



GOVERNMENT OF INDIA
MINISTRY OF URBAN DEVELOPMENT



REPORT OF THE SUB-COMMITTEE
ON
**OPERATIONS AND MAINTENANCE SYSTEMS
FOR
METRO RAILWAYS**

NOVEMBER 2013

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MESSAGE

The growth story of India is to be written on the canvass of planned urbannisation and the success of planned urbanisation depends upon sustainable urban transport and transit oriented development (TOD). Efficiently designed, operationally sustainable and user friendly urban transport systems are instrumental in urban mobility.

India's urbanization process has now gained pace and as per the latest census, the growth of population in the urban areas has already exceeded that in the rural areas. As urbanization accelerates, we would need to tackle the issues of redevelopment of existing areas, creation of newly urbanised areas as well as provision of mass transit systems, modernisation and up gradation of existing urban transport systems in a manner that meets the aspirations of all classes of society. The concept would have to strategic densification of the urban areas, so as to optimise the land use through TOD approaches. That would invariably lead to comprehensive mobility planning for the urban areas, including the potentially urbanisable areas.

Metro railways are undoubtedly the preferred mode for mass transport on high demand corridors in big and medium cities and lead to making growing cities more liveable and sustainable. As a matter of policy, the Ministry of Urban Development (MOUD) envisages cities with 2 million plus population to plan for metro rail networks in next few years. As can be seen in Delhi, mass transport facilities such as the Metro, have been a game changer for urban transport and urban development. And that would hold good for any other large city too in the country.

With the creation of new metro facilities in several cities (tier 1 and 2), and in view of capital intensive nature of the metro rail projects, there is a need for cost optimization strategies, such as standardization and indigenization, of metro rail systems. The setting up of a committee for "Standardization and Indigenization" of metro railway systems by the MOUD an endeavour in that direction. The Committee produced a "Base Paper" wherein consensus items were indicated and also suggestions were incorporated for constitution of a number of sub-committees for in-depth study. To make the task more manageable, the following thematic sub-committees were constituted:

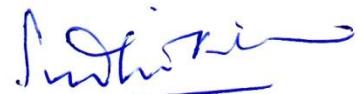
- Traction and power supply systems

- Rolling stock
- Metro railway Operation and Maintenance
- Signalling systems
- Fare collection systems
- Track structures

The initiative of MoUD to draw upon the expertise of professionals across various disciplines and also from industry has resulted in finalization of the reports of the various sub-committees. The Base Paper as well as the sub-committee reports have suggested multiple strategies for standardization and indigenization. Such evolving long term strategies for cost reduction are expected to yield significant results – in terms of both, cost optimization and high end knowledge accumulation in the country.

I encourage all cities, states, metro railway organizations and other organizations associated with metro rail systems to make full use of these reports for planning and implementation of metro rail systems in their cities as well as contribute to their further evolution in future.

I congratulate all the members of the Base Paper Committee and Sub-committees for successfully bringing out their respective reports.



New Delhi
19th November, 2013

(Sudhir Krishna)

PREFACE

1) In view of the rapid urbanization and growing economy, the country has been moving on the path of accelerated development of urban transport solutions in cities. The cities of Kolkata, Delhi and Bangalore have setup Metro Rail System and are operating them successfully. Similarly the cities of Mumbai, Hyderabad and Chennai are constructing Metro Rail system. Smaller cities like Jaipur, Kochi and Gurgaon too are constructing Metro Rail system. With the new policy of Central Government to empower cities and towns with more than two million population With Metro Rail System, more cities and towns are going to plan and construct the same. It is expected that by the end of the Twelfth Five Year Plan, India will have more than 400 Km of operational metro rail network (up from present 223 Km Approximate).

The National Manufacturing Competitiveness Council (NMCC) has been set up by the Government of India to provide a continuing forum for policy dialogue to energise and sustain the growth of manufacturing industries in India. A meeting was organized by NMCC on May 03, 2012 and one of the agenda items in that meeting was "Promotion of Manufacturing for Metro Rail System in India as well as formation of Standards for the same". In view of the NMCC meeting and heavy investments planned in Metro Rail Systems, Ministry of Urban Development (MOUD) has taken the initiative of forming a Committee for "Standardization and Indigenization of Metro Rail Systems" in May 2012.

The committee had a series of meetings in June- August 2012 and a Base paper was developed. With a view to promote domestic manufacturing for Metro Rail Systems and formation of Standards for such systems in India, Ministry of Urban Development has constituted various Sub-Committees on following topics:-

- Traction System
- Rolling Stock
- Signaling System
- Fare Collection System
- Operation & Maintenance
- Track Structure
- Simulation Tools

2) The Sub-Committee on Operation & Maintenance was constituted vide MOUD's orders F.No.K-14011/26/2012-MRTS/ Coord dated: 25th July 2012 and comprises of following Members:

- (a) Shri DD Pahuja, Director (RSE)/BMRCL – Convener
- (b) Shri AK Gupta, CGM, DMRC
- (c) Shri Prakash Singh, Director MRTS/MOUD
- (d) ShriDeenDayal, Under Secretary (MRTS)/MOUD
- (e) ShriSalabhTyagi, Director (PE)/RDSO
- (f) ShriSujit Mishra, Director (TI)/RDSO
- (g) ShriAlokKatiyar, Director (Signaling) / RDSO
- (h) Director (Track / Bridges) / RDSO
- (i) Shri Anil Kumar Saini, System Head, L&T HMRL
- (j) Shri Anil Jangid, Professional Consultant
- (k) Shri Parveen Kumar, Sr. V.P. RMGL
- (l) ShriKeshava Prasad, GM/Rail System Siemens/FICCI
- (m)Shri R. Satish Director / CII
- (n) Shri D.S Rawat Secretary / ASSOCHAM

3) The Terms of Reference of the Sub-Committee on Operation & Maintenance broadly included the following:

- i.) Study of the Operation and Maintenance practices adopted by DMRC, BMRCL and Kolkata Metro.
- ii.) Study of the Operation and Maintenance practices adopted by Metros outside India.
- iii.) Study of currently imported spares/consumables which can be considered for indigenization.
- iv.) Detailed study of manpower, M&P resources deployed by DMRC/BMRCL for different systems and civil infrastructure maintenance.
- v.) Report of study analysis and recommendations duly suggesting standardization/benchmarking of maintenance practices.

4) The Sub-Committee has since completed the assigned task, which effort has culminated in the production of this report. The report covers the following:

- i) Study of the Operation and Maintenance Practices on Metro Railways in Delhi, Bangalore, Hyderabad, Chennai and Gurgaon
- ii) Operation and Maintenance Practices in Foreign Metros
- iii) Safety, Security and Disaster Management.
- iv) Indigenization of Spares & Consumables.
- v) Manpower and M&P Resources Deployed in Metros
- vi) Operation & Maintenance cost.
- vii) Outsourcing Complete O&M services – Experience in India
- viii) Analysis of the study with Key findings & Recommendations.

The Key findings of the Study are given in Executive Summary.

The report is an outcome of dedicated efforts put in by the Sub-Committee members.

The Sub-Committee would like to thank Dr. Sudhir Krishna (Secretary/MOUD), Shri. SK Lohia (OSD/MOUD), Shri. IC Sharma (NPM/SUTP) and officials of Ministry of Urban Development for undertaking this seminal work.

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ABBREVIATIONS

AFC	Automatic Fare Collection System
AMS	Asset Management System
APTA	American Public Transportation Association
ATC	Automatic Train Control
ATO	Automatic Train Operation
ATP	Automatic Train Protection
ATS	Automatic Train Supervision
BMRCL	Bangalore Metro Rail Corporation Limited
BMS	Building Management System
CATC	Continuous Automatic Train Control
CBTC	Communication Based Train Control
CCTV	Close Circuit Television
CISF	Central Industrial Security Force
CMRL	Chennai Metro Rail Limited
CMRS	Commissioner of Metro Rail Safety
COD	Commencement Date
CoMET	Community of Metros
CRA	Customer Relation Assistant
CSIR	Council of Scientific and Industrial Research
DAMEL	Delhi Airport Metro Express Limited
DBFOT	Design Build Finance Operate and Transfer
DCC	Depot Control Centre
DDMA	Delhi Disaster Management Authority
DG	Diesel Generator
DLP	Defect Liability Period
DMP	Disaster Management Plan
DMRC	Delhi Metro rail Corporation
DPR	Detailed Project Report
ERP	Enterprise Resource Planning
GoAP	Government of Andra Pradesh
GOI	Government of India
GoK	Government of Karnataka
IFA	International Finance Advisory
IISc	Indian Institute of Science
IIT	Indian Institute of Technology
ISA	Independent Safety Assessor
KISF	Karnataka Industrial Security Force
KMRC	Kolkata Metro Rail Corporation
KPI	Key Performance Indicator
LTA	Land Transport Authority

LTHMRL	L&T Hyderabad Metro Rail Limited
MHA	Ministry of Home Affairs
MOUD	Ministry of Urban Development Department
MRT	Metropolitan Rapid Transit (Bangkok)
MRTS	Mass Rapid Transit System
NDMA	National Disaster Management Authority
NOVA	Group of Metros
NSG	National Security Guard
O&M	Operation and Maintenance
OCC	Operation Control Centre
OEM	Original Equipment Manufacturer
OMC	Operation and Maintenance Contractor
PPP	Public Private Partnership
PSC	Public Sector Comparator
RAM	Reliability, Availability, Maintainability
RDSO	Research Design and Standards Organization
RFP	Request for Proposal
RKM	Route per Kilometer
RSS	Receiving Sub-Station
SCADA	Supervisory Control and Data Acquisition System
SCR	Station Control Room
SMRT	Singapore Mass Rapid Transit
SPV	Special Purpose Vehicle
TOM	Ticket Office Machine
TRTKm	Total Rate Per Train Kilometer
UPS	Un-interrupted Power Supply
VFM	Value for Money Methodology

0.0 EXECUTIVE SUMMARY:

The sub-committee on standardization of Operation and Maintenance practices on Metro Railways held its first meeting at Bangalore on 24/09/2012 and second at Gurgaon on 07/12/2012. The details of Operation and Maintenance practices on different Metro Railways were shared and discussed in great depth amongst the members of the sub-committee. Subsequently, there has been exchange of views through E-mails in regard to Practices best suited for Indian Metro Railways. As a result of the deliberations, Key findings and recommendations are summarized here under:

- i. Delhi Metro and Bangalore Metro follow almost similar O&M practices where in core functions (operations and maintenance of major assets) are performed In-house, while House-keeping, Manning of Ticket Counters, Maintenance of Elevators, Escalators, Fire-fighting, Air Conditioning and Building maintenance services are fully/partly out-sourced.
- ii. Maintenance regime comprising of preventive and corrective maintenances prescribed by OEMs are generally followed, reviewed and revised periodically. DMRC has become a member of NOVA to have access to international O&M practices and follow Key performance indices (KPIs) as per international norms. BMRCL is in the process of acquiring membership of NOVA. The annual O&M cost per RKM is about Rs 3.75 Cr (including energy cost) on the above two Metro Rail systems (in the year 2011-12).
- iii. Hyderabad Metro Rail project is being implemented on PPP basis with a special purpose vehicle; L&T Metro Rail (Hyderabad) Limited is the concessionaire on DBFOT basis for 35 years. They have engaged Keolis SA (France) as its O&M contractor through international competitive bidding. The commercial services are scheduled to commence on the part section in the year 2015. The annual O&M cost per RKM is stated to be about Rs 4 Cr.
- iv. One Indian Metro Railway invited global bids for selection of O&M contractor. For reasons of high bid prices, the tender has been discharged. They have now decided to follow the O&M model of DMRC and BMRCL.
- v. Rapid Metro Rail Gurgaon Ltd. (RMGL) scheduled to commence the revenue operations in the year 2013, have planned to undertake core operations with the in-house staff. They have out-sourced maintenance of core assets to OEMs.
- vi. A Training Institute/Centre with “state of the art” facilities may be setup to meet the training needs of the O&M staff.

Final Report

- vii. Formation of a Metro Railway Research Centre may be considered by MoUD in collaboration with reputed Educational Institute (IIT/IISc etc.) to undertake research in Metro Rail Technologies.
- viii. Formation of Association of Indian Metro Railway operators for periodic exchange of ideas, evolution of uniform Operation and Maintenance practices including bench marking.
- ix. Adoption of a computerized Comprehensive Asset Management System.
- x. Implementation of a Security Plan as per guidelines issued by Ministry of Home Affairs/GoI on each Metro Railway in consultation with the respective state Government.
- xi. Creation of a separate safety department (reporting to Managing Director) for conducting Safety audit of operations & maintenance and enforcement of safe practices.
- xii. MoU between Metro Rail Operator and the Management for achieving Key Performance Indicators (KPIs) as per the proven International practice.
- xiii. Formulation of Disaster Management Plan and enforcement of periodical mock drills of various sub-systems to ensure preparedness in handling of emergency situations and disasters.
- xiv. Reliability, Availability, Maintainability (RAM) targets must become mandatory part of tender documents. Demonstration of RAM targets with regime of incentives/ penalties be insisted upon.
- xv. Presently no Metro Rail system in India has outsourced entire Operations and Maintenance activities. The business model for O&M service contract need to be decided on Techno-Economic considerations. The viability of Outsourcing entire Operations and Maintenance to an OMC will become clear in about next 10 years time.

1.0 INTRODUCTION

1.1 Background

Ministry of Urban Development formed a Sub-Committee for Standardization of O&M Practices for Metro Rail Systems vide letter no. K-14011/26/2012-MRTS/Coord dated 25.07.2012 ([Annexure-1](#)). The terms of reference of the Sub-Committee are as under:

- Study of the Operation and Maintenance practices adopted by DMRC, BMRCL and Kolkata Metro
- Study of the Operation and Maintenance practices adopted by metros outside India
- Study of currently imported spares / consumables which can be considered for indigenization
- Detailed study of manpower, M&P, resources deployed by DMRC / BMRCL for different systems and civil infrastructure maintenance
- Report of study, analysis and recommendations duly suggesting standardization / benchmarking of maintenance practices

The members of the Sub-Committee are as under:

- (a) Shri DD Pahuja, Director (RSE)/BMRCL – Convener
- (b) Shri AK Gupta, CGM, DMRC
- (c) Shri SKSinha, GM(HR), DMRC
- (d) Shri Prakash Singh, Director MRTS/MOUD
- (e) Shri DeenDayal, Under Secretary (MRTS)/MOUD
- (f) Shri Salabh Tyagi, Director (PE)/RDSO
- (g) Shri Sujit Mishra, Director (TI)/RDSO
- (h) Shri Alok Katiyar, Director (Signaling) / RDSO
- (i) Director (Track / Bridges) / RDSO
- (j) Shri Anil Kumar Saini, System Head, L&T HMRL
- (k) Shri Anil Jangid, Professional Consultant
- (l) Shri Parveen Kumar, Sr. V.P. RMGL
- (m) Shri Keshava Prasad, GM/Rail System Siemens/FICCI
- (n) Shri R. Satish Director / CII
- (o) Shri D.S Rawat Secretary / ASSOCHAM

1.2 Proceedings of Sub-Committee

First meeting of the sub-committee was held on 24.09.2012 at Baiyappanahalli Depot/BMRCL at Bangalore, as per MOUD /GOI letter No: F.No.K-14011/26/2012-MRTS/Coord dated: 16th September 2012. The crystallized agenda for the meeting covering each item of ToR is detailed in the above letter ([Annexure-2](#)). The meeting was attended by Shri DD Pahuja, Director (RSE)/BMRCL, Shri DeenDayal, Under Secretary (MRTS)/MOUD, Shri AK

Gupta, CGM, DMRC, Shri Anil Jangid, Professional Consultant and officers from O&M wing of BMRCL.

Presentations were made in the meeting by Shri. DD Pahuja, DRSE / BMRCL on Bangalore Metro O&M practices, Shri AK Gupta GGM / Electrical &TI / DMRC on some of the items of ToR and Shri Anil Jangid Professional consultant on Bangkok Airport Rail Line (ARL) Project. This was followed by discussions on items of ToR. Minutes of the Meeting were issued by the convener vide letter No. BMRCL/DRSE/PB/2011-12/4894 dated 27th September 2012.

A presentation on the progress of the sub-committee in respect of each item of ToR was made by Director/RSE in the meeting of the conveners held at Nirman Bhavan/New Delhi on 5th October 2012 Chaired by Secretary MoUD.

Second meeting of the sub-committee was held at RMGL conference room at Gurgaon on 7th December, 2012. In addition to the attendees to the first meeting, Shri Raminder Singh Jaura / Siemens, Shri Anil Kumar Saini / System Head LTHMRL and Shri Parveen Kumar, Sr. V.P. RMGL also attended the meeting. Shri I. C. Sharma / National Project Manager (SUTP) from MoUD/GOI also joined the meeting. The O&M practices proposed on LTMRHL and RMGL were furnished and discussed. Siemens representative also furnished brief details of the maintenance contract under implementation on Bangkok Metro Rail System. The analysis of the O&M practices followed on various Metro Railway Systems and the recommendations in the Indian scenario were discussed.

In the second meeting of the conveners held at NirmanBhavan/ New Delhi on 11th December, 2012, a presentation on the draft report was made by Director/RSE covering each item of ToR.

Based on the inputs collected/made available so far, this study report has been prepared.

2.0 OPERATION AND MAINTENANCE PRACTICES

2.1 Delhi Metro

2.1.1 Project- Background:

The Delhi Metro Rail Corporation is a Special Purpose Vehicle entrusted with the responsibility of implementation of Delhi Metro Rail Project. DMRC is a state owned company with equal equity participation from Government of India and Government of National Capital Territory of Delhi.

2.1.2 Project- Details:

The network consists of 6 lines with a total length of 189.63 RKM with 137 stations.

The first section, on the Red Line, Shahdara to Tis-Hazari of 7 RKM opened in 25 December 2002, followed by the Yellow Line in 2004, the Blue Line in 2005, its branch line in 2009, the Green and Violet Lines in 2010, and the Delhi Airport Metro Express in 2011, and is being operated & maintained by a private concessionaire M/s Reliance Infra for a period of 30 years.

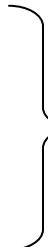
The Delhi Metro is being built in phases, Phase 1 completed 65.11 RKM with 59 stations and the inauguration of the Dwarka-Barakhamba Road corridor of the Blue Line marked the completion of Phase 1 in October 2006.

Phase 2 of the network comprises 128 RKM with 79 stations, and is fully completed, with the first section opened in June 2008 and the last line opened in August 2011.

2.1.3 Philosophy of Operation and Maintenance.

DMRC follows mixed approach for Operation and Maintenance. The core operation and maintenance of major assets are done in-house with the regular staff specially recruited and trained for this purpose. Non-core and offline activities are generally out-sourced though some of them are managed in-house. The out-sourcing of activities is decided on the basis of techno-economic considerations.

2.1.4 The Operation and Maintenance of major assets generally undertaken in-house is as under:

Item	Mode of Operation and Maintenance
Repairs & Maintenance of:	
i. Rolling Stock	Complete in-house after expiry of DLP
ii. Signal & Telecommunication	Complete in-house after expiry of DLP
iii. Traction Power system	Complete in-house after expiry of DLP.
iv. Track	Complete in-house
v. Automatic Fare Collection System	Complete in-house after expiry of DLP.
vi. TVS	In-house
vii. Fire Detection and Fire Fighting equipment	In-house
viii. Elevators/ Escalators	In-house / partly outsourced
ix. ECS	In-house / partly outsourced
x. DG Sets	In-house except for D/E check
xi. UPS	In-house/ major repairs outsourced
Core-Operations : I. Train Operations II. Station Control Rooms (SCR) III. Operation Control Center (OCC) IV. Depot Control Center (DCC) V. Receiving Sub-Stations (RSS) VI. Training Institute. VII. Station Management (Ticketing/House- Keeping/Parking/Customer Facilitation Agents)	 <p>Complete in-house</p> <p>outsourced</p>

Civil infrastructure maintenance is also out-sourced.

Security is managed by CISF.

2.1.5 Maintenance Regime

Maintenance Regime generally followed consists of:

- (a) Time based schedules.
- (b) Predictive replacement of components on the basis of usages as suggested by OEM and DMRC's own experience.
- (c) Maintenance periodicity, Down time & Man hours as prescribed in preventive maintenance schedules for major systems are enclosed at [Annexure-3](#), as under:

Annexure-3A	Maintenance Schedule, Down time and man hours for Rolling Stock.
Annexure- 3B	Maintenance Schedule, Down time and man hours for Traction Power Supply / Distribution System
Annexure- 3C	Maintenance Schedule, Down time and man hours for Track
Annexure- 3D	Maintenance Schedule, Down time and man hours for Signaling System (Maintenance schedule for Point Machine)
Annexure- 3E	Maintenance Schedule, Down time and man hours for various subsystems under Telecommunication
Annexure- 3F	Maintenance Schedule, Down time and man hours for Automatic Fare Collection System.
Annexure- 3G	Maintenance Schedule, Down time and man hours for Civil Structures and Works
Annexure- 3H	Maintenance Schedule, Down time and man hours for M&P
Annexure- 3I	Maintenance Schedule, Down time and man hours for Lifts, Escalators and D.G.Sets.

2.1.6 It is noted that DMRC first train (10+ years now) wheels have so far not yet needed replacement.

2.1.7 Key Performance Indicators

2.1.7.1 Key Performance Indicators (KPIs) followed by DMRC:

(a) **Punctuality:** The Delhi Metro considers a trip as delayed if it incurs delay of more than 2 minutes. The delay is calculated at the terminal station. The punctuality percentage of any line for the day is derived using following method:

$$\text{Punctuality \%} = (\text{Number of trips run on time}/\text{Number of trips run actually}) * 100$$

Where, Number of trips run actually =(No. of trips planned as per timetable+ No of trips run additional)-No. of trips cancelled. 99.89 % Jan, 2013.

(b) **Car KM:** All car km which were actually operated in revenue (passenger carrying) service. 1215803 (Jan, 2013)

(c) **Percentage of cars used during peak hours:** Total number of cars in use in the weekday peak hour as % of total cars available. 79.14 % (Jan, 2013)

(d) **Ridership (Passenger Journey):** Total number of passengers travelled on the metro including Token, Card and Group booking users. 60,724,465 (for January, 2013)

- (e) **Passenger Earning:** Total revenue from Fare Box collection. Rs 1,061,679,660 (for January, 2013)
- (f) **Passenger KM:** Total distance travelled by each passenger on metro trains, summed-up for all passengers. 885,980,174 (for January, 2013)
- (g) **Car Hours:** Actual time in which each car is operating in revenue (passenger carrying) service, summed-up for all cars. 19,888,732.9 (Jan 2013)
- (h) **De-boarding:** Train withdrawn from service and passengers need to be de-boarded en-route from the train due to failure. 2 Trains (for January, 2013)
- (i) **Trips run on time:** Number of trips run as per scheduled time. 80,875 (Jan 2013)
DMRC have not yet started following the KPI as per international benchmarks and they are in the process of implementing such system.

2.1.7.2 DMRC has recently started monitoring the following KPIs on monthly basis:

SN	Key Performance Indicator	For the Month - Jan 2013
1	Staff Cost (Rs. in lacs)	2276.80
1a	No. of Staff	5870.00
1b	No. of Route Km.	166.29
1c	a) Staff/Route Km.	35.3
1d	b) Avg. Cost/Staff (Rs. in lacs)	0.39
2	Civil (Rs. in lacs)	680.03
2.1	Cleaning & House Keeping Cost (Rs. in lacs)	401.29
2.1a	No. of Stations	137
2.1b	Cost Per Station (Rs. in lacs)	2.93
2.1c	No. of House Keeping staff deployed	3549
2.1d	Cost per Staff (Rs. in lacs)	0.11
2.2	Repair & Maintenance Cost (Rs. in lacs)	278.74
2.2a	Cost per station (Rs. in lacs)	2.03
3	Electrical Cost (Rs. in lacs)	2688.62
3.1	Traction Cost (Rs. in lacs)	1599.07
3.1a	total Units Consumed (in lacs)	276.18
3.1b	Cost per Unit	5.79
3.1e	No. of car Km.(in lacs)	121.26
3.1f	Units Consumed per car Km	2.26
3.2	Non Traction	
3.2a	Total cost (Rs. in lacs)	695.14
3.2b	total Units Consumed (in lacs)	120.06
3.2c	Cost per Unit (Rs.)	5.79

3.3	Electrical Maintenance	394.41
3.3a	Total cost (Rs. in lacs)	
3.3b	Cost per Station (Rs. in lacs)	2.88
4	Operation	170.12
4.1	Cost of Ticketing (Exp. on TOM Operators) (Rs. in lacs)	170.12
4.2	Cost of Ticketing per station (Rs. in lacs)	1.24
4.3	Avg.No. of TOM Operators	812
4.4	Cost per operator (Rs. in lacs)	0.21
5	Rolling Stock	412.23
5.1	Repair & Maintenance cost (Rs. in lacs)	412.23
5.2	Avg.No. of Cars	1070
5.3	Repair & Maintenance cost per car (Rs. in lacs)	0.39
6	S&T	568.72
6.1	Repair & Maintenance cost (Rs. in lacs)	568.72
6.2	Repair & Maintenance cost per station (Rs. in lacs)	4.15
7	Other expenditure (Rs. In Lacs) (Including insurance, printing and stationery, telephone, advertisement, publicity, vehicles hire charges etc.)	575.62
8	Total cost (1 to 7)	7372.12

2.1.8 DMRC has become a member of NOVA in the year 2008 and the terms of reference with NOVA are being shared only among the NOVA members. The organization maintains confidentiality regarding various operating parameters.

