



**DELHI METRO RAIL CORPORATION LIMITED**

*(A Joint Venture of Govt. of India and GNCTD)*

**Name of Work: Contract MS 07: “DESIGN, MANUFACTURE, SUPPLY, INSTALLATION, TESTING AND COMMISSIONING OF TELECOMMUNICATION SYSTEM (EXCEPT TETRA SYSTEM) OF LINE 9 (FROM DAHISAR EAST TO RAI) AND 7A (ANDHERI EAST TO CSMIA) CORRIDOR OF MUMBAI METRO INCLUDING DONGRI DEPOT”**

**ADDENDUM 03**  
**Summary Sheet**

S. No.	Tender Document	Page No.	Clause No. / Item No.	Addendum/ Corrigendum	Remarks
1.	Notice Inviting Tender (NIT)	19, 20	1.1.3.3 Bid Capacity Criteria	Change in tender Conditions	Page no 19, 20 are replaced with 19R, 20R
2.	Instructions To Tenderers (ITT)	17,18	C.10. Payment Schedule	Change in tender Conditions	Page no 17,18 are replaced with 17R, 18R
3.	Form of Tender (FOT)	5,6,24,25, 33,34	FOT	Appendix – 1, 15, 16, 19A have been modified. Appendix -36 has been added.	Page no 5, 6, 24, 25, 33, 34 are replaced with 5R, 6R, 24R, 25R, 33R, 34R. Page no. 6A has been inserted after page 5R, Page no. 54A has been inserted after page 54,
4.	Special Conditions of Contracts (SCC)	5, 7, 20, 29, 30, 37	SCC	Clause 1A, 7A, 43 have been added. Clause no. 27, 33, 34, 35 have been modified	Page no 5, 7, 20, 29, 30, 37 are replaced with 5R, 7R, 20R, 29R, 30R, 37R. Page no. 37A, 37B &37C have been inserted after page 37R,

S. No.	Tender Document	Page No.	Clause No. / Item No.	Addendum/ Corrigendum	Remarks
5.	SCC Schedules	-	SCC Schedules	Schedule 2 & 3 have been deleted  Schedule 10 has been added	Page no 1-5 of Schedule 2 are replaced with page no. 1R-5R. Page no 1-4 of Schedule 3 are replaced with page no. 1R-4R.  Page no 1R, 2R of schedule 10 have been added.
6.	Volume 3: Employer's Requirements: Particular Specifications  Chapter 1 – General Requirements	1 - 77	Chapter 1 – General Requirements	Chapter 1 – General Requirements  Existing file (77 pages) has been replaced with a new file (80 Pages)	Page no. 1-77 are replaced with 1R-80R
7.	Volume 3: Employer's Requirements Particular Specifications  Chapter 7 Telephone Systems	1-62	Chapter 7 Telephone Systems	Chapter 7 Telephone Systems  Existing File (62 Pages) Has Been Replaced With A New File (61 Pages)	Page No. 1-62 Are Replaced With 1R-61R
8.	Volume 3: Employer's Requirements Particular Specifications  Chapter 8: Closed Circuit Television System	1-53	Chapter 8: Closed Circuit Television System	Chapter 8: Closed Circuit Television System  Existing File (53 Pages) Has Been Replaced With A New File (53 Pages)	Page No. 1-53 Are Replaced With 1R-53R

S. No.	Tender Document	Page No.	Clause No. / Item No.	Addendum/ Corrigendum	Remarks
9.	Volume 3: Employer's Requirements Particular Specifications  Chapter 10: Interfaces and Appendices	88-90, 100-102, 106-108, 115	Chapter 10: Interfaces and Appendices	Chapter 10: Interfaces and Appendices : Appendix-B, E, H & N modified	Page no 88-90, 100- 102, 106-108, 115 are replaced with 88R - 90R, 100R – 102R, 106R - 108R, 115R
10.	Volume 3: Employer's Requirements Particular Specifications  Chapter 12: Access Control System	5	Chapter 12: Access Control System	Chapter 12: Access Control System : Change in tender Conditions	Page No. 5 is Replaced With 5R
11.	BOQ	-	-	BOQ has been updated	Existing BOQ file has been replaced with a new file.
12.	Replies to prebid queries				

audited balance sheet of any year other than the last year is not submitted, the tender may be considered as non-responsive.

- However, the tenderer including all substantial members of JV/Consortium should have been incorporated more than three years earlier from the last day of the previous month of tender submission. In this case, for such tenderer, the average annual turnover shall be arrived considering 'nil' turnover for the financial year(s) for which tenderer was not able to submit audited balance sheet on account of non-incorporation of tenderer. Such data shall be divided by 5 to work out the average annual turnover. In case balance sheet of the last year has not been audited so far, then data shall be divided by 4 to work out the average annual turnover.
- Any certification or document required to be provided by CA, must contain UDIN thereon and the particulars of certifications must be same as mentioned on document/certification and submitted to ICAI on its website which can be verified online.
- Where a work is undertaken by a group, only that portion of the contract which is undertaken by the concerned applicant/member should be indicated and the remaining done by the other members of the group be excluded. This is to be substantiated with documentary evidence.

#### 1.1.3.3. Bid Capacity Criteria:

**Bid Capacity:** The tenderers will be qualified only if their available bid capacity is more than the approximate cost of work as per NIT. Available bid capacity will be calculated based on the following formula:

$$\text{Available Bid Capacity} = 1.5 * A * N - B$$

Where,

**A** = Maximum of the value of ~~Telecommunication~~ **S&T** works executed in any one year during the last five financial years (updated to last day of the month previous to the month of tender submission price level assuming 5% inflation for Indian Rupees every year and 2% for foreign currency portions per year).

**N** = Time period in years prescribed for completion of the work being procured.

**B** = Value of existing commitments (i.e. balance amount of ongoing ~~Telecommunication~~ **S&T** works and also the ~~Telecommunication~~ **S&T** works which are awarded to tenderer but yet not started as on last day of the month previous to the month of original tender submission) to be completed in the next “N” years w.e.f. from the first day of the month of original tender submission.

The works considered in computing A and B should be of same category.

#### Notes:

- a) Value of ~~Telecommunication~~ **S&T** works executed year-wise for latest last five financial years has to be submitted by the tenderer in **Appendix-15 of FOT** along with audited financial statements. The financial data in the prescribed

format shall be certified by the Chartered Accountant with his stamp and signature in original with membership number and firm registration number (FRN) & UDIN.

- b) Value of existing commitments for on-going Telecommunication **S&T** works to be completed in the next “**N**” years w.e.f from the first day of the month of original tender submission has to be submitted by the tenderer in **Appendix-16 of FOT**. These data shall be certified by the Chartered Accountant with his stamp and signature in original with membership number and firm registration number (FRN) & UDIN. In case of no Telecommunication **S&T** works in hand or ongoing Telecommunication **S&T** works, a “**NIL**” statement shall be furnished.
- c) In the case of JV/Consortium, the above formula will be applied to each substantial member of the JV/Consortium to the extent of his proposed participation in the execution of the work.

**Example for calculation of bid capacity in case of JV/Consortium**

Suppose there are ‘P’ and ‘Q’ substantial members of the JV/Consortium with their participation in the JV/Consortium as 70% and 30% respectively and available bid capacity of these members as per above formula individually works out ‘X’ and ‘Y’ respectively, then Bid Capacity of JV/Consortium shall be as under:

$$\text{Bid Capacity of the JV/Consortium / Group} = 0.7X + 0.3Y$$

The bid capacity of non-substantial members of JV/Consortium shall not be considered for the evaluation of bid capacity of JV/Consortium.

- d) Value of “N” for the contract duration lesser or higher than one year shall be computed as follows:
  - i. Contract duration up to 12 months, value of “N” to be taken as 1 year.
  - ii. Contract duration more than 12 months, value of “N” to be taken as contract duration/12 years.

**1.1.3.4.** The tender submission of tenderers, who do not qualify the minimum eligibility criteria & bid capacity criteria stipulated in the clauses 1.1.3.2 to 1.1.3.3 above, shall not be considered for further evaluation and therefore rejected. The mere fact that the tenderer is qualified as mentioned in sub clause 1.1.3.2 to 1.1.3.3 shall not imply that his bid shall automatically be accepted. The same should contain all technical data as required for consideration of tender prescribed in the ITT.

**1.1.3.5. Tenderer shall submit the CV of Key Personnel’s as per Appendix-7A of FOT.**

**1.1.4. The Tender documents consist of:**

Contract MS07: “Design, Manufacture, Supply, Installation, Testing and Commissioning of Telecommunication System (Except Tetra System) Of Line 9 (From Dahisar East To RAI) and 7A (Andheri East to CSMA) Corridor of Mumbai Metro Including Dongri Depot”

such matters. The techniques to be employed, the equipment and facilities available or proposed to be setup offshore and/or in India, will be analyzed during technical evaluation and their descriptions shall be in sufficient detail to allow a full appreciation of the Tenderer's proposals in relation to all aspects of the Works.

**C.9.2. Maintenance**

**C.9.2.1.** The Contractor shall be responsible for maintaining the Works until final hand over to the Employer and for the provision of relevant maintenance manuals and drawings.

**C.9.2.2.** The Contractor shall be responsible for making good any and all defects of materials and workmanship, in the Works for the period stated in the General Conditions of Contract (Nov 2019).

**C.9.2.3.** The Contractor shall be responsible for the security of the Site during the work phase of the Contract, until the issuance of a Taking-Over Certificate.

**C.10. Payment Schedule:**

The payment for items given in Bill of Quantity (Volume 5) shall be made on the basis of milestones activities.

**C.10.1. Apportionment of Fixed Lump Sum Price to Sections and to Cost Centres and Milestones under each Section**

**C.10.1.1. The whole of the Works including design, are divided into Sections, primarily on a geographical basis. Each Section is divided into the various Cost Centres named according to their general scope of work.**

**C.10.1.2. The fixed Lump Sum price for whole of the Works shall be apportioned by the Tenderer amongst the various Sections. The apportioned amount for each Section will be further distributed among various Cost Centres included in that Section, separately for foreign currency and for the Rupee portion. The apportioned amount for each Cost Centres will be further distributed amongst various Milestones included in that Cost Centre, separately for the foreign currency and the Rupee portion.**

**C.10.1.3. The sum of amounts shown against Milestones in a Cost Centre is the Cost Centre Total that is to be carried forward to the Section Summary. The division of the respective Cost Centre Totals between Indian Currency and Foreign currency shall be shown in the said Summary. The Section Summary shall be carried forward to the Tender Total.**

**C.10.1.4. The scope and extent of the Works are to be ascertained by reference to the Contract Documents as a whole and shall not be limited in any manner whatsoever by the descriptions of the Cost Centres under each Section or of the Milestones under each Cost Centre, as given in the Appendices to the Pricing document.**

**C.10.1.5. The Tenderer shall note that the apportionment of the fixed lump sum price among the sections shall have correlation with the workload involved in each section, inter-alia keeping in view the route length of the section. Likewise, the apportionment of a section total into cost centres and then into milestones shall have relation to the content of work involved. Further, the sum of amount apportioned to Cost Centre ‘A’ and ‘B’ of a section except Section MS shall not exceed 15% of the apportioned amount for that Section. The sum if the amounts apportioned to Cost Centres ‘D’ and ‘E’ of a Section except Section MS shall not be less than 30% of the apportioned amount for that Section. (Note: Cost Centre ‘E’: shall not be less 10% of the Section total)**

**C.11. Sub-Contracts**

**C.11.1.** Sub-contracting shall be generally limited to 50% of the Contract price. The terms and conditions of sub-contracts and the payments that have to be made to the sub- contractors shall be the sole responsibility of the Contractor.

**Contract MS07: “Design, Manufacture, Supply, Installation, Testing and Commissioning of Telecommunication System (Except Tetra System) Of Line 9 (From Dahisar East To RAI) and 7A (Andheri East to CSMIA) Corridor of Mumbai Metro Including Dongri Depot”**

- C.11.2.** For sub-contracts exceeding Rs.10 Lakh, it will be obligatory for the Contractor to obtain a Notice of No Objection from the Engineer to the identity of the sub-contractor. The value of each sub-contract shall be provided by the Contractor to the Engineer. The Contractor shall certify that the cumulative value of the sub-contracts (including those up to Rs. 10 Lakh each) awarded is within the aforesaid 50% limit. In this regard the Tenderer’s attention is invited to Clause 8 of SCC.
- C.11.3.** The Terms and Conditions of the sub-contract are the sole prerogative of the Contractor and are deemed to be included in the contract price.
- C.12. Staffing Schedule and Related Details**
- C.12.1.** The Tenderer shall submit with his Tender (Appendix-7 of Form of Tender) a staffing schedule containing the names, qualifications, professional experience and corporate affiliation of all proposed management personnel (above the level of shift supervisor) and specialists for this work. Details shall be included for all such personnel whether directly employed or engaged on a consultancy or advisory basis and whether associated with the Design/ installation /wiring /termination /testing /commissioning (including integrated testing & commissioning) of the Works. The submission shall include a provisional management structure and organization chart showing areas of responsibility, relative seniorities and lines of reporting. The proposed staffing plan shall be in conformity with the Annexure 5 and 5A of ITT.
- The tenderer shall provide the CVs of Project Director/Project Manager, Design liaison Engineer and other key personals along with tender submission (Appendix-7A of FOT).
- C.12.2.** If the proposed Key Staff are to be changed from those indicated in the technical submission, then all details, including names and addresses and brief details of their experience, will be required to be furnished as per the Forms contained in Annexure 5 of this ITT. The minimum required qualifications and experience for each Key Staff member are also contained in Annexure 5A of this ITT.
- C.12.3.** The key personnel including the project manager as defined in Annexure5 & 5A of ITT for execution of this work shall be from substantial member(s) of JV/Consortia.
- C.13. Contractor’s Equipment:**  
The contractor shall deploy equipment required to complete the work as per the schedule and within the completion period.
- C.14. Proposals for Use of Work Areas:**
- C.14.1.** The Tenderer shall note the requirements of the Land Acquisition, Rehabilitation and Resettlement Act, 2013.
- C.14.2.** The Tenderer shall note the provision contained in Employer’s Requirements.
- C.14.3.** The Tenderer is to note that the Contractor will be fully responsible for the provision of all utility services like water, electricity, sewerage etc necessary for the construction and completion of the Works.
- C.15. Pricing Document**
- C.15.1.** The Pricing Document is included in Bill of Quantities/Pricing document; Volume 5. The Tenderer shall complete the Pricing Document in accordance with the instructions given in Bill of Quantity/Pricing Document. The completed Pricing Document including price of minor deviations in Annexure-N (included in BOQ) for such deviation as mentioned in Appendix-13 of FOT shall be submitted.
- C.15.2.** The price of each such minor deviation will be the price which the tenderer agrees to offer to the employer from his quoted offer in BOQ if deviation is agreed by the employer. Any such deviation without a price shall not be considered and will be treated as withdrawn by the tenderer. Any other deviation mentioned anywhere in the submission other than in Appendix-13 of FOT shall be considered as if mentioned inadvertently by the tenderer and shall be considered as withdrawn without any confirmation from the tenderer.

FORM OF TENDER- APPENDIX 1

[REQUIREMENTS UNDER GENERAL CONDITIONS OF CONTRACT (November 2019)]

S. NO	DESCRIPTION	REF TO CLAUSE NO. SUB-CLAUSE OF GCC	REQUIREMENT
i.	<u>Time for completion of whole of the work</u>	<u>1.1.3.11</u>	<u>54 Months (30 months + 24 months DLP)</u>
ii.	<u>Sections</u>	<u>1.1.6.6.</u>	<ol style="list-style-type: none"> <li>1. <u>LINE 9 (PHASE-1): DAHISAR EAST TO KASHIGAON STATION.</u></li> <li>2. <u>SECTION-LINE 9 (PHASE-2): SAI BABA NAGAR TO RAI STATION</u></li> <li>3. <u>SECTION-LINE 7A &amp; 9 (PHASE-3): ANDHERI EAST TO CSIA INCLUDING DONGRI DEPOT</u></li> </ol>
iii.	Amount of Performance Security	Clause 4.2 of the GCC	10% of the Contract Price in types and proportions of currencies in which the contract price is payable. In the event of variations during the execution of the contract which result in payments to the Contractor over and above the contract price, the Performance Security shall be adjusted in accordance with clause 4.2 of GCC.
iv.	Latest ‘date for commencement’ of the Works	Clause 8.1 of the GCC	Date given in LOA or Employer’s Notice to Proceed
v.	‘Time for completion’ of the work from the date of commencement of the work	Clause 8.2 of the GCC	Within 30 Months from the latest date of Commencement
vi.	Liquidated Damages (LD)	Clause 8.5 of the GCC	<ol style="list-style-type: none"> <li>(i) 0.01% of the fixed lumpsum price <u>Original Contract Value</u> per week* of delay for the key dates.</li> <li>(ii) The maximum limit of Liquidated Damages shall be 10% of the total <u>Original Contract Value Price stated in the letter of acceptance (LOA) unless other modified in SCC.</u></li> <li>(iii) Total maximum limit of LD including sums payable by the employer to designated contractors is 15% as mentioned in GCC <u>of The Original Contract Price stated in the letter of acceptance (LOA) unless otherwise modified in SCC.</u></li> </ol>

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S. NO	DESCRIPTION	REF TO CLAUSE NO. SUB-CLAUSE OF GCC	REQUIREMENT
vii.	‘Defects Liability Period (DLP)’ for the whole of the Works	Clause 10 of the GCC	<b>02 (Two) years (as per SCC Clause 29)</b> from the date of issue of Taking-Over Certificate for the Whole of the Works.
viii.	Amount of advance payment	Clause 11.2 of the GCC	As per clause 11.2 of GCC (November 2019) and SCC clause 34
ix.	Amount of Professional Indemnity Insurance (PII)	Clause 15.1 and 15.5 of the GCC	<del>10% of the Contract Price (in Eqv. INR of Total contract price after conversion of Foreign Currency in INR with same exchange rate used for evaluation as per ITT clause E5.3).</del> <b><u>AOA (any one accident) limit equal to 6% of the original contract price stated in the letter of acceptance (LOA) with AOY (Any one year) limit of 10% of the original contract price for all the incidents in a calendar year and the deductible amount shall not be more than 5% of AOA limit.</u></b>
x.	Insurance cover for Contractor’s All Risk and other requirements as specified in the GCC	<del>Clause 15 of the GCC</del> <b><u>15.2.</u></b>	<b>100% of the Total <u>Original</u> Contract Price <u>stated in the letter of acceptance (LOA)</u></b>

xi.	Amount of Third-Party Insurance	15.3 of the GCC	<p>The amount of Third-Party Insurance for any one incident or all incidents put together, shall be as under:</p> <p><b>I. For Works with <u>Original</u> Contract Value <u>Price up to Rs. 50 Crore:</u></b> 10% (ten percent) of the <del>Total</del> <b><u>Original</u></b> contract value <b><u>price stated in the letter of acceptance (LOA)</u></b></p> <p><b>II. For Works with <u>Original</u> Contract Value <u>Price more than Rs. 50 Crore and up to Rs. 250 Crore:</u></b> Rs. 5.00 Crore for first Rs. 50 crores plus 5% (five percent) of the remaining <b><u>Original</u></b> contract value (<del>Total</del> <b><u>Original</u></b> contract value minus Rs. 50 Crore).</p> <p><b>III. For Works with <u>Original</u> Contract Value <u>Price more than Rs. 250 Crore and up to Rs. 500 Crore:</u></b> Rs. 15.00 Crore for first Rs. 250 crores plus 2% (two percent) of the remaining <b><u>Original</u></b> contract value</p>
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Contract MS07: “Design, Manufacture, Supply, Installation, Testing and Commissioning of Telecommunication System (Except Tetra System) Of Line 9 (From Dahisar East To RAI) and 7A (Andheri East to CSMIA) Corridor of Mumbai Metro Including Dongri Depot”

			( <del>Total</del> <b>Original</b> Contract value minus Rs. 250 Crore). <b>IV. For Works with <u>Original</u> Contract Value <u>Price more than Rs. 500 Crore</u></b> : Rs. 20.00 Crore for first 500 crores plus 1% (one percent) of the remaining <b>Original</b> contract value ( <del>Total</del> <b>Original</b> contract value minus Rs. 500 Crore) subjected to a maximum of Rs. 25.00 Crore.
xii.	<b><u>General Requirements for Insurances</u></b>	<b><u>15.5</u></b>	<b><u>Evidence/ Copies of the insurance policies to be submitted to the engineer within 2 weeks when the insurance is effected as per the time stated in SCC.</u></b>
xiii.	Contract Key Dates	Clause 8.5 of the GCC	Refer Appendix B of the Employer’s Requirement (Particular Specifications of Telecommunication System)
xiv.	Period in which all insurances have to be effected	Clause 15.5 of the GCC	<del>Within 4 weeks from the “date of commencement”</del> <b><u>Insurance shall be effective as per the time stated in the SCC.</u></b>
xv.	<del>(a) Contractor’s Name and Address</del>	<del>GCC clause 18.1</del>	<del>.....(Tenderer to Complete)</del>
	(b) Employer’s Name and Address	GCC clause 18.2	<b>Sr. GM/Contracts</b> Delhi Metro Rail Corporation Ltd., Metro Bhawan, Fire Brigade Lane, Barakhamba Road, New Delhi – 110001

Note:

\* For the purpose of calculation of a week for LD, a period of 4 or more days will be counted as a full week and period less than 4 days will be counted as half week.

Stamp & Signature of the Authorized person of the Tenderer

Date: .....

Place: .....

**FORM OF TENDER – APPENDIX 15**

**[As per clause E4.2 of ITT]**

**FINANCIAL DATA**

**(Following table shall be filled in for the tenderer and for each substantial member of JV/Consortium in case tenderer is JV/Consortium)**

**(TELECOMMUNICATION S&T SYSTEM WORK DONE DURING THE LATEST LAST FIVE FINANCIAL YEARS)**

**NAME OF THE BIDDER (CONSTITUENT MEMBER IN CASE OF JV/CONSORTIUM):**

**(All amounts in Rupees in crores)**

S. No.	DESCRIPTION	Financial Data for Last 5 Audited Financial Years				
		Year 2019-20	Year 2020-21	Year 2021-22	Year 2022-23	Year 2023-24
1	2	3	4	5	6	7
	Total value of Telecommunication <u>S&amp;T</u> System Work done as per audited financial statements					

**NOTE:**

1. Separate Performa shall be used for each member in case of JV/Consortium.
2. Attach attested copies of the Audited Financial Statements of the last five financial years as Annexure.
3. All such documents reflect the financial data of the tenderer or member in case of JV/Consortium, and not that of sister or parent company.
4. Historic financial statements must be complete, including all notes to the financial statements.
5. Foreign applicants, in whose country calendar year is also the financial year, may submit all relevant data for the last 5 years i.e. 2020, 2021, 2022, 2023 and 2024.
6. The financial data in above prescribed format shall be certified by Chartered Accountant / Company Auditor in original under his signature, stamp & membership number, UDIN No. and Firm Registration Number.
7. The exchange rate of foreign currency shall be applicable 28 days before the submission date of tender.

**FORM OF TENDER- APPENDIX 16**

**[As per clause E4.2 of ITT]**

**FINANCIAL DATA**

(Following table shall be filled in for the tenderer and for each substantial member of JV/Consortium in case tenderer is JV/Consortium)

(Commitment for On-going Telecommunication S&T System Works / Works in hand which are awarded to tenderer but yet not started as on last day of the month previous to the month of original tender submission)

Date.....

Tenderer’s legal name .....

JV/Consortium Member’s legal name .....

Page ....of.....

(All amounts in Rupees in Crores)

Name and brief particulars of contract (Clearly indicate the part of the Telecommunication <u>S&amp;T</u> System work assigned to the applicant (s))	Name of Client with telephone number and fax number	Contract Value in Rupees Equivalent (Give only the value of Telecommunication <u>S&amp;T</u> System work assigned to the applicant(s))	Value of balance Telecommunication <u>S&amp;T</u> System work yet to be done in INR equivalent as on the last day of the previous month of original tender submission	Date of Completion as per Contract Agreement	Expected Completion Date	Delay if any, with reason	Value of Telecommunication <u>S&amp;T</u> System work to be done during next ‘N’ Years prescribed completion time of the work being procured) with effect from the first day of the month of original tender submission (B)
<b>TOTAL</b>							

**Note:**

The above Appendix shall be certified by Chartered Accountant in original under his signature, stamp and membership number and Firm Registration Number and UDIN number.

STAMP & SIGNATURE OF AUTHORISED SIGNATORY

## FORM OF TENDER- APPENDIX 19A

(Undertaking as per clause 1.1.3.1v(c) of NIT)

(To be submitted by tenderer (single entity) or by each member of the JV/Consortium separately)

- (i) We do hereby undertake that following is the list of all the on-going ~~Signalling/~~Telecom works awarded by DMRC/ any other Metro Organisation (100% owned by Govt.) of value more than 40% of NIT cost of work and the list of completed Telecom works awarded by DMRC/ any other Metro Organisation (100% owned by Govt.) within last one year (from the last day of the previous month of tender submission) of value more than 40% of NIT cost of work.

Date.....

Tenderer’s legal name .....

JV/Consortium Member’s legal name .....

Page ....of.....

S. No.	Contract No. & Name of Work	Name of Employer/ Client	Name of the contractor including constituent members in case of JV/Consortium	Performance of work.	Performance based on
				*Satisfactory/ Unsatisfactory	*Client’s certificate/ Undertaking by tenderer
1					
2					
Add required number of rows					

\* Strike through whichever is not applicable.

- (ii) We also do hereby undertake that the performance of works has been indicated above for all the works which are either based on client/Employer certificate or our undertaking. We also understand that DMRC at its sole discretion may get performance of any such work, for which undertaking of satisfactory performance has been given by us, directly from the Client / Employer for the Works listed above and if performance from Client / Employer for such work is found to be unsatisfactory, we shall be considered non-compliant to the tender condition.

**Note:**

- a) The tenderer may either submit satisfactory performance Certificate issued by the Client / Employer for the works or give an undertaking regarding satisfactory performance of the work with respect to completion of work/execution of work (for on-going works) failing which their tender submission shall not be evaluated and the tenderer shall be considered non-responsive and non-compliant to the tender conditions. In case of non-submission of either satisfactory performance Certificate from Client / Employer or undertaking of satisfactory performance of any of the above work, the performance of such work shall be

treated as unsatisfactory while evaluating the overall performance of tenderer in terms of Note (b) below.

- b) If the tenderer or any of the constituent ‘substantial member(s)’ of JV/Consortium has reported four or less number of works in the Appendix 19A then there should not be any unsatisfactory performance in any of the works of tenderer or any of the constituent ‘substantial member(s)’ of JV/Consortium. Otherwise, the tenderer including the constituent ‘substantial member(s)’ of JV/Consortium shall be considered ineligible for participating in tender process. In other cases, if the Overall Performance of tenderer or any member of the constituent ‘substantial member(s)’ in case of JV/Consortium, in more than 20% of the works reported in the Appendix 19A (rounding off to the nearest lower whole number) is unsatisfactory, the tenderer including the constituent ‘substantial member(s)’ of JV/Consortium shall be considered ineligible for participating in tender process and they shall be considered ineligible applicants in terms Clause 1.1.3.1 of NIT.
- c) If there are any adverse remarks in the client’s completion/performance certificate, the same shall be examined during technical evaluation.
- d) If there is any misrepresentation of facts with regards to performance in any of the works reported above, the same will be considered as “fraudulent Practice” under clause 4.33.1a (ii) of GCC and the tender submission of such tenderers will be rejected besides taking further action as per Clause 4.33.1(b) & 13.2.1 of GCC.
- e) The undertaking shall be signed by authorized signatory of the tenderer or constituent member in case of JV/Consortium and counter signed by the authorized signatory of tenderer.

Stamp & Signature of Authorized Signatory

Example:

Works reported in the Appendix 19A	0-4	5	6	7	8	9	10	14
No. of unsatisfactory works acceptable	Nil	1	1	1	2	2	2	3

**FORM OF TENDER-APPENDIX-36**

**(Checklist to be submitted by the contractor for following details in all types of Insurances)**

<b>S. No.</b>	<b>Items</b>	
i	Name of the Project and its scope of work as per contract	
ii	Locations where work under contract needs to be done	
iii	Sum insured	
iv	Period of policy	
v	Joint coverage of DMRC in policy	
vi	Amount of Premium Paid	
vii	Enclose Receipt of Insurance Premium	
viii	Deductibles under policy	
ix	Risks covered under policy	
x	Risk excluded under policy	
xi	<p>In case insurance policy of DMRC contract is of Comprehensive Policy / Global Policy / Umbrella Policy, a letter is required from office of Insurance company who issued the original policy stating the following:</p> <ul style="list-style-type: none"> <li>a. Specific Sum Insured for DMRC Contract &amp; Location</li> <li>b. Deductible for the DMRC Contract both in terms of percentage of claim and minimum amount of claim.</li> <li>c. Specific endorsement for the project.</li> </ul>	

SEAL AND SIGNATURE OF AUTHORISED SIGNATORY

**Note: This detailed checklist to be submitted by Contractor along with insurance policy.**

**Contract MS07 : “Design, Manufacture, Supply, Installation, Testing and Commissioning of Telecommunication system (Except TETRA System) For Line 9 (From Dahisar East to Rai) and 7A (Andheri East to CSMIA) Corridor of Mumbai Metro including Dongri Depot”**

<b>Clause No.</b>	<b>GCC Clause</b>	<b>Description</b>
1		<p><b>Preamble</b></p> <p>SCC is to be read in conjunction with GCC. Entire clause of GCC is not replaced unless specifically mentioned in SCC against the relevant Clause</p>
<u>1A</u>	<u>1.1.1.20</u>	<p><u>Special Conditions of Contract</u></p> <p><u>The special conditions of contract shall supplement the GCC. Wherever there is a conflict, the provisions herein shall prevail over those in GCC.</u></p>
2	<b>Clause 1.4</b>	<p><b>Contract Agreement</b></p> <p>In addition to the provision in Clause 1.4 of GCC</p> <p>The Form of Contract Agreement shall be in the format given in Schedule 1 to these Special Conditions of Contract.</p>
3	<b>Clause 1.5</b>	<p><b>Priority of Documents</b></p> <p>The priority of the documents shall be as follows:</p> <ul style="list-style-type: none"> <li>(a) The Contract Agreement;</li> <li>(b) The Letter of Acceptance;</li> <li>(c) Pre and Post Bid Proceeds</li> <li>(d) Form of Tender incl. Appendices</li> <li>(e) Pricing Document / BOQ</li> <li>(f) NIT</li> <li>(g) ITT incl. Annexures</li> <li>(h) The Employer's Requirements:</li> <ul style="list-style-type: none"> <li>(i) Employer's Requirements – Particular Specifications;</li> <li>(ii) Employer's Requirements – General Specifications</li> </ul> <li>(i) Drawings</li> <li>(j) The Special Conditions of Contract incl. schedules</li> <li>(k) The General Conditions of Contract;</li> <li>(l) The Contractor's Proposal; and</li> <li>(m) Any other document forming part of the Contract.</li> </ul>
4	<b>Clause 1.8</b>	<p><b>Employer's Use of Contractor's Documents</b></p> <p>Add item(d) to Clause 1.8 of GCC:</p> <p>“The Contractor’s Documents and other design documents made by (or on behalf of) the Contractor can, without the Contractor’s consent, be used, copied or communicated to a third party by (or on behalf of) the Employer provided this information is used for DMRC’s work.”</p>
5	<b>Clause 2.2</b>	<p><b>Access to and Possession of the Site</b></p>

**Contract MS07 : “Design, Manufacture, Supply, Installation, Testing and Commissioning of Telecommunication system (Except TETRA System) For Line 9 (From Dahisar East to Rai) and 7A (Andheri East to CSMIA) Corridor of Mumbai Metro including Dongri Depot”**

Clause No.	GCC Clause	Description
7	Clause 4.2	<p>Performance Security Amount</p> <p>First para of sub-clause 4.2.1 of GCC is replaced with the following:</p> <p>Within 30 days from date of issue of the Letter of Acceptance, the successful Tenderer shall furnish Performance Security, for an amount of Ten per cent of the Contract value in types and proportions of currencies in which the Contract Price is payable either in the form of a Bank Draft, FDR or in the form of a Bank Guarantee from a branch in India of a scheduled foreign bank or from a scheduled commercial bank in India acceptable to the Employer. <b>The Performance Security shall be valid up to 6 months beyond the Defect Liability Period.</b>The Extension of time for submission of Performance Security beyond 30(Thirty) days up to 60 days from date of issue of LOA may be given by the Authority who is competent to sign the Contract Agreement. However, a Penal Interest of 15% per annum shall be charged for the entire period i.e. from the date of issue of LOA to the date of submission of Performance Security. In case the Contractor fails to submit the requisite Performance Security within 60 days from the date of issue of LOA, the Contract may be annulled duly forfeiting any dues, payable against the Contract. The failed Contractor shall be debarred not only from participating in re-tender for that work but also in any other tender of DMRC for a period of one year from date of issue of <b>letter of annulment of LOA</b>. The approved form provided in the “Instructions to Tenderers documents shall be used for Bank Guarantee.</p>
7A	4.2.4	<p><b><u>Replace the GCC Sub-clause 4.2.4. with the following:</u></b></p> <p>a. <b><u>Notwithstanding any other provision of the Contract: Submission by the contractor of the requisite Performance Security shall be the condition precedent to the Contractor’s entitlement to any payment, under the Contract; and</u></b></p> <p>b. <b><u>Failure by the Contractor to provide a Performance Security shall entitle the Employer either to suspend the works or to terminate the Contract forthwith by notice in writing to that effect, notwithstanding that the Contractor may have been permitted to proceed with the Works, and the Contractor shall not be entitled to any compensation whatsoever as a consequence of such suspension or termination.</u></b></p> <p>c. <b><u>The contractor shall submit a Letter of Comfort after award of LOA (as prescribed in Schedule 10 of SCC) in case the contractor is not using the Technical Credentials, Financial Credentials, Resources and IPR of its Parent Company.</u></b></p>
8	Clause 4.5	<p><b>Sub-contractors</b></p> <p>Following para is added to GCC clause 4.5.2:</p> <p>The Employer shall screen the sub-contractors and vendors listed in Appendix 29 of FOT. It will be obligatory for the Contractor to obtain Notice of No Objection from the Engineer to the identity of the sub-contractors and vendors selected by the Contractor from such screened list.</p> <p>For installation and other sub-contracts for items not included in Appendix 29 of FOT, each costing over Rs. Ten Lakh, it will be obligatory on the part of the Contractor to obtain consent of the Employer to the identity of the sub-contractor. The Employer will give his consent after assessing the technical suitability of the sub-system/system including proven performance, and feasibility of its maintenance in India, etc.</p> <p>The eligibility criteria for the sub-contractor/vendor shall be as</p>

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Clause No.	GCC Clause	Description
26	<b>Clause 7.12.5</b>	<p><b>Statutory Requirements</b></p> <p>The Design &amp; Construction Standards shall be in conformity with the requirements of "Rules for Opening of a Railway or a Section of a Railway for Public Carriage of Passengers" and "Rules for Introduction of New Type of Rolling Stock" and to the satisfaction of the Commissioner of Metro Railway Safety whose sanction is mandatory for commissioning of the System. Sanction of the Commissioner of Metro Railway Safety and other Statutory Authorities will be required for introduction of S&amp;T systems. The Contractor shall in this regard carry out all statutory tests and trials necessary for obtaining sanction of the Competent Authority for opening the respective section for public carriage of passengers and provide assistance and information as required by the appropriate statutory authorities in India.</p> <p>In the event that the Contractor employs a Designer, then the Contractor shall furnish a Designer's Warranty in the format given in Schedule 7 of SCC.</p>
27	<b>Clause 8.5</b>	<p><b>Liquidated damages for delays</b></p> <p>Following is added to the last of first para:</p> <p>“Liquidated damages shall be recovered as specified in Appendix-1 to the Form of Tender.”</p> <p><b><u>The Total Contract Value used in the GCC sub clause 8.5 for the purpose of levy of liquidated damages on failure to achieve key dates shall mean the ‘Original Contract Price’ stated in the letter of Acceptance</u></b></p>
28	<b>Clause 9.1</b>	<p><b>Taking Over Certificate</b></p> <p>Following is added in the last of Clause 9.1 of GCC</p> <p>d) If some part of work is not completed along with rest of the works in the contract and the Employer agreed for such splitting of work in writing, the Taking Over Certificate can be issued for that part of work which has been completed and accepted by the Employer. However, such splitting of work for issue of taking Over Certificate is sole discretion of the Employer.</p>
29	<b>Clause 10</b>	<p><b>Defects Liability</b></p> <p>Following Para is added to GCC clause 10.1</p> <p>During the Defects Liability Period the Contractor shall provide, free of cost, competent and skilled personnel and maintain adequate stock of spares so as to promptly fulfil his obligations</p>

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Clause No.	GCC Clause	Description
		<p>of submission of tender.</p> <p>(i). Any new tax, which is imposed on Composite Works Contracts / <u>works contract Service</u> applicable on Metro Project.</p> <p>(ii). Change in the rate of GST on Composite Works Contracts / <u>works contract Service</u> applicable on Metro Project as per GST Act.</p> <p>(b) The Contract Price shall be adjusted due to any of the above two conditions. Adjustment in Contract Price will be applicable up to the stipulated date of completion where such extension has been granted under Sub-Clause 8.4.1 of GCC or it is specifically mentioned that extension is with adjustment for changes as stated above.</p> <p>(c) If the extension of contract period is on account of contractor’s fault under Sub-Clause 8.4.3 of GCC, no compensation shall be made towards upward revision towards “change in Taxes/Duty (taking place during the said extended contract period)” as mentioned at Sl. No. (a)(i) &amp; (a)(ii) above. Any benefit on account of downward revision towards “change in Taxes and Duties” as mentioned at Sl. No. (a) (i)&amp; (a) (ii) above, during the original contract period or extended contract period shall be on employer’s account.</p> <p>(d) Any other changes (except on account of Clause (a)(i) &amp; (a)(ii) above) in existing taxes/new taxes on supply of materials/ services/works etc. will not be considered and its impact shall be considered covered in the price variation clause provided in the contract and in contract where price variation clause is not provided, the impact on any other change (except on account of clause (a)(i) &amp; (a)(ii) above in existing taxes/new taxes on supply of materials/ services/ works etc. will be deemed to be included in the quoted contract price.</p> <p>(e) Also, the contract price shall not be adjusted on account of fluctuations on the rates of exchange between foreign currencies of the contract and Indian rupees from the last date of submission of tender.</p> <p>(f) The contractor shall produce documentary evidence to establish the requirement of adjustment of contract price in view of (a)(i) &amp; (a)(ii).</p>

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<b>Clause No.</b>	<b>GCC Clause</b>	<b>Description</b>
34	<b>Clause 11.2.1</b>	<p><b>Mobilisation Advance</b></p> <p>First paragraph of Clause 11.2.1 of GCC is replaced by following:</p> <p>Mobilisation advance of 5% of the <del>Fixed Lump Sum Price</del> <b>Original Contract Price</b> <del>(will be given in two equal instalments)</del> <b>is payable.</b></p> <p>The first instalment shall be paid when the Contract becomes effective and second instalment shall be paid on production of effective and proper utilization of the first instalment. The contractor shall provide a CA certificate for proper utilization of first instalment of mobilisation advance for procurement of material, insurance, BG and mobilisation of resources for this project only. The advance payment shall be in the same proportion of currencies in which the <del>Fixed Lump Sum Price</del> <b>Original Contract Price</b> has been quoted.</p>
35	<b>Clause 11.2.2</b>	<p><b>Advance against Plant and Machinery</b></p> <p><del>No advance shall be paid against Plant and Machinery.</del></p> <p><b><u>Not applicable on this Contract.</u></b></p>
36	<b>Clause 11.3</b>	<p><b>Provisional Payment against Material at Site</b></p> <p>Not applicable on this Contract.</p>
37	<b>Clause 11.4.1</b>	<p><b>Application for Interim Payment Certificate</b></p> <p>Following is added to first para of GCC clause 11.4.1:</p> <p>Contractor may apply for part completion of any milestone, if the milestone activity has been at least 50% completed, along with supporting details justifying the percentage completion being requested. The milestone which has already been at least 50% completed, further part payment of the same milestones may be requested for completed portion of the milestone along with supporting details justifying the percentage completion being requested. The part payment shall be released maximum upto 80% of the milestone value if the approval status of the related documents and/or drawings is in NOSC (No Objection subject to comments) state. The Employer’s Engineer shall have the full authority to accept, modify or reject any such request. The decision of the Engineer shall be final and binding. Notwithstanding early completion of the Milestones or part of milestones, the payment to the Contractor at any time shall not exceed the cumulative monthly cash flows agreed at the time of award of the Contract.</p>
38	<b>Clause</b>	<b>Payment</b>

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Clause No.	GCC Clause	Description
		Performance Security amount shall not be forfeited. However, if it is not possible to recover/ adjust the risk and cost amount from any on-account / final bill of the Contractor under the Contract or any other Contract between the Employer and the Contractor, in that case, the risk and cost amount shall be recovered from the amount of Performance Security by forfeiting it to that extent.
43	15.1	<p><del>Deleted</del></p> <p><b><u>Professional Indemnity Insurance (PII):</u></b></p> <p><b><u>Start date, Finish date and Amount of PII are modified as below:</u></b></p> <p><b><u>Start date of "Professional Indemnity Insurance (PII) shall be from original contractual Key date of Preliminary design or 15 days from the date of approval of Preliminary Design, whichever is earlier.</u></b></p> <p><b><u>Validity of PII (Professional Indemnity Insurance) shall be 05 years after the date of expiry of DLP of last corridor/Trainset.</u></b></p> <p><b><u>Further, value of PII will be AOA (Any One Accident) and AOY (Any One Year) limit equal to 6% &amp; 10% respectively of the contract value. In the PII policy, the deductible amount shall not be more than 5% of AOA limit.</u></b></p> <p><b><u>Wherever the contractor _____ Wherever the contractor submits policy for shorter period / annual renewable policy, the same shall be renewed before its expiry date. In such situation, the performance guarantee shall be retained till required validity period. The contractor's submission of such shorter period / renewable policy shall be construed as their irrevocable consent for retention of the performance guarantee.</u></b></p>
	15.2	<p><b><u>Insurance for works &amp; Contractor's Equipment:</u></b></p> <p><b><u>Start date and Finish date are modified as below:</u></b></p> <p><b><u>Start date of "Insurance for works &amp; Contractor's Equipment" shall be 3 months from Notice to Proceed.</u></b></p> <p><b><u>Finish date of the insurance shall be till expiry of DLP of each work/corridor/section/OCC. Accordingly, option to reduce insurance amount will be given once a year, with the approval of DMRC, based on the work for which DLP has expired in the year.</u></b></p> <p><b><u>Following is added at the end of the GCC clause 15.2</u></b></p> <p><b><u>Installation All Risk Insurance shall cover physical loss or damage to the facilities at the Site, occurring prior to Operational Acceptance of the facilities, with an extended maintenance coverage for the Contractor's liability in respect of any loss or damage occurring during the Defect Liability Period while the contractor is on site for the purpose of performing its obligations during the Defects Liability Period.</u></b></p> <p><b><u>The insurance cover shall be for a limit of not less than 100% of the original contract price stated in the LOA.</u></b></p>

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Clause No.	GCC Clause	Description
	15.3	<p><u>Third Party Insurance:</u></p> <p><u>The insurance cover shall be for the amount specified in the Appendix-1 of the Form of Tender.</u></p> <p><u>Start date and Finish date are modified as below:</u></p> <p><u>Start date shall be 08 weeks from Notice to Proceed, as stated in LOA.</u></p> <p><u>Finish date shall be the expiry of DLP of the last section/station/OCC.</u></p>
	15.4	<p><u>Insurance for Workers:</u></p> <p><u>Start date and Finish date are modified as below:</u></p> <p><u>Start date shall be 08 weeks from Notice to Proceed, as stated in LOA.</u></p> <p><u>Finish date shall be the end of DLP of the last corridor/section/station/occ.</u></p>
	15.5	<p><u>Following is added at the end of the GCC clause 15.5</u></p> <ul style="list-style-type: none"> <li>i. <u>First Running on account bill and advances such as mobilization advance, plant and machinery advance, material advance etc. shall not be released unless contractor has taken all applicable insurance policies. If any lapse period is observed in insurance policies submitted by the contractor, action shall be taken as deliberated in clause (x) below.</u></li> <li>ii. <u>Contractor may exclude insurance coverage for risk on account of Terrorism.</u></li> <li>iii. <u>Contractor shall include RSMD (Riots, Strike and Malicious Damage) in EAR/CAR (Insurance for Works &amp; Contractor's Equipment) to cover risks related to damages or theft by Mobs.</u></li> <li>iv. <u>Engineer shall ensure that premium for the insurances taken by contractor are regularly paid by the contractor before releasing subsequent Running on Account Bill. If any lapse is observed in between the validity of insurance policies submitted by the contractor, action shall be taken as deliberated in clause (x) below.</u></li> <li>v. <u>Deductibles in EAR / CAR (Insurance for Works &amp; Contractor's Equipment) shall be as per the limit of deductibles allowed as per Tariff norms.</u> <u>Deductibles in PII shall not exceed five (05) percent value of AOA value.</u></li> <li>vi. <u>Cases of Insurances being effective from retrospective date: In some cases, premium is paid by the contractor in the current date, while insurances are stated to be effective from retrospective dates. Claims in such insurances will be considered by the insurance agency, from the date of payment of insurance premium only, therefore policy will be considered effective from the date of payment of insurance premium or from the start date mentioned in policy, whichever is later.</u></li> </ul>

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Clause No.	GCC Clause	Description
		<p><u>Any gap in insurance will attract penalty as defined in S.No. (x) below.</u></p> <p>vii. <u>A detailed checklist (in Appendix-37 to FOT) to be submitted by Contractor along with insurance policy.</u></p> <p>viii. <u>Status of all existing insurances in Monthly Progress Report- Contractor shall add a section in Monthly Progress Report (MPR) of the contract regarding status of all Insurance related to the contract (in a format giving details of all insurances (name of insurance agency, date of start, valid upto, date of payment of premium, invoice number, due date of next instalment of premium etc.)</u></p> <p><u>These details should be jointly reviewed by the concerned Executive and the associate finance. The relevant pages of MPR shall be sent to finance for review, every month. The latest report along with all insurances will be enclosed along with every Running Account bill/claim also for review by finance.</u></p> <p>ix. <u>Insurances will be considered valid from the date of payment of insurance OR the start date mentioned in policy, whichever is later.</u></p> <p>x. <u>In case of shortfall in insurance period, and if DMRC has not purchased the insurance, only pro rata Insurance premium plus 20% overheads &amp; profits to be recovered from the contractor, as per clause for Variation procedure.</u></p> <p><u>If DMRC has purchased insurance, then Insurance premium plus 50% overheads &amp; profits to be recovered from the contractor, as per clause in GCC/SCC.</u></p> <p>xi. <u>Details (Email Id, Mobile Number) of DMRC’s Engineer’s representative and associated Finance to be added in Insurance policy to receive timely alerts (related to premium due date, modification, claim etc.) regarding insurance policy.</u></p> <p>xii. <u>Final bill shall be released to the contractor after ensuring that all the insurance policies are valid as per the requirements of the contract.</u></p> <p>xiii. <u>In case the contract price exceeds beyond 25% of the original contract price, the contractor shall submit all the insurances as per the revised contract price before the payment beyond the original contract price plus 25% is made.</u></p> <p>xiv. <u>In case of insurance policy of DMRC Contract is part of comprehensive policy/ global policy/ Umbrella policy the contractor shall submit, a letter from the Insurance company which issued the original policy, stating the following:</u></p> <ol style="list-style-type: none"> <li>a. <u>Specific sum insured for DMRC contract and location.</u></li> <li>b. <u>Deductible for the DMRC contract both in terms of percentage of claim and minimum amount of claim.</u></li> <li>c. <u>Specific endorsement for the project.</u></li> </ol>

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Clause No.	GCC Clause	Description
		<p>xv. <u>The Contractor shall submit following details in all type of insurances</u></p> <p>a. <u>Name of Project/ Work and its scope as per contract.</u></p> <p>b. <u>Location where work under contract needs to be done.</u></p> <p>c. <u>Sum insured.</u></p> <p>d. <u>Period of Policy.</u></p> <p>e. <u>Joint coverage of DMRC in policy.</u></p> <p>f. <u>Amount of premium paid.</u></p> <p>g. <u>Receipt of insurance premiums.</u></p> <p>h. <u>Deductible under Insurance policy.</u></p> <p>i. <u>Risks covered.</u></p> <p>j. <u>Risks excluded.</u></p>
44	<b>Clause 16.5</b>	<p><b>Payment to Contractor</b></p> <p>Replace the GCC clause 16.5 with the following:</p> <p>Any loss or damage caused to supplied Equipment at site, lab and in trains due to natural calamities like flooding, typhoons and heavy storms etc. including rioting, fire etc. shall be covered by an insurance policy by the Contractor and he shall not be entitled for any payment against the loss or damage from the Employer. The Employer may however consider an extension to the Contract on this account if it is established that all reasonable precautions were taken by the Contractor.</p>
45	<b>17.9 b)</b>	<p><b>Arbitration:</b></p> <p>Replace the clause 17.9 b) with the following:</p> <p>The Arbitration proceedings shall be assumed to have commenced from the day, a written and valid demand for arbitration is received by Sr. GM/Contract on behalf of MD/DMRC” at following address: -</p> <p>Office of Sr. GM/Contract, Delhi Metro Rail Corporation Ltd. 5th Floor, A-Wing, Metro Bhawan, Fire Brigade Lane, Barakhamba Road, New Delhi –110001 Tel: 011-23415838</p>
46	<b>17.9.2 i)</b>	<p><b>Replace the clause 17.9 2 i) with the following:</b></p> <p>In case of Sole Arbitrator: Within 60 days from the day when a written and valid demand for arbitration is received by Sr. GM/Contract on behalf of MD/DMRC, the Employer will forward a panel of 03 names to the Contractor. The Contractor shall have to choose one Arbitrator from the panel of three, to be appointed as Sole Arbitrator within 30 days of dispatch of the</p>

**DELHI METRO RAIL CORPORATION LIMITED**

**MASS RAPID TRANSPORT SYSTEM**

**SPECIAL CONDITIONS OF CONTRACT**

**SCHEDULE 2**

**PARENT COMPANY UNDERTAKING**

**DELETED**

**PARENT COMPANY UNDERTAKING**

~~{Refer Clause 4.2.4 of GCC}~~

~~THIS UNDERTAKING~~ is made the \_\_\_\_\_ day of

BY [ \_\_\_\_\_ ] [whose registered office is at/[of] [ \_\_\_\_\_ ] ("the Parent Company").

TO ~~The DELHI METRO RAIL CORPORATION LIMITED together with its successors and assigns, "the Employer") of:~~

~~Metro Bhawan, Fire Brigade Lane,  
Barakhamba Road  
New Delhi 110001, India.~~

**WHEREAS**

(A) By a contract [ \_\_\_\_\_ ] dated [ \_\_\_\_\_ ] ("the Contract") made between (1) the Delhi Metro Rail Corporation Limited (" the Employer") and

~~(2) [ \_\_\_\_\_ ] ("the Contractor") the Contractor has agreed to design, execute, complete and remedy any defects in the works ("the Works") upon the terms and conditions contained in the Contract.~~

(B) Pursuant to the terms of the Contract, the Contractor has agreed to procure the provision of an undertaking in the terms hereof.

(C) The Parent Company is the beneficial owner of [ \_\_\_\_\_ ]% [See Note 1] of the issued share capital of [the Contractor [See Note 2].

(D) At the request of the Contractor, the Parent Company has agreed to provide this undertaking.

