standees/sqm**	
a	Coach carrying capacity	
	DMC	253 (seating - 43; standing - 210)
	TC	280 (seating - 50; standing - 230)
	MC	280 (seating - 50; standing - 230)
b	Train Carrying capacity	
	3 car train	786 (seating - 136,standing -650)
	6 car train	1626(seating -286,standing-1340)
7	**Weight (Tonnes)**	
a	Coach weight	
	Tare Weight DMC	40
	Tare Weight TC	37
	Tare Weight MC	38
b	Train weight	
	Tare Weight of 3 Car train	117
	Tare Weight of 6 Car train	230
c	Pay load	
	Passenger Weight	
	Pay load of 3 Car train	47.16
	Pay load of 6 Car train	97.56
d	Gross weight	
	Gross weight of 3 Car train	164.16
	Gross weight of 6 Car train	327.56
8	**Performance parameters**	
a.	Acceleration (up to 30 kmph)	1.0m /s/s
b.	Deceleration	
	Service	1.1 m/s/s
	Emergency	1.3 m/s/s
c	Maximum jerk rate	0.7±0.5 m/s/s/s
d	Adhesion	
	Traction	18%
	Braking	15%
9	Axle load	**14 t** System should be designed for **15 t** axle load
10	Propulsion	
a.	Propulsion system	3 phase drive system with VVVF control
b.	Traction Motor rating	**190 KW**

Salient Features of Ahmedabad Metro Rolling Stock

S.No.	Parameter	Ahmedabad Metro
c	Braking	Regenerative, electro pneumatic and Parking brakes
11	**Coach**	
a.	Coach construction	Lightweight stainless steel body
b. c	Seating arrangement Class of accommodation	Longitudinal One
12 a. 13	**Air –conditioning** Coaches Door Type	 Air conditioned Plug and swing type Flush with exterior door having automatic door closing features
14	Communication	Passenger Information System, Passenger Announcement System, Passenger Emergency announcement from OCC, Emergency Talk Back units, Train Radio for communications between driver, OCC and station control
15	Train Control	Continuous Automatic Train Control system comprising ATP and ATO