The membership of NOVA will enable access to O&M practices followed by International Metro Rail Systems and benchmarking the same. With the increased ridership and expansion of network, DMRC is expected to migrate to group of large metros i.e. COMET

2.1.9 Fare Box system is the most important revenue generation source for a Metro Railway System. The Manning of ticket windows is been done by outsourced staff. Problems of under vending, improper equipment handling because of frequent change of staff, loss of token and high attrition rate of outsourced staff have been encountered. The measures such as training of the outsourced staff, constant monitoring & Counseling, incentives for good performance and penalties for lack of performance, have alleviated the problem to some extent. The use of automatic ticket vending machine on a large scale will reduce the work load on ticket windows and dependence on outsourced staff.

2.2 Bangalore Metro

2.2.1 Project- Background:

Bangalore Metro Rail Corporation Limited (BMRCL), a joint venture of Government of India and Government of Karnataka is a Special Purpose Vehicle entrusted with the responsibility of implementation of Bangalore Metro Rail Project.

2.2.2 Project- Details:

The phase -1 of the project envisages construction of 42.3 RKM consisting of 2 lines-Purple line (East-West corridor)of 18.10 RKM with 17 stations. Green line (North-South corridor)of 24.20 RKM with 24 stations. The first stretch of 6.7 RKM between Baiyyappanahalli and Mahatma Gandhi Road on Purple line has been commissioned for revenue services on October 20, 2011.

2.2.3 Philosophy of Operation and Maintenance:

The Operation and Maintenance practices followed on BMRCL are broadly similar to DMRC. The core operations & maintenance of major assets are done in-house. Maintenance of non-core assets and certain station management activities are out-sourced as expertise is available with the local industry.

2.2.4 Following assets / systems maintenance is done in-house with specially recruited, qualified & trained staff:

- I. Rolling Stock
- II. Traction Power & Distribution
- III. Signaling / Train Control
- IV. Track
- V. Telecom & AFC
- VI. Depot M&P

2.2.4.1 Following non-core assets maintenance is out-sourced:

- I. E&M assets,
- II. Lifts & Escalators,
- III. Civil Structures i.e., Buildings,
- IV. Fire Detection and Fire Fighting equipment.
- V. Security, Housekeeping& Personal for Ticketing is outsourced at Station & Depot.

2.2.4.2 Following operations are done in house:

- I. Train operations,
- II. Traffic control,
- III. Depot control,
- IV. Customer care facilitation

2.2.4.3 Following operations are outsourced:

- I. Medical,
- II. Auxiliary Security,
- III. House-keeping and
- IV. Manning of Ticket Houses

2.2.5 Maintenance Regime consists of:

- (a) Preventive maintenance and
- (b) Corrective maintenance

2.2.5.1 Preventive maintenance

Preventive maintenance is performed during non-revenue hours as per the schedules laid down by the OEM. The periodicity and extent of maintenance is reviewed (every six months) for fine tuning of the same based on local conditions in respect of track geometry (especially sharp curves), Environment (temperature, humidity, dust etc.) and use of indigenous consumables.

Details of the preventive maintenance schedules, downtime & man hours followed for major systems by BMRCL are enclosed at [Annexure-4](#), as under:

Annexure-4A	Maintenance Schedule, Down time and man hours for Rolling Stock
Annexure-4B	Maintenance Schedule, Down time and man hours for Traction Power Supply / Distribution System
Annexure-4C	Maintenance Schedule, Down time and man hours for Tracks
Annexure-4D	Maintenance Schedule, Down time and man hours for Signalling System
Annexure-4E	Maintenance Schedule, Down time and man hours for Telecom Systems

Annexure-4F	Maintenance Schedule, Down time and man hours for AFC System
Annexure-4G	Maintenance Schedule, Down time and man hours for Civil Structures and Works
Annexure-4H	Maintenance Schedule, Down time and man hours for M&P
Annexure-4I	Maintenance Schedule, Down time and man hours for Lifts, Escalators and D.G. Sets.

The comparison of maintenance periodicity, down time and man hours required, between DMRC and BMRCL for rolling stock is as under:

SN	DMRC	BMRCL
1	Daily check (30 min, 2 staff=1 man hour)	Daily check (30 min, 2 staff=1 man hour)
2	5,000km / 15 days (2 Hrs, 4 staff = 8 man hours)	6,000km / 15 days (1.5 Hrs, 4 staff = 6 man hours)
3	15,000km / 45 days (8 Hrs, 7 staff = 56 man hours)	18,000km / 45 days (4 Hrs, 8 staff = 32 man hours)
4	30,000km / 90 days (8 Hrs, 7 staff = 56 man hours)	36,000km / 90 days (6 Hrs, 8 staff = 48 man hours)
5	60,000km / 180 days (8 Hrs, 12 staff = 96 man hours)	72,000km / 180 days (12 Hrs, 8 staff = 96 man hours)
6	1,20,000km / 360 days (16 Hrs, 13 staff = 208 man hours)	15,0000km / 1 Year (20 Hrs, 8 staff = 160 man hours)
7	2,40,000km / 720 days ((16 Hrs, 13 staff = 208 man hours)	3,00,000km / 2 Years (28 Hrs, 8 staff = 224 man hours)
8	4,20,000km / 3.5 years (3096 man hours)	5,20,000km / 3.5 years (10 days, 4 staff per car)
9	8,40,000km / 7 years (7910 man hours)	10,40,000km / 7 years (20 days, 4 staff per car)

2.2.5.2 Corrective maintenance:

The essence of corrective maintenance is to prevent failure by continuous monitoring of certain vital installations and taking timely corrective action to eliminate/reduce the impact of failure. The following facilities are available/methodologies are adopted to enable corrective maintenance.

- (a) Manning of vital installations like RSS, OCC, DCC and SCR round the clock.
- (b) SCADA for Remote monitoring and control of Traction installations and Telecom installations
- (c) BMS for remote monitoring of E&M assets (Firefighting system, DG sets, UPS, lights, Escalators/Lifts etc.) at stations.
- (d) AFC, Station and Central Computers for monitoring of AFC gates, TOMs, TVMs etc. at stations.
- (e) Failure analysis through causative indications on the electronic equipment / sub-systems.

There were initial cases of wheel flat in BMRCL. Thereafter, BMRCL resorted to mill scale grinding of rails (by borrowing Rail grinding on Track machine from DMRC). Rail grinding has helped BMRCL achieving better rail wheel interaction, squeaking noise has reduced, rail profile is better, current collection is better, wheel re-profiling has reduced.

2.2.6 Key Performance Indicators:

Presently BMRCL monitors following performance parameters.

- (a) Punctuality
 - i. Arrival at destinations >180Seconds (of scheduled arrival time)
 - ii. Arrival at destinations >120 & \leq 180 Seconds (of scheduled arrival time)
 - iii. Arrival at destinations > 60 & \leq 120 Seconds (of scheduled arrival time)
 - iv. Within 60 seconds of scheduled arrival time
- (b) Trip Cancellations
- (c) Train withdrawal from service
- (d) Incidents /system defects not affecting train operations
- (e) Accidents
- (f) Evacuation
- (g) Ridership
- (h) Station Earnings
- (i) Train KM report

- (j) Availability of standby trains
 - (k) Energy consumption
 - i. Traction
 - ii. Non-Traction
- 2.2.6.1 BMRCL has sent a presentation on the O&M activities as a first step to become member of NOVA and they have favorably responded to BMRCL's membership request. BMRCL plans to introduce monitoring of KPIs as per international practice when they are admitted as a member of NOVA.

2.2.7 Pre-operation process / activities followed is described as under:

It is required to initiate pre-operation activities approximately 12 to 18 months before the planned Revenue Operation Date (ROD). The details of activities to be carried out during pre-operation phase are given in [Annexure-5](#). Similar pre-operation activities are followed on DMRC also.

2.3 Hyderabad Metro (LTMRHL)

2.3.1 Project- Background:

Hyderabad Metro Rail Project is being implemented on Public Private Partnership (PPP) mode under the Design, Build, Finance, Operate and Transfer (DBFOT) format. The Concession was awarded to L&T Metro Rail (Hyderabad) Limited(a SPV formed by M/s L&T) by the Government of Andhra Pradesh (GoAP). The Concession period is 35 years and further extendable by another 25 years.

2.3.2 Project- Details:

The Hyderabad Metro Rail Project will cover a total distance of 71.16 km across three elevated corridors:

Corridor I: Miyapur to L.B. Nagar (28.87km, 27 stations)

Corridor II: JBS to Falaknuma (14.78km, 16 stations)

Corridor III: Nagole to Shilparaman (27.51km, 23 stations)

The salient features of various technologies and systems are summarized below:

- a. Viaduct: segmental box construction (except special spans)
- b. Stations: Cantilever type construction on central piers (spine & wing concept)
- c. Depots: At-grade depot (one mother depot and 2 supporting depots)
- d. Rolling Stock: 2.9m wide 3-car consist (6 car train later)
- e. Traction: 25kV AC overhead system

- f. Track: Ballast-less on mainlines and ballasted in depot
- g. Signaling & Train Control: CBTC based CATC system (ATO/ATP/ATS)
- h. Telecom: IP based network and equipment
- i. AFC: Contactless smartcard/token technology based system

The project is under construction and is likely to commence operation in the year 2015-2016.

2.3.3 Approach and Methodology of operation & maintenance:

L&T Metro Rail Hyderabad Limited shall operate and maintain the Project in accordance with the Concession Agreement. For this, LTMRHL has entered into an operation and maintenance agreement and engaged a professional Operator to operate and maintain the system. Tenders based on International Competitive Bidding were called for the selection of OMC (Operation and Maintenance Contractor) for performing the O&M deliverables. The objective of LTMRHL is to engage a world class metro operator with a credible operating track record. Keolis SA (a subsidiary of SNCF France) has been selected as the O&M Operator for 5 years from amongst Keolis, SMRT, Veolia-RATP, Serco and Seoul Metro.

Keolis SA has the experience, expertise, capability and know-how to ensure that the O&M deliverables are executed in accordance with the terms of the O&M Agreement in a timely, safe and environmentally responsible manner.

The security of the Metro Rail Project is the responsibility of GoAP, who would provide all staff, resources and equipment required for security arrangements except that fixed security equipment at stations will be provided by LTMRHL as part of station works.

2.3.3.1 Scope of O & M Contractor (OMC):

Keolis SA shall act as the Operation and Maintenance consultant in the start-up phase as part of early Operator involvement and thereafter operate and maintain the MRTS project upon its commissioning in various stages. The scope of work of Keolis SA is divided into three phases:

- (1) Consultancy phase
- (2) Pre-Operation phase
- (3) Operation & Maintenance phase

The detailed scope of work of OMC in each of the above phases is given in the [Annexure-6](#).

2.3.3.2 Safety Engineering

- a) Safety is of utmost importance for the Project and a structured process of Safety Engineering shall be complied with by all stakeholders (Employer, OMC, Contractors etc.) as per EN50126 and Yellow Book guidelines.
- b) An Engineering Safety Case will be developed for the Project by consultants. Similarly, OMC shall develop an Operation Safety Case and Safety Management System (SMS). These safety cases shall be examined by Project-wide ISA and no-objection given before commercial opening.
- c) OMC shall take care of progressive updating of SMS system during the Project life cycle.

2.3.4 Philosophy of Operation and Maintenance:

- a) LTMRHL has completely entrusted the O & M activities to O & M contractor (M/s Keolis SA) who would carry out all operation and maintenance activities themselves except following outsourced activities:
 - Cleaning of train and stations
 - Auxiliary Security services (main security by State Govt. Police)
 - Maintenance of Lifts, Escalators, depot equipment etc.
 - Rail grinding activities
- b) OMC in general shall carry-out the following:
 - I. Support the Employer in designing a world class mass rapid Transit system with high focus on reliability, availability, maintainability, exemplary safety standards and ease of operations;
 - II. Perform and provide all the O&M Deliverables.
 - III. Build a professional team capable of performing all the O&M Deliverables.
 - IV. Create a well-defined revenue model with identifiable parameters and innovate wherever required to enhance the revenues;
 - V. Ensure that the MRTS is operated and maintained at least cost without Compromising on safety and comfort of the passengers;
 - VI. Create and maintain enabling environment in the MRTS to maximize the

- fare revenues and non-fare revenues related to the commercial developments associated with MRTS;
- VII. Support the Employer on controlling the evolution of costs with long-term visibility on the required payments;
- VIII. Responsible for supporting the Employer in testing, commissioning and Trial Runs by providing Key staff.
- IX. Provide suggestions and conduct the design reviews to enable development of a well-balanced Rail System that optimizes operational and maintenance facilities with a view to maximize real estate development;
- X. Develop, implement and maintain the O&M Manuals;
- XI. Maintain the key performance indicators to ensure compliance of the Employer with the terms of the Concession Agreement;
- XII. Train the Employer's staff in critical operations area to facilitate smooth operations in the absence of OMC staff.

2.3.5 Key Parameters Indicators:

2.3.5.1 The OMC shall submit a KPI Management Plan which shall include the Following:

- a. Formulate the performance hierarchy to manage specific KPI targets by each department across the organization;
- b. A detailed plan to describe how the OMC is going to achieve each KPI requirement;
- c. A database and the methodology to capture the required KPI in the system.

2.3.5.2 KPIs as per Concession Agreement between Hyderabad Metrorail Ltd. (Owner) & LTMRHL (Concessionaire) are given in [Annexure-7](#)

2.3.5.3 Additional KPIs included in the agreement between Concessionaire & OMC are given in [Annexure-7A](#)

2.3.5.4 Asset Management System

- i. A comprehensive asset management system (AMS) would be rolled out for the project before revenue operations start for the first section.
- ii. The main functions of the AMS would include:
 - a. Maintenance planning (preventive and corrective)
 - b. Budgeting for operations and maintenance
 - c. KPI reporting
 - d. Automatic SMS/email alerts to maintenance staff in case of failures
 - e. Procurement of spares & tools (inventory management)
 - f. Document management system
 - g. Data archiving and incidence capturing
- iii. The bidding process for AMS system is currently in progress.

2.4 Rapid Metro Rail Gurgaon Limited (RMGL)

2.4.1 Project- Background:

Phase-I of Rapid Metro Rail Gurgaon has a 5 km route in pinched loop configuration. It is an entirely elevated and electrified (third rail 750V DC) section permitting automatic train operation. Trains start and terminate their trip at the same terminal station (Sikanderpur). There is one elevated depot, six elevated stations and a fleet of five 3-car trains.

2.4.2 Philosophy of Operation and Maintenance :

- i. Rapid MetroRail Gurgaon's Operation and Maintenance (O&M) practices are based on best practices followed in Metro systems across the globe. At the same time, some of these practices are distinct due to its relatively small size which may not fit economies of scale and hence RMGL has decided to outsource maintenance of major systems.
- ii. RMGL has entered into a 10 year maintenance contract with M/s Siemens for maintenance of Rolling Stock, Signaling system, Traction system and Depot Plant & Machinery as these systems have been supplied by M/s Siemens.
- iii. The above maintenance contract has one main Key Performance Indicator (KPI) viz. number of actual train departure trips that are within 3 minutes of the scheduled departure time vis-a-vis scheduled train departure trips.

- iv. RMGL will also outsource, to a large extent, maintenance of other systems such as telecommunication, automatic fare collection, track and building infrastructure. Each contract will have measurable KPIs.
- v. RMGL has its internal organization to manage maintenance contracts and ensure KPIs, to maintain other assets and to coordinate with Operations.

2.4.2.1 Key Details of Operation

- a) Rapid Metro Rail Gurgaon will have in-house Operation primarily due to the following reasons:
 - i. Operation being the main 'delivery', it fits RMGL's strategy to be the public face
 - ii. In-house Operation will help RMGL in quickly developing key expertise and domain knowledge
 - iii. Operation has large & complex external interfaces and, for a small system, perceived risks by external agencies generally do not fit economies of scale.
- b) Following activities will be handled in-house:
 - i. Train Operation and Service Monitoring
 - ii. Station Management
 - iii. OCC and Depot Management
 - iv. Training and Competency Management
 - v. Safety, Performance and Planning
 - vi. Incident Handling
 - vii. Interface with Maintenance
 - viii. Interface with State Agencies
- c) Due to economic reasons, following type of activities will be out-sourced:
 - i. Station Security
 - ii. House Keeping and Cleaning activities
 - iii. Ticket Vending
 - iv. Maintenance of Telecommunication, Automatic fare collection, Track and Building infrastructure.

RMGL are likely to commence operations in the year 2013-2014.

3.0 OPERATION&MAINTENANCE PRACTICES IN FOREIGN METROS

3.1 Singapore Metro (SMRT)

- SMRT operates many metro lines in Singapore under an agreement with Owner of the Metro Project M/s Land Transport Authority (LTA). While LTA is responsible for initial investment and the project execution, SMRT (or other Operator) takes over the project as an Operator with a clear agreement to run the project for a certain period.
- The complete operation and maintenance and capacity augmentation (like additional trains, ticketing gates etc.) is the responsibility of the Operator and the Operator is responsible for strict adheres to KPIs given in the Agreement. Failure to achieve the KPI leads to penalties.

3.1.1 Philosophy of Operation and Maintenance:

- i. Entire maintenance including rolling stock overhauls are done by SMRT themselves i.e. no outsourcing is done.
- ii. The repair of cards and old machines are also carried out in-house except safety critical components.
- iii. The project has a comprehensive AMS system to capture all maintenance data history and also plan the maintenance.
- iv. Training of staff and skill development is given top priority and a state of the art training center has been established to provide requisite training to the staff.
- v. Minor activities (like cleaning, ticket selling, Lifts & Escalator maintenance etc.) are outsourced by SMRT.
- vi. The spares parts are procured from OEMS under long supply agreements.
- vii. An integrated ticketing system has been provided by LTA with clearing house for revenue reconciliation and settlement.

3.2 Seoul Metro:

3.2.1 Philosophy of Operation and Maintenance :

- Seoul Metro Line 9 is a Concession Project executed by a Consortium including Hyundai Rotem as partner. The Other lines of Seoul metro are operated by Seoul metro (owner of the project).
- The Concessionaire has appointed M/s Veolia-France as an Operator for the project having stringent KPIs and back to back operations & maintenance requirements drawn from Concession Agreement.
- M/s Veolia has outsourced the rolling stock maintenance to M/s Hyundai Rotem (supplier of the rolling stock) for initial 10 years including overhauling.
- Rest of the O&M activities are managed by Veolia on their own by hiring the local staff from Korea.

3.3 Bangkok Metro (MRT):

3.3.1 Project- Background:

- The Metropolitan Rapid Transit (MRT) is a rapid transit system serving the Bangkok Metropolitan Region in Thailand.
- The first section of the Blue Line between Hua Lamphong and Bang Sue has 18 operational stations along 27 Km of underground track with a fleet of 19 trains.
- The MRT Purple Line is under construction and It will connect Bang Sue with Nonthaburi in the north-west, and will be the first public transit line outside the Bangkok Metropolitan Administration.

3.3.2 Philosophy of Operation and Maintenance

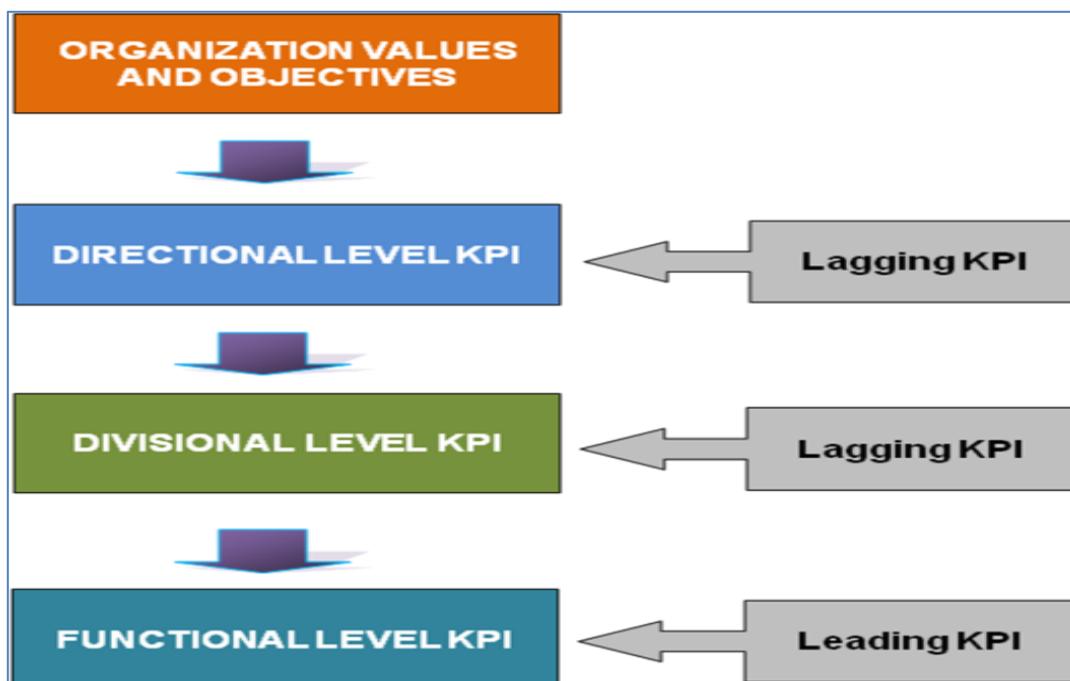
- MRT is responsible for the complete operation and capacity augmentation (like additional trains, ticketing gates etc.).
- MRT has entered in to a maintenance contract with M/s Siemens for the Purple line in respect of Signaling and Rolling stock.
- The maintenance contractor has to give technical support along with planned man power.

- The maintenance contractor has to follow strictly KPIs as given in the agreement and the scope of work includes viz. Availability of man power, preventive & corrective maintenance, analysis of failures & root causes, documentation & reporting and regular maintenance performance reviews (Audit).
 - MRT is a member of American Public Transportation Association (APTA) and NOVA, with the objectives to study and exchange the excellent practices with other international public transport operators, and apply as guidelines in the continued self-development and improvement.

3.4 Key Performance Indicators – Foreign Metros

3.4.1 EN 13816 is the European transportation standard for passenger transport service providers. This includes airlines, trains, subways, buses, water vessels and does not include individual passenger vehicles such as taxis. The elements within EN 13816 comprises include Availability, Accessibility, Information, Time, Customer care, Comfort, Security and Environmental impact.

3.4.2 KPIs shall be divided in 3 categories; Directional, Divisional and Functional.



3.4.3 Direction level, lagging KPIs shall be derived from the Organization values and objectives. O&M Agreement and Quality and Performance Module.

3.5 Nova and CoMET Key Performance Indicator System

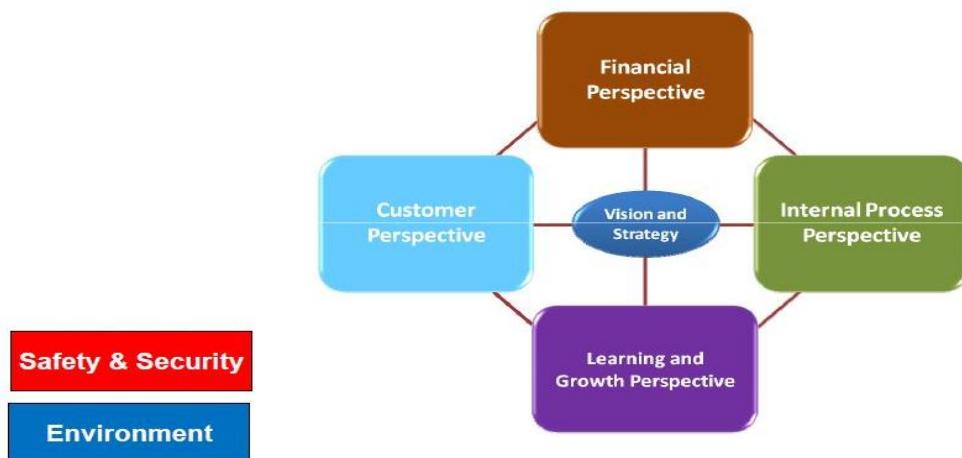
Key Performance Indicators (KPIs) form a fundamental aspect of benchmarking as they enable performance to be compared on a universally consistent and understandable basis between organizations. The structured KPI comparisons can be used for:

- Direct comparisons – to understand better the differences between operators
- Internal motivation – setting targets for improved performance
- Identifying high priority problems, strengths and weaknesses
- Supporting metros' dialogue with government, regulators, and other stakeholders

3.5.1 Performance Areas and Report Layout

- The framework for the KPI system has been developed based on the 'success dimensions' identified in the Harvard Business School Balanced Scorecard model: Financial, Customer, Learning & Growth, and Internal Business Processes.
- In addition to the four standard Balanced Scorecard Success Dimensions, the importance of 'Safety and Security' and the 'Environment' were considered important enough to warrant their own dimensions although these overlap with both the 'Customer and 'Internal Business Processes' dimensions.
- Performance areas for the KPIs describe how successful a metro is in achieving certain objectives.

3.5.2 Balanced Scorecard – Four Success Dimensions



3.5.3 The Key Performance Indicator Process- NOVA/CoMET KPIs are:

- Comprehensive and yet concise - There should be a balance between an all-rounded view and the flexibility for management focus. The reporting of high-level KPIs whilst collecting disaggregates data for more detailed analysis is to achieve this balance.
- Internally consistent - It is assumed that member metros use a consistent set of internal definitions and underlying assumptions when deriving their own KPIs. Wherever possible, the data should best be reconciled against other published data for consistency.
- Support business performance monitoring through critical success factors
- The KPIs should be designed to give a clear view of what constitutes success.
- Well-structured with the flexibility for change and evolution over time

3.5.4 The Key Performance Indicator System

The brief details of the KPIs being followed by NOVA/CoMET is given below. These KPIs are used for bench marking performance of 29 metros world-wide.