**NOW IT IS HEREBY UNDERTAKEN AND AGREED as follows:**

1. In consideration of the Employer entering into the Contract with the Contractor, the Parent Company hereby undertakes to the Employer that: –

(a) *the parent company will inform the Employer in the event that it sells transfers assigns or otherwise disposes of or deals with ownership of the whole or any part of the share holding or other interests in the subsidiary (the Contractor) of the parent company; and*

**Contract MS07 : “Design, Manufacture, Supply, Installation, Testing and Commissioning of Telecommunication system (Except TETRA System) For Line 9 (From Dahisar East to Rai) and 7A (Andheri East to CSMIA) Corridor of Mumbai Metro including Dongri Depot”**

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- ~~(b) In case of transfer of ownership/control of the subsidiary or of the parent company, an updated parent company guarantee and parent company undertaking will be provided from the new holding/ Parent company.~~
- ~~(c) not take any action which may result in the Contractor being unable to comply with his obligations or perform in any way his duties under the Contract [or take any action which may result in [the subsidiary forming part of the contractor] [See Note 3] being unable to comply with his obligations or perform in any way his duties under the [joint venture or other relevant] agreement] [See Note 6] without the written consent of the Employer,~~
- ~~(d) To provide full technical support including providing support with available patent rights, registered design, copyright, design, trademark, Trade Name, know how or other intellectual property right to our subsidiary during currency of the contract which may be deemed necessary to successfully comply with all obligations under this contract and for the service life of system/ equipment.~~

~~until such time as the Works shall have been completed, all the Contractor's obligations under the Contract shall have been performed and the Maintenance and Defects Liability Period (as defined in the Contract) for the whole and every part of the Works shall have elapsed and further that it will ensure [that the subsidiary forming part of the Contractor will take all steps necessary to ensure [See Note 6]] compliance by the Contractor with the provisions of the Contract.~~

2. ~~The obligations of the Parent Company under this Undertaking shall remain in full force and effect and shall not be affected or discharged in any way and the Parent Company hereby waives notice of:-~~

- ~~(a) any suspension of the Works, variation or amendment to the Contract (including without limitation extension of time for performance) or any concession or waiver by the Employer in respect of the Contractor's obligations [and/or the obligations of~~

~~[ \_\_\_\_\_ ] [See note 7]; \_\_\_\_\_~~

- ~~(b) any provision of the Contract being or becoming illegal, invalid, void, voidable or unenforceable;~~
- ~~(c) the termination of the Contract or of the employment of the Contractor [and/or [ \_\_\_\_\_ ] [See Note 7] under the Contract for any reason;~~
- ~~(d) any forbearance or waiver of any right of action or remedy the Employer may have against the Contractor [and/or [ \_\_\_\_\_ ] [See Note 7] or negligence by the Employer in enforcing any such right of action or remedy;~~

**Contract MS07 : “Design, Manufacture, Supply, Installation, Testing and Commissioning of Telecommunication system (Except TETRA System) For Line 9 (From Dahisar East to Rai) and 7A (Andheri East to CSMIA) Corridor of Mumbai Metro including Dongri Depot”**

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- (e) ~~any bond, undertaking, security or other guarantee held or obtained by the Employer for any of the obligations of the Contractor under the Contract [and/or [ ]][See Note 7] under the contract or any release or waiver thereof.~~
- 3. ~~This Undertaking shall extend to any variation of or amendment to the Contract and to any agreement supplemental thereto agreed between the Employer and the Contractor [and/or [ ]][See Note 7] and for the avoidance of doubt the Parent Company hereby authorises the Employer and the Contractor [and/or [ ]][See Note 7] to make any such amendment, variation or supplemental agreement.~~
- 4. ~~All documents arising out of or in connection with this Undertaking shall be served:~~
  - (a) ~~upon the Employer, at [ ] marked for the attention of [ ];~~
  - (b) ~~upon the Parent Company, at [ ] India [Note 8].~~
- 5. ~~The Employer and the Parent Company may change their respective nominated addresses for service of documents to another address in India but only by prior written notice to each other. All demands and notices must be in writing.~~
- 6. ~~This Undertaking shall be governed by and construed according to the laws for the time being in force in India and the Parent Company agrees to submit to the jurisdiction of the courts of Delhi/New Delhi.~~

~~**IN WITNESS** where of this Undertaking has been executed as a deed on the date first before written.~~

~~THE COMMON SEAL of [ ]~~

~~[ ]~~

~~was affixed hereto [ ]~~

~~in the presence of: [ ]~~

Notes: ~~(for preparation of but not for inclusion in the engrossment of this undertaking)~~

- 1. ~~If the parent Company is not the immediate parent company, the chain of ownership must be recited, identifying each company in the chain and the shareholdings or other interests in each subsidiary.~~
- 2. ~~If the Contractor comprises more than one company, the fact and the Joint Venture or other relevant agreement must be recited. In such case, insert the name of the subsidiary firm forming part of the Joint Venture, Partnership or Consortium, and in respect of which the parent company undertaking is being given.~~

**Contract MS07 : “Design, Manufacture, Supply, Installation, Testing and Commissioning of Telecommunication system (Except TETRA System) For Line 9 (From Dahisar East to Rai) and 7A (Andheri East to CSMIA) Corridor of Mumbai Metro including Dongri Depot”**

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3. ~~If note 2 applies, referred to the subsidiary of the parent company and not the contractor.~~
4. ~~If note 1 applies, use this alternative.~~
5. ~~If note 1 applies, add this provision.~~
6. ~~If note 2 applies, add this provision.~~
7. ~~If note 2 applies, add this provision and insert the name of subsidiary.~~
8. ~~The address for service shall be India.~~

**DELHI METRO RAIL CORPORATION LIMITED**

**MASS RAPID TRANSPORT SYSTEM**

**SPECIAL CONDITIONS OF CONTRACT**

**SCHEDULE 3**

**PARENT COMPANY GUARANTEE**

**DELETED**

**Contract MS07 : "Design, Manufacture, Supply, Installation, Testing and Commissioning of Telecommunication system (Except TETRA System) For Line 9 (From Dahisar East to Rai) and 7A (Andheri East to CSMIA) Corridor of Mumbai Metro including Dongri Depot"**

**PARENT COMPANY GUARANTEE**

**{Refer Clause 4.2.4 of GCC}**

~~THIS GUARANTEE is made on the.....day of .....between~~

~~(1) [.....] whose registered office is at [.....] and [.....] whose registered office is at [.....] ("the Guarantor").~~

~~(2) The Delhi Metro Rail Corporation Limited (together with its successors and assigns, "the Employer") of:~~

~~Metro Bhawan, Fire Brigade Lane, Barakhamba Road  
New Delhi 110001, India.~~

**WHEREAS**

~~(A) By a contract [No. ....] dated [.....] ("the Contract") made between (1) the Delhi Metro Rail Corporation Limited ("the Employer") and (2) [.....] ("the Contractor"), the Contractor has agreed to design, execute, complete and remedy any defects in the Works upon the terms and conditions contained in the Contract.~~

~~(B) Pursuant to the terms of the Contract, the Contractor has agreed to procure the provision of a guarantee in the terms hereof. [see Note 1].~~

~~(C) At the request of the Contractor, the Guarantor has agreed to guarantee performance of the Contract by the [Contractor] [see Note 2] as set out herein.~~

**IT IS HEREBY AGREED AS FOLLOWS:**

~~1. In consideration of the Employer entering into the Contract with the Contractor, the Guarantor irrevocably and unconditionally guarantees to the Employer as a primary obligation and not as a surety due performance by the [Contractor] [see Note 2] of all of its obligations and liabilities under and in accordance with the Contract save that nothing herein shall be construed as imposing greater obligations or liabilities on the Guarantor than are imposed on the [Contractor] [see Note 2] in the Contract.~~

~~2. The obligations of the Guarantor under this Guarantee shall remain in full force and effect and shall not be affected or discharged in any way by and the Guarantor hereby waives notice of:-~~

~~(a) any suspension of the Works, variation to or amendment of the Contract (including without limitation extension of time for performance) or any concession or waiver by the Employer in respect of the Contractor's obligations [and/or the obligations of [.....]] [see Note 3] under the Contract;~~

~~(b) any provision of the Contract being or becoming illegal, invalid, void, voidable or unenforceable;~~

~~(c) the termination of the Contract or of the engagement of the Contractor [ and / or [.....]] [see Note 3] under the Contract for any reason;~~

**Contract MS07 : “Design, Manufacture, Supply, Installation, Testing and Commissioning of Telecommunication system (Except TETRA System) For Line 9 (From Dahisar East to Rai) and 7A (Andheri East to CSMIA) Corridor of Mumbai Metro including Dongri Depot”**

---

- (d) ~~any forbearance or waiver of any right of action or remedy the Employer may have against the Contractor [ and / or [.....] [see Note 3] or negligence by the Employer in enforcing any such right of action or remedy;~~
  - (e) ~~any bond, undertaking, security or other guarantee held or obtained by the Employer for any of the obligations of the Contractor [ and / or [.....] [see Note 3] under the Contract or any release or waiver thereof.~~
3. ~~This Guarantee shall extend to any variation of or amendment to the Contract and to any agreement supplemental thereto agreed between the Employer and the Contractor [and/or [ ] [see Note 3] and for the avoidance of doubt the Guarantor hereby authorises the Employer and the Contractor [and/or [ ] [see Note 3] to make any such amendment, variation or supplemental agreement.~~
4. ~~This Guarantee is a continuing guarantee and accordingly shall cover all of the obligations and liabilities of the [Contractor] [see Note 2] under the Contract and remain in full force and effect until all the said obligations and liabilities of the Contractor shall have been carried out, completed and discharged in accordance with the Contract. This Guarantee is in addition to any other security which the Employer may at any time hold and may be enforced without first having recourse to any such security or taking any steps or proceedings against the Contractor.~~
5. ~~Until expiry of the Maintenance and Defects Liability Period (as defined in the Contract) for the whole and every part of the Works, the Guarantor shall not on any ground whatsoever make any claim or threaten to make any claim whether by proceedings or otherwise against the Contractor [and/or [ ] [see Note 3] for the recovery of any sum paid by the Guarantor pursuant to this Guarantee. Any such claim shall be subordinate to any claims (contingent or otherwise) which the Employer may have against the Contractor [and/or [ ] [see Note 3] arising out of or in connection with the Contract until such time as such claims shall be satisfied by the Contractor [and/or [ ] [see Note 3] or the Guarantor as the case may be. To that intent the Guarantor shall not claim or have the benefit of any security which the Employer holds or may hold for any monies or liabilities due or incurred by the Contractor [and/or [ ] [see Note 3] to the Employer and, in case the Guarantor receives any sum from the Contractor [and/or [ ] [see Note 3] in respect of any payment by the Guarantor hereunder, the Guarantor shall hold such sum in trust for the Employer for so long as any sum is payable (contingently or otherwise) under this Guarantee.~~
6. ~~The Employer shall be entitled to assign the benefit of this Guarantee at any time without the consent of the Guarantor or the [Contractor] [see Note 2] being required.~~
7. ~~All documents arising out of or in connection with this Guarantee shall be served:~~
- (a) ~~upon the Employer, at [ ], marked for the attention of [ ];~~
  - (b) ~~upon the Guarantor, at [ ] India [Note 4]~~
8. ~~The Employer and the Guarantor may change their respective nominated addresses for service of documents to another address in India but only by prior written notice to each other. All demands and notices must be in writing.~~

**Contract MS07 : “Design, Manufacture, Supply, Installation, Testing and Commissioning of Telecommunication system (Except TETRA System) For Line 9 (From Dahisar East to Rai) and 7A (Andheri East to CSMIA) Corridor of Mumbai Metro including Dongri Depot”**

---

9. ~~This Guarantee shall be governed by and construed according to the laws for the time being in force in India and the Contractor agrees to submit to the jurisdiction of the courts of India.~~

~~**IN WITNESS** whereof this Guarantee has been executed as a deed on the date first before written.~~

~~\_\_\_\_\_ THE COMMON SEAL of \_\_\_\_\_ )~~

~~\_\_\_\_\_ [ \_\_\_\_\_ ] \_\_\_\_\_ )~~

~~was affixed hereto in \_\_\_\_\_ )~~

~~the presence of: \_\_\_\_\_ )~~

Notes (for preparation of but not inclusion in the engrossment of this Guarantee)

1. ~~If the Contractor comprises more than one company, that fact, the joint venture or other relevant agreement and the relationship of the Guarantor to its subsidiary forming part of the Contractor must be recited.~~
2. ~~If Note 1 applies, replace the word "Contractor" with name of the subsidiary being guaranteed.~~
3. ~~If Note 1 applies, add additional wording and insert the name of the subsidiary being guaranteed.~~
4. ~~The address for service shall be in India.~~

**Contract MS07 : “Design, Manufacture, Supply, Installation, Testing and Commissioning of Telecommunication system (Except TETRA System) For Line 9 (From Dahisar East to Rai) and 7A (Andheri East to CSMIA) Corridor of Mumbai Metro including Dongri Depot”**

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**DELHI METRO RAIL CORPORATION LIMITED**

**MASS RAPID TRANSPORT SYSTEM**

**SPECIAL CONDITIONS OF CONTRACT**

**SCHEDULE 10**

**LETTER OF COMFORT**

Contract MS07 : “Design, Manufacture, Supply, Installation, Testing and Commissioning of Telecommunication system (Except TETRA System) For Line 9 (From Dahisar East to Rai) and 7A (Andheri East to CSMIA) Corridor of Mumbai Metro including Dongri Depot”

*[To be provided on Bidder's Letterhead]*

### **LETTER OF COMFORT**

To,  
**Senior General Manager/Contracts**  
Delhi Metro Rail Corporation Ltd.  
Metro Bhawan, Fire Brigade Lane,  
Barakhamba Road, New Delhi –110001.

**Subject: Contract MS07: “Design, Manufacture, Supply, Installation, Testing and Commissioning of Telecommunication System (Except Tetra System) Of Line 9 (From Dahisar East To RAI) and 7A (Andheri East to CSMIA) Corridor of Mumbai Metro Including Dongri Depot”**

Dear Sir,

This is in reference to the Contract MS07 between **Delhi Metro Rail Corporation Limited (“DMRC”)** and **(MS07 Contractor)**.

We hereby confirm that

1. We, (MS07 Contractor), are not utilising the technical credential, financial credential, resources and IPR of (Parent Company) and (MS07 Contractor) has participated for the subjected tender in Individual Capacity.
2. Should there be any sale, transfer, assignment or disposal otherwise, whole or any part of equity in (MS07 Contractor), during the currency of the Contract, we assure you that the same will be notified to DMRC.

Sincerely yours,

Authorised signatory of (MS07 Contractor)

*[Note:*

1. *All italicized text is for use in preparing this form and shall be deleted/replaced from the final product.*
2. *The Letter shall be submitted by tenderer (single entity) or by each member separately in case of JV/Consortium.]*



**DELHI METRO RAIL CORPORATION LIMITED**  
(A Joint Venture of Govt. of India & Govt. of NCT of Delhi)

**BIDDING DOCUMENTS**

**FOR**

**CONTRACT MS07**

**DESIGN, MANUFACTURE, SUPPLY, INSTALLATION, TESTING AND  
COMMISSIONING OF TELECOMMUNICATION SYSTEMS (EXCEPT  
TETRA SYSTEMS)**

**VOLUME 3: EMPLOYER'S REQUIREMENTS**

**PARTICULAR SPECIFICATIONS**

**CHAPTER 1 – TECHNICAL REQUIREMENTS**

**DELHI METRO RAIL CORPORATION LTD.  
5TH FLOOR, A-WING,  
METRO BHAWAN, FIRE BRIGADE LANE,  
BARAKHAMBA ROAD,  
NEW DELHI-110001,  
INDIA**



**DESIGN, MANUFACTURE, SUPPLY,  
INSTALLATION, TESTING AND COMMISSIONING**

**OF**

**TELECOMMUNICATION SYSTEMS  
(EXCEPT TETRA SYSTEMS)**

**CONTRACT MS07**

**PARTICULAR SPECIFICATIONS**

**CHAPTER 1**

**GENERAL REQUIREMENTS**



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**LIST OF DEFINITIONS**

In this Particular Specification, the following defined terms shall have the meanings ascribed to them below:

Availability	The probability that an item will be in a state to perform a required function under given conditions, at a given instant in time or over a time interval, assuming that the given external resources are provided
Corrective Maintenance	Maintenance performed to correct the occurrence of an equipment or system fault
Dark Fibre	An available, un-switched optical fibre
Engineer’s Train	A specially run non-passenger train used for engineering purposes
Integrated Training Facility (ITF)	An additional training system integrating separate functional training simulators to provide a “realism” training environment in the area of incident training
Line Replaceable Unit (LRU)	Equipment that can be replaced as a single complete unit and can be handled by a single person
Main Line	Lines other than those within the depot
Maintenance Track	Maintenance tracks are those tracks within the depot on which first, second and third line maintenance will be carried out
Man Machine Interface (MMI)	The visual interface between the Controller and the control system. The MMI consists of the computer screens, displayed objects, icons, and equipment as well as the facilities by which the Controller executes control
Mean Time To Restore (MTTR)	The average time to restore equipment, subsystems, systems to full functionality
Mimic	A graphical representation of the railway and its global operating status
Non-Passenger Train	A special train run without passengers, such as engineer’s trains or freight trains
Operating hours	MRTS Operating hours shall be (tentative) the following morning 7 days per week
Possession	Taking a section of the line out of service for engineering purposes
Preventative Maintenance	Periodic or regular maintenance performed in order to pre-empt the occurrence of equipment faults in the future. This shall include First, Second and Third Line Maintenance
Reliability	The measure of ability to rely upon equipment and systems to perform their intended function. The measure of reliability is MTBF.
Safety-Critical	Failure of the system, sub-system or equipment will directly lead to a situation with the potential to cause harm, injury, damage to property, plant or equipment, damage to the environment, or economic loss
Stopping Position	The specified point within a station at which the train is to stop
Sub-system	Any one of the eight systems comprising the System; i.e. Fibre Optic Transmission system, CTFRS system, Public Address system, Passenger Information Display system, Closed Circuit Television system, Telephone system, Master Clock System, Access Control System.
System	The Permanent Works described in the Particular Specifications



Train Description	An alphanumeric sequence uniquely identifying a running train
Train Operator/Driver	The person on the train responsible for its operation and who has to view the PF monitor from his sitting position on the cab.
Workstation	The collection of processors, screens and input devices necessary to provide one Controller with the necessary System displays and Commands
Station Control Room	A room for the Station Manager/Station Controller to monitor the running of trains and also the surveillance of the entire station for proper security and working.
Police Booth	The Police person at the station responsible for the surveillance of the entire station for proper security and working and at different location than the SCR.
RSS	(Traction) Receiving Sub Station along the Metro route where provision of CCTV cameras and Direct Line Telephone, integrating with the nearest station is required for viewing and for other communication requirements from the station and OCC/BCC to the RSS.

**LIST OF ABBREVIATIONS**

<b>ABBREVIATION</b>	<b>MEANING</b>
• AAL	• ATM Adaption Layers
• ACC	• Assistant to Chief Controller
• ADPCM	• Adaptive Pulse Code Modulated
• AFC	• Automatic Fare Collection
• AGC	• Automatic Gain Control
• ALARP	• As Low As Reasonably Practicable
• ASS	• Auxiliary Sub Station
• ASTM	• American Society for Testing and Materials
• ATM	• Asynchronous Transfer Mode
• BCC	• Backup Operation Control Centre
• BER	• Bit Error Rate
• BS	• British Standard
• BSHR	• Bidirectional Self Healing Ring
• BSNL	• Bharat Sanchar Nigam Limited (PSTN Company)
• CBR	• Constant Bit Rate
• CC	• Chief Controller
• CCD	• Charge Coupled Device
• CCIR	• International Radio Consultancy Committee
• CCITT	• International Telegraph and Telephone Consultative Committee
• CCTV	• Closed Circuit Television
• CD	• Compact (Optical) Disk
• CDRS	• Centralised Digital Recording System
• CENELEC	• European Committee for Electrotechnical Standardisation
• CER	• Central Equipment Room in OCC/BCC
• CMSS	• CCTV Management Software System
• CODEC	• Coder/Decoder
• CSS	• Communication System Supervisor
• CTU P	• Central Terminal Unit (Traction) Power
• CTU T	• Central Terminal Unit Telecommunication
• DAT	• Digital Audio Tape



ABBREVIATION	MEANING
• DCC	• Depot Control Centre
• DCE	• Data Communication Equipment
• DDF	• Digital Distribution Frame
• DDP	• Digital Distribution Panel
• DID	• Direct Inward Dialing
• DMRC	• Delhi Metro Rail Corporation
• DOT	• Department of Telecommunication
• DTC	• Depot Traffic Controller
• DTE	• Data Terminal Equipment
• DTMF	• Dual Tone Multi Frequency
• DVA	• Digital Voice Announcer
• EIA	• Electrical Industries Association
• EMC	• Electromagnetic Compatibility
• EMI	• Electromagnetic Interference
• EMU	• Electric Multiple Unit
• EPABX	• Electronic Private Automatic Branch Exchange
• ESP	• Emergency Stop Plunger
• ETU	• Engineering Train Unit
• FCP	• Fire Control Panel
• FOTS	• Fibre Optic Transmission System
• FSD	• Fire Services Department
• GPS	• Global Positioning System
• GS	• General Specification
• GUI	• Graphic User Interface
• HCL	• Hydrochloric Acid
• HQ	• Headquarters
• HV	• High Voltage
• HVAC	• Heating Ventilation Air Conditioning
• ICAO	• International Civil Aviation Organisation
• IDC	• Insulation Displacement Connector
• IEC	• International Electro-technical Commission
• IEE	• Institute of Electrical Engineers
• IEEE	• Institute of Electrical and Electronic Engineers
• IP	• Internet Protocol
• IR	• Infra-Red
• ISDN	• Integrated Services Digital Network
• ISO	• International Organisation for Standardisation
• IT	• Information Technology
• ITU-R	• International Telecommunications Union - Radio
• TU-T	• International Telecommunications Union– Telecommunications
• IVRS	• Interactive Voice Response System
• JPEG	• Joint Photographic Expert Group
• KB	• Key Board
• LAN	• Local Area Network
• LCD	• Liquid Crystal Display
• LCX	• Leaky Coaxial Cable
• LED	• Light Emitting Diode
• LSOH	• Low Smoke Zero Halogen
• LV	• Low Voltage



ABBREVIATION	MEANING
• MDF	• Main Distribution Frame
• MMI	• Man-Machine Interface
• MCK	• Master Clock System
• MRTS	• Mass Rapid Transport System
• MRTS HQ.	• Mass Rapid Transport System Head Quarter office
• MTBF	• Mean Time Between Failures
• MTTR	• Mean Time To Repair
• NFPA	• US National Fire Protection Association
• NMS	• Network Management System
• NTSC	• National Television Standards Committee
• NVR	• Network Video Recorder
• O&M	• Operations and Maintenance
• OAM&P	• Operations, Administration, Maintenance & Provisioning
• OCC	• Operations Control Centre
• ODF	• Optical Distribution Frame
• OLTE	• Optical Line Terminating Equipment
• ONVIF	• Open Network Interface Forum
• PAL	• Phase Alternation Line
• PAS	• Public Address System
• PB	• Police Booth
• PCM	• Pulse Code Modulation
• PIDS	• Passenger Information Display System
• PPIO	• Program Planning and Investigation Office
• PIP	• Picture In Picture
• PMP	• Point To Multipoint
• POE	• Power Over Ethernet
• PS	• Particular Specification
• PSB	• Platform Supervisors Booth
• PSE	• Power Supply Equipment
• PSTN	• Public Services Telephone Network
• PTP	• Point To Point
• PTT	• Press To Talk
• PTZ	• Pan/Tilt/Zoom
• QA	• Quality Assurance
• QRA	• Quantified Risk Assessment
• RAMS	• Reliability, Availability, Maintainability and Safety
• RDSO	• Research Design and Standards Organisation (IR)
• RFI	• Radio Frequency Interference
• RSS	• Receiving Sub Station
• SCADA	• Supervisory Control And Data Acquisition
• SCR	• Station Control Room
• SDH	• Synchronous Digital Hierarchy
• SMS	• Station Management System
• SP	• Sectioning Post
• SSP	• Sub Sectioning Post
• STM	• Synchronous Transport Module
• S&TC	• Train Control & Signalling
• TER	• Telecommunications Equipment Room in Stations and Depot
• TMN	• Telecommunications Management Network



<b>ABBREVIATION</b>	<b>MEANING</b>
• TOT	• Transfer of Technology
• TPC	• Traction Power Control
• TSS	• Traction Sub Station
• UG	• Under Ground
• UHF	• Ultra High Frequency
• UPS	• Uninterruptible Power Supply
• UTC	• Universal Co-ordinated Time
• UV	• Ultra Violet
• VDU	• Visual Display Unit
• VHF	• Very High Frequency
• VOIP	• Voice Over Internet Protocol
• VRLA	• Valve Regulated Lead Acid
• WAN	• Wide Area Network



**1. INTRODUCTION**

**1.1. SCOPE AND PURPOSE**

**1.1.1.** This Specification covers the design, manufacturing, delivery, installation, testing, commissioning and support for the telecommunication sub-systems to be supplied under this Contract, as described in the relevant chapters as detailed below:

**1.1.2.** The Particular Specification is divided into Twelve chapters:

CHAPTER	TITLE
1.	General requirements (This Chapter)
2.	Public Address System
3.	Passenger Information Display System
4.	Master Clock System
5.	Centralized Digital Recording System (CDRS)
6.	CTFRS
7.	Telephone Communication System & 48V DC Backup Supply
8.	CCTV Video Surveillance System
9.	Fibre Optic Transmission System
10.	Appendices and Interface Management
11.	IT System
12.	Access Control System

**Table 1.1: Chapters of the Particular Specification of Telecommunications Systems**

**1.1.3.** Chapter 1(This Chapter) covers scope of the works in general common to all Telecommunication sub-systems, i.e. system design, verification of testing, commissioning, maintenance support, spares, special tools, test equipment, training, documentation, packing, shipping, storage, delivery, installation, operation, power distribution and programme requirements of all sub-systems.

**1.1.4.** Chapter 2 of this Particular Specification specify the particular scope of works and performance, functional and design requirements and interfaces of the Public Address System.

**1.1.5.** Chapter 3 of this Particular Specification specifies the particular scope of works and performance, functional and design requirements and interfaces of the Passenger Information Display System.



- 1.1.6. Chapter 4 of this Particular Specification specifies the particular scope of works and performance, functional and design requirements and interfaces of the Master Clock System.
- 1.1.7. Chapter 5 of this Particular Specification specifies the particular scope of works and performance, functional and design requirements and interfaces of the Centralised Digital Recording system (CDRS).
- 1.1.8. Chapter 6 of this Particular Specifications specifies the particular scope of works performance, functional, and design requirements and interfaces of the CTFRS.
- 1.1.9. Chapter 7 of this Particular Specification specifies the particular scope of works and performance, functional and design requirements and interfaces of the Telephone System.
- 1.1.10. Chapter 8 of this Particular Specification specifies the particular scope of works and performance, functional and design requirements and interfaces of the CCTV Video Surveillance system.
- 1.1.11. Chapter 9 of this Particular Specifications specifies the particular scope of works performance, functional, and design requirements and interfaces of the Fibre Optic Transmission System including Wide Area Network.
- 1.1.12. Chapter 10 of this Technical Specifications specifies the interface specifications, Key Dates & Access Dates, Cable Specifications, List of Contract Spares, Section details, Provision of MMI Schedule, Earthing Policy etc.
- 1.1.13. Chapter 11 of this Particular Specifications specifies the particular scope of works performance, functional, and design requirements and interfaces of the IT System.
- 1.1.14. Chapter 12 of this Particular Specifications specifies the particular scope of works performance, functional, and design requirements and interfaces of the Access control system

**1.2. RELEVANT DOCUMENTS**

- 1.2.1. This Particular Specification (PS) shall be read in conjunction with the General Condition of Contract (GCC), the General Specification (GS), and any other document forming part of the Contract.
- 1.2.2. In the event of a conflict between the GS and the PS, the requirements of the PS shall prevail.
- 1.2.3. In the event of a conflict between the PS and any other standards or specifications quoted in the PS, the requirements of the PS shall prevail
- 1.2.4. Notwithstanding the contents of Sections 1.2.2. and 1.2.3. above, the Contractor shall always immediately seek advice from the Employer's Representative in the event of conflicts between specifications.

**1.3. EMPLOYERS DRAWINGS**

- 1.3.1. Employer's drawings consist Reference Drawings for typical stations, Depot layout plans and OCC/BCC. All drawings are conceptual design drawings and details shown on the drawings are for information only. The accuracy of



preliminary details shown on the drawings can't be guaranteed and should be treated accordingly.

**1.4. RELEVANT CODES AND SPECIFICATIONS.**

**1.4.1.** The Sub-system and its constituent parts shall comply with the relevant latest version of British Standards, International Electromechanical Commission (IEC) standards, International Organization for Specification (ISO) Standards, European Standard (EN) or UL Standards (Underwriters Laboratory) etc. as specified below:

S. No.	Details	Standards
1.	Safety of information technology equipment, including electrical business equipment.	EN 60950-1:2006
2.	Power Transformers	IEC 60076, EN 60076
3.	Protection Class for Components	As specified for individual equipment in this PS.
4.	Surge Protective Devices	IEC 61643 – 1
5.	EMC – Immunity	IEC 60801, EN 60801
6.	EMC – Emission	VDE 0875, IEC 60555, EN 60555
7.	Electromagnetic compatibility Testing and Measurement Techniques	IEC 61000-4, EN 61000-4, BS EN 50121
8.	Inter system EMC	EN 50082, EN 50121, EN 50123, EN 50155, IEC 571, IEC 1000 or equivalent
9.	RFI Suppression	EN55022A or VDE 0878
10.	Level measuring systems utilizing ionising radiation with continuous or switching output	IEC 60982
11.	Sound Level of Noise Source	ISO 3746, BS 4196–6
12.	Flammability Tests	IEC 60707
13.	Valve Regulated Sealed Lead Acid Rechargeable Single Cells	IRS: S93-96, DOT: TQ510G 92
14.	Low-voltage Switchgear and Control gear Assemblies	IEC 60439 – 1, EN 60439–1
15.	Low-voltage Switchgear and Control gear	IEC 60947, EN 60947, IEC947- 3, IEC 60898 or EN 60898
16.	Specification for contactors	IEC60947 – 4, EN 60947-4
17.	Code of practice for Earthing	IEEE 1100, NFPA 780, IEC 1024
18.	Transient Protection	MIL-STD-7041A
19.	Lightning Protection	BS-6651
20.	Quality	ISO 9001
21.	International Standard MPEG-4 Video	ISO/IEC 13818-2:2002 or later edition



S. No.	Details	Standards
22.	Specification for Safety of Information technology equipment including electrical business equipment.	BS EN 60950-1:2006
23.	Electromagnetic Compatibility (EMC) : Generic standards immunity for Industry environments.	BS EN 61326 (Annex A)
24.	Specification for safety requirements for equipment to be connected to telecommunication networks.	BS EN 41003:1999
25.	Safety requirements for electrical equipment for measurement, control & laboratory use.	BS 61010-1:2003/A2:1995
26.	Secondary protectors for Communication Circuits.	Underwriters Laboratory safety std 497A
27.	Any other specifications pertaining to MRTS & not included in this list.	

**1.5. OVERVIEW OF TELECOMMUNICATIONS SYSTEM**

- 1.5.1.1. For efficient Metro railway management and operation, it is essential to have a well-organized telecommunication network covering strategic locations like OCC/BCC, passenger stations, depot, and it is equally essential to have reliable links between the strategic locations and moving trains or working staff along the railway track/Tunnel.
- 1.5.1.2. The FOTS and Wide Area Network being provided under FOTS Sub-system of this Contract shall provide all necessary communication channels for carrying voice, data, and video signals for Metro railway management and operation from Station/Depot TER to OCC and BCC CER. The Transmission Backbone is to be used for Communication Based Train Control system.
- 1.5.1.3. A Master Clock System shall be provided under Master Clock Sub-System of this Contract to distribute time signal to all the clocks at stations and Depot and OCC/BCC. Master Clock System shall also provide reference timing signals for all Telecommunication and other systems for network synchronization.
- 1.5.1.4. This backbone transmission network, which shall provide the necessary communication channels in the MRTS, shall be of adequate high quality, and shall have high reliability, availability and expandability. On this backbone network in the MRTS, a private telephone exchange network shall be constructed to provide basic telephone communication within the MRTS it shall be used for MRTS management, personnel management, facility maintenance, train operation and passenger guidance.
- 1.5.1.5. The telephone communication system shall also consist of a direct line telephone communication network exclusively for the train operation and maintenance functions.
- 1.5.1.6. A Centralized Digital Voice Recording System is to be provided in CERs at the OCC and BCC for multichannel voice recording of direct line communication, two way radio conversations, emergency or fire messages



broadcast on station PAS and train borne PAS initiated from OCC/BCC.

- 1.5.1.7. At the stations, a suitable Public Address System shall be provided for making announcements to passengers regarding train arrival / departure and shall work as the primary means of communication with passengers and staff during emergencies. In the normal case, audio-broadcast shall be made from Station Control Room or Platform Supervisor's Booth/Panel and in a train by the driver. However, it shall also be possible for the OCC/BCC to make announcement to any station, group of stations or all stations.
- 1.5.1.8. A Passenger Information Display system triggered by TC& S system shall automatically provide real time visual information about train arrival/departure throughout the station. The PIDS display shall be co-ordinated with PAS for real time passenger audio broad casts for train arrival/departure. PIDS shall enable the operator in SCRs and OCC & BCC to display routine and special emergency messages for passengers and staff in stations. Display boards shall be provided for each platform side at all stations and in concourse at all stations of Mumbai Metro.
- 1.5.1.9. A CCTV station surveillance system shall be built through CCTV sub-system of this contract for supervising strategic operational locations like Station car park, AFC gates, ticketing offices and lobby, escalator, Lifts and staircase exits and platform operational area and PF ends to ensure safe operation of the Metro and security locations at stations. It shall be supervised from the station control room and Security room at each station simultaneously, and these video signals shall also be transmitted to the OCC & BCC both as live and as recorded from the stations/Depot for remote supervision. Similarly, a CCTV depot surveillance system shall be built under this contract. It shall be supervised locally from DCC & Security and remotely from OCC/BCC.
- 1.5.1.10. A Central Telecommunication Fault Reporting System (CTFRS) shall also be provided for the showing the alarms of various Telecommunication sub-systems / equipments.

**1.6. SYSTEM INTEGRATOR (SI)**

1.6.1.1. To achieve a completely integrated system, there is a need for the integration of Telecommunication subsystems and the IBMS in each of the stations and at the OCC/BCC level. To achieve this, it would be important that each of the NMS of Telecommunication subsystems should posses a framework, to be able to integrate with a third party centralized IBMS/SCADA system and its applications for enabling the relaying of its status and alarm information. The status and alarm information should be relaid through any of the following methods:

1. Snmp-v1
2. Snmp-v2
3. Snmp-v3
4. web service
5. Through api (application programming interface)
6. Through cli (command line interface)



7. At db level (Dbase integration SQL, My SQL)

The seamless integration including interoperability among all telecom subsystems of Line7 A and Line9 with existing Line-7, 2A and 2B shall also be responsibility of telecommunication System Contractor

**2. SCOPE OF THE WORKS**

**2.1. GENERAL REQUIREMENTS**

2.1.1. The scope of the works includes but not limited to design, design coordination with other Contractors, design submission, design approval, supply, manufacture, FAT inspection, packing, shipping, transportation, storage, delivery, handling, insurance, installation, interfacing, interfacing with other project contractors and interface design submission, integration with other systems, testing at Site & commissioning, Integrated testing with Other Project Contractors, maintenance support, spares, special tools, test equipment, training, Maintenance supervision assistance, documentation and providing DLP warranty (Defect Liability Period) for the entire Telecommunication systems.

2.1.2. For Line-7A and 9, OCC/BCC of Line 7, 2A & 2B shall be used.

2.1.3. The seamless integration among all telecom subsystems of Line7 A and Line9 with existing Line-7, 2A and 2B shall also be responsibility of telecommunication System Contractor

**2.2. SCOPE OF SUPPLIES**

2.2.1. The scope of supply shall include all necessary hardware, software, firmware, accessories, materials and documentation. The detailed requirements shall be as given for each sub-system in the relevant Chapter of this Particular Specification. The MS07 Contractor to please note that - in addition to any stipulation in the relevant Chapter for the particular sub system, pricing document gives the minimum BOQ to be covered as part of the scope of work and any other item or enhancement of the listed items required to complete the MS07 Contract shall also be provided as part of this lump sum Contract.

2.2.2. The supply scope shall be for 12 stations (10 of Line-9 (Dahisar East- Rai) and 2 stations of Line-7A (Andheri East- CSMIA) including Dongri Depot and OCC & BCC)

**2.3. SCOPE OF SERVICES**

2.3.1. The detailed requirements of the services to be provided by the Contractor shall be as given in the GS and PS.

2.3.2. The scope of services to be performed by the Contractor shall include, but not be limited to, the following:

1. Design, manufacture, delivery, system assurance, installation, testing and commissioning of the individual Sub- System as described in the relevant Chapter pertaining to each sub-system.(Services such as Design, installation, testing and commissioning is to be done for 8 stations (6 stations of Line-9 (Sai Baba Nagar- Rai) and 2 stations of Line-7A (Andheri East – CSMIA) including Dongri Depot and



existing OCC & BCC of Line-7) except for scope of work pertaining to Additional 244 fiber optical cable along the track to meet present Commercial requirement for Line 9 & 7A and viewing of CCTV images of Lift Cameras which are to be done for complete Line-9 (10 Stations (Dahisar East- Rai) and Line-7A (2 stations of Line 7A (Andheri East- CSMIA)) including Dongri Depot (if required).)

2. Design, Supply and Installation of Base Frame, False Floor & under False Floor Cable Trays with required risers for wall mounted units in TER of Stations/Depot and under false floor cable trays in SCR. List of Stations/Depot (The scope of the MS07 Contractor) is given in Appendix C Chapter 10 of this PS.
3. Presentations, reviews and audit support as specified in the Specification.
4. Project management of the implementation of the System.
5. Quality and safety management.
6. Overall site supervision and management.
7. Decommissioning, removal and disposal of Temporary Works.
8. Operation and maintenance support services.
9. Preparation and submission of documentation.
10. Training for Employer's Training Instructors, operations staff, maintenance staff and engineering staff.
11. Recommendation and provision of spares, tools and test equipment.
12. Manpower resources.
13. Main earth extension from Earthing strip in TER to Rack.
14. Prototypes, mock-ups, emulation and simulation as required.
15. Provision of clean earth and extension up to TER/UPS (if required)
16. Any other services requirement for satisfactory commissioning of the telecommunication system

**2.3.3.** All references to the Operations Control Centre (OCC) elsewhere in the PS shall be taken to refer to the Backup Control Centre (BCC) if the BCC is controlling the corridor, and Telecom system Equipment has to be provisioned accordingly.

**2.3.4.** Initially, existing BCC & OCC shall be responsible for monitor and control of line 7A and Line 9. In future, integrated OCC at Mandale shall be utilized for monitoring and controlling Line 2A, 2B, 7, 7A & 9.

**2.3.5.** Reference be made to the Appendix of the Chapter 10 of this PS for Key Dates, Access Dates and for Sections.

**2.4. WORK EXCLUDED FROM THIS CONTRACT**

**2.4.1.** All equipment, material, facilities and services to be provided by other Project



Contractor as specified in the interface Specification shall not be supplied as part of this Contract.

**2.5. THE SITE**

**2.5.1.** The site for the Permanent works shall include stations, depot, OCC & BCC. It will cover equipment rooms at stations, OCC & BCC, Depot, viaducts, bridges, RSSs and at grade tracks as also all the ancillary buildings along the alignments, stations, Depot.

**2.6. EMPLOYER'S FACILITIES**

**2.6.1.** The contractor shall submit to the Employer's Representative details and notice of intention to use any of the Employer's facilities like works area and the period of usage. This shall be submitted in accordance with the provisions in the GS. The Contractor shall note that the works areas may have to be relocated from time to time to suit the requirements of the Employer.

**2.7. CONTRACTOR'S PREMISE (PROJECT OFFICE/STORAGE SPACE)**

**2.7.1.** The Contractor shall be provided approximate space of 500 SQM to set up Project Office and Storage Space for telecom segments. The MS07 Contractor shall necessarily have to station at this Project Site Office throughout the contract period, the key personnel for design and implementation- co-ordination etc. and shall submit a list for the same to review.

**2.8. ASSET MANAGEMENT**

**2.8.1.** The Contractor shall develop and maintain an Asset Database for all assets provided under the contract, including equipment with serial number and version number, software with version number, system, configurations, documentation. The Contractor shall handover the initial database to the Employer on completion of the testing and commissioning works. The Contractor shall be responsible to maintain and update the Asset Database until the end of the Defect Liability Period, and handover the final database to the Employer.

**3. PERFORMANCE REQUIREMENTS**

**3.1. GENERAL**

**3.1.1.** The Contractor shall ensure that all equipment and material used is able to meet the specified availability throughout its service life as required to minimise disruption to the railway operation and to minimise the ongoing maintenance costs.

**3.1.2.** The Systems shall be so designed as to have a minimum of 15 years of service life operating continuously for the equipments (excluding Servers & workstations) For Servers & workstations it shall be 10 years. The life of all the cables shall not be less than 25 years.

**3.1.3.** The system shall be designed to facilitate normal train and station operation, management of incidents and abnormal operations as well as of emergencies.



**3.1.4.** The System shall, to the extent practicable, have no credible failure mode, which will directly cause an interruption to security surveillance or delay in the train services. The Contractor shall demonstrate that the probability of occurrence of the credible failure mode, if any, has been reduced to ALARP (as low as reasonably practicable) and no further cost-effective means of improving reliability can be identified.

**3.2. RELIABILITY REQUIREMENTS**

**3.2.1.** The inability to perform a required function, the occurrence of unexpected action by the equipment, or the degradation of performance to below the required specifications shall constitute a failure.

**3.2.2.** The Mean-Time-Between-Failures (MTBF) figure requirements for major equipment of each sub-system shall be as given in the relevant Chapters of this Particular Specification. These MTBF figures specify the minimum reliability requirement of all major equipment. If higher MTBF figures are required to achieve the required level of System availability, the Contractor shall adopt suitably higher MTBF figures in equipment selection.

**3.2.3.** Reliability calculations shall be based on data from past experience where such data is available for similar applications. Where there is no such information available, parts-count data or other generic data sources shall be used. The order of preference for data reliability prediction shall be as below:

- a) Data from operation of identical equipment in a similar railway environment, under similar conditions of usage, maintenance and climate
- b) Data from operation of similar equipment in a railway environment
- c) Specific test data carried out in simulated conditions appropriate for Metro Rail.
- d) Data from operation of similar equipment in a non-railway environment
- e) Data based on parts-count analysis or any other generic data sources

**3.2.4.** The Contractor shall assure reliability throughout all aspects of the design, manufacturing, installation and testing as necessary to satisfy the reliability requirements.

**3.2.5.** The Contractor shall submit Reliability Plan to the Employer's Representative for review in accordance with RAMS Plan.

**3.2.6.** The Reliability Plan shall describe the analytical methods to be used during design and development to demonstrate compliance with reliability requirements and identification of reliability-critical items in the System offered.

**3.2.7.** The Reliability Plan shall identify a comprehensive list of reliability-related submissions such as specifications, standards, method statements, procedures, drawings and records to the Employer's Representative for review. The Reliability Plan shall include the dates of the submissions.



**3.3. AVAILABILITY REQUIREMENTS**

- 3.3.1. Detailed availability requirements are given in the relevant Chapters of this Particular Specification pertaining to each individual telecom sub-system.
- 3.3.2. The Contractor shall submit calculations with reliability block diagrams for each sub- system to demonstrate the compliance with required availability figures. The availability calculation shall take all possible failure modes into consideration. The calculation shall be based on the Contractor's submitted equipment MTBF figures, MTTR figures and the configuration of each sub-system.
- 3.3.3. The Contractor shall predict the system failure rate or MTBF figures of each sub-system from the availability calculations.
- 3.3.4. Equipment duplication, hot-standby protection, parallel-run, path diversity, etc. shall be adopted whenever necessary and appropriate to meet the required availability.
- 3.3.5. Error detection and correction mechanism shall be included in the communication links as appropriate depending on the nature and functional criticality of the data conveyed.
- 3.3.6. Switchover between redundant equipment, or between redundant routings, shall occur automatically and immediately upon failure and shall be transparent to the users. Toggling in switchovers shall be prevented.
- 3.3.7. The Contractor shall conduct analysis and propose methods, if any, for further improvement of the availability of each sub-system beyond the minimum required availability figures mentioned above.

**3.4. MAINTAINABILITY REQUIREMENTS**

- 3.4.1. The System shall be designed such that the MTTR figures for restoring the operation of the System from fault condition shall not be more than four hours (excluding time of travel).
- 3.4.2. The MTTR figure shall be calculated from the individual equipment weighted by the failure rate of the equipment.
- 3.4.3. The MTTR figure shall be the total time calculated from the moment the occurrence of the fault at site is reported to the maintenance personnel to the time when the System is fully restored to normal operation.
- 3.4.4. The Contractor shall provide the history records from past works showing the achievement of MTTR figures declared. Where such records are not available, the Contractor shall provide simulation of faults to demonstrate that the declared MTTR figures are indeed achievable.
- 3.4.5. All plug-in modules shall permit hot swapping so as not to affect the normal or emergency operation of the System.
- 3.4.6. All line replaceable items shall not exceed the size and weight, which an average individual person can handle.
- 3.4.7. The System shall be suitably designed to minimise the need for frequent preventive maintenance.



- 3.4.8. The System shall be so designed as to avoid the need for a total shutdown for preventive maintenance. In the event that a total shutdown is inevitable, the preventive maintenance shall not require the System to be non-operational for more than two hours.
- 3.4.9. The System shall be so designed as to prevent failures or breakdown due to invalid or incorrect inputs.
- 3.4.10. Built-in self-diagnostics, power-up self-test and sufficient test points shall be provided in the System to minimise the time required to locate a fault.
- 3.4.11. All components, materials, software and supports required for repair and servicing of the System shall be available during the entire lifetime of the System.
- 3.4.12. The Contractor shall submit Maintainability Plan to the Employer's Representative for review in accordance with RAMS Plan.
- 3.4.13. The Maintainability Plan shall describe the analytical methods to be used during design and development stages to demonstrate compliance with maintainability requirements specified herein and to identify the maintainability-critical items of the System.
- 3.4.14. The Maintainability Plan shall identify a comprehensive list of maintainability-related submissions such as specifications, standards, method statements, procedures, drawings, and records to the Employer's Representative for review. The Maintainability Plan shall include the date of submission.
- 3.4.15. Alarms, health status & displays generated by the System shall be shown locally, as well as at remote location in OCC/BCC.
- 3.4.16. All alarms generated by the system shall be available in the alarm history even if acknowledged by the controller.
- 3.5. **SYSTEM SAFETY REQUIREMENTS**
- 3.5.1. The Contractor shall perform the mandatory safety activities as detailed in Appendix 2 of the GS.
- 3.5.2. The Contractor shall support other Project Contractors with the provision of information and relevant analysis where the availability and usability of the Telecommunications System is a contributing factor to the overall system risk.
- 3.5.3. Not used
- 3.5.4. All Man-Machine-Interfaces shall be designed with the risk of Repetitive Strain Injury (RSI), eye strain and radiation-induced illness (both non-ionising and ionising radiation) taken into consideration.
- 3.5.5. The design of the System shall minimise the risk of fire.
- 3.5.6. The design of the System shall minimise the build-up of static, as well as the effects of static discharge during maintenance.
- 3.5.7. No toxic or asbestos-containing materials shall be used anywhere in the System.



**3.6. ELECTROMAGNETIC COMPATIBILITY (EMC)**

**3.6.1.** Not used

**3.6.2.** Any Telecommunication circuits in the vicinity of AC Traction running parallel to 25K V AC lines are liable to be affected by AC induced voltage. Therefore, precautions should be taken to eliminate the possibility of induced voltage affecting equipment and human. A large number of sections where telecom equipment are to be deployed are electrified with 25KV AC traction. Special protective measures (viz. provision of SPD's, fuses and earthing etc) are required to be taken for telecommunication lines entering 25 KV substations /switching posts.

**3.6.3.** Instructions for protection of staff working personnel on signalling and telecommunications installations on 25 KV AC traction shall be strictly adhered to.

**3.6.4.** Precautions are required to be taken on account of following:

- 1) Proximity of live conductor.
- 2) Pressure of return current in Rails.
- 3) Induction in all metallic bodies situated close to 3rd rail equipment.

The tenderer will also comply to the EMI classification and specification ETS 300 386-1 and 386-2.

**3.6.5.** The MS07 Contractor shall identify all likely sources of EMI that are pertinent to and prevailing in the electromagnetic environment of Mumbai Metro. Appropriate mitigation measures shall be provided to ensure correct operation of the System in its intended operating environment.

**3.6.6.** The MS07 Contractor shall interface with all relevant Contractors by liaising, coordinating and exchanging of EMC data to ensure EMC integrity in the design stage. The MS07 Contractor shall submit a copy of all EMC related information exchange to the Employer Engineer for review.

**3.6.7.** An EMC Management Plan shall be submitted by the MS07 Contractor as specified in the Employer's Requirements: General Specification, for review by the Employer Engineer.

**3.6.8.** The EMC Management Plan shall include measures to reduce conducted, induced and radiated emissions to acceptable levels as specified by EN61000-6-2, EN61000-6-3 and EN50121:2006 or by equivalent relevant international standard. The plan shall specify measures to increase immunity of the System and all its subsystems.

**3.6.9.** The EMC Management Plan shall specify basic protective measures proposed for all electrical and electronic subsystems and components and specific measures to be adopted for selected subsystems and components.

**3.6.10.** The EMC Management Plan shall analyse EMI and EMC impacts on the design of the System, train borne and track-side equipment as well as the general environment.

**3.6.11.** Radiated emissions shall not exceed the level permitted by the relevant standards.



- 3.6.12.** Conductive emissions shall be below the levels deemed by the Communications equipment to the satisfaction of the Employer. This condition shall be met by each individual piece of equipment.
- 3.6.13.** Communications data cables shall be physically separated from power cables. These cables shall be so located and arranged as to minimize electrical induction or interference to Communication control circuits resulting from traction, auxiliary or other currents, both static and transient.
- 3.6.14.** All emission limits for Communication System should be identified in interface documents.
- 3.6.15.** The Contractor shall ensure and demonstrate that the System is adequately protected against electromagnetic interference (EMI) among the systems. The Contractor is required to conduct type tests as well as full EMC tests (if previous type test results are not available). Tests to be conducted shall include but not limited to satisfying standards (their latest version) as following:
1. Overall compliance of EN50121-1 & EN50121-4 and
  2. Specific Standards of Immunity: IEC1000-4
- 3.6.16.** The maximum levels of out-of-band emission shall be such as to ensure that the sub- systems perform in conformity with the criteria given in the respective Chapters of the PS.
- 3.6.17.** The maximum levels of radiated and conducted EMI of the System shall not exceed the levels specified in EN50081-1.
- 3.6.18.** Any equipment consisting of sensitive electronic components that is likely to be handled or touched by any person shall be protected against electrostatic discharge and shall be tested as defined in IEC61000-4-2.
- 3.6.19.** Not used
- 3.6.20.** All tests shall be conducted to meet EMC severity levels specified by the relevant international standards, as a minimum, the EM severity levels for industrial equipment shall apply.
- 3.6.21.** The cost incurred in the suppression of electromagnetic or electrostatic interference including any hardware shall be deemed to be included within the contract.
- 3.6.22.** The contractor shall ensure that all Intra system EMI are taken care of through proper design and other measures. All major subsystems shall be tested for emissions and immunities in accordance with the appropriate international standards for equipments operating in Railway environments.
- 3.6.23. INTER-SYSTEM EMC**
- The contractor shall ensure that all equipments are design and constructed in accordance with latest versions of EMC standards including but not limited to latest version EN50082, EN50121, EN 50123, EN50155, IEC571, IEC1000 or equivalents to ensure proper functioning

Adequate safety margins between the immunity levels of the



Telecommunication Systems and the emission levels of other electrical and electronic equipment must be maintained.

The design of the software shall take into consideration that with the interference injected into the system, it is possible to produce an abnormal condition. For example, the program may become "locked up" awaiting a signal which will never arrive (system hang). It is important therefore that the various possible failures are analysed and appropriate actions are taken when failures are detected.

The probabilities of various conditions which could lead to an unreliable operation must be determined wherever applicable.

**3.6.24.** Relevant EMC certificates for all standard off-the-shelf products shall be submitted to the Employer's Representative for review

#### **4. FUNCTIONAL REQUIREMENTS**

##### **4.1. GENERAL**

**4.1.1.** The Contractor shall design the system such that operation of the system shall be in line with the provisions in the GS under normal and emergency conditions.

##### **4.2. GENERAL**

###### **4.2.1. OPERATION**

4.2.1.1. This part of the document only covers the general operational requirements of the System.

4.2.1.2. The particular operational requirements and modes of individual Sub-systems shall be as given in relevant Chapters of this PS.

###### **4.2.2. IT SECURITY POLICY**

1. Every networking equipment associated with the Telecom system shall be password-protected.
2. Unused access port of every networking equipment shall be disabled to prevent any unauthorized access.
3. Used access port of every networking device shall be MAC-bounded.
4. Data Transmission ports such as USB, RS-232 port etc. shall be disabled if not in use.
5. Any default sharing of files and folder shall be removed from servers/workstations.
6. Hard-coded password shall not be used in any privilege level.
7. Remote Access of the System shall normally not be provided on security considerations.
8. The contractor shall submit an IT Security Policy document for the Telecom system for approval of the Employer's Engineer Representative.



**4.2.3. MAN-MACHINE INTERFACES (MMI/)**

4.2.3.1. The Contractor shall provide user-friendly Man-Machine Interfaces for Mumbai Metro staff to operate, control, monitor and maintain the Systems.

**4.2.4. NETWORK MANAGEMENT SYSTEM (NMS)**

4.2.4.1. All Subsystems shall be equipped with Network Management System individually, to provide the status monitoring, alarm management, configuration, analysis and overall control of respective sub-systems to the maintenance staff.

**4.2.5. CYBER SECURITY**

4.2.5.1. The Contractor shall submit an IT security plan/document to ensure safety of the System against cyber-attacks/threats. The contractor shall include the necessary provisions of information and cyber security in its design and shall ensure that the system remains safe and secure.

4.2.5.2. The system must be capable of detecting malicious activity aimed at violating the availability of the system and the integrity and confidentiality of their data. Those activities include unauthorized access, data exfiltration, tempering in audio/video, radio jamming, wiretapping, damaging critical communication cable or nodes and other types of physical tampering, attempts to execute malware code, attempts to cause denial of service generating excessive requests and spoofing source addresses, attempts to exploit Structured Query Language (SQL) or Cross Site Scripting (XSS) injections, buffer overflow, invalidated user input, and other types of threats. The Solution must be able, to automatically detect and respond automatically/manually depending on the criticality of the system

4.2.5.3. The system should have provision to present assets in the system almost in real time. It should detect for each asset: Type, IP, Application Level identifies and security insights. The system should be non-intrusive and rely on passive listening to network traffic in the operational network. The solution should detect connections between assets almost in real time. The system should filter assets according to properties. The system should export the asset inventory into CSV format.

4.2.5.4. The system should be capable to integrate with Security Information and Event Management (SIEM).

4.2.5.5. Logical access to all systems shall be centrally managed using an industry standard user authentication and access control platform.

4.2.5.6. All data shall be protected against loss or failure at a given cloud location or availability zone. The system shall be equipped with the appropriate hardware, software, and procedures to provide redundancy and meet all performance requirements. The system design shall ensure complete recovery from the loss of any system components at any point during operation.

4.2.5.7. A disaster recovery plan shall be developed that describes data backup and recovery and ensures minimal data loss in the event of a catastrophic event or system failure. The disaster recovery plan shall contain detailed procedures to be followed to restore the system to full operation following a disaster or failover event.



- 4.2.5.8. Connection to all external systems or sub-systems should be suitably protected to prevent any threat to system from any external source. Communication only for intended purposes is to be ensured. Necessary equipment such as firewall or any other for connecting external systems/Sub-systems is to be used for ensuring the same.
- 4.2.5.9. Antivirus/Internet Security software used in the system should be licensed version. Antivirus should have automatic virus definitions update settings or provision of updating of virus definition manually. System should ask for security/patches updates at defined configured period
- 4.2.5.10. All the systems must use only licensed version of software tools/utilities such as operating system, database, firmware, patches, drivers, utility software and antivirus software etc.
- 4.2.5.11. There should be a proper cryptography encryption technique applied during transmission & storage to ensure data security. Strong wired/wireless encryption protocols, industry standard cryptographic algorithms and mutual authentication between communicating systems shall be used
- 4.2.5.12. Backup plan, schedule and recovery procedures must be defined, implemented and updated as per system design. It should be possible to take Data backup copies of all systems at regular intervals so that recovery to the most up-to-date state is possible.
- 4.2.5.13. Systems should have provision of password management through user interface. Password policy should be applied to all systems.
- 4.2.5.14. System should be capable of detection of remote access to all type of system. It should be able to restrict the remote access. In case it is required, access can be granted for specific period subject to approval mechanism. The system should implement appropriate security technologies to protect information or information systems being accessed via remote access, such as using VPN based on SSL/TLS, SSTP or IPsec.
- 4.2.5.15. Third party access: Third party access to the IT/OT system should be restricted.
- 4.2.5.16. There should be authentication system to authenticate users. Authorization & access to resources should be role based rather than individual basis
- 4.2.5.17. It should be ensured that all default passwords of routers and switches are changed prior to deployment and only secure protocols such as SSH, SSL or IP Sec shall be used.
- 4.2.5.18. Application change control: Activity such as application maintenance, installation of critical changes, review of changes and post testing, responsibility of changes, document change requests amongst others must be documented with relevant details.
- 4.2.5.19. System should be able to monitor, implement and maintain a change management process to track and monitor activity related with changes to existing software applications.
- 4.2.5.20. Network diagram: The contractor must develop an accurate mapping of the core components, connections and information of the network to build system facility network diagram including network components such as



routers, switches, firewall and computer systems, IP addresses, data flow routes, blacklisted or white listed systems/IP addresses, open/entry ports, subnet mask, administrative interface, zones, access control lists, network name amongst others.

