

CHAPTER 11

MAINTENANCE DEPOTS

11.1 INTRODUCTION

It is proposed to provide two depots (one for each corridor) for maintenance and repairs of the rolling stock for Bangalore Metro.

This chapter covers following aspects of Bangalore Metro depots.

- Conceptual design and layout of Servicing Shed and Workshop to provide maintenance facilities and stabling facilities for Rolling Stock.
- Operational and functional safety requirements.
- Ancillary buildings for other maintenance facilities.
- Electrical & Mechanical Services, power supply and distribution system.
- Water Supplies, Drainage & Sewerage.

This chapter provides conceptual design of the depots and will only work as a guide for detailed design later. Salient features and requirement of rolling stock given in Annexure I.

11.2 MAINTENANCE PHILOSOPHY

The outline of the maintenance philosophy followed is:

- Continuous monitoring of the performance of equipment by condition monitoring of key parameters using “Train Integrated Management System”, the concept is to evolve the need based maintenance regime, which can be suitably configured in the form of schedules like “45 days check”, “IOH” and “POH”.
- Unit replacement and to get essential repairs done by the OEMs to be preferred.
- More automation with state-of-the-art machinery to ensure quality with reliability. Labour intensive procedures will be kept to the minimum.
- Maintenance staff shall be given special training to develop high-level skills in their trade to ensure quality and productivity in their performance.
- Energy conservation shall be given due attention

11.3 APPROACH OF MAINTENANCE FOR ROLLING STOCK

The East – West corridor and the North - South corridor are two operational corridors. There would be interlinking between two corridors. Thus, the rakes would be able to move from one corridor to another for IOH and POH. This will facilitate having one mother workshop for the two corridors at Baiyappanahalli. An inspection shed, which will have the stabling facilities at Baiyappanahalli and one inspection shed having stabling facilities at Yeshwantapur on the North – South Corridor will be required. Adequate facilities for the stabling would be provided at the terminal stations as well as at the depots. All the minor

maintenance schedules would be independently taken over in each corridor thus saving the idle run of trains for the minor maintenance. For the IOH and POH the rakes would be taken to the mother workshop.

11.4 ROLLING STOCK MAINTENANCE NEEDS

Servicing requirements shall be determined from the Rolling Stock manufacturer, and the modern, fully equipped facilities are to be provided that meet these requirements efficiently and in full. In meeting these requirements, it shall be assumed that the average daily distance travelled by each rolling stock unit is approximately 335 km. The following maintenance schedule has been followed for conceptual design (**Table 11.1**).

Table 11.1
Proposed Maintenance Schedule

Type of Schedule	Interval	Work content	Locations
Daily	Daily	Check on the train condition and function at every daily service completion. Internal cleaning / mopping of floor and walls with vacuum cleaner.	Stabling Bays
A. Service Check	5,000 Km (15 days)	Check on the safety and reliability of critical equipment, General visual inspection, testing of systems, replacement of oils & lubricants and consumables	Inspection Bays
B. Service Check	15,000 Km (45 days)	Detailed inspection of 'A' type tasks plus items at multiples of 15,000 Km ('B' type tasks)	Inspection Bays
Intermediate Overhaul (IOH)	400,000 Km	Check and testing of all sub-assemblies (Electrical + Mechanical). Replacement of parts and rectification, trial run	Workshop
Periodical Overhaul (POH)	800,000 Km	Dismantling of all sub-assemblies, bogies, suspension system, traction motor, gear, control equipment, air-conditioning units etc. Checking repair and replacement as necessary. Inspection and trial	Workshop

11.5 WASHING NEEDS OF ROLLING STOCK

The Metro trains are maintained to a high degree of cleanliness and therefore needs the following schedules (**Table 11.2**).

Table 11.2
Schedule of Cleaning

S. No.	Kind of Inspection	Maint. Cycle	Time	Maintenance Place
1.	Outside Cleaning (wet washing on automatic washing plant)	3 Days	10 mins	Automatic washing plant of Depot Single Pass
2.	Outside heavy Cleaning (wet washing on automatic washing plant and Front Face, Vestibule/Buffer area, Floor, walls inside/outside and roof. Manually)	30 days	3 Hrs	Automatic washing Plant & washing line

11.6 Baiyappanahalli DEPOT CUM WORKSHOP

The layout of Baiyappanahalli depot is shown in **drawing no. Bangalore/ Baiyappanahalli /001-Ro**. The concept layout is evolved keeping maximum number of stabling in the depot.