3.5.4.1 Growth, Learning & Innovation

G1a/b % change Network Size & Passenger Journeys

G2a/b % change Operated Capacity km & Car km

G3 Number of Training Hours / 1000 Staff Hours

G4a/b Non-fare Commercial Revenue / Fare Revenue & /Passenger Journey

3.5.4.2 Financial

F1 Total Commercial Revenue / Operating Cost

F2 Operating Cost / Revenue Car km

F2a Service Operations Cost / Car km F2b Maintenance Cost / Car km

F2c Administrative cost / Car km

F3 Investment cost / Car km

F4a/b Operating Cost / Passenger Journey & km

F5a/b Fare Revenue / Passenger Journey & km

3.5.4.3 Customer

Capacity Provision & Utilization

C1 Capacity km / Route km

C2 Passenger km / Capacity km

3.5.4.4 Service Quality

C3 Passenger Hours' Delay / Passenger Journey

C4 Passenger Journeys On Time / Passenger Journey

C5a/b Trains On Time / Total Trains (scheduled + actual)

C6 Train Hours Operated / Hours of Train Delay

3.5.4.5 Internal Processes

Reliability & Availability

P1a/b % of Cars Available & Used in Peak Hour

P2a/b Car km / hours between Incidents (by category)

3.5.4.6 Efficiency

P3 Passenger Journeys / Staff + Contractor hours

P4a/b Capacity & Car km / Staff + Contractor hours

P5 Train hours / Driver Hours

P6 % Employee Absenteeism

P7 Traction Energy Consumed / Car km

P8a/b Total Energy Consumed / Passenger Journey & km

3.5.4.7 Safety & Security

S1 Total Fatalities / Passenger Journeys

S1a Deaths from Suicide / Passenger Journeys

S1b Deaths from Accidents / Passenger Journeys

S1c Deaths from Illegal Activity / Passenger Journeys

S2 Incidences of Crime / Passenger Journeys S3a/b Staff Lost Time through Accidents / Staff Hours

3.5.4.8 Environment

E1 CO₂ per Passenger km

4.0 SAFETY, SECURITY AND DISASTER MANAGEMENT

4.1 Delhi Metro

4.1.1 Safety and Security of systems

- (a) The responsibility of security of DMRC system is with CISF and Delhi Police.
- (b) DMRC deploys CCTV for security purpose. However, the video analytic technique is not considered useful by DMRC. As per information available with DMRC through NOVA/CoMET, video analytics is not considered practical and feasible for mass rapid transport system. London Metro after serial Bomb Blast in 2005 had planned use of video analytics which was discontinued in 2008 as it was not considered useful
- (c) DMRC organizes Mock drills related to safety preparedness and handling of disasters in association with DDMA/NDMA/NSG/Delhi Fire Service/Delhi Police. During these mock drills evacuation of passengers from tunnels / Via-duct under various scenarios involving different line and stations is done. Normally these drills are conducted during non-revenue hours or early revenue hours in order to avoid in-convenience to passengers.
- (d) A contingency plan has been prepared by CISF as per directions of MHA detailing role and responsibility of each stake holder i.e. DDMA/NDMA/NSG/Delhi Fire Service/Delhi Police/DMRC. As per this contingency plan each stake holder has prepared its own contingency plan. Accordingly DMRC has prepared its own contingency plan. In addition to this DMRC has its own Disaster Management Plan, which is a requirement of Disaster Management Act 2005. CISF also prepared contingency for each station.

4.1.2 Drill for use of Rescue & Relief Train, Attending Lifts & Escalators Failure these are done on weekly basis on different lines and at different stations.

4.1.3 The details of mock drills which are conducted to check the preparedness of the various sub-systems in under-ground section are given in [Annexure-8](#)

4.1.4 Safety Organization:

DMRC is having a safety organization which is functioning under one of the heads of the department of O&M. Further there are part time executives drawn from different departments who conduct safety checks on regular basis.

4.2 Bangalore Metro

- 4.2.1** BMRCL have developed a Disaster Management Plan including Mock Drills to be undertaken by Operations & Maintenance Wing.
- 4.2.2** In order that the BMRCL staff members are aware of their responsibilities for disaster management, BMRCL has prescribed schedule of mock drills so that the O&M employees are responsive to various unexpected and abnormal incidents to mitigate the inconvenience to passengers and for restoration of normal metro services in quickest possible time.
- 4.2.3** Safety and security issues and special precautions required to be taken by BMRCL employees during rescue & restoration operations on metro system with 750 V DC Third Rail traction systems have also been addressed.
- 4.2.4** BMRCL staff displaying involuntary responses during serious incidents /accidents is the ultimate goal; this is attempted by imparting periodic and constant training & awareness to all staff, building a team spirit with appropriate knowledge to each and every employee to handle such events through mock drills on all matters periodically.
- 4.2.5** The frequency of Mock Drills is detailed below, will be done once in every month/ Quarterly depending on case by case basis as per the details of mock drills enunciated in the hand book for dealing with serious incidents, accidents & disasters. These are supplemented by prescribing additional mock drills based on the experience gained during the one year of revenue service and these are tailored to BMRCL environment.
- (a) Fire Drill
 - (b) Rescue of Disabled Train.
 - (c) Detrainment of Passengers between Stations
 - (d) Passenger Evacuation from Station and Via-duct
 - (e) Drill for use of Rescue & Relief Train
 - (f) Communication Failure (TETRA)
 - (g) Failure of Third Rail Power Supply
 - (h) Rail Fracture (leading to TC Failure)
 - (i) Point failure in Mainline /Depot
 - (j) Lifts & Escalators Failure
 - (k) Preparedness & Preventive actions against Terrorist attack
 - (l) Natural Calamities
 - (m)Temporary Single line working

4.2.6 Records to be maintained for Mock Drill

- (a) Staff & Officers attended; Coverage of all O&M staff during periodic exercises
- (b) Coordinated Communication for achieving results
- (c) Adequacy of facilities
- (d) Proper functioning of equipment, generation of alarms etc.
- (e) Technical problems, if any
- (f) Procedural short comings
- (g) Need for amending existing procedures & systems
- (h) Involvement of external agencies like fire force, police, hospitals, Meteorological depts.
- (i) Review and reforms

4.2.7 Observers for Mock drills

- (a) Observers for Mock drills are nominated from Project wing/GC to give impartial independent report to the management.
- (b) They have to note and give their report on mock drills and suggest methods required for early restoration of train services/ rescue operations in case of any eventualities and any other matter to be brought to the attention of Head of Operations.

4.2.8 Safety and Security of systems**(a) Security of the System**

In BMRCL, Karnataka Industrial Security Force would ultimately take care of the main security at stations. However Auxiliary security could be an option in depots etc. which are not frequented by the public.

For all unmanned installations, Access Control has been provided either through a bio-metric card or through keys which can be accessed by only authorized persons.

(b) Software locks have been provided for access control in the OCC like AFC System, SCADA, Train Control, Signal Servers so that the same can be accessible by only the authorized personnel.

(c) Surveillance is an important activity, which has to be given top priority by Metros. Video Analytic functions are not at present able to detect various scenario at the stations for face detection, leftover objects etc. especially since the Metros are crowded; but this is a very useful tool for intrusion detection, crowding at stations etc.

(d) Safety Case presentation

A committee of officers has carried out Safety inspections of the procedures being followed by O & M organization.

4.3 Rapid Metrorail Gurgaon Ltd (RMGL)

- 4.3.1** Safety is an inherent function of every RMGL discipline and there will be a separate team to periodically monitor and identify areas of improvement. Support of external professional agencies will be taken on need basis.
- 4.3.2** Security services are being outsourced to an agency registered with the state police and law & order will be taken-care by the state police.
- 4.3.3** A centralized security control room in the Operation Control Centre will be manned by Rapid Metro Rail and state police. Rapid Metro Rail premises will be under surveillance of CCTV cameras. X-ray baggage scanners and Door Frame Metal Detectors will be installed at public entry to stations.
- 4.3.4** Periodical mock drills related to preparedness and handling of disasters will be conducted by the O&M wing.

5.0 INDIGENISATION OF SPARES & CONSUMABLES**5.1 Delhi Metro**

5.1.1 Details of sourcing of components/systems/sub-assemblies in various system contracts are provided in [Annexure-9](#).

5.1.2 The suggestions of DMRC for such currently imported items, which can be developed through indigenous sources, are also provided in [Annexure-9](#).

5.2 Bangalore Metro

5.2.1 The details of sourcing of components/systems/sub-assemblies in various system contracts are provided in [Annexure-10](#).

5.2.2 The suggestions of BMRCL for such currently imported items, which can be developed through indigenous sources, are also provided in [Annexure-10](#).

6.0 MANPOWER AND M&P RESOURCES DEPLOYED IN METROS

6.1 Delhi Metro

6.1.1 The manpower benchmark of DMRC is as under:

Category	Benchmark	Total
Permanent Way	0.25 JE + 0.75 Maintainer	1 /Route km
Works	0.45 JE + 0.30 Maintainer	0.75 /Route Km
E &M	1.10 JE + 3.25 Maintainer	4.35 /Route Km
Traction	0.70 JE + 2.20 Maintainer	2.90 /Route Km.
Signal, Telecom/ AFC	1.7 JE + 4.2 Maintainer	5.9 /Route Km
RS (Depot Maintenance & Workshop activities)	0.38 JE + 0.87 Maintainer	1.25 staff per coach
Stores	0.41	0.41/ Route km
HR	0.30 per 100 employee	0.30 per 100 employee
Finance	0.50 per 100 employee	0.30 per 100 employee
Train Operator	26 per 100 train hours	4.5 / Route km
Station Controllers/ Revenue/ CRAs		8.5 / Route Km
Total		35.3 /Route KM

6.1.2 The current O&M manpower in DMRC, including managerial and supervisory staff is as under (as on 1.11.2012):

Subgroups	Opn & PD	Elct.& TI	Civil	S&T	RS	Stores	Accts	HR	Security	Total
Executives										
62000-80000 - ED	0	0	0	1	0	0	0	0	0	1
51300-73000 - HOD	1	1	1	0	1	0	0	1	1	6
43200-66000 - AGM	0	0	0	0	0	0	0	0	0	0
37400-67000-AGM	0	0	0	0	0	0	0	0	0	0
37400-67000-JGM	0	0	0	0	0	0	0	0	0	0
36600-62000 - JGM	2	1	0	1	1	0	1	1	0	7
29100-54500 - DGM	2	3	2	1	0	0	1	0	0	9
15600-39100-DGM	2	0	0	1	0	0	0	0	0	3
24900-50500 - Manager	9	9	4	13	11	2	3	2	0	53
20600-46500-Asst Mgr	9	8	6	10	17	0	2	1	0	53
Total	25	22	13	27	30	2	7	5	1	132
Non-Executives										
18500-35600-Sr Sup 2	23	21	2	13	17	0	4	0	1	81
16000-30770-Sr Sup 1	24	0	1	13	3	0	0	0	6	47
14000-26950 - Sup 2	430	67	20	61	54	5	2	0	3	642
13500-25520 - Sup 1	1183	169	43	175	224	12	4	8	1	1819
10170-18500 - Asstt	738	260	52	223	162	0	10	12	0	1457
8000-14140 - Skilled	0	588	60	406	561	0	0	0	0	1615
6670-11470 - Semi Sk	1	41	56	4	14	3	1	3	1	124
6090-9300 - Unskilled	3	2	3	1	2	5	2	1	0	19
5200-20200-SP STF	0	1	2	0	1	1	0	0	0	5
NON DMRC GRADE	1	0	0	0	0	0	0	0	0	1
Total	2403	1149	239	896	1038	26	23	24	12	5810

6.1.3 M&P resources deployed in DMRC are given in Annexure-11.

6.2 Bangalore Metro

6.2.1 BMRCL has sanctioned strength of 38.4 staff per route km for the Phase-1 project of 42.3 km comprising of 1624 non-executive posts and 72 executive posts. Details are as under:

SL No	Department	BMRCL Line -1 18.1 RKM	BMRCL Line-2 24.2 RKM	Total 42.3 RKM	Staff per RKM in BMRCL
1	S&T , AFC	123	165	288	6.8
2	Elect. Traction, E&M & Escalator	154	206	360	8.5
3	P Way	35	46	81	1.9
4	C&S works	18	24	42	1
5	Operation	232	310	542	12.8
6	R S Maintenance	101	168	269	1.6/C**
7	Finance, HR, Stores	18	24	42	1
Total		681	943	1624	38.4

SL No	Post	No. of staff Line-1	No. of staff Line-2	Total Staff Line 1&2
1	Senior Section Engineer (SSE)/Section Engineer (SE)	46	62	108
2	Asst. Section Engineer (ASE) / Junior Engineer (JE)	106	145	251
3	Sr. Maintainer/ Maintainer/ Customer Relation Manager CRM)	309	437	746
4	Unskilled	6	13	19
5	Track Maintainer	9	12	21
6	Track Men	20	26	46
7	Station Controller	65	72	137
8	Train Operator	102	152	254
9	Finance , HR ,Stores	18	24	42
Total		681	943	1624

6.2.2 M&P resources deployed in BMRCL are given in [Annexure-12](#).

6.2.3 There were initial cases of wheel flat in BMRCL. Thereafter, BMRCL resorted to mill scale grinding of rails (by borrowing grinding machine from DMRC). Rail grinding has helped BMRCL achieving better rail wheel interaction, squeaking noise has reduced, rail profile is better, current collection is better, wheel re-profiling has reduced.

6.3 Hyderabad Metro

6.3.1 As mentioned earlier LTMRHL have appointed an O&M Contractor. A total number of about 1900 staff for the complete project is projected excluding certain outsource activities given below:

- (a) Cleaning of trains and stations
- (b) Security services (Asset Security only as main security is in scope of Govt)
- (c) Maintenance of Lifts, Escalators, depot equipments etc.
- (d) Rail Grinding activities

6.3.2 O&M Organization is projected to comprise the manpower as under:

Group / Division	Total Staff
The Executive Management Team	25
HR Division	30
Financial Division	30
QHSE Division	20
Marketing & Sales Division	50
Operations Division	1500
Maintenance Division	200

The details are available at [Annexure-13](#).

The project is under construction and is likely to commence operation in the year 2015-2016.

6.4 Rapid Metrorail Gurgaon Ltd (RGML)

- 6.4.1** In-house O&M staff strength is approximately 125 including Operation Control Centre.
- 6.4.2** Outsourced O&M personnel will be approximately 200 including all maintenance contracts for assets, security services, ticket vending and cleaning services.

The project is under construction and is likely to commence operation in the year 2013-2014.

7.0 OPERATION AND MAINTENANCE (O&M) COST

7.1 Delhi Metro

7.1.1 The O&M cost of DMRC for various lines over the last 5 years is as under:

SN	Year	(Rs In Lakh)				
		Network Size (km)	Total O&M Cost	Total O&M Revenue	O&M Cost / RKM	O&M Revenue/RKM
1	2007-08	65.10	20035.44	31701	307.76	486.96
2	2008-09	74.56	22807.27	39287	305.89	526.92
3	2009-10	95.80	28898.64	52720	301.66	550.31
4	2010-11	160.87*	48890.63	93865	303.91	583.48
5	2011-12	166.76*	62784.90	128157	376.50	768.51

* Excluding Airport Express Line.

7.1.2 The breakup of cost into various activities is as under:

S N	Cost head	O&M Cost (Rs in Lakh)				
		2007-08	2008-09	2009-10	2010-11	2011-12
1	Staff Cost	8877.04 (44%)	8666.21 (38%)	11748.88 (41%)	21573.83 (44%)	26038.65 (41%)
2	Energy Cost	4893.21 (25%)	6731.47 (30%)	7779.94 (27%)	13439.85 (28%)	20632.97 (33%)
3	Maintenance cost (excluding Store consumed)	3032.92 (15%)	3799.37 (16%)	4316.91 (15%)	6754.47 (14%)	8231.32 (13%)
4	Store consumed	961.97 (5%)	1159.95 (5%)		2690.75 (5%)	3047.17 (5%)
5	Others	2270.3 (11%)	2450.27 (11%)	5052.91 (17%)	4431.73 (9%)	4834.79 (8%)
	Total	20035.44	22807.27	28898.64	48890.63	62784.90

DMRC confirmed that out of total energy, 54-56% is on account of traction and remaining on account of auxiliary systems. This is based on the actual data of past 5 years.

7.2 Bangalore Metro

7.2.1 BMRCL commenced commercial services on Reach 1 (about 6.7km) on 20th October, 2011. The O&M cost detailed breakup is as under:

SN	Year	(Rs In Lakh)				
		Network Size (km)	Total O&M Cost	Total O&M Revenue	O&M Cost / RKM	O&M Revenue/RKM
1	2011-12(Oct-Mar)	6.7	1092	1102	363	366
2	2012-13(Apr-Oct12)	6.7	1355	773	345	197

SN	Cost head	O&M Cost (Rs Lakh)	
		2011-12 (Oct– Mar)	2012-13 (April - Oct)
1	Staff Cost	482.9(44%)	521.04(39%)
2	Energy Cost	264.96(24%)	279.88(21%)
3	Outsourced Agency	254.13(24%)	417.78(30%)
3	Miscellaneous	90.35(8%)	135.83(10%)
4	Spares cost	-	-
	Total	1092.34	1354.53

BMRCL energy consumption presently is 43% on account of traction and remaining 57% on account of auxillary systems.

7.3 Rapid Metrorail Gurgaon Ltd (RGML)

O&M cost/km for RMGL may not be a representative sample in comparison to other large Metros. RMGL will be ready for service in 2013-2014. O&M costs can be substantiated with real figures only after certain years of service.

7.4 Hyderabad Metro (LTMRHL)

The cost details for the Operation & Maintenance contract are not available; however LTHMRL has stated that it is estimated to be approx.Rs 4 Cr/RKM / annum.

7.5 Foreign Metros

NOVA/CoMET has following KPIs for operating cost

1. Operating cost per passenger journey
2. Operating cost per passenger kilometer
3. Fare revenue per passenger journey
4. Fare revenue per passenger kilometer

DMRC has the least operating cost per passenger journey/ passenger kilometer compared to other 29 metros (at 2011 prices US \$ PPP) who are member of NOVA/CoMET. DMRCs operating cost per passenger journey is 0.5 US\$ & the maximum is 2.4US \$ for London Metro. Similarly operating cost per kilometer for Delhi is 0.03 US \$ and the maximum is 0.3 US \$for London Metro

8.0 OUTSOURCING COMPLETE O&M SERVICES—EXPERIENCE

8.1 Background

8.1.1 A Metro Railway system in India had appointed an International Finance Advisory (IFA) as Consultant to prepare the Transaction Structure report to evolve the strategy for outsourcing the Operation and Maintenance service and preparation of Request for Proposals (Bid Documents) for inviting the International Bids. As per the Transaction Structure Report and RFP documents prepared by IFA, global bids were invited to provide Operation & Maintenance services for the Metro Rail System. The objective of selecting an O&M service provider was to establish the most efficient and effective operation & maintenance of the Metro Rail System and bring to bear international best practices and value for money in the provision of O&M services.

8.1.2 The duration of O&M service period was fixed as detailed below:

a.	Pre-operation period	15 months
b.	Stage 1 Operation Period (10.61 km)	10 months
c.	Stage 1a Operation Period, including Stage 1 (18.3km)	7 months
d.	Phase-I Full Operation Period (43.6km)	5 years

8.2 Scope of O&M Services

8.2.1 The scope of O&M services in pre-operation phase, operation period for stage-wise & full section length is given in [Annexure-14](#)

8.3 Key Performance Indicators (KPIs)

8.3.1 Key Performance Indicators (KPI) was prescribed as per international norms. Bonus points and Penalty points were assigned in respect of achievements and failure to achieve the key performance indicators. The methodology for measurement of these KPI's was also stipulated in the documents. The KPI's are detailed in [Annexure-15](#)

8.4 Bidding Process and Evaluation

8.4.1 Pre-bid meeting was held by the Concessionaire and their advisor viz. International Finance Advisor (IFA) also attended. A large number of queries (900) were raised by the bidders and these were replied and consequently where modifications of the bid documents were required, addenda were issued. Finally three global bids were received from the reputed international companies. The technical package was opened and evaluated by the Concessionaire with the assistance of their advisor. All the three bids passed the technical evaluation criteria and financial bids of all the three were opened and evaluated by IFA.

8.4.2 In accordance with the RFP the Financial Proposals need to:

- Comply with the formatting of Financial Annexure of RFP.
- Comply with the requirement in clause xx of the IFB of the RFP that the Bidders total pre-operation fee shall not exceed 10% of its total service fee.
- Comply with the percentage requirements for the lump-sum fees proposed during pre-operation periods in the RFP.
- Comply with the requirements that total rate per train kilometer (TRTKm) for any operations period in RFP shall not exceed the range of + 25% over/under the average TRTKm.

One of the bids was disqualified due to non-fulfillment of RFP requirements and remaining two bids after arithmetic correction were found to meet all the RFP requirements and the approximate cost quoted were L1-Rs.1500 Crores approx., L2- approx 25 percentage higher than L1. The IFA recommended to the Concessionaire for acceptance of the lowest bid.

8.4.3 Methodology employed for justifying the acceptance of the lowest quoted bid;

Public Sector Comparator (PSC) and Value for Money Methodology (VFM)
Value for money (VFM) is a methodology developed originally by the UK government to answer the following questions:

- How much will it cost government to run a project as a public project verses doing it as a PPP?
- The answer to this question (i.e. the difference in costs between the two approaches) is the VFM realized by government in going with a particular approach.

- Under PSC/VFM methodology ‘value’ created through transferring risks to O&M Operator are added to ‘Public O&M’ cost estimate.
- Principle is risks are ‘included’ in price of O&M bids through risk premium. Value of Risk Transfer Added to Public O&M cost estimate to allow for accurate comparison of ‘true cost’ of public O&M with bids.

8.4.4 Public Sector Comparator (PSC) cost was estimated Rs.1591 Crores in July 2011 by IFA. Some assumptions used by IFA to prepare the PSC in July 2011 of INR Rs. 1591 Crores were adjusted in the course of finalizing the structure. This would result in a net reduction of the July 2011 PSC by 5 percent (-80 Crores) and adjusted IFA/PSC of INR 1511 Crores in July 2012. The lowest bid was also around the same price. The evaluation report concluded as under:

- The Competitive bidding process for the Metro Rail System O&M contract resulted in two of the three bids being almost in price (INR Cr 1,507 vs. INR Cr 1,514).
- IFA’s view based on hundreds of PPP tenders is that this provides very strong evidence that the market price for the Chennai Metro O&M Contract is around INR cr1, 500.
- There was very strong competition amongst the three bidders for this contract as they are all trying to establish or bolster their presence in the Indian market for metro O&M services.
- IFA believes there was significant pressure on each of the bidders to present the most competitive financial offer possible.
- In IFA’s view the Concessionaire has received the best possible price from the tender for this contract.

8.4.5 Concessionaire’s Tender Cost Estimate;

- The Concessionaire’s tendering approach involves the preparation of a cost estimate to assist it in assessing the financial results of the tendering process.
- The Concessionaire has prepared a cost estimate for the Metro Rail System O&M services tender as a comparative benchmark estimate: INR Cr 1,127.
- It is an estimate of O&M cost for a publicly run metro, and has been based primarily on information from the Delhi and Bangalore metros.

8.4.6 Converting the Concessionaire's cost estimate into a Public Sector Comparator (PSC)

- To accurately compare the Concessionaire's cost estimate with the Financial proposals received for the Metro Rail System O&M Contract tender, the Concessionaire estimate should be adjusted using the methodology for developing a PSC, namely:
 - Appropriate costing of all the risks that are transferred to the Operator under the O&M contract and inclusion within the PSC.
 - Application of competitive neutrality principle with regards to tax.
 - Then a VFM calculation can be made to determine if the private approach yields value for Concessionaire.
- I. Adjustments were applied to the Concessionaire's O&M Cost estimate of Rs. 1127 Cr for KPI risks, Electricity risks, Pre-operation cost risks, O&M cost risks and Inflation risks as per details given below.
- II. Risk allowance summary**

Elements	Details	INR in Cr
Pre-operation period		103.4
Operations Period		1023.6
Concessionaire Base O&M Cost Estimate (DMRC and BMRCL experience as the basis)		1127.0
IFA recommended risk allowances		
KPI risk	5% of 1024 Cr	+51.2
Electricity Risk	60% of 234 Cr	+140.4
Extended pre-operation risk	50% of 103.39 Cr	+51.7
O&M cost overrun risk	10% of 790	+79.0
Inflation risk	See table	+59.2
Revised Concessionaire PSC		1508.5

The details regarding valuation of various risks is provided in [Annexure-16](#)

8.4.7 Since the lowest bid was found near the revised Metro Rail System PSC, the bid was recommended for acceptance by IFA.

8.5 Decision Making

8.5.1 The Board of Directors of Metro Rail System appointed a sub-committee of Directors to analyze the key findings presented by IFA and to submit their recommendation on the following:

- (a) Vetting of Public Comparator Cost with reference to IFA's recommendation on various risk adjustments.
- (b) Compare DPR O&M Cost with reference to the L1 price.
- (c) Financial viability considering fare box and non-fare box revenue.

8.5.2 The sub-committee of Board after examination presented the following findings.

- (a) Base Public Sector Comparator Cost.

The staff cost, non-traction energy consumption in station and depot and maintenance logistic costs were reviewed and pruned down taking into account experience of DMRCL & BMRCL. The risk adjustment allowances (estimated by IFA) as given in the previous paras were also rationalized. The updated public sector comparator cost was pegged at Rs.1293.95 Cr.

- (b) DPR O&M Cost comparison

DPR O&M cost was estimated 6 years ago when full experience and data on O&M was not available in DMRC. The DPR O&M cost was found to be on the higher side. This was also normalized taking into account past 6 years' experience.