- 4.2.5.21. Virtual LAN should be used to logically separate zones that deal with critical systems from the rest of the network after consulting with the OEM.
- 4.2.5.22. Contractor shall provide cybersecurity awareness training to relevant personnel to ensure they understand their roles and responsibilities in maintaining security.
- 4.2.5.23. Security testing and auditing: Provisions should be included for regular security testing such as penetration testing and vulnerability assessment, as well as audits to verify compliance with security requirements.
- 4.2.5.24. Security incident response plan: Contractor should develop and maintain a documented incident response plan outlining procedure for responding to security breaches, including containment, eradication, and recovery.
- 4.2.5.25. Documentation and Reporting: The contractor shall maintain comprehensive documentation of security measures implemented and provide regular reports on security performance and compliance.
- 4.2.5.26. Interfaces between systems shall be jointly signed by the respective contractors and should fulfil the security requirements of the respective systems.
- 4.2.5.27. Telecommunication system has multiple sub systems i.e. PAS, PIDS, Master Clock, CCTV CDRS, FOTS, Radio System, Telephone System which are interfaced with one another via Fiber backbone WAN Network. Telecommunication system has also to be interfaced with other systems of DMRC like Building Management System (BMS) Automatic Fare Collection (AFC), Traction & Power Supply, Lift & Escalators, Rolling Stock. Platform Screen Doors (PSD) and Signalling & Train Control (S&TC) etc. at central equipment room (CER) level and TER at Station Level. Therefore, cyber security arrangements with audit facility (frequency as approved in Audit plan) for respective Telecom Sub-system complying prevalent international standards like ISO 27001, IEC-62443 Security Level SL-2 or equivalent shall be provided by the Telecom contractor for Stations, Depots. SCR. OCC/BCC, RSS, Onboard.
- 4.2.5.28. The Cyber Security plan must be regularly reviewed up to end of DLP (Defect Liability Period), updated and accepted through a process of security certification, access control. gateway security, communications security, physical security, accreditations and certifications
- 4.2.5.29. The Telecom contractor shall define procedures for assured operations and continuous monitoring of the security controls. The level of security shall be assessed on a regular basis during complete DLP by an independent recognized Security Consultancy, employed by the Contractor and approved by the Employer/Employer's Representative/Engineer. The Contractor shall submit detailed audit plan, report, policy and action plan for each security audit.
- 4.2.5.30. The Telecom contractor shall adopt and develop a software and/or firmware/system development label cycle information security framework, Global



security plan and a thorough SDLC process that integrates risk management for protection against malicious and inadvertent manipulation of data transmitted over various bands to maintain the confidentiality, availability and/or integrity of the wired or/and wireless data transmission.

- 4.2.5.31. Telecom contractor shall consider in design that the manipulation of Telecom Network may be caused by malicious activity like intrusion, hacking, phishing, wireless signal jamming, physical tampering, damaging critical communication cable or nodes, accident, or natural disaster and the same shall be taken care of with suitable measures.
- 4.2.5.32. The Telecom contractor must demonstrate practically, the capability of the system to proactively detect, contain, eradicate, and recover from a security breach. The system should be able to notify & generate alarms for unauthorized attempts at concerned system and system at central level.
- 4.2.5.33. Security incident response plan: Contractor should develop and maintain a documented incident response plan outlining procedure for responding to security breaches, including containment, eradication, and recovery.
- 4.2.5.34. Network Security: The general cyber security practices for installation and monitoring should be also be adopted. Maintain the network isolation (Air-Gap) from the public network to minimize the risk of unauthorized access and potential cyberattacks. Use MAC address binding to prevent the unauthorized access by unidentified devices.
- 4.2.5.35. Encryption of Data: Ensure all communication between Telecom devices &/or applications is encrypted. This prevents unauthorized individuals from intercepting and accessing sensitive information.
- 4.2.5.36. Telecom contractor shall cover cyber security training plan, Training material, and training to the Employer's personnel.

## **5. DESIGN REQUIREMENTS**

### **5.1. GENERAL**

#### **5.1.1. DESIGN APPROACH**

- 5.1.1.1. The Contractor shall adopt a structured, modular and top-down approach for the design and exercise proper design control to ensure that the designs are in accordance with the requirements given in the Specifications.
- 5.1.1.2. The technologies adopted for the design of the System shall be:
  - Field proven with past successful applications references
  - Suitable for 24\*7 operations without any degradation
  - Conforming to open international standards

The contractor shall submit details, of the above functionalities for the technologies & equipment adopted for the system, for approval of the Employer's Engineer.
- 5.1.1.3. The System shall be designed for continuous unattended operation for extended periods of time.



5.1.1.4. All server / computer-based equipment, router, switches etc. used in telecom. System(s) shall be sized / configured such that the processor loading does not exceed 50% under full load conditions (including spare capacity) to ensure satisfactory performance under full load without any performance degradation like slow response , hanging of processor etc. leading to requirement of restarting / rebooting of computer systems. The Contractor shall provide proper documentation in support of compliance to this condition.

5.1.1.5. Alarm should be generated for any hard disc (storage) capacity utilisation of 85% and above.

5.1.1.6. All of the Contractor's key design staff shall be located in Mumbai. The Contractor's design staff shall be competent with sufficient experience in the individual responsibility areas.

While the supply of equipment may be done from the OEM of the equipment, competent and sufficiently experienced technical representative of the OEM (qualification and experience to be approved by Employer Representative) shall be available at Mumbai for design reviews/discussions and for installation supervision of all the sub-systems during the implementation of the project.

5.1.1.7. The Contractor shall submit a Design Plan with requirements as stipulated in the GS and PS.

**5.1.2. DESIGN VERIFICATION AND VALIDATION**

5.1.2.1. The Contractor shall submit detailed design calculations and supporting drawings, documents, etc., for the system to the Employer's Representative for review.

5.1.2.2. The design calculations shall demonstrate that the Contractor's design fully complies with the requirements given in the Specification. The design calculations shall further demonstrate that the ratings, capacity and quantity of the proposed equipment are adequate.

5.1.2.3. The Contractor shall furnish the following calculations and analysis for all the relevant sub-systems as a minimum:

- 1) Estimation of the power consumption and heat dissipation per equipment and per location.
- 2) Prediction of the reliability and availability of the system.

5.1.2.4. The requirements on design calculations specific to the individual sub-system shall be as given in the relevant Chapters of this PS.

**5.1.3. DESIGN REVIEW**

5.1.3.1. Design review meetings shall be regularly held with the Employer's Representative.

5.1.3.2. The Contractor shall ensure that all design submissions are accurate, fully compliant relevant and of good quality before they are submitted to the Employer's Representative for review

5.1.3.3. The Contractor shall ensure that all comments of the Employer's



Representative have been properly incorporated or otherwise resolved before resubmission.

5.1.3.4. The Contractor shall exercise adequate control to ensure that the number of resubmissions is minimum.

5.1.3.5. In addition to the Contractor's own design reviews, the Contractor shall carry out design review meetings with the Employer's Representative at the appropriate design stages with at least one slated prior to the conclusion of the preliminary design and the final design. Competent and sufficiently experienced staff of the OEM (the supplier of the major equipment) shall also be present during design review meetings with the Employer's Representative. The Contractor shall include presentation of his design at the meeting and demonstrate how his design complies fully to all aspects of System requirements. The Employer's Representative's comments thereto shall be recorded and duly incorporated in the design.

5.1.3.6. The following issues shall be addressed during each of the design review meetings:

- Reliability, Availability, Maintainability and Safety (RAMS)
- Ergonomics and Human Factor Engineering
- Design Progress
- Interface Issues
- Cyber security
- Obsolescence Management

**5.1.4. MMI DESIGN**

5.1.4.1. For all MMI's specially designed or customised for the Systems, the Contractor shall provide and organise prototypes for demonstration and submission to the Employer's Representative for review prior to implementation.

5.1.4.2. The MMIs of all Subsystems shall be of consistent design and adopt similar conventions.

5.1.4.3. All MMIs of various sub-systems should have GUI interface with suitable levels i.e. Platform Level, Concourse level etc. All end devices provided on stations should depiction of various end devices indicated on 2D or 3D station layouts of various be suitably depicted on the GUI screens of nominated MMIs.

5.1.4.4. It should be possible to Operate & monitor all communication end devices mentioned in Para 4.2.1.4.3 above from the GUI interface of the MMI.

5.1.4.5. Health status of all the devices should also be suitably indicated on the GUI interface of the MMI. All alarms, current & history, of all sub-systems & devices should also be available in MMI functionality.

Access to MMI shall be password protected. The MMI shall incorporate a password/identification log-on procedure to individual operator.



The MMI shall support multiple Users (min. 10 nos.) and passwords for each level of authorization. The MMI shall automatically provide an option / prompt for periodic change of passwords for various users. The MMI operator actions and specific system configuration & operation shall be captured in event log for a minimum duration of 3 months without carrying out any housekeeping function.

All MMIs shall be equipped with virus checking and anti-virus protection facilities to prevent from virus infection

The Contractor shall provide and organize MMI prototypes for demonstration and submission for review by the Employer prior to their implementation.

In order to have consistency in LED monitors provided by MS07 Contractor in control rooms, the Employer will inform the Contractor details on the brand and model number of LED monitors required during Preliminary Design. The Contractor shall supply LED monitors in accordance with the details provided by the Employer.

The Employer shall ensure that the MMIs supplied are of reputed make and model. The contractor shall submit details of the proposed hardware for approval of the Employer.

- a) Generally operational Workstations (CPUs) for various telecom. Sub-systems shall be located/housed in modular furniture, where-in the, Workstation(s) are located in an integrated / protected cabinet provided with all requisite power & data connectivity arrangements.

All such Work-stations (CPUs) shall be connected to the: -

- Associated server(s) housed in Equipment rooms using dual port (electrical / optical) redundant connectivity and
- MMIs (Key Board, VDU & Mouse) using standard connectivity for the VDU & wireless connectivity for the Key Board & Mouse.

- b) At locations, where operational Workstations (CPUs) are not housed in modular furniture with integrated / protected cabinets or MMIs are directly connected to associated servers, in all such cases, MMIs will be extended to the operational location using dual port KVM extender switches having redundant connectivity from the Work station / Server equipment. This arrangement will prevent any outside/external interference to the Workstations (CPUs)

Associated Work stations / Servers, in such cases, shall be rack mounted in the TER or CER, as the case may be. With this arrangement, the operator location shall not have any processor / server and will only have KVM extender switches with associated MMI (KVM) devices connected, using standard connectivity for the VDU & wireless connectivity for the Key Board & Mouse.

- c) The MS07 Contractor shall plan /design the MMI connectivity using KVM extender switches or otherwise (direct), as the case may be, and submit a detailed proposal for approval of the Engineer. Non-compliance to the above provisions, shall require specific approval of/from the Engineer, which shall be considered by the Engineer only on receipt of detailed reasons for the same (non-compliance(s)).



- d) Minimum Specifications for the Workstation (MMI) & Lap Top (Local Craft Terminal) hardware for all Telecomm sub-systems has been specified in Appendix G, Chapter 12 (Appendices) of this Particular Specifications.

5.1.4.6. The MS07 Contractor shall carry out an ergonomic study for the MMI and console furniture design. The Contractor shall co-ordinate with other Project Contractors to ensure that the latter's recommendations are properly reviewed, commented upon and the agreed items incorporated in the Contractor's MMI design.

#### **5.1.5. NETWORK MANAGEMENT SYSTEM (NMS)**

5.1.5.1. NMS of all communication sub-systems shall essentially have Graphical User Interface (GUI) functionality with feature of auto discovery of network elements and user-friendly configuration techniques.

5.1.5.2. For DTS system, it shall be possible to configure circuits using Click, Drag & Drop functionality at from / to locations on the GUI on the NMS.

5.1.5.3. The GUI used for the NMS of all sub-systems should follow a Top down approach. The first/default screen should indicate status of the sub-system (Faulty/OK) of all Stations on a single line diagram of the Metro corridor. Selection of any station on the single Line of the Metro corridor should be able to select detailed status of all elements of the sub-system of that particular station.

5.1.5.4. NMS of all sub-systems shall interface with the CTFRS housed in the CSS room in the OCC for centralised monitoring of all systems.

5.1.5.5. NMS software will also be available in Local Craft Terminal (LCT) to monitor & control all the systems from management ports available in individual systems at all stations /sites.

5.1.5.6. It shall be possible to load NMS software of multiple systems in one LCT to enable local management of multiple systems from one LCT. The Contractor shall submit details of the same for Employer's Engineer approval.

5.1.5.7. Selected Network Management data from the individual Communication System required for the calculation of performance parameters to meet Availability targets shall be archived for twelve months. Search and playback recovery

5.1.5.8. facilities shall be flexible and dynamic and safeguards should be provided so that there is no loss of archived data.

5.1.5.9. The Network Management System of Subsystems shall have GUI functionalities and have following system management functions as a minimum:

- i. Enabling and disabling audio indication upon the receipt of alarm;
- ii. Configuration of system alarm level;
- iii. Equipment parameter configuration;
- iv. System parameter configuration;



- v. Performance management;
- vi. Accounting management;
- vii. Fault management; and
- viii. Security management

A system administration function shall be available to control the following as a minimum:

- i. Resetting of passwords;
- ii. Allocation of log-on control access level to each user;
- iii. Creation and deletion of users;
- iv. Administration and housekeeping functions; and
- v. Creation and deletion of designated functions and commands available to each log-on control access level.

#### **5.1.6. FAULT AND ALARM HANDLING**

- 5.1.6.1. The Network Management System shall have the capabilities of monitoring the respective system alarm status on a real time basis.
- 5.1.6.2. The Network Management System shall have the ability to store the detailed alarm in the database for future enquiries and to access the fault alarm history database for retrieval of alarm history data.
- 5.1.6.3. In addition to the alarms and status to be shown on the respective management system, status of major equipment shall be monitored and displayed with suitable indications to the local equipment racks of the respective system.
- 5.1.6.4. The Alarm shall be logged & stored in a storage media of the NMS for at least one month. In the event of the storage media exceeding 60% capacity utilisation, alarm logs shall be purged on FIFO basis to allow logs of new fresh alarms as also avoid hanging of NMS system.
- 5.1.6.5. Visual and audible indications shall be available for any failure alarm reported to the Network Management System. The audible indication shall be enabled and disabled through the Network Management System.
- 5.1.6.6. The Network Management System shall have a storage capacity for maintaining at least 3 months of alarm data, system configuration data, alarm history and event logging data without the need to perform any housekeeping function.
- 5.1.6.7. As a minimum, the following alarm conditions shall be provided and indicated on the Network Management System as appropriate:
  - i. Loss of communication link;
  - ii. Data corruption in an Ethernet communication link
  - iii. Loss of signal link;



- iv. Loss of Master clock synchronization;
- v. Power supply unit failure;
- vi. Failure of field equipment;
- vii. Failure of central equipment;
- viii. Failure of control equipment;
- ix. Loss of interface link with interfacing systems;
- x. Failure of the critical components or module, e.g. hard disk (if any), CPU, transceiver, etc.;
- xi. Failure of any hot-standby unit;
- xii. Failure to changeover the central control equipment; and
- xiii. Conflicts of system operation,
- xiv. CPU utilization more than 50%

5.1.6.8. The Contractor shall propose the alarm definition for individual Subsystems, which shall be sufficient for fault analysis and fault identification. The proposal of alarm definition shall be submitted for the review by the Employer's Engineer

**5.1.7. ALARM DISPLAYS**

5.1.7.1. The Contractor shall provide the following general capabilities and characteristics for the alarm display as a minimum:

- i. Quickly filter the alarm display to view alarms generated from a particular system component, by a geographic location, by time and date;
- ii. A colour coding scheme indicating the alarm severity according to the alarm classifications;
- iii. The display of the alarms in chronological order along with their associated time stamps;
- iv. A scrollable capability to enable the Network Management System user to view more alarms than can be displayed on one single screen; and
- v. The facility to acknowledge alarms.

5.1.7.2. The Alarm system shall work on the following general principles:

<b>Alarm Status</b>	<b>Indication</b>	<b>Audio</b>
Occurrence	Flashing	On
Acknowledgement	Steady	OFF
Fault Rectified	OFF	OFF



- 5.1.7.3. NMS of all communication sub-systems shall be separate and kept in Central communication maintenance room in the OCC building to enable monitoring, trouble shooting of all sub systems. Suitable ports should also be provided to connect LCTs for management of all individual sub systems.
- 5.1.7.4. The NMS shall enable generation of user configures / customised MIS reports on performance of the equipment / system.
- 5.1.7.5. High level alarms from NMS from all sub-systems will be forwarded to the Central Telecomm Fault Reporting System (CTFRS) for integrated management of all systems.
- 5.1.7.6. All systems shall be interfaced with the Central Telecomm Fault Reporting System (CTFRS) so as to enable centralized fault & status monitoring of all the systems.
- 5.1.7.7. The CTFRS shall have a SMS& e-mail alert facility to alert various users in event of generation of a system alarm.
- 5.1.7.8. The CTFRS shall interface with the Mumbai Metro's Work& Asset Management Systems (WAMS). Both the CTFRS & WAMS suppliers shall interface with concerned BMRC team for successful interface between these systems.
- 5.1.7.9. Notwithstanding provision / compliance of NMS features mentioned above, MS07 contractor shall also ensure provision of NMS & LCT features mentioned in individual sub-system chapters.

**5.1.8. SUBMISSION OF SAMPLES**

- 5.1.8.1. To assist the Employer's Representative in his evaluation of the Contractor's design submission, the Contractor shall submit samples to the Employer's Representative for review, when so required and instructed by the latter.
- 5.1.8.2. The Contractor shall arrange site visits and/or videos for illustration if the items are bulky or impracticable for submission.
- 5.1.8.3. Samples of installation or mounting accessories shall be properly mounted on a board, wherever feasible, prior to their submission to the Employer's Representative for review.
- 5.1.8.4. The Contractor shall provide samples of individual types of cables to the Employer's Representative prior to the commencement of cable installation. The samples shall be properly protected with transparent housing for independent cable components including sheath, armour, insulation, cable cores, etc. for ease of identification as well as inspection. Each sample shall be properly labelled with description of the cable type.
- 5.1.8.5. All samples submitted to the Employer's Representative shall become the property of the Employer.

**5.2. EQUIPMENT DESIGN**

**5.2.1. GENERAL CONSIDERATIONS**

- 5.2.1.1. Specific equipment design requirements for each sub-system are given in the relevant Chapters of this PS.



- 5.2.1.2. The Contractor shall develop the design based on this Specification. The design details shall be submitted with technical data and calculations to the Employer's Engineer for approval. The Communication System including all sub-systems and equipment shall be of proven design. All the systems/sub-system equipment / series / family, hardware and software proposed by the Contractor shall have been in use and have established their satisfactory performance in Metro Railways / Mono Rail/ Mainline Railways / large Airport environment. Details in support of the above facts shall be submitted by the Contractor for approval of the Employer's Engineer.
- 5.2.1.3. The design philosophy of all sub-systems shall meet the following criteria:
1. Service proven design;
  2. Minimum life cycle cost
  3. Ease of maintainability
  4. Use of interchangeable, modular components;
  5. Extensive and prominent labelling of parts, cables and wires;
  6. Use of unique serial numbers for traceability of components;
  7. High reliability;
  8. Energy efficient;
  9. System safety;
  10. Adequate redundancy and factor of safety to prevent single point of failure;
  11. Use of fire retardant materials;
  12. Environment friendly;
  13. Low Environmental Impact Adherence to functional, operational and performance requirements;
  14. Open Architecture for integration with other systems; and
  15. Ease of expansion and integration.
- 5.2.1.4. All sub-systems shall be designed on a distributed architecture principle, with equipment at all stations and central equipment in the CER / OCC. In event of failure of the central equipment all station equipment shall continue to operate, without loss of any functionality, at individual stations.
- 5.2.1.5. All modules used in the system shall be hot swappable with self-test routine functionality on initialisation / replacement.
- 5.2.1.6. Further, all sub-systems shall be designed based on redundant hardware in hot standby configuration with dual port connectivity both on the network and access level so that single point failure does not lead to failure of any system / sub system.
- 5.2.1.7. Considering principle of redundancy in hardware & software, all sub-systems shall be provided with dual -switches, routers & servers.



All workstations shall be equipped / configured with dual Ethernet ports to provide on-line connectivity to the redundant servers / switches/routers.

All equipment/sub-systems shall be suitably equipped/provisioned/configured such that all functionalities/features which are required to be supported by the respective equipment/sub-systems are available in the offered equipment without requirement of any additional hardware/software and/or any additional financial implications

All Switches required to connect IP based end devices, shall support PoE functionality and shall be equipped suitably with PoE compatible ports to avoid running of a separate power cable to the end devices. PoE port functionality in switches shall be modular to enable a mix of PoE & non PoE ports. All IP based end devices shall also support PoE functionality.

All Servers / Processors / Switches / Routers used in all the sub-systems shall support proper shut down feature in case of power failure with automatic restart in case of power restoration. Access to the Servers / Workstations etc. while shall be Password Protected, but shall not require use of any external hardware like Dongle etc.

**5.2.1.8. Use of temperature hardened / industry grade equipment & end equipment**

(a) All equipment / modules including HDDs (Hard Disc Drives) and end equipment used in various Telecommunication system(s)/sub-system(s) shall be so designed / manufactured so as to operate satisfactorily in the toxic / corrosive / polluted environment prevalent in various areas of the Mumbai Metro.

The equipment shall include various Modules, Servers, Workstations, Routers, Switches etc. and the End equipment shall include CCTV Cameras, Clocks (Digital & Analog), PIDS Boards & PIDS Panels , Radio Terminal Equipment etc. (as the case may be) provisioned under various Telecommunication systems.

(b) The contractor shall take following steps, as a min., so as to ensure all communication system(s)/sub-system(s) operate satisfactorily under highest level of toxic, corrosive & polluted environment prevalent in various areas of the Mumbai Metro:

- i. use of conformal coating (highest grade) during design and manufacturing of various equipment & end equipment detailed above.
- ii. use of Temperature Hardened /Industrial Grade Equipment & End equipment
- iii. Corrosion resistant as per a) IEC 60068-2-52 (salt fog) & IEC 60068-2-60 (flowing mixed gas)
- iv. Use of suitable IP rated Racks/ Housing

(c) The HDDs used in all the communication services particularly the NVR system shall be fully Data Optimised, Support Scalability including organic soldering to make it anti-corrosive & toxic environment proof and also ensure expeditious Data Recovery in case of any failure.



- (d) Attention is also drawn towards compliance to Clause 1.12 - Climatic Conditions / Operating Environment of GS.
- (e) The contractor shall submit details of the steps taken / proposed to be taken towards compliance to above requirements for all equipment & end equipment used in the Telecommunication system as part of Preliminary Design document for approval of the Engineer, so as to ensure there is no equipment (hardware) failure on account of environmental (toxicity, sulphation, pollution etc.) factors. Any non-compliance to the above requirement for any specific equipment &/or end equipment shall not be permitted unless supported with technical justification with requisite undertakings/ guarantees and shall require specific approval of the Engineer.

5.2.1.9. The offered equipment shall be field proven with past history of successful performance.

5.2.1.10. For all excess heat dissipating equipment including power amplifiers, the Contractor shall provide the following as necessary and applicable:

- Local warning signs
- Local over-temperature alarm indications
- Remote over-temperature alarm monitoring
- Facilities for remote power ON/OFF

5.2.1.11. All active equipment shall have LED/Lamp indications indicating:

- Normal power supply
- Summary alarm conditions

5.2.1.12. All equipment shall be designed and constructed to operate without degradation in quality, performance or loss of function in the electromagnetic environment prevalent in a standard Mass Rapid Transit Railway System including underground segments . The traction system of Mumbai Metro is 25KV AC, for the elevated section and underground sections.

## **5.2.2. FIRE AND SMOKE PRECAUTIONS**

5.2.2.1. The cable routes shall be suitably designed to prevent trapping of rubbish which could later become a fire hazard.

5.2.2.2. Every possible precaution must be taken to prevent the flow of fault currents through the cables, especially from the traction power system. Communication cables must be kept away as required from high tension power supply cables to avoid any interference.

5.2.2.3. All necessary measures shall be adopted to prevent the creation of hazardous conditions arising out of overheating and/or ignition of cables. All cables used must therefore, meet the following stipulations, unless otherwise specified:

5.2.2.4. The cables meant for the elevated section shall be made from fire-retardant, low- smoke, materials only or as specified in the detailed specification laid down in the relevant chapters of this PS.



- 5.2.2.5. Only cables which are housed inside closed cabinets may be as per standard specifications, as they are unlikely to cause hazardous condition.
- 5.2.2.6. Cabling in the elevated Sections may be exposed. Outer sheathing material for the cable specified shall be selected so that it is resistant to exposure to direct sunlight.
- 5.2.2.7. All of the above requirements shall be fully complied to, without compromising any of the mechanical or electrical properties of the cables.

**5.2.3. ENVIRONMENTAL CONDITIONS**

- 5.2.3.1. All equipment shall be protected from damage or degradation in performance due to shock or vibration as experienced in railway environment.
- 5.2.3.2. Unless otherwise specified, all telecommunication equipment installed under this Contract inside rooms with controlled environment shall be designed for operation in temperatures of 0<sup>o</sup> C to + 40<sup>o</sup> C. All equipment installed outside these areas shall be rated for continuous operation up to + 50<sup>o</sup> C.
- 5.2.3.3. No equipment other than such as cameras, field switches and cables and their junction boxes, display boards, Slave clocks, Loudspeakers, Noise Sensors, PAS control panels & CCTV MMI (in PSB), etc as required by the PS shall be placed outside the TER/CER unless the equipment are rated for temperatures up to + 50<sup>o</sup> C at 90% RH.
- 5.2.3.4. All MMI's in the SCR/PCR/OCC/BCC Theatre shall be extended through Line Extenders from their respective Severs/PC's kept in the TERs

**5.2.4. SYSTEM EXPANSION**

- 5.2.4.1. The Contractor shall design the System with sufficient capacity such that the System can operate properly under peak load or traffic conditions and with sufficient margins in performance to ensure normal operation for any change in design assumption and operating conditions.
- 5.2.4.2. The Contractor shall adopt a modular approach for design to enable System expansion with minor modifications such as parameter changes or addition of modules without the need for substantial equipment replacement or software rewrite.
- 5.2.4.3. The Contractor shall submit a System Expansion Plan to the Employer's Representative for review.

**5.2.5. OBSOLESCENCE MANAGEMENT**

- 5.2.5.1. Obsolescence refers to the condition when equipment can no longer provide its intended functions because spares, technical support or similar services (including essential technical modifications) are no longer available due to various reasons, e.g. Termination of production line, termination of supplier's business and phasing out of technology. The purpose of Obsolescence Management is to identify potential obsolescence issues of the Equipment over its life cycle and to provide mitigation measures whereby the Design Life of the Equipment as defined in the TS may be realized.
- 5.2.5.2. The Contractor shall ensure that Obsolescence Management activities are



undertaken for the Communication Equipment to ensure full and proper consideration has been given to obsolescence during design, construction, testing and commissioning and in-service operation. The Contractor shall perform the obsolescence management up to the point of interface with other systems. If any Spare Part is rendered obsolete by a design change or material change during the design life of the Works supplied under the Contract, the Contractor shall design a replacement item to match the identical mechanical and electrical interfaces as the former item.

5.2.5.3. The Equipment shall be designed for the Design Life specified in this TS from the date of Project completion. The Contractor shall explain how obsolescence can be managed over the Design Life of the system.

5.2.5.4. The Contractor shall submit an Obsolescence Management document which shall include the following:

- (a) A description of the obsolescence management roles and responsibilities of the Contractor;
- (b) A description of the obsolescence management process that the Contractor intends to follow;
- (c) A description of the Sub-Contractor obsolescence management process;
- (d) The format of the Spare Parts List;
- (e) The format of the Software List;
- (f) Register of Design Lives for different Telecommunication subsystem
- (g) The planning of any hardware renewal arrangements over the Design Life of the system, in particular key components identified, as defined in the Register of Design Lives
- (h) The planning of managing Software Intellectual Property Rights over the Design Life of the system
- (i) The planning of any Software upgrade arrangement over the Design Life of the system, in particular those that have shorter lives than the Design Life of the system;
- (j) The provision of hardware and Software services and support over the Design Life of the Equipment after the end of Defects Liability Period;
- (k) A description of approaches, methodologies and principles that will be adopted in the design, procurement, manufacturing, installation and Commissioning of the System to ensure that the Design Life specified in the TS will be realized by following the obsolescence management process

## **6. INTERFACES**

### **6.1. INTERFACES BETWEEN SUBSYSTEMS**

6.1.1. The details of interfacing with other project contractors shall be as described in the relevant Chapters of each Telecommunication subsystem and



Appendix A of this Particular Specification.

6.1.2. The Contractor shall provide the description of the interfacing between Subsystems with sufficient details so as to enable the Employer to modify or expand the interfaces between the Subsystems.

6.1.3. Tentative Interface matrix between the communication system, sub-systems and other systems which are anticipated, are listed in the following table:

S. No	Sub-system	Telephone	FOTS	TETRA	CDRS	CCTV	PAS/PIDS	MCLK	CTFRS	UPS	Signalling	AFC	SCADA	IT/LAN	L&E	RS	Access	(FIRE) (E&M)	ETS
1	Telephone		✓	✓	✓	✓	✓	✓	✓						✓				
2	FOTS	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
3	TETRA	✓	✓		✓		✓	✓	✓		✓					✓			
4	CDRS	✓	✓	✓			✓	✓	✓										
5	CCTV	✓	✓					✓	✓		✓				✓				✓
6	PAS/PIDS	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
7	MCLK	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓					
8	CTFRS	✓	✓	✓	✓	✓	✓	✓		✓									
9	UPS		✓				✓	✓			✓	✓							
10	Signalling		✓	✓		✓	✓	✓		✓			✓						
11	AFC		✓					✓		✓									
12	SCADA		✓					✓			✓								
13	IT/LAN		✓					✓											
14	L&E		✓			✓													
15	RS		✓	✓															
16	Access Control																	✓	
17	Fire (E&M)																	✓	
18	ETS					✓													

6.2. INTERFACES WITH PROJECT CONTRACTORS

6.2.1. The particular requirements between the MS07 contractor and the other Project Contractors shall be as given in the Interface Specifications in Appendix A of this PS.

6.2.2. The requirements specified in the Interface Specifications are by no means exhaustive. The Contractor shall submit an Interface Management Plan and Detailed Interface Documents to the Employer’s Representative for review in accordance with the requirements given in the GS. The Contractor shall ensure that the Interface Management Plan and Detailed Interface Documents are mutually acceptable with the other relevant Project Contractors before submission.

6.2.3. The Contractor shall liaise with the Employer’s Representative and the relevant Project Contractors and co-ordinate for site access.



- 7. VERIFICATION, TESTING AND COMMISSIONING**
- 7.1. GENERAL GUIDELINES FOR TESTING AND COMMISSIONING**
- 7.1.1.** The Contractor shall submit to the Engineer for review & approval, a design verification / confirmation table indicating various clauses of the PS vis-à-vis their availability in corresponding design documents (Chapter & Clause) along with their inclusions in the proposed PAT & SAT documents.
- 7.1.2.** The Contractor shall perform stage-wise testing and commissioning activities in accordance with the requirements given in this Specification The Line can be opened in any sequence or part without any financial implication on DMRC/MMRDA.
- 7.1.3.** The Contractor shall ensure that the Employer's Representative prior to the commencement of the test has reviewed test documentation associated with any test without objection.
- 7.1.4.** The Contractor shall ensure the System is in a state ready for testing and commissioning before the commencement of the tests witnessed by the Employer's Representative. The Contractor may conduct trial tests by himself before the Employer's Representative witnesses the tests, if necessary.
- 7.1.5.** Test results of the Contractor's own trial tests shall be made available to the Employer's Representative on request before the tests are witnessed by the Employer's Representative, to indicate the readiness of the System for tests witnessed by the Employer's Representative to commence.
- 7.1.6.** The Contractor shall satisfy himself that all items interfacing to Project Contractors are in satisfactory condition for the Contractor's tests to be carried out.
- 7.1.7.** The Contractor shall provide all necessary test instruments, special tools, emulators, simulators and test software to carry out the tests.
- 7.1.8.** The Contractor shall provide simulation for testing in case the interfacing equipment is not available for testing.
- 7.1.9.** The Contractor shall extend full support to the Employer's Representative and provide all necessary facilities to enable convenient inspection of materials, work and testing.
- 7.1.10.** The Contractor shall investigate and provide corrective actions for all the faults detected during the tests. The tests shall be resumed only after all the faults are properly cleared. The Contractor shall submit fault report to the Employer's Representative to describe the symptom and causes of the faults and the corrective actions taken.
- 7.1.11.** If the operation of other project contractor's system or equipment is suspected to be affected by the system during the test, the contractor shall withhold the test, investigate and provide corrective actions, if necessary, before resumption. The test shall be resumed only after the interference has been eliminated or found not to be related to the system.



**7.2. TESTING STAGES**

The Contractor shall carry out testing and commissioning activities in the following phases:

- (1) Factory Acceptance Tests (FAT)
- (2) Installation Tests (IT)
- (3) Partial Acceptance Tests (PAT)
- (4) System Acceptance Tests (SAT)
- (5) Integrated Testing and Commissioning (ITC)

**7.3. FACTORY ACCEPTANCE TESTS**

**7.3.1.** The Contractor shall carry out factory acceptance tests at the place of manufacturing in the presence of the Employer's Engineer. The test shall include, but not be limited to, visual, environmental, electrical and functional tests on each individual equipment and associated Subsystems as well as simulation before delivery of the equipment to the Site.

**7.3.2.** Factory acceptance test shall be carried out for equipment and cables.

**7.3.3.** The Contractor shall prepare and submit a Factory Test Plan at least Three months before the tests. In addition, the Factory Test Plan shall also include the following:

- (1) A list of equipment and cables for individual Subsystem to have factory acceptance test.
- (2) The program of all the activities related to factory acceptance tests.
- (3) The locations where factory acceptance tests to be carried out.
- (4) The estimated duration of tests activities at each locations.
- (5) Submission schedule of all the factory acceptance test procedures for equipment and cable.

**7.3.4.** The Contractor shall prepare the Factory Acceptance Test Procedures for equipment and cables and submit to the Employer's Representative for review.

**7.3.5.** The Factory Acceptance Test Procedures shall describe in detail all tests to demonstrate the functional, electrical and physical performance of the equipment and cable under designed environmental conditions.

**7.3.6.** Where any part of testing is carried out by an independent laboratory, a copy of Test Certificate issued by the relevant authority of that laboratory shall be submitted along with the Acceptance Test Procedure. The Employer's Representative reserves the right to demand Third Party Inspection to be carried out at the cost of the Contractor who is not able to provide or substantiate test results.

**7.3.7.** At least 5 samples from random supplies of each type of cables shall need to be got inspected by an Independent Govt Approved Laboratory in India by the Contractor at his own cost.



**7.4. ON-SITE TESTING AND COMMISSIONING**

**7.4.1. GENERAL**

7.4.1.1. The Contractor shall prepare and submit to the Employer's Representative for review an On-site Testing and Commissioning Plan.

**7.4.2. INSTALLATION TESTS**

7.4.2.1. Installation Tests shall be carried out on Individual Sub-systems location by location after the completion of equipment physical installation.

7.4.2.2. The objective of the installation tests shall be to ensure the following:

- 1) The equipment is installed in accordance with the reviewed design documentation.
- 2) The equipment is installed in accordance with the requirements detailed in this Particular Specification.
- 3) All cables are properly and accurately connected and terminated.
- 4) All installation works are of acceptable workmanship.

7.4.2.3. The Contractor shall develop Installation Tests Procedures and submit to the Employer's Representative for review.

7.4.2.4. The Installation Test shall not be started unless the test procedures have been reviewed with NOC/NOSC by the Employer's Representative.

7.4.2.5. All installed equipment and cables shall be physically inspected against all relevant review design documentation.

7.4.2.6. The Contractor shall measure the end-to-end performance of all cores of the copper cables and optical fibre cables, including all spare cores, laid between different locations.

7.4.2.7. All the installation test results, physical locations of the equipment and serial numbers shall be captured in the test record forms. The Contractor shall include completed test record forms in the Test Report and submit to the Employer's Representative for review.

**7.4.3. PARTIAL ACCEPTANCE TESTS**

7.4.3.1. Partial Acceptance Tests shall be carried out on each sub-system location by location, on areas or Section basis to verify the functions, performance and services coverage at the stage:

- (1) After successful completion of the Installation Tests with NOC/NOSC
- (2) After the Subsystems have been configured with correct settings and parameters.
- (3) Properly connected to the power supply and can be switched on for Partial Acceptance Tests.
- (4) Before the equipment of different locations are connected up and ready for System Acceptance Tests.



- 7.4.3.2. The Contractor shall develop Partial Acceptance Tests in accordance with the requirements of GS.
- 7.4.3.3. The Contractor shall develop Partial Acceptance Tests Procedures for each Subsystem and submit to the Employer's Representative for review.
- 7.4.3.4. The Partial Acceptance Tests procedures shall include:
- (1) Objectives of the Partial Acceptance Tests for all Subsystems
  - (2) List of specifications and standards, reviewed design documentation for reference
  - (3) Step-by-step test instructions
  - (4) List of test instrument and special tools
  - (5) Test record forms
  - (6) Pass or fail criteria
- 7.4.3.5. Where performance across interfaces to Project Contractors or to other parties is required to be verified during the Partial Acceptance Tests, the Contractor shall include a list of Project Contractors and the interface test procedures agreed with the relevant Project Contractors in the Partial Acceptance Tests procedures for the relevant Subsystem.
- 7.4.3.6. The functional, electrical and timing performances of the Subsystems shall be verified against the requirements and relevant international standards.
- 7.4.3.7. Wherever applicable, the Contractor shall have local loop back tests on circuits for electrical performance measurement such as error rate and signal level measurement.
- 7.4.3.8. All local alarms, control and monitoring functions shall be verified.
- 7.4.3.9. All equipment settings and parameters shall be verified and recorded in the reviewed test record forms.
- 7.4.3.10. The Partial Acceptance Tests are considered completed only if the Employer's Representative without objection reviews the Partial Acceptance Test results.
- 7.4.3.11. Upon completion of the Partial Acceptance Test, the individual Subsystem shall be operational and ready to be connected to other Subsystems and interfacing systems for testing.
- 7.4.4. SYSTEM ACCEPTANCE TESTS**
- 7.4.4.1. System Acceptance Tests shall be carried out to ensure the System operates in accordance with functional and electrical performance requirements given in the Particular Specification.
- 7.4.4.2. System Acceptance Tests shall be carried out at the following stages:
- (1) After completion of Partial Acceptance Tests for each Subsystem.
  - (2) After all individual Subsystems have been connected together and the System as a whole is capable to operate in all respect in accordance with



the requirements given in the Particular Specification.

- 7.4.4.3. The Contractor shall submit a System Acceptance Tests Plan to the Employer's Representative for review.
- 7.4.4.4. The Contractor shall conduct end-to-end circuit test to verify the circuit integrity and electrical performance for all circuits including spare.
- 7.4.4.5. All alarm points shall be verified with simulated faults.
- 7.4.4.6. All protection mechanisms such as hot-standby, parallel redundancy, automatic switchover, etc, built into the System and individual Subsystem shall be verified.
- 7.4.4.7. The system response time of relevant Subsystems and the System shall be tested and measured.
- 7.4.4.8. The Contractor shall carry out load test on each Subsystem to verify the designed system capacity and performance in accordance with the requirements given in the Particular Specification under full load condition.
- 7.4.4.9. The Contractor shall carry out tests on the operation of the System in accordance with the normal operation procedures and emergency operation procedures, which has been reviewed without objection by the Employer's Representative.
- 7.4.4.10. The Contractor shall carry out tests on the OCC/BCC operation of the System in accordance with the reviewed operation procedures as below:
  - (1) When OCC/BCC is the master control
  - (2) Switchover from main to standby control within OCC/BCC, if applicable
  - (3) Switchover from Main OCC to back up OCC
  - (4) Switchover from back up OCC to Main OCC
- 7.4.4.11. The Contractor shall conduct tests to verify the proper inter-operation among Subsystems.
- 7.4.4.12. Where performance across interfaces to Project Contractors or to other parties is required to be verified during the System Acceptance Tests, the Contractor shall include the list of Project Contractors and the interface test procedures agreed with the relevant Project Contractors in the System Acceptance Tests procedures for the relevant Subsystem or Subsystems.
- 7.4.4.13. The System Acceptance Tests are considered completed only if the System Acceptance Tests results are reviewed by the Employer's Representative without objection.
- 7.4.4.14. Upon completion of the System Acceptance Tests, the System shall operate in accordance with the functional and electrical performance requirements given in the PS.
- 7.4.5. INTEGRATED TESTING AND COMMISSIONING**
- 7.4.5.1. The Contractor shall carry out Integrated Testing and Commissioning after the completion of the System Acceptance Tests.



- 7.4.5.2. The Contractor shall co-ordinate with the Employer's Representative and with all the interfacing Project Contractors to ensure all the interface test activities are completed in accordance with the program on Completion Plan.
- 7.4.5.3. The Contractor shall provide all necessary supports, conduct investigation and provide corrective actions, if necessary, to ensure all matters related to interfacing are properly resolved.
- 7.4.5.4. Within one week upon completion of all interface test activities, the Contractor shall submit the test results to the Employer's Representative for review.
- 7.4.5.5. After the test results of all interface test activities have been reviewed by the Employer's Representative without objection, the Contractor shall start the reliability demonstration test in accordance with the reviewed reliability demonstration test plan.
- 7.4.5.6. The Contractor shall advise the Employer's Representative in writing the commencement date of the reliability demonstration test.
- 7.4.5.7. The reliability demonstration test period shall be at least three months.
- 7.4.5.8. The Contractor shall submit a Reliability Demonstration Test Plan to the Employer's Representative for review at least three months before the test.
- 7.4.5.9. The Contractor shall include the following in the reliability demonstration test plan as a minimum:
- (1) Calculation of the maximum allowable number of failures of equipment, Subsystems and System during the reliability demonstration period in accordance with requirements on reliability performance of the equipment, Subsystems and System given in the Particular Specification
  - (2) Definition of relevant failures
  - (3) Pass and fail criteria
  - (4) Sample of fault logs
- 7.4.5.10. During the reliability demonstration test period, the Contractor shall record details of all faults in a fault log which shall include:
- (1) The date and time the fault occurs
  - (2) The date and time the Contractor's staff arrive on site
  - (3) The date and time the fault is cleared and the normal operation is restored
  - (4) The description of the fault
  - (5) The cause of the fault
  - (6) Equipment or component replaced
- 7.4.5.11. All fault logs shall be submitted to the Employer's Representative for review.
- 7.4.5.12. The reliability demonstration test is considered a failure if:
- (1) The actual number of relevant failures exceeds the maximum allowable



number of failures for any equipment, Subsystems or System identified in the reliability demonstration test plan.

- (2) Any fault resulting from the design omission or commission of error requires design modification in order to fix the fault.

7.4.5.13. If the reliability demonstration test fails, the Contractor shall provide all the necessary corrective actions and rectify the fault to the satisfaction of the Employer's Representative.

7.4.5.14. The reliability demonstration test shall be repeated on the affected Subsystem or Subsystems for another three months until the test is successfully completed.

7.4.5.15. Within two weeks upon completion of the reliability demonstration test, the Contractor shall submit the test results for the Employer's Representative to review.

7.4.5.16. The Integrated Testing and Commissioning is considered completed only if all the test results of the Integrated Testing and Commissioning have been reviewed by the Employer's Representative without objection.

#### **7.4.6. SERVICE TRIALS**

7.4.6.1. The Contractor shall provide all necessary support and attendance to the Employer's Representative during the Service Trials period in accordance with the requirements given in General Specification.

7.4.6.2. The Contractor shall provide on-Site supports to the Employer's Representative in all aspects related to the operation of the System. The Contractor shall also conduct investigation and provide corrective actions for any problems related to the System or the interfaces with the System.

7.4.6.3. The Contractor shall assign competent staff to support the Service Trials as required by the Employer's Representative. The persons shall be the engineering staff who shall have sufficient skills and knowledge of the System and shall have been involved in the design, installation or commissioning of the System.

7.4.6.4. The Contractor shall submit a manpower plan to the Employer's Representative for review at least 1 month before the commencement of the Service Trials.

7.4.6.5. The manpower plan shall include the organisation chart of the Contractor's Service Trials supporting group, individual person's role and responsibility and 24-hour contacts for emergency cases.

7.4.6.6. The Contractor shall correct all faults found during testing, and shall arrange for the relevant tests to be repeated. The relevant tests shall only be repeated when the fault has been remedied and the equipment demonstrated to function correctly.

7.4.6.7. Where remedial measures involve significant modifications that might, in the Employer's Engineer opinion, affect the validity of earlier tests, the Contractor shall repeat the earlier tests and obtain results satisfactory to the Employer's Engineer before repeating the test in which the fault was first identified.



7.4.6.8. The Employer's Engineer shall have the right to order the repeat or abandonment of any test in the event that results demonstrate that the equipment is significantly non-compliant with the Contract.

7.4.6.9. The Employer's Engineer shall have the right to suspend any test in the event that errors or failures have become unacceptable. The Employer's Engineer shall also have the right to suspend any test if a fault was detected by the Contractor but not reported to the Employer's Engineer within 24 hours of the detection. In this event, the suspension shall remain in effect until reporting has been brought up to date to the satisfaction of the Employer's Engineer.

**7.4.7. REPEAT TESTS**

7.4.7.1. The Contractor shall correct and re-test every fault detected during the tests.

7.4.7.2. If the test results in a failure of the item under test the provisions of GCC shall apply.

7.4.7.3. For each hardware failure that occurs at any stage of testing, the Contractor shall investigate the failure and prepare a report on its cause(s) and design implications, if any, resulting from such failure.

**8. PACKAGING, SHIPPING, STORAGE AND DELIVERY**

**8.1. PACKAGING**

**8.1.1. GENERAL**

8.1.1.1. The requirements on packaging, shipping, storage and delivery shall be as given in the GS.

**8.1.2. CABLE DRUMS**

8.1.2.1. Immediately after the tests at the place of manufacturing, both ends of every length of cables shall be sealed by enclosing them with approved caps, tight fitting and adequately secured to prevent ingress of moisture.

8.1.2.2. The ends of the factory lengths of cable shall be marked "A" and "Z", "A" being the end at which the sequence of core numbers is clockwise and "Z" the end at which the sequence is anti-clockwise.

8.1.2.3. The end which is left projecting from the drum shall be consistently "A" or "Z", and shall be protected against damage in such a manner that the enclosure cannot be easily removed during handling while in transit.

8.1.2.4. Cables shall be supplied on drums in the longest possible lengths and within practical limits.

8.1.2.5. The maximum allowable diameter of cable drum shall be 2000mm. The use of cable drums with diameter in excess of 2000mm shall be subjected to the review of the Employer's Representative

8.1.2.6. All cable drums shall be designed to be securely mounted on the wagon with the mounting accessories provided by the Contractor for cable lying along trackside.

8.1.2.7. The drums shall also be designed for use in conjunction with any special



cable-laying equipment and accessories complete with spindles and cable drum braking gear, which shall be used to install the cables on Site.

- 8.1.2.8. Each drum shall bear a distinguishing number and label "Mumbai Metro Telecommunications System", either printed or neatly chiselled on the outside of one flange.
- 8.1.2.9. Particulars of the cable, i.e. voltage, length, conductor size, number of cores, finish, section and length number, gross and net weights, shall be clearly shown on one flange of the drum. In addition the words "Running End 'A'" or "Running End 'Z'" as appropriate shall be marked on the flange and the direction for rolling shall be indicated by an arrow.

**8.1.3. STORAGE**

- 8.1.3.1. The Contractor shall provide his own storage and facilities at his Project Office in Mumbai for storage of all items to be provided for this Contract before delivery to the Site for installation. Security of the same shall be responsibility of the Contractor.
- 8.1.3.2. The Contractor shall maintain records of stored items for this Contract and make available for the Employer's Representative for inspection upon request.
- 8.1.3.3. The Contractor shall ensure that the Site/Storage area provided will be neat and clean from the mosquito breeding.

**8.1.4. DELIVERY**

- 8.1.4.1. The Contractor shall deliver all items supplied under this Contract to the Site as desired by the Employer's Representative.
- 8.1.4.2. The Contractor shall include the delivery activities in his programme to draw the Employer's Representative's attention.
- 8.1.4.3. The Contractor shall ensure the Site is ready and in good conditions for delivery.
- 8.1.4.4. The Contractor shall ensure good conditions and security of the delivered items on Site. Security of the same shall be the responsibility of the contractor.
- 8.1.4.5. The Contractor shall remove temporary fittings, if necessary, for delivery of his items to site and shall restore the fittings to the original state and to the satisfaction of the Employer's Representative.
- 8.1.4.6. No dangerous goods shall be delivered to the Site.

**8.1.5. INSPECTION DURING DELIVERY**

- 8.1.5.1. Employer's Engineer at contractor's site office/store will do delivery inspection for the equipments supplied by the contractor. The format for the delivery form will be as follows:



**MS07: Particular Specifications**

Box no.	ED/ CD Reference	Code	Items/ Particulars	Qty. as per BOQ	Qty as per packing list	Qty. as per delivery inspection	Qty to be utilised for station/ section	Deficiency/Balance Qty	Remarks

- Material shall be delivered undamaged in manufacturer's original containers, as applicable packaged as indicated, with identifying labels intact and legible
- Deliveries shall be made in accordance with the contract documents, including general conditions and the contract schedule as approved by the Employer's Engineer
- Unless otherwise indicated, contractor shall notify the Employer's Engineer at least five working days prior to proposed delivery to the placement or set-up site. The contractor shall perform unloading at placement site or setup site.
- Contractor shall arrange the inspection from RDSO for the materials which are as per RDSO specifications.
- Contractor shall arrange the inspection from TEC for the materials which are as per TEC specifications.
- All inspection charges shall be borne by the MS07 Contractor.

**9. INSTALLATION**

**9.1. GENERAL**

- 9.1.1.** The Contractor shall supervise all installation of the Works and shall ensure all technical, safety and quality matters adhered to the design reviewed by the Employer's Representative.
- 9.1.2.** The Contractor shall maintain the Site in a neat and tidy state at all times. The Contractor shall also clear the Site daily before leaving.
- 9.1.3.** The Contractor shall take every precaution to protect existing equipment and facilities on Site from damage, and shall make good any damage caused. Care shall also be taken not to interfere with the operation of existing equipment, if any.
- 9.1.4.** The Contractor shall provide all necessary and sufficient resources such as tools, test instruments, spares, equipment, manpower and communication facilities to complete all the installation activities.
- 9.1.5.** The Contractor shall ensure his staff are competent and possess all the necessary skills to carry out the installation in a proper and safe manner.



- 9.1.6.** The Contractor shall carry out site surveys to ensure sufficient knowledge on the Site before submitting the relevant installation drawings and installation related submissions to the Employer's Representative for review.
- 9.1.7.** The Contractor shall submit calculation, if required by the Employer's Representative, to demonstrate the proposed brackets and mounting methods are sufficient to withstand the wind loading for the equipment.
- 9.1.8.** The Contractor shall submit installation method statements for each type of installation activities at least three months before the commencement of the activity to the Employer's Representative for review.
- 9.1.9.** The installation method statement shall include the details on the methods and procedures of installation, site arrangement, manpower resources, equipment and tools required. Drawings shall be included to illustrate the proposed installation details.
- 9.1.10.** All installation activities shall commence only after the method statement and related submissions have been reviewed without objection by the Employer's Representative.
- 9.1.11.** The Contractor shall assign competent site supervisors for each work site to be responsible for all site-related matters.
- 9.1.12.** The Contractor shall carry out regular site audit on both technical and safety matters and maintain records of the site audits. The Contractor shall make these records available to the Employer's Representative for inspection upon request.
- 9.1.13.** Installation and Mitigation Guidelines must be observed wherever applicable.
- 9.2. INSTALLATION PROGRAMME**
- 9.2.1.** The Contractor shall submit an Installation Programme for review by the Employer's Representative not later than 6 months before Commencement of installation.
- 9.2.2.** The Contractor shall co-ordinate with relevant Project Contractors to agree the date of access to the physical areas to carry out installation activities.
- 9.2.3.** The Contractor shall develop the Installation Programme and take the following into account:
- (1) Installation schedule
  - (2) Key Dates and Milestones
  - (3) Site access
  - (4) Interfacing with relevant Project Contractors
- 9.2.4.** The Contractor shall highlight in his Installation Programme any items, materials, equipment, resources and supports to be provided by the Employer's Representative with dates, duration and locations.
- 9.2.5.** The Contractor shall also highlight all relevant constraints, which may affect the Installation Programme, to the Employer's Representative's attention.



- 9.2.6. The Contractor shall include dependencies between relevant activities in the Installation Programme.
- 9.2.7. The Contractor shall ensure sufficient floats or slacks in all activities and avoid critical paths built in his Installation Programme. In case critical paths cannot be avoided, the Contractor shall highlight any critical paths to the Employer's Representative's attention.
- 9.2.8. The Contractor shall propose contingency plan to ensure all the major Key Dates and Milestones can be met in case there is slippage in the installation activities.
- 9.2.9. Any subsequent changes in the reviewed Installation Programme shall be submitted to the Employer's Representative for review.

**9.3. INSTALLATION WORKS**

**9.3.1. INSTALLATION IN EQUIPMENT ROOMS**

9.3.1.1. The following equipment rooms will be provided by Employer/Civil Works Project Contractors to install the telecommunication equipment:

- 1) Telecommunication Equipment Room at station and Depot
- 2) Central Equipment Room at OCC/BCC
- 3) Telecom Power Supply Room (UPS S&T Room)

The tentative space allocation for the Contractor in CER/TER will be as follows:

<b>Equipment Room</b>	<b>Approximate Total floor space (m<sup>2</sup>)</b>
CER at OCC/BCC	60
TER in stations & Depot	30
TER in HQ	20

**Table: Tentative Space allocation at CER and TER**

The MS07 Contractor shall interface with other contractors for the final layout of installation of outdoor equipment for all stations, depot and OCC/BCC based on the combined services diagram.

