MMRC

Mumbai Metro Rail Corporation Limited
(JV of Govt. of India and Govt. of Maharashtra)

Invitation for Bids "Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of Ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and Ballasted Track in the area of at-grade Aarey Station and in the Depot area of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ)

and

Procurement and Supply of Turnouts, Scissor Crossovers and Buffer Stops for the entire Mainline for Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ) including Package 10 B."

Date: 31-Jul-2019
Loan Agreement No: ID-P 268
IFB No: MM3-CBS-TWK-03 (Package 10C)

The Mumbai Metro Rail Corporation (MMRC) has received a loan from Japan International Cooperation Agency (JICA) towards the cost of Project Mumbai Metro Line 3 (Colaba- Bandra-SEEPZ). It is intended that part of the proceeds of this loan will be applied to eligible payments under the Contract for "**Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of Ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and Ballasted Track in the area of at-grade Aarey Station and in the Depot area of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ).**

and

Procurement and Supply of Turnouts, Scissor Crossovers and Buffer Stops for the entire Mainline for Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ) including Package 10 B."

1. Bidding will be conducted through procedures in accordance with the applicable Guidelines for Procurement under Japanese ODA Loans, and is open to all Bidders from eligible source countries, as defined in the Loan Agreement.

   The Mumbai Metro Rail Corporation (MMRC) now invites sealed Bids from eligible Bidders for the design, execution and completion of "**Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of Ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and Ballasted Track in the area of at-grade Aarey Station and in the Depot area of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ).**

   and

MMRC

Mumbai Metro Rail Corporation Limited

(JV of Govt. of India and Govt. of Maharashtra)

Procurement and Supply of Turnouts, Scissor Crossovers and Buffer Stops for the entire Mainline for Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ) including Package 10 B."

2. International Competitive Bidding will be conducted in accordance with JICA's "Single-Stage Two-Envelope Bidding (without Pre-qualification)"

3. The complete bid document Part 1 to Part 4 has been uploaded on MMRCL website for reference only.

Bidders may obtain further information from and inspect the Bidding Documents at the office of: *Mumbai Metro Rail Corporation Ltd., Line 3 Transit Office, Wing 'A' North Side of City park 'E'- Block, Bandra-Kurla Complex, Bandra (East) Mumbai 400 051, India.*

1. A complete set of the Bidding Documents may be purchased by interested eligible bidders on the submission of a written application to the address above and upon payment of a non-refundable fee of **INR 25,000.00 (Twenty-Five Thousand Indian Rupees Only) or US$ 370.00 (Three Hundred Seventy US Dollar Only)** (Inclusive of GST) **in the form of a crossed demand draft in favor of Mumbai Metro Rail Corporation, payable at Mumbai, from 03-08-2019 to 14-09-2019 between 10 AM and 5 PM.**

2. Bids must be delivered to the address above **on or before 2 PM on 15-09-2019** and must be accompanied by a Bid security of **INR 19.5 million or USD 0.27 million.**

Bids will be opened in the presence of Bidders representatives who choose to attend at **3 PM on 15-09-2019** at the office of: *Mumbai Metro Rail Corporation Ltd., Line 3 Transit Office, Wing 'A' North Side of City park 'E'- Block, Bandra-Kurla Complex, Bandra (East) Mumbai 400 051, India.* Telephone: +91 22 26575123, Website: http://www.mmrcl.com.

Place: Mumbai,

Date: 31-07-2019

(Smt. Ashwini Bhide, IAS)

Managing Director

Mumbai Metro Rail Corporation (MMRC)

BIDDING DOCUMENTS

MUMBAI METRO LINE 3
(COLABA-BANDRA-SEEPZ)

CONTRACT MM3-CBS-TWK-03
(Package 10C)

Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of Ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and Ballasted Track in the area of at-grade Aarey Station and in the Depot area of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ).

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Procurement and Supply of Turnouts, Scissor Crossovers and Buffer Stops for the entire Mainline for Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ) including Package 10 B.

PART 1
BIDDING PROCEDURE

Section I
INSTRUCTIONS TO BIDDERS

July 2019
JICA LOAN AGREEMENT ID - P 268

Mumbai Metro Rail Corporation Ltd
Line 3 Transit Office, Wing 'A' North Side of City park 'E'- Block,
Bandra-Kurla Complex,
Bandra (East) Mumbai 400 051, India

BIDDING DOCUMENTS
Composition of Documents

Part1	**Bidding Procedures**	
	Section I	**Instructions to Bidders(ITB)**
	Section II	Bid Data Sheet (BDS)
	Section III	Evaluation and Qualification Criteria
	Section IV- A	Bidding Forms
	Section IV- B	Pricing Document
	Section V	Eligible Source Countries of Japanese ODA Loan
Part2	**Employer's Requirements**	
	Section VI (1)	General Specifications A. General B. Functional C. Design D. Construction E. Inspection Testing and commissioning F. Appendices
	Section VI (2)	Outline Design Specifications
	Section VI (3)	Outline Construction Specifications
	Section VI (4)	Tender Drawings
Part 3	**Conditions of Contract and Contract Forms**	
	Section VII	General Conditions (GC)
	Section VIII	Particular Conditions (PC)
	Section IX	Annex to the Particular Conditions - Contract Forms
Part 4	**Reference Documents**	
	Section X	OHS&E Manual

Section I. Instructions to Bidders

Notes on Instructions to Bidders

The Instructions to Bidders governing this bidding process are the "Instructions to Bidders included in **Option A**, Single-Stage Two-Envelope Bidding (without Pre-qualification) Section I," of the Standard Bidding Documents for Procurement of Electrical and Mechanical Plant, and for Building and Engineering Works, Designed by the Contractor (Trial Version) published by JICA in July 2015. Those Instructions to Bidders are available on the JICA's web site shown below:

https://www.jica.go.jp/english/our_work/types_of_assistance/oda_loans/oda_op_info/guide/tender/index.html

A copy of the Instructions to Bidders is not attached to these Bidding Documents.

The Instructions to Bidders will not be part of the Contract.

BIDDING DOCUMENTS

MUMBAI METRO LINE 3 (COLABA-BANDRA-SEEPZ)

CONTRACT MM3-CBS-TWK-03 (Package 10C)

Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of Ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and Ballasted Track in the area of at-grade Aarey Station and in the Depot area of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ).

and

Procurement and Supply of Turnouts, Scissor Crossovers and Buffer Stops for the entire Mainline for Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ) including Package 10 B.

PART 1

BIDDING PROCEDURE

Section II
BID DATA SHEET

July 2019

JICA LOAN AGREEMENT ID - P 268

Mumbai Metro Rail Corporation Ltd
Line 3 Transit Office, Wing 'A' North Side of City park 'E'- Block,
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Section II

Bid Data Sheet

BID DATA SHEET (BDS)

A. General	
ITB 1.1	The number of the Invitation for Bid is **MM3-CBS-TWK-03.**
ITB 1.1	The Employer is **Mumbai Metro Rail Corporation Ltd. (MMRC).**
ITB 1.1	This bid document is for Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of Ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and Ballasted Track in the area of at-grade Aarey Station and in the Depot area of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ). and Procurement and Supply of Turnouts, Scissor Crossovers and Buffer Stops for the entire Mainline for Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ) including Package 10 B.
ITB 2.1	The Borrower is Government of India.
ITB 2.1	The number of the Loan Agreement is ID-P 268. The amount of a Japanese ODA Loan is One hundred (100) billion Japanese Yen. The signed date of the Loan Agreement is 29th March 2018.
ITB 2.1	The name of the Project is **Mumbai Metro Line 3 (Colaba-Bandra-SEEPZ)**.
ITB 2.2	"The applicable Guidelines for Procurement under Japanese ODA Loans are those published in April 2012."
ITB 3.1(c)	A list of debarred firms and individuals is available at the World Bank's website: www.worldbank.org/debarr
ITB 3.1(d)	Will recognize a contractor as ineligible to be awarded a contract in principle if the contractor or subcontractor has been debarred by Delhi Metro Rail Corporation and/or other Metro Rail Corporation chaired by Secretary of Ministry of Urban Development, Government of India as on the date of submission of bid. This would be with prior concurrence of JICA.
ITB 4.5	"This bidding is not subject to prequalification."
B. Bidding Documents	
ITB 6.1	**Replace ITB 6.1 with the following sentences:** The Bidding Documents consist of Parts 1, 2 and 3 and 4, which include all the

	Sections indicated below, and should be read in conjunction with any Addenda issued in accordance with ITB 8 as specified in the BDS. **PART 1 - Bidding Procedures** Section I Instructions to Bidders (ITB) Section II Bid Data Sheet (BDS) Section III Evaluation and Qualification Criteria Section IVA Bidding Forms Section IVB Pricing Document Section V Eligible Source Countries of Japanese ODA Loan **PART 2 - Employer's Requirements** Section VI (1) General Specifications A. General B. Functional C. Design D. Construction E. Inspection Testing and commissioning F. Appendices Section VI (2) Outline Design Specifications Section VI (3) Outline Construction Specifications Section VI (4) Tender Drawings **PART 3 - Conditions of Contract and Contract Forms** Section VII General Conditions (GC) Section VIII Particular Conditions (PC) Section IX Annex to the Particular Conditions - Contract Forms **PART 4 – Reference Documents** Section X OHS&E Manual The Bidder shall check the pages of all documents against page numbers given in the Contents Page to each Part/Section, and in the event of discovery of any discrepancy, the Bidder shall inform the Employer forthwith.
ITB 7.1	**MMRCL LINE 3 Transit Office** E-Block, Wing 'A', North Side of, City Park Road, E Block BKC, Bandra Kurla Complex, Bandra East, Mumbai, Maharashtra 400051. Telephone: +91 22 26575123
ITB 7.1	Responses to any request for clarification, if any will be published on the Employer's web page. www.mmrcl.com

ITB 7.4	A pre-bid meeting will take place at the following date, time and place: **Date: 09-08-2019** **Time: 11 AM** Place: MMRCL LINE 3 Transit Office, E-Block, Wing 'A', North Side of, City Park Road, E Block BKC, Bandra Kurla Complex, Bandra East, Mumbai, Maharashtra 400051. A Site visit shall not be conducted by the Employer. Attending pre-bid meeting is not mandatory.
ITB 8.2	Addenda, if any, will be published on the Employer's web page and sent to those who have purchase the Bidding documents.
C. Preparation of Bids	
ITB 10.1	The language of the Bid as well as of all correspondence is English.
ITB 11.1	Add the following sentence at the end of ITB 11.1: All documents must be spiral/hard bound. No loose papers will be accepted.
ITB 13.1	Alternative Bids are not permitted.
ITB 16.1 (b)	The period following completion of works during which spare parts, special tools etc. shall be available, is two (2) years.
ITB 18.1	Bidders shall quote for the entire works on a single responsibility basis.
ITB 18.3	Bidders shall quote rates as per BOQ against schedule 1 & 2 and a single lump-sum price for Schedule-3.
ITB 18.7	The duties, taxes and other levies are not exempted at present
ITB 19.1	The currency(ies) of the Bid shall be as follows: The unit rates and prices shall be quoted by the Bidder in the Price Schedule separately in the following currencies. (i) for those inputs to the works that the Bidder expects to supply from within the Employer's country in Indian **Rupees.(INR)** (ii) for those inputs to the works that the Bidder expects to supply from outside the Employer's country in **(Japanese Yen and/or USD and/or EURO)**.
ITB 20.1	The Bid validity period shall be **One Hundred and Twenty (120)** days.
ITB 20.3 (a)	Not Applicable
ITB 20.3 (b)	The adjustment factor for the fixed portion of the Contract price will be calculated on the basis of difference in Wholesale Price Index notified by Reserve Bank of India for the month after 56 days of initial validity to the WPI for the month of validity extended. This will be applied in either side +ve or -ve. The adjustment factor shall apply to both local and foreign currency portion.

ITB 21.1	The amount and currency of the Bid Security (Bid Form 9) for this Package **10C** shall be INR 19.5 Million or USD 0.27 Million
ITB 21.2 (d)	No other securities is permitted
ITB 22.1	In addition to the original of the Bid, the number of copies to be submitted is **two sets of copies and one electronic version** (Word/ PDF on CD for Technical).
ITB 22.2	The written confirmation of authorization to sign on behalf of the Bidder shall consist of the Power of Attorney and the document shall be notarized. In case of a foreign company, the document shall be Apostille or authenticated by Indian Embassy/Consulate in that country and shall be attached to the Bid.
D. Submission and Opening of Bids	
ITB 23.3	Add a sub-para below para 23.3 as follows: The sealed packet containing the Technical Bid shall contain 2(two) sections: i. Eligibility and Qualification criteria ii. Technical Bid In the first section, the bidder should enclose the documents and submissions as detailed in para 2.3-Part 1-Section III. The second section should contain the documents required for the technical bid.
ITB 24.1	For Bid submission purposes only, the Employer's address is: Attention : Md.Aasim Sulaiman, General Manager (Track) MMRCL LINE 3 Transit Office E-Block, Wing 'A', North Side of, City Park Road, E Block BKC, Bandra Kurla Complex, Bandra East, Mumbai, Maharashtra 400051. Telephone: +91 22 26575123 Email: md.aasim@mmrcl.com
ITB 27.1	The Bid opening shall take place at : MMRCL LINE 3 Transit Office E-Block, Wing 'A', North Side of, City Park Road, E Block BKC, Bandra Kurla Complex, Bandra East, Mumbai, Maharashtra 400051. Telephone: +91 22 26575123 Email: md.aasim@mmrcl.com Date : 15-09-2019 Time :3PM

E. Evaluation, and Comparison of Bids	
ITB 37.1	The currency that shall be used for Bid evaluation and comparison purposes to convert all Bid Prices expressed in various currencies into a single currency is **US Dollar (USD)**. The source of exchange rate shall be Reserve Bank of India reference rate (foreign currency). The Date for the exchange rate shall be twenty-eight (28) days prior to date of Technical Bid opening. If the source of the exchange rate for the Bidder's proposed currency cannot be found in the Reserve Bank of India reference rate (foreign currency), then with the Employer's concurrence, the rate in the web site; www.xe.com may be used.

BIDDING DOCUMENTS

MUMBAI METRO LINE 3 (COLABA-BANDRA-SEEPZ)

CONTRACT MM3-CBS-TWK-03 (Package 10C)

Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of Ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and Ballasted Track in the area of at-grade Aarey Station and in the Depot area of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ).

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PART 1

BIDDING PROCEDURE
Section III
EVALUATION AND QUALIFICATION CRITERIA

July 2019

JICA LOAN AGREEMENT ID - P 268

Mumbai Metro Rail Corporation Ltd
Line 3 Transit Office, Wing 'A' North Side of City park 'E'- Block,
Bandra-Kurla Complex,
Bandra (East) Mumbai 400 051, India

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1. EVALUATION

1.1.1. Technical Evaluation

In addition to the criteria listed in ITB 35.1 (a) – (b) the following factors shall apply:

1.1.2. Personnel

The Bidder must demonstrate that it has the personnel for the key positions that meet the following requirements:

#	Position	Total Work Experience (years)	Experience in similar Works (years)	As similar position of similar works (years)
1	Project Manager	15	8	3
2	Construction Manager (Ballastless Track);	10	4	-
3	Construction Manager (Ballasted Track including transition area with adjustable fastening system...)	10	4	-
4	Construction Manager (Low Vibration Track)	5	4	-
5	Construction Manager ((Welding destressing, rail grinding, turnouts, scissors crossing, buffer stop)	10	4	-
6	Chief Quality Assurance Manager	10	4	-
7	Chief Interface Co-coordinator	10	4	-
8	Lead Design Checker	10	4	-
9	Engineering Manager Design	5	4	-
10	Safety Manager	5	4	-
11	Programme Manager	5	4	-

Note:

1. The key staff shall be Graduate Engineer.
2. Diploma with 5 years additional experience in relevant field will be considered equivalent to degree.

The Bidder shall provide details of the proposed personnel and their experience records in Bid Form 10 PER-1 and Bid Form 11 PER-2 in Section IV, Bidding Forms.

1.1.3. Equipments

The Bidder must demonstrate the following key equipment in full working order. The equipment shall be owned or assured to access (through hire, lease, purchase agreement, availability of manufacturing equipment, or other means like memorandum of understanding with the supplier).

#	Equipment Type and Characteristics	Minimum Number Required
1	Mobile Flash Butt welding Machine	2

The Bidder shall give the commitment that minimum 2 nos of Flash butt welding plant will be maintained in working order to perform the welding as per Indian Railway Flash Butt welding code.

The Bidder shall provide further details of proposed items of equipment using Bid Form 12 EQU in Section IV -A, Bidding Forms.

1.1.4. Others

1.1.4.1 Underground Ballastless Track

The Technical proposal should be submitted in the Bid Form 1. In case the Bidder's Technical Proposal containing Particular Specification is not found acceptable by the Employer, the Bidder would have to carry out the work according to the specifications in Parts 2 and 4.

1.1.4.2 Turnouts/Cross overs

The bidder is required to submit an undertaking that the performance certificate from the clients and other relevant details, as required in the bid documents, would be submitted by the time of supply while seeking approval of the Engineer for the specific vendor of Turnouts/Cross overs and such approval of the Engineer shall be subject to the proposed material and vendor meeting the specifications.

1.1.4.3 Rail Fastening System for Turnouts

The bidder is required to submit an undertaking that the performance certificate from the clients and other relevant details, as required in the bid documents, would be submitted by the time of supply while seeking approval of the Engineer for the specific vendor of Fastening System for Turnouts/Cross overs and such approval of the Engineer shall be subject to the proposed material and vendor meeting the specifications.

The bidder shall also confirm that he has noted that the approval of W14 fastening is subject to MoR approval as per specification

1.1.4.4 Buffer Stops:

The bidder is required to submit an undertaking that the performance certificate from the clients and other relevant details, as required in the bid documents, would be submitted by the time of supply while seeking approval of the Engineer for the specific vendor of Buffer stops and such approval of the Engineer shall be subject to the proposed material and vendor meeting the specifications.

Booted Twin Block Sleepers:

The bidder is required to submit an undertaking that the performance certificate from the clients and other relevant details, as required in the bid documents, would be submitted by the time of design while seeking approval of the Engineer for the specific vendor of Booted Twin block sleepers and such approval of the Engineer shall be subject to the proposed material and vendor meeting the specifications.

1.1.4.5 Noise and Vibration Mitigation:

The bidder is required to submit an undertaking that the performance certificate from the clients and other relevant details, as required in the bid documents, would be submitted by the time of design while seeking approval of the Engineer for the specific vendor of Noise and Vibration Mitigation system and such approval of the Engineer shall be subject to the proposed material and vendor meeting the specifications.

1.1.5. Construction Details addressing the Outline Construction Specifications Section VI (3)

Manufacture, Installation and Construction Methods:

The Bidder shall submit with his Bid, the methods by which the Bidder intends to construct the Works, whether on the Site, off-site but in India, or offshore which shall be included as part of the Project Management Plan. The construction methods to be employed will be analysed during the Bid Evaluation and their descriptions shall be given in sufficient detail to allow a full appreciation of the Bidder's proposals in relation to all aspects of the Works. Details shall be given of the locations and arrangements for offshore work, the facilities available and any undertaking from subcontractors or suppliers which the Bidder has in such matters. (Bid Form 5).

The Bidder will give the undertaking that in case the construction methodology is not acceptable, the bidder will follow the employer’s guidelines for OCS Part-2, Section VI(3).

1.1.6. Outline Work Programme

Bidder shall address the program requirements. All submissions should match the with Key Dates given in Part-3,Section VIII and Appendix 2B (Bid Form 3) Part-2 and Key Organisation with the Project Organisation to be submitted in the Bid Form 2.

i) Outline Works Programme and Proposed Design Submission Programme (Bid Form 4).
ii) The Bidder shall submit with his Bid, an Outline Works Programme, including a narrative, which shall indicate how the Bidder intends to organise and carry out the Works and achieve Stages and complete the whole of the Works by the appropriate Key Dates.

iii) The Outline Works Programme shall be prepared in terms of weeks from the Date for Commencement of the Works. The Outline Works Programme shall not be construed as a submission of the Works Programme under Clause 8.3 of the GC and PC.

1.1.7. Management System

Bidder shall describe its management system including the following:

i. Project Management Plan (Bid Form 7)

In order to ensure satisfactory execution, achievement of Key Dates and timely completion of the Works, the Bidder shall submit an outline Project Management Plan as part of his Bid. This Plan, in co-ordination with the Bid Programme, shall clearly demonstrate the Bidder's proposed management system, methods, procedures, processes and organisation.

ii. Outline Quality Assurance and Quality Plan (Bid Form 6)

The Bidder shall establish and maintain a Quality Assurance System in accordance with Appendix 6 of Part 2 - Employer's Requirements for design, construction procedures and the interfaces between him and Interfacing Contractors.

The Bidder shall submit Bid Form to the Letter of Bid as part of his Bid Outline Quality Assurance and Quality Plans illustrating the intended means of compliance with Appendix 6 of Part 2 - Employer's Requirements and setting out in summary form an adequate basis for the development of the more detailed documents required under Sub-Clause 4.9 of Part 3 General and Particular Conditions of Contract.

iii. Outline Occupational Health, Safety and Environment Plan (Bid Form 13)

The Bidder shall submit Bid Form to the Letter of Bid as part of his Bid an Outline Occupational Health, Safety and Environment Plan which shall contain sufficient information to demonstrate clearly the Bidder's proposals for achieving effective and efficient health, safety and environment procedures. The Outline Occupational Health, Safety and Environment Plan shall include an outline of the safety procedures and regulations to be developed and the mechanism by which they will be implemented for ensuring safety as required by Appendix 20 of Part 2 - Employer's Requirements, Occupational Health, Safety and Environment Plan, OHSE Manual in Part 4 and Sub-Clause 6.7 of Part 3 - Conditions of Contract and as amended in the Particular Conditions.