- (c) Financial Viability Analysis

The financial viability analysis of revenues and expenditure considering the O&M expenditure, Fare box and non-fare box revenue were carried out applying various scenarios viz: PSC cost (Rs.1293.95 Cr.), DPR cost (Rs.1547 Cr), outsourcing cost as per the lowest bid taking into account traction energy and taxes etc. (Rs.1740 Cr).

- (d) On comparing the above, the outsourcing cost (lowest bid) was found to be about 34% higher than the updated PSC cost and about 12% higher than the DPR O&M cost.

- (e) Legal Responsibilities of Metro.

- The Concessionaire is presently classified as Metro Railway Administration in terms of Metro Railways Amendment Act 2009. For the purpose of Operation & Maintenance, the organization to which the Concessionaire outsource Operation and Maintenance under a contract agreement need to be classified as metro railway administration. This can be done by MOUD/GOI.

- The responsibility for getting the constructed system certified fit for safe carriage of passengers from CMRS rest with the Concessionaire. As per the current practice and rules the agency to whom operations and maintenance is outsourced cannot approach directly CMRS for safety certification process.
- The operating and maintaining staff either employed by the Concessionaire or O&M Service contractor, being part of certification process can be given competency certificate by the Concessionaire only. As per the past experience CMRS did not accept competency certification of drivers and other personal by DAMEL in case of Delhi Airport line. This can be perhaps handled by setting up an accredited training institute authorized to train and issue competency certificate to O&M personal of belonging to the Concessionaire or O&M service contractor. The competency certificate issued by accredited institute should be acceptable to CMRS.
- For any accident/unsafe operations due to fault of personal, the responsibility and liability rest with the O&M service contractor as per the conditions of contract agreement between the Concessionaire& Contractor. However, the owner will be held responsible to CMRS as well as other government authorities in respect of all safety related issues.
- Apart from the above there were certain more legal complications in the financial bids having different interpretations and opinions from legal experts.

8.5.3 The Board of Directors of Metro Rail System have decided to discharge this tender. And it is learnt that Metro Rail Authority is planning to take up O&M activity on the lines of Delhi Metro and Bangalore Metro.

F.No.K-14011/26/2012-MRTS/Coord
Government of India
Ministry of Urban Development
(MRTS CELL)

Room No.311, 'B' Wing, Nirman Bhawan,
New Delhi-110108, the 25th July, 2012

ORDER

Subject: Constitution of Sub-Committee on Standardization, etc.

The undersigned is directed to say that with a view to promote the domestic manufacturing for Metro Systems and formation of standards for such systems in India, this Ministry has constituted a Group for preparing a Base paper on Standardization and Indigenization of Metro Railway Systems vide Order of even number dated 30th May, 2012 (copy enclosed).

2. The Group has identified certain issues which require detailed deliberations / review, cost benefit analysis / study. The Group has suggested that to have examined / studied these issues, Sub-Committees may be constituted consisting of officers / professionals drawn from relevant field / profession from Ministry of Urban Development / Railways / Metros and industries associated with rail based systems / Metro Railway Systems.

3. Accordingly, it has been decided to constitute the Sub-Committee on Standardization, etc. The issues which are to be examined/studied under Standardization, etc. by the Sub-Committee, Terms of Reference and Members of the Sub-Committee are given below:-

Issues	Terms of Reference	Members of Sub-Committee
<ul style="list-style-type: none"> ➤ Standardization of maintenance practices of metro infrastructure, systems and rolling stock ➤ Identification of sub-systems/components items for sustainable operation & maintenance (over and above the list already identified by DMRC/BMRCL) 	<ul style="list-style-type: none"> Study of the maintenance and operating practices adopted by DMRC, BMRCL and Kolkata Metro - Study of the maintenance and operating practices adopted by metros outside India - Study of currently imported spares / consumables which can be considered for indigenization - Detailed study of manpower, M&P, resources deployed by DMRC / BMRCL for different systems and civil infrastructure maintenance - Report of study, analysis and recommendations duly suggesting standardization / benchmarking of maintenance practices 	<p>Shri D.D. Pahuja, Director (Rolling stock & signalling), BMRC – Convener</p> <p>Shri Prakash Singh, Director(MRTS), MoUD</p> <p>Shri Deen Dayal, US (MRTS) Coord, MoUD</p> <p>Shri Salabh Tyagi, Director (PE), RDSO, Lucknow</p> <p>Shri Sujit Mishra, Director (TI), RDSO, Lucknow</p> <p>Director/Signalling - RDSO, Lucknow</p> <p>Director/Track/Bridge – RDSO, Lucknow</p> <p>One officer to be nominated by MD/DMRC</p> <p>Shri Anil Jangid (Professional already associated with Committee preparing the Base Paper)</p> <p>Representative from associated Industry to be nominated by FICCI/CII/ASSOCHAM</p>

(3)

4. FICCI / CII / ASSOCHAM will nominate representative only from those Industries who are having long association with Design / manufacture of Rail Based rolling stocks with three phase drive (propulsions), systems/ sub systems infrastructures i.e. IGBT based propulsions/signalling systems/Third rail/overhead electric traction/AFC-ticketing and Power supply system specially used in Metro Railways.

5. The above Sub-Committee to review /study the issues related to standardization of maintenance practices for items required for sustainable operation and maintenance of infrastructure, systems and Rolling Stock on different Metro Railways has been constituted beyond ToR of the Base paper and will be required to work accordingly.

6. The Sub-Committee shall submit its Report within one month (by 21.8.2012) to Secretary (UD), Ministry of Urban Development from the date of issue of this Order.



25/7/12

(Deen Dayal)

Under Secretary to the Govt. of India

Tel. 23062935 / Fax. 23062594

E-mail: deen.dayal69@nic.in

(M) 9810 871851

To

All the Members of the Group.

Copy for information and necessary action to:-

1. Chairman, Railway Board, Ministry of Railways, Rail Bhavan, New Delhi.
2. Director General, Research Development & Standards Organization (RDSO), Manaknagar, Lucknow-226011.
3. Managing Director, Delhi Metro Rail Corporation Ltd., Metro Bhawan, Fire Brigade Lane, Barakhamba Road, New Delhi-110001 with the request to nominate one officer from DMRC.

4. Secretary, FICCI, Federation House, Tansen Marg, New Delhi 110001.
5. Secretary, Confederation of Indian Industry (CII), 23, Vardman Marg, Institutional Area, Lodi Colony, New Delhi, Delhi 110003
6. Secretary, Associated Chambers of Commerce and Industry of India (ASSOCHAM) Corporate Office, 1, Community Centre Zamrudpur, Kailash Colony, New Delhi – 110 048.
7. Shri I. C. Sharma, National Project Manager, Project Management Unit, Sustainable Urban Transport Project (SUTP), Ministry of Urban Development, Nirman Bhawan, New Delhi.
8. Smt. R. Dharini, Deputy Chief, Ministry of Commerce and Industry, Department of Industrial Policy & Promotion, National Manufacturing Competitiveness Council, Vigyan Bhawan Annexe, New Delhi

Copy also to for information:-

1. PS to UDM
2. Sr. PPS to Secretary (UD)
3. OSD(UT) & E.O. Joint Secretary
4. Director (UT)
5. Director (MRTS-I)
6. Advisory to OSD (UT)
7. US (MRTS-I) / US (MRTS-II) / US (MRTS-III) / US (MRTS-IV)


(Deen Dayal)
Under Secretary to the Govt. of India

Immediate

F.No.K-14011/26/2012-MRTS/Coord.

Government of India

Ministry of Urban Development
(MRTS CELL)Room No.311, 'B' wing Nirma Bhawan
New Delhi-110108, the 16th September 2012**OFFICE MEMORANDUM**

Sub: Constitution of subcommittee for study of operation and maintenances practices on various metro systems in India and abroad.

1. The undersigned is directed to refer this ministry's order of even No. dated 25.07.2012 on the subject mentioned above and to say that various activities for this study have been identified and Sri. D D Pauja Director (RSE) Bangalore Metro Rail Corporation Ltd has been nominated as the convener of the sub-committee.
2. In this connection a base paper is required to be prepared on each reference item to begin with by the members of the sub-committee. Convener of the sub-committee has nominated the following officers for different items as indicated below :

Sl.No	Item description	Nominated officer/consultant
1 1.1	Study of maintenance practices adopted by DMRC, BMRCL and Kolkatta Metro. <ul style="list-style-type: none"> a. Philosophy of maintenance i.e. in house or outsourced or mixed. b. Extent of outsourcing. c. Comparison of maintenance periodicity /schedule for Rolling Stock, Traction Power Supply/ Distribution System, Signalling/Telecom System, AFC System, Track and Civil Structure. d. Down time for various maintenance schedules and man hours required. 	<ul style="list-style-type: none"> i. Sh.Sudhir Chiplunkar, GM (M), BMRCL to collect details of Bangalore Metro. ii. Sh.S.K.Sinha, GM(HR), DMRC to collect details for Delhi Metro. iii. Sh.Salabh Tyagi, Director (PE), RDSO, Sh.Alok Katiyar, Director(Signalling) and Director(Track/Bridge)/RDSO, Lucknow to collect similar details from Kolkata Metro.
	Study of Operating practices adopted by DMRC, BMRCL and Kolkatta Metro. <ul style="list-style-type: none"> a. Philosophy of Operation i.e. in house or outsourced. b. Pre-operation Activities - Governing Act and laid down rules issued by Central Government. c. Minimum qualification, training schedule and competency procedures for staff dealing with train operations and maintenance. d. Operating procedures- SWRs, Depot Operating Procedure, Operation Manual, Safety Instructions etc. e. Business Rules, Ticketing system and fare 	<ul style="list-style-type: none"> i. Sh.S.S.Hegaradi, GM (O), BMRCL to collect details for BMRCL ii. Sh.S.K.Sinha, GM(HR), DMRC to collect details for Delhi Metro. iii. Sh.Salabh Tyagi, Director(PE), RDSO, Sh.Alok Katiyar, Director(Signalling) and Director(Track/Bridge)/RDSO, Lucknow to collect similar details from Kolkata Metro.

		structure f. Safety Case Presentation. g. Security of the systems.	
2		Study of maintenance and operating practices adopted by Metros outside India.	i. Sh.Prakash Singh, Director(MRTS), MoUD, ii. Sh.Deen Dayal, US(MRTS), Coord, MoUD, iii. Sh.Anil Jangid, Professional Consultant iv. Sh.Anil Kumar, Head (System), L&T/Hyderabad Metro.
3		Study of currently imported spares /consumables which can be considered for indigenization.	
	3.1	a. Rolling Stock/Traction/ Gen power supply / tunnel ventilation/Signalling & Telecom/AFC/Track for BMRCL	i. Sh.Sudhir Chiplunkar, GM(M)/BMRCL, ii. Nominees from FICCI/CII/ASSOCHAM
	3.2	b. Rolling Stock/Traction/ Gen power supply / tunnel ventilation/Signalling & Telecom/AFC/Track for DMRC	i. Sh.S.K.Sinha, GM(HR), DMRC ii. Nominees from FICCI/CII/ASSOCHAM
	3.3	c. Rolling Stock/Traction/ Gen power supply / tunnel ventilation/Signalling & Telecom/AFC/Track for Kolkata Metro.	i. Sh.Sujeet Mishra, Director(PSI)/RDSO, Lucknow, ii. Sh.Alok Katiyar, Director(Signalling)/RDSO, Lucknow and Director(Track/ Bridge)/RDSO, Lucknow. Nominees from FICCI/CII/ ASSOCHAM
4		Study of manpower, M&P, resources deployed by DMRC/ BMRCL for different systems and civil infrastructure maintenance.	
	4.1	BMRCL	Sh.Sudhir Chiplunkar, GM(M), BMRCL
	4.2	DMRCL	Sh.S.K.Sinha, GM(HR), DMRC.
	4.3	Kolkata Metro a. Traction/ Gen power supply /tunnel ventilation. b. Rolling Stock c. Signalling/ Telecom/AFC Systems d. Trackwork/tunnel/bridge	Sh.Sujeet Mishra, Director (TI), RDSO, Lucknow, Sh. Shlabh Tyagi, Director (PE), RDSO. Sh.Alok Katiyar, Director(Signalling), RDSO, Lucknow, Director/Track/Bridge RDSO, Lucknow.

5	<p>Report of study analysis and recommendations duly suggesting standardization/benchmarking of maintenance practices</p>	<ul style="list-style-type: none"> i. Sh. Sudhir Chiplunkar, GM(M), BMRCL to take the lead. ii. Sh.Sujeet Mishra, Director(PI)/RDSO, Lucknow. iii. Sh.Anil Kumar, head (System), L&T/Hyderabad Metro. iv. Mr. Anil Jangid, Professional Consultant.
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A meeting of the above mentioned sub-committee members is proposed to be held on 24th September 2012 at **Baiyappanahalli Depot/BMRCL** at Bangalore. Agenda of the meeting would be as under :

- | | |
|-------------------|---|
| 0.930 to 11.00 am | - Presentation on above topics by BMRCL nominees. |
| 11.15 to 12.15 am | - Presentation on above topics by DMRCL nominees. |
| 12.15 to 1.30 am | - Presentation by RDSO nominees for Kolkata Metro. |
| 1.30 to 2.30 pm | - Lunch Break |
| 2.30 to 3.30 pm | - Presentation by Shri.Anil Jangid, Professional Consultant and Shri.Anil Kumar, Head(System), L&T/Hyderabad Metro. |
| 3.30 to 5.00 pm | - Discussions and conclusion of the meeting. |

The concerned sub-committee members are requested to study and prepare the base paper as per the topics assigned above and may circulate the base paper amongst the members on E-mail.

(DEEN DAYAL)
Under Secretary to the Gov. Of India.
(E-mail:deen.dayal69@nic.in)

Copy To.

- 1) Shri.S.K.Lohia, Director(MRTS), Ministry of Urban Development, Nirman Bhavan, New-Delhi (E-mail id: sklohia65@gmail.com)
- 2) Shri Prakash Singh, Director (MRTS), Ministry of Urban Development, Nirman Bhavan, New-Delhi (E-mail id:)
- 3) I.C.Sharma,National Project Manager, PMU(SUTP), Nirman Bhavan, New-Delhi (E-mail id: ichandresharma@gmail.com)
- 4) Shri D.D. Pahuja, Director (RSE), Bangalore Metro Rail Corporation Ltd, Bangalore, 3rd Floor, BMTC Complex, Shanthinagar, Bangalore – 560027 (E-mail id: pahuja@bmrc.co.in)

- 5) Shri. Sudhir Chiplunkar, GM(M), BMRCL, Baiyappanahalli Depot, 3rd Floor, BMTC Complex, Shanthinagar, Bangalore – 560027 (E-mail.id: Sudhir_vc@bmrc.co.in)
- 6) Shri. S.S.Hegaraddi, GM(O), BMRCL, Baiyappanahalli Depot, 3rd Floor, BMTC Complex, Shanthinagar, Bangalore – 560027 (E-mail.id: hegaraadi@bmrc.co.in)
- 7) Shri Sujit Mishra, Director (TI), RDSO, Manaknagar, Lucknow - 226011 (E-mail id: mishrasujeet@ieee.org)
- 8) Shri. Salabh Tyagi, Director (PE). RDSO, Manaknagar, Lucknow - 226011 (E-mail id: dir.pemetro@gmail.com).
- 9) Shri. Alok Katiyar, Director(Signalling), RDSO, Manaknagar, Lucknow - 226011 (E-mail id:)
- 10) Director(Track/Bridge), RDSO, Manaknagar, Lucknow – 226011.
- 11) Shri Anil Jangid, 301, ONYXE Tower, Sector-21C, Faridabad-121002 (E-mail id: aniljngd@gmail.com)
- 12) Shri.Anil Kumar Saini, System Head, Hyderabad Metro Rail Ltd., Metro Rail Bhawan, Safiabad, Hyderabad – 500004.
- 13) Secretary, FICCI, Federation House, Tansen Marg, New-Delhi-110001.
- 14) Secretary, Confederation of Indian Industry (CII), 23, Vardman Marg Institutional Area, Lodi Colony, New-Delhi, Delhi – 110003.
- 15) Secretary, Associated Chambers of Commerce and Industry of India (ASSOCHAM)
Corporate Office, 1, Community Centre Zamrudpur, Kailas Colony, New-Delhi-110 048.

ANNEXURE-3A

**Maintenance Schedule, Downtime and Man hours for Rolling Stock adopted at
DMRC**

SINo	ACTIVITY	INTERVAL	Manpower Requirement for 4 Car Train		
			Downtime	Required Manpower	Required Man-Hour
1	Daily Check	-	30 Min	02	01
2	A Service Check	5,000 km, (15days)	02 Hrs	04	08
3	B1 Service Check	15,000 km, (45days)	08 Hrs	07	56
4	B2 Service Check	30,000 km, (90days)	Same as B-1Check		
5	B4 Service Check	60,000 km, (180days)	08 Hrs	12	96
6	B8 Service Check	120,000 km, (360 days)	16 Hrs	13	208
7	B16 Service Check-	240,000 km, (720 days)	Same as B-8 Check		
8	C1 Overhaul	420,000 km, (3.5years)	-	-	3096
9	C2 Overhaul	840,000 km, (7.0years)	-	-	7910
10	C3 Overhaul	1,560,000 km, (10.5 years)	-	-	
11	C5 Overhaul	2,250,000 km (15years)	-	-	
12	Daily Internal Cleaning (turn-around in platform)	Every turn around	Activity not performed		
13	Daily Internal Cleaning (SBL)	Daily	1	1	1
14	Internal light Cleaning	Weekly	-	-	-
15	Monthly Heavy Cleaning (Exterior & Interior + Roof Cleaning)	Monthly	6	8	48
16	External Washing (window cleaning)	Daily(AWP)	2	2	4
17	Pest and Rodent Control	Bi-monthly	01 Hrs	02	02
18	Air duct cleaning	Half yearly	-	-	-

ANNEXURE-3A

Study of Operation & Maintenance practices adopted at DMRC

SI No	ACTIVITY	INTERVAL	Manpower Requirement for 4 Car Train		
			Downtime	Required Manpower	Required Man-Hour
1	Daily Check	-	30 Min	02	01
2	A Service Check	5,000 km, (15days)	02 Hrs	04	08
3	B1 Service Check	15,000 km, (45days)	08 Hrs	07	56
4	B2 Service Check	30,000 km, (90days)	Same as B-1Check		
5	B4 Service Check	60,000 km, (180days)	08 Hrs	12	96
6	B8 Service Check	120,000 km, (360 days)	16 Hrs	13	208
7	B16 Service Check-	240,000 km, (720 days)	Same as B-8 Check		
8	C1 Overhaul	420,000 km, (3.5years)	-	-	3096
9	C2 Overhaul	840,000 km, (7.0years)	-	-	7910
10	C3 Overhaul	1,560,000 km, (10.5 years)	-	-	
11	C5 Overhaul	2,250,000 km (15years)	-	-	
12	LRU Replacement	-	-	-	
13	CM operations (including defect identification, replacement for defective LRUs and restoration to service condition) that do not require car lifting		04 Hrs	02	08
14	CM operations (including defect identification, replacement for defective LRUs and restoration to service condition) that require car lifting		08 Hrs	06	48
15	Daily Internal Cleaning (turn around in platform)	Every turn around	Activity not performed		

16	Daily Internal Cleaning (SBL)	Daily	1	1	1
17	Internal light Cleaning	Weekly	-	-	-
18	Monthly Heavy Cleaning (Exterior & Interior + Roof Cleaning)	Monthly	6	8	48
19	External Washing (window cleaning)	Daily(AWP)	2	2	4
20	Pest and Rodent Control	Bi-monthly	01 Hrs	02	02
21	Air duct cleaning	Half yearly	-	-	-

ANNEXURE-3B

Maintenance schedule Down time and manpower for traction power supply/distribution system adopted at DMRC

SL no	AC traction system	Inspection to be done with interval	Maintenance schedule (Interval)					Down time in hour	Required man power
			weekly	Monthly	quarterly	half yearly	yearly		
OVER HEAD EQUIPMENT									
1	Foot Patrolling			yes				4	2
2	Section Insulator (Non polluted zone)	Routine inspection		yes				0.2	2
		Cleaning and checking			yes			0.75	4
3	Section Insulator (polluted zone)	Routine inspection		yes				0.2	2
		Cleaning and checking		yes				0.75	4
4	Current Collection	Routine inspection			yes			4	6
5	Gas ATD Make : Brecknell Willis	Routine inspection		yes				0.2	2
		checking and adjustment					yes	1	6
6	Counter Weight ATD Make : Galland	Routine inspection			yes			0.2	2
		checking and adjustment				yes		0.5	6
7	Cross Over / Turn outs	checking and adjustment				yes		0.5	5
8	Overlaps	checking and adjustment					yes	0.5	5
9	Isolator	checking and adjustment				yes		2	6
10	Cantilevers (Via duct)	checking and adjustment					yes	0.5	6

11	Cantilevers (at grade)	checking and adjustment					yes		0.5	6
12	Cleaning of ST and BT insulators of polluted zones	Cleaning and checking				yes			0.25	6
13	Contact Wire Dia	Checking					yes		0.25	6
14	Tree trimming	trimming				sea son al			0.3	6
15	Kite, Thread / Bird nest removal					sea son al			0.3	4
16	Neutral Section	checking and adjustment	yes						1.5	6
17	Bond & Earthing Connection						yes		0.3	2
18	Mast for graded section	inspection					yes		0.1	2

POWER SUPPLY AND INSTALLATION

SL no	AC traction system	Inspectio n to be done with interval	Maintenance schedule (Interval)					Do wn tim e in hou rs	Required man power	
			weekly	Monthly	quarterly	half yearly	yearly			
1	Power transformer (AT & TT)	checking and cleaning			yes				2.5	5
2	CT/CVT/PT at RSS	checking and cleaning				yes			1	4
		testing and cleaning					yes		24	
3	Isolator	checking and cleaning			yes				1	4
		testing and cleaning				yes			2	4
4	LA	checking and cleaning			yes				0.25	4
		testing and			yes				0.5	4

		cleaning							
5	SF6/vacuum CBs	checking and cleaning		yes				2	4
		testing and cleaning			yes			3	4
6	Control panels at RSS	checking and cleaning		yes				2	4
7	ASS cleaning	checking and cleaning	yes					3	4
8	33 KV CB	checking and cleaning		yes				2	4
		testing and cleaning			yes			3	4
9	Dry type transformer	checking and cleaning		yes				2	4
10	Battery charger and battery bank	checking and cleaning		yes				2	2
11	AC DB and DC DB maintenance at RSS and ASS	checking and cleaning		yes				1	2
12	Earth resistance measurement	Measurement				yes		0.5	3

ANNEXURE-3C

Maintenance schedule, Down time and Man power for Track adopted at DMRC

Sl. No	Activity	Periodicity	Down Time in Hrs	Required Manpower (JE+TM/TN)	Total time required per year (in Hrs)	Remarks
1	Point & Crossing Inspection (Ballastless track)	Half yearly	2	1+4	296	$74*2*2=296$
2	Point & Crossing Inspection (Ballasted track)	Quarterly	2	1+4	120	$15*2*4=120$
3	Point & Crossing Inspection (Ballasted track in depot)	Yearly	2	1+4	290	$145*2*1=290$
4	Curve Inspection (up to 30 Stations) for Ballasted track	Quarterly	4	1+4	64	$4*4*4=64$
5	Curve Inspection (up to 30 Stations) for Ballastless track	Half yearly	4	1+4	880	$110*4*2=880$
6	Joint Inspection with S&T	Half yearly	1	1+2	178	$89*1*2=178$
7	Foot Inspection	Monthly	50	1+1	600	$12*50=600$
8	Cab Inspection	Weekly	4	1 + 0	208	$52*4=208$
9	Track Patrolling (Main line)	Whole Beat	50	0 + 2	2600	$52*50=2600$
10	Track Patrolling (Ballasted-Depot)	Daily	6	0 + 4	2190	$365*6=2190$
11	USFD Testing (Rails and welds)	Yearly	300	1+4	300	$1*300=300$
12	PC based OMS	Once in 2 months	20	1 + 2	120	$6*20=120$

	Recording					
13	Inspection and Maintenance of Buffer Stops	Yearly	3	1+4	279	93*3=279
14	Measurement of Toe Load(per 30mtrs)	Yearly	1	1+3	834	834*1=834
15	Measurement of Rail wear(up to 30 Stations) for Ballasted track	Half yearly	4	0 + 1	880	110*4*2=880
16	Measurement of creep	Monthly	Done along with Foot inspection			
17	Inspection and Maintenance of Fastenings and Fittings	Weekly	Done along with Track Patrolling			
18	Maintenance of Ballasted Track by TTM	Once in 2 yrs.	As per requirement - 1+20 staff for 4 hrs. daily		NA	NA
19	Greasing of ERC clips (30 clips/man/day)	Once in 3 Year	5	0 + 5	23334	70,000/3
20	Greasing of outer Rails on curves	once in 5 days	3	0 + 2	4161	19*3*73=4161
21	Preventive and need based Rail grinding for operation of RGM	Yearly	6	1+2	1152	192*6=1152
22	Attention of drainage pipes on viaduct / via-duct cleaning	Monthly	3	1 + 1		
23	REJ Inspection	Quarterly	3	1 + 4		
24	Officers Inspection	Weekly	4	1 + 4		
25	Joggled Fish plates Maint.	Quarterly	3	0 + 2		

