

CHAPTER 9

SIGNALLING AND COMMUNICATION

9.1 INTRODUCTION

The signaling system shall provide the means for an efficient train control, ensuring safety in train movements. It assists in optimization of rail / metro infrastructure investment and running of an efficient train services on the network. The telecommunication system acts as the communication backbone for signalling systems and provides telecommunication services to meet operational and administrative requirements of rail / metro network.

9.2 SIGANALLING AND TRAIN CONTROL

9.2.1. Overview

Metro carrying a large number of passengers at a very close headway requires a very high level of safety enforcement. At the same time heavy investment in infrastructure and rolling stock necessitates optimization of its capacity to provide the best services to the public. These requirements of the metro are planned to be achieved by adopting a State of Art Automatic Train Control and Computer based Centralized Train Operation and Management system. This will:

- i) Provide high level of safety with trains running at close headway, ensuring continuous safe train separation.
- ii) 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.
- iii) Provides safety and enforces speed limit on section having permanent and temporary speed restrictions.
- iv) Provides greater flexibility and precision in train control.
- v) Will 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 optimize the speed potential of the track section. It provides signal / speed status in the cab even in bad weather.
- vi) Increased productivity of rolling stock by increasing line capacity and train speeds, the same rolling stock will arrive at its destination sooner. Hence more trips will be possible with the same number of rolling stock.
- vii) Improve maintenance of signalling and telecommunication equipments by providing new ways of monitoring system status of track side and train born equipments and undertaking preventive maintenance.

A signalling and control system shall be provided on all running tracks of the metro including car shed except for lines used mainly for local shunting. At all stations with points and crossings, computer based interlocking 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 backed 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 located at stations with points and crossings. The depot shall be interlocked and equipments with a workstation to control and supervise the movements within its yards.

To ensure safety with close headway of train services and for optimization of heavy investment in the infrastructure and rolling stock, the metro shall be provided with an automatic train control system. This will enable running of optimum train services meeting traffic requirements in the most efficient and cost effective way.

9.2.2. Selection of System

The Signalling and Train Control system shall be as explained below:

a. Interlocking System:

At all stations with points and crossings, Solid State Interlocking (SSI) will be provided for operation of points and crossings and setting of routes. Six SSIs are planned to be provided on East West Line and five SSIs shall be on North South line. 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

The depot for East West line is situated at Baiyyappanahalli and that for North South line at Yeshwanthpur. Each depot / workshop yard except the lines mainly used for shunting shall be interlocked. A work station each shall be provided in the Depot Control Centre for electrical operation of the points and signals of the depot yard.

C. Automatic Train Protection

To ensure safety in train operation and to provide optimum train services on the section the train control on the metro shall be provided with Automatic Train Control system. For this the transmission from track to train will be continuous through coded audio frequency track circuit. The ATC system will provide on-board display of maximum safe speed, current speed and target speed / distance as deduced from ATP systems, signaling interlocks systems and based on track profile and brake characteristics. Facilities for automatic enforcement of temporary / permanent speed restrictions shall also be built in to enhance safety during maintenance work.

d. Train Describer and Control Office

A train describer system will be installed to facilitate the monitoring of train operation and also remote control of the stations .The train describer 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.

e. Passenger Information System

At all stations, suitable electronic passenger information display boards will be provided. The PIS shall be train actuated along with facility to be automatic inputted from the local station.

9.2.3. Standards

Table 9.1 shows the standards that will be adopted with regard to the Signalling system.