1.1.8. Subcontractors / Manufacturers

Subcontractors/ Manufacturers for the following major items of Plant and DDC / Installation services must meet the following minimum criteria, herein listed for that item. The Bidder shall submit the technical Information of Plant and DDC / Installation services proposed in respective Bid Form as mentioned below:

Item No.	Description of Item for Track work	Minimum Criteria to be met
1	Detailed Design Consultant (DDC) / Proof Checker	The DDC/Proof Checker shall have experience of Designing of 2 Nos of Project of Ballastless Track with attenuation of vibration in Tunnel for 10 Tkms track either in separate work or combined work in last five years on Metro System. Minimum two names to be provided for deployment as i) DDC and ii) Proof Checker (Bid Form: 33 & 34)
2	Flash Butt Welding Sub-contractor	The subcontractor shall have experience of 30 tkms Welding of track out of which minimum 7 tkms in Underground section in last 5 years. (Bid Form: 12)
3	Low Vibration Sub Contractor	The contractor if engaged shall have Minimum 5 Tkms experience in installation of low vibration track in underground section in last 5 years. (Bid Form: 33 & 34)

Note:

i) The DDC is not required if the Contractors exhibits the same experience as stated for the DDC. However, the must submit details of experience as required for the DDC. The experience certificate of the contractor or of the sub-contractor needs to be obtained from the employer.

ii) The FB Welding sub-contractor is not required if the Contractors exhibits the same experience as stated for the FB sub-contractor. However, the contractor must submit details of experience as required for the FB Welding sub-contractor. The experience certificate of the contractor or of the sub-contractor needs to be obtained from the employer

iii) The Low Vibration sub-contractor is not required if the Contractors exhibits the same experience as stated for the Low Vibration sub-contractor. But the contractor must submit details of experience as required for the Low Vibration sub-contractor. The experience certificate of the contractor or of the sub-contractor needs to be obtained from the employer.

iv) The satisfactory completion of works will be demonstrated by the certificate from client.

The Bidder's proposal shall provide the information for each subcontractor in the **Bid Form 33 &** 34**.**

In the case of a Bidder who offers to supply and install major items under the contract that the Bidder did not manufacture or otherwise produce, the Bidder shall provide the manufacturer's authorization in **Bid form 36 MAN, Section IV-A**, before commencement of supply showing that the Bidder has been duly authorized by the manufacturer or producer of the related plant

and equipment or component to supply and/or install that item in the Employer's country. The Bidder is responsible for ensuring that the manufacturer or producer complies with the requirements of ITB 4 and ITB 5 and meets the minimum criteria listed above for that item.

1.1.9. Time Schedule

Time to complete the Plant and Design–Build Services from the Commencement Date of the Contract Agreement for determining time for completion is: 731 days
No credit will be given for earlier completion.
Alternative Time Schedule – Not Applicable

1.1.10. Maintenance proposal

The proposed track structure should be maintainable. It has to be ensured that the maintenance shall be carried during nonoperational hours which will be limited to three hours per day in the night. The resilient material and rail fasteners should be replaceable within time constrains

The bidder is required to submit an undertaking that the track structure being designed and constructed will be maintainable as per employer requirement and that the Maintenance Proposal shall be submitted with the design of track structure.

1.1.11. Economic Evaluation

The criteria listed in ITB 38.2 (a) – (c) shall be applied for the evaluation of price bid.
Only those that passed the technical evaluation will have their financial envelope opened. Those that failed will have their envelope returned unopened.
The Price Bids shall be evaluated based on the following elements.

a. Examination of Price Bids

Bidders shall quote rates as per BOQ against schedule 1 & 2 and a single lump-sum price for Schedule-3. The value of Schedule-3, as well as the sub-divisions within the Schedule-3 are only, for the purpose of billing and payments and will be according to the percentages that have been specified in the bidding document.

Where necessary, the Bidder is required to indicate the percentage of the payment under the four permitted currencies.

For evaluation of the lowest bid, the total of Schedule-1, 2&3, and the effect of Schedule 6, if relevant, shall be considered.

b. Qualifications, Conditions or Remarks

The Price Bids shall contain no qualifications, conditions or remarks which have not been priced, as these shall not be considered as part of the Price Bids. If the Bidder inserts any qualifications, conditions or remarks these must be priced to enable unconditional withdrawal, such cost shall be detailed in the form contained in Bid Form 15 to the Letter of Price Bid.

1.1.12. Quantifiable nonmaterial nonconformities

The Bidder shall submit as part of his Technical Proposal a completed and signed Statement of Quantifiable Non-,material Deviations with Bid Form 14 to the Letter of Bid, identifying

any such deviations and confirming that price of withdrawal of each Deviation (s) is given in Bid form 15 with price bid. If no deviations are to be reported, the Form must still be completed and signed by the Bidder confirming that no deviations exist.

Any Bids containing any material deviations or reservations or conditions as described in Clause 33 of ITB will be deemed by the Employer to be non-responsive.

1.1.13. Other Factors

Not Applicable

1.1.14. Award criteria for multiple contracts

Not Applicable

1.1.15. Bidder's Award Capacity

Bid Capacity.

The Bidders will be qualified only if their available bid capacity is equal to or more than USD 28 million. The available bid capacity will be calculated as under;

Available Bid Capacity = (2*A*N-B)

Where,

A = Maximum value of civil infrastructure works executed in any one year during the last five years (Updated to 2017-18 price level assuming 5 % inflation for Indian Rupees every year and 2% for foreign currency portions per year).

N = No. of years prescribed for completion of the works (2 years).

B = Value of existing commitments for ongoing civil infrastructure work (During period of completion of work under this tender)

In the case of a consortium/JV, the above formula will be applied to each member to the extent of his percentage share in the execution of the MML 3 work (Bid form 23 & Bid form 24).

Bidders, which do not qualify bid capacity criteria, shall not be considered for further evaluation and shall be rejected.

2. QUALIFICATION

2.1. Exchange Rate for Qualification Criteria

Wherever a Form in Section IV- Bidding Forms, requires a Bidder to state a monetary amount, Bidders shall indicate the USD equivalent using the rate of exchange determined as follows:

1. For turnover or financial data required for each year - Exchange rate prevailing on the last day of the respective calendar year.
2. Value of single Contract - Exchange rate prevailing on the date of the Contract.

Exchange rates shall be taken from the publicly available source identified in BDS 37.1 or, in case such rates are not available in the source identified above, any other publicly available source acceptable to the Employer. Any error in determining the exchange rates may be corrected by the Employer.

2.2. Deleted

2.3. Eligibility and Qualification Criteria

The information requested for eligibility and Qualification criteria will be evaluated as per the criteria listed in various proformas:

Eligibility and Qualification Criteria			Compliance Requirements				Documentation
No.	**Factor**	**Requirement**	**Single Entity**	**Consortium/Joint Venture (existing or intended)**			**Submission Requirements**
				All Parties Combined	**Each Member**	**One Member**	
1. Eligibility							
1.1	**Nationality**	Nationality in accordance with ITA Sub-Clause4.3	Must meet requirement	N/A	Must meet requirement	N/A	Forms ELI–1.1 And 1.2,with attachments
1.2	**Conflict of Interest**	No conflicts of interest in ITA Sub-Clauses 4.4, 4.5 and 4.6	Must meet requirement	N/A	Must meet requirement	N/A	Bid Submission Form
1.3	**JICA Ineligibility**	Not having been declared ineligible by JICA, as described in ITA Sub-Clause 4.7	Must meet requirement	N/A	Must meet requirement	N/A	Bid Submission Form ACK
2. Historical Contract Non-Performance							
2.1	**History of Non-Performing Contracts**	Non-performance of a contract **(i)** did not occur as a result of contractor's default since 1st January 2018.	Must meet requirement **(ii)**	N/A	Must meet requirement **(ii)**	N/A	Form CON
2.2	**Pending Litigation**	All pending litigation shall in total not represent more than 50 % of the Bidders's net worth and shall be treated as resolved against the Bidders.	Must meet requirement **(ii)**	N/A	Must meet requirement **(ii)**	N/A	Form CON
2.3	**Litigation History**	No consistent history of court/arbitral award decisions against the Bidders **(iii)** since 1st June 2014	Must meet requirement **(ii)**	N/A	Must meet requirement **(ii)**	N/A	Form CON

Notes for the Bidders

(i) Non-performance, as decided by the Employer, shall include all contracts.
(a) where non-performance was not challenged by the contractor, including through referral to the dispute resolution mechanism under the respective contract and
(b) that were so challenged but fully settled against the contractor.
Non-performance shall not include contracts where Employer's decision was over ruled by the dispute resolution mechanism. Non-performance must be based on all

Eligibility and Qualification Criteria			Compliance Requirements				Documentation
No.	**Factor**	**Requirement**	**Single Entity**	**Consortium/Joint Venture (existing or intended)**			**Submission Requirements**
				All Parties Combined	**Each Member**	**One Member**	
information on fully settled disputes or litigation, i.e. dispute or litigation that has been resolved in accordance with the dispute resolution mechanism under the respective contract and where all appeal instances available to the Bidders have been exhausted. **(ii)** This requirement also applies to contracts executed by the Bidders as a Consortium/JV member **(iii)** The Bidders shall provide accurate information on the related Application Form about any litigation or arbitration resulting from contracts completed or on-going under its execution over the last five (5) years. A consistent history of awards against the Bidders or any member of a joint venture may result in failure of theBid.							
3. Financial Situation							
3.1	**Financial Performance**	The audited balance sheets or, if not required by the laws of the Bidders's country, other financial statements acceptable to the Employer, for the last five (5) years shall be submitted and must demonstrate the current soundness of the Bidders's financial position and indicate its Prospective long-term profitability. As the minimum requirement, an Bidders's net worth calculated as the difference between total assets and total liabilities should be **positive.**	Must meet requirement	N/A	Must meet requirement	N/A	Form FIN 1 With attachments
3.2	**Average Annual Construction Turnover**	Minimum average annual construction turnover of **USD 25 millions[(i)],** calculated as total certified payments received for contracts in progress and/or completed, within the last five (5) financial years, divided by five (5) years[)].	Must meet requirement	Must meet requirement	Must meet 25% of the requirement	Must meet 40% of the requirement	Form FIN 2

Eligibility and Qualification Criteria			Compliance Requirements				Documentation
No.	**Factor**	**Requirement**	**Single Entity**	**Consortium/Joint Venture (existing or intended)**			**Submission Requirements**
				All Parties Combined	**Each Member**	**One Member**	
3.3	**Financial Resources**	(i) The Bidder shall demonstrate that it has access to, or has available, liquid assets, unencumbered real assets, lines of credit, and other financial means (independent of any contractual advance payment) sufficient to meet the cash flow requirements estimated as **USD 7.0 million** for the subject Contract(s) net of the Bidder's other commitments	Must meet requirement	Must meet requirement	Must meet 25% of the requirement	Must meet 40% of the requirement	**Bid Form 21 FIR – 1** (Section IV-A Bidding Forms)
		ii) The Bidder shall also demonstrate, to the satisfaction of the Employer, that it has adequate sources of finance to meet the cash flow requirements on works currently in progress and for future contract commitments.	Must meet requirement	Must meet requirement	N/A	N/A	**Bid Form 21 FIR - 1** and **Bid Form 22 FIR – 2** (Section IV-A Bidding Forms)

Notes for the Bidders

(i) To bring at par, Turnover values will be escalated by assuming 5% inflation per annum for Indian Rupees and 2% inflation per annum for foreign currency for first 4 years of Turnover values.

Eligibility and Qualification Criteria			Compliance Requirements				Documentation
No.	Factor	Requirement	Single Entity	Consortium/Joint Venture (existing or intended)			Submission Requirements
				All Parties Combined	Each Member	One Member	
4. Experience							
4.1	**General Construction Experience**	Experience under construction contracts in the role of prime contractor (single entity or Consortium/JV member), subcontractor or management contractor **(i)** for at least the last five (5) years, ending 30th September 2019.	Must meet requirement	N/A	Must meet requirement	N/A	**Bid Form 25** EXP–4.1
4.2 (i)	**Specific Construction Experience**	Total of Twenty **(20) km single Ballastless track of Underground and or Elevated** from maximum of Two (2) number of distinct contracts of comparable nature and complexity (ii) of the proposed contract in Supply, installation, testing and commissioning Contracts that have been successfully (iii) completed as a prime contractor (single entity or Consortium/JV member)(iv), Starting from the period 1.1.2009 till the date of submission of the bids.	Must meet requirement	Must meet requirement	N/A	N/A	**Bid Form 26** EXP–4.2 (i)
4.2 (ii)	**Experience in Key Activities**	From the above or other contracts, execution and successful completion (iii) of Seven**(7) km single track underground ballastless Track work** of comparable nature and complexity (ii) from maximum of Two (2) number of distinct contracts, completed as prime contractor (single entity or Consortium/JV member),management contractor or specialist subcontractor (iv) during the period starting from 1.1.2009 till the date of submission of the bids."	Must meet requirement	Must meet requirement	N/A	N/A	**Bid Form 27** EXP–4.2 (ii)

Eligibility and Qualification Criteria			Compliance Requirements				Documentation
No.	Factor	Requirement	Single Entity	Consortium/Joint Venture (existing or intended)			Submission Requirements
				All Parties Combined	Each Member	One Member	
		(OR) Execution and successful completion of seven (7) km of single tunnel construction in urban conditions from maximum of two (2) numbers of distinct contracts, completed as prime contractor (single entity or consortium/JV member), management contractor or sub-contractor during the period starting from 1.1.2008 till the date of submission of bids.					

Notes for the Bidders

(i) Deleted

(ii) The comparable nature and complexity shall be based on the physical size, complexity, methods/technology and/or other characteristics described In Section VI, Scope of Works. The Design, Supply, Installation, Testing and Commissioning of Ballastless Track works executed on Mainlines on Railway/MRTS/LRT/High Speed Rail on systems having design axle load more than 12 tons and operation speed more than 70 km/h shall only be considered. Sidings and stabling tracks shall not be considered.

(iii) Successful completion shall be demonstrated with submission of a Certificate from the client. For the work in progress, the partial completion shall be considered only if the specified part or section of the track work is successfully Designed, supplied, installed, tested for the design speed of the section and certified by the, certifying / regulatory authority for public carriage. A certificate from the client to this effect shall be submitted.

(iv) For Contracts under which the Bidders participated as a Consortium/JV member, only the Bidder's share, by value, shall be considered to meet this requirement.

(v) In case of a JV, the value of Contracts completed by its members shall not be aggregated to determine whether the requirement of the minimum value of a single Contract has been met. Instead, each Contract performed by each member shall satisfy the minimum value of a single Contract as required for single entity. In determining whether the JV meets the requirement of total number of Contracts, only the number of Contracts completed by all members each of value equal or more than the minimum value required shall be aggregated.

(vi) Deleted

(vii) For Contracts under which the Bidder participated as a JV member or Subcontractor, only the Bidder's share shall be counted to meet this requirement.

BIDDING DOCUMENTS

MUMBAI METRO LINE 3 (COLABA-BANDRA-SEEPZ)

CONTRACT MM3-CBS-TWK-03 (Package 10C)

Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of Ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and Ballasted Track in the area of at-grade Aarey Station and in the Depot area of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ).

and

Procurement and Supply of Turnouts, Scissor Crossovers and Buffer Stops for the entire Mainline for Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ) including Package 10 B.

PART 1

BIDDING PROCEDURE

Section IV-A
BIDDING FORMS

July 2019

JICA LOAN AGREEMENT ID - P 268

Mumbai Metro Rail Corporation Ltd
Line 3 Transit Office, Wing 'A'North Side of City park'E'- Block, ,
Bandra-Kurla Complex,
Bandra (East) Mumbai 400 051, India

BIDDING DOCUMENTS

Composition of Documents

Part 1	**Bidding Procedures**	
	Section I	Instructions to Bidders(ITB)
	Section II	Bid Data Sheet(BDS)
	Section III	Evaluation and Qualification Criteria
	Section IV- A	**Bidding Forms**
	Section IV- B	Pricing Document
	Section V	Eligible Source Countries of Japanese ODA Loan
Part 2	**Employer's Requirements**	
	Section VI (1)	General Specifications A. General B. Functional C. Design D. Construction E. Inspection Testing and commissioning F. Appendices
	Section VI (2)	Outline Design Specifications
	Section VI (3)	Outline Construction Specifications
	Section VI (4)	Tender Drawings
Part 3	**Conditions of Contract and Contract Forms**	
	Section VII	General Conditions (GC)
	Section VIII	Particular Conditions (PC)
	Section IX	Annex to the Particular Conditions - Contract Forms
Part 4	**Reference Documents**	
	Section X	OHS&E Manual

Table of Bid Forms

Letter of Technical Bid

Date: [*insert date of Bid submission*]
Loan Agreement No.: ID-P268
IFB No.: MM3-CBS-TWK-03

To: **Mumbai Metro Rail Corporation Ltd.**

We, the undersigned, declare that:

(a) We have examined and have no reservations to the Bidding Documents, including Addenda issued in accordance with Instructions to Bidders (ITB 8): *[insert the number and issuing date of each Addendum]*;

(b) We, including any Subcontractors/ manufacturers, for any part of the Contract, meet the eligibility requirements in accordance with ITB 4 and ITB 5;

(c) We, including any Subcontractors/ manufacturers, for any part of the Contract, have no conflict of interest in accordance with ITB 4;

(d) We offer to

Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and ballasted Track in the area of at-grade Aarey Station and in the Depot area of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ).

and

Procurement and Supply of Turnouts, Scissor Crossovers and Buffer Stops for the entire Mainline for Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ) including Package 10 B.

(e) Our Bid shall be valid for a period of ……120…….. days from the date fixed for the Bid submission deadline in accordance with the Bidding Documents, and it shall remain binding upon us and may be accepted at any time before the expiration of that period;

(f) We are not participating, as a Bidder or as a Subcontractor/ manufacturers, in more than one Bid in this bidding process in accordance with ITB4.2 (c);

(g) We here by certify that we have taken steps to ensure that no person acting for us or on our behalf will engage in any type of fraud and corruption.

Name of the Bidder*[*insert complete name of the Bidder*]

Name of the person duly authorized to sign the Bid on behalf of the Bidder**** [*insert complete name of person duly* authorized *to sign the Bid*]
Title of the person signing the Bid [*insert complete title of the person signing the Bid*]

Signature of the person named above [*insert signature of person whose name and capacity are shown above*]

Date signed [*insert date of signing*] day of [*insert month*], [*insert year*]

*: In the case of the Bid submitted by a Joint Venture specify the name of the Joint Venture as Bidder

**: Person signing the Bid shall have the power of attorney given by the Bidder to be attached with the Bid.

Letter of Price Bid

Date: [*insert date of Bid submission*]
Loan Agreement No.: ID-P268
IFB No.: MM3-CBS-TWK-03

To: **Mumbai Metro Rail Corporation Ltd.**

We, the undersigned, declare that:

(a) We have examined and have no reservations to the Bidding Documents, including Addenda issued in accordance with Instructions to Bidders (ITB8): [*insert the number and issuing date of each Addendum*];

We offer

Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and ballasted Track in the area of at-grade Aarey Station and in the Depot area of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ).

and

Procurement and Supply of Turnouts, Scissor Crossovers and Buffer Stops for the entire Mainline for Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ) including Package 10 B.

(b) The total price of our Bid, excluding any discounts offered in item (b) below is:
In case of only one lot, total price of the Bid [*insert the total price of the Bid in words and figures, indicating the various amounts and the respective currencies*];

(c) The discounts offered and the methodology for their application are:
The discounts offered are: [*specify in detail each discount offered*]

The exact method of calculations to determine the net price after application of discounts is shown below: [*specify in detail the method that shall be used to apply the discounts];*

(d) Our Bid shall be valid for a period of 120 days from the date fixed for the Bid submission deadline in accordance with the Bidding Documents, and it shall remain binding upon us and may be accepted at any time before the expiration of that period;

(e) If our Bid is accepted, we commit to obtain a Performance Security in accordance with the Bidding Documents;

(f) We understand that this Bid, together with your written acceptance thereof included in your Letter of Acceptance, shall constitute a binding Contract between us, until a formal Contract is prepared and executed; and

(g) We understand that you are not bound to accept the lowest evaluated Bid or any other Bid that you may receive.

Name of the Bidder*[*insert complete name of the Bidder*]

Name of the person duly authorized to sign the Bid on behalf of the Bidder****** [*insert complete name of person duly authorized to sign the Bid*]

Title of the person signing the Bid [*insert complete title of the person signing the Bid*]

Signature of the person named above [*insert signature of person whose name and capacity are shown above*]

Date signed [insert *date of signing*] day of [*insert month*], [*insert year*]

*: In the case of the Bid submitted by a Joint Venture specify the name of the Joint Venture as Bidder

**: Person signing the Bid shall have the power of attorney given by the Bidder to be attached with the Bid.

Bid Form 1: Bidder's Technical Proposals

Technical Proposals	Bid Ref

Bid Form 2: Project Organization

Project Organization	Bid Ref
The Bidder shall provide an Organization Chart detailing the design team, construction/installation team and testing & commissioning team and role within the overall project management team.	