11.6.1 Operational Features

The rake induction and withdrawal from depot to the open line will be so planned that the headway of open line is not affected. Due to lack of space it is not possible to provide a transfer track at the start of depot, where the traffic controller can safely dispatch the train even though the approach inside the depot is not clear. Therefore an island platform at the station is planned. This shall ensure the simultaneous receipt and dispatch of trains from depot to open line. The stabling area would be interlocked with the open line thereby induction of train from the stabling would be safe and without loss of time. While entering depot 10 stabling lines can be reached after train is washed through wash plant.

The other movements in the depot, viz from the stabling to the inspection shed or workshop and vice versa would be non-interlocked. An emergency line is provided from which an emergency rescue vehicle may be dispatched to open line in the event of emergency if necessary. To cater to the peak requirements, all trains would be in the service, only trains under maintenance would be in the shed. However during the off-peak hour in daytime, approximately half of the trains will be withdrawn from the service. To economize on the air-conditioning energy, ten stabling lines would be under covered stabling shed. There would be pathways between the stabling lines, which are necessary for the “Safe to Run” examination and to facilitate the workers to move trolleys for the sweeping work. The scheduled inspections shall be carried out during the day off-peak hours and night. The third rails would be so laid that these do not come on those lines that have the pathways. Therefore the traction supply third rail of two adjacent lines would be in between them to facilitate the pathway construction on the other side of these two lines. The track bed would be ballasted in the depot area to save the cost.

The stabling and the yard layout would be at level for least power requirements in shunting movements and to avoid accidental rolling of Rolling Stock resulting into accidents and damages to the property.

11.7 INFRASTRUCTURE FACILITIES PLANNED AT Baiyappanahalli DEPOT

11.7.1 Design Capacity of Baiyappanahalli Depot

Table 11.3
Design Capacity of Baiyappanahalli Depot

S. No.	Schedule	Designed capacity (6 car length)	No. of lines for Designed capacity	No. Of lines for 21 rakes phase-i
Inspection shed				
1	Daily safety check on stabling lines	16 rakes	16	16*
2	15 days	27 rakes	1 (with sunken floor)	½ utilization
3	45 days	27 rakes	1 (with sunken floor)	½ utilization
4	Adjustment line	IOH/ POH/ lifting rakes adjustment	1 (with sunken floor)	½ utilization (with sunken floor)
5.	Unscheduled Line	Unscheduled Maintenance		
Workshop				
I	400,000 Km IOH	45 rakes	2 lines (3 car long)	2 line (3 car long)
li	800,000 Km POH	45 rakes		
lii	Unscheduled lifting	As and when needed. Say 1 per month	1 line (3 car long) equipped with pit jacks	1 line (3 car long)

- Assuming 4 nos rakes stabling at terminal station and one rake shall be in Inspection shed.

11.7.2 Stabling Lines in Depot

In the available land, sixteen (16) number 6-car length-stabling lines are possible at Baiyappanahalli Depot. Three (3) rakes would be housed in the inspection shed. The length of 6 cars Rolling Stock is approx 128.3 m. Stabling lines are designed for 155m lengths to cater for provision of the friction buffer stops and the signaling interlocking needs. The space between sidings shall be sufficient to include pathway to be constructed between each track to provide access for internal train cleaning.

11.7.3 Inspection and Overhaul

The Bangalore Metro servicing philosophy will be based upon a very high level of planned preventive maintenance.

Depending upon manufacturer's requirements, servicing facilities shall be provided to include the ability to carry out the inspection, maintenance, overhaul and repair of the full rolling stock fleet, including the following components:

- Bodies;
- Bogies;
 - Wheels (Redisling /reaxling is planned at mother depot cum workshop at Baiyappanahalli only);
- Traction motors;
- Electrical components;
- Electronics; PA/ PIS
- Mechanical components;
- Batteries;
- Rolling stock air conditioning;
- Brake modules;
- Vehicle doors, windows and internal fittings.

11.7.4 Inspection Shed

15-day inspection and 45 day inspections will be carried out in Inspection shed. 15-day / 45 day inspections shall be in two off peaks one in day and one in night. Size of shed is 152.5 x 21 m.

11.7.5 Material Movement Inside the Inspection Shed

Ramps of 1 : 8 slopes, 3 meter wide have been provided with sunken floor system for movement of material for the cars. Further 5m pathways are left at each end for movement of material by fork lifter/ Leister / hand trolley.

11.7.6 Test Track Line

A test track of 948 m length has been provided for testing of 6-car train upto a speed of 80kmph. This line is suitably isolated from other stabling lines for safety requirements.