The MS07 Contractor shall interface with other contractors for the final layout of installation of outdoor equipment for all stations, depot and OCC/BCC based on the combined services diagram.

- 9.3.1.2. For exact room dimensions, the Contractor shall however co-ordinate and refer to the final station building plans.
- 9.3.1.2.1. The Contractor shall liaise with the Employer's Representative and relevant Project Contractors for access to the equipment rooms for installation.
- 9.3.1.2.2. All floor mounted equipment cabinets at the equipment room shall be securely bolted to ground with base frame, properly aligned and levelled.
- 9.3.1.2.3. All wall-mounted equipment shall be installed at appropriate height to



avoid any hazards to the person passing by. The Contractor shall ensure the wall is of sufficient strength to hold the wall-mounted equipment in a secure and safe manner.

- 9.3.1.2.4. The floor mounted equipment cabinets shall be arranged in the way to allow sufficient space at the front and rear side of the cabinets for maintenance access. Sufficient space shall also be allowed for front maintenance access of the wall mounted equipment.
- 9.3.1.2.5. The equipment layout within the equipment room shall be co-ordinated with other contractors, who share the same equipment rooms for their equipment. Further the equipment layout within the equipment room shall be designed to allow sufficient clearance for escape out of the equipment rooms in case of emergency.
- 9.3.1.2.6. The Contractor shall submit the following to the Employer's Representative for review at least three months before the commencement of the installation inside the equipment room:
  - 9.3.1.2.6.1. Drawings showing the equipment layouts and positions of the racks, cabinets, enclosures and Base Frame duly agreed with other project contractor.
  - 9.3.1.2.6.2. Racks, cabinets layout drawings showing the arrangement of individual module Specifications, sample of all the mounting brackets and accessories
  - 9.3.1.2.6.3. Equipment mounting and installation methods
  - 9.3.1.2.6.4. Schematic diagrams and wiring diagrams of the System
  - 9.3.1.2.6.5. Electrical distribution schematics within the room including the earthing details
  - 9.3.1.2.6.6. Cable route diagrams for cables within the room, duly agreed with other project contractors.
- 9.3.1.2.7. Installation work inside the room shall be carried only after these submissions have been reviewed without objection by the Employer's Representative.

**9.3.2. INSTALLATION AROUND STATION AREAS**

- 9.3.2.1. The Telephone contractor shall provide mounting brackets for direct line telephones close to the cross passages along the tunnel.
- 9.3.2.2. CCTV contractor shall provide necessary mounting arrangements for installation of CCTV Camera at outdoor locations. i.e. Parking, periphery of depot & RSS, Ramp, Midshafts, Signal Point Crossing (SPC), River Bridges (if applicable) etc.
- 9.3.2.3. FOTS contractor shall provide all necessary mounting arrangements for installation of Network Switches at outdoor locations, i.e. Parking, Depot Periphery & RSS, Ramp, Mid- Shaft, Signal Point Crossing , river bridges etc.
- 9.3.2.4. All the ducts/space between the stations for laying cables will be provided by civil works project contractors. However cable ducts and trenches required between Station/depot and the RSS for laying of cables shall be



arranged by E&M Contractor.

- 9.3.2.5. All the mounting brackets and accessories shall be corrosion resistant, aesthetically designed to match with all architectural finishes and of sufficient strength to mount the equipment securely.
- 9.3.2.6. The Contractor shall submit the following to the Employer's Representative for review at least three months before the commencement of the installation activities:
- (1) Specifications, sample of all the mounting brackets, Base frame, False floor and accessories;
  - (2) Equipment mounting and installation methods; and
  - (3) Schematic diagrams and wiring diagrams of the System.
- 9.3.2.7. If the equipment is installed at location exposing to direct sunlight, the equipment, mounting brackets, cables and accessories shall be made of materials which are resistant to ultra violet rays.
- 9.3.2.8. All trackside equipment and the mounting method shall be designed in the way to minimise the frequency of preventive maintenance.

**9.3.3. WORKING IN CONFINED SPACES**

- 9.3.3.1. The Contractor shall observe the safety precautions under the Factories and Industrial Undertakings (Confined Spaces) Regulations when working in areas defined as Confined Spaces.
- 9.3.3.2. The Contractor shall provide adequate mechanical ventilation for the efficient removal of any harmful or explosive gas therein throughout the full working period.
- 9.3.3.3. The Contractor shall carry out a physical gas test at the beginning of each work shift in the confined space to ensure that there is no ingress of dangerous fumes and no oxygen deficiency.
- 9.3.3.4. The Contractor shall ensure that no person is allowed to enter or remain in the confined space until he has certified that the space in a specified period is safe for entry without the use of breathing apparatus by virtue of the gas test.
- 9.3.3.5. All electrical equipment used in the confined space shall be of flameproof type.

**9.4. CABLING**

- 9.4.1. Primary cable containment, common for all telecom sub-systems around the station areas and along track-side will be provided by Civil Works Project Contractor. The Contractor shall however give destinations of each cable and EMI requirements to the Project Contractors.
- 9.4.2. The MS07 Contractor shall provide all necessary secondary cable containment and supports in addition to the primary cable containment provided, if necessary, to complete the connection to the Contractor's equipment. In Elevated/At Grade Sections, in case Optic Fibre cable is laid on the viaduct in the cable duct, then the Contractor shall provide it in a



rugged “permanently solid lubricated” HDPE telecom duct of minimum diameter of 40 mm(Outer)/ 33 mm(Inner) with material characteristic as per TEC Specifications along with the accessories . HDPE Telecom duct as per TEC specifications shall be buried at a depth of 1.2 metres in the At Grade Sections and suitably supported/fixed on Elevated Sections (where the duct is not available).

**9.4.3.** The Contractor shall submit the working drawings with the following details to the Employer’s Representative for review at least three months before the cabling activities:

**9.4.3.1. CABLE ROUTES**

9.4.3.1.1. Details of the cables to be laid along the proposed cable routes including cable types, number of cables, cable diameter, core count and estimated cable Section length

9.4.3.1.2. Sections of the primary cable containment to be used

9.4.3.1.3. Sections of additional cable supports to be provided by the Contractor with details on dimension and type of the cable supports such as cable trays, trunkings and conduits. No surface mounted conduits shall be provided by E & M contractors. Conduits as required for laying of cables for outdoor equipment such as Public Address System, Passenger Information Display System, Master Clock System, Cameras, CCTV Monitors etc shall be surface mounted and provided by the contractor. Conduits and Accessories shall comply with the requirements listed in Appendix-O of this PS.

9.4.3.1.4. All cables shall be neatly run and fitted in ducts or conduits, laid in trunkings, formed trenches or troughs, or supported by trays, hangers or cleats as appropriate.

9.4.3.1.5. The Contractor shall make any wall and slab openings, including the temporary removal of architectural finishes that shall be required for his cabling. After cabling is completed, the Contractor shall seal these openings with fire resistant materials and restore the architectural finishes and fire resistance to their original state.

9.4.3.1.6. Before commencing work on any part of the Site, the Contractor shall ascertain that the Employer’s Representative and also, where applicable, the local and statutory authorities or other bodies/persons concerned have reviewed each cable route without objection. The Contractor shall further ensure that all necessary permits in such cases have been obtained and notices served. All costs for the same shall be borne by the Contractor.

9.4.3.1.7. After conduits and ducts have been laid, they shall be thoroughly cleaned by a mandrel of diameter slightly less than the conduit or duct being drawn through. The duct ends shall be sealed temporarily to prevent the entry of foreign matter. The conduits and ducts shall be cleaned again immediately before the cables are drawn in.

9.4.3.1.8. The Contractor shall provide his own brackets and clips to secure all the cables at an interval reviewed by the Employer’s Representative. Where cables are to be laid in troughs, the Contractor shall remove and re-instate trough lids prior to and after cable installation.

9.4.3.1.9. Selection of cables and connectors shall be appropriate to their function. The



Contractor must be able to demonstrate satisfactory usage of the type of cables proposed for use in a comparable MRTS under tropical conditions, be able to comply fully with the specifications herein, and be willing to guarantee 25 years or more of service life for all the cables.

- 9.4.3.1.10. A labelling scheme shall be applied for all cables installed. Each cable shall be uniquely identified. Labels shall be tied at both ends, at entry and exit points of cable trays, ducts and trenches and at appropriate locations where necessary. A record shall be provided to indicate clearly the type of cables, the sizes of cable, the use of each core or pair, and termination as well.
- 9.4.3.1.11. The installation and handling of cables shall be undertaken at all times by adequate staff suitably trained and supplied with all necessary plant, equipment and tools. The arrangement of the cables and all methods of laying shall be submitted to the Employer's Representative for review and shall be planned to provide an orderly formation, free from unnecessary bends and crossings. Following principles for laying of cables shall also be adopted:
- 9.4.3.1.11.1. During track crossings, following rules shall be observed:
- (1) The cable crosses the track at right angle.
  - (2) The cable does not cross the track under points and crossings.
  - (3) The cable is laid in concrete/GI pipes while crossing the track.
- 9.4.3.1.11.2. At culverts and at transition from at grade to elevated section the cables shall be suitably supported and protected with B-class GI pipes.
- 9.4.3.1.11.3. All cables shall be laid within the Mumbai metro boundary. If it is necessary to lay the cable outside the Mumbai metro boundary, permission shall be obtained before starting the trenching. It shall be responsibility of the Contractor to obtain all such clearances along with all cost therein.
- 9.4.3.1.11.4. At elevated sections HDPE Duct shall be installed in the ducts provided by Project Contractor.
- 9.4.3.1.12. Sleeves made of LSZH and flame-retardant materials shall be provided for cables passing through slab or wall openings. After cable installation, the contractor shall seal empty space in the sleeves with fire-resistant compound by the Contractor.
- 9.4.3.1.13. No cable joints shall be allowed along trackside.
- 9.4.3.1.14. At no location shall the cable be bent with a radius lower than the minimum radius recommended by the manufacturers. Sharp edges shall be avoided.
- 9.4.3.1.15. Every precaution shall be taken to ensure that cables and equipment are not installed in a manner or under conditions likely to cause electrolytic or other corrosive action or damage to, or be detrimental to, the performance of the cables and equipment during operation.
- 9.4.3.1.16. Communication cables shall not run with cables carrying high voltages or heavy currents and shall conform to the requirements specified in BS 7671.
- 9.4.3.1.17. All cables and wires inside cabinets shall be housed in appropriate cable conduits or tied neatly along the side of the cabinet. They shall not cause



any obstruction to the access of equipment within.

- 9.4.3.1.18. All cables shall be adequately rated for their duties. All power cables shall be able to withstand full load current for peak operation when the equipment is at its ultimate capacity. The Contractor shall comply with the latest edition of IEE Wiring Regulations.
- 9.4.3.1.19. Cable ties shall be made only from corrosion-resistant materials. They shall be further resistant to ultra-violet radiation if they are to be used at locations exposed to sunlight. In areas of significant vibration, cable ties shall be of metallic construction and coated further with a corrosion-resistant material.
- 9.4.3.1.20. Wherever possible, standard multi-pin plug/socket shall be used to terminate multi-core cables for connecting to equipment. Locking mechanism shall be integrated in the connector to secure the connection.
- 9.4.3.1.21. Use of soldering in cable connections shall be minimised and it shall be used only for terminating conductors. Cables and wires shall be terminated by more flexible means such as screw terminals, crimping or wire wrapping which shall be subject to review by the Employer's Representative.
- 9.4.3.1.22. Heat-shrinkable sleeves shall enclose all exposed and terminated contacts inside multi-pin connectors.
- 9.4.3.1.23. Any unconnected socket shall be covered up and properly labelled to avoid exposure for short-circuit and making wrong connection by mistake.
- 9.4.3.1.24. Unused cable cores of multi-core cables shall be neatly tied and wrapped up inside the connectors.
- 9.4.3.1.25. Connectors shall be suitably configured to avoid the possibility of wrong mating.
- 9.4.3.1.26. Connectors at cable ends carrying high voltages or current sources shall invariably use female contacts.
- 9.4.3.1.27. For metallic armour of outdoor cables an earthing and gapping policy shall be incorporated into an overall earthing policy to be agreed by the Employer's Representative.
- 9.4.3.1.28. All cables which run outside the station building shall be contained in protective conduits or where directly buried in ground shall be at minimum 1.2 Mtr depths in HDPE Duct/GI Pipe.
- 9.4.3.1.29. Each cable shall be tested to ensure correct continuity and loss.

## **9.5. MARSHALLING AND TERMINATION**

### **9.5.1. GENERAL**

- 9.5.1.1. Main distribution frames, digital distribution frames, Patch Panel shall be provided at appropriate locations for signal termination, distribution, disconnection, diversion and in-circuit testing. Intermediate termination points shall also be provided as appropriate to allow cable network flexibility.
- 9.5.1.2. The signal termination and distribution practice shall adopt a consistent approach for easy circuit identification and is subject to the review of the Employer's Representative.



9.5.1.3. The circuit terminations shall be secure enough to withstand vibration level, which is likely to be experienced in the railway environment.

9.5.1.4. These frames shall be designed to allow repeated circuit termination and disconnection.

**9.5.2. MAIN DISTRIBUTION FRAME (IF USED)**

9.5.2.1. Main distribution frame shall be provided at Telecommunication Equipment Room and Central Equipment Room for the signal distribution of all voice, analogue, alarm and control circuits.

9.5.2.2. The capacity of the main distribution frame and the associated connecting blocks shall be sufficient to accommodate all circuits including spares and the cross-connect field between equipment side and line side terminations. An extra of at least 20% capacity shall be included for future expansion.

9.5.2.3. The Contractor shall provide two set of the following accessories:

- (1) Tools for circuits connection and disconnection.
- (2) Plug-in devices for circuit disconnection.
- (3) Test cords and loop-back cords.
- (4) Signal patch cords.

9.5.2.4. The outgoing circuits connecting to external lines and all circuits liable for lightning or high induced voltage, lightning arrestors and surge protection devices shall be provided with the required earth connections. For details of Transient Protection please refer to 9.9 (Transient Protection).

9.5.2.5. All voice, analogue, alarm and control circuits including spares shall be properly terminated at the main distribution frame.

9.5.2.6. The main distribution frame shall be divided into different zones for different types of circuits.

9.5.2.7. The main distribution frame shall be equipped with copper earth bar to which all cable shields shall be connected. The copper earth bar shall be connected to the earth.

9.5.2.8. The main distribution frame shall be equipped with facilities such as use of different colours or markers to aid circuit pair's identification.

9.5.2.9. The Contractor shall maintain records of all the circuit terminations.

**9.5.3. DIGITAL DISTRIBUTION FRAME/PATCH PANEL (IF USED)**

9.5.3.1. Digital distribution frame/Patch Panel shall be provided at Telecommunication Equipment Room, Central Equipment Room and at other locations as appropriate for data circuit termination.

9.5.3.2. The DDF shall be Wire Wrapping type as per TEC Specification

9.5.3.3. The Contractor shall provide two set of the following accessories:

- (1) Tools for circuit connection and disconnection (Wrapping tool)



- (2) Plug-in devices for circuit disconnection
  - (3) Test cords and loop-back cords
  - (4) Optical patch cords.
- 9.5.3.4. All the connectors on the modules shall be of female type and equipped with locking mechanism, if applicable, for secure connection. All spare connectors shall be protected with covers.
- 9.5.3.5. Suitable Patch Panel/Panels shall be provided by the contractor for FOTS System for termination of user channel i.e. TCP/IP and GBIC Port etc. All the users shall connect their respective Patch Chord/ Cable/Connector etc. at this patch panel only for connections to their respective systems.
- 9.5.3.6. Different modules in the digital distribution frame shall be provided for different types of data circuits.
- 9.5.3.7. The digital distribution frame/Patch panel shall be equipped with sufficient capacity for data circuits including spare circuits. The digital distribution frame/Patch panel shall also be equipped with an extra of 25% of termination capacity for future use.
- 9.5.3.8. Markers or labels shall be included in the digital distribution frame/Patch panel for easy identification of the circuits.
- 9.5.4. OPTICAL DISTRIBUTION FRAME (ODF) (IF USED)**
- 9.5.4.1. Optical Distribution Frame (ODF) as detailed in Appendix Q, Chapter 10 (Appendices) of PS, shall be provided in Telecommunication Equipment Room, Central Equipment Room and at other locations as appropriate for Optical Signal distribution and spare fibre cores storages
- 9.5.4.2. The ODF shall comprise of equipment cabinet(s) or enclosures housing the following optical equipment: i) fibre splice module ii) fibre storage panel iii) optical patch panel
- 9.5.4.3. All fibre cores terminating in the ODF shall be spliced to factory connectorized pigtails and properly stored in the fibre storage panel.
- 9.5.4.4. Optical patch cords shall be provided to connect the optical terminal to the ODF and for patching within and between the optical patch panel.
- 9.5.4.5. Fibre storage panels shall be provided in the ODF to store the excess length of pigtail and patch chords.
- 9.5.4.6. All splices shall be fusion splices and heat shrink splice sleeves shall be used for splice protection and housed in a fibre spliced module.
- 9.5.4.7. All fibre splice modules shall either be telescopic or hinged type for easy access of splice element.
- 9.5.4.8. All fibre splice modules shall be equipped with built in fibre slack take up mechanism.
- 9.5.4.9. All optical distribution panels shall be either telescopic of hinged type for easy access of rear side of panel.



- 9.5.4.10. The optical distribution panel shall be fully equipped with adapters for optical signal termination. All spare adapters shall be protected with jackets.
- 9.5.4.11. One high quality optical connector such as LC single mode 10/125 um type shall be standardised. Optical connector type specified on the transmission equipment shall be compatible with the optic fibre termination. The coupling loss of the connector shall be below 0.3 db repeatable.
- 9.5.4.12. All optical connectors shall comply with ITU-T Recommendation G.652.
- 9.5.4.13. Mating face dimensions shall be in accordance with IEC 86 B.
- 9.5.4.14. All pigtailed and patch cords shall be properly labelled.
- 9.5.4.15. Optical interface at patch panel shall be LC only
- 9.5.4.16. The ODF shall be equipped with sufficient capacity for all optical signal distribution and fibre storages. A 25% spare capacity shall be provided, in each module, for future expansion

**9.6. IDENTIFICATION**

- 9.6.1. Descriptive labels shall be provided for all cabinets, enclosures, panels, assemblies and sub-assemblies.
- 9.6.2. Labels shall be of engraved type, with durable markings and shall have character size not less than 6mm high.
- 9.6.3. The details of the labels including the material and size of the characters and sample of the labels shall be submitted to the Employer's Representative for review.
- 9.6.4. Labels and notices on equipment shall be fixed with roundhead brass screws or self-tapping screws. Stick-on labels or fixing by adhesive shall not be accepted.
- 9.6.5. All enclosures containing terminals or exposed live parts where a voltage exceeds 120 volts shall have a label with lettering indicating the maximum voltage present in the enclosure.
- 9.6.6. Warning signs shall be provided with graphical symbols and wordings in red for hazardous electrical or optical laser equipment.

**9.7. ELECTRICAL DISTRIBUTION**

- 9.7.1. 3 Phase 415 V AC from the UPS, to meet the requirement of Telecom, AFC and Signalling Contract shall be provided by MS01A Contractor in UPS (S&T) Room. MS01A Contractor shall provide AC distribution panel having Six MCCBs (one for Signal, one for Telecom ,One for IT ,One for Access control, One for PSD and one for AFC). MS01A Contractor shall extend the AC Power supply from UPS Rooms to TER/CER and provide a Distribution system in a cubicle. The AC distribution system provided by the MS07 contractor shall meet with the requirements of all Telecom and IT sub-systems. Distribution circuits shall be suitably protected with MCBs, Earth Leakage Detectors and SPDs etc. The Signalling Contractor shall plan and take care of the Signalling, Telecom, IT Systems and AFC, for load requirement of the system.



9.7.2. Adequate no. of spare circuits of each type for each sub-system shall also be provided in the distribution system by The Contractor. The further cabling from AC Distribution cubicle to Equipment Racks and other required locations for powering equipments to be supplied and commissioned by the Contractor for all the equipments. The Contractor shall work out Signalling, Telecommunication and interface with AFC contractors for actual load and circuit requirements for stations/Depot/OCC/BCC and shall submit the design of the AC power distribution systems for each stations /depot / OCC/BCC for review by the Employer's Representative. The ratings of switch gears, cables etc. should have appropriate safety margin/derating factors. MS01A contractor shall lay a spare power cable from UPS distribution to TER distribution. Spare cables as above shall be of the same capacity as the cables in use.

9.8. **EARTHING POLICY**

9.8.1. An earthing system shall be designed to assure personnel safety and protection of installations against damage. It shall also serve as a common voltage reference and to contribute to the mitigation of disturbances. The Earthing Policy to be followed is as per Appendix M of Chapter 10 of this PS.

9.8.2. The earthing system shall generally meet the requirements of IEEE 1100, NFPA 780, IEC 1024.

9.8.3. To achieve the primary goal of assuring personnel safety and damage control, a low impedance path shall be made available to the current generated due to lightning or power system fault. The potential differences between any two points shall be as low as possible. Safety considerations also require the chassis or enclosure to be earthed to minimise shock hazards to passengers and transit system staff.

9.8.4. To achieve the secondary goal of providing protection for sensitive and interconnected electronic and electrical systems, earthing shall be designed to minimise the noise voltage generated by currents from two or more circuits flowing through common earth impedance and to avoid creating earth loops susceptible to magnetic fields and differences in earth potential.

9.8.5. Earthing shall be designed to accomplish the following minimum requirements:

- a) Protect personnel and equipment from electrical hazards, including lightning.
- b) Reduce potential to system neutrals.
- c) Reduce or eliminate the effects of electrostatic interference and electromagnetic interference arising from within the MRTS and other extraneous sources.
- d) Provide a proper earthing method for all equipment enclosures, cabinets, drawers, assemblies and sub-assemblies.
- e) Provide a clean zero-volt reference point.

9.8.6. There shall be a **Main Earth and Clean Earth (If required)**.

9.8.6.1. **MAIN EARTH:**



- 9.8.6.1.1. Main earth (< 2 Ohm) bus bar shall be provided in the TER, SCR & UPS (S&T) room by E&M Contractor with copper strip at each location consisting of minimum 20 holes (10 per row). This strip shall be used by Telecommunication contractor. The MS07 Contractor shall extend Main earth to the respective racks/equipments by own cable and arrangement.
- 9.8.6.2. **CLEAN EARTH (IF REQUIRED):**
- 9.8.6.2.1. Provision and extension of clean earth (<1 Ohm) up to TER/UPS to be done by the contractor. The Clean Earth to be terminated in TER on copper strip with a copper bus bar having minimum 20 holes (10 per row). The Contractor shall extend Clean Earth to the respective racks/equipments by own cable and arrangement.
- 9.8.6.3. The earthing system shall meet, but not be limited to, the following:
- a) The resistance to earth of the system “earth terminal” must remain within the stipulated limits at all locations and under all climatic conditions.
  - b) Any electrical joints in the earthing system shall be protected from moisture ingress by using proper wrapping, sealing with waterproof tapes, or such other measures.
- 9.8.6.4. The Clean Earth arrangements for Telecom Equipment shall be as below:
- a) All Telecom Equipments (under MS01 Contract) must be protected using a mesh of copper “earth” strips of appropriate cross-sectional dimensions, forming a local Earth Bus.
  - b) Each equipment rack shall be connected electrically to this bus. This bus shall be connected.
  - c) All joints of this connection shall be protected from moisture ingress by using proper wrapping, sealing with water-proof tapes, or such other measures.
  - d) The earthing connection shall be inspected periodically at intervals frequent enough to ensure that the Earth connection meets all the requirements.
- 9.8.6.5. The metallic sheath and armouring of all cables shall require earthing with Earth in Elevated/At Grade and Underground Sections.
- 9.8.6.6. The earthing electrodes for the Clean Earth shall be located at least 20 m away from the Main Earth.
- 9.8.6.7. The route for the Clean Earth shall be so chosen as to minimise the effect of any inductive interference.
- 9.8.6.8. For the purpose of measurement of earth resistance, a small interconnecting copper strip of appropriate cross-section shall be provided in the ring earth in a small manhole chamber so that the ring earth can be broken from the loop.
- 9.8.6.9. The earth resistance at any point on the Clean Earth shall be below 1.0 Ohm, and that for the Main Earth shall not exceed 2.0 Ohm at any location and under any soil and/or climatic condition.



9.8.6.10. All metal work and metallic items (including chassis) shall be earthed to the Main Earth to ensure the safety of personnel.

9.8.6.11. The earthing methods and details shall be submitted to the Employer's Representative for review.

**9.9. TRANSIENT PROTECTION**

**9.9.1. GENERAL**

9.9.1.1. Despite the provision of earthing as specified above, sometimes failures of communication equipment do occur on account of finite earth resistance, particularly high voltage transient and also due to lightning.

9.9.1.2. Typically, a transient & lightning are temporary, usually short duration, surge voltage of limited energy. Electronic equipment with high input impedance is inherently more susceptible to transients.

9.9.1.3. Physical distance from the transient source does not necessarily guarantee immunity from the transients.

9.9.1.4. To protect the Power & Telecommunication Equipments against surge voltage, external surge protection devices should be used at the input of vulnerable equipments.

**9.9.2. REQUIREMENT FOR EFFECTIVE TRANSIENT PROTECTION:**

9.9.2.1. Suitable surge protector devices (such as MOV's & suppressor diode & G.D Tube) having high surge handling capability, fast response time, low clamping voltage, etc., shall be incorporated in the communication equipment subsystems offered, to ensure that the latter withstands the conditions mentioned in (9.4.12) above without any damage or permanent degradation in performance throughout the system lifetime.

9.9.2.2. The selection criteria for such devices shall include, but not limited to, the following:

1. Reverse standoff Voltage: At least twice the maximum operating voltage.
2. Pulse Power Rating: This shall have a value to handle the peak pulse power of the transients and ensure their decay in less than 10% of the rise time for the worst pulse likely to be encountered from all possible sources including lightning and transients from overhead traction power system.
3. SPD should be capable enough to handle a surge current 10kA (8/20µs) impulse for Power & Telecom Network application.
4. SPD should be pluggable & resetting type, once surge is diverted, SPD shall have health status indication.
5. Device Lifetime: This shall not be less than that the life of system for which it affords protections.
6. The devices shall be tested against IEC 61643-1, 21 & 22 or UL 1449.



7. Peak transient of up-to 700 Volts on the DC Power Supply line for several microseconds.
8. Average transient duration of 2 microseconds with a repetition frequency of 15 kHz to 100 kHz.
9. For short duration transient (<5ms) the variation approaches a sine-wave.
10. For longer duration transients (>5ms) the variation approaches rectangular pulses with an initial rate of rise up to  $5 \times 10^4$  Volts per second.

Make: MTL, POLYPHASER, CRITEC, DEHN, PHONIEX, OBO Battermann or equivalent subject to meeting the above specifications as required in 25KV AC Traction environment in Metros.

**9.9.3.** Surge protection devices shall be provided on both the power and data cables going to the various Telecommunication equipment (monitors, camera, clocks, loudspeakers, displays, OFC wherever applicable as per approval) installed on the platform, outside station building/outside in the Depot/OCC/BCC.

**9.10. HOUSING, ENCLOSURE AND CABINET/ RACK AND MOUNTING SUPPORT**

**9.10.1.** The key or opening All indoor equipment cabinets and equipment enclosures used for housing the equipment shall be provided with lock and key. Padlocks shall not be used.

**9.10.2.** The Contractor shall provide to the Employer, as a minimum, 3 keys per cabinet or equipment enclosure.

**9.10.3.** Sufficient ventilation shall be provided for the indoor equipment cabinets and enclosures in which active equipment are housed.

**9.10.4.** All outdoor equipment cabinets and equipment enclosures used for housing the Communication equipment shall be provided with suitable locking or protection arrangement.

**9.10.5.** Arrangement for identical equipment shall be same. The key or opening arrangement for different equipment should be same as far as possible.

**9.10.6.** Universal locks with a common key for all Indoor Cabinets, Outdoor Equipment enclosures & Line side location/ equipment boxes shall be provided. Systems should have maximum of three types of keys.

**9.10.7.** All cabinets to be used in equipment rooms should conform to IP 54 with Glass doors except at OCC and BCC. All outdoor equipment / Location boxes shall confirm to IP 65. Uniformity in design of racks/cabinets shall be maintained.

**9.10.8.** The Contractor should supply equipment cabinets with required level of EMI & EMC immunity to ensure that the equipment housed in sub-racks would comply with the required EMI & EMC parameters.

**9.10.9.** All equipment installed shall be able to withstand vibration levels likely to be experienced in railway stations and structures.



- 9.10.10.** The MS07 contractors shall submit calculations to ensure the proposed brackets and mounting methods are of sufficient strength to withstand the wind load and weight of the equipment.
- 9.10.11.** All visible mounting arrangements will be ergonomically designed, preferably with stainless steel or better material. The final mounting arrangement will be got approved from the Employer.
- 9.10.12.** The Contractor shall submit installation method statements and related submission for each type of installation design and activities, at least 60 days before commencement of the activity, for review by the Employer Engineer
- 9.10.13.** The cabinet racks supplied shall be Rittal, Panduit, Conteg, APW President or equivalent make duly painted and finished to International standards and suitable for indoor use. The contractor shall submit details of cabinets proposed to be supplied for approval of Employer Engineer.
- 9.10.14.** The free-standing type racks shall have split doors at the rear and transparent single doors at the front. Wall mount type shall be” hinged three-part type” with transparent door opening at the front.
- 9.10.15.** Each rack shall house power distribution and local circuit breakers for each unit of equipment requiring power contained there-in.
- 9.10.16.** All free-standing racks should be fitted with bottom plinths for floor fixing to masonry or to steel frames beneath the false floor. All free-standing cabinets shall have eyebolts fitted on top of the cabinet for lifting purpose. All system cabinets and racks to be fully assembled and prewired by the vendor. At least two general purpose output sockets should be installed in the free-standing racks.
- 9.10.17.** All racks shall be fitted with internal fluorescent lights, maintenance sockets and integrated PIR sensor for both rear and front faces. The light and PIR can be disabled via an integrated override switch.
- 9.10.18.** All metallic equipment within the cabinet shall be connected to a single “common cabinet “safety earth point. Each cabinet shall be provided with a M10 Earthing bolt for connection to the site safety earthing system.
- 9.10.19.** All equipment installed shall be able to withstand vibration levels likely to be experienced in railway stations, tunnels and structures.
- 9.10.20.** All design of housing and enclosure shall be submitted to the Employer’s representative for review.

**10. OPERATION AND MAINTENANCE SUPPORT**

**10.1. GENERAL**

- 10.1.1.** The Contractor shall investigate all failures, major failures, repetitive failures, design defects and provide all necessary corrective actions throughout the Contract period.
- 10.1.2.** The Contractor shall investigate interference problems either from or to the systems of other Project Contractors and provide all necessary corrective actions throughout the Contract period.



**10.2. OPERATION AND MAINTENANCE DOCUMENTATION**

**10.2.1.** The Contractor shall prepare Operation and Maintenance documentation and the Employer's Operation and Maintenance Manual Specification.

**10.2.2.** The first submission shall be made to the Employer's Representative for review at least nine months prior to the issue of the Substantial Completion Certificate for the Works.

**10.3. MAINTENANCE PLAN**

**10.3.1.** The Contractor shall submit a Maintenance Plan in accordance with provisions in GS to the Employer's Representative for review before the commencement of installation activities.

**10.3.2.** The Maintenance Plan shall describe the Contractor's proposed maintenance regime for preventive and corrective maintenance of the System, including, but not be limited to the following:

1. The maintenance philosophy and approach
2. All necessary tasks for first line, second line, third line and corrective maintenance
3. Frequency of each maintenance task

**10.3.3.** The Contractor shall include the following information on each maintenance task described in the Maintenance Plan:

1. The equipment, Subsystems covered in the task.
2. Step by step procedure to carry out the task.
3. Tools and test equipment list of each task.
4. Diagrams and flowcharts for illustration, if applicable.
5. Recovery procedures, if applicable.
6. Precautions the maintenance personnel to follow.
7. Estimated duration and manpower required.

**10.3.4.** In addition to the Maintenance Plan, the Contractor shall also submit a Yearly Routine Maintenance Schedule to the Employer's Representative for review and shall indicate the schedule of maintenance tasks in a calendar year.

**10.4. SOFTWARE SUPPORT**

**10.4.1. GENERAL**

**10.4.1.1.** The Contractor shall provide all changes, debugging, updates, modifications and upgrade of all the software developed or delivered for the System including data configuration tables if such changes are necessary and in order to maintain the normal operation and meet the requirements given in this Particular Specification.

**10.4.1.2.** All changes and modifications of the software shall not degrade the performance or have adverse impacts of the System.



- 10.4.1.3. The Contractor shall maintain backup copies of all software developed or delivered for the System.
- 10.4.1.4. The Contractor shall ensure that all new versions are fully tested and validated and reviewed without objection by the Employer's Representative prior to loading into the System.
- 10.4.1.5. The Contractor shall provide training for the Employer's staff for use of new version, as and when incorporated.

**10.4.2. SECURITY OBLIGATIONS**

- 10.4.2.1. Within 60 days of the installation of any software, which is developed or modified for this Contract, into the Permanent Works by the Contractor, the Contractor shall submit to the Employer's Representative for retention by the Employer two backup copies of the software, which shall include, without limitation:
  - 1. All executable code including all data configuration tables
  - 2. All installation documentation relating to the software
  - 3. Any specified development tools required for maintenance of the software, including, but not limited to, editors, compilers and linkers.

**10.5. SUPPORT DURING DEFECTS LIABILITY PERIOD**

**10.5.1. GENERAL**

- 10.5.1.1. During the Defects Liability Period, maintenance will be conducted by the Employer with the support of the Contractor.
- 10.5.1.2. The Contractor shall provide workshop repair services of all defective and faulty items of the System.
- 10.5.1.3. The Contractor shall provide comprehensive DLP support for items supplied by him and provide call-out services to the Employer as required restoring the System to normal operation in case of faults and defects are found.
- 10.5.1.4. DLP shall be on section-by-section basis as detailed in the SCC.
- 10.5.1.5. The Contractor shall submit a maintenance manpower plan showing the Contractor's organization and committed resources level available for all types of activities to be carried out within the Defects Liability Period.
- 10.5.1.6. The Contractor shall ensure all his staff who provide maintenance support shall be competent and with sufficient training in the responsible Subsystems. CVs of all the staff shall be submitted to Employer's Representative for prior approval. Normal day- to-day maintenance will be carried out by Employer's personnel.
- 10.5.1.7. The Contractor shall keep sufficient stocks of Spare Parts in an off-site location in Mumbai throughout the Defects Liability Period to enable rapid replacement of any item in the Permanent Works found to require replacement as part of the Contractor's obligations during the Defects Liability Periods (Defects Liability Spares).
- 10.5.1.8. The Contractor shall replace, free of cost, the components/consumables



which may be necessary as a result of removal of the wear and tear during the period of DLP.

- 10.5.1.9. The Contractor's Engineer shall check all the system once a month for its perfect working and record the observations in the log book maintained by the Employer with his signature in addition to day attending of faults when reported by Employer's Representative.

**10.5.2. WORKSHOP REPAIR**

- 10.5.2.1.1. In case a failure cannot be attended to at site the Contractor shall arrange to remove the equipment from site and restore later upon rectification of the fault. In the meanwhile, the contractor shall arrange temporary replacement of defective equipment before removing the same.
- 10.5.2.1.2. The Contractor shall perform all necessary adjustments or alignments as to the repaired parts. The repair of defective parts can only be considered as completed and returned to stock or back to the System if the parts are tested and verified fit for use in the System.
- 10.5.2.1.3. The Contractor shall use only components of equal or higher specification than the original components in his repair activities.
- 10.5.2.1.4. The performance of the defective parts after repair shall not be degraded or deteriorated due to repairing.
- 10.5.2.1.5. The maximum turnaround time for workshop repair shall be less than 28 calendar days. The turnaround time is started to count when the defective parts are removed from the System and ended when the parts are repaired and returned to stock or to the System. Any extension of workshop repair time shall be agreed with the Employer

**10.5.3. SUPPORT AND CALL-OUT SERVICES**

- 10.5.3.1. The support and call-out services shall be available 24 hours per day and 7 days per week.
- 10.5.3.2. The Contractor shall provide sufficient number of competent and experienced staff for the support and call-out services.
- 10.5.3.3. The Contractor shall provide a list of maintenance staff together with the contact mobile telephone numbers who can be contacted for support and call-out services. List of all the Contractor's staff responsible for attending the failure during DLP shall be displayed at all the stations with their address and contact numbers.
- 10.5.3.4. Any changes in the call-out numbers and the maintenance staff shall be notified to the Employer's Representative at least two weeks before such changes become effective.
- 10.5.3.5. The Contractor's staff shall be available on Site for maintenance support within one hour upon receiving the call-out request from the Employer and shall proceed to perform corrective actions to restore the System to normal full operation.
- 10.5.3.6. The Contractor shall take every precaution to protect existing equipment from damage, and make good any damage caused.



10.5.3.7. Should any abnormal system behavior like intermittent faults, interference, frequent repeated faults, etc, or the performance be found to deviate from the specified tolerances, the Contractor shall conduct investigation and report the findings to the Employer's Representative together with the recommendation and proceed after the recommendation has been reviewed without objection by the Employer's Representative.

**10.5.4. MONTHLY MAINTENANCE MEETING**

10.5.4.1. The Contractor shall attend the Monthly Maintenance Meeting with the Employer's Representative to discuss the maintenance matters during the Defects Liability Period. The dates and agenda of the meeting shall be agreed with the Employer's Representative.

**10.6. FAILURE REPORTS**

**10.6.1. HARDWARE FAILURE REPORTS**

10.6.1.1. For each hardware failure that occurs the Contractor shall investigate the failure and prepare a report on its cause(s). The report shall clearly show:

1. The observed symptoms;
2. The most likely cause of the failure;

10.6.1.2. All such reports will be retained as part of the permanent quality assurance record for the system, which shall be subject to inspection by the Employer's Representative.

**10.6.2. SOFTWARE FAILURE REPORTS**

10.6.2.1.1. For each software failure that occurs, the Contractor shall generate a software failure report.

10.6.2.1.2. All such reports will be retained as part of the permanent quality assurance record for the system, which shall be subject to inspection by the Employer's Representative.

10.6.2.2. The report shall clearly show:

1. The observed symptoms;
2. The likely cause;
3. The operator input.

10.6.2.3. The report shall also clearly show the following information which shall be entered when the failure has been investigated:

1. The actual cause of the failure;
2. The corrective action taken; and
3. All software modules affected.



- 11. SPARES, SPECIAL TOOLS AND TEST EQUIPMENT**
- 11.1. SPARES**
- 11.1.1. GENERAL**
- 11.1.1.1. The Contractor shall provide his own spares during installation and commissioning period as well as for support during the Defects Liability Period. The Contractor shall also provide spares for the Employer to enable the Employer to operate and maintain the System.
- 11.1.1.2. The Contractor shall submit the lists of spares within six months after the Commencement Date of the Works to the Employer's Representative for review. The lists shall include:
  - 1. Grouping by Subsystem, diagnostic and test equipment and special tools, as applicable, for stocking identification.
  - 2. A cross-reference and indexing system for replacement components common to more than one subsystem.
  - 3. Detailed description with references and correlation with the maintenance manuals.
- 11.1.2. CONTRACTOR'S OWN SPARES**
- 11.1.2.1. The Contractor shall keep and maintain sufficient stock of his Commissioning Spares and Defects Liability Spares. In addition, in determining the list of spare parts for the Commissioning Spares and Defects Liability Spares, the Contractor shall provide calculation to support the proposed types and quantities with the following taken into account:
  - 1. The expected failure rate of the parts;
  - 2. Population of the parts in the System;
  - 3. Criticality of the parts in the System;
  - 4. Availability and MTTR figures of the System;
  - 5. Spare delivery lead time; and
  - 6. Workshop repair turnaround time.
- 11.1.2.2. The Contractor shall submit the list of Commissioning Spares, with the types and quantities of spares the Contractor intends to hold, at least three months before the commencement of installation activity to the Employer's Representative for review.
- 11.1.2.3. The Contractor shall submit the list of Defects Liability Spares, with the types and quantities of spares the Contractor intends to hold, at least three months before the commencement of the Defects Liability Period to the Employer's Representative for review.
- 11.1.2.4. The Contractor shall include details of the stock of the Contractor's own spares in the Monthly Progress Report. The status of the spares, either in store or under workshop repair, shall also be included.



**11.1.3. CONTRACT SPARES FOR EMPLOYER'S OPERATIONAL AND MAINTENANCE REQUIREMENTS**

- 11.1.3.1. The Contract spares shall be as per the list specified in Appendix E Chapter 10 of this PS. However for those of the spares not specifically included in this list but considered essential, the Contractor shall include a list of recommended additional spares. All Contract spares shall be taken over after the proper testing in presence of DMRC representative.
- 11.1.3.2. The Contract spares shall include, but not limited to, spare modules, sub-assemblies, special components and fuses.
- 11.1.3.3. Spare quantities of Cable of each type shall be supplied as per Appendix E Chapter 10 of this PS.
- 11.1.3.4. The Contractor shall submit item wise unit price list with quantities of each type of spare modules, sub-assemblies, and parts in the list of Works requirements and those recommended by the Contractor.

**11.1.4. SPARES FOR 10 YEARS OF SYSTEM OPERATION**

- 11.1.4.1. The Contractor shall submit unpriced list of spares required for 10 years of system operation of supplied system in the format as per 'FOT Appendix- 32 in Technical Bid and Priced list for the same in 'Form Appendix- 32 in the Price Bid.
- 11.1.4.2. The spares shall be provided as per provisions in Clause ITT and the Relevant clause of Special Conditions of Contract (SCC).
- 11.1.4.3. Description & Details of Spares should be the same in 'Appendix- 33 in Technical Bid & 'Form Form Appendix- 32 in Price Bid.
- 11.1.4.4. Proposed methodology of Escalation / De-escalation for Prices / Rates of the Spares shall be provided in Appendix- 32 in Technical Bid.

**11.1.5. SPECIAL TOOLS AND TEST EQUIPMENT**

- 11.1.5.1. The Contractor shall provide test equipment and tools during the installation, commissioning periods and Defects Liability Period.
- 11.1.5.2. The list of Tools and Test Equipment to be provided is as per the Appendix G Chapter 10 of this PS and shall be taken over after proper testing and demonstration.
- 11.1.5.3. All special tools and test equipment shall be supplied together with operation manuals, complete diagrams, schematics, assembly and connection drawings, maintenance and calibration instructions for the special tools or test equipment.
- 11.1.5.4. The special tools and test equipment provided for the Employer, used on Site prior to delivery to the Employer, should be properly handed back to employer without damage/ wear & tear.

**12. MMI PROVISION SCHEDULE**

- 12.1. Provision of MMI's for Mumbai Metro Corridor & OCC/BCC/Depot will be as per Appendix-H of Chapter 10 (Appendices) of this PS.



**13. TRAINING**

**13.1. TRAINING**

**13.1.1. GENERAL REQUIREMENTS**

13.1.1.1. The contractor shall provide comprehensive training to the employer's staff, including employer's trainers, in accordance with the requirements contained in this particular specification and in the general specification.

13.1.1.2. The contractor shall set up training class rooms at site, where he shall provide competent training instructors, training manuals, training setup, all necessary aids and materials as required for all the training courses.

13.1.1.3. All the training courses shall be conducted during installation period and completed before the commencement of testing and commissioning. No training course shall be started before the completion of design phase

13.1.1.4. The training courses shall normally be conducted at manufacturers' place and at the site(s).

13.1.1.5. The training instructors shall be qualified, competent, with sufficient years of practical experience in the relevant fields and possesses good communication skills.

13.1.1.6. The training instructors shall be either the system designer or engineering staff of the contractor, the contractor's subcontractors or the equipment manufacturers.

**13.1.2. TRAINING PLAN**

13.1.2.1. The Contractor shall submit a Training Plan to the Employer's Representative for review.

13.1.2.2. The Training Plan shall include, but not limited to, the following:

1. The program of the training courses and submission schedule of the training materials
2. Overview and description of objectives of each training course
3. The location where the training courses to be conducted
4. Set ups for practical exercises
5. The Contractor's training organisation chart, including the role and responsibilities of individual key persons
6. The qualifications and experience of the training instructors
7. Details of training simulators to be provided or developed, if applicable.

**13.1.3. TRAINING COURSES**

13.1.3.1. The Contractor shall provide training courses for each of the Subsystems, described in other relevant chapters pertaining to each sub-system.

13.1.3.2. Different types of training courses for each type of Telecommunication subsystem shall be provided for staff from different disciplines. Operations



training courses shall be provided for the operations staff. System engineering and maintenance courses shall be provided for engineering and maintenance staff. The Employer's Training Instructors shall attend all types of training courses such that the Employer's Training Instructors shall be able to subsequently train the Employer's staff in all aspects of operation and maintenance of the System.

13.1.3.3. The maximum number of trainees of each training class shall normally not be more than fifteen. Class size larger than fifteen shall be subject to the review of the Employer's Representative.

13.1.3.4. The Contractor shall determine the number of classes for each type of training course to ensure the objectives of the course can be met.

13.1.3.5. **OPERATIONS TRAINING COURSES**

13.1.3.5.1. The operations training courses shall be developed to provide all necessary knowledge and skills for operations staff of the Employer to operate the system under normal and emergency situations and recovery from minor or simple faults. In particular, the training course shall include the following as minimum:

1. Overview of the Particular sub-system.
2. Brief description of the operation principle of the units of the relevant sub- system
3. Operational features and functions
4. Familiarisation and use of all man-machine interfaces involved
5. Reading and interpretation of system status and alarm messages or indications
6. Normal operating procedures
7. Operating procedures under emergency situations
8. Procedures for recovery from minor or simple faults
9. Use of Operation and Maintenance Manuals and documentation

13.1.3.5.2. Particular exercises shall be included in the operations training course for each trainee to operate and manage the system under normal and emergency operating conditions and simple faults recovery. Minimum 2 such courses shall be conducted – first before the commissioning of the first section and second when 50% of the sections are commissioned.

13.1.3.6. **SYSTEM ENGINEERING AND MAINTENANCE COURSES**

13.1.3.6.1. The system engineering and maintenance courses shall be developed to provide all necessary knowledge and skills:

1. To perform full maintenance, including both preventive and corrective maintenance, on the System; and
2. To perform system engineering management including system parameter configuration, enhancement, expansion and provision of



new circuits.

3. Minimum 2 such courses shall be conducted – first before the commissioning of the first section and second when 50% of the sections are commissioned.

13.1.3.6.2. The Contractor shall determine the content of the courses and the courses shall include the following as minimum:

1. Overview of the relevant sub-system
2. Brief description of operation principle of the sub-system
3. Background theory.
4. System features and functions, System configuration and operation principles.
5. Description of system components and equipment down to card or module level.
6. Test and commissioning procedures.
7. Use of test equipment and special tools.
8. Reading and interpretation of alarm indications, messages and print-outs.
9. Preventive maintenance procedures.
10. Fault diagnosis, troubleshooting and corrective maintenance procedures.
11. Equipment settings and parameters configuration.
12. Use of equipment manuals, Operation and Maintenance manuals, circuit diagrams and wiring schematics.
13. Methods and procedures to provide new circuits, system expansion and enhancement.
14. Data, software backup and loading.
15. Use of software such as peripheral control and configuration, utility, database structure, generation and modification.

13.1.3.6.3. Practical exercises shall be provided for each trainee to practise the following as minimum:

1. Use of test equipment and special tools.
2. Preventive maintenance.
3. Fault diagnosis and troubleshooting with induced faults set by the Contractor to simulate real-life situation.
4. Faulty modules or cards replacement and restore the system to normal operation.



**13.1.4. TRAINING MATERIALS**

- 13.1.4.1. At least one month before the commencement of the training course, the Contractor shall submit all the training materials including the trainer's guides, training manual for trainees, training aids and presentation materials to the Employer's Representative for review. The training materials shall be prepared in a form allowing easy future reproduction.
- 13.1.4.2. The format of the trainer's guides and training manual for trainees shall be submitted to the Employer's Representative for review.
- 13.1.4.3. The Contractor shall, for each course, distribute two sets of trainer's guides, one set of training manual for each trainee and one additional set of training manual to the Employer's Representative before the commencement of the training course.
- 13.1.4.4. The trainer's guide shall be prepared in accordance with the requirements given in the GS.
- 13.1.4.5. All the training materials shall be accurate and match with the actual design of the System.

**13.1.5. TRAINING RECORDS**

- 13.1.5.1. The Contractor shall devise a system, standards in assessing the level of knowledge, understanding of the course content and proficiency of the trainees. The system and standards shall be submitted to the Employer's Representative for review four weeks before the commencement of the training course.
- 13.1.5.2. The Contractor shall issue appropriate training certificates to the trainees who pass the assessment.

**13.1.6. COURSE EVALUATION**

- 13.1.6.1. The Contractor shall develop questionnaires to trainees for each training course in determining the level of satisfaction with the course content. Appropriate scoring weighting shall be assigned to each question in the questionnaires such that the scores shall reflect the trainee's satisfaction to the training course. The questionnaires shall be submitted to the Employer's Representative for review four weeks before the commencement of the training course.
- 13.1.6.2. Upon completion of each training course, the Contractor shall distribute the questionnaires to the trainees to fill in.
- 13.1.6.3. The Contractor shall submit a training report to the Employer's Representative for review within two weeks after completion of each course. The training report shall include a summary of the training course conducted, the results of trainees' assessment and the course evaluation questionnaires.
- 13.1.6.4. The contractor shall submit the course evaluation criteria to the Employer's Representative for review.

**13.2. TRANSFER OF TECHNOLOGY**

- 13.2.1. The Contractor shall undertake to supply or make arrangement with the original manufacturer to supply additional equipment required for



replacement or expansion of the network in future.

- 13.2.2.** The Contractor shall undertake to provide, if required during the life of the equipment ordered, technical assistance in the form of additional drawings, maintenance practices and technical advice (including training).

**14. DOCUMENTATION**

**14.1. GENERAL**

- 14.1.1.** The Contractor shall submit a Submission Programme. The Submission Programme shall identify all submissions to be furnished, submission titles, submission numbers and target submission dates.

- 14.1.2.** The Contractor shall provide configuration management to ensure that the System is correctly configured. The Contractor shall ensure that a configuration control programme is maintained. The programme shall ensure that the configuration of each item is recorded and maintained during the life of the Contract and Defects Liability Period.

- 14.1.3.** The Contractor shall submit a Project Management Plan to the Employer's Representative for review as laid down in the GS. The Project Management Plan shall identify the persons to be responsible and the methods and arrangement to carry out the Project Management.

**14.2. SUBMISSION REQUIREMENT**

**14.2.1. GENERAL**

- 14.2.1.1.** The Contractor shall include records of amendment in each submission with the following details:

1. Revision history and status of the submissions.
2. Description on changes for each revision.
3. The Contractor's signature for authorisation of the submission indicating proper design check has been carried out before the submitting to the Employer's Representative.

- 14.2.1.2.** The revision status and date of preparation of the submission shall be clearly indicated at the header of each page of the submission.

- 14.2.1.3.** The first submission shall be revision 0 and subsequent revision shall be A, then B, so and so forth.

- 14.2.1.4.** The Contractor shall maintain records of the submission and updated record shall be included in the Monthly Progress Report. The submission record shall include the following details:

1. Submission number.
2. Submission title.
3. Revision history.
4. Status of Employer's Representative's Response for each revision.



5. Submission dates and dates of return from the Employer's Representative for each revision.
6. Current status.

**14.2.2. LEVELS OF SUBMISSION**

14.2.2.1. The Contractor shall adopt top-down approach and submit submissions of the following levels in a logical sequence for the review of the Employer's Representative

1. System level related submission
2. Equipment level related submission
3. Installation design related submission
4. Design calculations
5. Management plans and procedures
6. Approval certificates
7. Miscellaneous submission

14.2.2.2. System level related submission shall show the total system including the configuration block diagrams, operating principle, system features and functions, capacity, expandability, interconnection within the Subsystem, between Subsystems and between other Project Contractors.

14.2.2.3. Equipment level related submissions shall show the specifications on electrical, mechanical and functionality of the equipment/materials employed for the System and the Subsystems.

14.2.2.4. Installation design related submissions shall include:

1. The installation methods and procedures for different types of installation activities.
2. Drawings showing the equipment locations and positions,
3. Schematic and wiring diagrams.
4. Cable core plan and numbering scheme.
5. Equipment mounting details.
6. Configuration data, parameters and settings.
7. Cable route drawings.
8. Layouts in equipment racks, in equipment rooms, trackside, concourse, platform and all other equipment locations.

14.2.2.5. Design calculations shall demonstrate the performance of the System and Subsystems. Detailed requirements on calculation submissions are given in respective sections of individual Subsystem.

14.2.2.6. The Contractor shall submit a copy of certificates from relevant parties and



authorities as required including equipment calibration certificates from manufacturers and laboratories.

**14.3. AS BUILT-DOCUMENTATION**

**14.3.1.** The as-built documentation shall describe the System as installed and provide sufficient information for other users, maintainers and developers to execute their responsibilities. All documentation shall be submitted for review by the Employer's Representative, and shall include (but not be limited to):

1. Operation and Maintenance Manuals.
2. Configuration Data Tables.
3. As-built drawings.

**14.3.2.** The configuration data tables shall be prepared for each individual Subsystem and on an item-by-item basis as well as on location basis.

**14.3.3.** The As-built drawings shall show the as-built details of the Works and shall include:

1. Bill of quantity of equipment on location basis.
2. Location and connectivity of all equipment and cables.
3. Schematic and wiring diagrams.
4. Cable core plan and numbering scheme.
5. Equipment mounting details.
6. Cable route drawings.
7. Layouts in equipment racks, equipment rooms, trackside, concourse, platform, and all other equipment locations.

**15. PROGRAMME REQUIREMENT**

**15.1. ACCESS DATES AND EMPLOYERS' FACILITIES AVAILABLE DATES.**

**15.1.1.** Access dates and key dates are as given in the Appendix B of Chapter 10 of this PS. Additional access along the alignment may be available from time to time. The Contractor shall note that this additional access is not guaranteed and may be subject to change from time to time.

**15.1.2.** Major installation works in the stations and ancillary buildings requiring co-ordination with the civil works Projects Contractors shall be co-ordinated as per provisions in interface requirements.