Bid Form 3: Outline Work Program

Outline Work Program	Bid Ref

Bid Form 4: Design

Design	Bid Ref

Bid Form 5: Construction Details

Construction Details	Bid Ref

Bid Form 6: Outline Quality Assurance and Quality Plan

Outline Quality Assurance and Quality Plan	Bid Ref

Bid Form 7: Project Management Plan

Project Management Plan	Bid Ref

Bid Form 8: Deleted

Bid Form 9: Bid Security (Bank Guarantee)

(To be stamped in accordance with the Stamp Act of the Country of Issuing Bank)

[Guarantor letterhead or SWIFT identifier code]

Beneficiary: The Mumbai Metro Rail Corporation Ltd. (MMRC) MMRCL LINE 3 Transit Office, E-Block, Wing 'B', North Side of, City Park Road, E Block BKC, Bandra Kurla Complex, Bandra East, Mumbai, Maharashtra 400051, India

IFB No.: [MM3-CBS-TWK-03]

Date: [*insert date of issue*]

BID GUARANTEE No.: [*insert guarantee reference number*]

Guarantor: [*insert name and address of place of issue, unless indicated in the letterhead*]

We have been informed that [insert name of the Bidder, which in the case of a joint venture shall be the name of the joint venture (whether legally constituted or prospective) or the names of all members thereof] (hereinafter called "**the Bidder**") has submitted or will submit to the Beneficiary its Bid (hereinafter called "the Bid") for the execution

Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and ballasted Track in the area of at-grade Aarey Station and in the Depot area of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ).

and

Procurement and Supply of Turnouts, Scissor Crossovers and Buffer Stops for the entire Mainline for Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ) including Package 10 B.

Project under Loan Agreement No. [ID-P268].

Furthermore, we understand that, according to the Beneficiary's conditions, Bids must be supported by a bid guarantee.

At the request of the Applicant, we, as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of [*insert amount in words, (insert amount in figures*)] *upon* receipt by us of the Beneficiary's complying demand, supported by the Beneficiary's statement, whether in the demand itself or a separate signed document accompanying or identifying the demand, stating that either the Bidder:

(a) has withdrawn its Bid during the period of Bid validity set forth in the Bidder's Letter of Bid (hereinafter called "the Bid Validity Period"), or any extension thereto provided by the Applicant; or

(b) having been notified of the acceptance of its Bid by the Beneficiary during the Bid Validity Period or any extension thereto provided by the Bidder, (i) fails to execute the Contract Agreement, or (ii) fails to furnish the Performance Security, in accordance with the Instructions to Bidders of the Beneficiary's Bidding Documents.

This guarantee will expire and shall be returned to the Applicant: (a) if the Bidder is successful and is awarded the contract, upon our receipt of copies of the Contract Agreement signed by the Bidder and the Performance Security issued to the Beneficiary in relation to such Contract Agreement; or (b) if the Bidder is not the successful, upon the earlier of (i) our receipt of a copy of the Beneficiary's notification to the Bidder of the results of the bidding process; or (ii) twenty-eight (28) days after the end of the Bid Validity Period.

Consequently, any demand for payment under this guarantee must be received by us at the office indicated above on or before that date.

This guarantee is subject to the Uniform Rules for Demand Guarantees (URDG) 2010 Revision, ICC Publication No. 758 *(or subsequent ICC Publications).*

[Signature]

Bid Form 10 PER-1: Proposed Personnel

Date: [*insert day, month, year*]
Bidder's Legal Name: [*insert full name*]
Joint Venture Party Legal Name: [*insert full name*]
IFB No.: [MM3-CBS-TWK-03]
Page [*insert page number*] of [*insert total number*] pages

[*The Bidder shall provide the names of suitably qualified personnel to meet the specified requirements stated in Section III, Evaluation and Qualification Criteria*]

1.	Title of position:*
	Name:
	Professional qualifications:
	Summary of experience, Skills, & knowledge on the relevant project experience
	Skills:
	Knowledge:
2.	Title of position:*
	Name:
	Professional qualifications:
	Summary of experience, Skills, & knowledge on the relevant project experience
	Skills:
	Knowledge:
3.	Title of position:*
	Name:
	Professional qualifications:
	Summary of experience, Skills, & knowledge on the relevant project experience
	Skills:
	Knowledge:
4	

*As listed in Section III.

Bid Form 11 PER-2: Resume of Proposed Personnel

Date: [*insert day, month, year*]
Bidder's Legal Name: [*insert full name*]
Joint Venture Party Legal Name: [*insert full name*]
IFB No.: [MM3-CBS-TWK-03]
Page [*insert page number*] of [*insert total number*] pages

[*The Bidder shall provide the data on the experience of the personnel indicated in Form PER-1, in the form below.*]

Name of Bidder		
Position		
Personnel information	**Name**	**Date of birth**
	Professional qualifications	
Present employment	**Name of employer**	
	Address of employer	
	Telephone	**Contact (manager / personnel officer)**
	Fax	**E-mail**
	Job title	**Years with present employer**

[*Summarize professional experience over the last 20 years, in reverse chronological order. Indicate particular technical and managerial experience relevant to the project.*]

From	To	Company / Project / Position / Relevant technical and management experience

Bid Form 12 EQU: Equipment

[*The Bidder shall give the commitment that minimum 2 no's of Flash butt welding plant will be maintained in working order to perform the welding as per Indian Railway Flash Butt welding*] }

Bid Form 13: Outline Occupational Health, Safety and Environment Plan

Outline Occupational Health, Safety and Environment Plan	Bid Ref

Bid Form 14: Statement of Quantifiable Non-material Non-Conformity

[The Bidder shall submit this Form with Technical Bid]

Chapter Number	**Clause Number**	**Details of Deviation**	**Remarks explaining the benefits to the Employer if he elects to accept the deviations**	**Confirming that price of Withdrawal of each Deviation(s) is given in Bid Form 15 with Price Bid. (Yes/No)**

Notes:

1. Where there are no deviations, the statement should be returned duly signed with an endorsement indicating 'No Deviations'.
2. In case this Bid Form is not submitted, it will be construed that the bidder has not proposed any deviations from the bid documents and will provide all equipment as per the Technical Specifications.

We hereby confirm that the pricing for unconditional withdrawal of the above deviations has been given in Bid Form 15.

We hereby confirm that except for the deviations noted in this form, our offer is fully and truly complaint.

_____

Authorized Signatory
[*Insert name of signatory; title*]

Bid Form 15: Pricing of quantifiable Non-material Non-Conformity

[The Bidder shall submit PRICED Form with Price Bid and UNPRICED copy with Technical Bid]

Item	Proposed Deviation	Key date affected by deviation, if any	Increase or Decrease for unqualified withdrawal of each deviation	
			Foreign Currency	**Indian Currency**
Total				

Notes:

1. The Bidder shall show every key date that will be affected by each deviation, included in his Financial Package/ Price Bid.

We hereby confirm that except for the deviations noted in this bid form our offer is fully and truly compliant.

.

_____

Authorized Signatory
[*Insert name of signatory; title*]

Bid Form 16 ELI-1.1: Bidder Information

Date: [*insert day, month, year*]
IFB No.: [MM3-CBS-TWK-03]
Page [*insert page number*] of [*insert total number*] pages

[The Bidder shall provide the following information.]

1. Bidder's legal name: _____
2. In case of JV, legal name of the representative member and of each member: :[*insert full name of each member in the JV and specify the representative member*]
3. Bidder's actual or intended country of registration:[*insert country of registration*]
4. Bidder's actual or intended year of incorporation: [*insert year of incorporation*]
5. Bidder's legal address in country of registration:[*insert street/number/town or city/country*]
6. Bidder's authorized representative information Name:[*insert full name*] Address:[*inset street/number/town or city/country*] Telephone/Fax numbers:[*insert telephone/fax numbers, including country and city codes*] Email Address:[*insert E-mail address*]
7. Attached are copies of original documents of: ☐ Articles of Incorporation (or equivalent documents of constitution or association), and/or documents of registration of legal entity named above, in accordance with ITB 4.3. ☐ In case of JV, letter of intent to form JV or JV agreement, in accordance with ITB 4.1. 8. Included are the organizational chart, a list of Board of Directors, and the beneficial ownership.

Bid Form 17 ELI-1.2: Bidder's Party Information

Date: [*insert day, month, year*]
IFB No.: [MM3-CBS-TWK-03]
Page [*insert page number*] of [*insert total number*] pages

[The following form is additional to Bid Form ELI-1, and shall be completed to provide information relating to each JV member (in case the Bidder is a JV).as well as any specialist Subcontractor proposed to be used by the Bidder for any part of the Contract resulting from this process]

1. Bidder's legal name: [*insert full name*]
2. Bidder's Party legal name registered with the government: [*insert full name of Bidder's Party*]
3. Bidder's Party country of registration:[*insert country of registration*]
4. Bidder's Party year of incorporation:[*insert year of incorporation*]
5. Bidder's Party legal address in country of registration: [*insert street/number/town or city/country*]
6. Bidder's Party authorized representative information Name: [*insert full name*] Address: [*insert street/number/town or city/country*] Telephone/Fax numbers: [*insert telephone/fax numbers, including country and city codes*] E-mail address:[*insert E-mail address*]
7. Attached are copies of original documents of ☐ Articles of Incorporation (or equivalent documents of constitution or association), and/or registration documents of the legal entity named above, in accordance with ITB 4.3. 8. Included are the organizational chart, a list of Board of Directors, and the beneficial ownership.

Bid Form 18 CON: Historical Contract Non-Performance

[The following table shall be filled in for the Bidder and for each member of a JV.]

Date: [*insert day, month, year*]
Bidder's Legal Name: [*insert full name*]
Joint Venture Party Legal Name: [*insert full name*]
IFB No.: [MM3-CBS-TWK-03]
Page [*insert page number*] of [*insert total number*] pages

1. History of Non-Performing Contracts

Non-Performing Contracts			
☐ Contract non-performance did not occur since 1st January 2018, in accordance with the Prequalification criteria. ☐ Contract(s) not performed since 1st January 2018, in accordance with the Prequalification criteria is(are) indicated below:			
Year	**Non- performed portion of Contract**	**Contract Identification**	**Total Contract Amount (current value, currency, exchange rate and USD equivalent)**
[*insert year*]	[*insert amount and percentage*]	• Contract Identification: [*indicate complete Contract name, number, and any other identification*] • Name of Employer: [*insert full name*] • Address of Employer: [*insert street/city/country*] • Reason(s) for non performance: [*indicate main reason(s)*]	[*insert amount*]

2. Pending Litigation

Pending Litigation				
☐ No pending litigation in accordance with the Prequalification criteria or Section III, Evaluation and Qualification Criteria. ☐ Pending litigation in accordance with the Prequalification criteria or Section III, Evaluation and Qualification Criteria as appropriate, is indicated below:				
Year of dispute	**Amount in dispute (currency)**	**Outcome as Percentage of Net Worth**	**Contract Identification**	**Total Contract Amount (current value, currency, exchange rate and USD equivalent)**
[*insert year*]	[*insert amount*]	[*insert percentage*]	• Contract Identification: [*indicate complete Contract name, number, and any other identification*] • Name of Employer: [*insert full name*] • Address of Employer: [*insert street/city/country*] • Matter in dispute: [*indicate main issues in dispute*] • Status of dispute: [*indicate if it is being treated by the Adjudicator, under Arbitration or being dealt with by the Judiciary*]	[*insert amount*]

3. Litigation History

Litigation History		
☐ No court/arbitral award decisions against the Bidder since 1st June 2014, in accordance with the Prequalification criteria, or Section III, Evaluation and Qualification Criteria as appropriate. ☐ Court/arbitral award decisions against the Bidder since 1st June 2014, in accordance with the Prequalification criteria, or Section III, Evaluation and Qualification Criteria, as appropriate are indicated below:		
Year of award	**Contract Identification**	**Total Contract Amount (current value, currency, exchange rate and USD equivalent)**
[*insert year*]	• Contract Identification:[*indicate complete Contract name, number, and any other identification* • Name of Employer: [*insert full name*] • Address of Employer: [*insert street/city/country*] • Matter in dispute: [*indicate main issues in dispute*] • Party who initiated the dispute: [*indicate "Employer" or "Contractor"*] • Status of dispute: [*indicate if it is being treated by the Adjudicator, under Arbitration or being dealt with by the Judiciary*]	[*insert amount*]

Bid Form 19 FIN-1: Financial Situation

[*The following table shall be filled in for the Bidder and for each member of a JV.*]

Date: [*insert day, month, year*]
Bidder's Legal Name: [*insert full name*]
Joint Venture Party Legal Name: [*insert full name*]
IFB No.: [MM3-CBS-TWK-03]
Page [*insert page number*] of [*insert total number*] pages

1. Financial data

Type of Financial information in (currency)	**Historic information for previous** [*insert number*]**years (amount, currency, exchange rate, USD equivalent)**				
	Year 1	Year 2	Year 3	Year4	Year 5
Statement of Financial Position (Information from Balance Sheet)					
Total Assets (TA)					
Total Liabilities (TL)					
Net Worth (NW)					
Current Assets (CA)					
Current Liabilities (CL)					
Information from Income Statement					
Total Revenue (TR)					
Profits Before Taxes (PBT)					
Profits After Taxes (PAT)					

2. Financial documents

The Bidder and its Parties shall provide copies of the financial statements for 5 years pursuant to the Prequalification Criteria or Section III, Evaluation and Qualification Criteria. The financial statements shall:

(a) reflect the financial situation of the Bidder or in case of JV member, of each member, and not an affiliated entity (such as parent company or group member).

(b) be independently audited or certified in accordance with local legislation.

(c) be complete, including all notes to the financial statements.

(d) correspond to accounting periods already completed and audited.

☐ Attached are copies of financial statements for the 5 years required above; and complying with the requirements.

Bid Form 20 FIN-2: Average Annual Turnover

[*The following table shall be filled in for the Bidder and for each member of a JV.*]

Date: [*insert day, month, year*]
Bidder's Legal Name: [*insert full name*]
Joint Venture Party Legal Name: [*insert full name*]
IFB No.: [MM3-CBS-TWK-03]
Page [*insert page number*] of [*insert total number*] pages

Annual Turnover Data (Construction Only)			
Year	**Amount and Currency**	**Exchange rate**	**USD equivalent**
[*indicate year*]	[*insert amount and indicate currency*]	[*insert applicable exchange rate*]	[*insert amount in USD equivalent*]
Average Annual Construction Turnover *			

* Total USD equivalent for all years divided by the total number of years

Bid Form 21 FIR-1: Financial Resources

[*The following table shall be filled in for the Bidder and for each member of a JV.*]

Date: [*insert day, month, year*]
Bidder's Legal Name: [*insert full name*]
Joint Venture Party Legal Name: [*insert full name*]
IFB No.: [MM3-CBS-TWK-03]
Page [*insert page number*] of [*insert total number*] pages

[*Specify proposed sources of financing, such as liquid assets, unencumbered real assets, lines of credit, and other financial means, net of current commitments, available to meet the total construction cash flow demands of the subject Contract or Contracts as indicated in Section III, Evaluation and Qualification Criteria*]

Financial Resources		
No.	**Source of financing**	**Amount (USD equivalent)**
1		
2		
3		

Bid Form 22 FIR-2: Current Contract Commitments

[*The following table shall be filled in for the Bidder and for each member of a JV.*]

Date: [*insert day, month, year*]
Bidder's Legal Name: [*insert full name*]
Joint Venture Party Legal Name: [*insert full name*]
IFB No.: [MM3-CBS-TWK-03]
Page [*insert page number*] of [*insert total number*] pages

[*Bidders and each member of a JV should provide information on their current commitments on all Contracts that have been awarded, or for which a letter of intent or acceptance has been received, or for Contracts approaching completion, but for which an unqualified, full completion certificate has yet to be issued, in accordance with Section III, Evaluation and Qualification Criteria*]

Current Contract Commitments					
No.	**Name of Contract**	**Employer's Contact Address, Tel, Fax**	**Value of Outstanding Work[Current USD Equivalent]**	**Estimated Completion Date**	**Average Monthly Invoicing Over Last Six Months [USD/month)]**
1					
2					
3					
4					
5					

Bid Form 23 FIR-3: Financial Data

Date: [insert day, month, year]
Bidder's Legal Name: [insert full name]
Joint Venture Party Legal Name: [insert full name]
IFB No.: [MM3-CBS-TWK-03]
Page [insert page number] of [insert total number] pages

(All amounts in USD million)

S. No	DESCRIPTION	Financial Data for Last 5 Audited Financial Years				
		Year 1	Year 2	Year 3	Year 4	Year 5
	Total value of construction works executed 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 bidder or member in case of JV/Consortium, and not that of sister or parent company.

Bid Form 24 FIR-4: Bid Capacity

[*The following table shall be filled in for the Bidder and for each member of a JV.*]
Date: [*insert day, month, year*]
Bidder's Legal Name: [*insert full name*]
Joint Venture Party Legal Name: [*insert full name*]
IFB No.: [MM3-CBS-TWK-03]
Page [*insert page number*] of [*insert total number*] pages

Bid Capacity Calculation of Single Entity or Members of Consortium/JV

S. No	Each Member Name	Maximum value of works executed in any one year during the last five years (Updated to 2019 price level) (A)	Value of Price level, of existing commitments and ongoing works (During period of completion of work under this bid) (B)	No. of years prescribed for Completion of the works for which bids are invited, N=1.6 (N)	Bid Capacity (million USD) (2*A*N-B)	Balance bid capacity >34 million USD	Remarks

Bid Form 25 EXP-4.1: General Construction Experience

[The following table shall be filled in by the Applicant and by each member of a Consortium/JV]

Date: [*insert day, month, year*]
Applicant's Legal Name: [*insert full name*]
Applicant'sParty Legal Name: [*insert full name*] IFP No.: [*MM3-CBS-TWK-03*]
Page [*insert page number*] of [*insert total number*] pages

[Identify contracts that demonstrate continuous construction work over the past five (5) years pursuant to Section III, Qualification Criteria and Requirements, Sub-Factor4.1. List contracts chronologically, according to their commencement (starting) dates.]

General Construction Experience			
Starting Year	**Ending Year**	**Contract Identification**	**Role of Applicant**
[indicate year]	*[indicate year]*	Contract name: *[insert full name]* Brief description of the Works performed by the Applicant: *[describe Works performed briefly]* Amount of contract *[insert amount in currency, mention currency used, exchange rate and USD equivalent*]* Name of Employer: *[indicate full name]* Address: *[indicate*	*[insert "Prime Contractor (single entity or Consortium/JV member)","Management Contractor" or "Subcontractor".]*

(Please extend this table as required)

* Refer to Section II – Bid Data Sheet – ITB 37.1for date and source of exchange rate.

Bid Form 26 EXP-4.2 (i): Specific Construction Experience

[The following table shall be filled in for contracts performed by the Applicant, each member of a Consortium/JV.]

Date: [*insert day, month, year*]
Applicant's Legal Name: [*insert full name*]
Applicant's Party Legal Name: [*insert full name*]
IFP No.: [*MM3-CBS-TWK-03*]
Page [*insert page number*] of [*insert total number*] pages

[Fill out one (1) form per contract.]

Contract of Similar Size and Nature			
Similar Contract No. *[insert number]*of*[insert number of*	**Information**		
Contract Identification	*[insert contract name and Reference ID number, if applicable]*		
Award Date	*[insert day, month, year, e.g., 15 June, 2015]*		
Completion Date	*[insertday,month,year,e.g.,03October,2017]*		
Role in Contract *[check the appropriate box]*	**Prime Contractor**		
	Single entity		Consortium/JV member
Total Contract Amount	*[insert total contract amount and currency (ies)]*		USD*[insert exchange rate And total contract amount in USD equivalent]**
If member in a Consortium/JV, specify participation in total Contract amount	*[insert a percentage amount]*	*[insert total contract amount and currency(ies)]*	USD *[insert exchange rate and total contract amount in USD equivalent]**
Employer's Name:	*[insert full name]*		
Address: Telephone/Fax Number:	*[indicate street/number/town or city/country]* *[insert telephone/fax numbers, including country and city area codes]*		

Similar Contract No.[*insert number*]of [*insert number of similar contracts required*]	**Information**
Description of the similarity in accordance with Sub-Factor 4.2(a) (i) of Section III:	
1. Physical Size of required works items	*[insert physical size of items]*
2. Complexity	*[insert description of complexity]*
3. Methods/Technology	*[insert specific aspects of the methods/ technology Involved in the contract]*
4. Other Characteristics	*[insert other characteristics as described in Section VI, Scope of Works]*

* Refer to Section II – Bid Data Sheet – ITB 37.1for date and source of exchange rate.

Bid Form 27 EXP-4.2 (ii): Experience in Key Activities

[The following table shall be filled in for contracts performed by the Applicant, each member of a Consortium/JV.]

Date: [*insert day, month, year*]
Applicant's Legal Name: [*insert full name*]
Applicant's Party Legal Name: [*insert full name*]
IFP No.: [*MM3-CBS-TWK-03*]
Page [*insert page number*] of [*insert total number*] pages

[Fill out one (1) form per contract.]