**Maintenance schedule, Down time and Man power for Signaling Systems
(DMRC)**

S.No.	Details of Maintenance Activity	Schedule
P-1		Fortnightly
1	Checking for Absence of Ballast & Debris	
2	Checking for the control arm in good condition and property secured	
3	Checking for Good Sliding Condition of the Brass Piston	
4	Checking for the Point itself in good Condition	
5	Checking for Proper Operating of the point by Manual Operation	
6	Checking for Proper Operating of the point by Power Operation	
P-2		Monthly
	General	
1	Checking for any Abnormal Appearance of Parts.	
2	Checking for Presence & Condition of Split Pins	
3	Checking for condition & tightening of all screws and bolts	
4	Gauge testing with 2 mm & 5 mm test piece	
5	Measurement of Opening of Switch Blace	
	Maintenance of VCC Clamp Lock:-	
1	Checking for Contract Between the Locking Crank Slide & Plastic Sleeve	
2	Cleaning of all Greased parts of the VCC	
3	Lubrication of the Internal Corridor of the VCC Frame	
4	Lubrication of the Locking Piece	
5	Lubrication of the Stabilization Roller	
6	Lubrication with Motor Oil of the Shaft of the Locking Crank	
7	Checking for Condition & Tightening of Screws of Nuts Fixing the Base Plate	
8	Checking for Condition & Tightening of Screws fixing the Frame on the Base Plate	
9	Checking for Condition & Tightening of Screws fixing the Frame on the Rail Foot	
10	Checking for Condition & Tightening of Bolt fixing the frame on the Rail Web	
11	Checking for Condition & Tightening of Bolts fixing the Locking Crank on the Switch- Blade	
12	Checking for Condition & Tightening of Screws fixing the Plastic Sleeve Support on the Base Plate	
13	Checking for Condition & Tightening of screws fixing wear pad on the Locking Crank Assembly	
14	Checking for Condition & Tightening of Screws fixing the wear plate on the Base Plate	
15	Checking for contact between the Locking Crank slide and Plastic Sleeve	

	Details of Maintenance Activity	Schedule
	Maintenance of VCC Detector-	
1	Checking for Wiring & Contacts in Good Condition	Monthly
2	Oil in each Hole over the Camshafts	
	Maintenance of Drives:-	
1	Removing of the Surplus of Old Grease from all axles	
2	Greasing of all axles	
	Maintenance of MJ 81:-	
1	Checking for Case, Cover & Gear Box Housing in Good Conditions	
2	Checking for Internal Gear Box Components in God Condition	
3	Checking for Crank - Pin/Crown, roller & Lyre in Good condition	
4	Checking for Absence of any Abnormal Oxidation	
5	Checking for incoming Wires Property Secured	Monthly
6	Checking for Electrical Contacts in good Condition	
7	Cleaning inside the MJ 81	
8	Oiling of Gears, Teeth of Crank - Pin Crown & Control Shaft Bearings	
9	Greasing of Internal Part of the Lyre	
P-3		
	Maintenance of Drives	Quarterly
1	Checking for Condition & Tightening of all Fittings & Bolts	
2	Checking for Condition & Tightening of all nuts securing the Forks	
3	Checking of all Rods in Good Condition	
4	Checking for Presence & Condition of All split Pins	
5	Checking for wear on crank pins	
6	Checking for Wear of Insulating Bushes & Washers on Axles	
	Maintenance of VCC Clamp Lock:-	
1	Checking for Wear of the Locking Crank Pad	
2	Checking for Wear of the Locking Piece	Quarterly
3	Checking for Wear of the Locking Crank supporting Shoe (Presence of the Chamfer).	
4	Checking for Wear of the Locking Crank Joint (when gap on shim plates).	
	Maintenance of VCC Detector-	
1	Checking of Finger Working with switch rail Open Condition	Quarterly
2	Checking for the good compression stroke of contact blades of detector	
3	Checking for good sliding stroke of the cam assembly	
	Maintenance of MJ 81:-	
1	Checking for Condition & Tightening of all Fittings & Bolts	Quarterly
2	Measurement of the Manual/Motor establishment Contact Distance	
3	Measurement of the Clearance of the Dog Clutch on Motor Position	
4	Checking for Gap Between Plastic Control Roller & dog Clutch	
MAINTENANCE SCHEDULE FOR SDTC		
S.No	Details of Maintenance Activity	Schedule

T-1	SDTC Maintenance Track Side Activity	Quarterly
	Visual Check:-	
1	Verification of Tuning Unit Box Earthling	
2	Cable Termination on Tuning Unit	
3	CAD Weld Joints	
4	Condition of Glued Joints	
5	Condition of E-Joints	
6	Condition of Rail Clips	
	Shunt Test	
1	Vrx/Freq. (with 0.5 ohm, 0.2 ohm)	
2	Vrx/Freq. (with pre-shunt)	
	Replacement of Filters	
T-2		
	Measurements:-	Normal DOT every Quarter and Reverse DOT every six months
	Outdoors:	
1	I-Rail:	
2	V-Rail:- at TX end Va & Vb	
3	Directionality (Va / Vb)	
4	Q-Factor	
5	V-Rail:- at Rx and Vc & Vd.	
6	Directionally (Vc/Vd)	
	Indoors:	Normal DOT every Quarter and Reverse DOT every six months
1	Input Power Supply (V.AC)	
	Tx Card:-	
1	Tx-50V DC Voltage	
2	Vtx/Freq.	
	Rx Card	Normal DOT every Quarter and Reverse DOT every six months
1	Vix/Freq.	
	RT Card:-	
1	O/P Vdc	Normal DOT every Quarter and Reverse DOT every six months
2	MSR Vdc	
3	20 Khz Vac	
MAINTENANCE SCHEDULE FOR Signal		
S. No.	Details of Maintenance Activity	Schedule
	S-1	Quarterly
1	Cleaning of Aspect Housing & LED Unit.	
2	LED Functioning.	
3	Earthing Verification	
4	Cleaning of STB & SRB Box.	
5	Tightening of all Nuts & Bolts.	
6	Healthiness of all Supports, Brackets & Foundation etc.	
7	Voltage Check in STB	
	ROUTE INDICATORS (RS-1)	Quarterly

1	Breakage of Lens.	
2	Cleaning of Lens & Lamps.	
3	Cleaning of Route indicator Housing	
4	Lamp Functioning. (UECR Test with two Lamps)	

MAINTENANCE SCHEDULE FOR UPS/SMPS

S.No.	Details of Maintenance Activity	Schedule
	C-1	
1	Cleaning of Front Face of CCIP with Dry Cloth	
2	Check Fans are working	
3	Check Proper Working of Push Buttons	
4	Check Proper Operation of Counters	
	C-2	
1	Cleaning of front face of CCIP with Vacuum Cleaner	
2	Cleaning of inside of panel with Vacuum Cleaner	
3	Functioning of Buzzer	
	ESP	
S.No.	Details of Maintenance activity	Schedule
1	ESP Functional Test	Quarterly

MAINTENANCE SCHEDULE FOR UPS/SMPS

S.No.	Details of Maintenance activity	Schedule
	UPS/SMPS Maintenance activity:-	
1	Battery Float Charge Voltage	
2	Battery Charge Current	
3	O/P voltage & O/P current (R, B, Y & freq.) for UPS-1 & UPS-2	
4	Battery Terminals	
5	Checking of loose Connections	
6	Checking of any Leakage from Cells	
7	Average Ambient Temperature	
	Individual Cell Voltage on Float:-	
1	Cleaning of Cells	
2	Individual Cell voltage on Float	
3	Spare Cells Voltage	
	Battery tested on Load:-	
1	Battery voltage before load test & after load test	
2	Battery charge (%) after load test	
3	Charging current after load test	
4	Load during test (L1, L2, and L3 in KVA) for UPS-1 & UPS-2.	
	Cleaning of (PDC, UPS, IDB, SMPS, SCVS & BSC)	
1	PCBs	
	Working Condition of:-	
1	Cable & connectors	
2	Cabinet Doors	
3	Switching between UPS-1, UPS-2 & SCVS	

Maintenance Schedules for various Sub-Systems in Telecommunication adopted at DMRC

SL No	System	Monthly	Quarterly	Half Yearly	Yearly
1	FOTS	Cleaning of Rack & checking of alarms	Power supply (- 48V) checking at SDH equipment.	Checking loss of spare fibers both sides of a station Checking of FMS, jumper cable and connector	BER Testing of redundant cards STM input and output power level with optical power meter Testing of SDH ring Cleaning of equipments at card level
2	RADIO	Cleaning and testing of Zetron sets and antennas at station and, DCC. Checking of alarms	Cleaning and Testing Train radio Units. Checking of GPs antenna	Checking and cleaning of BDA in U/G stations Internal cleaning of Train radio unit and power system	Cleaning and checking all connection of EBTS & Power measurement 'Checking of Antenna and RF cable.
3	TELE PHONE	Checking & cleaning of Rack & Physical verification of IDF & MDF. Underground Emergency Phone Testing	Checking of BRMA. VT-100 Functioning of NMS. Network accessibility	Checking of CPU Switchover. Checking of Call diversity and other facilities	Cleaning of Server, Checking of PFCT, Cleaning of rack at card level disconnecting all units and cables Cable testing
4	PAS	Cleaning of Loudspeakers	Checking of PAS line, loudspeaker , NLDC Testing centrally/locally announcement zone-wise at station	Switching of amplifier by spare one and functioning of gatekeeper	Internal cleaning of amplifiers

5	PIDS	Cleaning external surface of display boards. Checking of LED status	Cleaning of internal portion of PIDS. Performing centrally/locally sending of written messages zone wise.	Cleaning and Testing of MMI	Internal cleaning of PAS/PIDS server
6	CCTV	Cleaning of CCTV rack and Monitors at Platforms	Cleaning of Cameras. Focusing and alignment (if required)	Internal cleaning of CCTV equipment rack. Checking of power supply and SPD	Testing of DVR Optical fiber ring testing
7	CLOCK	Cleaning of rack and clocks at stations		Checking of CLK parameters at station equipment rack and platform	
8	ACCES S	Cleaning of the rack & Checking of alarms	Measurement of -48V and different voltages at cards	Checking Redundancy of DTU and control card	Cleaning of racks at cards level
9	EARTH PIT	Visual inspection of Earth Pits			Earth resistance measurement and Maintenance of earthling Pits
10	NW	Cleaning of the rack & checking all Rack's Alarms		Checking the redundancy of switches and router as well as power supply	Internal cleaning of routers
11	UPS	Load test - Battery Banks & terminals Individual Battery Terminal voltage reading Spare Cell charger O/P voltage reading	Cleaning of Ups cabinets		Interior Cleaning of UPS, SCVS, Isolation Txr cabinets, Battery Banks & terminals. Tightening and checking of cable condition of different terminals of UPS Individual Battery Terminal voltage reading Diagnostic tests available on UPS MMI

12	SMPS	Battery Banks & terminals Individual Battery Terminal voltage reading and load testing	Cleaning of Rack		
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Preventive Maintenance Schedule for AFC System adopted at DMRC

SL No		Monthly (T1)	Quarterly (T2)	Half Yearly (T3)	Yearly (T4)
1	Gate	<p>Emergency Switch Test and Testing of Emergency from SC, Extensive Cleaning and alignment of all modules of Gates, Check any physical damage/ unscrewing of all modules of gate, Functionality test and Alignment/Tightening (if required) of CDS, ADS and Container Replacement, Run All Maintenance Tests, Checking Power Supply or Earthing, Analyzing the Failures of Gates and taking Corrective Action accordingly.</p>			
2	Switch and Router		<p>Cleaning exterior of switches, Router & switch, Router rack, Check data connections, fan status</p>	<p>Internal Cleaning of Switch and Router, Cleaning and checking of Switch rack fan, Check internal fan status of Switch and Router, Check if Switch and Router is working normal and all equipments are on LAN and sending data properly</p>	
3	TR	Check the serviceability, contrast and			

		electrical connection, Check the maximum distance from which the Media is detected.		
4	TVM	Testing & Internal Cleaning of BNA, Check Date & Time of TVM, Check if TVM is on LAN and sending data properly, calibration of screen (if required), Run the maintenance Tests.	Cleaning and checking of all Hoppers, data and power cards, SVT, Check Rear door lock and sensor, Check if TVM has sufficient battery back-up, Check fan status of TVM, CSC antenna functioning & buzzer testing, Check all the cables are properly routed through cable ducts and cable duct covers are in place, Checking of Container Detection Switch (CDS)(Thales) , Check contrast of PID (LCD) & message is OK, Checking of Keyboard with trackball(Thales).Testing & Internal Cleaning of SVT and its internal mechanical assembly, Cleaning & Testing of CHS (Coin Handling System Thales).	
5	TOM	Analyzing the Failures of TOM and taking Corrective Action accordingly	Check Container Detection Switch of TDM/ AFM, Cleaning of Hopper, Checking TDM/ AFM data and power cards and TOM CPU, Check contrast of TOM PID & message is OK, Check whether Receipt Printer is working OK, Check Maintenance Shift Test, Cleaning and Checking Electrical cabinet MCBs & its connections, Check Date & Time of TOM, Check all the cables are properly routed through cable ducts and cable duct covers are in place.	

6	SC			Cleaning of CPU interior & exterior, Cleaning and checking of sub modules of SC (Printer, Keyboard and Mouse etc.), Cleaning of HDD and check their proper fitment, Check if supervision services running.	
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**Preventive Maintenance Schedule for Civil Structure and works adopted at
DMRC**

Sl No	Activity	Periodicity	Down Time	Required Man Power	Remarks
1	Allension of drainage pipes on viaduct	➤ Pre monsoon ➤ Post Monsoon	1 Hrs/ Pier 7 Days/ Pier	• 1+1 • Full Team/ Agency	As per required
2	Pier Inspection Routine	➤ One Year	2 Hours	• 1+2	
3	Detailed inspection of Piers by TMHP	➤ Ones in 5 years	4 Hours	• 2+4	
4	Maintenance of Depot Buildings (1) OBD etc. (2) Leakage/ Drainage (3) Repairs	➤ Once in 3 year ➤ Once Month As per required		• Agency • 2+Agen cy	
5	Maintenance of station Buildings (1) OBD etc. (2) Leakage/ Drainage (3) Repairs	➤ Once in 2 years		• Agency	
6	Truck Mount Hydraulic platform vehicle (TMHP) Maintenance				
7	Land Scaping Maintenance work	➤ Daily Basis	Regular	• Agency	
8	Rolling Shutter Maintenance work (1) O&G (2) Repair	➤ Once in 3 Months ➤ As Required	4 Hours		
9	Viaduct inspection (1) Visual (2) Detail	➤ Once in year ➤ Once in 5 Years			With TMHP
10	Cleaning of Over Head Tank (OHT) (1) Drinking Water (2) Raw Water	➤ Once in Months ➤ Once in 3 Months			
11	Maintenance of parking area at station and Depot (1) Cleaning (2) Repair	➤ Once in Week ➤ As per required			

Maintenance schedule, Down time and Man power for M&P adopted at DMRC

Sl. No.	Equipment	Periodicity	Down time in Hr	Required Man power
1	Electric Bogie Tractor	Weekly	4	1
		Monthly	8	1
		Yearly/12000 hr	8	3
2	Road Cum Rail Vehicle	Daily	1	1
		Weekly	-	-
		Monthly	4	1
		3 Monthly	---	-
		Yearly	8	1
3	Re-railing Equipment	Monthly	4	1
4	CNC Under Floor Wheel Lathe	Weekly	4	1
		Monthly	4	3
		3 Monthly	6	3
		Yearly	16	3
		3 Yearly	---	---
		5 Yearly	-	-
5	Synchronized Pit jacks	Weekly	8	1
		Monthly	-	---
		3 Monthly	6	2
		6 Monthly	-	---
		Yearly	16	4
6	Synchronized Mobile jacks	Weekly	6	2
		Monthly	-	---
		3 Monthly	8	4
		6 Monthly	---	---
		Yearly	16	3
7	EOT crane	Weekly	8	1
		3 Monthly	16	3
8	Bogie turn table	Weekly	—	-
		Monthly	8	3
		Yearly	16	3
9	High Pressure Wash Pump	Weekly	2	1
		Monthly	4	1
		6 Monthly	6	
10	Diesel Fork lift	Weekly	1	1
		Monthly	4	1
		6 Monthly	8	
		Yearly	—	—

11	Electric Fork Lift	Weekly	1	1
		Monthly	4	1
		6 Monthly	8	
		Yearly	—	—
12	Electric Stacker	Weekly	1	1
		Monthly	4	1
		6 Monthly	8	2
		Yearly	8	2
13	Compressor	Weekly	3	1
		Monthly	-	-
		3 Monthly	8	3
		Yearly	16	3
14	Scrubber	Weekly	-	-
		Monthly	6	1
15	Aerial Work lift Platform	Weekly	8	1
		3 Monthly	8	2

Maintenance schedule, Down time and Man power for Lifts Escalators and D.G. Sets Installed in DMRC Stations

LIFTS

SI No	Session	Interval	D/T and Manpower Requirement	
			Down Time	Required Man-hours
1	Daily Check (Dry)	Daily	10Mins	1 Person / Lift
2	Monthly Maintenance	Monthly	4 Hrs	2 Person / Lift
3	Quarterly Maintenance	Quarterly	6 Hrs	2 Person / Lift
4	Half Yearly Maintenance	Half Yearly	8 Hrs	2 Person / Lift
5	Yearly Maintenance	Yearly	8 Hrs	2 Person / Lift

ESCALATORS

SI No	Session	Interval	D/T and Manpower Requirement	
			Down Time	Required Man-hours
1	Daily Check (Dry)	Daily	10Mins	1 Person / Escalator
2	Monthly Maintenance	Monthly	6 Hrs	2 Person / Escalator
3	Quarterly Maintenance	Quarterly	12 Hrs	2 Person / Escalator
4	Half Yearly Maintenance	Half Yearly	14 Hrs	2 Person / Escalator
5	Yearly Maintenance	Yearly	16 Hrs	2 Person / Escalator

D.G.Sets (Elevated Stations)

SI No	Session	Interval	D/T and Manpower Requirement	
			Down Time	Required Man-hours
1	Daily Check (Dry)	Daily	30Mins	1 Person / DG
2	A- Check	Monthly	2 Hrs	1 Person / DG
3	B- Check	Quarterly	8 Hrs	2 Person / DG

**Maintenance Schedule, Down time and Man hours for Rolling Stock adopted at
BMRCL**

Sl No.	Session	Interval	D/T and Manpower Requirements	
			Downtime	Required Man-hours
1	Daily Check		30 mins	2 persons per train
2	A Service Check	6,000 km (15days)	1.5 hours	4 persons per train
3	B1 Service Check	18,000 km (45days)	4 hours	8 persons per train
4	B2 Service Check	36,000 km (90days)	6 hours	8 persons per train
5	B4 Service Check	72,000 km (180days)	12 hours	8 persons per train
6	B8 Service Check	150,000 km (360days)	20 hours	8 persons per train
7	* B16 Service Check	300,000 km (720 days)	28 hours	8 persons per train
8	C1 Overhaul	520,000 km (3.5years)	10 days	4 persons per car
9	C2 Overhaul	1,040,000 km (7years)	20 days	4 persons per car
10	C3 Overhaul	1,560,000 km (10.5 years)	20 days	4 persons per car
11	C2 Overhaul	2,250,000 km (15years)	20 days	4 persons per car
12	Daily Internal Cleaning (turn-around in platform)	Every turn around	10 mins	2 persons per train
13	Daily Internal Cleaning (SBL)	Daily	45 minutes per train set	2 persons per car
14	Internal Light Cleaning	Weekly	1.5 hours	2 persons per car
15	Monthly Heavy Cleaning (Exterior & Interior)	Monthly	4 hours	4 persons per car
16	External Washing	Daily(AWP)	5 min. (app.)	-
17	Pest and Rodent Control	Bi-monthly	2 hours	2 persons per car
18	Air duct cleaning	Half yearly	4 hours	2 persons per car

**Maintenance schedule, Down time and Man power for Traction Power supply/
Distribution system adopted at BMRCL adopted by BMRCL**

SL N O	DC SYSEM / 3RD RAIL EQUIPMENTS	Inspections to be done with interval	Maintenance Schedule(Interval)				Down Time in Hours	Required Man Power
			Weekly	Quarterly	Half Yearly	Yearly		
1	SWS DISCONNECT OR S/W	Routine	-	-	6 Month		10	8
		Complete Inspection	-	-	-	1 Year	20	4
2	HSCB FEEDERS	Visual Insp	-	-	-	2 Year	30	4
		Detailed Insp	-	-	-	-	3	6
3	SEPCOS DISPLAY	Cleaning	-	1 Month	-	-	5	3
4	SEPCOS NG (CPU)	Cleaning	-	1 Month	-	-	5	3
5	HSCB INCOMERS	Visual Insp	-	-	-	1 Year	20	5
		Detailed Insp	-	-	-	2 Year		10
6	DC SWITCH GEAR COMPLETE	Visual Insp	-	-	6 Month	-	8	6
		Cleaning & Lubrication	-	-	6 Month	-	8	6
		Mechanical Check	-	-	-	1 Year	20	8
		Electrical Check	-	-	-	1 Year	20	8
7	RECTIFIER CUBICLE	Visual Insp	-	-	6 Month	-	8	4
		Cleaning & Lubrication	-	-	6 Month	-	8	4
		Mechanical Check	-	-	-	1 Year	20	4
		Electrical Check	-	-	-	1 Year	20	4
8	750 V DC INCOMING CUBICLE	Visual Insp	-	-	6 Month	-	8	4
		Cleaning & Lubrication	-	-	6 Month	-	8	4
		Mechanical	-	-		1	20	4

		Check				Year		
		Electrical Check	-	-		1 Year	20	4
9	750 V DC FEEDER CUBICLE	Visual Insp	-	-	6 Month	-	8	4
		Cleaning & Lubrication	-	-	6 Month	-	8	4
		Mechanical Check	-	-		1 Year	20	4
		Electrical Check	-	-	-	1 Year	20	4
10	BY PASS CUBICLE	Visual Insp	-	-	6 Month	-	8	4
		Cleaning & Lubrication	-	-	6 Month	-	8	4
		Mechanical Check	-	-	-	1 Year	20	4
		Electrical Check	-	-	-	1 Year	20	4
11	DISCONNECT OR CABINET	Visual Insp	-	-	6 Month	-	8	4
		Cleaning & Lubrication	-		6 Month	-	8	4
		Visual Insp	-	-	6 Month	-	8	6
12	OVPD CABINET Electrical Check			1 Year	20 month	8		

3 RD RAIL SYSTEM INSPECTION

13	CONDUCTOR RAIL	Visual Insp	-	3 Month	-	-	5	4
14	EXPANSION JOINT	Visual Insp	-	3 Month	-	-	5	4
		Cleaning & Checking	-	-	6 Month	-	5	4
15	ANCHOR ASSEMBLY (MPA)	Visual Insp ,Cleaning & Checking	-	3 Month	-	-	5	4
16	RAMPS	Visual Insp	-	3 Month	-	-	8	4
		Cleaning & Checking	-	-	6 Month	-	8	4
17	INSULATOR SUPPORT ASSEMBLY	Visual Insp	-	3 Month	-	-	8	4
		Cleaning & Checking	-	-	6 Month	-	8	4

18	POWER FEED	Visual Insp	-	3 Month	-	-	7	4
		Cleaning & Checking	-	-	6 Month	-	5	4
19	COVER SYSTEM	Visual Insp	-	3 Month	-	-	5	4
		Cleaning & Checking	-	-	6 Month	-	5	4
20	CONDUCTOR RAIL CLEANING	Cleaning & Checking	-	3 Month	-	-	5	6
21	INSULATED JOINTS (IJ)	Cleaning & Checking	-	-	6 Month	-	5	5
22	3 RD RAIL GENERAL PATROLLING	Visual Insp	7 Days	-	-	-	5	4

ANNEXURE -4C

Maintenance schedule, Down time and Man power for Track adopted by BMRCL

Sl no	Activity	Periodicity	Down Time	Required Manpower
1	Point & Crossing Inspection (Ballastless track) Mainline	Half yearly	1 y ₂ Hrs	4
2	Point & Crossing Inspection (Ballasted track) Mainline	Quarterly	1 y ₂ Hrs	4
3	Curve Inspection (up-to 30 Stations) for Ballastless track Mainline	Half yearly	4 Hrs	4
4	Curve Inspection (up-to 30 Stations) for Ballasted track Mainline	Half yearly (Quarterly)	4 Hrs	4
5	Joint Inspection with S&T	Half yearly	1 Hr	3
6	Foot Inspection	Monthly	6 Hrs (for whole beat)	2
7	Cab Inspection	Weekly	1 Hr	1
8	Track Patrolling (Ballastless - Main line)	Whole beat (Weekly)	6 Hrs (for whole beat)	3
9	Track Patrolling (Ballasted - Depot)	Daily (Weekly)	3 Hrs	2
10	USFD Testing (Rails and welds)	Yearly (Rails-after 200GMT, thereafter every 8GMT: Skv welds- after 1 year, thereafter every 5 years)	36 Hrs	6
11	PC based OMS Recording	Quarterly	3 Hrs	3

12	Inspection and Maintenance of Buffer Stops	Yearly	3 Hrs	5
13	Measurement of Toe Load	Yearly(1/5 th yearly-all clips of 1 out of 30 sleepers)	1 Hr	4
14	Measurement of Rail Wear (upto 30 Stations) for Ballasted track	Monthly (Half Yearly)	3 Hrs	3
15	Measurement of Creep	Monthly (Yearly)	2 Hr (for R1)	2
16	Inspection and Maintenance of Fastenings and Fittings	Weekly (insp-weekly: attention-need based)	12 Hrs	3
17	Maintenance of Ballasted Track by TTM	Yearly(need Based)	4 Hrs	6
18	Greasing of ERC clips	Once in 2 Years (25% yearly)	3 Hrs	4
19	Greasing of outer Rails on curves	Weekly, (If rolling stock is not designed with greasing equipment)	3 Hrs	3
20	Preventive and Need based rail grinding for operation of RGM	Yearly	3 Hrs	7
21	Attention of drainage pipes on viaduct	Monthly	3 Hrs	3