**DELHI METRO RAIL CORPORATION LIMITED**

(A Joint Venture of Govt. of India & Govt. of NCT of Delhi)

**BIDDING DOCUMENTS**

**FOR**

**CONTRACT MS07**

**DESIGN, MANUFACTURE, SUPPLY, INSTALLATION, TESTING AND  
COMMISSIONING OF TELEPHONE SYSTEMS**

**VOLUME 3: EMPLOYER'S REQUIREMENTS**

**PARTICULAR SPECIFICATIONS**

**CHAPTER 7 – TECHNICAL REQUIREMENTS**

**DELHI METRO RAIL CORPORATION LTD.**

**5TH FLOOR, A-WING,**

**METRO BHAWAN, FIRE BRIGADE LANE,**

**BARAKHAMBA ROAD,**

**NEW DELHI-110001,**

**INDIA**



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**DESIGN, MANUFACTURE, SUPPLY,  
INSTALLATION, TESTING AND COMMISSIONING**

**OF**

**TELECOMMUNICATION SYSTEMS  
(EXCEPT TETRA SYSTEMS)**

**CONTRACT MS07**

**PARTICULAR SPECIFICATIONS**

**CHAPTER 7  
TELEPHONE SYSTEMS**



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## **1. INTRODUCTION**

### **1.1. GENERAL**

1.1.1. This Chapter-7 specifies the Particular Technical and performance requirements of the Telephone System of the Telecommunication system ~~and the 48 V.D.C backup supply.~~

1.1.2. This Chapter shall be read in the conjunction with other Chapters of the Particular Specification (PS), General Specification and other documents forming part of the Contract.

### **1.2. OVERVIEW OF TELEPHONE SYSTEM**

1.2.1.1. The Telephone System shall provide the Mumbai Metro staff with voice, fax and data communications between Line 7A and Line 9 of Mumbai Metro personnel internally and also externally to the PSTN on IP-PBX Exchange. Objective is to use the network infrastructure which is redundant. The same infrastructure shall be used on a separate CAT6 / CAT 7 for Voice / Video application on IP-PBX.

1.2.1.2. In addition to IP-PBX and DLT telephones, help points shall also be provided for passengers for assistance when they are within the concourses, platforms , elevators inside the stations and Telephones for ETS (Emergency Trip Switch) phones at underground station platform.

1.2.1.3. Following shall be adopted for the IP based PBX telephone system

- (a) Standalone/integrated system for Line-7A and Line -9 Corridors of Mumbai Metro. The bidder shall provide integrated hardware (servers etc) , NMS & MMI etc (both at OCC, BCC and Station level) for both the corridors so as to provide all functionalities including control, management and other common functionalities as per extant provisions in these specifications
- (b) The IP PBX network provided for Line7A and Line 9 shall be seamlessly integrated with the existing telephone system(s) available for Line 2A, 2B and 7 corridors of Mumbai Metro.
- (c) The hardware (servers) provided for the above solution shall be configured with high availability, redundant mode in clustered servers and virtual machine Environment for smooth integration of running softwares / application (s) between the servers of the active central system.
- (d) The Telephone system shall interface with the Central Telecom Fault Reporting System (CTFRS system) to provide information of Alarms/Faults for integrated monitoring of the telephone system for entire Line 2A, 2B, 7, 7A & 9 including Depot(s).

1.2.1.4. The Telephone System shall consist of the following subsystems:

### **1.2.2. IP PBX NETWORK**

1.2.2.1. It shall be a highly reliable State of the art, non-blocking, ISDN compatible IP PBX Telephone network for voice, facsimile and data communication services throughout the Mumbai Metro Corridor. Telephone sets (where



applicable) shall be provided in the control rooms, offices, administration offices, for operation (including Station Manager Room, Audit & Cash Room), maintenance rooms, security room and equipment rooms, staff rooms in the OCC/BCC, depot, TSS/RSS and all stations. Each OCC/BCC controller position shall also be provided with IP PBX telephones. These locations are examples and will be finalized in design stage for smooth operation and administration of line 7A & 9 metro telephone network.

- 1.2.2.2. IP PBX network shall be equipped with IP PBX switches, line and trunk interface units and different type of telephone sets for telephone communication.
- 1.2.2.3. Telephone System user shall have voice mail facility which shall be 20% of the total user of this project. (Users = number of extensions provided)
- 1.2.2.4. The Telephone System shall interface to the Radio System to enable radio users to initiate and receive calls from IP PBX extension or from the PSTN telephones.

**1.2.3. DIRECT LINE TELEPHONE COMMUNICATION**

1.2.3.1. The Direct Line Telephone Communication System shall provide control telephone lines for train operation, traction power supply control and maintenance telephone lines for track, rolling stock, signalling and telecommunication. The system shall ensure instant, uninterruptible, communication between key points, which shall include, but not be limited to:

1. Between OCC/BCC and different key locations like all Station Control Rooms (SCR), Depot Control Centre (DCC), Traction Substation (TSS), Receiving Sub Stations (RSSs), Auxiliary Sub Station (ASS), each signalling equipment room, telecommunication equipment room at stations and depot.
2. Between adjacent/interfacing station control rooms;
3. Between adjacent interlocked station control room and DCC;
4. Not used
5. Between OCC/BCC and State Electricity Board Sub-stations and control rooms through leased PSTN (BSNL / Private Operator) telephone lines; The leased line shall be arranged by the Contractor but paid for the initial cost & recurring cost by Mumbai Metro.
6. Between RSSs and State Electricity Board Control room, OCC/BCC control room through leased PSTN (BSNL/MTNL/Private Operator) telephone lines; The leased line shall be arranged by the Contractor but paid for the initial cost & recurring cost by Mumbai Metro.
7. Between OCC/BCC / Head Quarter and security control rooms at stations, depot.

**1.2.4. VOICE OVER IP PHONES (IP PBX) SYSTEM**

1.2.4.1. The Voice Over IP telephone communication system shall provide telephone lines over IP network using proven protocols such as H.323, SIP etc for



stations, depot and OCC/BCC. The system shall ensure instant, uninterruptible, real time audio/video communication between key points, such as between OCC/BCC and different key locations like all Station Control Rooms (SCR), Depot Control Centre (DCC), Auxiliary Sub Station (ASS), cash & audit room, maintenance room each signalling equipment room, telecommunication equipment room at stations and depot, between adjacent/interfacing station control rooms, between station control room and DCC as a minimum.

1.2.4.2. The IP PBX network shall be equipped with state of art switches and other related hardware and software such that it shall provide sufficient bandwidth and processing speeds to allow low delay, jitter and echo free, high quality, low latency audio/video communication over IP network.

1.2.4.3. The IP PBX enabled phones, switches etc should be POE type with appropriate wattage.

1.2.4.4. The IP PBX network shall integrate with PSTN, IP PBX and Direct Line Telephone network allowing calls to be made between these networks. IP PBX network too shall support facsimile and other data communication services throughout Mumbai Metro System including administrative offices.

**1.2.5. CENTRALISED DIGITAL RECORDING SYSTEM (CDRS)**

1.2.5.1. The Telephone System shall be interfaced with a Centralised Digital Recording System for recording of designated telephone lines including emergency telephone lines. It shall be possible to select any one additional PABX phone conversation for recording purposes from the HMI. CDRS shall be provided as part of the Contract and it shall be the responsibility of the MS07 Contractor to coordinate, finalise the number and type of channels, interface, test and commission the recording of Telephone Communication in the CDRS. All Direct Line Telephone communication from and to all the Direct Line Consoles in both the OCC/BCC / depot shall have to be recorded in the CDRS. The number of channels has to be accordingly finalized by the MS07 Contractor.

1.2.5.2. The Telephone System shall be interfaced with a Centralised Digital Recording System for recording of free space voice conversations of all Controllers in SCO Room, DCC Room, and OCC/BCC Theatre. The micro phones shall be so placed in SCO, DCC, OCC/BCC to enable clear recording of all controller positions without any mixing / disturbance.

1.2.5.3. The CDRS and Telephone System termination shall be such that it shall not be possible to disable recording from Direct Line Consoles or the Direct Line Telephones. Also calling & called party information and other relevant information viz. date, time etc for recording shall be provided by the MS07 Contractor through the Telephone System to the Radio system duly making all the required interface arrangements.

**1.2.6. NETWORK MANAGEMENT SYSTEM (IF SEPARATE NMS IS REQUIRED)**

1.2.6.1. The MS07 Contractor can utilize the existing NMS preferably or provide separate NMS (if required) for seamless integration of the Line 7A & 9 with Line 2A, 2B & 7.

1.2.6.2. The Telephone Network Management System (NMS) main at OCC/BCC



and redundant at BCC with Maintenance Supervisory Console, Keyboard and Log Printer shall be provided by the MS07 Contractor.

- 1.2.6.3. IP PBX, Direct Line Telephone System, IP PBX system and IP Network shall be monitored, supervised, and controlled by Network Management Systems. The Contractor can propose a common NMS for IP PBX, Direct Line Telephone System, IP PBX, IP Network. The number of NMS MMI should be minimum keeping the availability of space in mind.

## **2. SCOPE OF THE WORKS**

### **2.1. GENERAL REQUIREMENTS**

- 2.1.1. The system provided for Line-7A and Line9 shall be integrated /interfaced with the existing system (s) available for Line-7, Line-2A and Line-2B corridors of Mumbai Metro such that the upgraded system also seamlessly function for the Line7 A and Line-9 corridors alongwith the existing Line-7, Line-2A and Line-2B corridors of Mumbai Metro.

- 2.1.2. In addition to the requirements on the scope of works as identified in Chapter 1 (General Requirements) of the Particular Specification, the specific requirements on the scope of the works for the Telephone System shall be as specified below.

### **2.2. SCOPE OF SUPPLY OF TELEPHONE SYSTEM**

The Contractor shall design, supply, deliver, install and conduct testing and commissioning of all necessary hardware and software to meet the specified requirements in this Particular Specification. The Contractor shall provide, but not be limited to, the following:

#### **2.2.1. IP PBX NETWORK**

- 1) IP PBX switches;
- 2) Line and trunk interfaces;
- 3) Basic Telephone sets(in case distance is more);
- 4) Digital telephone
- 5) Workstations and Servers
- 6) IP Telephone sets
- 7) Emergency Telephone sets / Help point units
- 8) Voice mail system
- 9) Network management system
- 10) Digital Voice Recording System
- 11) Distribution Frames
- 12) Portable PC notebook suitable for site equipment programming/testing and local maintenance of Telephone Exchange. The quantity is given in Appendix P of this Particular Specification



- 13) Testing and commissioning facilities;
- 14) Power supply equipment, cables, accessories, distribution frames, cabinets, enclosures, mounting brackets, equipment housing, racks and earthing etc.
- 15) Minimum 50% cables shall be available as spares.

**2.2.2. DIRECT LINE TELEPHONE COMMUNICATION**

- 1) Automatic exchange/processor unit with line and trunk interfaces.
- 2) Multifunction control console (direct line console) with key pad etc.
- 3) Appropriate subscriber telephone sets.
- 4) Power supply equipment, cables, accessories, distribution frames, cabinets, enclosures, racks and earthing etc

**2.2.3. IP PBX PHONES**

- 1) Automatic exchange/processor unit with line and trunk interfaces
- 2) Gateways for interface between the LAN and switched circuit network
- 3) Gatekeeper for admission control functions
- 4) Network Switches
- 5) Multifunction control console (audio/video) with key pad etc., FAX support equipment
- 6) Power supply equipment, cables, accessories, distribution frames, cabinets, enclosures, racks and earthing etc

**2.2.4. NETWORK MANAGEMENT SYSTEM**

The Telephone Network Management System (NMS) main at OCC/BCC and redundant at BCC Maintenance Supervisory Console, Keyboard and Log Printer shall be provided by the MS07 Contractor.

IP PBX, Direct Line Telephone System, IP PBX system and IP Network shall be monitored, supervised and controlled by Network Management Systems. The Contractor can propose a common NMS for IP PBX, Direct Line Telephone System, IP PBX, IP Network. The number of NMS MMI should be minimum keeping the availability of space in mind.

Also, a printer shall be provided at OCC & BCC for alarms and event printing.

**2.3. SCOPE OF SERVICES**

- 2.3.1. The MS07 Contractor shall coordinate with civil works project Contractors and provide comments or recommendations on subjects of station building materials, finishes and architectural layouts. The Contractor shall also coordinate with civil works project Contractors to ensure the availability of proper duct/support facilities for telephone cables in the stations, depot and other areas like connectivity to TSS/RSS.



2.3.2. The Line-7, 2A and 2B, network numbering plan consists of 5-digit numbering plan. The Network shall support closed homogeneous numbering plan across the Line-7, 2A, 2B, Line 7A & 9 network such that the user has to just dial the extension number of the user, he wishes to reach from anywhere in the network. However, the telephone system shall have the provision to support 6-digit numbering scheme. The numbering plan shall require to be finalized by the contractor in consultation with Employer's Representative as part of detailed design.

2.3.3. Any change in software/ hardware (including provision of cards) required in Line-7, 2A and 2B corridors for Mumbai Metro telephone system to implement the homogenous/closed numbering scheme in telephone system of Line7A , Line-9 and Line7, 2A and 2B shall be the responsibility of the MS07 Contractor within scope of this contract without any additional financial implications on DMRC/Mumbai Metro

## **2.4. SCOPE OF SUPPLY/SERVICES EXCLUDED FROM THIS CONTRACT**

2.4.1. Un-interruptible Power Supply (UPS) 230 V AC to meet with the power supply requirements of the Telephone System for all locations including OCC/BCC, Stations and Depot is included in the scope of the MS01A Signalling Contract.

2.4.2. Provision of Two 3 Phase 415 V AC Power Supply Feeders (Main & Emergency) terminated in Distribution board on wall to meet with the Power Supply requirements of the Contract for all locations including OCC/BCC, stations and depot to be provided by E&M contractor.

2.4.3. Main earth (<1Ω) provision and extension to TER, SCR & UPS (S&T) with a copper strip at each location consisting of minimum 20 holes (10 per row) shall be provided by E&M contractor.

## **3. PERFORMANCE REQUIREMENTS**

### **3.1. GENERAL**

3.1.1. In addition to the overall system performance requirements as identified in Chapter 1 (General Requirements) of the Particular Specification, the specific performance requirements for the Telephone System shall be as specified below.

3.1.2. The technical system performance requirements for the Telephone System are specified in Section 6 (this chapter) of this Particular Specification.

### **3.2. RELIABILITY**

3.2.1. The inability to perform any required function, the occurrence of unexpected action or the degradation of performance below the specifications shall be considered as a failure.

3.2.2. MTBF shall be the average operating time accumulated by the total population of identical items between failures.

3.2.3. The Telephone System equipment supplied under the contract shall comply with the reliability figures given below:



<b>Equipment</b>	<b>MTBF (Hours)</b>
Switching module	>150,000
Processor module	>200,000
Memory module	>200,000
Line and trunk interface module	>100,000
Power supply equipment	> 50,000
Multifunction direct line console	> 20,000
Network Management System	> 50,000
Battery Backup System	> 50,000
Network Switch	>200,000
Gateway	>200,000
ETS Telephone (If Applicable)	>100,000
Help point Phone	>100,000

**Table 7.1: MTBF Figures**

**3.3. AVAILABILITY**

- 3.3.1. The MS07 Contractor, in meeting the required availability mentioned below, shall substantiate his design by providing detailed calculations and evidence of statistical failure rates for the equipment for review by the Employer’s representative.
- 3.3.2. The availability of the Telephone System (IP PBX, Direct Line and IP PBX) shall be defined as the availability of the connections between extensions.
- 3.3.3. The availability of the connection between any extensions shall be better than 99.99%.
- 3.3.4. The availability of connection between extensions within Direct Line Communication system shall be better than 99.99%.
- 3.3.5. The Network Management System for the Telephone System shall be considered unavailable if any functions provided by it could not be properly exercised. The availability of Network Management System for the Telephone System shall be better than 99.95%.

**3.4. MAINTAINABILITY REQUIREMENTS**

- 3.4.1. The mean time to restore (MTTR) of the Telephone System to normal operation after a failure shall be less than four hours (excluding the time required to travel to the site).
- 3.4.2. The Telephone System shall be of modular design and designed with Line Replaceable Units to minimize the system MTTR.
- 3.4.3. The service life of the Telephone System shall not be less than 15 years. Service life of all type of cables shall not be less than 25 years. The service life of work stations/servers shall not be less than 10 years. Service life shall be counted from the commencement date of the Defects Liability Period.



**3.5. SAFETY**

- 3.5.1. The Telephone System is classified as safety related and as such should incorporate necessary protection measures.
- 3.5.2. All equipment must comply with and be installed in accordance with IEC 65, IEC 64.
- 3.5.3. All metal enclosures shall be provided with an earthing terminal. Earthing of all equipment shall be carried out in accordance with the overall earthing policy stipulated in chapter 1 as well as Appendix-M (Chapter 10) of the particular specification.
- 3.5.4. External surge protection devices should be used at the input of all vulnerable equipment for effective transient protection as specified in Appendix-M of Chapter-10 of this PS

**3.6. CONNECTION TIME**

- 3.6.1. The time taken to connect one extension line to any other extension line (to application of ring tone) within the network shall conform to latest ITU-T recommendation

**3.7. POWER FAILURE TRANSFER CIRCUITS.**

- 3.7.1. The connection time of any fallback lines on failure of the main switching equipment shall not be greater than 200 milli-seconds.

**3.8. ALARMS**

- 3.8.1. Alarms shall be received and implemented by the Network Management System with delay no longer than 500ms.

**3.9. REMOTE MONITORING**

- 3.9.1. Remote scanning of system conditions, alarms and traffic data shall not take longer than 10 seconds for the total network.

**3.10. PSOPHOMETRIC NOISE**

- 3.10.1. The Psophometric Noise Voltage of any other telephone line shall not exceed 2 mV.

**4. FUNCTIONAL REQUIREMENTS**

**4.1. IP PBX**

**4.1.1. IP PBX SWITCH NETWORK**

**4.1.1.1. NETWORK TOPOLOGY**

- 4.1.1.1.1. There is one main node at OCC/BCC. The main node shall be connected with Ethernet links to the Telephone Exchanges at individual stations. The Ethernet Links should follow the same ring as in FOTS. The interconnection plan should be designed and approval taken from employer. The Contractor shall provide necessary Ethernet Link port cards in their system and all required materials for Ethernet connectivity between exchanges. Further details shall be as given in Clause 4.3 below.



**MS07: Particular Specifications**

4.1.1.1.2. The IP PBX's shall be installed in TER at all locations. The IP PBX switches shall be connected to each other through Ethernet links of the FOTS to form the IP PBX switch network. The Ethernet channels shall be provided by FOTS on a DDF in the TER.

4.1.1.1.3. The MS07 Contractor shall lay cable up to the DDF to access the Ethernet channels. IP PBX network with requisite Ethernet rings as described above, as a minimum, shall be provided. However, to meet the requirements of the contract and requirements of the Designated Project Contractors, additional equipment/services as required shall also be provided by the Contractor at no additional cost to the Employer.

4.1.1.2. **Requirements of IP PBX Telephone System are given in Table below.**

Item No	Description of Item	Station (Elevated)	Station (Underground)	OCC/ Depot	BCC/
1.	Equipped Ports	48	48	512	
2.	Wired Ports including the License therein	96	96	1024	
3.	Basic Telephones	27	27	100	
4.	Digital Phones	1	1	-	
5.	CLIP	Yes Required	Yes Required	Yes Required	
6.	Management PC + Printer (Common for IP PBX & Direct Line System)	-	-	As Required	
7.	MDF including protection devices No. of pairs	100	100	512	
8.	DCR (Detail Call Records)	Yes Required	Yes Required	Yes Required	
9.	ETHERNET Ports	As Required	As Required	As Required	

**Table 7.2: IP PBX Telephone System Requirements**

4.1.1.3. The IP PBX switch network shall be synchronized to the master clock signal from the existing Master Clock System provided by the MS01 Contractor.

4.1.1.4. The IP PBX switch network shall have internal clock in free running mode in the event of the failure or absence of the master clock signal.



4.1.1.5. The IP PBX switch network shall synchronize automatically back to the master clock signal when master clock signal is recovered.

4.1.1.6. The IP PBX switches at all locations shall provide extensions locally:

- i) At depot throughout Mumbai Metro boundary and OCC/BCC including other buildings (like ancillary buildings of Mumbai Metro (Line 7A & Line 9) (TSS, RSS, police station, etc.)) in close proximity to OCC/BCC/Depot and
- ii) At the particular stations where exchange is located through multi pair telephone indoor/outdoor cables.

Two 50 pair cables, if required, are to be laid for staff quarter from TER/CER at Depot to the guard room. Cables are to be terminated at MDF/IDF which shall be provided inside guard room of staff quarter. Further extensions within the Staff Quarters are not within the scope of the Contractor.

4.1.1.7. A number of PSTN (BSNL/MTNL) PRI/CO lines essentially to provide power failure transfer links for operational services as defined in row 8 of Table 7.2 above shall connect on total failure of the exchange to pre-defined extensions.

4.1.1.8. The IP PBX switch shall restart automatically when the power supply to the IP PABX switch resumes normal after failure.

**4.1.1.9. NUMBERING PLAN OF THE IP PBX TELEPHONE SYSTEM**

4.1.1.9.1. The Network shall support closed homogeneous numbering plan across the network such that the user has to just dial the extension number of the user, he wishes to reach from anywhere in the network. The numbering plan shall be required to be finalized by the MS07 Contractor with Employer as a part of Detailed design.

**4.1.1.10. NETWORK FEATURES**

4.1.1.10.1. The IP PBX switch network shall provide feature transparency across all the IP PBX switches new and the existing throughout Mumbai Metro. The minimum required network features shall be as given in Table 7.3. Any additional features available in the exchange and not listed in the Table may be indicated, during the Design phase.

S. No	Feature	Requirements of the Feature
1.	Automatic callback	The Telephone System shall allow internal extension users who have placed a call to a busy internal extension to have the call automatically set up when the busy extension becomes free.



<b>S. No</b>	<b>Feature</b>	<b>Requirements of the Feature</b>
2.	Call forward	The Telephone System shall allow all incoming calls to an extension number to be forwarded or diverted to a selected internal extension. The Telephone System can be defined in three modes:  (1) Call forward without exception;  (2) Call forward on busy; and  (3) Call forward on no reply.
3.	Call Park	The Telephone System shall allow a called extension to put call on hold and retrieve new call.
4.	Caller party extension number display	The Telephone System shall display internal call party's extension numbers on the telephones with alphanumeric displays. The display shall operate during telephone ringing.
5.	Call pick-up	The Telephone System shall allow an extension to answer calls made to other extensions within the call pick-up group. The call pick-up group shall be user programmable.
6.	Call transfer	The Telephone System shall allow extensions to transfer internal or external calls to other extensions.
7.	Call waiting	The Telephone System shall notify an extension user, who is engaged on an established call, that another call is waiting to be connected.
8.	Conference call	The Telephone System shall allow an extension on an established call to add additional parties to the call connection.
9.	Direct inward dialing	The Telephone System shall allow calls external to the Telephone System to call an internal extension directly without attendant intervention.
10.	Direct outward dialing	The Telephone System shall allow internal extension users to obtain external network lines directly by keying an appropriate access digit.
11.	Distinctive ringing	The Telephone System shall provide different ringing tones and cadences for assignment.
12.	Hot-line	The Telephone System shall allow calls to be placed, to a pre-assigned extension group or external network number, when the telephone handset is off-hooked.



S. No	Feature	Requirements of the Feature
13.	Hunting	The Telephone System shall support different modes of hunting to route calls from extensions to idle telephones in a pre-programmed hunt groups. The hunting groups shall be user programmable.
14.	Abbreviated Dialling	Authorised extensions shall be able to dial frequently called extensions by abbreviated numbers.
15.	Access Paging to	Extensions and attendant shall have dial access to a loudspeaker or any other type of voice paging system.
16.	Executive Override	An extension with class of service shall be able to access a busy extension. A warning tone shall be given to the parties.
17.	Attendant Recall	Facility to draw the attention of the exchange operator on an attendant established call
18.	Alternate Route Selection	Primary and secondary routes shall be provided for inter exchange routing with facility of automatic alternate route management over the network.
19.	Forced Release	Measure applicable <ul style="list-style-type: none"> <li>• User exceeds preset inter digit time interval.</li> <li>• Calling user exceeds pre-set time while listening to ringing or busy tone.</li> <li>• When any one of the two users of normal call terminates.</li> </ul>
20.	Line lock out	Automatic line lockout if user does not start dialing after a preset time or when there is permanent loop on the line.
21.	Malicious call trace	The Telephone System shall provide functions for user to activate and deactivate a call trace. On activation a printed report of the calling and called parties shall be generated.
22.	Music on hold	The Telephone System shall provide music to a party on hold, waiting in a queue, parked or on an external call that is being transferred.
23.	Recorded announcement	The Telephone System shall provide a pre-recorded announcement to intercept different kinds of incoming calls that cannot be completed.
24.	Voice mail	Voice mail facility to 20% telephone users.

**Table 7.3 : List of Network Feature to be supported by the IP PBX**



## **Switch Network**

- 4.1.1.10.2. The assignment of the class of services and features to any telephone extension shall be configurable.
- 4.1.1.10.3. The IP PBX switch network shall support a minimum of the following four levels of programmable restrictions to each telephone extension:
- (1) Totally restricted level which user cannot make or receive calls to and from the PSTN (MTNL/BSNL/Private Operators) through the telephone extension;
  - (2) Semi-restricted level which user cannot make PSTN (BSNL/Private Operators) calls but can receive PSTN (MTNL/BSNL/Private Operators) calls through the attendant console telephone/DID;
  - (3) Local level which the telephone extension user can make or receive local PSTN (BSNL/Private Operators) calls only and
  - (4) Unrestricted level which there shall be no restriction on the telephone extension for call connection.
- 4.1.1.10.4. The IP PBX switch network shall be connected to the Radio system to provide switching and connection for user to make telephone call connection through the hand portable/train mobile radios and call to hand portable/train mobile radios through telephone extension. This facility shall be programmable.
- 4.1.1.11. LINE INTERFACES**
- 4.1.1.11.1. The IP PBX switch shall be equipped with modules to support a minimum the following interfaces:
- (1) PRI trunks/PRI/CO outgoing trunks (at OCC/BCC/Depot);
  - (2) Fax support;
  - (3) Digital trunks ETHERNET interconnection with other exchanges.
- 4.1.1.11.2. The IP PBX shall provide analogue and digital connections to support analogue and digital telephone sets
- (1) The analogue subscriber line card shall provide, but not be limited to, the following:
    - Over voltage protection to protect the line equipment from lightning and power line induction;
    - Test and monitoring circuitry which connects test equipment to the two wire lines to test the line for continuity, short circuits, and impedance characteristics;
    - Signal to light up the telephone message waiting indicator.
  - (2) The digital subscriber line card shall support digital telephone sets and digital terminals for voice and data services. The digital subscriber line card shall provide, but not be limited to the following:



- Over voltage protection to protect the line equipment from lightning and power line induction
- Test and monitoring circuitry which connects test equipment to the two wire lines to test the line for continuity, short circuits, and impedance characteristics;
- Signal to light up the telephone message waiting indicator; and Voice and data communications to and from digital telephones and digital terminals using a standard unshielded twisted pair (UTP) cable at the same time without any degradation in transmission quality.

#### **4.1.1.12. BLOCK WIRING**

4.1.1.12.1. All the voice circuits from the IP PBX switch shall be terminated at the main distribution frame inside the TER for distribution of the internal and external lines and interface with relevant Subsystems and Project Contractors. The circuit termination shall be of IDC (insulation displacement contact) type.

4.1.1.12.2. All the data circuits from the IP PBX switch shall be terminated at the digital distribution frame inside the TER or CER for distribution of the internal and external lines and interfaces with relevant Subsystems.

4.1.1.12.3. Multi-core cables shall be provided and connected from the distribution frames inside TER or CER to the distribution frames at the MDF for connection between the IP PBX switch and the trunk circuits of PSTN. The interface between the Telephone System and the PSTN circuits shall be at the MDF.

4.1.1.12.4. Telephone distribution boxes shall be provided and installed at suitable locations for intermediate distribution of the circuits from the IP PBX switch. The telephone distribution box shall include connection blocks for the circuits termination.

4.1.1.12.5. Multi-core cables shall be provided and connected from the distribution frames inside TER or CER to the telephone distribution boxes. A minimum spare capacity of 50% pairs shall be reserved in the multi-core cables, distribution frame and the telephone distribution boxes. Where only one phone is required there also the cable used shall be of 2 pairs to provide reserve spare capacity

4.1.1.12.6. Standard RJ-11 modular socket shall be provided for termination of the telephones via plug and socket arrangement. The RJ-11 modular socket shall be connected to the nearest telephone distribution boxes to complete the connection between the IP PBX switch and the telephone.

4.1.1.12.7. Short circuit and over voltage protection device shall be provided to protect circuits from faults occurring in all outdoor cables.

#### **4.1.1.13. OPERATION TELEPHONE INSTRUMENTS**

Telephone instruments shall be provided and equipped with minimum components as follows:



4.1.1.13.1. **BASIC IP TELEPHONES**

The basic telephones shall be with following facilities:

- 1) Handset;
- 2) Lamp for message waiting;
- 3) Powered by the Layer-2/Layer-3 LAN switch;
- 4) 12 push-button keypad;
- 5) 4 feature buttons for redial, hook flash, mute and hold.
- 6) CLIP
- 7) Desktop/Wall mounted type as per site requirement.

4.1.1.13.2. **DIGITAL FEATURE TELEPHONE**

4.1.1.13.2.1. The digital feature telephone shall be equipped with, but not be limited to, the following facilities:

- 1) Handset;
- 2) 12 push-button keypad;
- 3) Adjustable volume control for speaker and ringer;  
A minimum of 10 programmable function keys for assignment of features or additional extension circuits;
- 4) A minimum of 20 memories for speed dialing;
- 5) Hands-free operation through built-in speaker and microphone;
- 6) Powered by the IP PBX switch;
- 7) Visual display of details for incoming and outgoing calls;
- 8) Display of call duration;
- 9) Dial by name, dictionary
- 10) Intercom facility;
- 11) System clock display;
- 12) On-hook dialling;
- 13) Programmable for multi-lines operations with more than one extension number assigned; and
- 14) Support “boss-secretary” combination with intercommunication between the two parties via the depression of a single button
- 15) Lamp for message waiting; and

4.1.1.13.2.2. The digital feature telephone shall support ISDN BRI (2B+D) signaling (supply to exclude the supply of the adapter module)



4.1.1.13.2.3. The digital feature telephone shall be programmable for multi-lines with more than one extension number assigned.

## **4.2. DIRECT LINE COMMUNICATION SYSTEM**

### **4.2.1. GENERAL**

4.2.1.1. The Direct Line Communication system shall provide non-blocking Direct Line Communication between

- 1) OCC/BCC and different key locations like all station control rooms (SCR), Security room, depot control centre (DCC), traction substation (TSS), receiving substation (RSS), auxiliary substation (ASS), and emergency telephones, each signalling equipment room and telecommunication equipment room in stations and depot;
- 2) Between adjacent/interfacing station control rooms;
- 3) Between adjacent interlocked station control room and DCC;
- 4) Between OCC/BCC and other locations like State Electricity Board Control Room, RSSs, TSS, Stations, Depot and Security Control Room through leased telephone line of PSTN (MTNL/BSNL/Private Operator).
- 5) Between RSS and State Electricity Board, Security Control room through leased PSTN (MTNL/BSNL/Private Operator) telephones lines.
- 6) Between OCC/BCC/Head Quarter and security control rooms at stations, depot

4.2.1.2. The Direct Line Communication system shall be logically independent of the IP PBX network on the Mumbai Metro network.

4.2.1.3. The Direct Line Telephones shall be single button selection connected to OCC/BCC so that an audible alarm is sounded and the location of the calling telephones is displayed on appropriate console at OCC/BCC. At the locations other than the OCC/BCC, Direct Line Telephones shall be terminated on standard telephone sets. Consoles shall be provided with single button selection for each direct line connection.

4.2.1.4. The IP PBX Switch at each station shall also provide additionally Direct Line communication. But to make Direct Line Communication network more reliable and non-blocking, the IP PBX switch network shall be kept logically separated from this network. Direct Line Communication network shall have separate extension cards, its own separate logical network links and its own routes defined for establishing the communication. With this architecture, during emergencies when the Direct Line Communication does not work or is overloaded, the IP PBX network can be made available on demand for Direct Line communication.

### **4.2.1.5. DIRECT LINE COMMUNICATION NETWORK TOPOLOGY**

4.2.1.5.1. Direct Line Communication network shall use topology similar to the IP PBX for stations described above. The interconnection plan should be designed and approval taken from employer. The IP PBX at OCC/BCC shall



be the main central node The network shall have alternate call routing paths to make it totally non-blocking. Direct Line Telephone network with its exclusive Ethernet rings as a minimum shall be provided. However, to meet with the requirements of this contract and requirements of the Designated Project Contractors, additional equipment/services as required shall also be provided by the Contractor at no additional cost to the Employer. The system will cater to the requirements of control telephone circuits for operation, maintenance, and the direct lines between key locations.

4.2.1.6. The Direct Line Telephone System shall permit

- 1) Individual selective calls with privacy of communication
- 2) Group call ;
- 3) General call;
- 4) Conference call, to add additional users to an established call connection;
- 5) Emergency call with priorities.

The MS07 Contractor shall specify in his Design all the detailed interlocking and switching arrangement for all the direct lines.

4.2.1.7. For provision of Direct Line Console in the OCC/BCC and the Depot refer to HMI/MMI Provision Schedule of this Particular Specification. System capacity for OCC/BCC able to install DLC. The elevated Stations/Depot/OCC/BCC shall have 9 numbers each of Direct Line Telephones (10 Lines) and 01 number at each TSS/RSS, which shall be programmed for the required Direct Lines, to be reviewed by Employers representative.

#### **4.2.2. DIRECT LINE CONSOLE**

4.2.2.1. Direct Line Consoles shall be provided at OCC/BCC for each of the controls listed at 4.2.1.7. above.

4.2.2.2. The Direct Line Console shall be configured as a desktop model/flush mounted in a desk ergonomically matching with the control room furniture.

4.2.2.3. The Direct Line Console for each of the OCC/BCC controller positions shall have a minimum direct line capacity of 90 lines and shall be capable of interfacing with required Direct Line Extensions defined in this Chapter the Particular Specifications including MMI Provision Schedule of this Particular Specification. The exact size of each Direct Line Console and the Direct Line Extensions to be terminated on each Console shall be determined by the Contractor and reviewed and approved by the Employer's Representative.

4.2.2.4. The Direct Line Console shall provide selection facilities, in the form of push button and/or soft keys with visual display unit for user to perform, but not be limited to, the following functions as a minimum:

- 1) Originate outgoing calls to the selected user;
- 2) Select and answer any incoming calls destined for the direct line console;



- 3) Originate outgoing calls to a pre-defined group of users;
- 4) Originate outgoing calls to a group or all users defined by the Direct Line Console at the time before the call is placed;
- 5) Make conference calls to add additional users to an established call connection;
- 6) Patch calls or put through two individual users for call connection;
- 7) Transfer call to IP PBX extension;
- 8) Make and receive emergency call (override facility).

4.2.2.5. The Direct Line Console shall be equipped with, but not be limited to, the following facilities:

- 1) Handset;
- 2) Push button or soft key for each Direct Line Telephone;
- 3) 12-push button keypad for dialling;
- 4) Adjustable volume control for speaker and ringer;
- 5) Hands-free operation through built-in speaker and microphone;
- 6) Powered by the Central communications processor;
- 7) Visual display of details for incoming and outgoing calls
- 8) Display of call duration;
- 9) System clock display;
- 10) Lamp for message waiting;
- 11) Lamp for ringing signal
- 12) Transmit DTMF signal when call has been connected.

4.2.2.6. The Direct Line Communication system shall support a minimum of 8 simultaneous incoming calls to the Direct Line Console to be queued before these calls are answered. The identity of the calling parties in the queue shall be displayed on the Direct Line Console in ascending order of the incoming sequence. Console controller shall be able to answer calls in queue in any sequence. Call answered shall be removed immediately from the display.

4.2.2.7. The selection facilities of the direct line console, in the form of physical push button and/or soft key, shall be labelled with identity of the called party or functions of the selection facilities.

4.2.2.8. The selection facilities shall provide selection status indication in the form of LCD or LED displays.

4.2.2.9. Dedicated push button and/or soft keys shall be assigned to each telephone line which can be connected to the direct line console.



- 4.2.2.10. At least 10 spare push buttons and/or soft keys shall be provided for assignment of additional functions or telephone lines.
- 4.2.2.11. The push buttons and/or soft keys of similar functions or nature shall be grouped together to facilitate the user to locate the required selection.
- 4.2.2.12. The Direct Line Console shall also be provided with functions for operation as an ordinary telephone set. The Direct Line Console shall be equipped with keypad for dialling to originate IP PBX telephone call and support on-hook dialling.
- 4.2.2.13. The Direct Line Console shall give different audio/visual indication for normal and emergency calls.
- 4.2.2.14. Once the Direct Line Extensions have been programmed on the Direct Line Telephones it shall not be possible for unauthorized change of program from the Direct Line Extensions (Direct Line Telephones).

**4.2.3. DIRECT LINE TELEPHONES**

- 4.2.3.1. Direct Line Telephones shall be standard Telephones connected to OCC/BCC Direct Line Console through single push button selection. In each station 1 nos. of such telephones, 20 lines for SCR/DCC, and 10 lines for each of the other locations in the Stations/Depot/RSS shall be provided. It shall be possible for the SCR to make normal and emergency direct line calls to the designated controllers in OCC/BCC. Different audio/visual indications shall be provided for incoming direct line calls on the Direct Line Telephones for normal and emergency calls.

**4.2.4. HELP POINTS IP PHONE (ONE AT EACH PSB)**

- 1) Another type of DLT connected to SCR and SC
- 2) Hands free operation with a call button, a microphone and a speaker
- 3) An integrated hands-free telephone unit with hearing aid facility shall be provided as Help points at designated locations (PF & Emergency staircases) for assistance of passengers
- 4) Function as a uni-directional Direct Line Telephone with a built-in induction loop to provide better reception for hearing-impaired passengers wearing hearing aids. It shall meet the requirements of IEC 60118-4 – Magnetic Strength in Audio Frequency Inducting Loops for Hearing Aid Purposes. The induction loop shall be operated in RF with the modulating frequency suitable for the usage in India. The Contractor shall ensure the frequency used meet the statutory requirements and apply for the license required; and
- 5) Suitable for wall mounting
- 6) The Help-Point Speaker Phone shall interface with the CCTV system such that on activation of the Help-Point Speaker Phone, the image of the associated CCTV Camera shall POP up with an alarm on the CCTV MMI in the SCR & OCC. Final working of the interface along with the alarm system shall be submitted to the Employer's Engineer for review / approval. Details of Help Point Interface with the CCTV system are detailed in Appendix-A14, Chapter-10 of this Particular



Specifications. The Help Point Telephone unit proposed to be supplied shall be submitted to the Employer's Engineer for review/approval.

**4.2.5. ETS TELEPHONES AT PLATFORMS.**

- 4.2.5.1. ETS Telephone shall operate as an Analog, connected to the IP-PBX.
- 4.2.5.2. The ETS telephone shall be configured as a Hot Line functionality.
- 4.2.5.3. These shall be provided at Platform ends and located next to the Traction Power Supply Contractor's ETP Boxes (Emergency trip Box). It shall be ensured that Fire Alarm unit is not located near the ETS telephone, so that the Fire Alarm does not interfere with the Emergency Communication.
- 4.2.5.4. Exact position of the ETS Telephone shall be coordinated by the Telephone Contractor as part of the Interface requirements.
- 4.2.5.5. In addition to functionalities specified above, the ETS Telephones shall provide the following features / functionalities:
- 4.2.5.6. Each telephone will be a self-contained unit consisting of a metal box containing a heavy-duty telephone hand set and cord and calling facility. The unit will be adaptable to wall/column mounting.
- 4.2.5.7. An outgoing call is generated on lifting the handset of ETS phone; the call is routed to Traction power Controller's DLC and if it not answered in predefined period then the call shall be automatically routed to designated Traffic Controller's position in OCC.
- 4.2.5.8. Conspicuous audio and visual indications to alert the controllers shall be displayed on lifting of a handset from any location. Identity of calling location shall also be displayed on the DLC. Facility of conference call with other ETS telephones shall be possible through the Controller position.
- 4.2.5.9. The contractor shall submit details of the ETS Phones proposed to be supplied to the Employer's Engineer for review & approval.

**4.2.6. EMERGENCY TELEPHONES AT CROSS PASSAGES IN TUNNEL (WHEREVER APPLICABLE).**

- 4.2.6.1. Normally when a train is disabled in a tunnel, the driver shall be able to call for assistance by means of his train radio. However, to cater for possibility of a train radio failure, trackside telephones from IP PBX system configured with hot line telephone functionality shall be provided at regular intervals close to the cross passages in each tunnel separately.
- 4.2.6.2. These shall also be provided at the start of the tunnel at platform ends and located next to the Traction Power Contractor's ETP Boxes (Emergency Trip Boxes). It shall be ensured that Fire Alarm unit is not located near the Emergency Telephone , so that fire alarm doesn't interfere with the emergency communication. The Exact position of the Emergency Telephone shall be coordinated by the contractor as part of the interface requirements.
- 4.2.6.3. Passenger emergency evacuation design for cross passages between running tunnels which are constructed either by cut and cover or bored methodology shall be in accordance with requirements of NFPA 130-2007 as under:



- a) The distance between two emergency phones shouldn't exceed 250 meters.
- b) Emergency phones must be provided at cross passage and mid-way shaft compulsorily.
- c) Emergency phones must be provided at platform ends of underground stations.
- d) Emergency phones must be provided , as far as possible, adjacent to ETP boxes of Traction Power System.
- e) Marking of emergency phone indication throughout the tunnel at 25 meters intervals to indicate the location of nearest emergency phones.
- f) Track crossover shall not be considered as cross passages.

4.2.6.4.

In addition to functionalities specified above, the Emergency Telephones shall provide the following features/functionalities :

- a) Each telephone will be a self -contained unit consisting of a metal box containing a heavy duty telephone hand set and cord and calling facility. The nit will be adaptable to wall mounting
- b) The telephone set and box shall work satisfactorily in tunnel environment. An outgoing call is generated on lifting the handset of emergency phone. The call is routed to the Traction Power Controller's DLC and if it is not answered in predefined period then the call shall be automatically routed to designated traffic controller's position in OCC.
- c) Conspicuous audio and visual indications to alert the controllers shall be displayed on the DLC. Facility of conference call with other emergency telephones shall be possible through the controller position.
- d) Loud audio and prominent visual indication shall be provided on the field telephone for attracting attention of staff /driver in the neighbourhood of telephone box when called by the OCC. This shall be provided by a hooter and speaker arrangement as part of emergency telephone.
- e) The emergency telephone shall be a proven make and model, which has been in use previously in an Underground Metro Railway for at least 3 years,
- f) The emergency telephone shall work on the telephone cable and it is anticipated that the flasher & hooter shall also be able to work on the same cable. However, if the visibility and audibility of the arrangement ( to be approved by the employer) requires more power, then separate power cable will have to be laid by the Telephone contractor for powering the Emergency Telephones in the tunnel.
- g) The cables for emergency phones through the tunnel shall be armoured type with Fire Resistant and LSZH properties as defined in the cable specifications. Each Emergency phone shall be fed from separate cables and alternate phones shall be fed from different nodes



between two neighbourhood stations as far as possible.

- h) The contractor shall submit details of the Emergency Phones proposed to be supplied to the Engineer for review & approval.

### **4.3. IP PBX TELEPHONE SYSTEM**

#### **4.3.1. VOICE OVER IP SWITCH NETWORK**

4.3.1.1.1. The IP PBX Call Management Server, in hot redundant configuration, will be placed at OCC/BCC with the redundant part at the BCC and should be configurable in two different subnets. It shall be configured in hot standby configuration such that no single failure should affect the availability of the system.

4.3.1.1.2. IP PBX facility shall be provided at OCC/BCC, stations and depot. At OCC/BCC, the IP PBX facility shall support 10 voice phones + 4 video phones. IP PBX shall provide facility for connecting to other exchange networks. For this, IP PBX shall provide Media Gateway with gatekeeper (1+1 redundant) to support PRI Trunks to connect exchanges in the Line 2B, 9, 7, 7A of Mumbai Metro network in feature transparent manner (QSIG in heterogeneous environment). For connectivity to the IP PBX network 4 PRI trunks shall be made available as a minimum.

4.3.1.1.3. A NMS for managing the IP PBX, IP network switches will also be provided at OCC/BCC. This NMS can be common or separate from the Telephone System NMS.

#### **4.3.1.2. MAIN NODES**

4.3.1.2.1. IP PBX at OCC/BCC shall form the main node with backup at BCC. This main node shall be connected with central switches (1+1 hot standby) at OCC/BCC and through Ethernet links to the station managed switches (L2 Managed POE) in Star and Ring Topology. The IP phones at OCC/BCC and stations will connect to POE switches. Indicative inter connection between main node and station nodes is as given in Table 7.4 .The above arrangement has to be commissioned providing dedicated link to maintain connectivity.

#### **4.3.1.3. IP NETWORK TOPOLOGY**

4.3.1.3.1. For IP PBX network it is envisioned that a group of 4 stations shall be connected in a ring topology and the IP PBX at OCC/BCC shall be main node forming a Star topology in effect. Each group shall be connected to the main node of OCC/BCC directly on Ethernet link in redundant configuration.

4.3.1.3.2. In each group, L2 Managed Switch in one station shall be connected to the switch in the next station through an Ethernet link. The first node is connected to switch of OCC/BCC and last node of the group is connected back to switch of OCC/BCC. IP PBX network as a minimum shall be provided as per this topology. Alternative route Ethernet links shall be provided for each of the groups.

4.3.1.3.3. The managed switches shall be installed in TER at all locations. The switches shall be connected to each other through Ethernet links of the FOTS to form the IP PBX switch network. The Ethernet link shall be provided as part of FOTS by the Contractor in the TER's and CER.



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4.3.1.3.4. The Contractor shall lay the cables up to the FOTS rack to access the Ethernet. IP PBX network as a minimum shall be provided as per indicative network topology in Table 7.4 shown below. However, to meet the requirements of this Contract and requirements of the Designated Project Contractors, additional equipment/services as required shall also be provided by the Contractor at no additional cost to the Employer.

4.3.1.3.5. Requirements of IP PBX System are given in Table 7.4. below as a minimum.

#	Description	Elevated	OCC/BCC	Depot
1.	Bandwidth on Ethernet between Station/Depot and OCC/BCC.	5Mbps	-	10Mbps
2.	Bandwidth on Ethernet	-	150Mbps	-
3.	Call Server	-	1	-
4.	Media Gateway with gatekeeper (1+1 redundant)	-	04 PRI link	-
5.	Switch	1 no., Layer 2 managed, 8 port POE, 2 uplink ports	Two no. Layer 3 twenty-four Port, Two no. Layer 2 eight port POE 2 uplink ports	1 no., Layer 2 managed, 8 port POE, 2 uplink ports
6.	Voice mail facility	Required	Required	Required
7.	FAX Support	On PC based application	FAX support for 300 users in the network	On PC based application
8.	IP PBX Phones (Voice)	2	10	10
9.	IP PBX Phones (Video)	1	4	1
10.	NMS + Printer (refer Clause 1.2.6.)	-	As required	-
11.	Total Number of user (Voice Phones)	-	72	--
12.	Total Number of user (Video Phones)	-	34	--
13.	IP Trunks	-	30 Channels for SIP Trunk and 30 Channels for H.323 Trunks	-

**Table 7.4: IP PBX Telephone System Requirement**

4.3.1.3.6. The System can be programmed to send a simulated ring tone to T1 or equivalent trunks when the CO does not provide a ring back tone



**4.3.1.4. UNIFIED MESSAGING APPLICATION (UMA)**

4.3.1.4.1. A Unified Messaging Application (UMA) shall be provided for IP PBX system with facilities such as Email, Voice mail, Faxes, Conferencing & Collaboration and inbuilt Soft phone. The Unified Messaging Application shall be accessible from desktop clients and shall support features such as making calls, sending, replying, forwarding Voice messages and recording live conversation and accessing the IP PBX services. UMA must have a Unified directory that allows the IP Phone, Soft phone user to call by name and identify their correspondents. The Unified Messaging Application shall support minimum 300 users expandable in future up to 750 users.

**4.3.1.4.2. DIRECTORY SERVICES**

- i. A unified Telephone directory of all the Telephone extensions used in Mumbai Metro comprising Line-7,2A, 2B , 9 and 7A including depot shall be prepared/ configured by the MS07 contractor in IP PBX as a part of this MS07 contract without any additional cost to DMRC.
- ii. In addition, a handbook (500 Nos) giving details of all Telephone features/ functionalities along with their methodology shall be provided as a part of this contract without any additional financial implication on DMRC/MMRDA. Format of this handbook shall be submitted to Engineer for review and approval.

4.3.1.4.3. The IP PBX network shall support FAX on protocols such as T.38. Media Gateway at OCC/BCC shall be equipped to provide support over Desktop PC's at stations and depot

4.3.1.4.4. The Fax support for Unified Messaging Application shall allow Web Administration for searching, viewing FAX contents, monitor FAX status, forwarding, re-routing or blocking Fax messages. The administration features shall support creating, editing, deleting User fax profiles. The Fax support shall also be able to access Unified directory. Fax support shall allow archiving of all inbound & outbound faxes in central system database. The Fax users shall be able to access the Fax support via web interfaces such as browsers using their user id's and passwords to view, send or search faxes. Notifications shall be available to Users for successful or failed faxes. The Fax facility shall provide Group 3 Fax support with minimum resolutions 400x400. The Fax application should have 2 port minimum to send and receive the fax.

4.3.1.4.5. A Conferencing and Collaboration application shall also be provided for all types of IP Phones (soft-phones included) under UMA for Audio Conferencing, Data collaboration & Video Conferencing. The Audio and data collaboration should be with recording capabilities upto 50 hrs minimum. The facility shall be accessible to Users over web interface

4.3.1.4.6. Audio conferencing shall be Ad-Hoc/On Demand Conferencing, allowing the users to start an audio conference at any time by just aggregating the participants from the list or by calling them at any telephone number. Audio conferencing via "Conference Room" facility where in Users call a particular number with access code to log into a conversation room shall also be supported. Scheduling, notification & confirmations for such "Conference Room" shall be over web interface. The Audio conference application should



have at least 24 ports with various combination as:- 1 no. of 24 parties or 2 nos. of 12 parties or 3 nos. of 8 parties or 4 nos. of 6 parties or 6 nos. of 4 parties or 8 nos. of 3 parties.

- 4.3.1.4.7. Data Collaboration shall allow attaching and sharing any documents during conferencing. It shall also enable sharing Conferencing initiator's desktop to allow demonstration of presentations, applications etc. The Data collaboration application should have at least 24 ports with various combination as:- 1 no. of 24 parties or 2 nos. of 12 parties or 3 nos. of 8 parties or 4 nos. of 6 parties or 6 nos. of 4 parties or 8 nos. of 3 parties
- 4.3.1.4.8. Video Conferencing shall allow Selective switch mode, 24 party conference in a single group achieved by built in soft video conference bridge with various combinations as:- 1 no. of 24 parties or 2 nos. of 12 parties or 3 nos. of 8 parties or 4 nos. of 6 parties or 6 nos. of 4 parties or 8 nos. of 3 parties. Hardware video conference bridge can also be provided but they should support all features as available in software video bridges. During a conference the collaboration tool must allow the ability to attach other participant into the conference. Casual, immediate, on the fly, 3 ways, 3 party or 6 party conferences operate in the same way as Ad hoc conferences. No conference identification is provided or required. No conference resources are reserved. They are acquired from a pool of resources. If no resources are available, the conference will not be established.
- 4.3.1.4.9. IP PBX system shall have provision to support Video Conferencing between OCC/BCC and Stations to provide Continuous mode Video Conferencing thorough 3<sup>rd</sup> Party solution.
- 4.3.1.4.10. Presence and Instant Messaging must use icons and colors for On-Line Presence, Telephony Presence (like free, busy or on phone etc), Calendar Presence, coming from Outlook calendar, User-Choice Presence, (Busy, Be right back, Away, Out to lunch and Appear off-line). The instant messaging application must allow instant messaging (chat) sessions between members.
- 4.3.1.4.11. The IP PBX Server shall be synchronized to the master clock signal from the Master Clock System to be commissioned by the Contractor
- 4.3.1.4.12. IP PBX shall synchronize time signal with Station and OCC/BCC IP PBX equipment.
- 4.3.1.4.13. The IP PBX Server shall have internal clock in free running mode in the event of the failure or absence of the master clock signal.
- 4.3.1.4.14. The IP PBX Server shall synchronies automatically back to the master clock signal when master clock signal is recovered
- 4.3.1.4.15. IP PBX should provide Logical Partitioning to segregate IP to IP, IP to PSTN calls as per DOT regulations.
- 4.3.1.4.16. IP PBX system shall provide 30 channels on SIP Trunk and 30 channels on H323 Trunk as minimum for high availability.
- 4.3.1.4.17. IP PBX should be type approved for latest TEC GR (Interface Type Approved).
- 4.3.1.4.18. Call Servers shall have minimum 2 Ethernet 10/100/1000BT ports with



redundant power supplies, hot swappable. The Call server shall be high performance, server grade machine.

- 4.3.1.4.19. The IP PBX network shall be linked with IP PBX network at OCC/BCC to enable calls between IP phones and Analog/Digital Phones at OCC/BCC, Stations, Depot etc.
- 4.3.1.4.20. The IP PBX network shall link with PSTN lines to enable calls between IP phones to PSTN through PRI.
- 4.3.1.4.21. The IP PBX shall provide extensions locally at depot in DCC, OCC/BCC in close proximity to OCC/BCC/Depot and at all station TER/SCR, through CAT 6 indoor/outdoor cables.
- 4.3.1.4.22. The IP PBX system shall restart automatically when the power supply to the IP PBX system resumes normal after failure.
- 4.3.1.4.23. The Contractor shall submit Bandwidth utilization plan to evaluate the Traffic calculation of IP PBX network.
- 4.3.1.4.24. At least 25% spare traffic bandwidth and capacity must be planned. Minimum requirement is given in Table 7.4. The detailed calculations have to be submitted to Employer for review.
- 4.3.1.4.25. 25% free slots must be available in Media Gateways for future expansion.
- 4.3.1.4.26. The maximum traffic interruption time on any circuit due to link, node or any other failure shall be less than 50 ms.
- 4.3.1.4.27. The Layer 3 Managed switch at OCC/BCC shall provide 24 ports, delivering intelligent services with optimal quality of service (QoS) and integrated security, as well as network admission control (NAC). The Switch shall be mounted in IP PBX rack.
- 4.3.1.4.28. The Layer 2 Managed switch at OCC/BCC and stations shall support Virtual LANs delivering intelligent services with optimal quality of service (QoS) and integrated security, as well as network admission control (NAC) The Switch for stations shall be installed in wall mounted rack provided by the Contractor.
- 4.3.1.4.29. The Layer 3 Managed and Layer 2 Managed switches at OCC/BCC and Stations to be provided to meet overall design

#### **4.4. IP PBX FUNCTIONALITY**

##### **4.4.1. GENERAL**

- 4.4.1.1. It shall be able to define at least 6 different classes of service that can be allocated to each extension.
- 4.4.1.2. Direct dialed outgoing calls to the PSTN (i.e. long distance, international and mobile) shall be restricted by the appropriate class of service allocated to the extension.
- 4.4.1.3. Call statistics shall be compiled and stored on hard disk
- 4.4.1.4. The function of direct incoming dialing (DID) shall be restricted according to the class of service allocated to the extension.