Contract of Similar Size and Nature			
Contract No. *[insert number]*of*[insert number of*	**Information**		
Contract Identification	*[insert contract name and Reference ID number, if applicable]*		
Award Date	*[insert day, month, year, e.g., 15 June, 2015]*		
Completion Date	*[insertday,month,year,e.g.,03October,2017]*		
Role in Contract *[check the appropriate box]*	**Prime Contractor**		
	Single entity ☐		Consortium/JV member ☐
Total Contract Amount	*[insert total contract amount and currency (ies)]*		USD*[insert exchange rate And total contract amount in USD equivalent]**
If member in a Consortium/JV, specify participation in total Contract amount	*[insert a percentage amount]*	*[insert total contract amount and currency(ies)]*	USD *[insert exchange rate and total contract amount in USD equivalent]**
Employer's Name:	*[insert full name]*		
Address: Telephone/Fax Number:	*[indicate street/number/town or city/country]* *[insert telephone/fax numbers, including country and city area codes]*		

Similar Contract No.[*insert number*]of [*insert number of similar contracts required*]	**Information**
Description of the similarity in accordance with Sub-Factor 4.2(a) (i) of Section III:	
1. Physical Size of required works items	*[insert physical size of items]*
2. Complexity	*[insert description of complexity]*
3. Methods/Technology	*[insert specific aspects of the methods/ technology Involved in the contract]*
4. Other Characteristics	*[insert other characteristics as described in Section VI, Scope of Works]*

* Refer to Section II – Bid Data Sheet – ITB 37.1for date and source of exchange rate.

Bid Form 28: Deleted

Bid Form 29: Deleted

Bid Form 30: Deleted

Bid Form 31: Deleted

Bid Form 32: Deleted

Bid Form 33 SUB: Proposed DDC/Proof Checker/Subcontractors

[The Bidder shall provide information for Proposed Subcontractors in the Table below.]

The following Subcontractors are proposed for carrying out the items of the facilities indicated.

[Bidders are free to propose more than one subcontractor for each item].

Major items of Plant and Design Build Services	Proposed DDC/Proof Checker/Subcontractors	Nationality

The bidder shall ensure that the proposed DDC/sub–contractors are licensed to carry out the works and are able to comply with the technical specification.

.

Bid Form 34: Experience in Key Activities (DDC/Proof Checker/Sub Contractors)

[The Bidder shall provide information for Proposed Subcontractors in the Table below.]

Date: [insert day, month, year]
Bidder's Legal Name: [insert full name]
Joint Venture Party Legal Name: [insert full name]
Subcontractor's Legal Name: [insert full name]
IFB No.: [insert number]
Page [insert page number] of [insert total number] pages

[Fill out one (1) form per Contract, in accordance with Evaluation Qualification Criteria]

Note-For Sub-Contractor: [Fill out one (1) form per Contract, in accordance with Section III. Evaluation and Qualification Criteria, Annexure 1, iii]

1. Key Activity No. (1): [insert brief description of the Activity, emphasizing its specificity]
Total Quantity of Activity under the Contract:

Contract with Similar Key Activities Information				
Item	**Information**			
Contract Identification	[insert Contract name and number, if applicable]			
Award date	[insert day, month, year, e.g., 15 June, 2015]			
Completion date	[insert day, month, year, e.g., 03 October, 2017]			
Role in Contract [check the appropriate box]	Prime Contractor		Management Contractor ☐	Sub-contractor ☐
	Single ☐	JV member ☐		
Total Contract Amount	[insert Contract amount(s) and currency(ies)]		USD [insert Exchange rate and total Contract amount in USD equivalent]	
Quantity (as applicable) performed under the Contract over the period. [insert extent of participation indicating physically executed quantity of key activity successfully completed in the role performed]	Total quantity in the Contract (i)	Percentage Physically Executed (ii)	Physically Executed Quantity (i) x (ii)	
Employer's Name	[insert full name]			

Address Telephone/fax number E-mail	[indicate street / number / town or city / country] [insert telephone/fax numbers, including country and city area codes] [insert E-mail address, if available]

2. Activity No. (2) _____
3. Activity No. (3) _____

Evaluation Qualification Criteria: For projects executed outside India, all Completion Certificate or Performance Certificate or Implementation Completion Report shall have notarial "Stamp & signed" by Client or executing Government Agency from country of origin (project) and attested by Indian Embassy in that country or by placing Apostille marking (Hague Convention Stamp from countries who are signatories to the Hague Convention) on the documents for submission of bids. Failure to comply with this requirement will result in disqualification of the submitted bid.

Bid Form 35: Proposed Manufacturers for Major Items of Plant

[The Bidder shall provide information for Proposed Manufacturers for Major Items of Plant, in the Table below.]

The following manufacturers are proposed for carrying out the item of the facilities indicated.

[Bidders are free to propose more than one manufacturer for each item].

Major Items of Plant	Proposed Manufacturers	Nationality

Bid Form 36 MAN: Manufacturer's Authorization

[The Bidder shall require the Manufacturer to fill in this Form in accordance with the instructions indicated. This letter of authorization should be signed by a person with the proper authority to sign documents that are binding on the Manufacturer.]

Date: [insert date (as day, month and year) of Bid Submission]
IFB No.: [MM3-CBS-TWK-03]

To: [insert complete name of Purchaser]

WHEREAS

We [insert complete name of Manufacturer or Manufacturer's authorized agent], who are official manufacturers of [insert type of goods manufactured], having factories at [insert full address of Manufacturer's factories], do hereby authorize [insert complete name of Bidder] to submit a Bid the purpose of which is to provide the following goods, manufactured by us [insert name and/or brief description of the goods], and to subsequently negotiate and sign the Contract.

We hereby extend our full guarantee and warranty in accordance with Clause 11, Defect Liability, of the General Conditions of Contract and Particular Conditions of Contract, with respect to the goods offered by the above firm.

Name: [insert complete name of person signing the Bid]

In the capacity of [insert legal capacity of person signing the bid]

Signed: [insert signature of person whose name and capacity are shown above]

Duly authorized to sign the bid for and on behalf of: [insert complete name of Bidder]

Dated on _____ day of _____, _____ [insert date of signing]

Bid Form 37: ACK
Acknowledgement of Compliance with the Guidelines for Procurement under Japanese ODA Loans

A) I, [insert name and position of authorized signatory], being duly authorized by [insert name of Bidder/members of joint venture ("JV")] (hereinafter referred to as the "Bidder") to execute this Acknowledgement of Compliance with Guidelines for Procurement under Japanese ODA Loans, hereby certify on behalf of the Bidder and myself that all information provided in the Bid submitted by the Bidder for [Loan No ID-P268 and project Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ)] is true, correct and accurate to the best of the Bidder's and my knowledge and belief. I further certify, on behalf of the Bidder, that:

(i) the Bid has been prepared and submitted in full compliance with the terms and conditions set forth in the Guidelines for Procurement under Japanese ODA Loans (hereinafter referred to as the "Guidelines"); and

(ii) the Bidder has not, directly or indirectly, taken any action which is or constitutes a corrupt, fraudulent, collusive or coercive act or practice in violation of the Guidelines and is not subject to any conflict of interest as stipulated in the relevant section of the Guidelines.

<If debarment for more than one year by the World Bank Group is NOT imposed, use the following sentence B).>
B) I certify that the Bidder has NOT been debarred by the World Bank Group for more than one year since the date of issuance of Invitation for Bids.

<If debarment for more than one year by the World Bank Group has been imposed BUT three (3) years have passed since the date of such debarment decision, use the following sentence B').>
B') I certify that the Bidder has been debarred by the World Bank Group for a period more than one year BUT that on the date of issuance of Invitation for Bids at least three (3) years had passed since the date of such debarment decision. Details of the debarment are as follows:

Name of the debarred firm	Starting date of debarment	Ending date of debarment	Reason for debarment

C) I certify that the Bidder will not enter into a subcontract with a firm which has been debarred by the World Bank Group for a period more than one year, unless on the date of the subcontract at least three (3) years have passed since the date of such debarment decision.

D) I certify, on behalf of the Bidder, that if selected to undertake services in connection with the Contract, the Bidder shall carry out such services in continuing compliance with the terms and conditions of the Guidelines.

E) I further certify, on behalf of the Bidder, that if the Bidder is requested, directly or indirectly, to engage in any corrupt or fraudulent action under any applicable law, such as the payment of a rebate, at any time during a process of public procurement, negotiations, execution or implementation of contract (including amendment thereof), the Bidder shall report all relevant facts regarding such request to the relevant section in JICA (details of which are specified below) in a timely manner.
JICA's information desk on fraud and corruption (A report can be made to either of the offices identified below.)

(1) JICA Headquarters: Legal Affairs Division, General Affairs Department
URL: https://www2.jica.go.jp/en/odainfo/index.php
Tel: +81 (0)3 5226 8850
(2) JICA India office,
2nd Floor, Dr. Gopal Das Bhawan, 28, Barakhambha Road, New Delhi - 110001
Tel: +91 11 47685500
FAX: +91 11 47685555
URL: http://www.jica.go.jp/india/english/office/index.html

The Bidder acknowledges and agrees that the reporting obligation stated above shall NOT in any way affect the Bidder's responsibilities, obligations or rights, under relevant laws, regulations, contracts, guidelines or otherwise, to disclose or report such request or other information to any other person(s) or to take any other action, required to or allowed to, be taken by the Bidder. The Bidder further acknowledges and agrees that JICA is not involved in or responsible for the procurement process in any way.

F) If any of the statements made herein is subsequently proven to be untrue or incorrect based on facts subsequently determined, or if any of the warranties or covenants made herein is not complied with, the Bidder will accept, comply with, and not object to any remedies taken by the Employer and any sanctions imposed by or actions taken by JICA.

_____

Authorized Signatory
[*Insert name of signatory; title*]

For and on behalf of [*Insert name of the Bidder***]**
Date:

Bid Form 38: Deleted

Bid Form 39: Deleted

BIDDING DOCUMENTS

MUMBAI METRO LINE 3 (COLABA-BANDRA-SEEPZ)

CONTRACT MM3-CBS-TWK-03 (Package 10C)

Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of Ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and Ballasted Track in the area of at-grade Aarey Station and in the Depot area of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ).

and

Procurement and Supply of Turnouts, Scissor Crossovers and Buffer Stops for the entire Mainline for Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ) including Package 10 B.

PART 1

BIDDING PROCEDURE

Section IV - B

PRICING DOCUMENT

July 2019

JICA LOAN AGREEMENT ID - P 268

Mumbai Metro Rail Corporation Ltd
Line 3 Transit Office, Wing 'A' North Side of City park 'E'- Block,
Bandra-Kurla Complex,
Bandra (East) Mumbai 400 051, India

BIDDING DOCUMENTS

Composition of Documents

Part 1	**Bidding Procedures**	
	Section I	Instructions to Bidders(ITB)
	Section II	Bid Data Sheet(BDS)
	Section III	Evaluation and Qualification Criteria
	Section IV - A	Bidding Forms
	Section IV- B	**Pricing Document**
	Section V	Eligible Source Countries of Japanese ODA Loan
Part 2	**Employer's Requirements**	
	Section VI (1)	General Specifications A. General B. Functional C. Design D. Construction E. Inspection Testing and commissioning F. Appendices
	Section VI (2)	Outline Design Specifications
	Section VI (3)	Outline Construction Specifications
	Section VI (4)	Tender Drawings
Part 3	**Conditions of Contract and Contract Forms**	
	Section VII	General Conditions of Contract (GCC)
	Section VIII	Particular Conditions of Contract (PCC)
	Section IX	Contract Forms
Part 4	**Reference Documents**	
	Section X	OHS&E Manual

Table of Contents

1.1 Preamble

1.1.1 The Pricing Document shall be read in conjunction with Invitation for Bids, Instructions to Bidders (ITB) and all Bidding Documents, Specifications and Drawings and Employers Requirements.

1.1.2 The Contract is a lump sum price Contract (partly BOQ), adjusted by the Price Adjustment Formula as detailed in Particular Conditions of Contract (PCC), Sub-Clause 13.8 of Part 3, Section VIII.

1.1.3 The item descriptions, if given, are general summaries only. Any error/omission within these forms shall not warrant an adjustment of the Contract Price nor entitle the Bidder to seek an extension of time under the Contract. If Bidders are unclear or uncertain about the scope of any item, they shall seek clarification in accordance with Clause 7 of ITB prior to submitting their Bid.

1.1.4 Price shall be filled in indelible ink, and any alterations necessary due to errors, etc., shall be signed by the Bidder.

1.2 Contract Price

1.2.1 The Contract Price consists of:

i. Itemized price of the major items enlisted in the Bills of Quantities (BOQ) stated in the Schedule 1 and 2 in this documents and Lump Sum price for the items covered in Schedule 3

"Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and ballasted Track in the area of at-grade Aarey Station and in the Depot area of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ).

and

Procurement and Supply of Turnouts, Scissor Crossovers and Buffer Stops for the entire Mainline for Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ) including Package 10 B", as per the Employer's Requirements in Part 2, Section VI read along with the drawings and all other parts of the Bidding documents.

ii. Payment at the rates in Schedule 7 – Day Work

iii. An amount of Rs 25 lakh against Provisional Sums – Schedule 4.

1.2.2 The price shall include all taxes and duties including, but not limited to, items such as Customs duties, GST (IGST, SGST, CGST, and UTGST, etc.), Octroi, etc. as stipulated in GC 14.1(b).

1.2.3 The payment shall be:

(i) In line with supply of the BOQ items by rates in Schedule 1 & 2 and

(ii) As percentages of the accepted single lump-sum offer price in Schedule 3 for installation in accordance to the prescribed Payment Schedule stated in para 1.9 of this document.

(iii) The lump sum price is divided according the percentages shown against the cost centers indicated at para 1.9 and the price for each cost center is divided according to

the percentages shown against the items under the cost centers.

(iv) The payment shall include all relevant items of cost such as preliminary and detailed design, supply of all materials, equipment, landing charges, shipping costs for transport by air, sea or land (or any combination thereof), insurance charges, taxes and duties, unloading, storage, and all works required for this work, including supply of spare parts and special tools, training of Employer's O&M staff, provision of as-built drawings, provision of O&M manuals, and all types of clearances/approvals required from government authorities. The rate shall also include the Bidder's profit and establishment overhead, all general risks, insurance liabilities, compliance with labor laws as per statutory obligations set out or implied in the Contract, attending to defects list prepared by the Employer prior to handover of works and facilities, and any other contractual requirements stated in the Bidding Documents.

1.2.4 Deemed Export

The Bidder shall solely be responsible for claiming and availing all deemed export benefits, if available, during the currency of contract. However, for availing the said benefits, necessary payment certificate in accordance with the laws of the land and extant policies of the Government of India will be issued by MMRCL at the specific request of the Bidder. Bidder shall process for refund for 100% of the paid Custom Duties/Basic custom duty (as applicable) for items as above after availing the concessional duties such as Project Import Benefits under chapter 98.01 of Customs Tariff Act etc. from the Statutory Authorities based on submission of documentary evidence by the Bidder. Bidder shall be fully responsible for ensuring that all necessary documentation/information, as may be required, for processing the refund of paid duties from the Statutory Authorities are correctly prepared by them and are timely submitted, to claim the refund of paid duties from the Statutory Authorities. The Bidder shall arrange for the remittance of the refund so obtained to the Employer within 15 days. In case of failure by the Bidder to obtain and remit the refund within reasonable time (to be decided by the Project Manager & intimated to Bidder) to the Employer, the same will be recovered by the Employer from the amounts due to the Bidder or as debt due from the Bidder.

1.2.5 Exemption in state taxes

Should the Employer, during execution of the contract, obtain a waiver for GST (IGST, SGST, CGST, UTGST, etc.), Custom Duty or any other tax in full or part thereof, the Bidder will be advised on the process to be followed to obtain exemption/refund of such taxes, duties etc., from the concerned authorities. The Bidder shall arrange for the remittance of the refund so obtained to the Employer. In case of failure by the Bidder to obtain and remit the refund within reasonable time (to be decided by the Project Manager and intimated to Bidder) to the Employer, the same will be recovered by the Employer from the amounts due as payment to the Bidder or as debt due from the Bidder.

1.2.6 Record of Taxes, Duties, etc.

The Bidder shall also give breakdown of his offer clearly giving the Custom Duty, GST (IGST, SGST, CGST, UTGST, etc.), Octroi/Entry Tax and any other Tax, levy, Cess, etc.

The Bidder shall maintain complete records in respect of payments made by them for taxes, duties, Octroi, and other levies payable to various authorities and advise the Employer the summary of such payment every month in a format advised by the Employer during execution of the contract.

The detailed records shall remain open for inspection by the Employer/Project Manager at any time, and copies of the records shall be furnished as required by the Employer/Project Manager. Should there be any statutory changes in taxes & duties with respect to the tax structure as it was twenty-eight (28) days prior to the deadline for submission of Bids, the amount payable/recoverable from the Bidder in accordance with the conditions of the bid will generally be calculated based on these records.

The Bidder shall also maintain records of the imported components supplied to local manufacturers and actual utilization of the same in the manufacture of complete equipment. The Bidder shall be fully responsible for any loss or misuse of these components in manufacture of equipment.

1.2.7 Concessional benefits for Project Import

Mumbai Metro Line 3 Project is eligible for availing concessional duty benefits as per Customs Tariff Act for Project Imports. After award of contract, at the request of the Bidder, MMRCL can facilitate the Bidder for obtaining sponsoring/recommendation Letter from the Ministry of Urban Development (MoUD) for getting themselves registered for availing Project Import Benefits. However, the responsibility to avail the concessional benefits under Project Import or otherwise as extended in accordance with the law of the land shall solely rest with the Bidder.

1.3 Description of Pricing Schedule

The Pricing Documents comprise the following Schedules:

a)	Schedule No.1.	Procurement of P-Way Material
b)	Schedule No. 2.	Spare Parts & Equipment
c)	Schedule No. 3.	Part Procurement Part Design, Installation Testing and Commissioning
d)	Schedule No.4.	Provisional Sum
e)	Schedule No.5.	Grand Summary
f)	Schedule No.6.	Price for Withdrawal of Non Material Deviation
g)	Schedule No.7.	Day Work Rates

1.3.1 Schedule 1 - Procurement of P-WAY Material

Schedule 1 is dedicated to procurement and supply of P.WAY Material. This includes Turnouts, Buffer Stops, PSC Sleepers, PSC Turnout sleeper sets, related fittings and miscellaneous items

Note:

a) The material supplied would conform to the relevant specification from Employers Requirement (ER) in Part 2 and as per the latest correction slips issued.
b) All Turnouts with Rail fasteners, Friction Buffer stops and joggle fish plates procured for Package 10B will be supplied to the store of contractor of Package 10B at Mumbai. The unloading at the place of storage of Package 10B shall be done by the Package 10B contractor.

1.3.2 Schedule 2 - Spare Parts & Equipment

This item is for supply of spares for maintenance, including tools and equipment.
The Bidder has to supply the items stated in this schedule confirming the specification and quantity mentioned in this schedule and also as approved by the Engineer and as given in Employer's Requirement (ER), Part 2.

1.3.3 Schedule 3 - Part Procurement, Part Design, Installation Testing and Commissioning

Schedule 3 includes items of Part Design, Part Supply, Installation, Testing and Commissioning of Ballast less track, Ballasted Track and Specialized Track, as per the Employer's Requirements in Part 2, Section VI (1) B - read along with the drawings and all other relevant parts of the Bidding documents.

1.3.4 Schedule 4 - Provisional Sum

Provisional sums shall include One-half of the Employer's cost estimates of the Dispute Board. Bidder's overhead and profits shall not be included in this amount. All other amounts included as Provisional sums are only indicative and shall be incurred by the Bidder only and only as per the instructions of the Engineer, if and when ordered by him. Kindly refer to GC 13.5 read with GC 20.2.

a) Provisional sums L.S may be kept INR 2.5 million.

1.3.5 Schedule 5 - Grand Summary

Schedule 5 is dedicated to the Grand Summary of Prices quoted against Schedule 1, 2, 3, and 4. Total of Schedule – Grand Summary to be carried forward to Bid Form.

The Bidder shall also give breakdown of his offer Price clearly giving the Custom Duty, GST (IGST, SGST, CGST,UGST etc.), Octroi/Entry Tax and any other Tax, levy, Cess, etc. along with the applicable rate in the Form attached as Appendix A of Section IVB

1.3.6 Schedule 6 - Price for Withdrawal of Non Material Deviation

The amount in this schedule that becomes payable shall be added against total of the concerned schedule and distributed as appropriate.

1.3.7 Schedule 7 - Day Work Rates

Day work rates are intended to facilitate the Execution of minor or incidental item of work that the Engineer may find necessary to be executed as a variation. Kindly refer to GC 13.6

1.4 Price / Cost Breakdown

1.4.1 The payment for the material supplied as per Schedule 1 & 2, shall be paid as per BOQ rates and supplied quantity.

1.4.2 The payment against Schedule 3 is distributed within para 1.9, placed after schedule 7.This is based on the weightage of the activity or part of the project value has specified, for the purpose of payment and is covered in that schedule.

1.4.3 Payments to the Bidder will be made in accordance with the percentage (%) indicated against each schedule, further divided within the schedule as a milestone or completion of an activity. It is also governed in accordance to Procedure for Payment as mentioned in GC 14.3 to 14.5 read with the Schedule of Payments. In the case of part supply/installation proportionate payment will be made based on the quantities stated in Schedule-3, which are for the purpose of the proportion of payment only.(Although the quantities in detail design may be different, only the stated percentage the lump sum price shall be paid against each item)

1.5 Payment Concept

Payment will be calculated using the Schedule of Payments, subject to the Engineer being satisfied that the facilities for each item are 100% complete. Payment will be based on the Bidder's submissions for the issue of monthly IPC as per GC 14.3
In case of a Joint Venture/Consortium, Payment will be made in the name of Joint Venture/Consortium only. However on combined request by all members of JV/Consortium, payments can be made to Individual JV/Consortium members with approval of Employer.

1.6 Customs Clearance

a) The Bidder shall be solely responsible for Custom and Excise clearances (including any other related activities) of all items that may be directly or indirectly required for execution of this Contract.