11.7.7 Coach Unloading / Loading line

As the coaches are on standard gauge, these shall reach the depot by the road on trawlers. To unload the coaches and bring them to the Metro track, an unloading siding is provided merging to test track.

11.7.8 Automatic Coach Washing Plant

Provision is made for Rolling Stock exterior surfaces to be washed using a fully automated Train Washing System, with a throughput capacity of approximately six trains per hour.

11.7.9 Washing Apron

Monthly heavy Cleaning of interior walls, floors, seats, windows glasses etc, outside heavy Cleaning, Front/ rear Face, Vestibule/ Buffer area, outside walls and roof shall be done manually.

11.7.10 Power Supplies

An auxiliary substation has been planned for catering to the power supply requirement of the whole depot and workshop. Details of connected load feeder shall be worked out. Taking diversity factor of 0.5 the maximum demands shall be computed.

11.7.11 Standby Power Supply

The standby power supply is proposed through DG set with AMF panel. The capacity of DG set will be adequate to supply all essential loads without over loading.

11.7.12 Water Supply, Sewerage and Drainage Works

In-house facilities shall be developed for water supply for the entire depot cum workshop. Sewerage, storm water drainage will be given due care while designing the depot for efficient system functioning. Past records of Municipal Corporation will be used to design the drainage system. Rainwater harvesting would be given due emphasis to charge the under ground reserves.

11.7.13 Engineering Train Unit Workshop

Since the workshop cum depot is designed optimally, it would not be wise to waste its capacity in maintaining the other than passenger Rolling Stock vehicles. Carrying these vehicles to the inspection shed affects the RS maintenance as shunting is also involved. Therefore other vehicles like diesel locomotive, tower wagons, flat wagon for work trains etc shall be housed and given required inspection attention in a separate shed called ETU workshop. However for the heavy lifting needs, these vehicles may be taken to main workshop:-

11.7.14 Facilities For Rolling Stock Overhaul in Workshop

The size of the workshop is 152.5 x 42 m. Following equipment repair/overhaul facilities are planned in the workshop.

1. Body furnishing.
2. Bogie.
3. Wheels.
4. Traction Motor.
5. Axle box and axle bearing.
6. Power Collector.
7. Electrical equipment like transformer converter/inverter, circuit breaker, relays.
8. Battery.

9. Air compressor.
10. Air conditioner.
11. Brake equipment.
12. Door actuators.
13. Control and measuring equipments.
14. Pneumatic equipment.
15. Coach painting.

Cross track equipped with bogie turntables shall be provided for movement between bays. The capacity of O/H crane shall be optimized to minimise structure cost. Repair of heavy equipments such as air conditioner shall be located close to dismounting location to minimize the movement. Bogie washing area shall have location so that it does not affect the workshop environment. The small component and bogie painting, and battery maintenance be located such that fumes are extracted by suitable exhaust systems. The unscheduled lifting line shall have sunken floor jack system capable to lift the three car unit simultaneously for quick change of bogie, thereby saving down time of Rolling Stock.

Workshop will have service building with room of size 152.5 x 8 m, made of brick works to cater for offices, costly item store, locker room, toilet etc.

11.7.15 Ancillary Shed and Buildings

The ancillary shed and buildings in the depot with their sizes and brief functions are indicated in **Annexure-II**.

11.7.16 Plant and Machinery

Requirement of major plants and machinery, which are vital for operational needs, is given in **Annexure-III**.

11.8 Yeshwantapur Depot

The layout of Yeshwantapur depot is shown in drawing no. Bangalore/Yeshwantapur Depot /Layout/002. The concept layout is evolved in the thinking that there would be maximum number of stabling in the depot. Few trains will be stabled at the terminal stations. The depot is on elevated structures.

11.9 Operational Features

The land available at Yeshwantapur is very small. To have least operational constraints, rake induction and withdrawal from depot to the open line will be independent of each other making rake induction and withdrawal simultaneously. The rakes can be directly taken to seven stabling lines from the main line. Other four stabling lines can be accessed through a rake transfer line near the stabling shed. The access for the inspection shed and the unscheduled lifting line is also through the rake transfer line. The stabling area would be interlocked with the open line thereby induction of train from the stabling would be safe.