- 4.4.1.5. The function of direct outgoing dialing (DOD) shall be restricted according to the class of service allocated to the extension.
- 4.4.1.6. A warning tone shall be provided to alert in the event of an extension being off-hook.
- 4.4.1.7. It shall be possible to transfer a call from any one extension to any other subject to any restriction applied to the class of service for the extension.
- 4.4.1.8. A pre-determined code dialed from any extension phone shall be treated as an emergency call and routed to the Controller.
- 4.4.2. **System Features**
- 4.4.2.1. The IP PBX switch shall provide, but not be limited to, the following system features:
- 4.4.2.2. **Automatic Ring Back** - This feature allows internal users who have placed a call to a busy or unanswered internal user to be called back automatically when the called extension becomes available.
- 4.4.2.3. **Automatic Overflow** - This feature allows users to place tie line calls via public switch networks automatically when all tie lines are not available.
- 4.4.2.4. **Automatic Trunk Call Back** - This feature allows internal users who experience an "all trunks busy condition" to be called back automatically when the trunk becomes available.
- 4.4.2.5. **Break-in** - This feature allows a priority user to break-in an established connection in case of an emergency.
- 4.4.2.6. **Busy Hunt** - This feature allows calls which encounter busy extension to automatically route to another extension. Hunting path can be user defined within a specific group and is useful for a group of extensions having high volume of calls.
- 4.4.2.7. **Call forward / divert** - This feature allows all incoming calls to an extension number to be forwarded to a selected internal extension number. This feature can be defined in three conditions:
- 1) Call forward on any conditions;
  - 2) Call forward on busy; and
  - 3) Call forward on no answer.
- 4.4.2.8. **Call Park** - This feature allows users to put a call on hold and then retrieve the call from any other extension within the system.
- 4.4.2.9. **Calling Party Name Display** - This feature provides internal station users with an enhanced visual aid in making and receiving calls. In addition to the calling or called party's extension number, a customer definable identification (typically the party's name) also appears on a set capable of displaying alphanumeric characters.
- 4.4.2.10. **Call Pick Up** - This feature allows users to answer calls to other extension numbers within the user's specified Call Pick Up group.



- 4.4.2.11. **Call Transfer** - This feature allows users to transfer trunk or internal calls to other users within the system without attendant's assistance.
- 4.4.2.12. **Call Waiting** - This feature notifies a station user on an established connection (internal or external) that an external call is waiting to be answered.
- 4.4.2.13. **Conference** - This feature allows a station user on an established call to add additional parties to the conversation. The conferencing parties may be inside or outside the PABX and at least one party must be an internal extension. And this feature shall support three or more than 3 connections at a time.
- 4.4.2.14. **Direct Inward Dialing** - This feature connects calls from the public telephone network directly to the dialed extension number without attendant's assistance. Direct Inward Dialing provides the outside calling party with immediate contact with the called party.
- 4.4.2.15. **Direct Outward Dialing** - This feature allows users to access the public telephone network without attendant's assistance.
- 4.4.2.16. **Distinctive Ringing** - This feature helps users to distinguish between various types of incoming calls by means of different ringing cycles. The incoming call can be internal, external and automatic call back on Local or Trunk calls.
- 4.4.2.17. **Do Not Disturb** - This feature allows users to request that no calls, other than priority calls, terminate at a particular extension number for a specific time.
- 4.4.2.18. **Hot Line** - This feature allows single-line users, by simply lifting the handset, to automatically place a call to a pre-assigned extension number or public telephone number.
- 4.4.2.19. **Intercom** - This feature allows users of feature telephones to communicate by speak call with hands free mode.
- 4.4.2.20. **Last Number Redial** - This feature allows users to redial the last number dialed automatically when user presses the Last Number Dialed button or dial the Last Number feature access code.
- 4.4.2.21. **Loudspeaker Paging** - This feature allows authorized users to page locations via Loudspeaker Systems on a zone basis.
- 4.4.2.22. **Music On Hold** - This feature provides music to a party that is on hold, waiting in a queue, parked, or on a trunk call that is being transferred. The music lets the waiting party know that the connection is still effective.
- 4.4.2.23. **Recorded Announcement** - Provides a pre-recorded announcement to intercept different kinds of incoming calls that request for call set up cannot be completed.
- 4.4.2.24. **Speed Call** - This feature allows a user to place calls by dialing a one, two or three digit code. Speed Call can be used for both internal and external calls.
- 4.4.2.25. **Voice Mail** - This feature allows an incoming trunk or internal call to be



automatically routed to a Voice Mail Box if it is not answered at the original destination. In addition, authorized users can compose a message and send or broadcast it to one or a group of users in the form of Voice Mail.

- 4.4.2.26. **Voice Message Retrieval** - This feature allows users to retrieve messages from Voice Mail Box in the form of a voice output from any telephone set within the network. The user shall also be able to retrieve messages through the PSTN by using a standard DTMF telephone set.
- 4.4.2.27. **Voice Monitoring** - This feature allows system administrator / console operator / user with special right to monitor but not to disturb an existing conversation by using system console / administration phone.
- 4.4.2.28. **Access to Paging** – Extensions and attendant shall have dial access to a loudspeaker or any other type of voice paging system
- 4.4.2.29. **Executive Override** – An extension with a higher priority level shall be able to access a busy extension by overriding the ongoing call. A warning tone shall be sent to the parties concerned.
- 4.4.2.30. **Attendant Recall** – Facility to draw the attention of the exchange operator on an attendant established call.
- 4.4.2.31. **Forced Release** – A feature applicable when A user exceeds pre-set inter-digit time interval; or The calling user exceeds pre-set time while listening to ringing or busy tone; or When either of the two users (calling and called party) terminates call
- 4.4.2.32. **Line Lock-out** – Automatic line lock-out if the user does not start dialing within a pre- set time after receiving dial-tone or if there is a permanent loop on the line
- 4.4.2.33. **Malicious Call Trace** – The system shall provide functions for the user to activate and deactivate a call trace. On activation the system shall generate a printed report of the calling and called parties to locate source of the malicious call across the network including calls from PSTN.

#### **4.4.3. NETWORK FEATURES**

- 4.4.3.1. The telephone IP PBX switch shall provide, but not be limited to, the following network features:
  - (i) Automatic Re-route - This feature provides alternate routing to public network when all tie lines busy is encountered.
  - (ii) Call Party Name Display - This feature provides users in the network with an enhanced visual aid in making and receiving calls. In addition to the calling or called party's extension number, a customer definable identification (typically the party's name) also appears on a set capable of displaying alphanumeric characters. Call parties name shall be displayed on the calling parties' telephone when ring back tone is returned to the calling party.
  - (iii) Centralized Voice Mail - This feature allows network users to be served by a single message centre. Both internal and external callers shall be able to leave message in the Centralized Message Centre for network users at any location within the network. The system shall be



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able to inform the network user the presence of voice mail in his mail box by lighting an indicator on the telephone set, or in case of an analogue set user, giving a special tone when the handset is off-hook.

- (iv) Centralized Voice Mail Retrieval - This feature allows users to retrieve messages from the Message Centre in the form of a voice output.
- (v) Facsimile - This feature allows FAX users to send hard copies to any other users within the network, from G4 FAX terminal in dial up operation.
- (vi) Network Call Forward - This feature allows a called station to be forwarded to any station within the network pre-defined by the user, when it is busy, no answer or in all conditions.
- (vii) Network Call Hunting - This feature allows a call from a calling party (station A) reaching a called party that is busy (station B) to be routed to any other telephone number in a hunt group within the network.
- (viii) Network Call Transfer - This feature allows a called party (station B) to transfer the calling party (station A) to any other station within the network (station C), any time during the established call.
- (ix) Network Conference - The feature capabilities are extended throughout the network, allowing someone within the network to establish a three-party conference. The conferencing parties may be inside or outside (PSTN) the network, but the conference shall be under the control of the parties inside the network.
- (x) Network Ring Again - This feature allows a caller from location A, encountering a busy station in location B, to press the Ring Again key and be notified when the busy station becomes idle.
- (xi) Network Speed Call - This feature allows callers within a network to make calls that are normally restricted to them. This feature allows a user to temporarily override Class of Service and access restrictions for calls placed.
- (xii) Network Voice Mail - This feature allows callers to leave messages to a group of users within the network. In addition, authorized users can broadcast messages to a group of users in the form of Voice Mail.
- (xiii) Network Management System - The Telephone Subsystem shall incorporate on- line automatic, self-diagnostic maintenance facilities that enable fault management, configuration and performance management. All equipment shall be monitored to ensure that a failure at card level can be detected and be reported to the internal fault diagnostics system. A database shall be built for defining the system configurations. Any change in the database shall automatically be updated on to suitable storage devices such that an up to date version of the configuration is available in case there is a system or power failure. The Network Management System shall have GUI functionality, auto discovery features and will be able to monitor and provide overall control and supervise all station/depot PABXs as well as the Tandem switch to carry out the following system administrative and monitoring functions:



- Call Management;
- Fault Monitoring;
- Performance Management; and
- Record and History Management.
- Traffic Monitoring.
- Graphical view of the Telephone network
- Call details recording of PSTN, between the extensions and between the PABXs with the date, time, duration, caller no., called no. etc. for billing purposes
- The NMS shall support billing services,
- The Telephone Subsystem shall have provision of at least one month call details record in case of Network management system fails.

GUI functionality of the NMS shall be provided with proper hierarchy to enable proper monitoring and operation of all elements of the voice network at all Stations, Depots, and other locations. The Contractor shall submit details of the proposed GUI interface and functionality for Employer's approval before implementation.

#### **4.4.4. FAULT AND ALARM MANAGEMENT**

- i. The network management system shall be equipped with a, self-diagnostic, fault and alarm management of all elements of the operational Telephone Network and associated interfaces.
- ii. All relevant information shall be accessible to the operator from the Management Workstations.
- iii. The fault management system shall, on a real-time basis, monitor and display the fault, event and alarm status in addition to the acknowledgement and resetting of alarms.
- iv. The system shall store alarms in the database for future analyses.
- v. All incidents together with equipment and software failure shall be recorded, time and date stamped with an immediate alert provided to the Workstation operator.
- vi. The Management Workstations shall provide a centralised and integrated colour display of all the Operational Telephone Subsystem alarms and events.

#### **4.4.5. VOICE MAIL SYSTEM (VMS)**

##### **4.4.5.1. GENERAL**

- i. A Voice Mail System (VMS) shall be integrated with the Tandem Switch at the TER such that the access to the Voice Mail System shall be via the switch at the TER.



- ii. The VMS shall provide voice mail boxes for users to retrieve, record, playback and broadcast voice messages
- iii. The assignment of voice mail box to any telephone extension of the Telephone System shall be programmable.
- iv. The VMS shall alert the user of the presence of new voice messages in his voice mail box by providing a special tone when the handset is off-hook. Where the users telephone set is equipped with a message waiting lamp, the lamp shall also be either on or flashing in addition to the tone indication. Both the visual and audio indication shall be reset automatically after the voice message has been retrieved. Both the visual and audio indication shall be programmable to be enabled or disabled.
- v. The VMS shall be fully operational across PABX switches over the Telephone System.
- vi. All messages left in the VMS shall be immediately stored in a hard disk or other storage medium subject to review by the Employer. The hard disk or the storage medium shall be backed up with a mass storage device automatically and periodically. The interval between back up shall be user-programmable.
- vii. Incoming calls to the VMS shall be served on a first-come-first-serve basis. The PABX switch network shall provide automatic call distribution functions to evenly distribute the calls to input ports of the VMS.
- viii. The VMS shall automatically and periodically run diagnostic tests to ensure normal operation.
- ix. The VMS shall provide on-going and historical statistical reports on the usage, traffic handling and the storage capacity on an hourly format.
- x. The VMS shall be equipped with automatic gain control with digital speech compression to provide quality playback and to minimise the storage size of the voice messages.
- xi. Alarms from the VMS shall be managed by the PABX management system

#### **4.4.5.2. CALL HANDLING**

- (i) Calls to extensions assigned with voice mail boxes shall be automatically forwarded to the VMS when the call is not answered, when the called subscriber is busy or when the call is forwarded by the called subscriber.
- (ii) Calls forwarded to the VMS shall be greeted by playing a greeting voice message. The default greeting message shall include the extension number of the called party.
- (iii) The Contractor shall develop the VMS default greeting messages which shall be submitted to the Employer for review
- (iv) Calls forwarded to the VMS shall be informed of the reason by a



standard message playback which shall include, but not be limited to, the following:

- the called party is busy; and
  - No answer from the called party.
- (v) The caller shall be guided with the voice message playback to leave his message into the voice mail box assigned to the called party. The caller shall be notified of the start of recording by a beep tone.
- (vi) The recording of the caller's message shall stop immediately after the call is disconnected.
- (vii) The VMS shall automatically disconnect the call for message recording if the duration of message exceeds the user-programmable limit.

#### **4.4.5.3. VOICE MAIL BOX ACCESS**

- i. Callers from any extension of the Telephone Subsystem or from PSTN may directly access the voice mail box by dialling the access number.
- ii. Once the call is connected to the VMS, access to the voice mail box shall be protected by correct entry of an extension number and a password. The password shall be of at least 4 digit lengths and user programmable.
- iii. The VMS shall verify the entries. Calls shall be disconnected immediately after a number of successive invalid passwords are detected. The number of password entries shall be programmable by the VMS. The system default value shall be at least 3 trials.
- iv. Upon successful log-in, a mailbox summary on the number of new messages or no new message shall be played back to the user.
- v. A warning message shall be delivered to the user to delete unwanted messages if the total duration of the messages exceeds the storage limits assigned to the voice mail box.
- vi. The VMS shall provide voice message playback to the user on the available functions and the associated push button entry for selection. The functions shall include, but not be limited to, the following:
  - a. Listen to the messages in the voice mail box;
  - b. Repeat playing of the same message;
  - c. Skip messages until the desired message for retrieval;
  - d. Delete any message from the voice mail box;
  - e. Forward any message from the voice mail box to other mail boxes or extensions;
  - f. Compose messages and broadcast to other voice mail boxes;
  - g. Customize the voice mail box greeting message; and



- h. Help messages.
- vii. All commands to activate the voice mail box functions shall be via the DTMF signals transmitted from the user's telephone set when the user pushes the button on the telephone keypad.
- viii. The VMS shall provide facilities for users to:
  - a. Record his own customized greeting message;
  - b. Playback for verification;
  - c. Replace the system default greeting message for his own voice mail box;
  - d. Restore the system default greeting message.
- ix. Functions shall be grouped into different levels and users shall select functions by dialling a single digit command. No more than 10 functions shall be grouped into the same level.
- x. No more than 2 entries shall be required for users to listen to the new messages in the voice mail box.
- xi. A message summary of the sender, time and date sent and duration shall be played prior to the message playback.

#### **4.4.5.4. VMS SYSTEM ADMINISTRATION**

- (i) The VMS shall be accessed by means of a VMS Workstation through a EIA-422 or equivalent digital interface. The VMS Workstation shall be installed at the TMR.
- (ii) The maintenance functions shall include the following:
  - a. Assign or remove voice mail box to any extension;
  - b. Configuration of the VMS;
  - c. Programming of system parameters and settings;
  - d. Performing system start-up and backup;
  - e. Monitoring system status and display of alarms;
  - f. Generating system and user statistical reports.

#### **4.4.6. ENGINEERING TERMINAL**

- 4.4.6.1. A data port shall be provided for connection of a local portable Engineering Computer Terminal for system set-up, testing, diagnostics, and administration and maintenance operations.
- 4.4.6.2. The terminal shall be equipped with a colour display and shall be preloaded with appropriate software to access full management facilities.
- 4.4.6.3. Access to the Operational Telephone Subsystem functions shall be provided via a password control system which shall require the entry of both a unique user name and password.



4.4.6.4. Various hierarchical levels of access shall be provided so that access is restricted to users in accordance with the pre-determined functions which they are permitted to access.

4.4.6.5. All successful logging on and attempts to gain access shall be recorded and time/ date stamped by the Operational Telephone, Network Management System.

**4.4.6.6. IP PBX FEATURES**

4.4.6.6.1. The IP PBX network shall provide feature transparency across all the IP PBX switches throughout Mumbai Metro for voice communication. IP PBX shall support PRI trunk and to connect other exchanges in future in a transparent manner (Q SIG in heterogeneous environment). The minimum required features shall be as given in Table 7.5 , in addition to features mentioned in Table 7.3 . Any additional features available in the exchange and not listed in the Table may be indicated as part of design. In addition the following shall also be provided

<b>S. No</b>	<b>Feature</b>	<b>Requirements of the Feature</b>
1.	Voice mail	Voice mail facility to all IP telephone users of Mumbai Metro
2.	Call Barge	As per IP PBX standard
3.	Soft Phone	IP PBX supported Soft phones installable on desktop computers with RTP, RTCP supporting SIP, H.323. PIP, Conferencing support.
4.	Auto Attendant	As per IP PBX standard
5.	Corporate Directory	As per IP PBX standard (active directory integration)
6.	IP Faxing (Fax Support)	As per IP PBX standard
7.	Extension Mobility	As per IP PBX standard

**Table 7.5: List of Network Feature to be supported by the IP PBX**

4.4.6.7. The assignment of the class of services and features to any telephone extension shall be configurable.

4.4.6.8. The IP PBX network shall support a minimum of the following four levels of programmable restrictions to each telephone extension:

- a) Totally restricted level which user cannot make or receive calls to and from the PSTN (MTNL/BSNL/Private Operators) through the telephone extension;
- b) Semi-restricted level which user cannot make PSTN (BSNL/Private Operators) calls but can receive PSTN (MTNL/ BSNL/Private Operators) calls through the attendant console telephone/DID;
- c) Local level which the telephone extension user can make or receive local PSTN (BSNL/Private Operators) calls only
- d) Unrestricted level which there shall be no restriction on the telephone



extension for call connection.

**4.4.6.9. LINE INTERFACES**

4.4.6.9.1. The IP PBX shall be equipped with modules to support a minimum the following interfaces:

- a. PRI trunks
- b. Interconnection with existing IP PBX
- c. Fax support

4.4.6.9.2. The IP PBX shall provide support for Video and Audio phone sets over H323 and SIP protocols. The system shall support the following as a minimum

Description	Standard
Call Signaling Protocol	RAS (ITU-T Rec. H.225.0), H.245 SIP : RFC 3261, FAX: T.38
Real Time Protocol, Real Time Control Protocol	RFC 3550, RFC 3551
Device Control Protocol	MGCP
Support for other Protocols	H.325 (up-and-coming standard)
Audio Codes for Voice Compression	G711, G722, G723.1, G729a
Video Codes	H.263/H.263+/H.264
Internet Protocol	QoS support, TOS diffserv, 802.1 P/Q, 802.1AB LLDP

**Table 7.6 : List of Protocols to be supported by the IP PBX.**

**4.4.6.10. BLOCK WIRING**

4.4.6.10.1. All the IP phone circuits shall be terminated at the IP network switch inside the TER for distribution of the internal and external lines and interface with relevant Subsystems and Project Contractors.

4.4.6.10.2. The MS07 Contractor shall provide all installation materials which shall include all cables, cable glands, connectors and junction boxes for the installation of the IP PBX and associated interfaces

4.4.6.10.3. CAT6 cables shall be provided and connected from IP network switch inside TER or CER to end points in station rooms. All terminations at end points in rooms shall be RJ45 type with Flush mount wall jack RJ-45, Category 6, Terminations in TER or CER shall be done with patch panels, cable manager etc.

4.4.6.10.4. The Contractor shall provide 19" 6U space wall mounted rack in Station & DCC TER for installation of Layer 2 Managed POE switch, Patch Panel, cable manager etc. to be supplied and installed by the Contractor

4.4.6.10.5. A minimum spare capacity of 25% pairs shall be reserved in the cables,



Flush mount wall jacks and patch panels. Where only one phone is required there also the cable used shall be of 2 pairs to provide reserve spare capacity.

4.4.6.10.6. Standard RJ-45 modular socket shall be provided for termination of the telephones via plug and socket arrangement.

4.4.6.10.7. Short circuit and over voltage protection device shall be provided to protect circuits from faults occurring in all outdoor cables.

#### 4.4.6.11. **OPERATION TELEPHONE INSTRUMENTS**

##### 4.4.6.11.1. **IP PBX TELEPHONES**

4.4.6.11.1.1. The IP PBX telephones (Audio & Video) shall be equipped with, but not be limited to, the following facilities:

###### (1) **Desktop Voice Phone (from OEM of IP PBX)\***

- a. Handset with 12 push-button keypad;
- b. Adjustable volume control for speaker and ringer
- c. Monochrome 4 line text display screen
- d. A minimum of 4 programmable function keys for assignment of features or additional extension circuits and a minimum of 20 memories/phone book for speed dialing;
- e. Hands-free operation through built-in speaker and microphone;
- f. Display of call duration;
- g. System clock display (synchronized);
- h. On-hook dialing;
- i. Visual display of details for incoming and outgoing calls;
- j. CLIP support
- k. Support for H.323/SIP
- l. Two 10/100 BT PC port, POE Type Class 1/2
- m. Supporting DHCP Client or static IP address allocation plan
- n. Inbuilt Lost-packet compensation mechanism, Self-adaptive jitter cache and echo suppression for smooth voice function Voice compression standards G711, G722, G723.1, G729a
- o. QoS support, TOS diffserv, 802.1p/q
- p. RTCP and RTP support
- q. XML support

###### (2) **Video Phone (from OEM of IP PBX)\***



- a) Handset
- b) Adjustable volume control for speaker and ringer
- c) Hands-free operation through built-in speaker and microphone
- d) Display of call duration;
- e) System clock display (synchronized)
- f) On-hook dialing;
- g) Visual display of details for incoming and outgoing calls
- h) CLIP support
- i) Powered via POE Class 2/3
- j) Support for H.323/SIP
- k) 5" Screen or better, Picture in Picture support (PIP)
- l) Preferably integrated camera with high quality video for video calling. Provision for support of external HD camera.
- m) Automatic low light correction
- n) Video codec support ITU-T H.263/H.263+/H.264 as a minimum
- o) Video frame rate CIF 30FPS or better
- p) Bandwidth Support: 16kpbs-512kpbs or better
- q) 2 RJ-45 10/100/1000BT Ethernet port POE
- r) Supporting DHCP Client or static IP address allocation plan
- s) RTCP and RTP support
- t) QoS support, TOS diffserv, 802.1p/q
- u) XML support

\* In case of phones from manufacturer other than IP PBX, all features of IP PBX switch, Telephone features of this chapter, features of UMA of this chapter and features of NMS shall be available to the users and non-OEM equipments shall not put any limitation during implementation. All liability of support shall equally be applicable on IP Phone providers. Non-OEM IP Phones and Video Phone (manufacturer other than OEM of IP PBX) should be reputed and proven.



#	Specifications	Switch Type
1.	L2 Managed Switch 8 Ethernet 10/100/1000BT PoE Ports supporting IEEE 802.3AF and 802.3AT compliant PoE (dynamic PoE allocation) with 2 combo 10/100/1000Base-T/SFP ports for Uplink, 1K VLANS. Basic L3 features for Static routing, IPv4 and IPv6 support. Provision for local/remote configuration backups.	Layer 2
2.	L3 Stackable Managed Switch 24 Ethernet 10/100/1000 RJ-45, 2 10G SFP+ for Uplink, 4 combo 10GBase-T CX-4 ports, Redundancy at all levels including power supplies, software and hot-swappable Small Form Factor Pluggable (SFP) modules. One SFP port should be populated in switch to carry data upto 40kms minimum. IPv6 compliant. Routing protocols such as OSPF, Border Gateway Protocol, Multicasting protocol, Flood control, 4K VLANS. Provision for local/remote configuration backups.	Layer 3
3.	Minimum 128 MB RAM & 16 MB Flash Memory	Layer 2
4.	Minimum 256 MB RAM & 64 MB Flash Memory	Layer 3
5.	Physical Stackable.	Layer 3
6.	ACL's supported based on IPv4/v6 address, Protocol type, Time based ACL, Vlan- ID, MAC-ID, DSCP, TCP/UDP Port, Switch port & user defined packet content	Layer 2 and 3
7.	Support for VRRP/HSRP	Layer 3
8.	Support IEEE 802.3u, IEEE 802.3ab, IEEE 802.3ad, IEEE 802.1P/Q, IEEE 802.1x	Layer 2
9.	Support IEEE 802.1x, 802.3ad, IEEE 802.1P/Q, IEEE 802.1ag, IEEE 802.3ah.	Layer 3
10.	Switching and routing at 10G and gigabit speeds. 10 Gb/s stacking ports. Stacking ports to be separate from Uplink port.	Layer 3
11.	Support for QoS, ToS, Diffserv	Layer 2 and 3
12.	Support the operating temperature up to 0-40°C and can be operated in 10% -90 % RH	Layer 2 and 3

**Table 7.7: Specifications of Switches for IP PBX Network**

**5. NETWORK SECURITY**

5.1. All IP based Telephone equipment across the IP-PBX Telephone network shall strictly comply the IT security policy as specified in Chapter-1 (General Requirements) of this PS including the following requirements

- 1) Telephone network shall not be accessible from any other Telecom system with which no interface has been provided.
- 2) To ensure security of IP PBX System(s) from vulnerabilities &



breaches and discourage false undertaking from OEMs, security auditing and testing of equipment including source code of equipment and software shall be carried out from STQC (Ministry of Electronics & Information Technology) or any other Government Agency from the list of CERT-In empanelled Information Security Auditing Organization. So as to ensure security of network and other IT equipment of the IP-PBX System(s), before bulk supply & installation, purchaser should ensure Security auditing and testing at the time of Factory Acceptance Test (FAT) of 1st Lot of material or as specified by the Purchaser. In case any security breach is found in the system at any stage, immediate strict penal action shall be initiated by the purchaser.

- 3) All OEMs involved in this system contract must submit a declaration certificate regarding their genuinity, have their own manufacturing setups and IPR for the hardware(s)/software(s), and shall not have 3rd party manufacturing from any company blacklisted in India or abroad (due to proven backdoor access and data vulnerability) or any company sharing land border with India. The Intellectual Property Rights (IPR) of all manufactured final products and source code of all software including firmware, software etc. should not reside in countries sharing land borders with India, until unless specifically allowed by Government of India and is registered with the Competent Authority of Government of India. Proof / Declaration of IPR & country of source Code (residing) along with requisite permission & registration with Competent Authority of Govt. of India, as applicable towards compliance to the above, shall be provided by the OEMs. In case any breach or false declaration is found at any stage, immediate strict penal action shall be initiated by the purchase.

## **6. DESIGN/APPLICATION ENGINEERING REQUIREMENTS**

### **6.1. GENERAL**

- 6.1.1. In addition to the Design/Application Engineering requirements as identified in Chapter 1 (General Requirements) of this Particular Specification, the Telephone System shall meet technical system performance and equipment specification as specified herein.

### **6.2. TECHNICAL SYSTEM PERFORMANCE**

#### **6.2.1. IP PBX SWITCH NETWORK**

- 6.2.1.1. The Telephone System shall provide non-blocking connection for extension-to-extension calls. The Telephone System shall offer a fully integrated and transparent digital service acting as a single digital switch.
- 6.2.1.2. Redundancy for the important interfaces/modules such as power supply, processor, control card, etc. shall be provided. The IP PBX network shall be designed such that there is redundancy and diversity in terms of the communication links for call routing and call establishment.
- 6.2.1.3. The system design shall ensure high system availability with minimum common mode failure allowing graceful degradation.
- 6.2.1.4. Network and system shall be resilient to failure providing automatic reconfiguration of equipment with minimum system loss in particular the avoidance of common mode failure of site equipment, fibre, cable and



power supply and software affecting system operation.

- 6.2.1.5. Network architecture shall be future proofed to accommodate in the flexible manner enhancements to equipments and systems with respect to hardware and software upgrades.
- 6.2.1.6. IP PBX switch network shall be synchronized to the master clock signal for merging into a single synchronized network along with the digital transmission system. The IP PBX switch network shall have internal clock in free running mode in the event of the failure or absence of the master clock signal. The slip allowable in the exchange network shall conform to ITU-T Rec. G.822. A highly resilient Telephone network synchronisation scheme shall be developed possibly employing multiple fallback protection and details furnished to the Employer's representative for review.
- 6.2.1.7. The Telephone System shall have the capacity of ringing up to minimum of three telephone sets connected in parallel.

**6.2.2. Direct Line Telephone System**

- 6.2.2.1. System shall be configured as described in section 4.2.

**6.2.3. IP PBX Telephone System**

- 6.2.3.1. The System shall be configured as described in section 4.3.

**6.3. IP PBX SWITCH SPECIFICATIONS**

- 6.3.1. The IP PBX switch shall be a digital, non-blocking, stored program controlled (SPC).
- 6.3.2. The IP PBX switch shall be of modular, plug-in unit and keyed design.
- 6.3.3. The IP PBX switch shall support (2B+D) ISDN and 2Mbps digital interfaces conforming to ITU-T recommendation G 703 and G 704.
- 6.3.4. The IP PBX switch shall support digital DID Trunks for incoming calls from PSTN (MTNL)
- 6.3.5. The IP PBX switch shall utilise 8Khz sampling rate and PCM "A Law" digital companding method conforming to ITU-T recommendations G.711,G.712 and G.731
- 6.3.6. The transmission characteristic including frequency/attenuation response, group delay, cross talk and noise shall meet the ITU-T recommendation Q. and G series.
- 6.3.7. The extension line interface in the exchange equipment shall match analogue or digital extension equipment as required and fulfill the following requirements :
  - (1) Loop resistance of subscriber connected on physical cable pairs shall be limited to 1200 $\Omega$ .The minimum value of the leakage resistance of the line shall be 20 K Ohms
  - (2) Shall connect long distance subscriber lines with loop resistance upto1800 Ohms and minimum leakage of 15 K ohms;



- (3) The exchange line shall block the extension line after certain period of "Off- Hook" condition without a selection being received. This period shall be between 10 and 20 seconds. Busy tone shall be sent to the blocked extension;
  - (4) The working distance of the digital subscriber line for 0.6 mm dia single unshielded twisted pair shall not be less than 800 meters.
- 6.3.8. The digital extension line equipment shall be capable of data transmission simultaneously with speech (ISDN working).
- 6.3.9. The IP PBX switch shall support both common channel Signalling and channel associated signaling. Common channel signaling shall conform to ITU-T recommendations I.431 and I.441. The frame structure shall contain voice, data, synchronization and Signalling channels.
- 6.3.10. All software and configuration data operating the IP PBX switch shall be stored in non-volatile memory and shall not be corrupted or lost in case of IP PBX failure or loss of power supply.
- 6.3.11. The IP PBX switch shall be equipped with the capacity of ringing up to a minimum of three standard telephone sets connected in parallel.
- 6.3.12. The interface for trunk lines shall meet ITU-T Rec. G734 or similar.
- 6.3.13. The exchange equipment shall be capable of interfacing with traffic to and from the PSTN (MTNL/BSNL) exchange. All incoming calls from DOT/BSNL/MTNL system shall be received via DID or PRI Trunks. All outgoing calls to PSTN (BSNL/Private Operator) system shall utilize PRI/CO outgoing trunks individually equipped.
- 6.4. TELEPHONE NETWORK MANAGEMENT SYSTEM (IP PBX/DIRECT LINE & IP NETWORK)**
- 6.4.1. GENERAL**
- 6.4.1.1. Telephone Network Management System shall be provided at CERs at OCC/BCC for the overall control, supervision, maintenance and configuration of the entire Mumbai Metro Telephone Switch Network. The Telephone Network Management System shall be equipped with a management Workstation, printer and mass storage device.
- 6.4.1.2. Notebook computers or equivalent suitable for field maintenance shall be provided as given in List of telecommunication spares at Appendix P of this Particular Specification. Appropriate software shall be pre-loaded onto the computers to access the local maintenance port of the IP PBX and Direct Line Communication switches for system administration and management.
- 6.4.1.3. The IP PBX Notebook shall include simulation tools such as
- a. For testing and simulation of RTP and RTCP packets etc, manual creation and terminate RTP sessions, independent of call-signaling protocols such as SIP, H323, or MGCP.
  - b. Test routines to support testing of
    - Analog 2-wire interfaces such as PSTN and Media Gateway



- Interactive Voice Response testing,
- Voice Quality Testing,
- Delay Measurements,
- Echo measurements,
- Round Trip Delay measurement,
- One Way Delay Measurements,
- Measurement of Jitter Buffer Statistics, Degradation Factor.

6.4.1.4. The Contractor shall submit the specification and make of notebook computers with software or equivalent for Employer's review and approval and shall supply these portable note books with the supply of Telephone Exchanges and accessories.

6.4.1.5. Access to the Telephone Network Management System shall be password protected.

6.4.1.6. Failure in the Telephone Network Management System shall not affect the normal operation of the IP PBX, Direct Line Communication switch network, & IP Network.

6.4.1.7. The Telephone Network Management System shall provide the following management and administrative functions through the management Workstation:

- (1) User data management
- (2) Alarm monitoring;
- (3) Performance management;
- (4) Call detail recording (IP PBX, Direct Line ); and
- (5) System administration
- (6) Graphical Topology View

#### **6.4.2. USER DATA MANAGEMENT**

6.4.2.1. A database shall be built for defining the hardware and software configurations for all the IP PBX, Direct Line Communication switches, IP PBX & IP Network. Any changes in the database shall be updated automatically on the mass storage devices. One copy of the database shall be downloaded to secondary off-line storage, either tape or disk.

6.4.2.2. The database shall contain all configuration data pertaining to switching system equipment and connecting details including data on subscribers, lines, trunks, service circuits, switching network equipment, call routing, features, traffic data collection schedules and data for network management purposes.

6.4.2.3. Upload, download, addition, deletion and editing of subscriber's data, trunk data, assignment of class of services, features, programming of system



parameters and settings shall be provided through the management Workstation. NMS shall be capable to take Backup/Restore configurations & firmware to the equipments.

#### **6.4.3. ALARM MONITORING**

6.4.3.1. The Telephone Network Management System shall monitor and display the status of the IP PBX, Direct Line Communication switches, & IP Network on the management Workstation on a real-time basis. All alarm records shall include details of the faults, be time stamped with date, hour, minute, and stored in the Telephone Network Management Systems.

6.4.3.2. All alarm events including the detection of alarm, alarm acknowledgement and reset shall be recorded and stored in the Telephone Network Management Systems.

6.4.3.3. The Telephone Network Management Systems shall monitor the network traffic and give alarm in case of traffic overload.

6.4.3.4. The Telephone Network Management Systems shall be programmable to enable or disable the alarm print out by the printer. When the printer is enabled, the alarm event shall be printed real time by the printer. Failure of the printer or paper jam shall not affect the operation of the Telephone Network Management Systems.

6.4.3.5. Reports based on network inventory, network elements, alarms, events, health checks to be visible from GUI interface to allowing users to monitor the health of the network.

#### **6.4.4. PERFORMANCE MANAGEMENT**

6.4.4.1. The Telephone Network Management Systems shall collect the network performance data continuously and provide reports upon user's request.

6.4.4.2. Types of network performance data shall include, but not be limited to, the following:

- (1) Traffic within the same IP PBX, Direct Line Communication switches & IP Network;
- (2) Traffic between switches;
- (3) Traffic offered, blocked; and
- (4) Traffic of individual trunk and tie circuit.

6.4.4.3. Upon user's request, the Telephone Network Management Systems shall print out hard copy of the reports or download the reports to disk for further processing by software applications commonly available in the market.

#### **6.4.5. SYSTEM ADMINISTRATION**

6.4.5.1. The Telephone Network Management Systems shall store commands entered through the management Workstation and display the command history log or provide print out upon user's request.

6.4.5.2. The Telephone Network Management Systems shall provide facilities for users to run diagnostics on the control, voice and data circuitry without



causing interruption to the operation of the system.

- 6.4.5.3. As part of threat isolation and tracking provision for IP Network, MAC/IP tracing associations for troubleshooting and intrusion control is required. Isolation of networks based on such assessments should be possible from IP Network NMS to contain potential threats.
- 6.4.5.4. The Telephone Network Management Systems shall provide housekeeping functions for database backup, files deletion, download and upload.
- 6.4.5.5. Call detail logs for all types of call from an extension shall be generated.

**6.4.6. GRAPHICAL TOPOLOGY VIEW**

- 6.4.6.1. The Telephone Network Management Systems shall provide Server/Client architecture. NMS to provide Web View over browsers and Command line interface support for network configuration. The NMS should support Network-wide visibility with Physical and Logical Network Topology View and Device auto discovery. Topology Views to allow the network manager to launch specific applications to manage Network resources.
- 6.4.6.2. The Telephone Network Management Systems shall support for integration with other systems.

**6.5. TELEPHONE EQUIPMENT**

- 6.5.1. The telephones shall be of modular design and construction to allow easy replacement of keypad and PCBs.
- 6.5.2. All analogue telephones shall be of DTMF dialing in accordance with ITU-T Recommendations Q.23.
- 6.5.3. The transmission and reception including sending, receiving and side tone sensitivities shall comply with relevant ITU-T Recommendations P series.
- 6.5.4. At stations and depot where Direct Line Telephones are used to access the control consoles at OCC/BCC basic telephone instruments shall be provided with single selection push buttons for each direct line. More than one telephone instrument, wherever necessary, may be provided.

**6.6. POWER SUPPLY SYSTEM**

- 6.6.1. The Telephone equipment shall operate satisfactory work on 180-240V Single phase UPS power supply, provided by MS01A contractor. The Contractor shall provide power supply equipment for power conversion if necessary. The equipment should be capable of withstanding voltage spikes up to 3 volts over the maximum voltage.

**6.7. LINE DISTRIBUTION**

**6.7.1. CABLING SYSTEM**

- 6.7.1.1. A cable network shall be provided at each facility to support operation of the Telephone System.
- 6.7.1.2. The network shall include all cables, distribution, termination and installation facilities together with RJ11 socket outlets or equivalent.



- 6.7.1.3. Termination facilities shall be provided within TER at each site to serve as the interface connection point between the equipment and the cable installation.
- 6.7.1.4. The termination equipment shall be arranged with separate equipment side and line side facilities which shall include all necessary insulation displacement connectors (such as IDCs), fuses, circuit test and isolation facilities, patch fields, patch cords and audio/data connectors. These shall provide a highly flexible and reliable cross connect arrangement which shall be readily accessible and shall cater for future reconfiguration and expansion, as appropriate.
- 6.7.1.5. Sub-distribution facilities shall be provided external to the TERs for the termination and distribution of the external field cables.
- 6.7.1.6. These termination facilities shall consist of IDC or equivalent terminal blocks equipped with circuit test and isolation facilities installed within a cabinet unit suitable for wall mounting in non-public areas throughout the site.
- 6.7.1.7. A quantity of at least 25% of the used pairs shall be provided as extra pairs in each distribution cable rounded up to the nearest whole pair.
- 6.7.2. MAIN DISTRIBUTION FRAME (MDF)**
- 6.7.2.1. Within each TER, a floor or wall mounted MDF as appropriate shall be provided equipped with IDC terminals. The MDFs shall be equipped with sufficient capacity to terminate and cross-connect as appropriate all internal and external cabling including the 50% spare capacity.
- 6.7.2.2. All MDFs shall be of the same type and standardized throughout and shall serve as the interface connection point between the central equipment and field devices at each location.
- 6.7.2.3. The outgoing sections (connecting external lines) of the frame shall be fitted with lightning arrestors and surge protection devices with the required connections to the protective ground. The protective grounding point will be provided by others and made available inside the equipment room.
- 6.7.3. CABLING OF REMOTE TELEPHONES**
- 6.7.3.1. Where telephone equipment is located between sites at locations not served by the FOTS either telephone type or optical fibre cables, as appropriate to meet the psophometric noise requirement, shall be provided and installed by the Contractor.
- 6.7.3.2. All external cables installed within the local site shall be terminated at one end on the MDF and at the equipment device end via a local junction box as required.
- 6.7.3.3. Telephone type cables used in telephone systems, shall be as per general requirements of cable specifications detailed in Appendix D of this Particular Specification and Specific requirements of telephone cables as described below in Section 7 of this Chapter
- 6.7.3.4. Data cables (UTP Cable CAT 6 & 5e) and Low Voltage power cables wherever used in telephone system should conform to the details given in Appendix D of Chapter 10 of this PS.



**6.8. SYSTEM EXPANSION**

- 6.8.1. The Telephone System shall be expandable to include additional IP PBX switches into the central IP PBX switch network and telephone switching equipment at stations, OCC/BCC and depot for Direct Line Telephone communication system without affecting the performance and the operation of the Telephone System.
- 6.8.2. The Network Management System shall be expandable to control and monitor the additional IP PBX switches and Direct Line Telephone switching equipment required for expansion of the network/
- 6.8.3. The IP PBX switches shall be expandable to the maximum line capacity by adding extra line cards only with the common control equipment, including the processor unit, memory modules, switching modules, power supply unit, remaining unchanged. However, the software license for the full line capacity as per the wired requirement given in this PS shall be provided as part of this Contract.
- 6.8.4. Direct Line Communication system shall be expandable for future sections with the facility for providing additional consoles in OCC/BCC.

**7. CABLE SPECIFICATIONS FOR TELEPHONE COMMUNICATION SYSTEM**

**7.1. TELEPHONE CABLE (OUTDOOR):**

In addition to meeting the general requirements for Cable specifications indicated at Chapter 10 of the Particular Specifications, following specifications shall be complied with by Telephone Cable for Elevated / at-grade outdoor sections:

**7.1.1. CONSTRUCTION REQUIREMENTS**

**7.1.1.1. CONDUCTORS**

- 1) The conductor sizes, cores and colours shall comply with IEC 60189 / BS3573. However, size shall be 0.6 mm as a minimum.
- 2) Each conductor in the cable shall consist of a solid wire of annealed high conductivity copper drawn so as to have an even cross-section and no surface irregularities, circular in cross-section uniform in quality, free from defects and uniformly coated with pure tin.
- 3) Cable construction shall be designed to limit the generation of dangerous voltages and noise or interference on all circuits connected with the Telephone system to the levels not greater than those specified in the relevant ITU directives.

**7.1.1.2. INSULATION**

- 1) The cable sheath & jacket shall consist of extruded low smoke low halogen material while the conductor insulation shall be solid polythelene.
- 2) The nominal thickness of the jacket & sheath shall be minimum 1.6 mm.



- 3) The insulation shall not break down when spark tested in accordance with BS 5099.
- 4) The insulation of individual conductor shall be such that electrical/mechanical specifications as per BS 3573 are met.

#### **7.1.1.3. CORE IDENTIFICATION**

- 1) The insulated cores shall be clearly identified by colours, and the identification scheme shall be in accordance with IEC 60189/ BS 3573.
- 2) The required number of pairs shall be laid up in concentric layer to form a compact symmetrical cable.

#### **7.1.1.4. PAIRS**

- 1) The insulated cores shall be twisted together to form pairs or quads.
- 2) The attenuation of each pair shall be measured and shall not exceed average 1.28 dB/ km at 1 kHz at a temperature of 20°C.

#### **7.1.1.5. BEDDING**

7.1.1.5.1. The bedding shall consist of an extruded layer of low smoke zero halogen/ low halogen bedding compound. When tested in accordance with BS 6425 Part 1/ IEC 60754, the level of hydrochloric acid shall not be greater than 0.5%. In the case of low halogen bedding compound the level of hydrochloric acid shall not exceed 20% .

#### **7.1.1.6. SCREENING**

- 1) Screening shall be achieved by the use of laminated tape, consisting of an aluminium foil bonded to a polyester film for the strength, applied to the cable with an overlap so that full 100% coverage of the conductors is afforded. The spray-on type construction shall not be provided.
- 2) The cable pairs shall be individually screened for the circuits where to improved cross talk immunity is required and where cable pairs are used for high speed (i.e. 64 kbps or above) data applications.
- 3) A drain wire or continuity conductor, laid under and in contact with the aluminium foil shall be provided and shall be in accordance with BS 5308 Clauses 7 and 10 as appropriate. The tinned annealed copper conductor, which may be solid or a stranded construction, in keeping with current manufacturing techniques, shall have a minimum cross-sectional area of 0.5 sq.mm.
- 4) The maximum resistance of the drain wire or continuity conductor provided shall meet with the requirements of IEC 60228/BS 6360.

#### **7.1.1.7. ARMOUR**

##### **1) General**

Armouring the cables, shall be by means of galvanised steel wire or tape. In addition to providing protection against accidental damage the armour shall also form a resistive barrier against the ingress of rodents.



2) **Wire Armour**

Armouring shall be of galvanised steel wire to BS 5467. The direction of lay of the armour shall be left hand, and the wire shall be sized in accordance with the manufacturer's recommendations or

3) **Tape Armour**

- i. The cable shall be armoured with a steel tape wound or lapped to at least 30% minimum. Steel tape thickness shall comply with the relevant British Standard minimum 0.30 mm
- ii. The metal flat tape shall consist of a single flat tape applied helically and directly over the bedding sheath with a suitable lay and overlap as specified in BS 2870. Alternatively, two tapes may be applied each with a slight gap, the second tape covering the gap of the first.

**7.1.2. ELECTRICAL REQUIREMENTS**

Conductor Resistance	65 ohm/km maximum
Insulation Resistance	50 M ohm km minimum
Mutual Capacitance at 1KHz	56 nF/km maximum
Resistance Unbalance	+/- 2% maximum
Near End Cross-talk	≥ 60dB at 800Hz

**7.1.3. MECHANICAL REQUIREMENTS**

Maximum pulling tension	250 Newtons
Minimum bending radius	15 x outer diameter
Operational conditions	0°C to 55°C

**7.1.4. CABLE CONSTRUCTION IDENTIFICATION**

7.1.4.1. The Oversheath of the cable shall be embossed with type of cable and the manufacturers name every 20 metres and length marker every 1 metre.

**7.1.5. TESTING**

**7.1.5.1. ELECTRICAL TEST**

7.1.5.1.1. Electrical tests as specified in BS 3573 shall be carried out on every length of installed cable and shall include the following:

- (1) Conductor resistance;
- (2) Insulation resistance;
- (3) Mutual capacitance;



(4) Resistance unbalance; and

(5) Near end cross-talk.

7.1.5.1.2. Dielectric strength of the cable shall be tested in accordance with IEC 60189-1: section 5.2.2 using a voltage of 1.5 KV.

#### **7.1.5.2. MECHANICAL TEST**

7.1.5.2.1. Mechanical test as specified in BS 3573 shall be carried out and shall include the following as a minimum:

(1) Conductors - elongation test;

(2) Insulation - elongation;

(3) Insulation - breaking force;

(4) Insulation - resistance to compression;

(5) Insulation - retraction;

(6) Metal sheath thickness;

(7) Dimensions of magnetic screen tapes; and

(8) Extruded anti-corrosion flame retardant sheath thickness.

#### **7.1.5.3. FIRE PERFORMANCE TEST**

7.1.5.3.1. Fire performance tests shall be carried out and include the following as a minimum:

(1) Oxygen index measurement (type and sample test);

(2) Temperature index measurement (type and sample test);

(3) Flame propagation (type test);

(4) Corrosive & acid gas emission (type and sample test); and

(5) Smoke emission (type and sample test).

#### **7.1.5.4. TEST RESULTS**

7.1.5.4.1. Test results and certificates shall be submitted for review by the Employer's Representative.

### **7.2. TELEPHONE CABLE (INDOOR)**

In addition to the requirements specified Appendix D of Chapter 10 of the Particular Specifications, following specifications shall be complied with by Telephone Cable for indoor usage:

#### **7.2.1. CONSTRUCTION REQUIREMENTS**

##### **7.2.1.1. CONDUCTORS**

(1) The conductor sizes, cores and colours shall comply with IEC 60189 / BS 3573. However, the minimum conductor diameter shall be 0.6



mm.

- (2) Each conductor in the cable shall consist of a solid wire of annealed high conductivity copper drawn so as to have an even cross-section and no surface irregularities, circular in cross-section uniform in quality, free from defects and uniformly coated with pure tin.
- (3) Cable construction shall be designed to limit the generation of dangerous voltages and noise or interference on all circuits connected with the Telephone system to the levels not greater than those specified in the relevant ITU directives.

#### **7.2.1.2. INSULATION**

- (1) The cable sheath and jacket insulation shall consist of low smoke & low halogen, while the conductor insulation shall be solid polyethylene.
- (2) The nominal thickness of the jacket insulation shall be minimum 1.6 mm.
- (3) The insulation shall not break down when spark tested in accordance with BS 5099.
- (4) The insulation of individual conductor shall be such that electrical/mechanical specifications as per BS 3573 are met.

#### **7.2.1.3. CORE IDENTIFICATION**

- (1) The insulated cores shall be clearly identified by colours, and the identification scheme shall be in accordance with IEC 60189/BS 3573. Other identification scheme shall be submitted to the Employer's Representative for review.
- (2) The required number of pairs shall be laid up in a concentric layer to form a compact symmetrical cable.

#### **7.2.1.4. PAIRS**

- 1) The insulated cores shall individually be twisted together to form pairs.
- 2) The attenuation of each pair shall be measured and shall not exceed average 1.28 dB/km at 1 kHz at temperature of 20°C.

#### **7.2.1.5. BEDDING**

7.2.1.5.1. The bedding shall consist of an extruded layer of low smoke low halogen bedding compound. When tested in accordance with BS 6425 Part 1/ IEC 60754, the level of hydrochloric acid shall not be greater than 0.5% In the case of low halogen bedding compound the level of hydrochloric acid shall not exceed 20%.

#### **7.2.1.6. SCREENING**

- 1) Screening shall be achieved by the use of laminated tape, consisting of an aluminium foil bonded to a polyester film for the strength, applied to the cable with an overlap so that full 100% coverage of the conductors is afforded. The spray-on types of construction shall not be provided.



- 2) The cable pairs shall be individually screened for circuits where to improve cross talk immunity is required and where cable pairs are used for high speed (i.e. 64 kbps or above) data applications.
- 3) A drain wire or continuity conductor, laid under and in contact with the aluminium foil shall be provided and shall be in accordance with BS 5308 clauses 7 and 10 as appropriate. The tinned annealed copper conductor, which may be solid or a stranded construction, in keeping with current manufacturing techniques, shall have a minimum cross-sectional area of 0.5 sqmm.
- 4) The maximum resistance of the drain wire or continuity conductor provided shall meet with the requirements of IEC 60228/BS 6360.

**7.2.1.7. OVERSHEATH**

7.2.1.7.1. The oversheath of the cable shall be an extruded layer of anti-corrosion, reduced flame propagation, low smoke / low halogen compound complying with the fire performance requirements specified in Appendix –D of this PS.

**7.2.2. ELECTRICAL REQUIREMENTS**

Conductor Resistance	65 ohm/km maximum
Insulation Resistance	50 M ohm km minimum
Mutual Capacitance at 1 kHz	56 nF/km maximum
Resistance Unbalance	+/- 2% maximum
Near End Cross-talk	≥60 dB at 800Hz

**7.2.3. MECHANICAL REQUIREMENTS**

Maximum pulling tension	25 Newtons
Minimum bending radius	10 x outer diameter
Operational conditions	0°C to 55 °C

**7.2.4. CABLE CONSTRUCTION IDENTIFICATION**

7.2.4.1. The oversheath of the cable shall be embossed with the manufacturer's name every 20 metres and length marker every 1 metre.

**7.2.5. TESTING**

**7.2.5.1. ELECTRICAL TEST**

7.2.5.1.1. Electrical tests as specified in BS 3573 shall be carried out on every length of installed cable and shall include the following as a minimum:

- 1) Conductor resistance;
- 2) Insulation resistance;



- 3) Mutual capacitance;
- 4) Resistance unbalance; and
- 5) Near end cross-talk

#### **7.2.5.2. MECHANICAL TEST**

7.2.5.2.1. Mechanical test as specified in BS 3573 shall be carried out and shall include the following as a minimum:

- 1) Conductors - elongation test;
- 2) Insulation - elongation;
- 3) Insulation - breaking force;
- 4) Insulation - resistance to compression;
- 5) Insulation - retraction;
- 6) Dimensions of magnetic screen tapes; and
- 7) Extruded anti-corrosion flame retardant sheath thickness.

#### **7.2.5.3. FIRE PERFORMANCE TEST**

7.2.5.3.1. Fire performance tests shall be carried out and include the following as a minimum:

- 1) Oxygen index measurement (type and sample test);
- 2) Temperature index measurement (type and sample test);
- 3) Flame propagation (type test);
- 4) Corrosive & acid gas emission (type and sample test); and
- 5) Smoke emission (type and sample test).

#### **7.2.5.4. TEST RESULTS**

7.2.5.4.1. Test results and certificates shall be submitted for review by the Employer's Representative.

### **7.3. DATA CABLE**

7.3.1. The Data Cable used for IP Phones shall meet the specifications of data cable as detailed in Appendix D -Chapter-10 of this PS.

## **8. INTERFACES**

### **8.1. INTERFACES WITH SUBSYSTEMS TO BE PROVIDED UNDER THIS CONTRACT**

#### **8.1.1. GENERAL**

8.1.1.1. All equipment interfaces between Subsystems shall be provided at the main distribution frame, digital distribution frame or optical distribution frame, as appropriate, depending on the type of circuit connections.



8.1.1.2. The MS07 Contractor shall determine the appropriate type of circuits for interface connections and ensure the interfacing circuits are of sufficient quantity and bandwidth to meet the requirements.

**8.1.2. INTERFACE WITH FOTS AND CLOCK**

8.1.2.1. The Telephone System shall be synchronized with the master clock source and timing reference provided by the master clock system provided by the MS07 Contractor.

8.1.2.2. The IP PBX switches shall be connected with appropriate types and quantities of the subscriber and junction line circuits provided by the FOTS and this shall be ensured by Contractor.

8.1.2.3. The switches and processors for Direct Line Communication shall be connected with appropriate types and quantities of circuits of the FOTS.

8.1.2.4. The central IP PBX switches shall be interconnected with junction lines of appropriate quantity of circuits of the FOTS.

8.1.2.5. The contractor to provide the Ethernet links at TER/CER as per their IP PBX communication bandwidth requirements. The contractor shall provide such link at patch panels inside their rack and shall extend for their further use.

8.1.2.6. In addition, The MS07 contractor shall provide redundant links for IP PBX redundant Call Servers and switches at OCC/BCC.