1.7 Price Adjustment

As specified in the Contract Data, price adjustment is followed by the detailed Price Adjustment Formula as stipulated in Particular Conditions of Contract (PCC), Sub Clause 13.8 of Part 3, Section VIII.

1.8 Quantity Variation

This Contract is a lump sum (Partly BOQ), design-build contract. No variation, whether positive or negative shall be considered in the lump sum Schedule 3, unless the scope of work stated in the Employer's Requirements is changed by the Engineer in accordance with GC 13.1 to 13.3.

In case of increase in the total quantity of facilities beyond the original scope as indicated in the Employer's Requirements, the Key Dates for the increased quantities shall be mutually agreed.

Schedules of Rates and Prices

Schedule No. 1: Procurement of P-Way Material

Sr. No.	Description	Unit	Quantity	Rate				Amount			
				INR	USD	EURO	YEN	INR	USD	EURO	YEN
1	**Procurement of Turnout set**										
1.1	1:7 Turnout R190 - (1 set consist of 2nos thick web switches HH, Stock rail with sliding chairs, 1no weldeable CMS crossing with check rail set for ballastless track and Turnout fastening complete from Toe of switch to Back of crossing for ballastless track) **(Note: 8 nos of 1:7 Turnout R190 sets are required to be supplied at the store depot of Contractor 10B at Mumbai**)										
a	For project - 18 Sets	Sets	22								
b	As spares - 4 Sets										
1.2	1:9 Turnout -R300 - (1 set consist of 2nos thick web switches HH, Stock rail with sliding chairs baseplate complete, 1no weldable CMS crossing with check rail set for ballastless track and Turnout fastening complete from Toe of switch to Back of crossing for ballastless track) **(Note**: **4 nos of 1:9 Turnout R300 sets are required to be supplied at the store depot of Contractor 10B at Mumbai)**										
a	For project - 6 Sets	Sets	9								
b	As spares - 3 Sets										
1.3	1:9 Turnout -R300 - (1 set consist of 2nos thick web switches HH, Stock rail with sliding chairs baseplate complete, 1no weldable CMS crossing with check rail set for Mono block PSC										

	sleepers and Turnout fastenings complete from Toe of switch to Back of crossing for ballasted track)										
a	For project - 10 Sets	Sets	12								
b	As spares – 2 Sets										
1.4	1:7 Turnout R190 - (1 set consist of 2nos thick web switches HH, Stock rail sliding chairs baseplate complete, 1no weldable CMS crossing with check rail sets for Mono block PSC sleepers and Turnout fastenings complete from Toe of switch to Back of crossing for ballasted track)										
a	For project - 57 Sets	Sets	63								
b	As spares – 6 Sets										
2	**Procurement Diamond- Xing**										
2.1	Diamond Xing HH of 1 in 5.5, Cuffe Parade with Fastening System including check rail set for ballastless track **(Note**: **This 1 set of Diamond crossing are required to be supplied at the store depot of Contractor 10B at Mumbai)**										
a	For Project – 1 set	Sets	2								
b	As spares – 1 set										
2.2	Diamond Xing HH of 1 in 7 at CST and Acharya Atre and Sahar Road with Fastening System including check rail set for ballastless track **(Note**: **Two sets of Diamond crossing are required to be supplied at the store depot of Contractor 10B at Mumbai)**										
a	For Project – 3 set	Sets	6								
b	As spares – 3 set										

2.3	Diamond Xing HH of 1 in 7, Aarey (Ballasted Track) with Fastening System including check rail set										
a	For Project – 1 set	Sets	2								
b	As spares – 1 set										
3	**Procurement of Joggle Fish Plate**										
a	Joggle Fish Plate for UIC 60 rail with special clamp (1 set consist of 2 joggle plate +2 clamp with all necessary fittings) Joggle plate length would be 600 mm.										
	For project – 1700 Sets (850 for 10C and 850 for 10B)	Sets	1700		NA	NA	NA				
b	Joggle Fish Plate for UIC 60 rail with special clamp (1 set consist of 2 joggle plate +2 clamp with all necessary fittings) Joggle plate length would be 1000 mm.										
	For project – 300 Sets (200 for 10C and 100 for 10B)	Sets	300		NA	NA	NA				
4	**Procurement of Buffer Stop & Wheel Stop**										
4.1	Friction Buffer Stop 25 KMPH (Note: 2 sets of Buffer stop 25 KMPH will be supplied at the store depot of contractor 10B at Mumbai)										
a	For project – 6 sets	Sets	8								
b	As spares – 2 sets										
4.2	Procurement of Friction Buffer Stop 10 KMPH										
a	For project - 2 sets	Sets	4								
b	As spares – 2 sets										
4.3	Procurement of Friction Buffer Stop 5 KMPH (Including Depot)										
a	For project - 43 sets	Sets	47								

b	As spares – 4 sets										
4.4	Procurement of Retractable Buffer Stop 5 KMPH										
a	For project - 3 sets	Sets	5								
b	As spares – 2 sets										
4.5	Procurement of Wheel stopper	Nos.	8		NA	NA	NA				
5	**Procurement of PSC Sleepers**										
5.1	PSC Sleepers of Turnout of ballasted track system for 1in7 R190										
a	For project – 57 sets	Sets	59		NA	NA	NA				
b	As spares – 2 sets										
5.2	PSC Sleepers of Turnout of ballasted track system for 1in9 R300										
a	For project – 10 sets	Sets	12		NA	NA	NA				
b	As spares – 2 sets										
5.3	PSC Sleepers of Diamond crossing according to the depot track system for 1in7 R190 for ballasted track										
a	For project – 1 set	Sets	2		NA	NA	NA				
b	As spares – 1 set										
6	Rail fasteners system for ballasted track. 1 set of Rail fasteners consists of for one-rail seat, 2-Metal liners, 2-ERC Mark 3, 1-Grooved Rubber sole plate 10mm.										
a	For projects- 49,600 sets	Sets	55,600		NA	NA	NA				
b	As spares – 6,000 sets										
7	Procurement of PSC Sleepers including Inserts for rail seats only as per design.										

a	For project – 24,800 nos	Nos	25,100		NA	NA	NA				
b	As spares – 300 nos										
8	Procurement of Check Rail including Check rail fastener/clamps etc., for Level crossing at Aarey Depot and also at Cross passage and stations at Mainline with Rail fasteners as per IRS specification (For Package 10C – 1500 M including Depot)	M	1500		NA	NA	NA				
TOTAL											

Notes:

1. The indigenous items should be quoted in INR only, accordingly other currency for those items have been marked as NA (Not Allowed).
2. The balance Joggle fish plates shall be returned to the Employers after its uses.

Schedule No. 2: Spare Parts & Equipment

Sr. No.	Description	Unit	Quantity	Rate				Amount			
				INR	USD	EURO	YEN	INR	USD	EURO	YEN
1	Booted Twin block sleepers with resilient pad for mainline	Nos.	200								
2	Booted Twin block sleepers with Resilient pad for turnouts complete 1 in 9 R300 including CMS crossing (1 set of LH and 1 set of RH).	Sets	2								
3	Booted Twin block sleepers with Resilient pad for turnouts complete 1 in 7 R190 including CMS crossing (1 set of LH and 1 set of RH).	Sets	2								
4	Booted Twin block sleepers with Resilient pad for diamond crossing complete 1in 7 R190 including crossing (1 set of LH and 1 set of RH).	Sets	2								
TOTAL											

Notes applicable on Schedule 1 and Schedule 2

1. The quantities have been assessed based on preliminary drawings. If there is additional requirement attributable to the contractor, the cost of such material used shall be recovered from the contractor at the bid price. If there is any change in the requirement of material on account of detailed design, then the material required shall be arranged by the Employer.

2. The surplus items from the project, spares in Schedule-1 and the spares of Schedule-2 shall be handed over to the Employer store depot at Mumbai after successful installation and commissioning

3. The quantity for each item has been provided. The bidder is required to fill the unit price and total amount without altering the quantities.

4. Cases where the bidder has quoted unit rates but the total price does not tally with (price multiplied by quantity) then unit price quoted will be considered for calculating the procurement price of the quantities specified in the bid and this calculated price will be considered for evaluation.

4.1 Cases where bidder has mentioned unit rates as ‘ZERO’ or '0' or '-' or 'NIL':

a) For all such items the prices shall be considered as '0 (Zero)' for evaluation and payment.

b) Also, during actual contract execution, such items, if any, will be considered as to be supplied free of cost to the Employer.

4.2 Cases where bidder has either left unit rates blank or some items have been excluded from the specified list

a) For all such items, the maximum prices quoted by any of the other responsive bidder for such item will be considered and added to the respective item price quoted by the bidder. This calculated price will be considered for evaluation.

b) However, during actual contract execution, such items, if any, will be considered as to be supplied free of cost tothe Employer.

4.3 Cases where the bidder has quoted for additional items (over and above the items specified in the bidder):

- Price of additional items quoted by the bidder will not be considered for evaluation and such items will not form part of the contract.

Schedule No. 3: Part Procurement, Part Design, Installation, Testing & Commissioning.

Sr. No.	Description	Amount			
		INR	USD	EURO	YEN
1	Part Design, Procurement and Supply, Installation, Testing and Commissioning of ballastless Track on High Attenuation booted twin block sleepers for the Mainline from Aarey station (excluded) until BKC station (included) and ballasted Track in the area of at-grade Aarey Station and in the Depot area as per the scope of work given in the Employer's Requirement in Part 2 and not limited to: a. Part Procurement, Installation, Testing & Commissioning of Ballastless Low vibration track on Main line, as per the Employer Requirement including installation of Turnouts, Buffers, weldings & destressing etc. b. Part Procurement and Installation of ballasted and specialised track in Aarey Depot and for specific utilities (embedded track, pit line track on pedestals, washable aprons, etc) and ballasted Track in the area of at-grade Aarey Station in main line And Obtain the "Notice of No Objection" or "Notice of No objection Subject to ---" from the Project Manager as per Employer's Requirement (detailed in Part-2) for: • Submission of Project Management Plan; Interface Management Plan and Detailed Interface Documents; Works Programme; Design Submission Programme; Quality Assurance Plan; Safety Assurance Plan and Site Safety Plan; Environmental Plan; Quality Assurance Plan; Inspection, Testing & Commissioning (including Integrated Testing & Commissioning) Plan; Liaison with other Designated Contractors during the design process; Submission of the Preliminary Design, the pre-Final Design; the Detailed Design Submission of Proof Checking Document; As-Built drawings etc. • Completion of laying of Track with turnouts, buffer stops, and other fittings. • Completion of Integrated Testing and Commissioning on the track and in the Depot;				

	• Completion of integrated testing and commissioning on the section in conjunction with Designated contractors; • Instrumentation Tests, Oscillation trials; • Service Trials and Final Commissioning; • Sanction of Statutory Authorities of Test results Obtain the "Notice of No Objection" or "Notice of No objection Subject to ---" from the Project Manager as per Employer's Requirement (detailed in Part-2) for the delivery of the following: • Training and Maintenance Manual				

Notes:

1. Bidder should quote one lump sum rate for this item, under each currency if and as applicable.

Schedule No. 4: Provisional Sums

Sr. No.	Description	INR
1.	One half of the Employer's cost estimate of Dispute Board (DB)[1] (carry forward to Grand Summary Schedule 5)	2,500,000.00 (2.5 Million only)
Name of Bidder		
Signature of Bidder		

Notes

1. Use of Provisional Sums shall require a prior instruction by the Employer/Project Manager. Contractor shall pay 100% of fees and expenses to Dispute Board (DB) member(s) and therefore Contractor will be reimbursed 50% of the payment made to DB member(s), by the Employer.

Schedule No. 5: Grand Summary

Schedule	Description	Amount			
		INR	USD	EURO	YEN
1	Procurement of P.WAY Material				
2	Spare Parts & Equipment				
3	Part Design, Installation, Testing & Commissioning				
4	Provisional Sums				
	BID TOTAL				
	EQUIVALENT BID TOTAL (IN USD)				

BID TOTAL (In words): USD

Name of the Bidder	
Signature of the Bidder	

Notes:

1) Payments for this Contract will be made in Indian Rupees, Japanese Yen and/or maximum two other international currencies (USD and/or EURO), if the Contractor so desires, or in a combination of all four currencies.

2) The Bidder shall complete the equivalent Bid Total in USD in word above. For the conversion to USD/Euro/Yen for INR equivalent the date of exchange rate will be Base Date as mentioned in ITB 37.1

3) Source for Foreign Currency rate will be RBI and if not available on the site of RBI then bidder can use rate from website of www.xe.com

4) Employer shall evaluate the extent of acceptability of deviations indicated in Statement of Nonmaterial Deviations, Section IV-A, Bidding Form 14 and their Prices in Bid Form 15 for unqualified withdrawal of any remark, comment, condition, qualification or deviation etc. to determine the final Price of Schedule 6 for taking into account for determination of lowest Bidder.

Appendix A

Details of Taxes/Duties/Levies etc. included in The Bid Price

Sr. No.	Taxable Amount	Custom Duty		CGST		SGST		IGST		UTGST		Any Other Tax/Levy/Cess		Total Amount of all Taxes/Duties /Levies/Cess
		Rate%	Amount	Rate%	Amount	Rate%	Amount	Rate%	Amount	Rate%	Amount	Rate%	Amount	
1														
2														
3														
4														
5														
5														
Total														
Grand Total														

*Please mention similar group of goods/services which attracts same rate of tax under each schedule. You may add more rows wherever required. Refer to Clause 1.2.3 of Section IV-B above and the Notes below for an explanation of the above table.

Notes:

The Bidder is to give in his Bid offer, a breakdown of his fixed Lump Sum Price clearly detailing the following:

a) Custom duty on offshore manufactured Plant/ equipment, if any along with rate of Custom duty.

b) GST (CGST/SGST/IGST/UTGST etc) (after availing relevant Credit) on completely assembled/manufactured Plant/ equipment, if any along with rate of GST (CGST/SGST/IGST/UTGST etc).

c) Custom duty on imported spares, special tools, etc. along with rate of Custom duty.

d) GST (CGST/SGST/IGST /UTGST etc) on Spares, Jigs, Fixtures, Special tools, Testing and Diagnostic equipment etc. along with rate of GST.

e) GST (CGST/SGST/IGST/UTGST etc) on the completely assembled/manufactured Plant/ equipment along with the rate of GST.

f) GST (CGST/SGST/IGST/UTGST etc) on the indigenous finished Spares, Special tools and Testing Equipment etc. along with rate of GST.

g) GST (CGST/SGST/IGST/UTGST etc) on works along with applicable rate.

h) Octroi /Entry Tax/ Other levies/ Cess. Etc. (if any)

i) If the rates of taxes mentioned in above table is different from the actual applicable rates, then the actual applicable rates will be considered for variation purpose only, however no change in bid prices quoted in different schedules shall be considered.

Name of the Bidder	
Signature of the Bidder	

Schedule No. 6: Pricing for unqualified withdrawal of conditions, qualifications, deviations etc. submitted in "Statement of Nonmaterial Non-Conformity", Bid Form-15, Section IV-A, Bidding Forms

Sr. No.	Condition, Qualification, Deviation	Relevant Price Schedule (1/2/3/4)	Key date affected by each condition, qualification, deviation etc.	Increase or Decrease for unqualified withdrawal of each conditions, qualification, deviation etc.			
				Foreign Currency (ies)	Indian Rupees	Schedule No.	Key date

Notes:

- In this Appendix, the Bidder shall indicate every key date that will be affected by each remark, comment, condition, qualifications or deviation, etc. that has been specified in Statement of Nonmaterial Deviations, Section IV-A, Bid Form 15 "Statement of Nonmaterial Non-conformity".

- Prices for unqualified withdrawal of each remark, comment, condition, qualifications or deviation, etc. that has been specified in Statement of Nonmaterial Non-conformity, Section IV-A, Bid Form14- Bidding Forms shall be quoted in this Schedule 6, clearly indicating the Schedule No. and Key date to which it will be

allocated. The Price quoted by the Bidder in 'BID TOTAL' in Grand Summary (Schedule No. 5) shall not include the Price for withdrawal of remark, comment, condition, qualifications or deviation etc. quoted in this Schedule 6. However, the Employer shall adjust the Bid Price by taking into consideration the nonmaterial nonconformities to evaluate the Bid Price (for comparison purpose only) of the Technical Bids which are substantially responsive.

- In case price for unqualified withdrawal of any remark, comment, condition, qualification or deviation etc. indicated in Statement of Nonmaterial Deviations, Section IV-A, Bid Form 15 is not quoted in Schedule No. 6, it shall be considered that the remark, comment, condition, qualification or deviation is unconditionally withdrawn without any financial implication. However, Employer at its sole discretion and option may assess the financial implication of the said remark, comment, condition, qualification or deviation etc. based on best engineering principles and concepts, which shall be binding on the bidder, and the same may be considered by Employer for financial evaluation.

Schedule No. 7: Day Work

Day work will be carried out in terms of clause 13.6 of GCC/PCC

1.9 Payment Schedule of Schedule 3

Cost Centre	Percentage of Schedule 3 value
1.9.1 General	**4%**
1.9.2 Design	**5%**
1.9.3 On-Site Construction, Installation and Testing & Commissioning	**90%**
1.9.4 Training & Manual	**1%**
TOTAL	**100%**

1.9.1 General

Percentage Weightage					**4%**
Sr. No.	**Description**	**Frequency**	**Unit**	**Quantity**	**Percentage Weightage**
101	**Contractual Submissions**				
101.1	Performance Security, Insurances, etc.	One Time	Item	1	4
102	**General Items**				
102.1	Initial Works Programme,	One Time	Item	1	4.5
102.2	Detailed Works Programme updates, revisions and Three Month Rolling Programme	Quarterly	No	8	4.5
102.3	Monthly Progress Report (as in App 5)	Monthly	No	24	6.5
102.4	Design Statement & Programme for Design Deliverables (Design Units) (as per section VI(1), Part 2	One time	Item	1	4.5
102.5	Quality Assurance & Quality Control Plans & quarterly Audits (as per App 6)	Quarterly	No	8	9
102.6	System Interface Management Plan & quarterly Audits and compliance	Quarterly	No	8	4.5
102.7	Interface Matrix and Specific Contract Interface Sheets	Monthly	Item	24	2

102.8	All Interface management and coordination meetings, including compliance of issues relating to the Interfacing Bidders	Monthly	No	24	9
102.9	Interface management and coordination meetings and compliance, from the issue of Taking Over Certificate until start of Revenue Services. (Employer to instruct if required.)	Quarterly	No	8	4.5
102.10	Attendance, Coordination and Management, and compliance during Service Trials.	Yearly	No	2	2
102.11	Bidder's Staff Organisation Plan & Key Staff.(Bidder to note Key Staff Payment Deduction , refer Clause 1.3.1 above)	Quarterly	No	8	1
102.12	Project Sign Boards.	One Time	No	1	2
102.13	OHS&E Plan Submission (as per Manual Part 4 and Part 2)	One Time	Item	1	2
102.14	Compliance with Occupational Health, Safety and Environmental Plan & quarterly Audits.	Quarterly	No	8	13
102.15	Project Management Information System	Monthly	No	24	4.5
102.16	Comprehensive Testing and Commissioning Programme - Section VI (1) E	On Time	No	1	2
102.17	Comprehensive Testing and Commissioning Programme - Section VI (1) E	Quarterly	No	8	4.5
102.18	Schedule of Spare Parts.	One Time	Item	1	1.5
102.19	Training Plan Updates	One Time	No	1	1

102.20	Training Plan, Compliance and Audit	One Time	No	1	3.5
102.21	Construction of Engineer's Site Office(s), Bidders Storage Depot and Bidders Site Office	One Time	Item	1	3
102.22	Maintenance and Removal of Engineer's Site Office(s), Bidders Storage Depot and Bidders Site Office	One Time	Item	1	1
102.23	Documents (CMRS and RDSO) for opening as per C5.2(3), including but not limited to:				6
	Contract specification,				10
	Design manual,				10
	Design report on interfacing Bidders,				10
	Testing and commissioning report				10
	Track Maintenance report for Maintainability				10
	Relevant supporting documents for design Submission				10
	Survey report				10
	Temporary works design report				10
	Construction installation analysis report				5
	Construction method statement				5
	Proforma for quality check				5
	Report on use of works area				5
TOTAL%					**100%**

Note:

The quantities noted against the items below may be revised by the Engineer during the course of the contract; the total payment however would be limited to the stated percentage of the lump sum price against Schedule-3