Table 9.1 (Standards adopted with regards to Signalling System)

Description	Standards
▪ Interlocking	Solid State Interlocking, adopted for station having switches and crossing. All related equipment as far as possible will be centralized in the equipment room at the station. 5 interlocked stations in North South line and 6 interlocked stations in East West line are envisaged. Depot shall be interlocked except for lines mainly used for shunting.
▪ Operation of Points	With Direct current 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
▪ Signalling along the line.	ATC with line side signal as fall back.
▪ Train protection systems	Automatic train control with over speed protection and protection against signal passing at danger.
▪ Train Descriptor 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. Also remote control of stations from the OCC.
▪ Redundancy for ATP/Train Descriptor.	Future space provision for redundancy for Train born equipments in Rolling Stock.
▪ Cables	Cables will be steel armoured, as far as possible.
▪ Fail Safe Principles	Application to the signalling system – SIL4 level safety
▪ Immunity to External Interface.	All data transmission on telecom cables/ OFC/Radio. All signalling and telecom cables will be separated from power cables.
▪ Train Working Under Emergency	Running on site with line side signal.
▪ Environmental Conditions	Window 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.
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9.2.4. Specifications

1. Line Side Signalling and Train Protection

Line Side Signalling and 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) Solid State Interlocking
 - (iv) Signal and speed enforcement.
 - (v) Brake assurance
 - (vi) Interface with electrical sub-systems of the vehicle like brake control.
- Track circuits/balise shall be will be used for vehicle detection.
- Sub-system/components will conform to international standards like BS, IS, IEC, ITU-T etc.

2. The cab borne equipment

They 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. Train Describer

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

4. SSI at Stations

This sub-system is used for controlling vehicle movements into or out of stations automatically from a work station. 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.

9.3. COMMUNICATION

The telecommunication facilities proposed will be 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
- Exchange Telephone
- Passenger Announcement System within the station and from Central Control to each station.
- Centralized 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.

9.3.1. Telephone communication System and Transmission Media

1. Optical Fibre Cable - Main Telecommunication Bearer

The main bearer of the bulk of the telecommunication network is proposed with optical fiber cable system. Considering the channel requirement and keeping in view the future expansion requirements optical fiber cable is proposed to be laid in ring configuration with path diversity. Apart from meeting required optical characteristics, it will be low smoke/ low halogen type optical fibre cable.

SDH STM-1 155 Mb 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.

2. Telephone Exchange

Three EPABX of 512 ports will be provided at three locations preferably one at the OCC, one at an intermediate station and other at the depot. 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.

3. 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 Digital Trunked Radio Technology to TETRA International 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 six Radio Base stations shall be provided, 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 TETRA 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 locked etc., thus improving safety performance

4. 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.

5. 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.

6. Train Destination Indicators

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, platform numbers, arrival/departure time, and also special messages in emergencies. The boards shall be provided at all platforms and concourses of terminal & junction stations.

7. 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 the 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.

9.3.2. Standards

The standards proposed to be adopted for telecommunication systems are as under

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 three locations preferably one at OCC, one at an intermediate station and other at the depot. Further small exchanges shall be at each station. These are to be connected together through optical fiber, which will provide communication at each stations and depots.
• Train Radio System	Digital Train radio (TETRA) communication between motorman of moving cars ,stations, maintenance personnel and central control.
• Train Destination Indicator System	LED 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 synchronization system of slave clocks driven from a master clock at the OCC. The system shall ensure identical display of time at all locations. This shall also be used for synchronization other systems.
• Passenger Announcement	Passenger Announcement System covering all platform concourse areas with local as well as Central

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

9.3.3. 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.

The EPABX will be networked with other EPABX of the network with 2 MB level through the optical Fiber line to establish telecom system as a whole.

9.4 SPACE REQUIREMENT FOR S & T INSTALLATIONS

Adequate space for proper installations of all Signalling and 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, UPS Room and 40 sq.m at station with points & 25 sq.m at other stations for Signalling. At interlocked stations this will be approximately 40 sq. m. These areas shall also cater to local storage and space for maintenance personnel to work. The tower for mobile train radio system shall be located at approximately 5 km interval along the section. The tower shall be normally placed not more than 40m away from Base Station Equipment Rooms. Necessary land/ space acquisition for the same should be planned. 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.

9.5 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.



Radio Tower