8.1.2.7. Bandwidth requirement mentioned in Table 7.4 above are taken as tentative. The contractor shall provide exact bandwidth as per requirement and shall interface for ultimate / exact bandwidth requirement (for IP PBX communication network) at OCC/BCC and each station in compliance of this particular specification for IP PBX communication.

8.1.2.8. Contractor shall provide required Bandwidth for extension of all NMS Workstations at CER/CSS.

8.1.2.9. Provision and extension of clean earth (< 1 ohm) up to TER to be done by the contractor. A minimum cross section of 16 mm<sup>2</sup> insulated copper wire shall be used for earthing. The earthing to be terminated in TER/CER on copper strip with a copper bus bar having minimum 20 holes for use of all the telecommunication equipments.

8.1.2.10. The Contractor shall use the main earth strips provided by E&M in SCR and TER for their equipments. Further cabling from the earth strips shall be done by Contractor himself for his equipment.

**8.1.3. INTERFACE WITH RADIO SYSTEM.**

8.1.3.1. The Radio system shall connect to the Telephone System and the Telephone System shall provide necessary circuits and facilities so that user can make telephone call through the hand portable/train mobile radios and call to hand portable/train mobile radios.

8.1.3.2. CDRS shall be provided by the MS07 Contractor and the number and type of channels have to be finalized with the Radio contractor for interface, testing and commissioning the recording of Telephone Communication in



the CDRS. The interface shall be at ETHERNET or an agreed link approved by the Employer. Tapping of DLC/Phones through CDRS for recording should be over unified link. Individual tapping of each Phone/DLC is not permitted for feeding to CDRS for recording.

**8.1.4. INTERFACE WITH CIVIL PROJECT CONTRACTORS.**

8.1.4.1. The interface requirement between the Telephone System and civil works project Contractors shall be as given in Appendix A of Chapter 10 of this Particular Specification.

8.1.4.2. For Telephone System Equipment, conduits with junction/termination/gang box are to be provided by MS07 Contractor as per system requirements in technical/non technical rooms, Administration rooms, PSP etc in station, depot and OCC/BCC areas. These conduits are to be extended from nearest S&T Data/Power trays up to location of the telecom equipments to be installed. Separate conduit for Data and Power cable to be extended.

**8.1.5. INTERFACE FOR AC POWER SUPPLY UPS SYSTEM – DISTRIBUTION CUBICLE**

8.1.5.1. 230 V AC supply distribution cubicle in each TER/CER of stations/OCC/BCC/Depot shall be provided by the Contractor for use to all the other Telecom Sub System in that location. shall design and supply the AC distribution board along with the protective devices keeping in view the overall requirement of all telecom systems.

8.1.5.2. The MS07 Contractor shall make all the arrangements to work out the AC load requirements of Equipments.

**8.1.6. INTERFACE WITH CTFRS SYSTEM (APPENDIX- A6 OF CHAPTER-10)**

8.1.6.1. The Telephone system shall interface with the CTFRS system to provide information of Critical and Major faults from Each IP-PBX system. Telephone system shall share the MIB trap file & provide the SNMP v1/v2c/v3 Trap or API integration with the CTFRS system contractor.

8.1.6.2. The Contractor shall interface with CFTRS to monitor the telephone system to agree the extent and configuration of both the physical and electrical interfaces to be provided. Both the System shall agree to assess the level of data being received from the monitored equipment to classify each datum as record, warning or alarm indications and for process the data to be displayed base on this classification

**8.1.7. INTERFACE WITH CCTV SYSTEM (APPENDIX- A14 OF CHAPTER-10)**

8.1.7.1. The Help Point shall interphase with the CCTV system such that on activation of the Help Point, ETS points/ETS phones &, the image of the associated CCTV Camera for the Help Point shall PoP up with an alarm on the CCTV MMI in the SCR & OCC. Final working of the interface along with the alarm system shall be submitted to the Employer's Engineer for review / approval.



**DELHI METRO RAIL CORPORATION LIMITED**

(A Joint Venture of Govt. of India & Govt. of NCT of Delhi)

**BIDDING DOCUMENTS**

**FOR**

**CONTRACT MS07**

**DESIGN, MANUFACTURE, SUPPLY, INSTALLATION, TESTING AND  
COMMISSIONING OF CLOSED CIRCUIT TELEVISION SYSTEM**

**VOLUME 3: EMPLOYER'S REQUIREMENTS**

**PARTICULAR SPECIFICATIONS**

**CHAPTER 8 – TECHNICAL REQUIREMENTS**

**DELHI METRO RAIL CORPORATION LTD.**

**5TH FLOOR, A-WING,**

**METRO BHAWAN, FIRE BRIGADE LANE,**

**BARAKHAMBA ROAD,**

**NEW DELHI-110001,**

**INDIA**



**DESIGN, MANUFACTURE, SUPPLY,  
INSTALLATION, TESTING AND COMMISSIONING**

**OF**

**TELECOMMUNICATION SYSTEMS  
(EXCEPT TETRA SYSTEMS)**

**CONTRACT MS07**

**PARTICULAR SPECIFICATIONS**

**CHAPTER 8**

**CLOSED CIRCUIT TELEVISION SYSTEM**



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- 1. INTRODUCTION**
- 1.1. GENERAL**
- 1.1.1. This Chapter of this Particular Specification specifies the particular requirements of the Closed-Circuit Television system of the Telecommunication system.
- 1.2. OVERVIEW OF CLOSED-CIRCUIT TELEVISION SYSTEM**
- 1.2.1. CCTV system is required to be provided to ensure effective surveillance of an area as well as to create tamper proof video recording for post event analysis.
- 1.2.2. Video surveillance system shall be end to end IP Based with Full HD IP cameras.
- 1.2.3. The CCTV system shall consist of the following principal sub-systems:
1. Platform Surveillance- CCTV system for monitoring of entraining and detraining of passengers at all platforms of all stations of entire line 7A & 9.
  2. Station Surveillance - CCTV system for monitoring entire station area locally from concerned station and remotely from OCC/BCC.
  3. CCTV surveillance system for monitoring important locations in all Depots of entire line 7A & 9 both locally and remotely from OCC/BCC.
  4. CCTV surveillance system for monitoring important locations outside the stations like RSS (as per list in Appendix-C), Ramp, Parking and specifically identified theft prone areas (at grade alignment) etc, from adjacent station and remotely from OCC/BCC. Night Vision (IR illuminated) cameras are to be used at these locations.
  5. CCTV surveillance system for monitoring of the signalling point crossing/crossovers at tracks at main lines (stations having point and crossing). The list of interlocking stations is given at Appendix-B. Night Vision (IR illuminated) cameras are to be used for this purpose.
- 1.2.4. The Contractor must ensure that all the critical locations such as Audit & Cash Room, Cash transfer routes at the station, Evacuation Routes, Ticket Counter, CCO/EFO Counter, staircases, escalators (covering the entire length), inside lift and at road level landings, DG Rooms, Pump Room and all station areas etc. are covered via CCTV surveillance, ensuring no blind spots.
- 1.2.5. The station (including RSS, Parking, specifically identified theft prone track areas, signalling point crossings and Ramps) surveillance CCTV system both live and recorded videos shall be accessed simultaneously from the following locations as a minimum:
1. At Station.
    - a. Station Control Room
    - b. Station Security Control Room
    - c. Platform Supervisor Booth



2. At OCC/BCC
  - a. OCC/BCC Controllers (Traffic Controllers/ Chief Controller/ Auxillary Chief Controllers, etc) of the concerned OCC/ BCC.
  - b. Security Controllers in Security Control Room

Failure of one of them shall not affect the monitoring at the others. To improve the performance of the system, items such as Workstation (CPU) shall be located only in the TER or CER and the videos to SCR/PCR/PSB/Controllers are to be extended by using suitable KVM extender without compromising the video quality.

- 1.2.6. The depot surveillance CCTV system shall be accessed simultaneously both live and as recorded videos from the following locations as a minimum:
  - 1) Depot Control Centre (DCC) and Security Control Room in depot.
  - 2) Controllers at OCC/BCC.
- 1.2.7. The LASER Video wall of size 8x2x70" shall be provided in the security control room at the designated location to view all cameras of corridors of Mumbai Metro lines 7, 7A & 9. Detailed specifications of the Video Wall are given in attachment Annexure-A of this Chapter of PS.
- 1.2.8. Video recording system shall provide primary recording locally at the stations itself and mirror recording at adjacent station of Mumbai Metro Line 7A and Line 9. For Depots only the local recording shall be provided in the depots itself. The primary and mirror recording of OCC/BCC shall be done at OCC/BCC.
- 1.2.9. In emergencies or as required it shall, however, be possible, without any additional resources, to view images from any/all cameras and/or record any dynamically selected location on the system.
- 1.2.10. Layer-3 network for Transmission of video from Stations; Depot shall be provided by the Contractor using optical fibre network (Drawing No. MS07) as part of FOTS Chapter. The Layer 2 Field Switches and any other hardware including switches/converters at Stations/Depot/OCC/BCC, as required, shall be provided by the Contractor.
- 1.2.11. Station entries, parking if exists, specifically identified theft prone track areas, signalling point crossings, RSS, Ramps shall be covered by providing cameras with IR illuminator at the pole/wall keeping in view the lighting conditions.
- 1.2.12. Depot perimeter camera shall also be required to be provided with IR illuminator for night vision capabilities. The mounting details (poles, wall mount etc.) for the perimeter camera shall be submitted to the Employer's Engineer for approval.
- 1.2.13. The CCTV system shall interface with the Central Telecom Fault Reporting System (CTFRS system) to provide information of Alarms/Faults for integrated monitoring of the CCTV system.



## 2. SCOPE OF THE WORKS

### 2.1. GENERAL REQUIREMENTS

2.1.1. In addition to the requirements of the Scope of Works as identified in Chapter 1 of this Particular Specification, the specific requirements on the scope of Works for the CCTV system shall be as specified below.

2.1.2. Line 7A and 9 are extension of existing Line-7 line and therefore the CCTV systems for these extension lines shall preferably be integrated with the existing CCTV system, wherein the existing servers, MMI, NMS etc (at OCC, BCC and station level) shall be suitably enhanced to provide all functionalities for both the existing lines as well as extensions, without any degradation.

2.1.3. Any one of the following solutions can be adopted:

Standalone integrated system for Line 7A and 9. The bidder shall have to provide hardware (servers, cameras, VMS software etc), NMS & MMIs etc (both at OCC & Station Level) for Line 7A and 9 corridors so as to provide all functionalities including control management and other functionalities as per extant provisions in these specifications. The system provided for Line 7, 7A and 9 shall be integrated at the video wall level for live viewing.

or

Alternatively, by enhancing the capacity of the existing system provided for Line 7, including control, licences (if any) etc., management & other common functionalities such that the upgraded system shall provide view of Line 7A and 9 on a separate video wall without any degradation.

2.1.4. The enhancement of the existing CCTV storage capacity from 15 days to 30 days for the 4 stations of Line 9 (i.e. Dahisar (East) to Kashigaon) at the server(s) or wherever applicable, shall be done by the MS07 Contractor. The Contractor may please note that Any hardware, software, Licenses and interfacing, if required for upgradation shall be the responsibility of the MS07 contractor

### 2.2. SCOPE OF SUPPLY FOR CLOSED CIRCUIT TELEVISION SYSTEM

2.2.1. The scope of supply for the IP based CCTV system shall include, but not be limited to, the following:

- 1) CCTV Control Equipment at OCC & BCC, Stations, Depot and RSSs.
- 2) Full HD Fixed Box type Colour IP cameras (day/night) with varifocal lens complete with housing and mount.
- 3) Full HD Fixed Dome type Colour IP cameras (day/night) complete with housing and mount.
- 4) Full HD Fixed Box type Colour IP, IR illuminated (day/night) cameras with varifocal lens complete with housing and mount for areas like Station Entry, Parking, Ramp, signalling point crossing, specifically identified theft prone areas on track and PF ends, etc.



- 5) Full HD PTZ Dome colour IP cameras (day/night)
- 6) 360-degree panoramic view cameras.
- 7) CCTV MMI consisting of client workstation, Monitor, Key Board, mouse and joy stick for PTZ functionality in SCR, Security Control (Police Booths) in stations, PSB in stations, Depot Control Room, Security control room in depots and Controllers in OCC & BCC.
- 8) Video Wall in Security Control Room at designated location.
- 9) Server Based Network Video Recorders for stations, depots and OCC/BCC.
- 10) Armoured Optical Fibre Cable minimum (12 fibres) with physically separate path to connect the cameras of stations, depots, RSS, Parking, Ramp, Signal point crossing, etc. to the station TER. Tentative distance as an average between the RSSs/Ramp/Signal crossing and the stations/depots shall be within 1 Km.
- 11) All type of cables as per Appendix D of PS Chapter 3.
- 12) Layer-2 Field Switch (Industrial grade) for all stations/Depots/Ramp etc.
- 13) CCTV Management system at the OCC/BCC.
- 14) Supports, Mounting brackets (Primary and Secondary), installation material and accessories for cameras, monitors, field switches, ODF, videowall etc.
- 15) Equipment cabinet, racks and cubicles;
- 16) All power supplies/Converters, cabling and earthing accessories including termination protection devices;
- 17) Laptops pre-loaded with CCTV system softwares.
- 18) Contract Spares
- 19) 48 Port Rack mount Fibre Management system (FMS) in TER for fibre cable splicing.
- 20) 24 Port FMS for field switches.
- 21) All software and licences for end-to-end IP based Video surveillance system.
- 22) All software and firmware as supplied shall be with license given to Mumbai Metro for lifetime and any upgrades within the currency of contract shall be free of cost.
- 23) Centrally Managed Anti-Virus and network security Software for the entire CCTV network.
- 24) Corner Lift Camera with all accessories.
- 25) Any other equipment/ materials/ softwares as required for completion of the contract.



**2.3. SCOPE OF SERVICES**

- 2.3.1. The Contractor shall co-ordinate with Civil Project Contractor on subjects of station building materials, finishes and architectural layouts.
- 2.3.2. For RSS connectivity, HDPE pipe/duct (2 x 100 mm diameter) shall be provided by E&M Contractor for laying of optical fibre cable from RSS to the nearest station for RSS CCTV video integration. The Contractor shall timely coordinate with electrical Contractor for laying of fibre cables for the RSS connectivity. In case the Contractor fails to coordinate/interface with Electrical Contractor, then trenching, ducting, road cutting and related approvals from the local authorities, for laying of optical fibre cable from RSS to the nearest station etc. to be done totally by the Contractor as part of this contract.
- 2.3.3. For all cables laid in trenches or otherwise in close proximity of any power cables necessary protection measures shall be taken by the Contractor to comply with the EMI/EMC requirements for CCTV system. Interface/co-ordination as required shall be done by the Contractor with the relevant project Contractor.

**2.4. SCOPE OF SERVICES EXCLUDED IN THIS CONTRACT**

- 2.4.1. Provision of uninterruptible AC power supply to meet with the power supply requirement of MS07 contract for all locations including stations and depots shall be provided by Signalling Contractor at AC Distribution Board in TER/CER with MCB/MCCB interface. Further cabling for powering of Equipment of MS07 shall be done by MS07 contractor.

**3. PERFORMANCE REQUIREMENTS**

**3.1. GENERAL**

- 3.1.1. The specific system performance requirements for the CCTV system shall be as specified herein.

**3.2. RELIABILITY REQUIREMENTS**

- 3.2.1. The inability to perform any required function, the occurrence of unexpected action or the degradation of performance below the specifications shall be considered as a failure.
- 3.2.2. MTBF shall be the average operating time accumulated by the total population of identical items between failures. MTBF shall be sustainable throughout the DLP and substantiated by actual performance over the same. The data sheets from the OEM of the cameras, monitors and other equipments for the indoor and outdoor shall be specifically conforming to the same, including temperature and humidity requirements.
- 3.2.3. The Contractor shall ensure that the CCTV system equipments supplied under the Contract shall comply with the reliability figures herein:

CCTV system Equipment	MTBF (Hours) per unit
Station and central equipment	>50,000



CCTV system Equipment	MTBF (Hours) per unit
IP fixed cameras	>60,000
PTZ Cameras	>25,000
Video recording equipment	>50,000
Video Display Units (monitors)	>35,000
Digital CCTV Keyboard	>50,000
Layer-2 Switch	>50,000

Table 8.1: MTBF Figures

**3.3. AVAILABILITY REQUIREMENTS**

3.3.1. The CCTV system shall have a system availability of better than 99.95%. MTBF of each equipment shall be substantiated by the previous experience or if calculated by a confidence factor, all supporting calculations, assumptions and specifications to arrive at the MTBF figures and system availability shall be supplied.

**3.4. MAINTAINABILITY REQUIREMENTS**

3.4.1. The Mean Time to Restore (MTTR) of the CCTV system to full normal operation following a failure shall be less than four hours (excluding travel time).

**4. FUNCTIONAL REQUIREMENTS**

**4.1. GENERAL**

4.1.1. The CCTV system shall have facilities for colour monitoring in real time.

4.1.2. System should provide inter-operability of hardware (Work stations, servers/ Storage, monitors, cameras). System expansion should be possible through off-the shelf available hardware.

4.1.3. The CCTV system shall have combination of IP Based Full HD (fixed, IR illuminated Fixed, fixed Dome and PTZ Dome) Colour video Cameras, Varifocal lens, with Indoor/Outdoor housing and feed through mountings.

4.1.4. The MS07 Contractor shall design the distribution of all cameras at each location to comply with the coverage requirements and submit to the Employer Representative for review. CCTV camera coverage plots shall also be submitted with the detailed design for review. The CCTV Coverage to be provided by provision of fixed cameras only. The PTZ cameras shall not be counted for CCTV coverage calculation. The requirement of verification, testing and commissioning are given in Chapter 1 of this PS. In addition, the Contractor as part of PAT procedure shall conduct continuous CCTV coverage tests following the pre- defined spots for each camera at each station/depot/OCC/BCC as given by the Employer Representative.

The Contractor shall submit procedures for measurement of picture quality, visibility distance and visibility angle for MMI and Video Wall.



Tentative Typical drawings of Mumbai Metro Line 7A & 9 are given in Volume 4 for tenderers information.

- 4.1.5. System shall use video signals from various types of indoor/outdoor IP cameras installed at different locations, process them for viewing on workstations/monitors simultaneously at Central Control Room (OCC/BCC) and local control rooms (SCR, PSB and at Police booth) at each station. Network Video Recording system shall provide local recording at the station itself and mirrored recording (at different location) for all line Mumbai Metro stations. Joystick & Mouse-Keyboard controllers shall be used for Pan, Tilt, Zoom, and other functions of desired cameras. The configuration of the cameras, monitors/workstations shall be provided from the OCC/BCC and any other locations simultaneously.
- 4.1.6. The Video signal output of all the cameras in various locations at stations, OCC & BCC shall be fed to TER/CER at respective stations/OCC/BCC and through Ethernet switch network, distribute these Video signals to the following:
- Network Video Recorders at the stations/OCC/BCC.
  - The MMIs at the SCR, PSB (where available), at the Security booth(s) of the relevant station
  - The OCC/BCC,
  - Any other location to be decided by the Employer's representative at the time of detailed design.
- 4.1.7. In Depot there are many buildings which are geographically scattered i.e. DCC, workshop, DCO office, time office, security gate, watch towers, etc. These buildings/locations are far from the Telecommunication Equipment Rooms (TER) where CCTV system will be installed. For the installation of CCTV cameras in these buildings/locations suitable optical fibre connectivity arrangements have to be made by the Contractor.
- 4.1.8. The Video signal output of all the cameras in various locations at the Depot shall be fed to the TER at Depot and through Ethernet switch network, distribute these Video signals to the following:
- Network Video Recorder at the depot
  - the OCC/BCC
  - MMI at Depot Controller, Security Controller.
  - any other location to be decided by the Employer's Representative at the time of detailed design.
- 4.1.9. The CCTV system shall have control equipment located in the TER at all stations/Depots/OCC/BCC. CCTV control equipment for RSSs/Ramp/ Signalling point crossings shall be installed in the TER of adjacent station/depot.

For RSS, coverage shall be provided to the extent possible by providing four cameras mounted on pole or the RSS wall. In case, a pole is required for installing a camera, it will be supplied, erected & installed by the Contractor.



The Optical Fibre Connectivity for these equipments to be provided by the Contractor for connecting these cameras to the nearest station TER. This equipment shall be compact and in suitable wall mounting enclosure and shall be installed inside the RSS in a non-air-conditioned environment. The AC 230V commercial supply shall be taken from the RSS, and any other type of the supply converter/regulator, if required, to operate the system is to be provided by the MS07 Contractor.

Some of the cameras in depot, RSS, Signal crossings, parking, specifically identified theft prone area etc. are required to be installed outdoor i.e. outside the buildings with no covering shed. A proper weather proof mounting arrangement complying with IP 66 or better shall be provided for housing these cameras including any other accessories/equipment required shall also be provided as part of this contract.

- 4.1.10. The station and depot surveillance CCTV control equipment, for connection to the equipment located in the CERs at OCC/BCC for remote viewing, recording and control, shall be interfaced through Layer-3 Switch Network (Provided by the MS07 Contractor) at every station/Depot/OCC/BCC.

There shall be 4x1 Gbps optical ports and 10x10/100/1000 Base T ports available for CCTV system on Layer-3 switch at stations/ depot and 24x10/100/1000 Base-T redundant ports available as part of FOTS chapter at OCC/BCC for CCTV system. All the cameras in the station/Depot/OCC/BCC shall be connected to the layer 2 switches (as part of this contract) and no cameras will be directly connected to the layer 3 network.

Layer-2 Field Switch as part of this contract shall be optically integrated with the Layer-3 switches (Please Refer Drawing MS07/1). All the Configuration/integration of Layer 2 switches with Layer 3 Networks shall be the responsibility of the MS07 Contractor.

The MS07 Contractor shall interface for the port requirements and integration of Layer2/Layer3 network at Stations/depots/OCC/BCC. Layer 2 network NMS shall preferably be integrated with Layer 3 network NMS, if not possible then to be provided separately.

- 4.1.11. The list of stations and Depot to be provided with Video Surveillance System in Mumbai Metro Line 7A & 9 is given in Appendix C (Sections) of this PS Chapter 10.

- 4.1.12. The internal clock for all the CCTV system equipment (servers, workstations, Cameras, etc.) shall be synchronised to within 1 second of the Master Clock system being provided by the MS07 Contractor at all times.

## **4.2. CCTV COVERAGE**

- 4.2.1. The station CCTV surveillance system shall provide 100% coverage of the following specific areas at all stations as a minimum:

1. All train doors (Present 6 Coaches) at the platform,
2. platform operational area including third platform and platform ends/tunnel ends.
3. complete length of all escalators and stairs;



4. concourse area including all the Lifts
5. all station entrances and exits (including Emergency, fire exit);
6. all automatic fare collection (AFC) gates with facing entry/exit;
7. exterior of ticket booking offices;
8. exterior of fare adjustment office;
9. parking areas
10. subways;
11. Foot Over Bridge (FOB)
12. Lifts in OCC, BCC, Administrative Building for this line & Depot wherever applicable

The CCTV Coverage of the above areas is to be provided by provision of fixed cameras only. The PTZ cameras shall not be counted for CCTV coverage calculation.

4.2.2. Coverage of CCTV surveillance system for the stations, Depot, OCC/BCC shall be developed by the Contractor and submitted to the Employer for review. However, the minimum number of cameras shall be as per following:

Location	No. of fixed cameras				No. of PTZ Cameras	Bullet Camera	Corner Lift Camera (IP mini dome camera)
	Box type	Box type-Night Vision (with IR illuminator)	Dome Type	360 Degree Panoramic view			
Station	38	6	11	4	2	-	
Depot	11	173	5	-	4	-	-
RSS/TSS		4	-	-	-	-	-
OCC/ BCC/ HQ Building	-					-	-
Ramp/ Tunnel	-	2	-	-	-	45	-
Parking Areas	-	4	-	-	-	-	-
Signal Point Crossing (For Each Turnout	-	2	-	-	-	-	-

**Table 8.2: Minimum No. of Cameras for CCTV System**

4.2.3. The location of the CCTV monitors and control panel shall be as follows:



- i. One CCTV control MMI shall be provided each for SCR, Security Booth(s), PSB, DCC & DSC (Depot Security Controller), Traffic Controller, Chief Controller and for the OCC & BCC Security Controller. Please refer to Appendix- H MMI Provision Schedule for the requirements of the MMIs.
- ii. MMI for SCR, PSB and Police Booth at stations, and Security control in OCC & BCC shall consist of work station with two monitors, one Key Board with Joystick controllers and one Mouse-KeyBoard controller.  
  
MMI for Depot/Security Controllers in the depot and Traffic Controller / Chief Traffic controller in OCC & BCC shall consist of work station with one monitor and Key Board with Joystick controllers, Mouse, Keyboard controller.
- iii. In addition, the security control room at designated location, a Video Wall of 8x2x70-inch i.e. 16 cubes of 70-inch size arranged in two rows and 8 columns shall be used for monitoring images from stations, depot, RSS etc.

4.2.4. The display of full screen mode of a 1.6m tall person standing upright, within the CCTV camera coverage area, on any monitor shall not be less than one tenth of screen for the fixed cameras at the shortest focal length.

#### 4.2.5. **CCTV STANDARDS**

The TV standard to be employed shall be ITU-T, PAL, 768 scan lines per frame, 30 frames per second with progressive scan.

Advanced video compression techniques, such as MPEG-4 and H.264 shall be employed to minimize transmission bandwidth and recorder storage capacity without compromising the subjective quality of the displayed video images.

The frame rate and resolution of the video signals shall be a programmable feature which shall be optimized to reflect the nature of the image types (such as low motion to very high motion video) being displayed and recorded.

Frame rates shall be variable from 1 to 30 frames per second and resolution values shall be fully selectable to include atleast 4 CIF HD and Full HD. The ability to select the frame rate (1 to 30 fps) and resolution (4 CIF HD and Full HD) will apply to monitoring as well as recording.

Where cameras with Video Motion Detection are used as part of the Intruder Detection system very high-quality video images are required employing minimal compression.

### 4.3. **MONITORING OF ENTRAINING AND DETRAINING OF PASSENGERS**

4.3.1. The cameras at the platform shall be planned keeping in view the entraining/detraining at maximum platform capacity.

4.3.2. Monitoring of entraining and detraining of passengers and surveillance of train doors from the head end driving cab position at all stations of Mumbai Metro Line 7A and 9 shall be provided by the platform CCTV system.



At least 6 CCTV fixed cameras for each platform side shall be provided and their position shall be arranged such that the whole platform and the train doors for 6/8 coach train shall be monitored.

4.3.3. The video signals of these CCTV cameras monitoring the platform and train shall be available to the following equipment simultaneously at all stations.

1. OCC/BCC Traffic Controller and Chief Controller;
2. OCC/BCC Security Controller;
3. SCR, PSB and Police Booth(s) for surveillance of that station.
4. NVR for recording.

4.3.4. The Station /Depot Surveillance System shall have minimum 65 Cameras at Elevated Stations of all types put together, 2 cameras per parking and 193 cameras at Depots

The Contractor is advised to study the site before finalising the camera quantity and the exact location for each camera and indicate the same in a drawing. Where-ever more cameras may be required to achieve the coverage, the same shall be proposed by the Contractor in his Design/Application Engineering without any additional cost.

#### **4.4. VIDEO RECORDING AND RETRIEVING**

4.4.1. Network Video recording system shall provide local recording at the station itself and mirrored recording at adjacent station for all stations. The Network Video Recording system shall provide Failover and Redundancy.

4.4.2. All recordings shall have the associated time and date stamped information superimposed onto the video image.

4.4.3. The video recorder shall be capable of operation for 24 hours per day, 365 days per year.

4.4.4. In the event of recording operation being interrupted, for example by power failure, it shall automatically resume recording, on resumption of power supply, of all the cameras it was recording prior to the interruption.

4.4.5. In the event of network disconnection with central system, local recording and local live viewing/retrieval at the stations/Depot shall not be affected.

4.4.6. Video recording shall be tamper proof so as even the administrator shall not be able to delete any video clip from any camera. Any attempt to delete or edit of video clips shall generate the alarm in the system which can be sent to the administrator.

4.4.7. The MS07 Contractor shall note that Appendix J of pricing document gives the minimum BOQ to be covered as part of the scope of work and any other item or enhancement of the listed items required to complete the Telecommunication system work shall also be provided as part of this fixed lump sum Contract. Additionally, the Contractor to please also note that all responsibilities and costs for materials, services, interface with all other relevant Contractor, etc in connection with integration of videos with the video wall to be provided at the designated location (to be provided by the



MS07 Contractor) shall be borne by the MS07 Contractor as part of this lump sum contract with no additional cost.

#### **4.5. FAULT AND ALARM MANAGEMENT**

- 4.5.1. All alarm status of the CCTV system equipment including CCTV cameras, video recorders, Layer-2 Switches etc as necessary and approved by the Employer Representative shall be monitored by CCTV Management system/Network Management system in the CER at the existing OCC/BCC and shall automatically generate an audio/visual alarm on the CCTV Management system on occurrence of an alarm. **MS07 contractor shall be responsible for integration of Line 7A and 9 fault and alarms with the existing CCTV system provided on Line 7, 2A and 2B (At CTFRS Level). Any additional hardware, software and Licences if required shall be borne by the MS07 contractor.**

### **5. DESIGN/APPLICATION ENGINEERING REQUIREMENTS**

#### **5.1. GENERAL**

- 5.1.1. Proposed CCTV system shall be based on Non-Proprietary open standard based integrated system with network centric functional and management architecture, aimed at providing high-speed manual/automatic operation for best performance.
- 5.1.2. All control equipment e.g. servers/workstation (CPU), storage devices etc. shall be placed in TER/CER of each station/depot/OCC/BCC in standard racks.
- 5.1.3. No equipment other than monitors, cameras, cables, field switch and their junction boxes shall be installed outside the TER/CER.
- 5.1.4. Failure of one camera shall not affect other cameras.
- 5.1.5. Laptop computers with preloaded CCTV system software shall be supplied as part of MS07 contract so that the Technician can connect and do the maintenance.
- 5.1.6. The CCTV central management system in existing OCC/BCC shall be installed on servers within a cluster of two servers or more. In case a server in the cluster fails, another server in the cluster shall automatically take over the failed server's job running the management system
- 5.1.7. The Central system shall include the management of all devices, servers and users for centralized monitoring, reporting, and alarm management, software configuration uploads and downloads to client stations, firmware and software upgrades. These functionalities shall be implemented on two terminals in each OCC/BCC.
- 5.1.8. The CCTV system shall afford viewing simultaneously at the SCR, PBS, Police booths/Security control at the station, Depot Control Centre/Depot Security Control at the Depot and from the OCC/BCC at full frame rate. The viewing shall be at 4CIF 25 fps resolution while recording shall be at Full HD 25 fps. The normal Full HD 25 fps shall determine the size of the storage device. The storage capacity shall be calculated keeping in view the spare capacity of 25% of the installed capacity. The primary recording shall be at



the Station TER and the recording shall also be mirrored at the adjoining station at the same frame rate and resolution.

5.1.9. While certain brands of the hardware have been specified, considering the requirement of availability, maintainability, and MTBF, it is preferable that the brands out of those specified may be chosen by the tenderer so as to justify the MTBF and availability of the entire system during the detailed design from the published figures in the data sheets and later substantiate the same during the DLP period.

**5.2. EQUIPMENT DESIGN**

**5.2.1. CCTV CAMERAS**

5.2.1.1. All CCTV cameras shall be of colour CCD/CMOS, IP based Full HD type with low light capability to produce clear and detailed picture quality as well as under high lighting contrast condition. CCTV cameras shall have Wide Dynamic Range (WDR) for excellent image quality in different lighting conditions.

5.2.1.2. Fixed box type IP colour cameras with Varifocal lens shall generally be used in Concourse, Platforms, Ticketing area(s), AFC gates etc. In concourse some fixed cameras shall be of dome type and having fixed in the ceiling to match the station aesthetics. IR illuminated IP camera shall be used for RSS, Station Entry, Ramps, Parking, specifically identified theft prone areas, Platform end track side, signal point crossings at tracks, etc. where proper lighting conditions are not available.

5.2.1.3. MS07 Contractor shall design the distribution of all cameras at each location to comply with the coverage requirements and submit to the Employer Representative for review. CCTV camera coverage plots shall also be submitted with the detailed design for review.

5.2.1.4. Unless specified otherwise elsewhere in the PS, Cameras, field switches, PF Monitors & other equipment, meant for outdoor installations, shall be suitable to work from 0°C to +50°C with RH up to 80% non-condensing.

5.2.1.5. The data sheets from the OEM of the cameras, for outdoor and indoor are to be specifically conforming to the above in regard to the temperature and humidity requirements. The data sheets shall be submitted with the Technical Description in the bid documents.

5.2.1.6. The contractor shall ensure that cameras shall be designed/equipped with defogging capabilities/arrangement to ensure that there is no adverse effect on camera footage due to fogging.

**5.2.2. VARIFOCAL LENSES:**

5.2.2.1. Varifocal Lenses compatible with fixed box type cameras without compromising the resolution/picture quality shall have the following specifications as minimum:

S. No.	Parameter	Value
1	Focal length	9mm- 40 mm
2	Iris range	F1.5 to F8



S. No.	Parameter	Value
3	Format	1/3" or better, Full HD, 3MP IR corrected
4	Lens mount	C/CS-mount
5	Angle view wide(1/3")	30° x 22° or better
6	Angle view tele (1/3")	7.1° x 5.3° or better
7	Iris Control	Auto/DC control
8	Focus Control	Manual
9	Zoom Control	Manual
10	Operating Temperature	0°C to + 50° C
11	Storage Temperature	0°C to + 70°C
12	Operating Humidity with camera and housing	Up to 90%, non- condensing
13	Approval (Safety & EMC Immunity, Emission)	CE or equivalent.
14	Makes subject to meeting the above requirements.	Only from a reputed make. Printed data sheet of manufacturer to be attached with the bid proposal, clearly identifying clause by clause compliance

**Table 8.3: Varifocal Lens specification**

5.2.3. **HOUSING ARRANGEMENT FOR FIXED IP BOX TYPE CAMERA:**

5.2.3.1. Housing arrangement shall be designed for both outdoor and indoor use and shall meet requirements for camera enclosures.

5.2.3.2. It shall protect camera and lens combination.

5.2.3.3. The housing arrangement shall have the following technical specifications and features:

S. No.	Parameter	Value
1	Window	3 mm (0.12 inch) glass
2	Camera Mounting	Removable camera/lens tray, mounted with minimum two screws
3	Cable Entry	Internal cable management



S. No.	Parameter	Value
4	Construction	Aluminium/ fibreglass Reinforced Composite/ Polycarbonate housing & casing , neoprene gaskets , UV-resistant polymer end caps
5	Tamper-resistance	Tamper-resistant screws for locking clasps
6	Enclosure Protection	IP66/NEMA-4x or better
7	Approvals (Safety)	UL/EN and FCC standards for safety, EMC & Immunity
8	Makes subject to meeting the above requirements.	Only from a reputed make. Printed data sheet of manufacturer to be attached with the bid proposal, clearly identifying clause by clause compliance

**Table 8.4: Technical specification**

5.2.3.4. The Housing shall either be integrated with the camera by the manufacturer or it shall be of same make as the camera or one of the reputed makes.

5.2.3.5. The camera shall work on 220V AC voltage or 24V AC or 12VDC or 24 V DC or PoE as required as per the design and implementation.

**5.2.4. MOUNT FOR THE CAMERA:**

5.2.4.1. Mounts shall be suitable for indoor and outdoor mounting units designed for fixed cameras or camera housing installations. The mount shall be of the same make as housing. Mounting height will be ascertained during the detailed design phase.

5.2.4.2. Mount shall have the following features:

- a) Feed-through design for cable management
- b) 360° rotation, 180° tilt
- c) Versatile design
- d) Adjustable mount heads
- e) Corrosion-resistant finish

**5.2.5. HIGH-DEFINITION IP FIXED BOX CAMERA (DAY/NIGHT)**

S. No.	Parameter	Value
1	Pick-up device	1/3" or bigger CCD/CMOS progressive scan image sensor
2	Active Pixels	1920X1080



S. No.	Parameter	Value
3	Sensitivity	(@ F1.2, 30 IRE or better)
	Colour Mode	0.25 Lux
	Night Mode (Black & White)	0.08 lux
4	Compression technology	Two independently configurable H.264 streams: Stream 1: 1080p @ 25 FPS, Stream 2: Standard Definition @ 25 FPS
5	Video resolution	1920X 1080p, 1280X720p, standard definition (4CIF/D1)
6	Data Rate	64 Kbps to 8 Mbps
7	POE	802.3af compliant and 12VDC/24VAC dual power options
8	Auto Focus	Auto back focus through web browser or software.
9	Supported Protocols	Telnet, SFTP, TCP/IP, UDP/IP (Unicast, Multicast IGMP), IPv4/v6, SNMP, SNTP, RTSP, ONVIF etc. or as required to fulfil the functional requirement of project.
10	IR Filter	Auto, Manual, remotely
11	Video S/N	≥ 50 dB
12	Time	Embedded Real Time clock, NTP client
13	Auto Gain Control	On/Off / Auto
14	Shutter Speed	1 to 1/10,000 or better
15	Wide Dynamic Range	76 dB or better
16	Back Light Compensation / Anti Blooming	ON/OFF
17	White Balance	Auto/Manual
18	Network Interface	RJ-45 connector for 10/100BaseT auto sensing
19	Firmware upgrade	It shall be possible to remotely upgrade the firmware of the camera



S. No.	Parameter	Value
20	Operating Temperature	0 °C to + 50° C
21	Storage Temp	-10 °C to + 60° C
22	Humidity	Up to 90% non-condensing
23	Approval (Safety & EMC Immunity, Emission)	UL/EN and FCC.
24	Interoperability Conformance	The camera shall be ONVIF (Open Network Video Interface forum) Standards.
25	Makes for cameras.	Only reputed make. Printed data sheet of manufacturer to be attached with the bid proposal, clearly identifying clause by clause compliance.

**Table 8.5: IP Fixed Box CCTV Features**

5.2.6.

**HIGH-DEFINITION IP FIXED DOME CAMERA (DAY/NIGHT)**

S. No.	Parameter	Value
1	Pick-up device	1/3" or bigger CCD/CMOS progressive scan image sensor
2	Active Pixels	1920X1080
3	Sensitivity	(@ F1.2, 30 IRE or better)
	Colour Mode	0.25 Lux
	Night Mode (Black & White)	0.05 lux
4	Compression technology	Two independently configurable H.264 streams: Stream 1: H 264, 1080p @ 25 FPS, Stream 2: H264, Standard Definition (4CIF) @ 25 FPS
5	Video resolution	1920X 1080p, 1280X720p, standard definition (4CIF/D1)
6	Lens	3.8 mm- 8mm
7	Data Rate	64 Kbps to 8 Mbps
8	Enclosure	IP66/NEMA-4 or better



S. No.	Parameter	Value
9	POE	802.3af compliant and 12VDC/24VAC dual power options
10	Supported Protocols	Telnet, SFTP, TCP/IP, UDP/IP (Unicast, Multicast IGMP), IPv4/v6, SNMP, SNTP, RTSP, ONVIF etc. or as required to fulfil the functional requirement of project.
11	IR Filter	Auto, Manual, Remotely
12	Video S/N	≥ 50 dB
13	Time	Embedded Real Time clock, NTP client
14	Auto Gain Control	On/Off / Auto
15	Shutter Speed	1 to 1/10,000 or better
16	Wide Dynamic Range	76 dB or better
17	Back Light Compensation / Anti Blooming	ON/OFF
18	White Balance	Auto/Manual
19	Network Interface	RJ-45 connector for 10/100BaseT auto sensing
20	Firmware upgrade	It shall be possible to remotely upgrade the firmware of the camera
21	Operating Temperature	0 °C to + 50° C
22	Storage Temp	-10 °C to + 60° C
23	Humidity	Up to 90% non-condensing
24	Approval (Safety & EMC Immunity, Emission)	UL/EN and FCC
25	Interoperability Conformance	The camera shall be ONVIF (Open Network Video Interface forum) Standards.
26	Makes for cameras.	Only reputed make. Printed data sheet of manufacturer to be attached with the bid proposal, clearly identifying clause by clause compliance.

**Table 8.6: IP Fixed Dome CCTV Features**



5.2.7.

**HIGH SPEED, HIGH-DEFINITION IP PTZ DOME CAMERA (DAY/NIGHT)**

S. No.	Parameter	Value
1	Pick-up device	1/3" or bigger CCD/CMOS progressive scan image sensor
2	Active Pixels	1920X1080
3	Sensitivity	(@ F1.2, 30 IRE or better)
	Colour Mode	1.0 Lux
	Night Mode (Black & White)	0.12 lux
4	Compression technology	Two independently configurable H.264 streams: Stream 1: H 264, 1080p @ 25 FPS, Stream 2: H264, Standard Definition (4CIF) @ 25 FPS
5	Video resolution	1920X 1080p, 1280X720p, standard definition (4CIF/D1)
6	Data Rate	512 Kbps to 8 Mbps
7	Lens	Optical zoom 20X or better, Digital zoom minimum 8X
8	Shutter Speed	1 to 1/10,000 or better
9	Supported Protocols	Telnet, SFTP, TCP/IP, UDP/IP (Unicast, Multicast IGMP), IPv4/v6, SNMP, SNTP, RTSP, ONVIF etc. or as required to fulfil the functional requirement of project.
10	IR Filter	Auto, Manual, Remotely
11	Video S/N	≥ 50 dB
12	Auto Gain Control	On/Off
13	Wide Dynamic Range	76 dB or better
14	Automatic White Balance	On/Off
15	Iris Control	Automatic with manual override
16	Back Light Compensation	On/Off
17	Housing Arrangement	IP 66/NEMA 4 or better.
18	Pan/Tilt movement	360°/ 90°



S. No.	Parameter	Value
19	PoE	POE+ As per IEEE 802.3 at (compliant)/ AC24V, PoE++ (IEEE 802.3 bt)(class 6) compliant
20	Time	Embedded Real Time Clock, NTP Client.
21	Presets	99 presets
22	Sector Blanking	Camera 360 degree pan rotation to be divided in 8 sectors and any sector should be blanked as required by the operator
23	Tours	3 Tours
24	Preset Speed	Pan 200° per second, Tilt 100° per second
25	Network Interface	RJ-45 connector for 10/100BaseTX
26	Firmware upgrade	It shall be possible to remotely upgrade the firmware of the camera
27	Operating Temperature	-10 °C to + 50° C
28	Storage Temp	-10 °C to + 60° C
29	Humidity	Up to 90% non-condensing
30	Approval (Safety & EMC Immunity, Emission)	UL/EN and FCC
31	Interoperability Conformance	The camera shall be ONVIF (Open Network Video Interface forum) Standards.
32	Makes subject to meeting the above specs.	Only reputed make. Printed data sheet of manufacturer to be attached with the bid proposal, clearly identifying clause by clause compliance.

**Table 8.7: High Speed, IP PTZ Dome CCTV Features**

5.2.8.

**360 DEGREE PANORAMIC VIEW CAMERA**

S. No.	Parameter	Value
1	Pick-up device	1/3" CMOS



<b>S. No.</b>	<b>Parameter</b>	<b>Value</b>
2	Total Sensor Pixels	5MP
3	Sensitivity	
A	Colour Mode	0.36 lux
B	Night Mode (Black & White)	0.12 lux
4	Compression technology	H.264 (MP) or better
5	Video resolution for 360 Deg.	5 MP
6	Video resolution for 180 Deg.	5 MP
7	Encoding Interval	1 FPS to 15 FPS
8	POE/POE+	IEEE 802.3af
9	Supported Protocols	IPv4, IPv6, UDP, TCP, HTTP, HTTPS, RTP/RTCP, IGMP, V2/V3, ICMP, ICMPv6, RTSP, Telnet, SFTP, ARP, DHCP, NTP (SNTP), SNMP, (V1 MIB-II), 802.1x, DNS, SMTP, UPnP, DiffServ (QoS), etc, or as required to fulfil the functional requirement of project.
10	Video S/N	≥ 50 dB
11	Time	Embedded Real Time clock, NTP client
12	Shutter Speed	Automatic Electronic Shutter (AES) Fixed selectable
13	Wide Dynamic Range	76 dB or better
14	Back Light Compensation (on/off)	Yes
15	White Balance	3 automatic modes
16	Network Interface	10/100 Base-T auto sensing
17	Firmware upgrade	It shall be possible to remotely upgrade the firmware of the camera
18	Operating Temperature	-20 °C to + 50° C
19	Humidity	Up to 90% non-condensing
20	IP66	Yes



S. No.	Parameter	Value
21	Approval (Safety & EMC Immunity, Emission)	UL/EN and FCC.
22	Interoperability Conformance	The camera shall be ONVIF (Open Network Video Interface forum) Compliant.
23	Makes for cameras.	Only reputed make. Printed data sheet of manufacturer to be attached with the bid proposal, clearly identifying clause by clause compliance.

**Table 8.8: 360 Degree Panoramic View CCTV Features**

5.2.9.

**BULLET CAMERA**

S. No.	Parameter	Value
1	Pick-up device	1/3" or bigger CMOS progressive scan image sensor
2	Active Pixels	2560 X 1920 p or better Bit rate
3	Focal Length (Zoom Ratio)	5 9.4 mm motorized focus/zoom lens.
4	Angle of View (Horizontal & Vertical)	33° x 20° (wide)
5	Data Rate	64 Kbps to 4 Mbps
6	IR Viewable Length	50 m
7	Sensitivity or better	@ F1.2, 30 IRE or better
	Colour Mode	0.07 lux
	Night Mode (Black & White)	0.06 lux or better
8	Compression technology	At least Two independently configurable H.264 streams: Stream 1: H 264, 1080p @ 25 FPS, Stream 2: H264, Standard Definition (4CIF) @ 25 FPS
9	Video resolution	5 MP
10	Frame	H.264, Max. 30fps at all resolution



S. No.	Parameter	Value
11	Input Voltage /current	12 V DC +/-10% or 24 V AC +/-10% or PoE+ IEEE 802.3at
12	Auto Focus	Auto back focus through web browser or software.
13	Supported Protocols	TCP/IP, UDP/IP (Unicast, Multicast IGMP), IPv4/IPv6, SNMP, SNT, RTSP, ONVIF etc. or as required to fulfil the functional requirement of project.
14	IR Filter	Auto, Manual, Remote
15	Video S/N	≥ 50 dB
16	Time	Embedded Real Time clock, NTP client
17	Auto Gain Control	On / Off / Auto
18	Shutter Speed	1 to 1/ 10, 000 or better
19	Wide Dynamic Range	100 dB or better
20	Back Compensation/Anti Blooming Light	On/off
21	White Balance	Auto / Manual
22	Network Interface	RJ - 45 connector for 10/100 Base T auto sensing
23	Firmware upgrade	It shall be possible to remotely upgrade the firmware of the camera
24	Operating Temperature	0 °C to + 50° C
25	Humidity	Up to 90% non-condensing
26	Approval (Safety & EMC Immunity, Emission)	CE, FCC, and UL/BIS certified
27	Ingress Protection	IP 66/NEMA 4X or better

**Table 8.9: Bullet Camera Features**

5.2.10. **LAYER 2 SWITCHES FOR FIELD**

Field Switches (industrial grade) shall be provided at Platforms, Concourses and in Depot areas, where air-conditioning environment is not available. Ethernet output from the IP cameras (Fixed and PTZ) shall be directly connected to the field switch through data cable and suitable protection devices. The outputs of the field switch shall be connected to the two



aggregate switches by using 2 x 1 Gigabit Fibre Uplinks through separate optical fibre cable to the redundant ports available in TER switches

For powering the PTZ, if the power (PoE) available on the field switch ports is not sufficient to drive the PTZ functionalities, a separate power cable shall be laid by the MS07 Contractor.

The Field Switch shall include, but not limited to the following specifications:

<b>S. No.</b>	<b>Specs</b>
1	The Switch shall be high performance, manageable and shall have minimum 16x10/100/1000Mbps ports including Minimum 2x1 Gigabit Fibre Uplink ports.
2	All Ethernet Switch ports shall be PoE compliant as per IEEE 802.3af.
3	It shall support Multicasting protocols (IGMP snooping, etc.) required for CCTV system
4	All the ports shall be equipped and the SFP modules should comply with Multi-Source Agreement (MSA), enabling the compatibility with other vendors' equipments
5	Operating temperature 0°C to + 60°C, Humidity up to 90% (noncondensing). Switch shall be without any moving parts (no fans)
6	All Switches shall have high RFI/EMI immunity and shall have IEEE/UL/EN and FCC approval.
7	Shall be capable to withstand shock and vibrations as per IEC or equivalent standards.
8	Shall have Port security (IP/MAC).
9	Shall have the following protocols- SNMP v2/v3, Web, Telnet, Rapid Spanning Tree (RSTP) as per IEEE802.1w, etc or as required for CCTV operation.
10	Switches shall meet all the above specifications and shall be from the reputed manufacturer which will be decided during design stage.

**Table 8.10: Layer 2 Switches Specifications**

4 port layer 2 industrial grade switches as required to meet with the requirements of CCTV shall be provided for connecting the CCTV cameras outside the stations to the nearest station.

5.2.11.

**REQUIREMENT OF LARGE VIDEO WALL**

8x2x70" LASER video wall shall be installed in the Security Control Room at designated place to view all cameras of corridors of Mumbai Metro lines 7, 7A & 9. The specifications of this video wall are given Attachment A of Ch.8 (this chapter) of this PS.



5.2.12. **DIGITAL CCTV KEYBOARD**

1. The digital keyboard shall be fully functional, multipurpose keyboard used for system control and programming.
2. Keyboard shall include an integral variable speed pan/tilt/ zoom joystick and shall be able to select any camera and display it on any monitor of that location.
3. Keyboard shall control multiple PTZ cameras.
4. Keyboard shall be with user-friendly menu displayed on LCD with dynamic menu and easy to read display.
5. Joystick (Keyboard) should support RS232/RS485 connectivity, ethernet connection and RJ 11 connections and should be supplied with required interface units.
6. The Key Board shall be UL or EN and FCC approved and shall be of one of the reputed makes of same make as cameras.
7. Keyboard shall automatically number monitors, cameras, sequences and guard tours. Users shall view video on monitors in the same way as controlling a matrix.

5.2.13. **WORK STATION FOR VIEWING, MONITORING**

The PC Workstation Hardware shall be Rack Mountable for viewing, Monitoring and management of CCTV images at the stations and shall meet the following specification as a minimum whereas latest processor, chipset and OS should be considered:

Sr No	Parameter	Specs
1	Processors	Intel Xeon Processor E5-2600 series, 2.4 GHz, Hyper threading, 10MB L3 Cache, 1600 MHz memory or better.
2	Operating systems	Genuine latest Windows /Linux or better
3	Chipset	Intel C600 or better
4	Memory	DDR3 1600 MHz memory 8GB expandable to 64 GB
5	Graphics Display card	Dual NVIDIA Quadro 600/FirePro V4900 or better
6	Drive Controller	6 Gb/s controller, RAID 0,1,5 and 10 capable.
7	Hard Drives	2 x 146GB 10K/15K SAS/ SATA
8	Networking	Dual Integrated GbE Controller
9	Keyboard	USB keyboard



Sr No	Parameter	Specs
10	Mouse	USB two-button optical mouse
11	Optical Devices Storage	DVD -ROM
12	Approvals	The workstation shall be UL/FCC approved and shall be from reputed make

Table 8.11: Work Station Features

5.2.14.

**SPECIFICATIONS OF MONITORS FOR WORKSTATION (MMI):**

S. No.	Parameter	Value
1	Viewable Size	20 degree or better when measured diagonally on LED backlit LCD monitor screen
2	Resolution	1920X1080 pixels
3	Image Contrast Ratio (Typical)	1000:1 or better
4	Viewing angle	160° by 160° or better
5	Video Input Signals	Digital video DVI-D ( HDCP/HDMI)
6	Response Time	5 ms
7	Colour Support	16.7 million or better
8	Image Brightness (typical)	250 cd/m2 or better
9	Display Position Adjustments	Tilt Swivel, Pivot, Height adjustment etc.
10	Approvals	UL or EN & FCC
11	Compliant Standards	ENERGY STAR/ EPEAT Gold/TCO
12	Make subject to meeting the above specifications	Only Reputed Make

Table 8.12: Work Station Monitors Features

5.2.15.

**NETWORK VIDEO RECORDER (SERVER/STORAGE) HARDWARE**

The Network Video Management and Recorder system shall be 19” Rack Mountable. It is essential to have the recorded images to be stored at least for 30 days of all critical areas to facilitate investigations of reported case. The storage with RAID5 or better configuration shall be inbuilt hard disks on



**MS07: Particular Specifications**

the server or Direct Attached Storage or Network Attached Storage or Storage Area Network. Each NVR (Primary/Secondary) shall have 20TB minimum usable storage capacities as per design requirement for CCTV video recordings with a provision of expansion of up to 25%. The NVR shall meet the following specifications as a minimum:

<b>S No</b>	<b>Parameter</b>	<b>Specs</b>
1	Processors	Intel Xeon processor E5-2640 2.2 GHz or better 15MB L3 cache, Hyper-Threading Technology with 7.2 GT/s QPI Speed and scalable up to 2 Processors, configured with Redundant supplies
2	Chipset	Intel C 600 or better
3	Memory	32GB DDR3 Registered Low Voltage DIMMS, 1333 MHz or better scalable to 128 GB of memory
4	OS Hard Drives	Minimum 2x300GB SAS 15K RPM or Better in RAID 1
5	Data Hard Drive	Hot Plug Hard drive SAS/SATA 7.2K or better with 20TB or better usable in RAID5 with one HDD as hot spare. (Total storage can increase as per design. Contractor has to provide it without any additional cost to it)
6	Optical Storage	External DVD ROM Drive should be supportable
7	Network Controller	4x1GbE with Load Balancing and Fail over Support. Remote management card with IPv6 compliance
8	Power supply	Two hot plug high efficiency rated power supplies
9	Management	Dedicated Remote management card, with support for full out of band remote management. Remote management system to provide Firmware updates and Roll back without installing any software.
10	OS	Windows Server/Linux/Sun Solaris or as required for CCTV system operation



S No	Parameter	Specs
11	Approvals	<p>The Network Video Recorder shall be CE/FCC/UL listed and shall be one of the reputed makes such as IBM, Dell, HP, Fujitsu, Sun Microsystems or equivalent subject to meeting the above specifications.</p> <p>The Server accessories shall also be CE and UL listed. Contractor is responsible for seamless integration of NVR recorder network with CCTV services and functionality.</p> <p>NVR hardware and software shall be from same OEM with tested and proven credentials. If it is from different OEM, proposed solution should have been implemented at least in one metro project and subject to Employer's Representative approval.</p>

Table 8.13: NVR Specifications

5.2.16.