1.9.2 Design

Percentage Weightage				**5%**
Sr. No.	**Description**	**Unit**	**Quantity**	**Percentage Weightage**
201	**Preliminary design of Main line [Aarey station(Including) to BKC(Including)]**			**7.5%**
201.1	Ballasted track at Aarey station (both up & down line)	M	2,499	15
201.2	Ballast less Low vibration track from Aarey station (excluding) to BKC station	M	24,472	30
201.3	Drainage system along track and outlet to cross passage			
	(a) Ballasted Aarey Station	M	2,499	1.5
	(b) Ballast less Main Line (Aarey Excluding to BKC Including)	M	24,472	3.5
201.4	Buffer stop			
	a) BKC Station 5 KMPH	Nos	2	4
	b) Cuffe Parade 25KMPH	Nos	2	6
201.5	Turnouts & Scissor Crossovers			30
	a) BKC Station 1:9 R300 – Turnout	Nos	2	
	b) BKC Station 1:7 R190 – Turnout	Nos	6	
	c) Sahar Road 1:7 R190 – Scissor Crossover	Nos	1	
	d) Acharya Atreya Chowk 1:7 R190 – Scissor Crossover	No	1	
	e) Cuffe Parade 1:9 R300 – Scissor Crossover	No	1	
	f) Aarey Station 1:9 R300 – Turnout	Nos	10	
201.6	Design of interfacing Bidders and including miscellaneous drawings	Nos	6	10
202	**Preliminary design of – Depot**			**2.5%**
202.1	Design of ballasted track including fastenings	M	14,739	30
202.2	Design of all special track such as embedded track, pit line track on pedestals, washable track, etc.	M	2,082	25
202.3	Drainage system along track and outlet of drain			
	a) Ballasted track	M	14,739	10
	(c) Special Track	M	2,082	5
202.4	Friction Buffer stop at Depot	Nos	52	10
202.5	Turnouts (Aarey depot) on ballasted track complete with PSC sleepers and fittings			

	a) Aarey Depot 1:7 R190	Nos	53	15
	b) Aarey Depot 1:7 R190 – Scissor Crossover	Set	1	
202.6	Design of other interfacing Bidders including miscellaneous design	Nos.	6	5
203	**Detailed design of Main line Aarey to BKC**			**35%**
203.1	Ballasted track at Aarey station (both up & down line)	M	2,499	15
203.2	Ballast less track from Aarey station (excluding) to BKC station	M	24,472	30
203.3	Drainage system along track and outlet to cross passage			
	a) Ballasted Aarey Station	M	2,499	1.5
	b) Ballast less Main Line (Aarey Excluding to BKC Including)	M	24,472	3.5
203.4	Buffer stop			10
	a) BKC Station 5KMPH	Nos	2	
	b) Cuffe Parade 25KMPH	Nos	2	
203.5	Turnouts & Scissor Crossovers			30
	a) BKC Station 1:9 R300 – Turnout	Nos	2	
	b) BKC Station 1:7 R190 – Turnout	Nos	6	
	c) Sahar Road 1:7 R190 – Scissor Crossover	Set	1	
	d) Acharya Atreya Chowk 1:7 R190 – Scissor Crossover	Set	1	
	e) Cuffe Parade 1:9 R300 – Scissor Crossover	Set	1	
	f) Aarey Station 1:9 R300 – Turnouts	Nos	10	
203.6	Design of interfacing Bidders and including miscellaneous drawings	Nos	6	10
204	**Detailed design of – Depot**			**10%**
204.1	Design of ballasted track including fastenings	M	14,739	30
204.2	Design of all special track such as embedded track, pit line track on pedestals, washable aprons, etc.	M	2,082	25
204.3	Drainage system along track and outlet to cross passage			
	a) Ballasted track	M	14,739	10
	b) Special Track	M	2,082	5
204.4	Buffers from Aarey to Cuffe Parade including Depot	Nos	52	10
204.5	Turnouts (Aarey depot) on ballasted track complete with PSC sleepers and fittings			15
	a) Aarey Depot 1:7 R190	Nos	53	
	b) Aarey Depot 1:7 R190 – Scissor Crossover	Sets	1	
204.6	Design of other interfacing Bidders including miscellaneous design	Nos.	6	5
205	**Proof Checking of Detailed Design**			**15%**
205.1	Proof Checking of the Detailed design of Ballastless Low vibration track slab, Turnouts & Buffers from approved party as specified in Part I, section III, clause 7.5 (item 5) (Aarey to BKC)	LS		75
205.2	Proof Checking of the Detail Design of layout and other track structure from approved party as specified	LS		25

	in Part I, section III, clause 7.5 (item 5) for Depot			
205	**Construction working Drawings of Main line Aarey to BKC**			**10%**
205.1	Ballasted track at Aarey station (both up & down line)	M	2,499	15
205.2	Ballast less track from Aarey station (excluding) to BKC station	M	24,472	30
205.3	Drainage system along track and outlet to cross passage			
	c) Ballasted Aarey Station	M	2,499	1.5
	d) Ballast less Main Line (Aarey Excluding to BKC Including)	M	24,472	3.5
205.4	Friction Buffer stop			
	a) BKC Station 5KMPH	Nos	2	10
205.5	Turnouts & Scissor Crossovers			30
	a) BKC Station 1:9 R300 – Turnouts	Nos	2	
	b) BKC Station 1:7 R190 – Turnouts	Nos	6	
	c) Sahar Road 1:7 R190 – Scissor Crossover	Sets	4	
	d) Aarey Station 1:9 R300 - Turnouts	Nos	10	
205.6	Design of interfacing Bidders and including miscellaneous drawings	Nos	6	10
206	**Construction working drawings of Depot**			**10%**
206.1	Design of ballasted track including fastenings	M	14,739	30
206.2	Design of all special track such as embedded track, pit line track on pedestals, washable aprons, etc.	M	2,082	25
206.3	Drainage system along track and outlet to cross passage			
	a) Ballasted track	M	14,739	10
	b) Special Track	M	2,082	5
206.4	Buffers from BKC to Cuffe Parade including Depot	Nos	52	10
206.5	Turnouts (Aarey depot) including Scissor Crossover on ballasted track complete with PSC sleepers and fittings			
	a) Aarey Depot 1:7 R190	Nos	53	15
	e) Aarey Depot 1:7 R190 – Scissor Crossover	Sets	1	
207.6	Design of other interfacing Bidders including miscellaneous design	Nos.	6	5
207	**As Built drawings and miscellaneous drawings (such as for opening of section) for Main Line (Aarey to BKC)**	**Sets**	**8**	**5%**
208	**As Built drawings and miscellaneous drawings for opening the section for Depot**	**Sets**	**8**	**5%**
TOTAL %				**100%**

1.9.3 On-Site Construction, Installation, Testing and Commissioning

Percentage Weightage				**90%**
Sr. No.	**Description**	**Unit**	**Quantity**	**Percentage Weightage**
401	Part Procurement, Installation, Testing & Commissioning of Ballastless Low vibration track on Main line, so as to achieve the vibration within limit as per RDSO guidelines	km	24.24	
401.1	Supply of twin block sleeper	km	24.24	5
401.2	Supply and fixing of Boot and Resilient Pad with twin block sleeper	km	24.24	12
401.3	Flash butt welding	km	24.24	5
401.4	Installation of Rail on twin block sleeper including Track Slab	km	24.24	30
402	Part Procurement, Installation, Testing of Ballastless Low vibration track for Turnout & Scissors on RCC slab, so as to achieve vibration within the limit as per RDSO guidelines and Installation of Switches, CMS crossings and Rails			
402.1	a) Turnout 1:7 R190/1:9 R300 including CMS Crossing	Nos	12	8
402.2	b) Scissors 1:7, R190 at Sahar	Set	1	1
403	Installation & Testing of Rails (LWR/CWR) including related fittings and welding(Flash butt welding / AT welding at Isolated locations) and destressing with rail fasteners on ballastless track and USFD testing	km	24.24	5
404	Installation & Testing of Friction Buffer Stop 25 KMPH	Nos.	5	0.5
405	Installation & Testing of Friction Buffer Stop 10 KMPH	Nos.	2	0.5

406	Installation & Testing of Friction Buffer Stop 5 KMPH including 8 nos. of Wheel stopper in depot.	Nos.	55	1
407	Grinding of Rails for Main line	M	48,606	2
408	Transportation of HH Rails UIC 60E1 1080 to site from the store depot and lowering the rails into tunnel including handling for welding & transportation of welded panels into tunnel at site	MT	2954	2
409	Other balance items for Ballastless track on completion	km	24.24	13
410	Installation of Turnouts on PSC Sleepers sets and including 3 rounds of tamping for Turnouts	Sets	67	1.5
411	Installation of the ballasted track on PSC sleepers with rails including welding, destressing and USFD testing including 3 rounds of tamping	km	**16**	4
412	Procurement, Supply of Ballast for Ballasted track including turnout at Aarey station & Depot complete as per the drawing and specification.	Km	**17**	3
413	Installation of specialised track with all the materials and fittings in Aarey Depot for specific utilities (embedded track, pit line track on pedestals, washable aprons, etc)	km	**2.08**	4
414	Other balance items for Ballasted track on completion	km	17	2.5
TOTAL%				**100%**

1.9.4 Training & Maintenance Manual

Percentage Weightage				**1%**
Sr. No.	**Description**	**Unit**	**Quantity**	**Percentage Weightage**
501	Training of Employer's O&M staff as per Employer's Requirement in Part 2	No of Participant	40	80
502	Provision of Operation & Maintenance Manuals as per Employer's Requirement in Part 2	LS	2	20
TOTAL %				**100%**

BIDDING DOCUMENTS

MUMBAI METRO LINE 3
(COLABA-BANDRA-SEEPZ)

CONTRACT MM3-CBS-TWK-03
(Package 10-C)

Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of Ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and Ballasted Track in the area of at-grade Aarey Station and in the Depot area of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ).

and

Procurement and Supply of Turnouts, Scissor Crossovers and Buffer Stops for the entire Mainline for Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ) including Package 10 B.

PART 1

BIDDING PROCEDURE

Section V
Eligible Source Countries of Japanese ODA Loans

July 2019

JICA LOAN AGREEMENT ID - P 268

Mumbai Metro Rail Corporation Ltd
Line 3 Transit Office, Wing 'A' North Side of City park 'E'- Block,
Bandra-Kurla Complex,
Bandra (East) Mumbai 400 051, India

BIDDING DOCUMENTS
Composition of Documents

Part1	**Bidding Procedures**	
	Section I	Instructions to Bidders(ITB)
	Section II	Bid Data Sheet (BDS)
	Section III	Evaluation and Qualification Criteria
	Section IV- A	Bidding Forms
	Section IV- B	Pricing Document
	Section V	**Eligible Source Countries of Japanese ODA Loan**
Part2	**Employer's Requirements**	
	Section VI (1)	General Specifications A. General B. Functional C. Design D. Construction E. Inspection Testing and commissioning F. Appendices
	Section VI (2)	Outline Design Specifications
	Section VI (3)	Outline Construction Specifications
	Section VI (4)	Tender Drawings
Part 3	**Conditions of Contract and Contract Forms**	
	Section VII	General Conditions (GC)
	Section VIII	Particular Conditions (PC)
	Section IX	Annex to the Particular Conditions - Contract Forms
Part 4	**Reference Documents**	
	Section X	OHS&E Manual

Section V. Eligible Source Countries of Japanese ODA Loans

[All countries and Areas]

MUMBAI METRO LINE 3
(COLABA-BANDRA-SEEPZ)

CONTRACT MM3-CBS-TWK-03
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and

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TENDER DOCUMENTS
Part 2
Section VI (1)
EMPLOYER'S REQUIRMENT
General Specification
SUB SECTION A GENERAL

July 2019

JICA LOAN AGREEMENT ID - P 268

Mumbai Metro Rail Corporation Ltd
Line 3 Transit Office, Wing 'A' North Side of City Park 'E'- Block,
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	Section VI (2)	Outline Design Specifications
	Section VI (3).	Outline Construction Specifications
	Section VI (4)	Tender Drawings
Part 3	**Conditions of Contract and Contract Forms**	
	Section VII	General Conditions of Contract (GCC)
	Section VIII	Particular Conditions of Contract (PCC)
	Section IX.	Annex to the Particular Conditions - Contract Forms
Part 4	**Reference Documents**	
	Section X	OHS&E Manual

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Part 2

Section–VI (1)

EMPLOYER'S REQUIRMENTS

GENERAL SPECIFICATIONS

SUB-DIVISION – A.GENERAL

July 2019

TABLE OF CONTENTS

A1 INTRODUCTION

These Employer's Requirements are divided into six Sub Sections in Section VI (1) as follows:

(a) **General:** these apply throughout the Contract (Sub-division A).

(b) **Functional:** these include the specific core requirements for the design and performance of the Works (Sub-division B).

(c) **Design:** these apply in respect of responsibilities and obligations relating to the design of the Permanent Works (Sub-division C).

(d) **Construction:** these apply in respect of responsibilities, obligations and other requirements relating to the construction of the Works (Sub-division D).

(e) **Inspection, Testing and Commissioning:** these apply to the requirements relating to Inspection, testing and commissioning (Sub-division E).

(f) **Appendices:** (**Sub Division – F**).

A2 DEFINITIONS AND INTERPRETATIONS

In addition to the words and expressions defined in the Conditions of Contract (CC), the following words and expressions shall have the meaning assigned to them except where the context otherwise requires:

"As-Built Drawings": means those drawings produced by the Contractor and endorsed by it as true records of construction of the Permanent Works and which have been given a Notice by the Engineer.

“Baseline Programme”: means the first Works Programme issued with a Notice of No Objection by the Engineer that is used solely to assess the Contractor’s progress.

"Construction Phase": has the meaning identified in Clause A4 of the Employer's Requirements -General.

"Construction Reference Drawings": means those drawings referred to in Clause C2 (8) of the Employer's Requirements Sub-division C - Design in respect of which a Notice has been issued. It is also called as Construction Working Drawing.

"Construction Reference Drawings Submission": means the submission of Construction Reference Drawings representing elements of the Permanent Works and for which the Contractor seeks a Notice.

"Construction Specification": means those parts of the Standard Outline Specification which relate to construction.

“Core System”: means the train sets, catenary, electrification, signaling, communication, driving simulator, wayside electrical and mechanical facilities, ventilation systems, escalators and lifts, and any other related miscellaneous equipment.

“Designer" or “Lead Designer": means the designer (consulting firm) appointed by the Contractor to Design the Works and Temporary Works

"Lead Design Checker": means a suitable DDC approved by the Employer to

check the detailed design and specification performed by the DDC of the contractor. He will have the role of Proof checking.

"Definitive Design Submission": means the submission of documents which comprise the whole or parts of the proposed Definitive Design and for which the Contractor seeks a Notice of No Objection from the Engineer. This is also defined as the detailed design.

"Design Criteria": means those parts of the Outline Design Specification Section VI (2), which relate to design.

"Design Manual": means the manual to be prepared and submitted by the Contractor as part of the Definitive Design and as described in the Employer's Requirements – Design (Sub-division C5.2).

"Design Package": has the meaning identified in Clause C2 (6) of the Employer's Requirements – Design (Sub-division C).

"Design Phase": has the meaning identified in Clause A4 of the Employer's Requirements – General (Sub-division A).

"Engineer": means the Employers representative where sometimes it is referred as MMRC's representative or Project Manager.

"Tender Drawings": means those drawings included in Part 2, Section IX. (Sub – Division F)

"Employer's Requirements": means the requirements set out in this Part 2, Section VI.

"Final Design": has the meaning identified in Clause C3 (5) of Employer's Requirements – Design (Sub-division C).

"Key Equipment": means items of Contractor's Equipment (whether owned by the Contractor or not) specified as in Section III, Part I, Clause 1.1.3.

"Key Personnel": means those persons named or positions so specified in Clause No 1.1.2 Section III, Part 1 and

Bid form No 10 & 11 placed in Section IV Part 1 of Bid Document or designated by the Engineer at any time during the Contract. Para Sub Section A15(7).

"Monthly Progress Report": means the report referred to in General Conditions (GC) Clause 4.21 to be prepared by the Contractor, in the form and detail prescribed in Appendix 5 of this Part 2, section VI(1), and submitted monthly to the Engineer.

"Notice": means a Notice of No Objection, as given in writing by the Engineer on Document Submission Report(DSR) Status Sheet with comments sheets as in Appendix 6 – Section VI (1) F – Part-2.

"Outline Design Specification": means the Design Criteria as laid down in Section VI(2) and the **Outline Construction Specifications** as laid down in Part 2 Section VI(3) that specify standards issued by the Employer for development by the Contractor for design and construction.

"Particular Specification": means the combined Specifications prepared by the Contractor in Construction Specification Institute (CSI) format which combines the

Employer's Outline Design Specifications, any Design Criteria contained elsewhere within the Contract, the Employer's Outline Construction Specifications and those parts of the Contractor's Technical Proposals which specify standards for design and construction which are developed during the Design Phase.

"Preliminary Design": means the submission of documents which comprise the initial stage of the design phase.

"Pricing Document": means Part 1, Section IV-B of the Contract."

"Project": means the design, construction, commissioning, operation and maintenance of Mumbai Metro Line-3(MML-3) rail system, including the Core System, E&M Works, Track work, Stations, Depot and Stabling Yards and Civil Works.

"Quality Plan": means the quality plan, setting out the Contractor's means of complying with his obligations in relation to Quality Assurance provided and maintained in accordance with General Conditions (GC) Clause 4.9, in the form and detail prescribed in Appendix 6 of Part 2, Section VI(1) of the Contract.

"Railway Envelope": means the zone or zones within the Works which will contain the track-work and equipment necessary for the operation of the railway.

"Safety Plan": means the safety plan setting out the Contractor's means of complying with his quoted, the requirements of the Design Criteria shall prevail obligations in relation to safety provided and maintained in accordance with GC Clause 6.7, in the form and detail prescribed in Appendix 20 of Part 2, Section VI (1) of the Contract.

"Scope of Works": means the brief description of the Works as detailed in Clause B2 of Section VI (1), Sub –Section B.

"Specification": has the meaning identified in Clause A5 of the Employer's Requirements -General.

"Structure Gauge": means the profile related to the designed normal coordinated axis of the track into which no part of any structures or fixed equipment may penetrate as per Appendix 18 of schedule of Dimensions.

"Working Drawings": comprise the Construction Reference Drawings and such other drawings and documents, such as bar bending schedules and manufacturing drawings, as are necessary to amplify the Construction Reference Drawings for construction purposes.

"Works Programme": means the time-scaled and resource-loaded critical path network, updated from time to time in accordance with Section VI (1)F, Appendix 2B – Key dates and Appendix 4 of this Part 2, depicting activities, durations, sequences and interrelationships that represent the Contractor's work plan, work breakdown, schedule structure for constructing and completing the Works.

A3 RELEVANT DOCUMENTS

The Design and Design Data shall be read in conjunction with the Particular

Conditions of Contract (PC 1.1.1.11)Part3, the Employer's Requirements, the Tender Drawings and any other document forming part of the Contract.

In the event of a conflict between any Design data and any other standards or specifications.

The order of precedence is:

(a) Design and Design Data
(b) Employer's Requirements
(c) Indian and other International Standards referenced herein.

A4 PHASES (DESIGN AND CONSTRUCTION)

(1) The Contractor shall execute the Works in two phases, the Design Phase and the Construction Phase.

(2) The Design Phase shall commence upon the Commencement Date. This phase shall include the preparation and submission of:

(a) The Preliminary Design
(b) The Definitive Design; and
(c) The Construction Reference Drawings.

The Detailed Design Phase will be completed for the determination of the milestone of the design upon the issue of a Notice by the Engineer in respect of the comprehensive and major design and Construction reference drawings except shop drawings and interfacing drawings which should be submitted before 3 months starting of the key dates complete Construction Reference Drawings Submission for the whole of the Permanent Works.

(3) The requirements for the Preliminary Design, Definitive Design and Construction Reference Drawings are stated in Clause C2 of the Employer's Requirements – Design (Sub-division C).

(4) The Construction Phase for the whole or a part of the Permanent Works shall not commence until the issue by the Engineer of a Notice in respect of the relevant Construction Reference Drawings submission. Such Notice may be issued by the Engineer in respect of a Construction Reference Drawing submission covering a major and distinctive part of the Permanent Works.

The Construction Phase shall include the completion and submission of the Final Design and the preparation and submission of the As-Built Drawings and other records as specified.

(5) Notwithstanding Clause A4(4) above, for those elements identified under Clause C2(6) of the Employer's Requirements – Design (Sub-division C), the Construction Phase may commence immediately upon the issue of the Notice in respect of the Definitive Design approval in respect of each such part work

where construction is to commence subject to availability of the Site in accordance with the agreed programme to implement the works programme

A5 PARTICULAR SPECIFICATIONS.

In accordance with the provisions of these Employer's Requirements, the Outline design Specification contained in the Contract, the Particular Specifications if any if required shall be developed during the design stage and submitted as part of the Definitive Design Submission. When the Specification has received a Notice of No Objection from the Engineer it shall become the Particular Specifications and shall take precedence over other Specifications for construction purposes.

A6 SPECIFICATIONS IN METRIC AND IMPERIAL UNITS

(1) The Contract shall utilize the SI system of units. Codes and Standards in Imperial units shall not be used unless the Engineer has given a Notice.

(2) Conversion between metric units and imperial units shall be in accordance with the relevant Indian Standards.

A7 WORKS PROGRAMME

(1) The Key Dates are defined in Appendix 2B to these Employer's Requirements.

(2) The Contractor shall prepare and submit his Works Programme and three month rolling programmes in accordance with the detailed requirements contained in Appendix 4 to these Employer's Requirements.

(3) In compiling his Works Programme and in all subsequent updating and reporting, the Contractor shall make provision for the time required for coordinating and completing the design, construction, inspection , testing , commissioning and integrated testing of the Works, including, inter alia, design co-ordination periods during which the Contractor shall co-ordinate his design with those of Project and other Interfacing Contractors, the assessment procedures, determining and complying with the requirements of all Government Departments and all others Whose consent, permissions, authority or license is required prior to the execution of any work.

(4) The Works Programme shall take full account of the Design Submission Programme.

(5) The Engineer shall designate certain of their computers for installation, by the Contractor, of software programs that the Contractor intends to use for the design, programming, production of drawings, etc. All software shall be originals and licensed by the manufacturer and issued at the Contractor’s cost.