**Maintenance schedule, Down time and Man power for Signalling System
adopted by BMRCL**

SI No	Gear	Periodicity	Down Time	Man power	Remarks
1	Signals	Quarterly	30 min	3	Per unit
2	Point machines	Biweekly	15 min	2	Per unit
		Monthly	30 min	3	Per unit
		Quarterly	30 min	4	Per unit
		Quarterly	30 min	3	Per unit
4	SDTC Cubicle	Half yearly	4 hr	3	Per station
5	UPS	weekly	10 min	2	Per station
		Monthly	30 min	3	Per station
		Quarterly	1 hr	3	4 hrs wait time for discharge
		Quarterly	1 hr	3	Complete shut- down needed
7	ASCV cubicle	Half yearly	3 hr	5	Per station
8	ATC track side cubicle	Half yearly	1hr	3	Per station
9	ESP	Quarterly	30 min	2	Per station
10	LATS Cleaning	Half yearly	1 hr	3	Per station
11	CATS cleaning	Half yearly	1 hr	3	Per station
12	ATC onboard	Fitness	30 min	2	Per train
		Biweekly	20 min	2	Per train
		Quarterly	30 min	2	Per train
13	Video Wall	Quarterly	3 hr	3	Per line
14	Joint Inspection with Track	Half yearly			

Maintenance schedule, Down time and Man power for Telecom Systems adopted at BMRCL

SI No	System	Periodicity	Down Time	Man Power Required
1	CCTV	DAILY	15 Min/Station	1
		WEEKLY	20 Min/Station	1
		MONTHLY	1.25 hrs/Station	4
		QUARTERLY	30 Mins/Station	4
		HALF YEARLY	45 mins/Station	3
		YEARLY	2 hrs/Station	3
2	VIDEO WALL	QUARTERLY	1.5 hrs	4
		HALF YEARLY	1 hr	4
		YEARLY	1.5 hr	4
3	GE	MONTHLY	15 mins/Station	4
		QUARTERLY	1 hr/Station	4
		HALF YEARLY	45 Mins/Station	4
		YEARLY	2 hrs/Station	4
4	PIDS/PAS	DAILY	10 Mins/Station	1
		WEEKLY	10 mins/Station	1
		MONTHLY	45 Mins/Station	4
		QUARTERLY	4 hrs/Station	5
		HALF YEARLY	1 hr/Station	3
		YEARLY	1.5 hrs/Station	3
5	SDH	MONTHLY	30 Mins/Station	3
		QUARTERLY	30 Mins/Station	3
		HALF YEARLY	30 Mins/Station	3
		YEARLY	2 hrs	3
6	TELEPHONE	MONTHLY	30 Mins/Station	4
		QUARTERLY	1 hr/Station	3
		HALF YEARLY	1 hr/Station	3
		YEARLY	2 hrs/Station	2
7	RADIO	MONTHLY	15 Mins/Radio	3
		QUARTERLY	45 Mins/BTS	3
		HALF YEARLY	1 hr/MSO	3
		YEARLY	2 hrs/MTS	3
8	CLOCK	MONTHLY	30 Mins/Station	4
		HALF YEARLY	30 Mins/Station	2
		YEARLY	30 Mins/Station	3
9	T-SCADA	MONTHLY	15 Mins	2
		QUARTERLY	1 hr	2
10	Train radio system	WEEKLY	15 mins/Train	2
11	CDRS	HALF YEARLY	30 Mins	2
		YEARLY	1 hr	2

ANNEXURE-4F

Maintenance schedule, Down time and Man power for Telecom Systems

SI NO	System	Periodicity	Required Time	ManPower
1	TOM/EFO	MONTHLY	20 Mins/System	3
		YEARLY	2 hrs/System	3
2	AG & RVCT	MONTHLY	45 Mins/System	3
		HALF YEARLY	1 hr/System	3
		YEARLY	1.5 hrs/System	3
3	SC	MONTHLY	3 hrs/System	3
		HALF YEARLY	3 hrs/System	3
4	CC	DAILY	1 hr/System	3
		WEEKLY	1.5 hrs/System	3
		MONTHLY	2 hrs/System	3
		QUARTERLY	2 hrs/System	3
		HALF YEARLY	4 hrs/System	3
		YEARLY	4 hrs/System	3
5	NETWORK	MONTHLY	20 Mins/System	3
		QUARTERLY	1 hr/System	3
		YEARLY	2 hrs/system	3

ANNEXURE-4G

Maintenance schedule, Down time and Man power for Civil Structures & Works adopted at BMRCL

Sl. No.	Activity	Periodicity	Down Time	Required Manpower
1	ETP/STP Operation	Weekly	1 Hr	5
2	WTP Operation	Weekly	1 Hr	2
3	Pier inspection by TMHP,	Yearly	2Hrs	2
4	Maintenance of Depot buildings	Yearly	2Hrs	2
5	Maintenance of Station buildings	Yearly	2Hrs	2
6	Truck Mounted Hydraulic Platform Vehicle (TMHP) Maintenance	Daily	1 Hr	1
7	Land Scaping maintenance work	Weekly	1 Hr	4
8	Rolling Shutter Maintenance work	Monthly	J4 Hr	2
9	Via-duct Inspection	Weekly	4 Hrs	2
10	Cleaning of Over Head Tank (OHT)	Quarterly	4 Hrs	4
11	Maintenance of Parking Area at Stations and Depot	Weekly	2 Hrs	2
12	Maintenance of pump rooms and checking of water availability at stations	Weekly	2 Hrs	3

Maintenance schedule, Down time and Man power for M&P adopted at BMRCL

Sl.No.	Equipment	Periodicity	Down Time in Hr	Required Manpower
1	Electric Bogie Tractor	Weekly	3	
		Monthly	4	
		Yearly/ 1200 hr	16	
		Daily	1	
		Weekly	4	
2	Road Cum Rail Vehicle	Monthly	4	
		3 Monthly	6	
		Yearly	8	
3	Re-railing Equipment	Monthly	8	
		Daily	1	
		Monthly	4	
4	CNC Under Floor Wheel Lathe	6 Monthly	8	
		Yearly	20	
		3 Yearly	30	
		5 Yearly	60	
		weekly	4	
		Monthly	8	
5	Synchronized Pit jacks	3 monthly	16	
		6 monthly	16	
		yearly	24	
		weekly	4	
		Monthly	8	
6	Synchronized Mobile jacks	3 monthly	16	
		6 monthly	16	
		yearly	24	
7	EOT crane	Monthly	4	
		Weekly	0.5	
8	Bogie turn table	Monthly	1	
		Yearly	3	
		Weekly	2	
9	High Pressure Wash Pump	Monthly	4	
		3 Monthly	8	
		Weekly	2	
10	Diesel Fork lift	Monthly	4	
		6monthly	8	
		Yearly	16	
		Weekly	2	

11	Electric Fork Lift	Monthly	4	
		6monthly	8	
		Yearly	16	
		Weekly	2	
12	Electric Stacker	Monthly	4	
		6monthly	6	
		Yearly	8	
		Weekly	2	
13	Compressor	Monthly	4	
		6 Monthly	6	
		Yearly	8	
14	Scrubber	weekly	1.5	
		Monthly	4	
15	Aerial Work Lift Platform	Weekly	2	
		Monthly	4	

Maintenance schedule, Down time and Man power for Lifts Escalators and D.G. Sets Installed in BMRCL Stations

LIFTS

Sl No	Session	Interval	D/T and Manpower Requirement	
			Down Time	Required Man-hours
1	Daily Check (Dry)	Daily	10Mins	1 Person / Lift
2	Monthly Maintenance	Monthly	3 Hrs	2 Person / Lift
3	Quarterly Maintenance	Quarterly	4 Hrs	2 Person / Lift
4	Half Yearly Maintenance	Half Yearly	6 Hrs	2 Person / Lift
5	Yearly Maintenance	Yearly	8 Hrs	2 Person / Lift

ESCALATORS

Sl No	Session	Interval	D/T and Manpower Requirement	
			Down Time	Required Man-hours
1	Daily Check (Dry)	Daily	10Mins	1 Person / Escalator
2	Monthly Maintenance	Monthly	6 Hrs	2 Person / Escalator
3	Quarterly Maintenance	Quarterly	8 Hrs	2 Person / Escalator
4	Half Yearly Maintenance	Half Yearly	12 Hrs	2 Person / Escalator
5	Yearly Maintenance	Yearly	14 Hrs	2 Person / Escalator

D.G.Sets (Elevated Stations)

Sl No	Session	Interval	D/T and Manpower Requirement	
			Down Time	Required Man-hours
1	Daily Check (Dry)	Daily	30Mins	1 Person / DG
2	A- Check	Monthly	2 Hrs	1 Person / DG
3	B- Check	Quarterly	8 Hrs	2 Person / DG

Pre-Operation Activities (BMRCL)

- 1) Train operations in BMRCL are governed by the Metro Railway (Operation and Maintenance Act) 2002 as amended in 2009. Six sets of rules/subordinate legislation covering various areas of Metro operations have been framed and notified by MoUD/GoI as detailed below:
 - i. Bangalore Metro Railway General Rules, 2011
 - ii. Bangalore Metro Railway (Opening of Public Carriage of Passengers) Rules, 2011.
 - iii. Bangalore Metro Railway (Notices of Accidents & Inquiries thereto) Rules, 2011.
 - iv. Bangalore Metro Railway (Claims Procedure) Rules, 2011.
 - v. Bangalore Metro Railway (Carriage & Ticket) Rules, 2011. Of Misbehavior or Incapacity of the Claims Commissioner.
 - vi. Bangalore Metro Railway Rules, 2011 for Investigation
- 2) Notification of Commissioner of Metro Railway safety (CMRS) was made.
- 3) Prior to opening of a section for public carriage of passengers, approval of Commissioner of Metro Rail Safety is to be obtained for which the following activities need to be completed :
 - i. Schedule of Dimensions (SoD) for Metro has to be approved by GoI (Railway Ministry) prior to construction of a Metro and start of oscillation trials
 - ii. Oscillation Trials by RDSO and issue of speed certificate
 - iii. Issue of signaling Safety Certificate by an Independent Safety Assessor
 - iv. Service Trial Runs
 - v. Authorization by Ministry of Railways for first time use of type of Rolling stock for passenger carriage.
 - vi. In-principle approval of Ministry of Railways for various systems viz., traction, rolling stock, signaling, track, telecom etc.
 - vii. Nomination of Authorized officer by the Concerned Metro Administration.

- viii. Issue of various documents related to operations by Authorized Officer as listed in Para 5 below.
 - ix. MoU with hospitals, Police authorities and Fire Department.
- 4) Prescribing Minimum qualification, training schedule and competency procedure for staff dealing with the train operations and maintenance
- i. The minimum qualification requirements have been laid down by the BMRCL Administration in accordance with the requirements of a particular post. Overqualified/Under-qualified staffs are not recruited for a particular post. Recruitment to various posts is done by means of competitive examination by an independent agency like the KEA in case of BMRCL.
 - ii. With the approval of the Authorized Officer training schedule, duration and competency procedure for all the staff dealing with the train operation and maintenance have been drawn.
 - iii. The training includes institutional training, covering all areas of BMRCL working, safety and first aid, communication skills, customer handling, specialized training by the OEMs, on the job training in the related areas, etc. In the case of train operators, a minimum driving experience has been prescribed.
 - iv. The trainees are issued competency certificates only after successful completion of training, written evaluation and screening by a committee nominated by the Authorized Officer for the purpose
 - v. Only trainees in possession of competency certificates are eligible to work independently in the field.

5) Operating Procedures

- i. On BMRCL, following documents have been issued for operations:
 - I. Special Instructions to Bangalore Metro Railway General Rules, 2011.
 - II. Station Working Order (SWO) for all the stations.
 - III. Standard Operating Procedure for the Depot.
 - IV. Standard Operating Procedure for OCC.
 - V. Standard Operating Procedure for Station Staff and Train Operators.
 - VI. Competency Procedure for O&M staff.
 - VII. Hand book for dealing with serious incidents, accidents and disaster.
 - VIII. Procedure for availing power blocks and traffic blocks.
 - IX. In addition draft Maintenance Manuals for various equipment's for Signaling, Track, Traction, Telecommunication and Rolling Stock are issued in consultation with System Contractors.

6) Business rules, Ticketing system & Fare Collection System

- i. BMRCL has formulated Business Rules for Ticketing System and Fare Structure.
- ii. One innovation done by BMRCL in the area of ticketing is the issue of Debit-Cum-Transit Card through nationalized as well as private banks which can be used as a single card for debit in ATMs as well as for transit on Metro Railway.
- iii. Common Mobility Card (More Bangalore) is being evolved which will enable seamless travel over Metro, BMTC and KSRTC, etc.

Scope of work of OMC (LTMRHL)

- 1) **Consultancy phase: In Consultancy phase, the OMC shall carry out following functions:**
 - ❖ To undertake a comprehensive review and analysis of all the relevant documents to develop an operation and maintenance plan and strategy.
 - ❖ Provide inputs and suggestions on proposed alignment drawings to optimize the alignment design.
 - ❖ Review the curvature and gradients, depot facilities, including entry-exits, size of rail car and train formation. The interfacing with other city transport systems shall also be studied including the interchange between the metro lines.
 - ❖ Review the Basic Design Document and provide inputs on the system design parameters linked to the operations and maintenance requirements especially in the design of the guide way and stations, OCC (Operations Control Centre), DCC (Depot Control Centre), AFC (Automatic Fare Collection), Depot layouts (including workshops for maintenance of equipment and trains), training facilities, signaling and train control and Rolling Stock, telecoms and other systems.
 - ❖ Carry out simulation studies to the servicing of the trains including timetable modeling to validate the O&M plans.
 - ❖ Review the depot operation philosophy for the Project keeping in mind the revenue maximization from commercial development of the depot area.
 - ❖ Review the track layout diagrams (turnouts/crossovers/sidings) and location of the stations so as to ensure sufficient redundancy for degraded or maintenance operations.
 - ❖ Review and comment on the Design Basis Report from operations and maintenance point of view.
 - ❖ Assist in developing depot concept design and station layout design.
 - ❖ Assist in planning and design of the stations on each corridor including transport network plan for the multi modal facility.
 - ❖ Review and comment on the functional specifications of a sub-system forming part of the Rail System with respect to O&M Deliverables and

provide inputs on technical specifications for procurement such that it is in line with the philosophy of the O&M Deliverables.

- ❖ Prepare test procedures and plans for Operational Readiness Tests, Trial Runs and RAM demonstration.
- ❖ Provide list of Capital Equipment and suggest suitable procurement strategy for the same.
- ❖ Provide suggestions and inputs for Real Estate Development keeping in mind goal of revenue maximization.
- ❖ Review drawings and technical documentation provided by other Contractors.

2) Pre-Operation phase: In Pre-operation phase, the OMC shall carry out following functions:

- ❖ Finalise the O&M Plans and SOPs for safety, operations and maintenance of the MRTS as required.
- ❖ Recruit and train the O&M staff.
- ❖ Review the system manuals provided by other Contractors.
- ❖ Prepare safety manual, O&M manual, disaster management manual.
- ❖ Prepare detailed Operation plan and philosophy, maintenance plan and philosophy required for the Project.
- ❖ Prepare Operation safety case for MRTS.
- ❖ Prepare mechanism for audit of the condition of the Asset.
- ❖ Prepare system for dealing with customer complaints and grievances.
- ❖ Advice Employer in procurement of softwares.
- ❖ Prepare a takeover plan for various systems from the Contractors.
- ❖ Develop Key Performance Indicators and provide detailed performance measurement systems.
- ❖ Recommend the Employer items to be identified on the Punch List which relate to operability of the MRTS.
- ❖ Environmental and Safety audits.
- ❖ Submit to the Employer and obtain approval of all the O&M Manuals.
- ❖ Prepare procedures for Operational Readiness Test, Trail Run plans, RAMS Demonstration (detailed in Para-4)
- ❖ Safety Engineering

3) O&M phase: During O&M phase, the OMC shall carry out following functions:

- ❖ Operate, maintain and repair the MRTS in a professional, timely, safe and environmentally responsible manner as per laid down Key Performance Indicators (KPI).
- ❖ Act in accordance with the Good Industry Practice.
- ❖ Implement time to time staffing plan.
- ❖ Provide Daily/ Monthly reports.
- ❖ Responsible for managing the warranty obligations of the Other Contractors.

Document the allocation of revenues and expenditures between the Real Estate Development and the MRTS.

4) Operational Readiness Tests, Trial Runs and RAMS Demonstration

OMC has to play an important role during Operation Readiness Tests, Trial Runs and RAMS demonstration phase

I. Operational Readiness Tests

Objectives of Operational Readiness Tests are:

- a. To demonstrate that the MRTS is in accordance with the operations [philosophy], customer service requirements and asset management requirements.
- b. To demonstrate that all system interface functions are integrated so that the overall system operates properly and safely in accordance with the requirements of the project.
- c. To ensure that training is provided for all staff involved in operations and maintenance of the MRTS.
- d. The Operational Readiness Tests are part of the running tests which will be conducted after system integration test mainly for checking the readiness of staff and equipment before the Trial Run and shall be completed.

II. Trial Run

Objective and outline of Trial Run

- a. Prior to commencing Trial Run, the systems and/or sub-system forming a part of the MRTS should have successfully completed Testing and Commissioning. The Employer should have certified that system and/or sub-system are ready to commence the Trial Run in accordance with the O&M Agreement.
- b. The objective of the Trial Run is to demonstrate that the systems and/or sub-system forming part of the MRTS (and their operations by the OMC organization(including any subcontractors or affiliates) function sufficiently to enable the Independent Engineer and Safety Commissioner to evaluate and validate the readiness of the systems and/or sub-system.

- c. The process of Trial Runs will identify any requirements to optimize the system functionality, to amend procedures and/or to implement additional or revised training for the OMC staff.

III. RAMS Demonstration

- a. In the final phase of Trial Run, the entire Rail System shall be operated as if Revenue Operation has started, using the headways specified and planned.
- b. In general no specific test scenarios shall be planned for this phase but the OMC shall perform their duties as they would if passengers were using the system.
- c. The simulated Revenue Operation shall demonstrate the System Availability for a specific period and allocate this to various subsystems (e.g. Rolling Stock, Signaling, Track, Traction etc.)
- d. Specific issues and lower availability issues will be taken up with various contractors for compliance through a punch-list format and section would be opened for public if the availability of the system as a whole meets the stipulated requirements.

IV. Safety Engineering

- a. Safety is utmost important for the Project and a structured process of Safety Engineering shall be complied with by all stakeholders (Employer, OMC, Contractors etc.) as per EN50126 and Yellow Book guidelines.
- b. An Engineering Safety Case will be developed for the Project by consultants. Similarly, OMC shall develop an Operation Safety Case and Safety Management System (SMS). These safety cases shall be examined by Project-wide ISA and no-objection given before commercial opening.
- c. OMC shall take care of progressive updation of SMS system during the Project life cycle.

KPIs as per Concession Agreement (LTMRHL)

The Trains shall be operated continuously such that the first Train in each direction shall depart no later than 0500 hours and the last Train shall terminate not earlier than 2330 hours.

- (b) The Trains in each direction shall be operated such that the difference between arrival time of two Trains at any Station shall not exceed 3 (three) minutes; provided that such difference may be increased, subject to a maximum of 15 (fifteen) minutes, depending upon the number of Users in the respective hour.
- (c) The average speed of train movement from terminal to terminal during any hour of the day, including stops at the Stations, shall not be less than 30 (thirty) kilometers per hour.
- (d) For the avoidance of doubt, stops at the Stations shall not be less than 20 (twenty) seconds each.
- (e) The punctuality for the day, calculated at the terminal Stations with respect to the time table, shall be more than 95% (ninety five per cent). For the avoidance of doubt, if the arrival of a train at the terminal Station is delayed by more than 1 (one) minute, it will be deemed to have lost punctuality.
- (f) The number of coaches in each train and the frequency of Trains per hour shall be such that the average number of Users does not exceed 6 (six) persons per square meter of the floor space available for use by passengers inside a coach during 4 (four) Peak Hours in a day and is less than 4(four) such persons per square meter during other hours; provided that the restriction herein contained shall not apply if the concessionaire is operating 22 (twenty two) trains per hour in each direction with every Train having a floor space of not less than 325 (three hundred and twenty five) square meters.
- (g) The design, construction, operation and maintenance of the Stations shall be such that:

- i. a User alighting at the platform should be able to reach a point outside the Station in not more than 3 (three) minutes of brisk walking and
 - ii. a User crossing the fare collection point should be able to reach the platform in not more than 2 (two) minutes of brisk walking; and
 - iii. In case of emergency, evacuation from any point on the platforms to a point of safety in an open space within or outside the Station shall not exceed 100 (one hundred) meters.
- (h) The entry and exit gates, including the automatic ticket verification machines, shall be so designed and operated that the waiting time for Users shall not exceed 2 (two) minutes during Peak Hour.
- (i) The Concessionaire shall provide adequate number of ticket vending machines and ticket counters such that the waiting time for Users shall not exceed 2 (two) minutes during Peak Hour.
- (j) During Operation Period, the Concessionaire shall, no later than 7 (seven) days after the close of each month, furnish a monthly report stating in reasonable detail the compliance with all the Key Performance Indicators along with an analysis of the reasons for failures.
- (k) The Concessionaire shall, within 6 (six) months from COD, achieve and thereafter maintain throughout the Concession Period, ISO 9001:2000 certification or a substitute thereof for all the facilities at the Rail System, and shall provide a certified copy thereof to the Government forthwith.
- (l) The Concessionaire shall publish and implement a charter articulating the rights and expectations of Users (the Passenger Charter).

Additional KPIs Agreement between Concessionaire & OMC (LTMRHL)

Operating Performance Standard	Target
Departures from terminal within 1 minute of scheduled timetable	During first half year of commercial operation: >=95% Increasing by 0.5% every half year up to >= 97% after 2 years of commercial operation.
Arrival at terminal within 1 minute of scheduled timetable	During first half year of commercial operation >=95%, increasing by 0.5% every half year up to >= 97%
Train service availability (train-km operated / scheduled)	During first half year of commercial operation >=96%, increasing by 0.5% every half year up to >= 98%
Train Reliability (Carkm / Train failure causing delay >=5 mins)	90,000 km
Train Availability in Peak Hour Total train available in peak / Train required for peak	100%
Service performance (Delays of 20 minutes or more at any station)	<= 10
Passenger Injury Rate(other than first aid cases)(cases per million pax)	<= 0.4
No. of Complaints (Complaints/ million passenger journey)	5
Complaint Handling Response Time (% of complaints settled within 3 working days)	>=98%

Operating Performance Standard	Target
Availability of Fixed & Mobile Telephone Systems (Total operating hours – Total non-operating hours) / Total operating hours (%)	>=98%
Time through Entry/Exit Ticket Gates Waiting time for users at ticket gate <= 2 mins during peak / Total no of uses (%)	>=98%
Waiting Time to Buy Tickets Waiting time for users at ticket machines or counters <= 2 mins during peak / Total no of uses (%)	>=98%
Availability of Ticketing Vending Machines	>= 98%
Availability of Automatic Fare Collection	>= 98%
Availability of Escalators and Conveyors	>= 98%
Availability of Lifts	>= 99%
Availability of Passenger Announcement System (PAS) (Total operating hours – Total non-operating hours) / Total operating hours (%)	>=98%
Mainline service collision	0
Mainline service derailment	0
Passenger Injury Rate (Reported passenger injury / Million passenger journey)	<=0.4%
Fire incidents at stations	0
Fire incidents on trains	0

Operating Performance Standard	Target
Fire incidents at permanent way	0
Revenue loss through unauthorized access/tail gating	0%
Cleanliness of Train and Station Train compartment and station areas being cleaned daily	>=98%
Temperature and Ventilation Levels of Train To maintain a cool, pleasant and comfortable train environment generally at or below (to be decided locally) degree	>=98%
Average Traction Energy Consumption per Train Trip	To be 98% of previous operating year
Average Cumulative Energy Consumption of stations (weighted per passenger trips in stations for the E&M component) and depots (weighted per train quantities in depots)	To be 98% of previous operating year
Customer Satisfaction Survey (by independent agency appointed by Concessionaire)	>= 90%

Details of Mock Drills followed by DMRC

SL No	Mock drill Item	Location	Frequency	Remarks
1	Emergency Stop Plunger	At PSB and SCR	Quarterly	
2	Under Platform Sprinkler	Key switch in PSBs and operation also by motor operated valves	Monthly	Switching OFF of OCS supply is desirable
3	Emergency tripping switches	At platform ends, inside tunnel and in SCRs	Yearly	Emergency telephone checked every two months
4	Fire Alarm and Control panel	SCRs	Fortnightly	
5	Seismic sensor	At Patel Chowk station	Fortnightly	
6	Mimic Fire Repeater panel	Fireman Staircase	Fortnightly	
7	Public Announcement System	Mic in PSBs and SCRs	Fortnightly	
8	Hooter with strobe (flasher)	At PFs & Concourse	Fortnightly	
9	Switching ON of tunnel lights through MCBs	In ASS rooms at platform ends	Fortnightly	At Patel Chowk control is through BMS
10	DG Set	Ancillary building	Monthly	Load test for 30 minutes
11	Fire pumps	Ancillary building	Monthly	
12	Tunnel Ventilation System		Monthly	SC also associates
13	Gas Flooding System	ASS Room	Fortnightly	SC also associates
14	Extension of Power supply	OCC	Monthly in non-revenue hours	Carried out by all TPCs

INDIGENISATION OF SPARES & CONSUMABLES (DMRC)

Rolling Stock-

Phase-1- out of 60 trains which were procured 15 trains were manufactured offshore and remaining 45 trains were to be progressively indigenized. Further out of these 45 trains, car body shell with mostly indigenous material was used in 25 trains.