The other movements in the depot, viz from the stabling to the inspection shed or workshop and vice versa would be non-interlocked. An emergency line from which an emergency rescue vehicle may be dispatched in the event of emergency is provided. To economize on the air-conditioning energy, seven stabling lines that are directly accessible from the main line and vice versa would be under covered stabling shed. There would be pathways between the stabling lines, which are necessary for the “Safe to Run” tests and to facilitate the workers to move trolleys for the sweeping work. The third rails would be so laid that these do not come on those lines that have the pathways. Therefore the traction supply third rail of two adjacent lines would be in between them to facilitate the pathway construction on the other side of these two lines. The track bed would be ballasted in the depot area to save the cost.

The stabling and the yard layout would be at level for least power requirements in shunting movements and to avoid accidental rolling of Rolling Stock resulting into accidents and damages to the property. Total Inter Centre Distance between adjacent tracks would be 4.6m where the third rails are not there. Stabling lines with two traction third rails in between shall have total inter Centre Distance of 5.0m.

11.9 INFRASTRUCTURE FACILITIES PLANNED AT YASHWANTPUR DEPOT

11.9.1 Design Capacity of Yeshwantapur Depot

Table 11.4
Design Capacity & Yeshwantapur Depot

S. No.	Schedule	Designed capacity (6 car length)	No. of lines for Designed capacity	No. Of lines for 18 rakes phase I
Inspection shed				
1	Daily safety check on stabling lines	18 rakes	18	14*
2	15 days	18 rakes	1 (with sunken floor)	1
3	45 days	18 rakes	1 (with sunken floor)	1
4	Unscheduled Line	Unscheduled Maintenance	1 (with sunken floor)	1 (with sunken floor)
Workshop linked with Inspection shed				
1	Unscheduled lifting	As and when needed. Say 1 per month	1 line (3 car long) equipped with pit jacks	1 line (3 car long)

* Assuming 4 nos rakes stabling at terminal station. Eleven rakes shall be on the stabling lines. Three shall be on the inspection shed lines. Phase I stage itself shall have 6 car long stabling lines.

11.9.2 Stabling Lines in Depot

Fourteen number 6-car length-stabling lines are possible at Yashwantpur Depot. Out of this three (3) rakes would be housed in the inspection shed. The length of 6 cars Rolling Stock is approx 128.3 m. Stabling lines are designed for 155m lengths to cater for provision of the friction buffer stops and the signaling interlocking needs. The space between sidings shall be sufficient to include

pathway to be constructed between each track to provide access for internal train cleaning.

11.9.3 Inspection

Following facilities shall be provided to include the ability to carry out the inspection, of the following equipments of rolling stock fleet:

- Electrical components;
- Electronics; PA/ PIS
- Mechanical components;
- Batteries;
- Rolling stock air conditioning;
- Brake modules;
- Bogie; traction motor
- Vehicle doors, windows and internal fittings.

11.9.4 Inspection Shed

15-day inspection and 45 day inspections will be carried out in Inspection shed. 15-day / 45 day inspections shall be in two off peaks one in day and one in night.

11.9.5 Material Movement inside the Inspection Shed

Ramps of 1 : 8 slopes, 3 meter wide have been provided with sunken floor system for movement of material for the cars. Further 5m pathways are left at each end for movement of material by fork lifter/ Leister / hand trolley.

11.9.6 Automatic Coach Washing Plant

Provision is made for Rolling Stock exterior surfaces to be washed using a fully automated Train Washing System, with a throughput capacity of approximately six trains per hour. Since the land available is small it could not be provided at the entry to depot. It can be accessed through the rake transfer line. The plant shall be 9m wide and 30 m long.

11.9.7 Washing Apron

Monthly heavy Cleaning of interior walls, floors, seats, windows glasses etc, shall be done manually.

11.9.8 Power Supplies

An auxiliary substation has been planned for catering to the power supply requirement of the whole depot. Details of connected load feeder shall be worked out. Taking diversity factor of 0.5 the maximum demands shall be computed.

11.9.9 Standby Power Supply

The standby power supply is proposed through DG set with AMF panel. The capacity of DG set will be adequate to supply all essential loads without over loading.

11.9.10 Water Supply, Sewerage and Drainage Works

In house facilities shall be developed for the water supply of the entire depot. Sewerage, storm water drainage shall be given due care while designing the depot for efficient system functioning. Past records of Municipal Corporation shall be used to design the drainage system. Rainwater harvesting would be given due emphasis to charge the under ground reserves.

11.9.11 Ancillary shed and buildings

The ancillary shed and buildings in the depot with their brief functions are indicated in **Annexure-IV**.

11.9.12 Plant and machinery

Requirement of major plants and machinery, which are vital for operational needs, is given in **Annexure-V**.