A8 MONITORING OF PROGRESS

(1) The Contractor shall submit to the Engineer six copies of a Monthly Progress Report (MPR), as described in Appendix 5 to these Employer's Requirements, describing the progress and current status of the Works. The MPR shall address the matters set out in the Works Programme.

(2) The MPR shall be submitted by the last day of each calendar month. It shall account for all works actually performed from the twenty sixth day of the last month and up to the twenty fifth day of the current month. The processing of the Interim Payment Certificate will only commence after the receipt of the MPR on the due date. Late receipt will delay the processing of the IPC.

(3) The MPR shall be divided into two sections. The first section shall cover progress and current status relating to design and the second section shall cover progress and current status relating to construction.

(4) The MPR shall be signed by the following Key Staff; Project Manager, Chief QA Manager, Safety Manager, Chief Interface Coordinator and by all the Concerned key Staffs who by signing the MPR shall certify that all information contained in the MPR, as relating to their section of the Works, has been accepted and verified by each signatory as being accurate, honest, true and meets the requirements of the Contract.

(5) A monthly meeting to monitor the progress of the project shall be convened by the Engineer and the Contractor and the representatives of the Interfacing Contractors shall also attend the meeting. The Engineer may also be present in the meeting. Refer to Clause A18 of this Employer's Requirements Part 2, section VI (1), Sub –Division A.

(6) The Engineer shall arrange Quarterly Review Meetings and Site mobilization meeting for the Project which the Contractor shall attend and participate in as required. Refer to Clause A18 of the Employer's Requirements Part 2, section VI (1).

A9 QUALITY ASSURANCE

The Contractor shall establish and maintain a Quality Assurance System in accordance with Appendix 6 to these Employer's Requirements for design and construction procedures and the interfaces between them. This Quality Assurance System shall be applied without prejudice to, or without in any way limiting, any Quality Assurance Systems that the Contractor already maintains.

A10 SOFTWARE SUPPORT

10.1 General

(1) The Contractor shall provide copies of all computer software and programs and full support to the Engineer for all computer programs used/proposed to be used, by the Contractor under the Contract, also refer to Clause A7(5) of these Employer's Requirements Sub-division A -General.

(2) The Contractor shall submit a software support plan at least 90 days before commencement of software installation. This plan shall require the Contractor to provide all changes, bug fixes, updates, modifications, amendments, and new versions of the program as required by the Engineer.

(3) The Contractor shall provide all tools, equipment, manuals and training as necessary for the Engineer to use, maintain and re-configure all of the software provided under the Contract.

(4) The Contractor shall submit all new versions to the Engineer for a Notice at least 2 weeks prior to their installation. New Versions of any program shall not result in any non-conformance with the Specification, or degrade the operation of the System. The Contractor shall:

(a) Ensure that all new versions are fully tested and validated on the simulation and development system prior to installation.

(b) Ensure that all new versions are fully tested and commissioned once installed on the Site.

(c) Deliver to the Engineer any new version, together with the updated Operation and Maintenance Manuals.

(5) The Engineer shall not be obliged to use any new version and that shall not relieve the Contractor of any of his obligations. Any effect upon the performance or operation of the computer controlled system that may be caused by a new version shall be brought to the Engineer's attention including updating the files to suit the new version.

10.2 Software Obligations

(1) Within 14 days of the installation of any software into the Permanent Works by the Contractor, the Contractor shall submit to the Engineer for retention by the **Engineer**, two backup copies of the software, which shall include, without limitation:

(a) All licenses in favor of the Engineer for their use.

(b) All design documentation relating to the software; and

(c) Any specified development tools required for maintenance of the software, including, but not limited to, editors, compilers and linkers.

10.3 Error Correction

(1) When a fault is discovered within delivered software or documentation, the Contractor shall take necessary steps to rectify errors or faults at the earliest.

(2) The Contractor shall provide written details as to the nature of the proposed correction to the Engineer.

(3) The Contractor shall notify the Engineer promptly of any fixes or patches that are available to correct or patch faults.

(4) The Contractor shall detail any effect such fixes or patches are expected to have

upon the applications.

10.4 Training

(1) The Contractor shall provide training for the Employer's staff to enable them to make proper use of any software, training for any new versions.

A11 CO-ORDINATION WITH INTERFACING CONTRACTORS

(1) The Contractor shall be responsible for coordinating his own design, technical, programming and construction activities and for coordinating these with the design, technical, programming and construction activities of other Project Contractors, Utility Agencies, Statutory Authorities, Public Service Providers, Developers, Consultants and other Contractors whether or not specifically mentioned in the Contract, that may be working on or adjacent to the site, to achieve fully coordinated construction of the facilities. For the purpose of these Employer's Requirements and the Contract, all of the above parties shall be referred to as "Interfacing Contractors" as per Appendix 19 of this Part 2 Section VI (1) ,Sub-Division F Appendices .

(2) The Contractor has to include in his Interface Management Plan, as required in **Appendix 19, "System Interface Management** "the latest dates for the Contractor to pass information to the Interfacing Contractors in order for them to complete their design submissions to the Engineer. Any claims of additional costs by the Interfacing Contractors as a result of the Contractor's failure in adhering to these dates shall be borne by the Contractor. The Contractor shall note that the information exchange is an iterative process requiring the exchange and updating of information at the earliest opportunity and shall be carried out on a regular and progressive basis so that the process is completed for each design stage by the cut off dates.

(3) The Provision of **Appendix 19, "System Interface Management"** will be followed for coordination team, Design Interface, construction interface, testing and commissioning interface.

A12 SURVEY AND SITE INVESTIGATIONS

1) The datum to be used for the Contract shall be Mean Sea Level Datum.
2) The Contractor shall carry out all further site investigations, including surveys, necessary for the design of the Permanent Works and to enable the determination of the methods of construction and the nature, extent and design of the Temporary Works.

A13 CLIMATIC CONDITIONS

Mumbai experiences tropical wet and moderately hot climatic conditions with high level of humidity and heavy rains in some part of the year, and designs and plans for the Works must take this into account accordingly.

The Contractor shall obtain information on the climatic conditions in Mumbai,

such as temperature, rain fall, wind, sunshine, relative humidity, etc. from the Meteorological Department and/or other authorities and shall make full provision for the effects of the local weather/climatic conditions in his designs, planning, programming and execution of the Works.

A14 PROJECT MANAGEMENT INFORMATION SYSTEM (PMIS)

The Contractor shall devise and utilize a PMIS provided by the Engineer such that all documents generated by the Contractor can be transmitted to the Engineer by electronic means (and vice versa) and that all documents generated by either party are electronically captured at the point of origin and can be reproduced later, electronically and in hard copy. A similar link shall also be provided between the Engineer's office at site and the Employer's Office by the Contractor.

A15 CONTRACTOR'S PROJECT ORGANISATION

(1) The Contractor shall employ on this Project, a competent team of Managers, Engineers, Technical staff etc. so as to complete the Work satisfactorily as per the various requirements of the Contract.

(2) A site control room with 'around the clock' radio communication or telephone switch board links with all safety offices, works sites, design offices, site offices, batching plants, casting yards, workshops, fabrication yard, off site offices, Engineer's site offices, testing labs etc. shall be maintained and manned 24 hours a day, seven days a week. Residence and mobile telephone numbers of the Contractor's Senior Project team members shall also be linked with the control room. Vehicles for emergency use should be on stand-by at the control room around the clock.

(3) The designations of the various project organizations team members shall be subject to a Notice from the Engineer before adoption so as to avoid any duplication of the designations with those of the Employer or the Engineer.

(4) The Contractor shall submit his Staffing Proposal to the Engineer for a Notice, which shall include:

(a) The Contractor's proposed Staff Organization showing in chart form the names of his proposed staff for each position;

(b) CVs of the Contractor's proposed Key Staff, with adequate details and copies of documentary proof on the qualification and experience (with contract titles, position held and dates) of each staff to substantiate that he is competent for undertaking the proposed position;

(c) The scope of responsibilities of each staff and the reporting lines between individual staff;

(d) The documents that each staff is authorized to sign on behalf of the Contractor.

(5) The Staff Organization shall cover the Contractor's Key Staff and Specially Required Staff as specified in Sub-clauses A15(7) below, as well as other working-level staff, with a narrative of the authorities and responsibilities of

each staff member in directing execution of the Works on Site, or in deciding technical details of the Contractor's proposals.

(6) The Contractor's Staffing Proposal shall include the Key Staff proposed in their Tender submission, unless it is necessary to propose better qualified and more experienced staff in order to meet the requirements of the Contract, in which case the Contractor shall include in the Staffing Proposal an explanation for each change in Key Staff. Any such change in Key Staff shall require a Notice from the Engineer.

Each member in the Contractor's Staffing Proposal, including the Key Staff and the Specially Required Staff, shall be allocated to this Contract on a full-time basis on Site, until the activities that he is responsible for have already been completed or have to be carried out off-site. Should it be necessary to replace any staff before the activities he is responsible for have been carried out, the Contractor shall submit the CV of the proposed substitute for the Engineer Notice of No Objection, at least 30 days before the proposed change. The substitute shall not be less qualified or experienced than the person he is replacing.

(7) **Key Staff**

(a) The Contractor's Staffing Proposal shall include as a minimum the following Key Staff:

Serial No	Position
1	Project Manager
2	Construction Manager (Ballastless Track);
3	Construction Manager (Ballasted Track including transition area with adjustable fastening system...)
4	Construction Manager (Low Vibration Track)
5	Construction Manager ((Welding destressing, rail grinding, turnouts, scissors crossing, buffer stop)
6	Chief Quality Assurance Manager
7	Chief Interface Co-coordinator

Serial No	Position
8	Lead Design Checker
9	Engineering Manager Design
10	Safety Manager
11	Programme Manager

All the Key staff will have Experience & Qualification as detailed in Section III, Part-1, Para 1.1.2

A16 TRAINING AND TECHNOLOGY TRANSFER

(1) The Contractor shall ensure that all local Contractors and Sub-Contractors engaged in the Works are given training, guidance and the necessary opportunity for transfer of technology in various areas of construction such as, control of ground settlements, instrumentation, safety, quality assurance, interface management etc.

(2) Refer to Clause E5 of this Sub-division E of these Employer's Requirements for training requirements for the Employer's staff.

(3) The Engineer / Technical Staff's and Skilled workers involved for Construction & Maintenance will be trained in the reputed training institute for their standard training module and the workshops, seminars etc. The contractor will also arrange the site visit of the Engineers / Technical staffs at contractors expenses for travel, stay and training.

(4) The maintenance manual will also be prepared depending on the infrastructure to be provided and indicating the schedule inspection & maintenance including emergencies as being adopted on metro systems.

A17 MAINTENANCE REPORT

(1) The Maintenance Report shall be submitted as part of the Definitive Design and shall include full details of the long term inspection and operations for each major component of Track works such as Track slab, Low Vibration Track, Ballasted Track, Ballastless Track, Drainage, Flash butt welding, Alumino–Thermit Welding, LWR maintenance track Grinding,turnouts etc. and managing emergencies including transportation of material .

(2) The Contractor shall provide inspection and maintenance manuals for the Track work covering maintenance organization and infrastructure including attending emergencies/accidents etc.

(3) For each area an inspection checklist shall be supplied giving inspection

frequency, items to be inspected, criteria for acceptance, criteria for remedial works and details of the remedial works, including proposed materials and method statements. The recommended regular maintenance regime of each area shall also be given including cleaning methods and frequency for different surfaces ; cleaning of drainage channels, sumps and pipes; repainting of metallic items;

(4) A long term monitoring regime shall also be included covering items such as Rails and fittings maintenance.

(5) All instruments necessary to carry out the inspections and monitoring that are identified in the report shall be provided by the Contractor.

A18 MEETINGS

A.18.1 General

The Contractor shall participate in meetings as indicated in this Sub-division. The Engineer shall record minutes of all meetings and distribute them within 5 days of the meeting. Meetings will be chaired by the Engineer.

A18.2 Initial Kick off/Contract Meeting

The Engineer shall arrange an initial meeting within seven (7) days following the issue by the Employer of the Letter of Acceptance.

The meeting shall take place at a location in Mumbai, India, determined by the Engineer.

The agenda of the meeting shall include, but not be limited to, the following:

(a) Arrangements to be made for execution of the Contract Agreement;
(b) Submission of bonds, guarantees, undertakings, warranties, insurance policies, certificates, etc. if not already provided;
(c) Arrival of Key Staff, tools and plant;
(d) Planned activities for the first 30 days and 60 days after the Commencement Date; and
(e) Other items as may be advised by the Engineer.

The Contractor shall be represented by all appointed Key Staff.

A18.3 Site Mobilization Meeting

The Engineer shall arrange a meeting at the Engineer's office prior to the Contractor being given possession of any part of the Site. The agenda shall include, but not be limited to, the following:

(a) Proposed use of the Site by the Contractor;

(b) Employer's Requirements;

(c) Temporary utilities and facilities;

(d) Security and "housekeeping";

(e) Programme for establishing work areas, temporary facilities, and Site Accommodation for the Engineer;

(f) Temporary Works; and

(g) Contractor's initial Three Month Rolling Programme.

(h) Procurement and delivery dates for major items of Tools and Plant.

The Contractor's Key Staff, and those with responsibility for activities on the agenda,

shall attend.

A18.4 Quarterly Review Meetings

Quarterly Review Meetings shall be arranged at a time and venue determined by the Engineer to generally review progress and outstanding issues in regard to the Contract and the Project. They shall be attended by the Project Manager and supervisory board members of the Contractor and Interfacing Contractors. The agenda for these meetings will be advised by the Engineer, at least 5 days in advance. The Engineer or his designated representative will chair the meeting, and prepare and distribute the minutes. All key staffs will attend the meeting.

A18.5 Monthly Progress Meetings

The contractor will submit the Monthly Progress Report on last day of the month to the Engineer covering period from 26th day of the last month and up to and including the twenty-fifth (25th) day of the month of the submission as per Appendix 5 Section VI (1) F. Engineer will hold monthly meeting on nominated date in the first week of the following month. Monthly Progress Meetings shall be held throughout the progress of the Works. These meetings shall normally be held at the Engineer's Site office. Contractor's Key Staff shall attend the Progress meetings. The Engineer shall chair progress meetings, and prepare and distribute the minutes. The Engineer shall prepare and distribute the agenda at least 1 day prior to the meeting which may include, but not be limited to, the following:

(a) Confirmation of minutes of the previous month's meeting and matters arising there from;

(b) Review of design work progress;

(c) Review of construction work progress;

(d) Field observations, problems and decisions;

(e) Identification of issues affecting planned progress;

(f) Planned activities for the coming period;

(g) Quality assurance;

(h) Safety;

(i) Interface coordination;

(j) Status of variations, if any;

(k) Design/Construction coordination.

The Contractor's Project Manager must attend the Monthly progress meetings with Contractor's Key Staff.

A18.6 Weekly Meetings

Weekly meetings shall be held on Site to discuss detailed technical and construction issues plus the status of the Contractor's submittals. These meetings shall be chaired by the Engineer, who shall also prepare and distribute minutes. The Contractor's Key Staff shall attend this meeting with the exception of the Project Manager whose attendance is optional. Sub-Contractor's representatives shall also attend these meetings when requested to do so by the Engineer.

A18.7 Other Meetings

Interfacing Contractors, the Contractor's Key Staff, superintendents and Sub-Contractor's representatives shall attend other meetings as required with the Engineer.

A19 DOCUMENT SUBMISSIONS

The number and format of the required document submissions from the Contractor as detailed in Appendix 6 – Section VI (1) F – Part-2

A20 ATTACHMENT – A1

Required Number of Copies of Submittals and Format Requirements

SI. No	Description	Frequency	Unit	No of Electronic copies	No. of Paper copies		
					A1	A3	A4
1	Initial Works Programme,	One Time	No	2		12	
2	Detailed Works Programme updates, revisions and Three Month Rolling Programme	Quarterly	No	2		12	
3	Monthly Progress Report (as in App 5)	Monthly	No	2		12	
4	Three Month Rolling Programme	Quarterly	No	2		12	
5	Design Statement & Programme for Design Deliverables (Design Units) (as per section VI(1), Part 2	One time	No	2			12
6	Quality Assurance & Quality Control Plans & quarterly Audits (as per App 6)	Quarterly	No	2			12
7	System Interface Management Plan & quarterly Audits and compliance	Quarterly	No	2			12
8	Interface Matrix and Specific Contract Interface Sheets	Monthly	No	2			12
9	All Interface management and coordination meetings, including compliance of issues relating to the Interfacing Bidders	Monthly	No	2			12

10	Interface management and coordination meetings and compliance, from the issue of Taking Over Certificate until start of Revenue Services. (Employer to instruct if required.)	Quarterly	No	2			12
11	Attendance, Coordination and Management, and compliance during Service Trials.	Yearly	No	2			8
12	Bidder's Staff Organisation Plan & Key Staff.(Bidder to note Key Staff Payment Deduction , refer Clause 1.3.1 above)	Quarterly	No	2			8
13	Project Sign Boards.	One Time	No	2			
14	OHS&E Plan Submission (as per Manual Part 4 and Part 2)	One Time	No	2			12
15	Compliance with Occupational Health, Safety and Environmental Plan & quarterly Audits.	Quarterly	No	2			12
16	Project Management Information System	Monthly	No	2			8
17	Comprehensive Testing and Commissioning Programme - Section VI (1) E	On Time	No	2			
18	Comprehensive Testing and Commissioning Programme - Section VI (1) E	Quarterly	No	2			

19	Schedule of Spare Parts.	One Time	No	2			12
20	Training Plan Updates	One Time	No	2			12
21	Training Plan, Compliance and Audit	One Time	No	2			12
22	Construction of Engineer's Site Office(s), Bidders Storage Depot and Bidders Site Office	One Time	No	2			12
23	Maintenance and Removal of Engineer's Site Office(s), Bidders Storage Depot and Bidders Site Office	One Time	No	2			12
24	Documents (CMRS and RDSO) for opening as per C5.2(3), including but not limited to:	One Time	No				
	a. Contract specification,			2			12
	b. Design manual,			2			12
	c. Design report on interfacing Bidders,			2			12
	d. Testing and commissioning report			2			12
	e. Track Maintenance report for Maintainability			2			12
	f. Relevant supporting documents for design Submission			2			12
	g. Survey report			2			12
	h. Temporary works design report			2			12

	i. Construction installation analysis report			2			12
	j. Construction method statement			2			12
	k. Proforma for quality check			2			12
	l. Report on use of works area			2			12

Note: The unit indicated are for the final copies .

MUMBAI METRO LINE 3

TENDER DOCUMENTS

Part 2

Section VI (1)

EMPLOYER'S REQUIRMENTS

GENERAL SPECIFICATION

SUB-DIVISION - B – FUNCTIONAL

July 2019

Mumbai Metro Rail Corporation Ltd
Line 3 Transit Office, Wing 'A' North Side of City Park 'E'- Block,
Bandra-Kurla Complex,
Bandra (East) Mumbai 400 051, India

TABLE OF CONTENTS

EMPLOYER'S REQUIREMENTS – FUNCTIONAL

OBJECTIVE:

The objective of the Contract is to design, procurement of part material, construction, testing and commissioning of the permanent works, including without limitation, the design, installation and removal of the Temporary Works, and the rectification of defects appearing in Permanent Works, in the manner and to the standards and within the time stipulated by the Contract. In full recognition of this objective, and with full acceptance of the obligations, liabilities and risks which may be involved, the Contractor shall undertake the execution of the Works.

B1 GENERAL

1. The design and performance of the Permanent Works shall comply with the specific core requirements in Clause B2 – Scope of work and also contained in these Employer's Requirements – Part 2, section VI (1) C and all requirements in General specifications Part-2, Section VI (1) including Appendices
2. The design of the Permanent Works shall be developed in accordance with the Employer's General & Outline Design Specifications- Part 2, section VI (2), the Employer's Outline Construction Specifications-Part 2, section VI (3) and Tender drawings Part 2 section VI (4), as included in this Contract, other requirements of the Contract and the Contractor's Technical Proposals.
3. The Permanent Works shall be designed and constructed to the highest standards available using proven up-to-date good practice. The Contractor's Specification shall in any case not specify standards which, in the Engineer's opinion, are less than or inferior to those described in the Outline Design Specifications and Outline Construction Specifications, Section VI (2) and VI (3) respectively and shall be carried out employing the procedures established by the contractor in his Quality, Safety and Environmental and Interface management plans within the compliance of provision of OHS&E manual Part-4.

4. The Contractor shall be responsible for obtaining all necessary approvals from the relevant agencies in the design and construction of the Works.

B2 SCOPE OF WORKS

The Track alignment drawings enclosed in Tender drawings are based on jumping chainages of Civil packages UGC-05 to UGC-07. The starting coordinates of Package 10C near BKC is (E=274406.423, N=2108502.434) at chainage 20957.420m and ending coordinates at depot are (E=277869.379, N=2116900.743) at chainage 34154.410m of track depot layout.

The coordinates are based on UP line coordinates and for the Down line coordinates will be perpendicular to the UP line, in case of straight alignment and in case of curve alignment it will be radial of up line intersecting the Down line. The chainages have been indicated on the basis of jumping chainages of the tender

alignment drawings enclosed. These chainages will be revised once the alignment is freezed, however the starting point of Package 10C and ending point of Package 10B will be evaluated on the basis of coordinates indicated above.