Phase-2 (Broad Gauge) - Out of 85 train sets it was mentioned that minimum 20 train sets will be manufactured in India. Further the items which were identified for indigenization are given below:

Essential:

SI No	Description of Items
1.	Pantograph
2.	Vacuum Circuit Breaker (VCB)
3.	Current Transformers, Potential Transformers and Insulators
4.	Traction Motors
5.	Converter / Inverter unit
6.	Static inverter
7.	Electrical Panels and cab Panels
8.	Cables
9.	Battery set box
10.	Saloon air conditioner
11.	Cab AC
12.	Luminaries and lamps
13.	All types of glasses
14.	Public address (PA)/Public Information System (PAS)
15.	DC-DC Converter
16.	Consumables, Lubricants, Sealants, Oils, Greases etc.

Desirable:

SI No	Description of Items
1.	Axle box , covers with taper roller bearings
2.	Floor cover
3.	Floor board
4.	Dampers
5.	Earthing brush assembly
6.	Stainless steel sections
7.	Steel sections
8.	Insulation like glass wool etc.
9.	Internal paneling
10.	Cab mask
11.	Brake system
12.	Couplers
13.	Axle box housing
14.	Door panels
15.	Auxiliary motors
16.	Gangways
17.	Bearings
18.	Valves and cocks
19.	Wipers
20.	Pneumatic pipes
21.	Reservoirs
22.	Primary conical + secondary springs
23.	PCBs used in different equipment's

Phase-2 (Standard Gauge) – Minimum 48 cars i.e. 16 three car train sets were to be manufactured in India. Further the items which were identified for indigenization are given below:

Essential:

SI No	Description of Items
1	Pantograph
2	Vacuum Circuit Breaker (VCB)
3	Current Transformers, Potential Transformers and Insulators
4	Traction Motors
5	Converter / Inverter unit
6	Static inverter
7	Electrical Panels and cab Panels
8	Cables
9	Battery set box
10	Saloon air conditioner
11	Cab AC
12	Luminaries and lamps
13	All types of glasses
14	Axle taper roller bearing complete with axle box, housing & cover
15	DC-DC Converter
16	Consumables, Lubricants, Sealants, Oils, Greases etc.
17.	Earth brush assembly

Desirable:

SI No	Description of Items
1	Cab mask
2	Floor cover
3	Floor board
4	Dampers
5	Internal panelling
6	Stainless steel sections
7	Steel sections
8	Insulation like glass wool etc.
9	Public address (PA)/Public Information System (PAS)
10	Brake system
11	Couplers
12	Door panels
13	Auxiliary motors
14	Gangways
15	Bearings
16	Valves and cocks
17	Wipers
18	Pneumatic pipes

19	Reservoirs
20	Primary conical + secondary springs
21	PCBs used in different equipment's

Phase-3 (Standard Gauge)- It has been proposed in the new RS tender that only 20 train sets of six car each can be manufactured in offshore factory out-side India. Further the items which were identified for indigenization are given below:

Essential:

SI No	Description of Items
1	Pantograph including strips
2	Vacuum Circuit Breaker (VCB)
3	Brake blocks
4	Traction Motors
5	Converter / Inverter unit
6	Static inverter (Auxiliary Converter)
7	Electrical Panels / cab Panels
8	Application & release valve, relay valve, isolating cocks, safety valves & check valves
9	Battery set box
10	Saloon air conditioner
11	Saloon door accessories
12	Luminaries and lamps
13	All types of glasses
14	Axle taper roller bearing complete with axle box, housing & cover
15	DC-DC Converter
16	Consumables, Lubricants, Sealants, Oils, Greases etc.
17	Earth brush assembly
18	Gear drive

Desirable:

SI No	Description of Items
1	Floor cover
2	Floor board
3	Dampers
4	Stainless steel sections
5	Steel sections
6	Insulation like glass wool etc.
7	Brake system
8	Couplers
9	Auxiliary motors
10	Gangways
11	Bearings
12	Wipers

13	Pneumatic pipes
14	Reservoirs
15	Primary & secondary Springs
16	PCBs used in different equipment's
17	Internal paneling
18	Public address (PA)/Public Information System (PAS)
19	Cab mask

AFC Equipments:

Following items have been indigenized:

- 1) AFM
- 2) Hybrid Flap
- 3) Normal Flap
- 4) PID with Voice
- 5) SMA top cover
- 6) SMV top cover
- 7) Talk back system
- 8) Ticket vending machine
- 9) Hand held device for common ticketing

ROLLING STOCK INDIGENISATION (BMRCL)

SI.No	Description of Equipment	Name of Manufacturer	Indigenous Supply possible/ acceptable	Manufacturer
1	Car body(except side wall skin)	Hyundai Rotem, Korea	Yes	Raw material from M/s SAIL, Salem or Jindal Steel
1.1	Side wall Skin	Nippon Steel, Japan	No	
2				
2.1	Bogie Frame	Hyundai Rotem, Korea	Yes	M/s Premier Pune
2.2	Primary Spring	Gummi Metal Technik,Germany	No	M/s Siemens, Aurangabad
2.3	Secondary Spring	SEI , Japan	No	
2.4	Wheels	Bonatrans A.S. Czech Republic	No	
2.5	Axles	Bonatrans A.S., Cezh Republic	No	
2.6	Damper	ZF Sachs AG, Germany	No	
2.7	Gear Box and Couplings	Flender Industriegetriebe, Germany	No	
2.8	Wheel flange Lubrication equipment	Kelsan, Canada	yes	
2.9	Axle bearing		Yes	
3				
3.1	Complete Brake System	Knorr Bremse, Munchen	yes	M/s KBIL
3.2	Main air compressor-motor set	Knorr Bremse, Munchen	No	
3.3	Air Dryer	M/s KB, Munchen	No	

3.4	Brake disc	Knorr Bremse, Munchen	No	
3.5	Brake pads	Knorr Bremse, Munchen	No	
4				
4.1	Passenger Saloon Doors	Faiveley Transport, Iberica, Spain	Yes	M/s KBIL, India
4.2	Cab Side Doors	ADS Rail, Korea	No	
4.3	Saloon to Cab doors	ADS Rail, Korea	No	
5	Current Collector	Ferraz Shawmut Co.Ltd, Mersen	No	
6	High Speed Circuit Breaker	Secheron SA, Switzerland	No	
7	Lighting Arrester (Metal Oxide, Gapless) → Surge Arrester	OTOWA ELECTRIC, Japan	No	
8	Traction Motor	MELCO, Japan	No	
9				
9.1	Complete Traction Inverter	MELCO, Japan	no	
10				
10.1	Complete Auxiliary Inverter	Mitsubishi Electric Corp, Japan	No	
11	Battery	HBL Power System Ltd, India	Yes	M/s AMCO, M/s HBL, India
11.1	Battery box	M/s Jindal, Gurgaon, India	Yes	
12	HVAC Unit	Sigma Coachair Group, Australia	Yes	M/s KBIL, India
13	Main relays	Mitsubishi Electric Corp. Japan	No	
14	MCB	Schneider Electric SA	No	
15	Isolating Switches	Mitsubishi Electric Corp. Japan	No	
16	Cables	Huber + Suhner AG, Switzerland	No	
16.1	Cable duct		Yes	

17				
17.1	Automatic Digital voice announcement and Public Address System	TOA Engineering , Japan	No	
17.2	Electronic information Display System	TOA Engineering ,Japan	No	
17.3	Electronic Destination Display	TOA Engineering, Japan	No	
18				
18.1	Automatic coupler	Voith turbo Schharfenberg, Germany	No	
18.2	Semi permanent coupler	Voith turbo Schharfenberg, Germany	Yes	M/s Voith Hyderabad
19				
19.1	Flooring Board	M/s Milwaukee Composites Inc., USA	No	
19.2	Cushion	Getnerg, Austria	No	
19.3	Floor Cover	Mando, Italy	NO	
19.4	Glass wool	U D TWIGA, India	Yes	
20	Interior / Panelling	Han Kuk Fibre Glass Co. Ltd, Korea	Yes	M/s Kemrock, Vadodara
21				
21.1	For Train operator	Dae won Kang, Korea	No	
22.2	For passenger	KBI tech company limited, Korea	Yes	M/s Presston Engg Bangalore
23				
23.1	Vestibules (inter Gangways)	Hubner, GMBH	No	
23.2	Cabling harnessing system	Kyung Sung, Korea	Yes	M/s Presston Engg, Bangalore and M/s Bhoruka, Bangalore
23.3	Head light, taillight, flasher lights etc.,	Samkong, korea	Yes	M/s K Lite, India
23.4	Saloon Light	Samkong, korea	Yes	M/s K Lite, India

24				
24.1	Master Controller	MELCO, Japan	No	
24.2	Mode Selector	MELCO, Japan	No	
24.3	PWM Generator	MELCO, Japan	No	
24.4	Windscreen wiper	Sparague, USA	Yes	M/s KBIL
24.5	Horn	Knorr Bremse, Munchen	Yes	M/s KBIL
24.6	Earthing brush assembly	Stemman, Germany	Yes	M/s Schunk India
25	TMS	MELCO, Japan	No	
25.1	Axle Box and covers (Casting)	Shin-Myung Steel Cast Co., Ltd., Korea	Hyundai Rotem	M/s Rine Engg, Himachal Pradesh
26	Stickers and Labels	Hyundai Rotem, Korea	Yes	3M, Permacel India
27	Sun visor	Hyundai Rotem, Korea	Yes	
28	Foot Pedal	Hyundai Rotem Korea	Yes	
29	Cab mask, Cab skirt, driver desk and end fairing	Hyundai Rotem, Korea	Yes	M/s Kemrock, Vadodara

TRACK/PWAY INDIGENISATION (BMRCL)

Sl. No.	Description of Spares	Supplier	Indigenous supply possible	likely /recommended source
1	Rail 60 kg 90 UTS	M/s. SAIL, BHILAI, India		
1	Rail 60 kg HH	Austria	YES	M/s. SAIL, BHILAI, M/s. Jindal , Laxmi Mittal, etc.
2	Washer Uls 60	M/s. Vossolooh, Germany	YES	-
4	Thermit Welding portion for SAIL rail	M/s. ITC, Kanpur, India	-	-
5	Thermit Welding Portion for HH rail	M/s. ITC, Kanpur, india	-	-
6	Grooved Rubber Pad	Local,India	-	-
7	GFN Liner	Local,India	-	-
8	Elastic Rail Clips (ERC)	Local,India	-	-
9	Elastomeric pad - 4 holes	M/s. Vossolooh,Germany	YES	-
10	Elastomeric pad - 2 holes	M/s. Vossolooh,Germany	YES	-
11	Insulating Bush	M/s. Vossolooh,Germany	YES	-
12	Rail Pad	M/s. Carbanaire Industries (Madras) Pvt. Ltd. / India	-	-
13	Collared Washer	M/s. Carbanaire Industries (Madras) Pvt. Ltd. / India	-	-
14	Helical Spring	M/s. Vossolooh,Germany	YES	-
15	Ribbed plate Rph 49/20/12 - 4 Hole	M/s. Nelcast Ltd., Gudur, India		
16	Ribbed plate Rph 49/20/12 - 2 Hole	M/s. Nelcast Ltd., Gudur, India		
17	Tension Clamp Skl-12	M/s. Vossolooh,Germany	YES	-

18	Intermediate Pad - 4 hole	M/s. Carbanaire Industries (Madras) Pvt. Ltd. / India	-	-
19	T Bolt (HS-32) with nut	M/s. Hiten Fasteners Pvt Ltd, Gadag/ Maddur, India	-	-
20	Anchor Bolt M- 27X38285mm long with nut	M/s. Hiten Fasteners Pvt Ltd, Gadag/ Maddur, India	-	-
21	Jogled fish plate C-clamp	Local,India	-	-
22	Glued Insulated Rail Joint 60kg	M/s. Paramount Industries, Hyderabad, India	-	-
23	CMS Crossing 1 in 9	M/s. VAE, Austria	YES	-
24	CMS Crossing 1 in 7	M/s. VAE, Austria	YES	-
25	PSC Sleeper for 3rd rail	M/s. Mazda, Tumkur, Bangalore, India	-	-
26	PSC Sleeper for Standard Gauge	M/s. Mazda, Tumkur, Bangalore, India	-	-
27	Intermediated Pad - 2 hole	M/s. Carbanaire Industries (Madras) Pvt. Ltd. / India	-	-
28	Wheel Stop/ Stopper	M/s. Balfour Beatty, UK	YES	-
29	Buffer stop for slow line	M/s. Balfour Beatty, UK	YES	-
30	Buffer stop for main line	M/s. Balfour Beatty, UK	YES	-
31	Derailing Switch - 60 kg RH	M/s. VAE, Austria	YES	-
32	Derailing Switch - 60 kg LH	M/s. VAE, Austria	YES	-
33	Switches of 1 in 9 RH Turn out	M/s. VAE, Austria	YES	-
34	Switches of 1 in 9 LH Turn out	M/s. VAE, Austria	YES	-

35	Switches of 1 in 7 RH Turn out	M/s. VAE, Austria	YES	-
36	Switches of 1 in 7 LH Turn out	M/s. VAE, Austria	YES	-
37	PSC Sleeper for Scissor Cross over including Daimond Crossing	M/s. Mazda, Tumkur, Bangalore, India	-	-
38	Dry Mould (60kg)	M/s. ITC, Kanpur, India	-	-
39	1 m fish plate with modified clamp	Local, India	-	-
40	1 m long fish plates for 60 kg rail with C-Clamp	Local ,India	-	-
41	Fish plate with Bolt & nut	Local, India	-	-

P-Way M&P Spares INDIGENISATION (BMRCL)

Sl. No	Description of Spares	Supplier	Indigenous supply possible / acceptable	likely /recommended source
1	Split Head Tamping Machine	M/s. Plasser, Austria	Indigenous supply possible	M/s. Plasser India, Faridabad
2	Rail Grinding Machine (RGM)	M/s. LORAM, USA	-	-
3	Ultra Sonic Flaw detector machine	M/s. EEC, M/s. PARAS, M/s. Modsonic, etc. (RDSO Approved), India	-	-
4	PC Based OMS 2000 Machine	M/s. Systems Aids, Bangalore, India	-	-

CSW INDIGENISATION (BMRCL)

Sl. No	Description	Supplier	Indigenous supply possible/acceptable	likely /recommended source
1	Station Building	Local,India	-	-
2	Viaduct	Local,India	-	-
3	Depot (facilities and service buildings)	Local,India	-	-
B.				
Sl. No	Description	Supplier	Indigenous supply possible/acceptable	likely /recommended source
1	Truck Mounted Hydraulic Plat form	M/s. Vanjax Sales Pvt Ltd., etc.- India	-	-

Traction Power Equipments (BMRCL)

Sl. No.	Equipment	Location of Works, Country of origin	Remarks
(i) Items manufactured in India			
1	20/25 MVA Power Transformer	ABB-Vadodara, India	
2	66 kV SF6 breaker	ABB-Vadodara, India	
3	66 kV CVT	ABB-Vadodara, India	
4	66 kV IVT	Vishal-Meerut, India	
5	Neutral Grounding Resistor	National Switchgear-Chennai, India	
6	33 kV Indoor Switchgear	ABB-Nasik, India	
7	415 V LT & Control Cable	Polycab-Daman, India	
8	ACDB/DCDB	Jasper-Noida, India	
9	SCADA System	ABB-Bangalore, India	
10	Control & Relay Panels	ABB-Bangalore, India	
11	Ni-Cd Batteries	Amco Saft-Bangalore, India	
12	Battery Chargers	Amraraja-Tirupati, India	
(ii) Imported items and likely indigenous source			Likely indigenous source
13	66 kV cable	Phelphs Dodge - Bangkok, Thailand	Universal-Pune, Polycab-Daman, LS-Haryana
14	33 kV Cables	Phelphs Dodge - Bangkok, Thailand	Universal-Pune, Polycab-Daman, LS-Haryana
15	750 V DC Positive and Negative cables	Phelphs Dodge - Bangkok, Thailand	Universal-Pune, Polycab-Daman, LS-Haryana
16	750 V DC rectifier	Secheron-Prague, Czech Republic	Hind Rectifiers-Mumbai
17	HSCB panels	Secheron-Prague, Czech Republic	GE India-Bangalore
18	750 V DC Disconnector Switches	Secheron-Prague, Czech Republic	Trans Electrical-Kolkata
19	Conductor Rail	Alcan-Singen, Germany	Not available due

20	Conductor Rail accessories & stinger	Railtech-Paris, France	to small requirement
21	66/33 kV Gas Insulated Substation	ABB-Fujian, China	Areva-Chennai
22	415 V LT Bus Duct	Schneider-Guangzhou, China	Bus bar systems India, Bangalore
23	33kV/415 V Auxiliary Transformer	ABB-Cheonan, S Korea	Electromechanic a-Jammu, RPG-Pune
24	33 kV/292-292V Traction Transformer	ABB-Cheonan, S Korea	Electromechanic a-Jammu, RPG-Pune
25	66 kV SF ₆ CT	ABB-Lodi, Italy	Non SF ₆ ABB, Areva, C&G

Indigenous equipments including services for testing and commissioning constitute 32% of the total Contract value.

SIGNALLING EQUIPMENT (BMRCL)

Sl. No.	Equipment	Location of works, Country of origin	
(i) Items manufactured in India			
1	Design of Signalling concepts	M/s Alstom India Limited, Bangalore.	
2	Design of Interlocking system	M/s Alstom India Limited, Bangalore.	
3	Point Machines for Depot	M/s Crompton Greaves, Indore	
4	Relays	M/s Crompton Greaves, Indore & M/s Urban Engineering, Kolkata.	
5	Track Circuits	M/s Alstom, Bangalore	
6	Cables	M/s Tirupati Plastomatics, Jaipur & M/s Advance Cable Technologies, Bangalore.	
7	Batteries	M/s Amararaja, Tirupati.	
8	Signalling Equipments	M/s Agarwal Engineering, Kolkata	
9	Signalling Aspects	M/s General Auto, Mumbai	
10	Signalling Accessories	M/s LD Fabricators, Bangalore	
11	Switches & Computer Equipments	M/s Advance Technique, New Delhi.	
12	Display System	M/s BARCO, New Delhi	
13	Cabinets	M/s Rittel, Doddaballapur	
14	Power Distribution Cubicles	M/s Kaynes, Bangalore.	
15	Transformers & Servo stabilizers	M/s Alstom, Bangalore	
16	Installation, Testing & Commissioning	M/s Alstom, Bangalore	
(ii) Imported items and likely indigenous source			Likely indigenous source
17	Interconnecting Cables & connectors.	ATSA, France	Tyco Electronics, Bangalore.

TELE-COMMUNICATION SYSTEMS EQUIPMENT (BMRCL)

SI. No.	Equipment	Location of Works, Country of origin	
(i) Items manufactured in India			
1.	Tetra Tower and Mast	M/s TVS, India	
2.	Tetra Radio system (Cabinet, cables, splitter, tray, distb board)	M/s Thales Portugal, Netrack, Motorola, India	
3.	Master Clock (Fixtures, wago)	M/s Hensel, India	
4.	Telephone system (MDF, IDF, IPM, analog phones)	M/s Krone, India	
5.	Passenger Announcement system (Fixtures, connectors, wago)	M/s Hensel, India	
6.	Passenger Display System (Fixtures, fibre converter)	M/s Trendnet, India	
7.	CCTV (fixture, surge protection, BNC connectors)	M/s MTL, India	
8.	Optical Fibre system (ODF, patch cords, HDPE)	M/s Krone, India	
9.	Cabinets	M/s Netrack, India	
10.	BBRS (Mast, connectors, cables, ODF, patch cord, HDPE, fibre converter)	M/s Krone, Trendnet	
(ii) Imported items and likely indigenous source			Likely indigenous source
11.	Passenger Display System Panel	AESYS, Italy	Chemito Technologies, Pune
12.	Passenger Announcement system Speakers	ASL, UK	Ahuja, Audix
13.	CCTV Camera	Bosch, Germany	Nimbus, Textel
14.	Platform Monitor	Mitron, Finland	Not available
15.	CCTV Encoder, Decoder, NVR	NICE, Israel	Not available
16.	TETRA Radio BTS, MSO, handsets	Motorola, Malaysia	Not available

17.	Master Clock	Weststrand, Germany	Not available
18.	Optical Fibre Cable	Draka, Spain	Sterlite, Uniflex
19.	BBRS	Firetide, USA	Not available
20.	GE 10 Gb routers	Alcatel-Lucent, Portugal	Not available
21.	SDH	Keymile, Germany	HFCL/Tejas/ FIBCOM

AUTOMATIC FARE COLLECTION SYSTEMS (BMRCL)

Sl. No.	Equipment	Location of Works, Country of origin	
(i) Items manufactured in India			
1.	Contactless Cards & tokens	M/s Siepmanns India	
2.	Network switch	M/s HP, India	
3.	Cat-6 cable	M/s RM, India	
4.	Optical Fibre Cable	M/s RM, India	
5.	Electrical cables	M/s CMI India	
6.	Network rack	M/s HCL, India	
(ii) Imported items and likely indigenous source			Likely indigenous source
7.	Ticket Office Machine	HP Singapore	HCL, Wipro India
8.	Servers	HP Singapore	HCL India
9.	Printer	Lukan Korea	Wipro, TVS India
10.	Automatic Gates	Huangmin, Shanghai, China	Not available

M&P resources deployed (DMRC)

- 1) Electric bogie tractor
- 2) Road cum rail vehicle
- 3) Re-railing equipment
- 4) CNC under floor wheel lathe
- 5) Synchronized pit jacks
- 6) EOT cranes
- 7) Bogie turn table
- 8) High pressure wash pump
- 9) Diesel fork lift
- 10) Electric fork lift
- 11) Electric stacker
- 12) Compressor
- 13) Scrubber
- 14) Aerial work lift platform

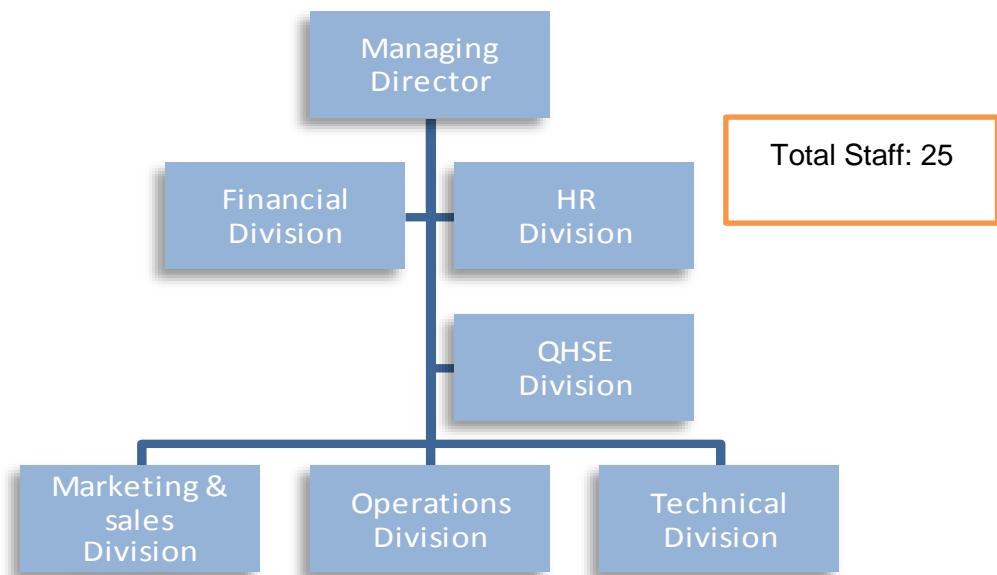
M&P resources deployed / planned (BMRCL)

- (a) Overhead Crane
- (b) Pit Jacks, Mobile Jacks
- (c) Under floor wheel lathe
- (d) Automatic Wash plant
- (e) Rail cum Road vehicle
- (f) Electric Bogie Tractor
- (g) Battery powered locomotive
- (h) Split Head Tamping Machine
- (i) Truck Mounted Hydraulic Platform for viaduct inspection and maintenance
- (j) Fork lift vehicle
- (k) Motor Trolley
- (l) Train simulator for TO Training

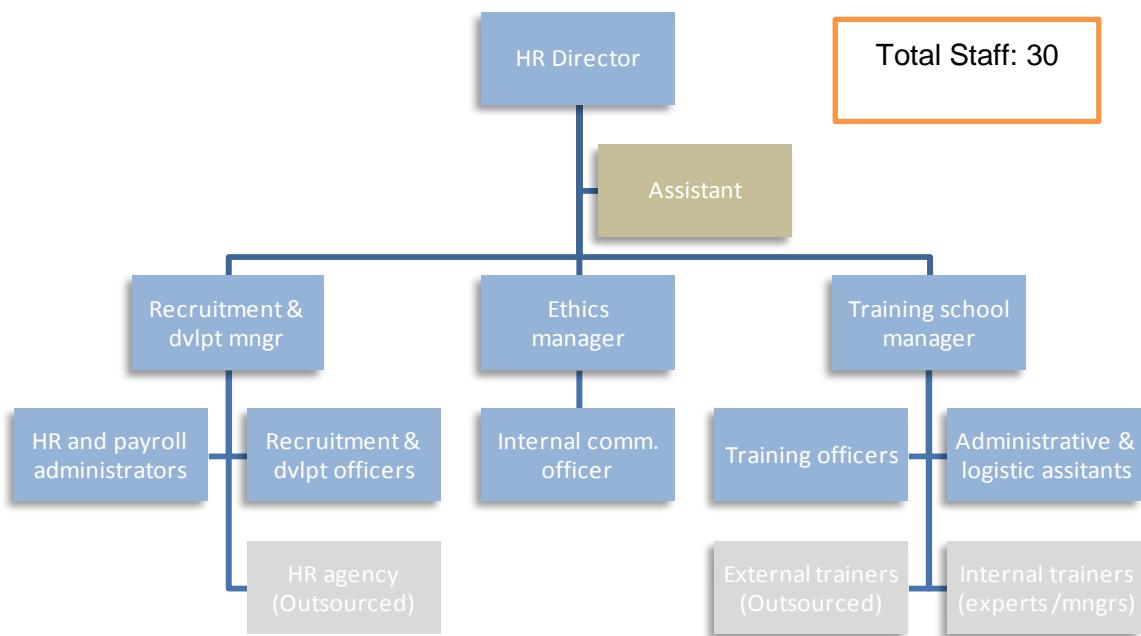
Human Resource Management (LTMRHL)