**KVM EXTENDER**

Workstation for CCTV MMIs shall be kept in Telecommunication Equipment Room (TER) and the extension of Video, Key board, Mouse and CCTV joystick to the OCC/BCC Controllers, Station Control Room (SCR), Security Rooms and Platform Supervisor Booth (PSB) in OCC/BCC/stations shall be done through KVM Extenders. The distance between TER and SCR/Security Rooms/PSB in some cases may be more than 150 mts. The KVM extenders shall be selected keeping in view of the distance and the screen resolution of MMI. The KVM extenders shall include, but not limited to the following specifications:

S No	Parameter	Parameter
1	Operating temperature	0° to 40° C
2	Humidity	Upto 80% non -condensing
3	Indicator	Device status LED indicator with network activity
4	Remote connection	Ethernet (RJ45) with port activity indicator
5	Network protocol	TCP/IP, LDAP, SNMP or as required for the CCTV operations.
6	Screen resolution	1920 x 1080 @ 50 Hz or better

Table 8.14: KVM Extender



5.2.17. **IR ILLUMINATOR FOR IP FIXED BOX CAMERA**

The Infra-Red (IR) illuminator (inbuilt in camera or external) shall provide high quality 850nm or better IR illumination. The IR function can be controlled via the video output of the camera and or the camera's IR-cut filter can be synchronized via a contact closure in the housing.

5.2.18. **REQUIREMENTS FOR CCTV VIDEO ANALYTICS FOR CCTV SYSTEM**

5.2.18.1. Analytics can be enabled or disabled on each unit individually without degrading video performance on the system.

5.2.18.2. Intelligent Video Analytics shall be implemented in the proposed cameras. Different types of Video analytics features shall include but not limited to:

- Intrusion detection,
- Unattended baggage detection (including tracking of person who left the unattended baggage.)
- crowd estimation and crowd management alarms for platforms
- line control,
- counter flow detection overcrowding detection,
- camera tampering alerts
- Loitering
- Removed Object Detection and
- any other video analytic feature relevant to Mumbai Metro

Analytics such as Facial Recognition, Face Capture/Detection, Black Listed Person Identification shall also be implemented in the CCTV System. The SOP related to facial recognition for Operators will be made by Contractor and approved by Engineer in design stage to secure the data.

The Video Analytics functionality shall have mechanisms to continue alarm generation in case of failure of the Server. The Video Analytics shall not be bound to the MAC address of the device and hence any video analytics feature shall be possible to be deployed on any camera.

Alarms shall be generated and relevant data and video shall be transferred to OCC/Stations/Security room through optical fiber network.

The Removed Objected detection analytic functionality shall be used to detect removal of pre-defined objects (thefts) in following areas as a min:

- 1) At Platforms, concourses & back of the house.
- 2) At external locations (RSS, Mid Shaft etc)
- 3) Any other pre-defined area.

Note: while edge analytics for all of the above conditions shall be preferred. However, in event of any of the above conditions not being monitored through edge analytics an alternate solution can be proposed duly ensuring



there is no degradation of any other functionality of the CCTV subsystem. Details of the alternate solution shall be include in the technical offer for the consideration

5.2.18.3. **ABANDONED/UNATTENDED OBJECT DETECTION**

Detects an unattended bag on a crowded platform. Immediately detects and notifies if an object has been permanently placed on the concourse, ticketing area, technical room, SCR area, PSB and on the PF.

5.2.18.4. **DEPOT/OCC/BCC PERIMETER PROTECTION:**

As lighting is available near the gates (max 2 gates) and as the night vision cameras are being installed, it is necessary to provide security with fixed camera with video analytics to view the entrance and exit of the Depot/OCC/BCC/stations. Further the periphery of the compound has to be provided with such cameras close to the gates or as convenient by which any one scaling the compound wall nearby triggers the alarm.

5.2.18.5. **HUMAN MOVEMENT DETECTION DESIGNED TO SPOT INTRUDERS AND UNUSUAL BEHAVIOUR OF AN INDIVIDUAL MOVING AGAINST THE GENERAL CROWD FLOW.**

It should be possible to detect intrusion outside OCC, BCC, Depot, SCR, TER in case of loitering for some time and can be programmed to alarm as required at night or day as necessary. The cameras being fixed can have the analytics for detecting loitering, wrong side movement in escalators. This is to be provided at all stations.

5.2.18.6. It shall be possible to detect the following events:

1. Camera Tampering
2. Overcrowding/Congestion Detection in Platform Excessive
3. Excessive Queuing
4. Track Protection
5. Falling object detection in platform track area.

5.2.18.7. **RULE BASED DETECTION**

The video management system shall support solution that makes it possible to integrate video content applications seamlessly into viewing client environments to trigger alarms.

Minimum of 16 cameras of each station, 4 cameras of depot, 16 cameras of OCC/BCC shall be provided with Video Analytic functions. Total number of camera Analytics for all 16 cameras of each station shall be 20, for depot it shall be 10 and for OCC/BCC, it shall be 18. The distribution of the total Analytics to the various cameras at the relevant locations shall be developed during detailed design.



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- 5.2.19. **CCTV VIDEO SURVEILLANCE SOFTWARE**
- 5.2.19.1. **GENERAL SYSTEM DESCRIPTION**
- 5.2.19.1.1. The software shall be based upon standard components and proven technology using open and published protocols. All the software and licenses shall be for perpetual use by Mumbai Metro. This applies for all kind of software and licenses being supplied as part of MS07 Contract.
- 5.2.19.1.2. The video management system shall be an enterprise class IP enabled fully distributed solution, designed for limitless multi-site and multiple server installations requiring 24/7 surveillance with support for devices from different vendors.
- 5.2.19.1.3. The video management system shall offer centralized management of all devices, servers and users for centralized monitoring, reporting, and alarm management, software configuration uploads and downloads to client stations, firmware and software upgrades. These functionalities shall be implemented on two workstations in each OCC & BCC.
- 5.2.19.1.4. The video management system shall allow all installed cameras, recording servers and clients of Line 7A & 9 to be connected to management server across multiple sites.
- 5.2.19.1.5. The video management system shall include a distributed architecture, allowing clients on the host system with the user rights to view video sources belonging to multiple independent video management systems simultaneously.
- 5.2.19.1.6. The video management system shall contain a management server that shall be the central manager of the system and control recording servers, cameras, devices and users. The management server shall handle the initial client login, system configuration and logging.
- 5.2.19.1.7. The video management system shall include an alarm management function that shall provide central overview, control and scalability in any number of federated video management system installations.
- 5.2.19.1.8. The video management system shall support high availability of recording servers. A failover option shall provide standby support for recording servers with automatic synchronization to ensure maximum uptime and minimum risk of losing data.
- 5.2.19.1.9. The video management system shall support a versatile rule system including scheduled or event-driven actions with numerous options, including support for time profiles.
- 5.2.19.1.10. The video management system shall incorporate a fully integrated video sharing functionality for distributed viewing of video from any camera in the system on any computer with the viewing client.
- 5.2.19.1.11. The video management system shall support a video wall application, which shall be flexible and hardware independent to allow for seamless integration with the management client and viewing client.
- 5.2.19.1.12. The video management system shall support encryption of video for export purposes.



- 5.2.19.1.13. The video management system shall include a standalone viewing client application to be included with video exported from the viewing client application. The standalone viewing client application shall allow recipients of the video to browse and playback the exported video without installing separate software on their computers
- 5.2.19.1.14. The video management system software shall provide fast evidence export by exporting video in various formats, including video from multiple cameras in an encrypted database format with an included standalone viewing client. It shall be possible to write a digital signature to the database files containing recorded data. This shall allow the viewing client and the standalone viewing client to verify that the contents of imported and opened databases have not been tampered with and that no database files have been removed.
- 5.2.19.1.15. The video management system shall support a solution that makes it possible to integrate multiple third-party video content applications seamlessly into viewing client environments.
- 5.2.19.1.16. The video management system shall include a Software Development Kit (SDK) that offers important capabilities for integrating the video management system with third party software and applications like access control, video analytics, etc.
- 5.2.19.1.17. The video management system shall include support for Active Directory to allow users to be added to the system. Use of Active Directory requires that a server running Active Directory, acting as a domain controller is available on the network.
- 5.2.19.1.18. The VMS shall support the generation of audit trails. Audit trails shall consist of logs of actions done by operator/administrator e.g. login/logout, additions, deletions, and modifications, etc. The VMS shall support Audit trails report generation from the audit trail database into standard reporting tools e.g. Excel.
- 5.2.19.1.19. The system shall allow the recording, live monitoring, playback of archived video simultaneously.
- 5.2.19.1.20. The system shall support multicasting of video feeds to client workstations in order to conserve network resources. Multicasting shall send a single stream of video to multiple clients, where the stream may be decoded and displayed on all clients simultaneously. The system shall switch to unicast, if the client fails to connect to the multicast stream.
- 5.2.19.1.21. The system shall allow live multi-streaming from the cameras in different resolutions, formats, and frame rates. In addition to this, the system shall support a separate recording stream.
- 5.2.19.1.22. The system shall support a built-in Virtual Matrix Switcher. The Virtual Matrix Switch shall have the capability of creating camera sequences with the following functionalities:
- a) Each Sequence shall have capability up to hundreds of cameras.
  - b) Each camera in the sequence shall have its own individual dwell time, from 1 to 60 second.



- c) Each entry in a sequence shall have the capacity to trigger PTZ camera pre-sets, patterns or auxiliaries.
- d) Multiple users shall be able to view the same camera sequence simultaneously, not necessarily synchronized one with the other.

5.2.19.2. **MANAGEMENT SERVER**

- 5.2.19.2.1. A management server shall control the video management system so that the system administrator has full control of all CCTV equipment locally, or from a remote location. The management server shall contain the Event, Log, Data collection, etc services, which by default shall be installed on the same server as the management server software; however, if not feasible, it shall be installed on separate servers.
- 5.2.19.2.2. The management server shall be able to handle client login, system configurations, performance counters and logging.
- 5.2.19.2.3. A management client shall be available for remote administration of recording servers (Status of Server like online/off-line), devices, security, rules, logging etc.
- 5.2.19.2.4. The management server shall be able to store the system's configuration for all clients, servers and IP cameras in database, either on the management server computer, or on a database server in the network.
- 5.2.19.2.5. The management server shall be able to manage all user authentication and user rights.
- 5.2.19.2.6. The software shall allow for installation of Anti-Virus and network security Software
- 5.2.19.2.7. The system shall act as an SNMP agent which can generate an SNMP trap as a result of rule activation in addition to other existing rule actions.
- 5.2.19.2.8. The system shall support interoperability with IP camera standards including, at a minimum, the Open Network Video Interface Forum (ONVIF).
- 5.2.19.2.9. The system shall include a universal driver that shall support any generic network camera. The driver must be able to handle standard video streaming formats including MPEG4 and H.264 or latest.
- 5.2.19.2.10. Suitable indication to the OCC/BCC operator to be given if one video recording server fails/ shut down.
- 5.2.19.2.11. The administrator through the relevant software shall be able to do software auditing which displays the software versions running on the CCTV equipments.
- 5.2.19.2.12. The system shall be capable to generate reports of stored device configuration, alarms and alarm logs. The log shall be able to be archived, printed and displayed using a device filter, a device group filter and/or a time window.
- 5.2.19.2.13. The system shall support search of recorded video for motion in user specified areas of a camera image. This intelligent post-recording motion search will work for cameras connected.



5.2.19.2.14. It shall be possible to backup and restore system configuration in order to quickly restore the configuration of the video management system. Two types of backup of system configuration shall be possible:

- a) Scheduled backup,
- b) Manual backup System logs shall not be backed up or restored when performing manual backup or restore.

5.2.19.2.15. The system monitoring feature shall be available. The system monitoring feature shall give operators the possibility of viewing system information and creating reports on:

1. Management servers, recording servers, Failover servers which shall show CPU and memory usage of the servers.
2. Cameras, which shall show a minimum list of the following items.
  - a) Camera status (connected or disconnected)
  - b) an individual camera is recording or not
  - c) The name of the camera, the hardware device and the IP address of the hardware device
  - d) The recording server the camera is connected to
  - e) What storage the camera is using
  - f) Live frames per second (FPS)
  - g) Live video format, for example H.264 or MJPEG
  - h) Recording video format, for example H. 264 or MJPEG
  - i) Media data received (Kbit/s)

5.2.19.3. **NETWORK VIDEO RECORDING SERVER**

- A. The recording servers shall be used for recording video feeds and for communicating with all cameras of Telecommunication system and rolling stock and other devices. The recording server(s) shall be able to communicate with the management server.
- B. All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp and shall be programmable by the system administrator with User ID & Password.
- C. Video stream from individual cameras shall be recorded on storage device. System shall have provision to automatically purge old data in FIFO format when the storage space is exhausted. Under no circumstance, storage usage etc shall the server hang/ stop the recording process. All data available in the storage device should be possible to be retrieved.
- D. The CCTV application should allow retrieval of data instantaneously for any date / time interval chosen through search functionality of the application software.



- E. The NVR shall provide Network Time Server function to ensure the synchronisation of the Video Servers and the recordings.
- F. The NVR shall provide a status of the available recording capacity, as well as an indication of the remaining possible recording time. An alarm shall pop-up on the workstation/terminal when the storage device is nearly full.
- G. Once configured, recording servers shall run independently of the management server, and shall continue to operate even if the management server is offline.
- H. Network video recorders (NVRs) shall be designed to operate in a mirrored redundancy mode. The station cameras will be recorded in primary NVR server at the station itself and in mirrored mode at the adjacent station. The system shall support an unlimited number of recording servers.
- I. Each recording server shall have a default storage container. The storage container shall specify the complete recording and archiving configuration. The Software shall be able to do video recording on any of the following options - inbuilt hard disks on the server, Direct Attached Storage boxes attached to servers, Network Attached Storage or Storage Area Network.
- J. System should ensure that once recorded, the video cannot be altered, ensuring the audit trail is intact for evidential purposes. This has to be achieved using Authentication with SHA-1 hashing function, combined with 1024-bit RSA public-private key pair or latest proven algorithm. Water marking alone for ensuring tamper proof recording is not sufficient.
- K. System must be capable of protecting video (based on Alarms or certain parameters) so as to prevent it from being deleted.
- L. The system shall support H.264, MPEG-4 or latest compression formats.
- M. The recording server shall utilize high performance iSCSI, SCSI, SAS or SSD disk drives or SATA hard drives for online recording storage. Use of online archiving shall ensure that data is always readily available.
- N. The online archiving capability shall be transparent and shall allow viewing client users to playback archived recordings without the need to restore the archived video to a local hard drive for access.
- O. The system shall allow the frame rate, bit rate and resolution of each camera to be configured independently for recording. The system shall allow the user to configure groups of cameras with the same frame rate, bit rate and resolution for efficient set-up of multiple cameras simultaneously.
- P. Minimum recording shall be for 30 days.



- Q. The system shall provide seamless access to recordings on the failover server for all clients through the same client views once the services are fully started.

5.2.19.4.

**VIEWING CLIENT**

- A. The viewing client shall enable operators to connect to the management server for initial authorization. Upon authorization, the viewing client shall be able to connect to the recording server(s), for access to live and recorded videos. Once authorized, the viewing client shall run independently of the management server, and shall continue to operate even if the management server is offline. However, in the downgraded mode (when the connectivity between central server and the station is not available), the viewer client shall be able to login the system and the video recording & the local viewing shall not be affected.
- B. The Client operator shall be able to drag and drop a camera from a tree of available cameras or a camera sequence into any video tile for live viewing.
- C. The viewing client shall allow the user to be able to:
1. view live video from cameras
  2. play back recordings from cameras with a selection of advanced navigation controls, including an intuitive timeline browser.
  3. switch between a number of views, each able to display videos from 1 up to 16 cameras from multiple servers at a time. The system shall make it possible to create views based on different layouts optimized for 4:3 and 16:9 display ratios.
  4. access views of cameras on any PC with a viewing client installed.
  5. Should switch to secondary recording by simply pressing tab in viewing page.
  6. Should have visible notification that from which storage camera is playback like Failover or Primary
  7. use multiple screens as well as floating windows for displaying different views simultaneously.
  8. quickly replace one or more views of cameras with other cameras.
  9. view images from several cameras in sequence in a single camera position in a designated carousel position.
  10. view video from selected cameras in greater magnification and/or higher quality in a designated special view position.
  11. control PTZ cameras.
  12. use digital zoom on live as well as recorded video.



13. activate manually triggered events.
14. Use sound notifications for attracting operator's attention to detected motion.
15. get a quick overview of sequences with detected motion.
16. quickly search for motion in selected areas of a video recording.
17. skip gaps (periods with no recordings) during playback of recordings.
18. configure and use several different joysticks.
19. print images, with optional comments.
20. copy images for subsequent pasting into word processors, e-mail, etc.
21. export recordings (for example, for use as evidence) as still images (JPEG), in media player format (AVI), or native database formats.
22. add a digital signature to exported recordings in the database format in order to verify that the recordings have not been tampered with.

5.2.19.5.

**MAPS:**

- A. The viewing client shall include a built-in map function which shall provide an intuitive overview of the system and shall offer integrated access to all system components.
- B. The map function shall be able to use standard graphical file formats.
- C. It shall be possible to use any number of layered maps and to easily drag and-drop and point-and-click icons representing cameras.
- D. The viewing client shall support a map function which shall support instant camera preview when moving the mouse pointer over a specific camera.
- E. The map function shall support real-time status monitoring indication from all system components.
- F. The map function shall support graphical at-the-glance visualization of the system status through colour coding. Graphical tool illustrating health status of various equipment on a single screen, such as line diagram, normal status of all equipment at a station shown in Green colour and fault status shown in Red colour. The Contractor may propose alternate graphical scheme for review and acceptance of the Employer's Representative.
- G. The map function shall support status details for cameras and servers, for example: camera resolution, FPS, network usage, disk space, etc.
- H. The map function shall provide a central overview of the video management system via an alarm list containing high, medium or low



prioritized alarms. It must be possible to acknowledge alarms by right clicking elements on maps.

- I. The maps shall have the ability to contain hyperlinks to create a hierarchy of interlinked maps.
- J. The operator shall be able to drag and drop a camera from a map onto a video tile for live viewing in the same browser without using a new browser.
- K. Map function shall allow the real time status monitoring for VRM server/storage devices.

5.2.19.6.

**ALARM MANAGEMENT FEATURE**

- A. Alarms defined in the system shall be based on user groups. Specific alarm shall go to only selected users. Alarms, health status & displays generated by the CCTV system shall be shown locally as well as at remote location in OCC/BCC.
- B. The alarm management feature shall be available in the CCTV system. It shall allow alarms from Hardware, Software and 3rd Party systems. The system shall allow configurable alarm escalation, alarm priority, etc.
- C. The alarm management shall allow operators to have a centralized point from which it shall be possible to keep track of incoming alarms.
- D. The camera associated with alarm shall be displayed as a separate video window.
- E. An alarm preview window shall display recorded video from a selected alarm or event if these have videos associated with them. If there are more than one camera associated with an alarm or if more than one alarm is selected, the preview shall show video from all associated cameras (up to 9 cameras).
- F. The alarm list shall include a number of columns that shall describe different details of the alarm/event, for example the time of the alarm, the alarm priority level, alarm ID and type of alarm.
- G. It shall be possible to filter the columns in the alarm list, to drag them to other positions and to right-click to show and hide certain columns.
- H. The System shall provide an alarm reaction time of less than 1 second when sufficient network bandwidth is available.
- I. It shall be possible to double-click an alarm to open an alarm window. The window shall show a preview of the alarm incident and live video.
- J. It shall be possible to acknowledge that an alarm has been received and will be handled. It shall be possible to acknowledge multiple alarms simultaneously.
- K. It shall be possible to view alarm reports, representing predefined reports on category, state, priority, reasons for closing the alarm, site, and response time.



- L. It shall be possible to enable a sound notification which shall alert operators of new alarms. It shall be possible to use a default sound file or a custom .wav file which can be uploaded to and tested in the management client. It shall be possible to remove the sound notification if it is no longer needed.
- M. An alarm sound settings option shall make it possible to configure the sounds to be available. By default, the video management system shall use Windows default sounds. An alarm data settings option shall make it possible to define and customize alarm priorities, states and categories.
  - 1. Default alarm priorities shall be available, which shall be low, medium, and high.
  - 2. Default alarm state shall be available, which shall be new, in progress, on hold, and closed.
  - 3. It shall be possible to assign sounds to alarm priorities.
- N. Selecting alarms in the navigation pane shall open the alarm function which, based on functionality handled in the management server, shall provide central overview, control and scalability of alarms in any number of federated video management system installations throughout an organization.
- O. The system shall allow the Camera Server to capture video prior to the alarm /event, as well as after the alarm/event and shall be selectable from a list of values ranging between 0 seconds and 5 minutes.

5.2.19.7. **STANDALONE VIEWING CLIENT**

- A. The standalone viewing client shall make it possible to view exported video.
- B. The standalone viewing client shall run from an .exe file, and no installation of any other software shall be required in order to view exported video.
- C. It shall be possible to assign a password to a project or to devices so that only people with permission shall be able to access the project or devices. Once a password has been set to a project, the password shall not be possible to delete. It shall be possible to edit the password.

It shall be possible to verify signatures of native database format video sequences to verify that the files have not been tampered with.

5.2.19.8. **MOBILE VIEWING CLIENT (AT LEAST 20 LICENSES)**

It shall be possible to access and view cameras and views on a Smartphone or a tablet (a mobile device). Mobile Client should have live and Playback functionality.

5.2.19.9. **VIDEO WALL APPLICATION**

- A. The application shall provide dynamic control of the layout of the video wall, and content shall easily be added by dragging and dropping cameras into view positions on the video wall.



- B. The federated architecture shall support integration and user control of the video wall application when the video wall is installed on the same site that the users are logged into.
- C. It shall be possible for operators to manually set video wall to pre-sets and set a video wall monitor to show specific cameras.

### **5.3. POWER SUPPLY SYSTEM**

5.3.1. All equipment of CCTV system shall work from 230 VAC single phase supply from UPS System which shall be provided by MS01A Signalling contractor. The MS07 Contractor shall provide power supply converters with associated surge arresters etc as required for satisfactory performance of various equipment of CCTV system. Cameras which shall be distributed close to the 25 KV traction systems at stations/Depot, the MS07 contractor shall provide suitable, proven and of adequate rating surge suppressers on the data, power and video cables both at the camera end and at the TER. To avoid interference from 25KV AC, the MS07 Contractor shall accordingly plan the cameras for platform.

#### **5.3.2. POWER SUPPLY DISTRIBUTION BOARDS FOR CCTV BY THE CONTRACTOR**

5.3.2.1. To meet with the requirements of power supply for various CCTV equipments, a Separate Power Supply Distribution board is required to be provided by the Contractor shall submit the design of the Distribution Board to the Employer Representative for review and approval.

5.3.2.2. Each distribution board shall be arranged for top and/or bottom cable entry and shall be provided with ample cable termination plates and chambers to enable cables to be neatly glanded with tails grouped and terminated on to appropriate internal terminations.

5.3.2.3. Multi-terminal connectors shall be provided within the distribution board for connection of protective conductors of all outgoing circuits including spares.

### **5.4. SYSTEM EXPANSION**

5.4.1. All CCTV system provided shall be modularly expandable to an expansion capacity of 25% by the addition of cards and/or modules without the need to replace the installed hardware and software of the system as a minimum.

### **5.5. NETWORK SECURITY**

5.5.1. All IP based CCTV equipment across the CCTV network shall strictly comply the IT security policy as specified in Chapter-1 (General Requirements) of this PS including the following requirements

5.5.2. CCTV network shall not be accessible from any other Telecom system with which no interface has been provided.

5.5.3. To ensure security of Video Surveillance system (Camera & Software) from vulnerabilities & breaches and discourage false undertaking from OEMs, security auditing and testing of equipment including source code of equipment and software shall be carried out from Standardisation Testing and Quality Certification (STQC) Laboratory or any other agency notified by MeitY from time to time and shall take immediate remedial actions for



observed non-conformities. In order to ensure security of network and other IT equipment of Video Surveillance System, before bulk supply & installation, purchaser should ensure Security auditing and testing (STQC Certification) at the time of Factory Acceptance Test (FAT) of 1st Lot of material or as specified by the Purchaser. In case any security breach is found in the system at any stage, immediate strict penal action shall be initiated by the purchaser.

- 5.5.4. All OEMs involved in this system contract must submit a declaration certificate regarding their genuinity, have their own manufacturing setups and IPR for the hardware(s)/software(s), and shall not have 3rd party manufacturing from any company blacklisted in India or abroad (due to proven backdoor access and data vulnerability) or any company sharing land border with India. The Intellectual Property Rights (IPR) of all manufactured final products and source code of all software including firmware, software etc. should not reside in countries sharing land borders with India, until unless specifically allowed by Government of India and is registered with the Competent Authority of Government of India. Proof / Declaration of IPR & country of source Code (residing) along with requisite permission & registration with Competent Authority of Govt. of India, as applicable towards compliance to the above, shall be provided by the OEMs. In case any breach or false declaration is found at any stage, immediate strict penal action shall be initiated by the purchaser.

## **6. INTERFACES**

### **6.1. GENERAL**

- 6.1.1. MS07 contractor shall interface with the other Project Contractors as per interface table in PS chapter 10 as a minimum and ensure the interfacing requirements are complied with the requirement of the CCTV system

### **6.2. FIBRE OPTIC TRANSMISSION SYSTEM (FOTS)**

- 6.2.1. All video and control signals from stations/ Depot to the OCC/BCC shall be transmitted through FOTS Network being provided by the contractor in the TER/CER.
- 6.2.2. The MS07 contractor shall take care of the interface to implement proper interfacing and integration of CCTV system with the Wide Area Network (WAN)
- 6.2.3. All fibre/circuit interfaces between FOTS Network and CCTV System shall be provided at the Main Distribution Frame, digital distribution frame or optical distribution frame, as appropriate, depending on the type of circuits.

### **6.3. MASTER CLOCK SYSTEM**

- 6.3.1. The CCTV system shall receive time data message from the Master Clock system, at the OCC/ BCC CER for time synchronisation.
- 6.3.2. The MS07 contractor shall take care of interface with the Master Clock System for time synchronisation of CCTV .



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**6.4. POWER SUPPLY UPS SYSTEM- DISTRIBUTION CUBICAL**

- 6.4.1. AC power from the UPS, to meet the requirement of Telecom, AFC and Signalling Contractors shall be provided by MS01A Signalling contractor in UPS (S&T) Room. The MS01A Signalling contractor shall provide AC distribution panel having three MCCBs (one for Signal, one for Telecom and one for AFC) The MS07 contractor shall extend the AC power supply (for Telecom) from UPS Room to TER/CER and provide a Distribution system in cubicle. Distribution circuits shall be suitably protected with MCBs, Earth Leakage Detectors and SPDs etc.
- 6.4.2. Adequate no. of spare circuits of each type for each sub-system shall also be provided in the distribution system by MS07 Contractor.

**6.5. Civil works Project Contractors**

- 6.5.1. MS07 contractor shall co-ordinate with the Civil Works Project Contractors to ensure that all requirements of the specifications pertaining to interfaces are properly satisfied as per Appendix A of PS chapter 10



## ANNEXURE A

### REQUIREMENTS OF LARGE VIDEO SCREEN

The large screen graphics wall in the Security control room shall be used for the display of important Images from IP video cameras, graphics from the PC, Workstation, etc. It should have the functionality to pre-configure and save various display layouts to be accessed at any given point time with a simple mouse click. The video wall arrangement including all equipments accessories, cables, mounting structure/frame, Controllers, Wall management Software, etc shall be provided and implemented by the Contractor.

The cube and controller should be from the same manufacturer and the display OEM shall have its own service centre in India.

The large screen should be able to show the images of the monitor, which is connected on the LAN with Windows latest OS and the windows should be freely resizable, re-scalable and repositionable on any part of the large video screen. Normally all the stations of the OCC/ BCC's jurisdiction shall be viewed simultaneously on the full 8x2 video Wall at OCC/BCC windows of equal sizes. Thus, each window shall represent one station view on which sequentially all cameras of that particular station shall automatically will be displayed. However, in case required, the configuration can be changed and even it shall be possible to see a single camera view on the full Video Wall. It shall be possible for the user to define different views and sizes and save them, so as to be used as and when required.

The large graphics wall shall be consisting of multiple rear projection modules in multiple rows and columns behaving as single logical screen.

The display wall should be rugged and industrial nature and should be able to work in 24\*7 environments.

#### A. Display unit:

The display wall should consist of the Visual Display Unit, Mounting Stand, Display Controller and the Wall Management Software, which should be supplied from a single manufacturer with the following specifications:

1. The Visual Display Unit / Rear Projection Module must be based on Single Chip DLP-based Rear Projection Technology equipped with multiple laser Banks.
2. Should have the scalability and upgradeability to be made up of multiple rear projection modules stacked up in rows and columns to achieve a display wall for better viewing ability in linear or curved configuration.
3. The Rear Projection Modules must be based on Single Chip DLP, Full HD (1920X1080) Native, and Rear Projection technology.
4. The DMD chip should have minimum 2.0 Mega pixels and the DMD mirrors should be square in shape.



5. The Large Screen Graphics wall shall be installed in Control Room at OCC/BCC or at any other designated location. The Large Screen Graphics wall shall be made up of 10 Rear Projection Modules fitted in 8 Columns wide and 2 row and high and the overall screen size shall be approximately 7750 (w) mm X 1744 (h) mm.
6. The overall resolution of the full graphics wall shall be min. 9,600 x 2160 pixels.
7. The Minimum Diagonal Size of each Visual Display Unit / Rear Projection and should offer 16.7 million colours.
8. The life of Laser Light Source should be minimum 100000 hrs.
9. The replacement of defective module should be possible in field with MTTR < 4 hours.
10. The brightness uniformity should not be less than 98%.
11. The Dynamic contrast will be 1,000,000:1 or better (Typical).
12. The luminance on each rear projection module shall be 500 cd/m<sup>2</sup> or higher.
13. Each of the Rear Projection Modules should have an arrangement to adjust the brightness of individual projection module automatically to have a completely uniform graphics wall over time without compromising the contrast & colors. User must be able to control (switch on/off) the automatic bright adjustment as per control room requirements.
14. Each cube shall have its own IP address to have the access from a standard web page from any PC over the Ethernet and shall communicate to a viewer via Ethernet.
15. The screen should be of almost Zero Gap technology (Inter-screen gap < 0.8 mm). The screen surface should not be reflective with the half gain angle of the screen used in +35° horizontal and +27° vertical position. Screen should be of minimum three layers with a Hard backing to prevent bulging.
16. The input to projection module will be DVI-D to have a flicker free image on the Large Screen Graphics Wall. Other input ports- HDMI, analog RGBHV & display port must be available for multiple inputs connectivity.
17. Operating temperature should be between 5°C to 40°C.
18. Dust protection: projection unit should meet IEC/EN-60529 requirements (IP6X certification) and should submit a certificate from a third-party laboratory.
19. Power consumption for each Visual Display Unit / Rear Projection Modules should be ~350 watts.



20. Base stand shall be covered from all sides. Rear covers shall be openable preferably screwless, suitable rodent repeller shall be provided.

**B. Display Controller:**

The Complete Display Controller including I/O Modules and decoding units shall be redundant with auto switchover facility to ensure that no single failure of any controller or I/O module shall result in failure/blanking of a zone on the display wall. The Display controller should have the following specifications:

1. The controller should be in an industrial 19" rack mounted casing based on Intel Xeon 2.3 GHz or better.
2. The minimum memory of 8GB (standard) expandable up to 32 GB and should be DDR3 or latest type.
3. The unit should be equipped with a DVD ROM Drive.
4. The system should be equipped with minimum 500 GB HDD in RAID 1 Configuration.
5. The display controller should have dual redundant hot swappable power supply.
6. Should have 10/100/1000 Mbps Redundant Ethernet port for LAN connection.
7. Supplied with a Keyboard and mouse with 20 m cable extension.
8. The Display Controller should be based on latest Windows/Linux OS.
9. It should give multiple DVI graphics outputs to be connected to the multiple rear projection modules.
10. There should be possibility of connecting the various types of analog and digital sources using inputs in freely scalable and moveable windows on the graphics wall. It should support 2 Nos. of either of the following inputs:
  - SDTV analog PAL, NTSC, SECAM (Composite, S-Video, Component)
  - HDTV 720p, 1080i, 1080p (Component)
  - RGB analog up to 1920x1080 (up to 165 MHz pixel clock)
  - DVI-D/VGA up to 1920x1080 (up to 165 MHz pixel clock)
11. There should be possibility of connecting Video Inputs from different IP based Surveillance servers installed at stations/Depot/OCC/BCC to show the multiple Streams sources in scalable and moveable windows on the graphics wall.
12. The controller unit shall have a dual 10/100/1000 Base-T failover Ethernet interfaces.



**C. Software:**

The Software should have the following specifications:

1. The software should be able to pre configure various display layouts and access them at any time with a simple mouse click or based on the timer.
2. The software should enable the users to change the size and position of the various windows being shown on the Display Wall.
3. The software should enable various operators to access the display wall from the local keyboard and mouse of their workstation connected with the Display Controller on the Ethernet,
4. The software should copy the screen content of the Windows 10 or latest workstations (Showing semi static content) connected on the Ethernet with the Display Controller to be shown on the Display wall in scalable and moveable windows in real time environment.
5. The wall management software shall allow switching the video inputs.
6. The software should support open API for third party integration.
7. The System should have self-correction with software to perform health monitoring that allows timely detection of faults.
  - a) Internal temperature
  - b) Ambient temperature
  - c) Humidity
  - d) Cooling
  - e) System Status
8. Software shall allow commands on wall level or cube level or a selection of cubes
  - a) Switching the entire display wall on or off.
  - b) Setting all projection modules to a common brightness target
  - c) Light source status

**D. The MS07 Contractor should fulfil the following requirements:**

- 1) The complete solution i.e. the projection modules, display controller, video streaming decoding units and the wall management software should be compatible and proven.
- 2) Manufacturer owned local after sales support organization to be there in India.

Should have the experience of executing at least 2 such similar projects of the display wall in past two years in India or abroad to the same specifications as in this tender.



Please refer Appendix-C of PS Chapter 10

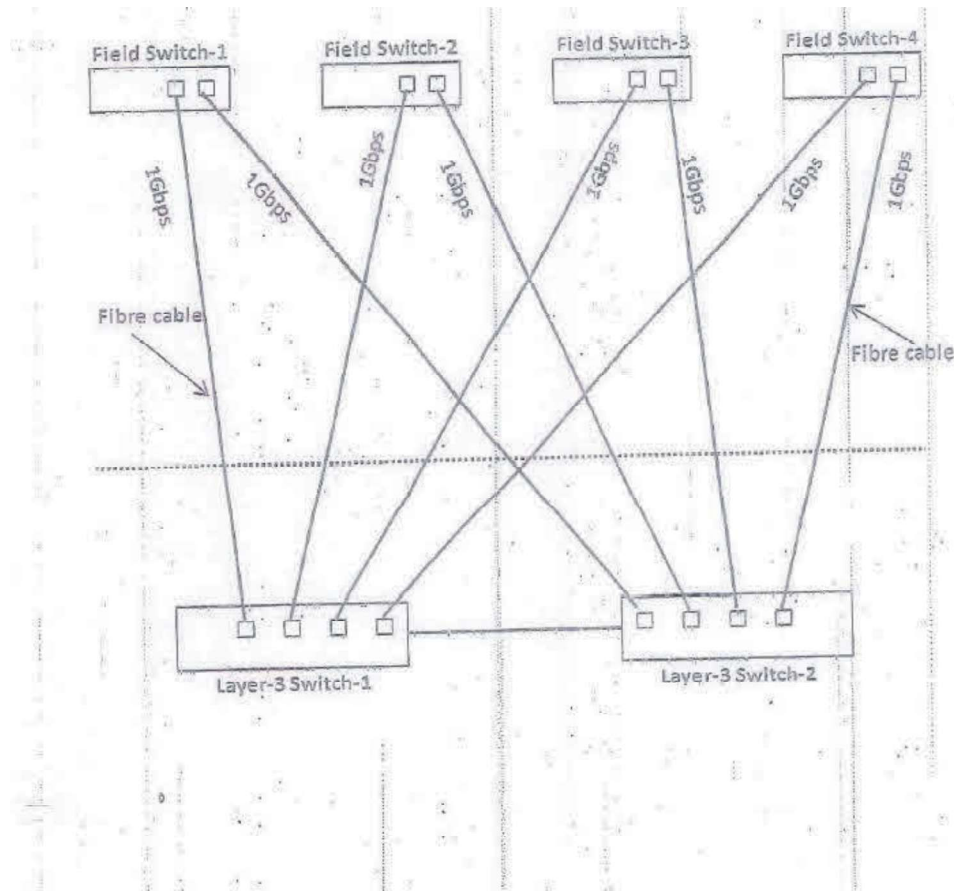


For Phase1 Commissioning: Existing RSS at Nancy Colony will be used.

For remaining :1 RSS is planned at Dongri Depot



Drawing No. MS07/1 (Layer 2 and Layer 3 switch integration)



**KEY & ACCESS DATES****1. KEY DATES**

The work includes a number of stages. These stages, which are inter-related with and essential to completion of the Telecommunication system are to be achieved by the Key dates indicated in the schedule of Key Dates.

If the identified stage is not achieved by the stated Key Date, liquidated damages may become applicable as set out in the contract.

**1.1. Stage 1- Key Date 1 (KD1): Preliminary Design Submission.**

**Achievement:** Submission to the Employer's Engineer of the Preliminary Design as specified in the Particular Specifications.

**1.2. Stage2- Key Date 2 (KD2): Final Design Submission**

**Achievement:** Submission to the Employer's Engineer of the Final Design as specified in the Particular Specifications.

**1.3. Stage-3 Key Date 3 (KD3) Obtain "No Objection/No Objection Subject to Comments" from Employer's Engineer on Final Design submission.**

**Achievement:** Obtain "No Objection/No Objection Subject to Comments" from Employer's Engineer on Final Design submission as detailed above.

**1.4. Stage-4 Key Date 4 (KD4): Delivery of Telecommunication Equipment and other accessories covered under the scope of MS07 contract at Mumbai.**

**Achievement:** Delivery of Telecommunication Equipment and other accessories covered under the scope of MS07 contract at Mumbai.

**1.5. Stage 5- Key Date 5 (KD5) Revenue operation****1.5.1. Key Date 5A (KD5A) Revenue Operation**

Taking Over of the section by the Employer for Running Revenue Services including Completion of all testing including integrated testing to start of revenue service and;

**1.5.2. Key Date 5B (KD5B): Revenue Operation (UTO)**

Commissioning of Unattended train operation (UTO) mode and associated modes viz standby mode etc.

**1.6. Stage 6- Key Date 6 (KD6): Completion of contract**

**Achievement:** This Key date relates to the following:

Completion of all contract responsibilities including completion of outstanding work mentioned in Taking Over Certificate (TOC), satisfaction of Defects Liability period requirements; Issue of a performance certificate in accordance with GCC.

**2. ACCESS DATES**

The MS07 contractor shall require access to information as well as to various locations at station/guide-ways, etc, in stages in order to plan his activities for time bound - completion of his obligations under the contract. The dates on which such access become available are indicated in the schedule of Access Dates.

The contractor shall develop his work plan based on these Access Dates. If in the course of construction, the achievement of these access points must be shifted in time, to be either earlier or later, such adjustments shall be notified by the contractor for modification of the work plan. If such readjustment cannot be accommodated without changes to the Key Dates and/or the level of effort, then the contractor shall notify the Employer's Engineer of such conditions for resolution under the terms of the contract.

MS07 contractor shall give all inputs required for meeting the Access Dates defined hereunder to other Designated contractor in a timely manner to match the programme schedule of the designated contractor. In any case, all these inputs must have been given by MS07 contractor and agreed jointly between the designated contractors at least 16 weeks before the stated access date.

The Access Dates are defined as hereunder, which are for planning purposes only:

- 2.1. STAGE 1- Access Date 1 (AD1): Access to Equipment rooms at stations/Depots/OCC**
- 2.1.1. By this date, The MS07 contractor will have access to the Telecom Equipment Rooms for MS07 use. Prior to such access, Civil and Electricals works specified below will have been completed:
  - 2.1.1.1. Wall finishes, False floor (if applicable ) and Doors/windows.
  - 2.1.1.2. Cable support structures from main cable guide-ways along the track to the above room for optical fibre cables/Power cables.
  - 2.1.1.3. Concealed conduits within the equipment room.
  - 2.1.1.4. Installation (not commissioning) of electrical lighting fixtures and smoke detectors.
- 2.2. STAGE 2- Access Date 2 (AD2): Access to cable Ducts / Hangers /Trays along viaduct**
- 2.2.1. By this date the MS07 contractor will have general access to cable Ducts /hangers along the viaduct for MS07use pertaining to laying of optical fibre cables/main cables/leaky co-axial cable along the viaduct and tunnel.
- 2.3. STAGE 3 Access Date 3(AD3): Shared Access to track**
- 2.4. STAGE 4 Access Date 4(AD4): Access to Permanent Power & OHE.**
- 2.4.1. By this date, the provision of permanent power & OHE will have been completed.

**SCHEDULE OF ACCESS DATE**

<b>AD NO.</b>	<b>ACCESS DATE</b>	<b>MML-9 Phase-1 (Dahisar East to Kashigaon) (4 stations)</b>	<b>MML-9 Phase-2 (Sai Baba Nagar to RAI stadium) (6 Stations)</b>	<b>MML-9,7A Phase-3 (Andheri E to CSMIA &amp; Dongri Depot)</b>
AD1	ACCESS TO EQUIPMENT ROOM	15.05.2025	15.09.2025	15.07.2026
AD2	ACCESS TO CABLE DUCTS/ HANGERS/TRAYS ALONG THE VIADUCT	30.05.2025	30.10.2025	30.09.2026
AD3	SHARED ACCESS TO TRACK	05.06.2025	15.09.2025	15.08.2026
AD4	ACCESS TO PERMANENT POWER & OHE	30.05.2025	31.12.2025	31.03.2027

**SCHEDULE OF KEY DATES**

<b>Key Dates</b>	<b>Description</b>	<b>MML-9 Phase-1 (Dahisar East to Kashigaon) (4 stations) {weeks from commencement date}</b>	<b>MML-9 Phase-2 (Sai Baba Nagar to RAI stadium) (6 Stations) {weeks from commencement date}</b>	<b>MML-7A &amp; Depot Phase-3 (Andheri E to CSMIA &amp; Dongri Depot) {weeks from commencement date}</b>
KD1	Submission of Preliminary Design	8 Weeks	12 weeks	16 weeks
KD2	Submission of Final Design	16 weeks	28 weeks	40 weeks
KD3	Obtain consent of Employer's Engineer on Final Design Submission	18 weeks	34 weeks	50 weeks
KD4	Delivery of related and required Telecommunication System at Contractor's premises in Mumbai.	56 weeks	56 weeks	64 weeks
KD5A	Revenue Operation	70 weeks	82 weeks	94 weeks
KD5B	Revenue operation (UTO)	98 weeks	110 weeks	130 Weeks
KD6	Completion of Contract.	(on completion of DLP of Complete work)		

**END OF APPENDIX B**

## CONTRACT SPARES

1.

## FOTS

S. No	Item	Qty
1.	All replaceable parts (Cards/Modules) of Core switch at OCC/BCC	5 each
2.	Distribution Switch (Layer-3 switch for stations) fully equipped and associated accessories as per General Specification and Particular Specifications	7
3.	Access Switch	7
4.	OFC 144 Fiber Armoured Cable for Elevated/At Grade Section as per RDSO or TEC Specifications (km)	10 Km
5.	OFC 244 Fiber Armoured Cable for Elevated/At Grade Section as per RDSO or TEC Specifications (km)	10 KM
6.	Terminals and Connectors of all types	27 for each type
7.	Optical Fiber splices box	7
8.	Optical Patch Cords/Pigtail Cables	27 for each type

2.

## TELEPHONE SYSTEM

S. No	Item	Qty
1.	IP PBX fully equipped 48 port/96 Wired	2
2.	IP PBX Server including Gateway (fully equipped)	1
3.	Exchange Subscriber Line Cards	10% of Supplied Population for Each type
4.	Exchange Junction Line Cards	10% of Supplied Population for Each type
5.	Exchange System Control Cards	10% of Supplied Population for Each type
6.	Direct Line Exchange Cards	10% of Supplied Population for Each type
7.	Digital Telephones	2
8.	Analogue Telephones (Basic IP telephone )	40
9.	Direct Line Telephones (Each Type)	2
10.	IP Phone (Voice) with all accessories	5
11.	IP Phone (voice & video) with all accessories	5
12.	Cards for FCBC	10% of Supplied Population for Each type
13.	Fuses of all types	10% of Supplied Population for Each type

S. No	Item	Qty
14.	Terminals of all types ( For Telephone system)	10% of Supplied Population for Each type
15.	CAT 6 Cable Each Type	2
16.	Direct Line Telephone Console (90 Line Capacity) with Direct Line Master Conference set	2

3.

### PIDS/PAS/MASTER CLOCK

S. No	Item	Qty
1.	PIDS/PA Integrated Workstation for Station (Workstation, Monitors, Mics, Keyboard, Mouse, Speakers, Headphones etc.)	7
2.	All type of PCB Cards including motherboard and power supply unit of PIDS, PIDS Control & Switching Equipment, PIDS LED Modules (For Platform LED Panels)	10% Population of each type
3.	All type of PCB Cards including motherboard and power supply unit of PIDS, PIDS Control & Switching Equipment, PIDS LED Modules (For Concourse LED Panels)	10% Population of each type
4.	PIDS Platform Display Board Complete	7
5.	PIDS Concourse Display Board Complete	5
6.	Complete PAS Equipment cabinet including PA system control & Switching equipment	5
7.	PA Control Panel	7
8.	PA System Pre-Amplifier	10% Population of each type
9.	PA Speakers	10% Population of each type
10.	PA System noise sensing & feedback equipment	10% Population of each type
11.	All replaceable module/cards for OCC/BCC Master Clock Unit as equipped in OCC/BCC	1 No Each
12.	Station Sub-Master Clock Complete (With connecting cables & connectors)	5
13.	Indoor Digital Clocks	23
14.	Outdoor Digital Clock	19
15.	Analogue Station Clocks	10
16.	Fuses of all types	10% Population of each type
17.	Terminals of all types	10% Population of each type

4.

### CCTV

S. No	Item	Qty
1.	Fixed IP Camera as per PS	53
2.	Fixed Dome Type Camera as per PS	25
3.	PTZ Dome IP Camera as per PS	12

S. No	Item	Qty
4.	IR Illuminated IP Camera as per PS	12
5.	360 Degree Panoramic View Camera	12
6.	IP Based Corner lift camera	5
7.	Local Work Station (Complete MMI with one monitor for Monitoring) as per GS	12
8.	Keyboard with joystick as per PS	12
9.	NVR Server with RAID 5 or better each to record all cameras of each station as per PS	12
10.	Layer 2 switch (Industrial Grade) as per PS	12
11.	04 Port Industrial grade switch as per PS	12
12.	All type of replaceable/plug-in modules for CCTV System	10% of the total population
13.	Protection Devices for Power, Control and Data Circuits as per PS	10
14.	Data Cable Cat 5e (Kms) as per PS	5
15.	Power Cable (Kms) as per PS	2
16.	Optical Fiber Cable as per PS (Km)	2
17.	KVM TX/RX Pair	12
18.	Consumables for Video Wall (e.g. Light Source, Dust filter etc.)	10% of the Population

5. **ACS:** 10% of the installed Quantity for each type of equipment
6. **IT Active Equipments:** 10% of the Population for each type of equipment
7. **IT Passive Equipments:** 10% of the Population for each type of equipment

**Note:**

- (i) "Each Type" denotes the type actually provided during execution.
- (ii) Spare Qty to be delivered per section should be rounded off to the next higher integer.

**END OF APPENDIX E**

## MMI PROVISION SCHEDULE

<b>Control Centre</b>					
<b>MMI Provision Schedule</b>					
<b>Location</b>	<b>Position</b>		<b>Workstation/Control Panel</b>		
			<b>Type</b>	<b>Quantity</b>	
Control Centre	Traffic Controller (TC1)	Controller	1	CCTV Control Panel (Station Surveillance)	1
				Direct Line Telephone Console	1
	Train Controller (TC2)	Controller	2	CCTV Control Panel (Station Surveillance)	1
				Direct Line Telephone Console	1
	Train Controller (TC3)	Controller	3	CCTV Control Panel (Station Surveillance)	1
				Direct Line Telephone Console	1
	Chief Controller (CC)			CCTV Control Panel (Station Surveillance)	1
				Direct Line Telephone Console	1
				PIDS/PAS Workstation + PAS Control Panel	1
	Traction Power Controller 1 (TPC 1)			Direct Line Telephone Console	1
	Traction Power Controller 1 (TPC 2)			Direct Line Telephone Console	1
	Auxiliary Systems Controller 1 (ASC1)			Direct Line Telephone Console	1
	Auxiliary Systems Controller 1 (ASC1)			Direct Line Telephone Console	1
	Rolling Stock Controller (RSC)			Direct Line Telephone Console	1
	Assistant to Chief Controller (ACC)			Direct Line Telephone Console as for chief controller (for all stations)	1
				PIDS/PAS Workstation + PAS Control Panel	1
	Fault Management Controller			Direct Line Telephone Console	1
	Security Controller in Control Centre			Direct Line Telephone Console	2
CCTV Workstation (for all stations and OCC/BCC Surveillances) & Associated Equipment				2 (Dual Monitor)	

MMI Provision Schedule			
Location	Position	Workstation/Control Panel	
		Type	Quantity
	PIDS/PAS Back-up MMI (Position to be specified later)	PIDS/PAS Workstation + PAS Control Panel	1
	CSS	Direct Line Telephone Console	1
		PIDS/PAS Workstation + PAS Control Panel	1
		CCTV NMS	2
		PIDS/PAS NMS	2
		FOTS NMS	2
		Clock NMS	2
		CDRS NMS	2
		Telephone NMS	2
		CTFRS NMS	2
		SCR All Stations	
CCTV Workstation (Station Surveillance)	1 (Dual Monitor)		
Security Control Room All stations		CCTV Workstation (Station Surveillance)	1 each (Dual Monitor)
On each Platform (PSB) All Stations		PAS Control Panel	1 in each platform (PSB) (Dual Monitor)
On Platform (PSB)		CCTV Workstation (Station Surveillance)	1
Depot			
Depot	Depot Controller	PAS Workstation (Depot Area)	1
		Direct Line Telephone Console	1
		CCTV Control Panel for Depot	1
	Crew Controller		
	PPIO	PAS Control Panel	1
	Security Controller Room	CCTV Control Panel for Depot	1

**Notes:**

1. All above are parts of MS07 Contract Package.
2. CCTV MMI shall be provided with Dual Monitor for SCRs, Depot controller and CSS Controller.
3. The existing Telecom Sub System provided for Line 7,2A,2B may preferably be

integrated with system(s) proposed for Line 7A & 9, such that existing work stations/MMIs for Telecom sub system of Line 7,2A and 2B available at OCC/BCC, are applicable for Line 7A and 9 as well. Alternatively new, additional workstations, MMIs for line 7A and 9, if required to meet the scope shall be provided.

4. Location of security controller may be finalized during design stage.

**END of APPENDIX-H**

## SPECIFICATIONS FOR LAP TOP (LOCAL CRAFT TERMINAL)

S. No	Parameters	Minimum Specifications
1.	Processor	11th generation Intel Core-i7 or better Processor (8 MB Cache)
2.	RAM	16GB, DDR4, 3200MHz
3.	Storage	1 TB M.2 PCIe NVMe Solid State Drive
4.	Display	15.4 -inch FHD (1920 x 1080)
5.	Port	RJ45 Ports - 10/100/1000Mbps GbE - 1 no. USB 3.x Gen. Ports - 3 nos. HDMI Port- 1 no.
6.	Graphics Memory	2GB dedicated NVIDIA/AMD graphics card
7.	Operating System	Preloaded Genuine Windows 10 (64bit) professional
8.	Pre-Loaded Software	Anti-Virus, MS Office 2019 or latest, Adobe PDF
9.	OS Recovery Media	Recovery DVD/media for Operating system
10.	Approvals	Laptop shall be from reputed makes.  The Contractor shall submit a proposal indicating the make & model of the proposed Laptop to the Engineer for review & approval. The Laptop shall be procured only after receipt of no objection from the Engineer.
<p><b>Note:</b></p> <p>Laptop shall be used as Local Crafts Terminal (LCT) and shall therefore be compatible and loaded with system maintenance software. The laptop shall be supplied with all accessories i.e. Charger, Laptop Bag etc.</p>		

END of APPENDIX N



- 2.6.5 Post implementation on-site support and maintenance.
- 2.6.6 All other items in the scope of system implementation.
- 2.7 Only standard, certified, maintainable equipment and accessories shall be used. Sample of each item shall be approved by DMRC before supply / installation. Contractor should highlight this aspect in their technical offer.
- 2.8 The contractor will initially install the system at one pilot station/depot. After Engineers' approval, the contractor will proceed for further installation. The contractor should submit a detailed schedule plan for system implementation.
- 2.9 It shall be responsibility of the contractor to install electromagnetic door locks at fire rated doors. Also, contractor shall submit design of electromagnetic door lock arrangement before installation and take approval.

**3. ACCESS CONTROL SYSTEM EQUIPMENT**

The tentative types of equipment installed under Access Control System are as follows.

The Final list & its Specification will be finalized during Design of the System.

- 3.1 Recessed/Surface mounted Networkable multiprocessor controlled 4 reader controllers capable of controlling multiple readers (IN/OUT) with inbuilt trouble shooting indications on front panel, Memory Buffer, Power supply and 6 hours battery back-up along-with TCP/IP connectivity 8 inputs and 8 outputs; readers expandable up-to 8 per controller as required. The hardware and software should be preferably the same OEM.
- 3.2 4 Reader Controller- 100 mm read range Contactless smart card readers as per suitable for mounting on metal surface/ metal frames or wooden frames wall or as required based on site conditions including all accessories, complete as required.
- 3.3 4 Reader Controller- 100 mm read range Contactless smart card readers as per suitable for mounting on metal surface/ metal frames or wooden frames wall or as required based on site conditions including all accessories, complete as required.
- 3.4 100 mm Read range Contactless smartcard readers with keypad suitable for mounting on metal surface/metal frames or wooden frames wall or as required based on site conditions including all accessories, complete as required.
- 3.5 Recessed/Surface mounted Electromagnetic Locks for Single Doors & Double doors suitable for glass/ wood doors capable of withstanding minimum force of 600 lbs complete as per specifications and as per model specified.
- 3.6 Supply, installation and commissioning of Access Management Software with networked multi-user option/client & server configuration complete as per specifications and as required and including PC as required. Software to be interfaced with time and attendance management software and to be suitable to interface with the Client's existing access management system.