The OMC shall set-up a robust and standardized recruitment process to manage in a smooth and efficient way the very large number of employees to be recruited during mobilization periods for various Stages of opening of sections. A total number of about 1900 staff for the complete project are required excluding certain outsource activities given below:

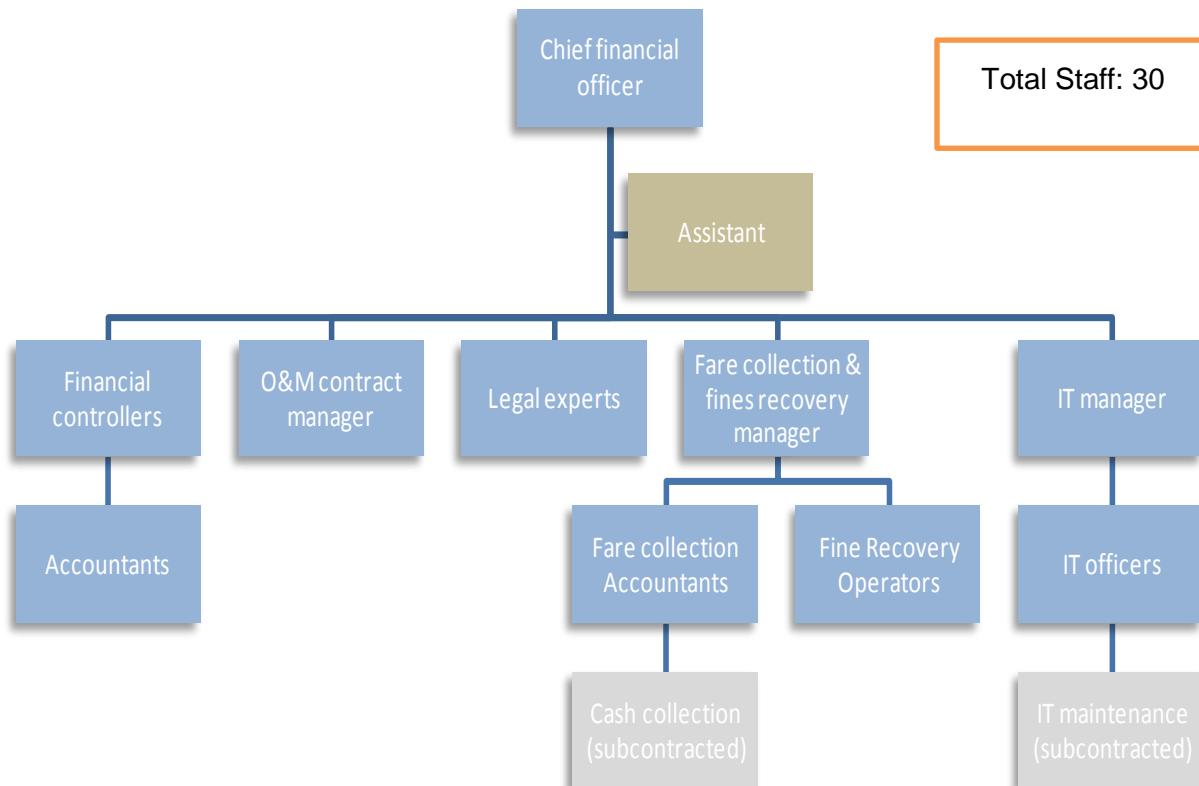
- a. Cleaning of train and stations
 - b. Security services (Asset Security only as main security is in scope of Govt)
 - c. Maintenance of Lifts, Escalators, depot equipment etc
 - d. Rail Grinding activities
1. O&M Organization overview:
 - i. The Executive Management Team:



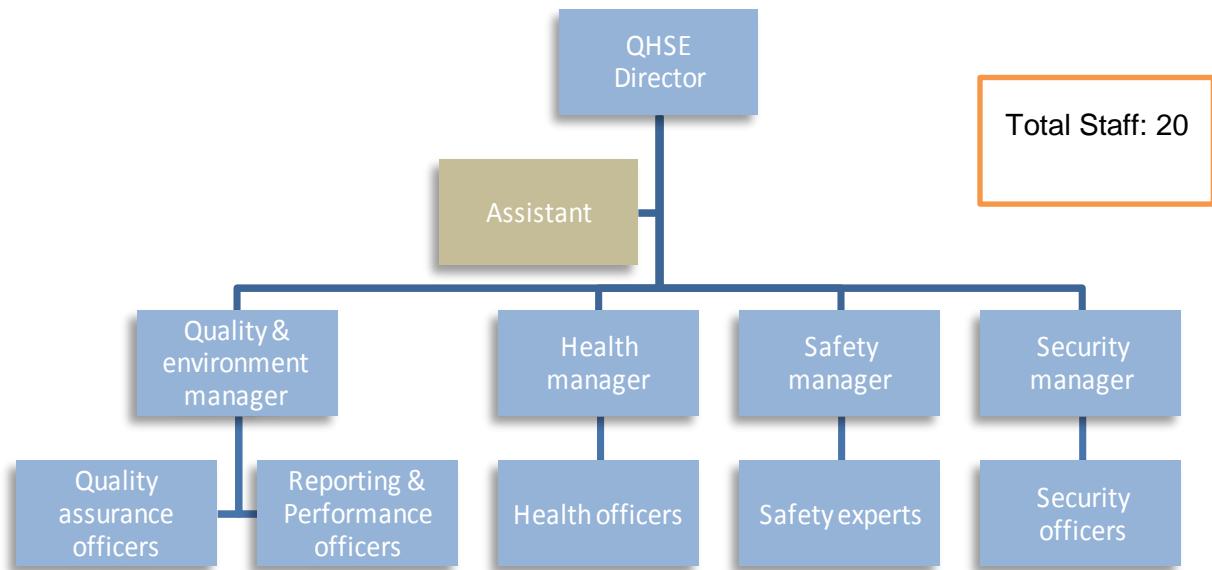
ii. HR Division:



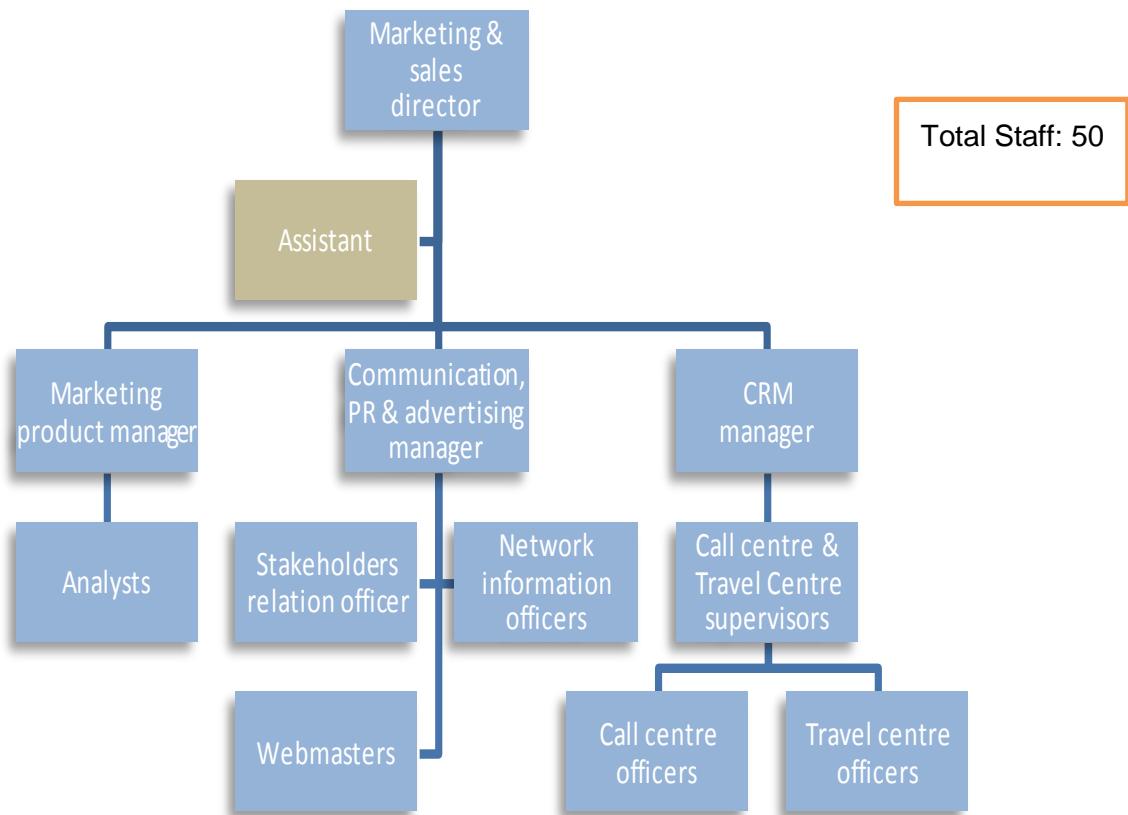
iii. Financial Division:



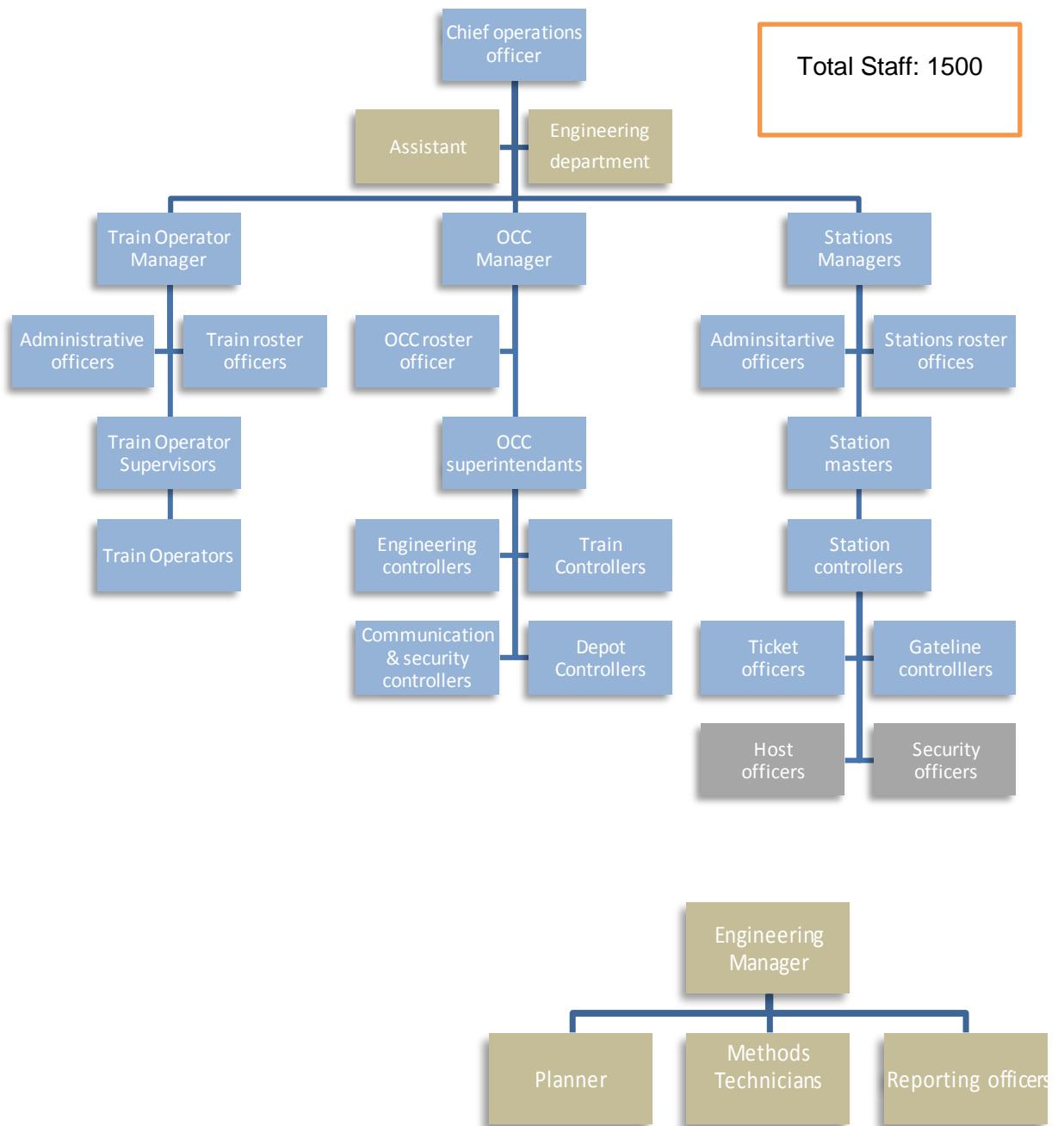
iv. QHSE Division:



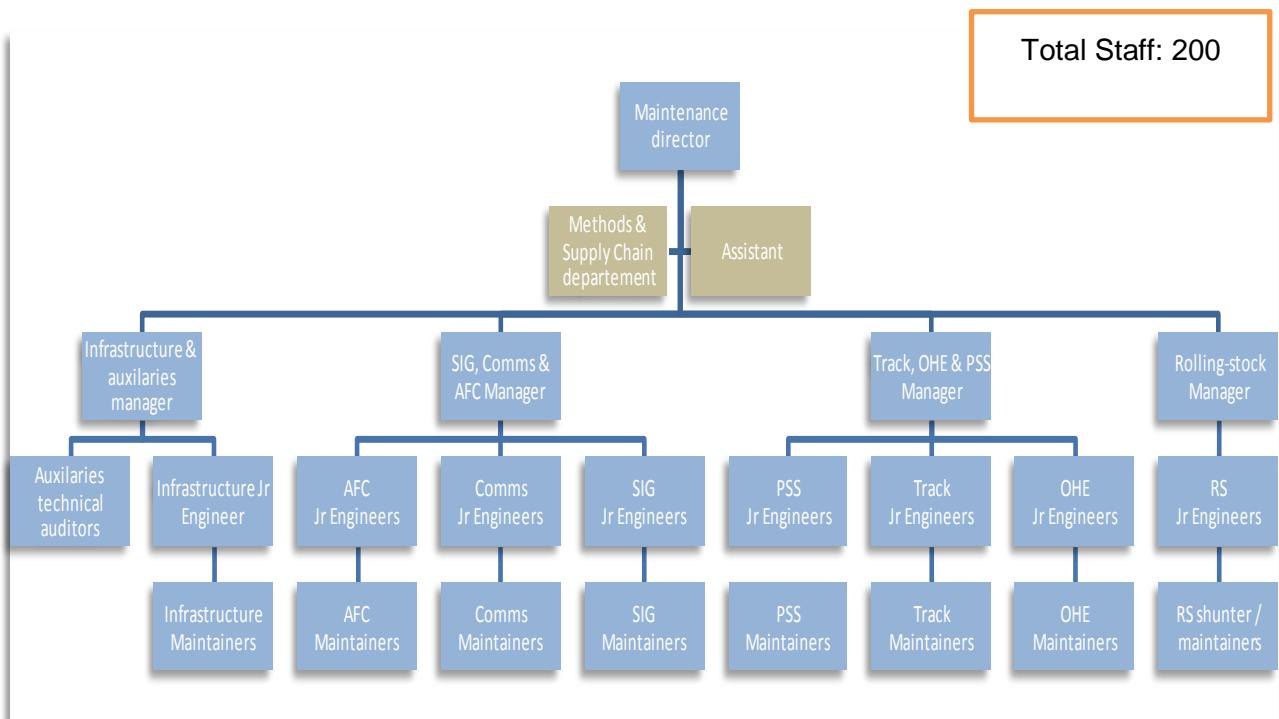
v. Marketing & Sales Division:



vi. Operations Division:



vii. Maintenance Division:



Scope of Services for OMC (One of Indian Metros)

- 1) Mobilization of the Key Operator Personnel and the Operator Personnel (through the O&M Employee Vehicle), organization of the team's relocation and settlement in the city, opening company bank accounts, establishing temporary office accommodation (within the 3,000 sq.ft. of space provided by Concessionaire during the Pre-Operation Period for Stage-1) and hiring the first of the local office staff, etc.;
- 2) Assisting Concessionaire in obtaining and maintaining the Consents that a Metro Rail System is required to obtain and obtaining and maintaining the necessary Operator Consents that the Operator is required to obtain, to enable the operation of the Metro Rail System as soon as the testing and commissioning of each Relevant Stage is completed;
- 3) Examination of the final designs and as-built drawings to determine whether any significant changes have been made after the submission of the Bids, inspection of the condition and finish of the construction to date, comparison with Project Data Room assumptions, analysis of maintenance liabilities, etc.;
- 4) Assisting the Concessionaire, the GC and Metro Rail System Contractors in the testing and commissioning of each system or component of the Metro Rail System, in accordance with the directions of Metro Rail System;
- 5) Once testing and commissioning of each system or component of the Metro Rail System is completed, assisting the Concessionaire and the GC in the testing and commissioning of the Metro Rail System as a whole, (including in relation to Burn-In), in accordance with the directions of Concessionaire;

- 6) conducting the Blank Operations of each Relevant Stage;
- 7) Design and implementation of suitable operational and management plans such as an operations plan, safety manual, maintenance plan and any other documents that the Operator is required to prepare in accordance with the Contract; and
- 8) Recruitment and training of the Operator Personnel and ensuring that the Operator Personnel are well qualified and competent prior to the commencement of Blank Operations.
- 9) The services to be provided by the Operator during the Operation Period included the following:
 - ❖ Responsibility for all operation-related activities, operational reliability and safety of operation
 - ❖ Planning of operation
 - ❖ Operation of Trains and technical systems like signaling, telecom, and power systems
 - ❖ Operation of the depot, including OCC building including operation of central control room and back up modes
 - ❖ Operation of station buildings
 - ❖ Operation of the infrastructure linking the stations along the alignment
 - ❖ Responsibility of maintenance and management of staff in respect of Heating, Ventilating, and Air Conditioning (HVAC) System for Trains, stations and tunnels
 - ❖ Operations of escalators and lifts
 - ❖ As appropriate, provide the necessary interface related to surveillance, security and safety arrangements, and safety & security personnel as required under this Contract
 - ❖ Coordination of procedures and actions during fall back and emergency situations
 - ❖ Emergency management planning

- ❖ Staff on Trains and at stations
- ❖ Passenger information
- ❖ Cleaning
- ❖ Reporting
- ❖ Training and education of the staff
- ❖ Ticket control and revenue control
- ❖ Admission control systems
- ❖ Closed Circuit Television (CCTV) systems
- ❖ Video and voice recorders
- ❖ Maintenance services is also expected to include upkeep (e.g., washing, painting, landscape, trimming flora) of civil works such as:
 - Depots
 - Control and maintenance centers like the OCC
 - Stations, both paid and unpaid areas, as well as stations surroundings
 - Tunnels, elevated bridges, and embankments
 - Permanent ways or rights of way
- ❖ Other areas of maintenance will include all system and equipment assets
 - Rolling stock
 - Technical systems, such as Signaling and Telecommunication systems, auxiliary and Traction Power system
 - Supervisory control and data acquisition (SCADA)
 - Electrical and mechanical equipment
 - Track

Key Performance Indicators

(One of Indian Metros)

1.1.1 Primary KPI

- Train Availability
- Station Accessibility
- Reliability of Train Service – Peak Hour Service (PHS)
- Non-Peak Hour Service
- Punctuality

1.1.2 Secondary KPI

- Passenger information
- Time table availability
- Availability customer staff
- HVAC & Tunnel ventilation
- Passenger comfort
- Cleanliness of train
- Removal of graffiti from trains
- Removal of station & depot
- Removal of graffiti from station
- Availability Ticket vending machine
- Elevator/Escalator availability
- Help points
- CCTV availability
- Lighting availability
- Revenue protection
- Customer satisfaction

Valuation of various risks

(One of Indian Metros)

I. KPI risks

- The KPI regime contained in the O&M contract includes maximum penalties of 10% per annum and maximum bonuses of 5% per annum based on the operator's performance against the KPI's.
- The probability of receiving penalties is nearly nine times greater than earning bonus payments.
- It is worked out that a prudent operator would assess the overall KPI penalty risk at approximately 5% of the service fee.
- Value is created for MetroRail System through the KPI regime in the O&M contract-this value equals 5% of the total service fee during the life of the contract.
- In a publically operated metro, where there are no financial incentives or penalties connected to the performance of the metro against the KPIs, the authority managing the metro would have the same incentive structure.

II. Electricity Risks

- The Concessionaire has prepared O&M cost estimates based on DMRC experience and BMRCL experience. The cost estimate towards non-energy consumption is asset to be too low due to a range of possible reasons such as climate, equipment rating, lighting design, lift and escalators specification etc.,
- All the electrical information for all the non-traction power equipments was up-loaded into the Data Room for the bidders use. In the assessment of the non-traction power consumption by bidder, the current power consumption estimate of the Concessionaire is too low and they estimated non-traction power electricity risks at 60% of the Concessionaire cost estimate.

III. Pre-Operation Cost Risk

- The operator is responsible for the hiring of the new workforce in a timely fashion to enable them to be trained for the start of the operation of each phase of the railway opening.
- Thus, there is a risk that delays by the GC and then main construction and supply contractors delaying the opening of any of the section will cause the Operator to have to retain its staff and continue training, maintenance and trial operation support of the emerging infrastructure and equipment, whilst it awaits the opening.
- The Concessionaire has transferred this risk to the Operator through a fixed lump-sum payment provision for Pre-Operations in the O&M contract.
- If the Concessionaire were to operate the metro on itself, it would bear the cost of any pre-operation delays and cost overruns.
- 50% risks factor on all the O&M budget for the pre-operation periods was added to the Concessionaire estimate.

IV. O&M Cost Risks

- The Concessionaire estimated the cost of the O&M phases of the contract by using recent operational data from DMRC, since this is the nearest available equivalent metro system.
- It is likely that DMRC in its early years of operation allowed for a risk factor in its operating budgets to cover the large number of new pieces of equipment that need to work in harmony, as nearly every new railway operates with high level of faults over the first year to two.
- If the Concessionaire were to operate the metro itself, it would certainly budget for operation cost overruns.
- Therefore, the Concessionaire has achieved value in transferring this risk to the operator through the O&M contract, and the competitive bidding process has ensured that the Bidders have offered a competitive price for the operation period rates.

- Based on the experience of Metro OMC project contracts in Europe and North America, a 10% risk factor value was added to The Concessionaire operations period estimate less electrical cost.

V. Inflation Risk

- Under the O&M contract, the operator is only protected from 80% of the India inflation risk, therefore it will be exposed to approximately 1.4% inflation risk per annum, over the next seven years; based on an assumed rate of Inflation at seven percent ($1.4\% = 20\% \times 7\%$).
- If the Concessionaire were to operate the metro itself, it would bear 100% of the inflation risk.
- Therefore inflation risk value was added to the Concessionaire base O&M cost estimate.

DETAILS OF MOCK DRILLS FOR DISASTER MANAGEMENT PREPAREDNESS

SI No	Mock drill Item	Location	Frequency	Remarks
1	Emergency Stop Plunger	At PSB and SCR	Quarterly	
2	Under Platform Sprinkler	Key switch in PSBs and operation also by motor operated valves	Monthly	Switching OFF of OCS supply is desirable
3	Emergency tripping switches	At platform ends, inside tunnel and in SCRs	Yearly	Emergency telephone checked every two months
4	Fire Alarm and Control panel	SCRs	Fortnightly	
5	Seismic sensor		Fortnightly	
6	Mimic Fire Repeater panel	Fireman Staircase	Fortnightly	
7	Public Announcement System	Mic in PSBs and SCRs	Fortnightly	
8	Hooter with strobe (flasher)	At PFs & Concourse	Fortnightly	
9	Switching ON of tunnel lights through MCBs	In ASS rooms at platform ends	Fortnightly	
10	DG Set	Ancillary building	Monthly	Load test for 30 minutes
11	Fire pumps	Ancillary building	Monthly	
12	Tunnel Ventilation System		Monthly	SC also associates
13	Gas Flooding System	ASS Room	Fortnightly	SC also associates
14	Extension of Power supply	OCC	Monthly in non-revenue hours	Carried out by all TPCs
15	Fire Drill	Depot & Stations	Quarterly	
16	Rescue of Disabled Train.	Main Line (Non-Revenue Hours)	Quarterly	
17	Detrainment of Passengers between Stations	Main Line (Non-Revenue Hours)	Quarterly	
18	Passenger Evacuation from Station and via duct	Main Line (Non-Revenue Hours)	Quarterly	
19	Drill for use of Rescue & Relief Train	Main Line (Non-Revenue Hours)	Quarterly	
20	Communication Failure (TETRA)	Main Line & Depot (Revenue Hours)	Half Yearly	
21	Failure of Third Rail Supply	Main Line & Depot (Non-Revenue Hours)	Half Yearly	
22	Rail Fracture (leading to TC Failure)	Depot (Non-Revenue Hours)	Half Yearly	
23	Point failure in	Mainline & Depot	Quarterly	
24	Lifts & Escalators Failure	Stations & Depot	Monthly	
25	Preparedness & Preventive actions against Terrorist attack	Stations & Depot	Quarterly	
26	Single line working	Main Line	Half Yearly	