2.1 Scope of Main line

Mainline: The main line is from coordinates (E=274406.423, N=2108502.434) at chainage 20957.420m to coordinates (E=277632.029, N=2116650.376) at chainage 33789.411m at Aarey depot station including all the loop lines and turnouts on both Up and Down line excluding Aarey depot as shown in tender alignment drawings

The scope of Main line work is given below,

Part Design, Part Procurement, Supply, Installation, Testing and Commissioning of Ballastless low vibration track from Ch.20957.420 to Ch.33027.253, including installation of Turnouts, Buffers with welding and destressing of rails and all incidental work.

i. The track structure will consist of precast high attenuation twin block sleepers embedded in track slab at 700mm spacing (average) with rails UIC 60 HH 1080 grade.

ii. The rail fastenings may be W14 or Fast clip or similar used for Ballastless track satisfying ODS.

iii. The track structure shall be capable of achieving a minimum vibration attenuation of 22 VdB as prescribed in Section VI) (2) ODS para 5.12

iv. The track structure will have natural frequency of approximately 18 Hz. Variation in natural frequency is acceptable if the attenuation prescribed in Para (iii) above is achieved.

Note: It has been assessed by employer that by achieving 22VdB attenuation the vibration will be within the limit at receiver. The contractor will be required to demonstrate the above by calculation as prescribed in Section VI) (2) ODS para 5.12

2.2 Scope of Aarey Depot

The depot area is defined from coordinates (E=277632.029, N=2116650.376) at Chainage 33789.411 on Main line and up to coordinates (E=277869.379, N=2116900.743) at chainage 34154.410m including Stabling lines at Aarey station and entire depot track consisting of Wash track, Stabling lines, Shunting necks, Workshop lines, Test track, special Ballastless track etc. as per depot track layout in Aaray station & Depot as shown in tender drawings

The scope of work is given below but not limited to

a) Design, Procurement, Supply and Installation, Testing & Commissioning of ballasted track in depot.
b) Special ballastless track in Aarey Depot and for specific utilities (Pit track, embedded track, Pedestal Track etc.) This include procurement of P-way material of depot including Monoblock PSC sleepers, Rail fasteners for ballasted track and

special track, Ballast, Buffer stops, Welding etc. for the track The tamping of ballasted track, destressing etc.

c) The scope of various track form at Aarey station and depot including mainline has been shown in the tender drawing enclosed in the Part-2, Section VI(4)
d) The depot has been distributed in zones for prioritization of work
e) The Track on level crossing shall be provided with the check rail.

2.3 Other related items are in the Scope given below

2.3.1 The Preliminary and Construction reference drawings detailed drawings will be developed based on tender drawings keeping in view the ODS Section VI (2).

2.3.2 No variation in the scope of work of Part-1, Section IVB, and Schedule - 3: Installation, Testing & Commissioning will be permitted after development of detailed drawings, unless the facilities proposed in the tender drawings are changed.

2.3.3 The material required as given in Part-1, Section IVB, Schedule- 1 will be payable as per quantity of the detailed reference drawings..

2.3.4 The quality of the work will ensure that the Reliability, Availability and Maintainability provisions are achieved as per target laid down in Appendix 22 of Part-2, Section VI (1)F

2.4 Scope of Procurement of Material

The procurement of material for project & spares shall be in accordance to the Contract Document MML3-CBS-TWK-03 , Part 1, section IV-B, pricing document's schedules.

a) Design and Supply of Turnouts/Crossovers, Scissor Crossovers with rail fasteners will be supplied including contract of Package 10B
b) Procurement and Supply Buffer Stops for the entire Mainline and Depot including stations and Contract Package 10 B.
c) Procurement and Supply of wheel stop and retractable buffer stop for the workshop in depot.
d) Procurement and Supply of PSC Monoblock Sleepers for Ballasted Track including ballast.
e) The rail fastener system for the mainline ballastless track of this contract shall be procured and supplied by the Contractor of Package 10 B.
f) Procurement and Supply of Ballasted track Rail Fasteners System including Turnouts/Crossovers, Scissor Crossovers.
g) The responsibility between contractors of Package 10C & other packages10B, , D, E for various items of procurement and supply of materials is summarized in the table below.

Table 1.0			
SN	**PROCUREMENT AND SUPPLY OF MATERIALS**	**RESPONSIBLE CONTRACTOR**	
		FOR PACKAGE 10C	**FOR PACKAGE 10B**
1	Turnouts including Diamond crossing (1in7 R190, 1in9 R300) including rail fastenings with base plates/holding of bolts/inserts complete etc. for Ballastless track for Main line	10C	10C
2	Turnouts including Diamond crossing (1in7 R190, 1in9 R300) including rail fastenings for Ballasted track	10C	Not Applicable
3	Rails UIC 60 E1 HH 1080 grade	10D	10D
4	Rails UIC 60 E1 880 grade	10E	Not Applicable
5	Friction Buffer Stop 25 KMPH/10KMPH/5KMPH	10C	10C
6	Retractable Buffer Stop	10C	Not Applicable
7	Wheel Stop	10C	Not Applicable
8	PSC Sleepers,rail fastners for ballasted track for plain track and turnout	10C	Not Applicable
9	Ballast	10C	Not Applicable
10	Booted Twin block sleepers with Resilient Pad for Ballastless track	10C	10B
11	Rail Fastener system for Ballastless Track excluding Turnouts	10B	10B
12	Rail Fastener system with base plates/holding of bolts/inserts complete etc. for Special Track at depot	10C	Not Applicable
13	Check Rails (For Depot and Mainline)	10C	10C
14	Joggled Fish Plate	10C	10C
15	Spares to be supplied to the Employer	10C	10B

The quantities of Items to be supplied by the contractors of other packages, free of cost, are given in the table.

S. No	Item	Unit	Quantity	To be supplied by
1	Rails UIC 60 E1 HH 1080 grade	MT	3060	10D
2	Rails UIC 60 E1 880 grade	MT	2100	10E
3	Rail Fastener system for Ballastless track	Sets	69000	10B

Note:

1. Package 10C contractor will be responsible for delivering the above material at the store depot of Package 10B contractor at Mumbai. The responsibility for unloading will rest with the contractor of Package 10B.

2. Package 10B contractor will be responsible for delivering the Rail fasteners at the store depot of Package 10C contractor at Mumbai. The responsibility for unloading will rest with the contractor of Package 10C.
3. The Rails supplied by the Package 10D and Package 10E will be delivered, unloaded and stacked by the contractors of Package 10D and Package 10E.

If there is any additional requirement on account of detailed design, then the additional material required shall be supplied. However if there is saving in consumption then the balance quantity will be returned to the Employer.

2.5 Other Scope of work

The following items are included in lump sum cost of schedule 3 of section IVB – Part 1.

i) Obtain the "Notice of No Objection" or "Notice of No objection Subject to ---" from the Engineer as per Employer's Requirement (detailed in Part-2) for:
   a) Submission of Project Management Plan; Interface Management Plan and Detailed Interface Documents; Works Programme; Design Submission Programme; Quality Assurance Plan; Safety Assurance Plan and Site Safety Plan; Environmental Plan; Inspection, Testing & Commissioning Plan;
   b) Completion of laying of Track with turnouts, buffer stops, and other fittings.
   c) Completion of Integrated Testing and Commissioning on the main line track and Depot;
   d) Completion of integrated testing and commissioning on the section in conjunction with Designated contractors;
   e) Instrumentation Tests, Oscillation trials;
   f) Service Trials and Final Commissioning;

ii) Training and Site visit: The Training & Site visit will be arranged by the contractor as per Clause A16 of Section VI(1)A

iii) The maintenance manual will be prepared depending on the infrastructure to be provided as per employer requirements stated in Clause A16 of Section VI(1)A and Appendix 21, Section VI (1) F

iv) Rails, Turnouts, Flash butt welds and AT welds will be tested by USFD, the AT welds will be protected by joggle fish plates and clamps, Destressing of LWR track will be done,supply and fixing of Signs and permanent Markers boards.

v) Recording of Measurements of Track and testing of Track as per international standard and to the satisfaction of the Employer including all logistic.

vi) The requirement of Safety, Health & Environment to be complied as per Appendix 20 – Section VI(1) F and Guidelines of OHS&E manual

vii) The factory acceptance test will be arranged as per Clause 1.11 of Section VI (1) E – Part 2. All expenditure for the test will be at cost of contractor as per laid down procedure in the specification. Rail grinding as per international standards suitable for metro train operation with notice from Engineer. The employer will assist to get the grinding machine from other metro's on hire basis

viii) The derailment guard in tunnels will be provided as per drawing on curves having radius 500m and less.

ix) The location of cross-passage in the tunnel will be provided with check rail and walk way at rail level for smooth access to the cross passage and with suitable ramp on both sides.

x) The locations of walkway in track towards the cross passage, stations and depot roads will be provided check rail with fasteners and suitable surfacing for crossing the track.

xi) The cost of all temporary works barricading and other incidental works at work site, store depot and site office

xii) Procurement and supply of all other P-way material not listed in Part 1- Schedule No. 1 Section IV B Pricing Document and to be supplied by other contractor of Package 10B, 10D, 10E and required for installation of track as per specification / drawings, such as Booted Twin Block sleepers, Boot Resilient pad, material required for RCC works, Rail fastener system for special track (Pit track, Embedded track, Pedestal track etc.), Fish plates, all other incidental materials are included in a scope of lump sum cost of in Schedule 3 Section IV B Pricing Document. No extra payment will be made for such items.

2.6 Scope of Design & Testing:

Liaison with other interfacing contractors during the design process; Submission of the Preliminary Design, the pre-Final Design; the Detailed Design Submission with Proof Checking Document, Construction Reference Drawings, As-Built drawings etc.

2.6.1 The responsibility of the contractors between Packages 10B and 10 C for various stages of design with corresponding part of the project is as stated in the table below:

Table 2.0 : Design responsibility			
Design Part	**Contract Portion**	**Responsible Contractor**	
		For Package 10C	**For Package 10B**
Preliminary Design & Drawings	Ballasted Track for Main line and Aarey Depot including turnouts	10C	Not applicable
	Ballastless Track for Main Line including best fit alignment	10C	10B
	Turnouts including rail fasteners for ballastless track excluding sleepers	10C	10C
	Rail fasteners with base plates/holding of bolts/inserts complete etc. for Main Line – ballastless track	10B	10B
	Buffer Stops (Friction / Retractable type)	10C	10C
	High attenuation Twin Block sleepers for Main Line ballastless track	10C	10B
	High attenuation Twin Block sleepers for Turn Out for ballastless track	10C	10B
Detailed Design & Drawing	Ballasted Track for Main line and Aarey Depot including turnouts	10C	Not applicable
	Ballastless Track for Main Line including best fit alignment	10C	10B
	Turnouts including rail fasteners for ballastless track excluding sleepers	10C	10C
	Rail fasteners with base plates/holding of bolts/inserts complete etc. for Main Line – ballastless track	10B	10B
	Buffer Stops (Friction / Retractable type)	10C	10C
	High attenuation Twin Block sleepers for Main Line ballastless track	10C	10B
	High attenuation Twin Block sleepers for Turn Out for ballastless track	10C	10B
Construction Reference Drawings	Ballasted Track for Main line and Aarey Depot including turnouts	10C	Not applicable
	Ballastless Track for Main Line including best fit alignment	10C	10B
	Turnouts including rail fasteners for	10C	10C

	ballastless track excluding sleepers		
	Rail fasteners with base plates/holding of bolts/inserts complete etc. for Main Line – ballastless track	10B	10B
	Buffer Stops (Friction / Retractable type)	10C	10C
	High attenuation Twin Block sleepers for Main Line Ballastless track	10C	10B
	High attenuation Twin Block sleepers for Turn Out for ballastless track	10C	10B
As Built Drawing	All Fixed Structures	10C	10B

B3 ALIGNMENT

1. The alignment has been shown in the Tender Drawings as final alignment drawing of civil contractors. The contractor shall review the as built data of tunnel and best fit alignment to be given by civil contractor, by site check and verification. The contractor shall check design of best fit and validate it with respect to his own design and construction proposals and shall also satisfy himself that there is no conflict with reference to the provision of the SOD and the alignment criteria given in ODS section VI(2).
2. The Contractor is permitted to propose deviations in alignment to suit his construction proposals or rectify any error/mismatch/conflict etc. detected in the as-built data given by the civil contractor / tender drawings of depot, but he must demonstrate that any such deviations do not reduce the technical and operational performance. The Contractor needs to verify the Contract boundaries while proposing any change in vertical and/or horizontal alignment, but such deviations shall require a Notice of No Objection from the Engineer subject to the following conditions:
    a. There is no extra cost to the Employer,
    b. Changes proposed are essentially to suit the Contractor's specific design or rectify any error/mismatch/conflict etc. detected in the Tender drawing.
    c. There is no change at the Contract boundaries or if there is any, the same is agreed by the Interfacing Contractors including the Contractor of the adjoining section (Civil Contractor of the adjacent contract package) without any extra cost to the Employer.

B4 CLEARANCES

1. The Permanent Works shall not infringe the Structure Gauge as shown on the drawings in the approved Schedule of Dimensions (SOD) of the project. Extra clearance shall be provided on curved alignment as per the approved Schedule of Dimensions. The SOD is appended in Appendix 18 of this Part 2, section VI(1) F.
2. The Permanent Works shall provide for the installation by the Interfacing Contractors of operating equipment for the railway and without infringement of

the Structure Gauge as per Appendix 19 System Interface Management

3. Railway clearances:

   Various clearances shall be provided as per the approved Schedule of Dimensions.

4. Construction limits:

   (a) The limits of land for the Works are shown on the Tender Drawings. The Contractor shall design the Works to be contained totally within these limits, respecting the regulations concerning construction and property boundaries of the local Authorities. In the event that the Contractor, having used his best endeavors, is unable to design the permanent works and utilities to be contained totally within these limits, Contractor may be required to redesign the alignment as instructed by the Engineer, at no extra cost to the Employer.

   (b) The limits of land as shown in the Tender Drawings may undergo changes, after final survey and the Contractor shall make any adjustments necessary to the design to acknowledge the changes to the limits as then defined.

B5 DESIGN LIFE

The design life of the Permanent Works for civil engineering structures shall be 120 years.

B6 DURABILITY AND MAINTENANCE

1. The Permanent Works shall be designed and constructed such that, if maintained reasonably and in accordance with the Contractor's statement of maintainability contained in the Contract, they shall endure in a serviceable condition throughout their minimum lives as described in the Outline Design Specifications.
2. The Permanent Works shall be designed and constructed so as to minimize the cost of maintenance whilst not compromising the performance characteristics and ride quality of the railway.
3. The track structure should satisfy the maintenance requirement as per Clause 1.1.11 of Section III Part-1

B7 OPERATIONAL REQUIREMENTS

1. The Permanent Works shall be designed to permit the railway to operate satisfactorily at a maximum operating speed of 85Km/hr (design speed being 95Km/hr).
2. The vertical and horizontal alignments for the main line track work shall comply with the conditions laid in Clause B3.
3. Attention shall be paid to locations where flooding could enter tunnel and Depot areas. In particular,
   (a) Construction of surface water drainage systems including Track Slab/plinth and ducts shall be avoided in the vicinity of Auxiliary substations to obviate any risk of flooding of electrical equipment areas.

(b) Entrances and all other points of access to the Depot and tunnel areas shall be adequately protected against flooding.

(c) Equipment and other facilities shall be adequately protected against flooding.

4. During construction the Contractor shall be responsible for providing and maintaining adequate flood protection to ensure protection of the Works and for all adjacent areas, buildings and structures within the vicinity of the Works.
5. In the design and construction of the Works, the Contractor shall, as a fundamental objective and as a priority, ensure that passengers, staff and the public will, throughout the operational period of the Mumbai Metro Line-3 , and within the confines thereof, be provided with as safe an environment as is reasonably possible.

B8 ENVIRONMENTAL CONSIDERATIONS

The design of the Permanent Works shall be undertaken with high environmental standards as given in Part 4, Section X, OHS&E Manual.

B9 TRAFFIC MANAGEMENT

The Contractor shall carry out the Works so as to minimise disruption to road and pedestrian traffic. The Contractor shall prepare his traffic management plan based on his proposed construction methodology in co-ordination with Employer's Representative and as approved by Mumbai Traffic Police. He shall comply strictly with the Police approved TM plan during construction of his works. The design shall provide for temporary road decking wherever necessary to provide minimum number of traffic lanes as agreed with Mumbai Traffic Police.

B10 SAFETY CERTIFICATION

The Contractor shall note that the Commissioner for Metro Railway Safety (CRS) will inspect the Works from time to time for the purpose of determining whether the Mumbai Metro 3 complies, in terms of operational and infra structural safety, in accordance with the Laws of India. The Contractor shall note that CRS approval is mandatory for commissioning the system. Notwithstanding other provisions of the Contract, the Contractor shall ensure that the Works comply with the requirements of CRS in terms of being constructed to the drawings and shall assist the representatives of CRS in carrying out their inspection duties and also comply with their instructions regarding rectification of any defects and making good any deficiencies. The Contractor shall provide to the Engineers all the forms, documentation and information promptly that are prescribed by the CRS, for completion and submission to the CRS, to enable him to accord the sanction for commissioning the project, complying the provision of the following guidelines;

i. The MOR/RDSO Manual for procedure for safety certification and technical clearance of Metro Systems Dec 15 and up to date correction slip.

ii. Appendix 17 - Transit System Test, Commissioning and Opening Of Public Carriage of Passengers Requirements.

B11 STANDARDS

1. Equipment, materials and systems shall be designed, manufactured and tested in accordance with the latest issue of International and/or National codes and standards. The Contractor shall submit copies to the Employer's Representative of all codes and standards to be used for the work.
2. Reference to standards or to materials and equipment of a manufacturer shall be regarded as followed by the words "or equivalent". The Contractor may propose alternative standard materials, or equipment that shall be equal to or better than those specified. If the Contractor for any reason proposes alternatives to or deviations from the specified standards, or desires to use materials or equipment not covered by the specified standards, the Contractor shall apply for a Notice from the Engineer. The Contractor shall state the exact nature of the change, the reason for making the change and relevant specifications of the materials and equipment in the English language. The decision of the Engineer in the matter of will be final.

MUMBAI METRO LINE 3

TENDER DOCUMENT

Part 2

Section VI (1)

EMPLOYER'S REQUIRMENTS

GENERAL SPECIFICATION

SUB-DIVISION – C. DESIGN

July 2019

Mumbai Metro Rail Corporation Ltd
Line 3 Transit Office, Wing 'A' North Side of City Park 'E'- Block,
Bandra-Kurla Complex,
Bandra (East) Mumbai 400 051, India

TABLE OFCONTENTS

C1 INTRODUCTION

(1) The Employer's Requirements – Sub-division C Design, specifies the procedural requirements for the preparation of the design of the Permanent Works. These requirements are subdivided into: **Design Phase**, **Construction Phase** and **General Application**.

(2) In addition to the express requirements herein, the Contractor shall, whenever the Engineer so requests, provide information and participate in discussions that relate to design matters.

(3) The Contractor shall engage the Lead Detailed Designer who shall undertake and prepare the design of the Permanent Track and civil Works and Temporary Works. The Contractor shall establish an office for his lead design team near the Site area in Mumbai. The lead design team shall function from this office and all meetings and discussions relating to design shall be held in this office.

(4) The Contractor shall ensure that the Designer continues to be represented in Mumbai at all times by staff whose seniority and experience are to the satisfaction of the Engineer and whose representative is available on the Site as necessary or as required by the Engineer.

(5) The Contractor shall appoint a suitable consultant as approved by Employer to act as the Lead Design Checker to proof check the detailed design. The Lead Design Checker shall not produce any of the design or temporary works designs nor work directly for or report to the Contractor’s Project Manager.

(6) The Contractor shall ensure that at the end of each month, the Lead Design Checker shall issue a written report to the Contractor’s Site office, with a copy to the Engineer, covering the status of all designs checked during the preceding month. The format of the Design Checker’s monthly reports shall be one to which the Engineer raises a Notice

(7) The Lead Design Checker shall undertake design checks on the Contractor’s designs. All design documents, drawings, plans, calculations and reports produced by the Contractor and Designer shall be checked by the Design Checker, accompanied by two original copies of a `Design Certificate' as set out in Attachment C1, signed by all parties when the design is submitted to the Engineer.

(8) The Contractor shall ensure that, as all designs being complex structures and having the potential to affect the safety, quality and durability of the Permanent Works, the Lead Designer shall approve in advance the Contractor’s proposed materials, construction and removal procedures and the lead designer shall inspect all temporary works at Site before they are put into use

(9) The Engineer, and such other parties as he shall give a Notice in writing, shall have full and unrestricted access to the Lead Design Checker, the Lead Designer, and to all persons carrying out the design and checking, and all their data, information, calculations, drawings and records

(10) The Contractor shall submit his Design Quality Assurance Plan as required in Appendix 6 of this Part 2, section VI (1) F, for the design required by the Contract.

C2 REQUIREMENTS DURING DESIGN PHASE

(1) The principal requirements of the Design Phase are the production of the Preliminary, Definitive Design based on the Tender drawings and the Construction Reference Drawings. It should be clearly understood that the Contractor's technical proposal which forms a part of this Contract, shall only form the basis for further design development into the Definitive Design, subject to the compliance of the design with relevant regulations and standards and conforming to the Outline Design Specifications and all other provisions of the Contract.

(2) Contractor's Design shall be reliable, with due considerations to safety, ease of operation, maintenance,

(3) Preliminary Design

The Tender Drawing have been given in Section VI (4).These drawings are for guidance of contractor for developing Preliminary & Definitive and construction Reference Drawing.

(4) Definitive Design shall accord with and incorporate the Preliminary Design and shall be the design developed to the stage at which all Track Structure elements are fully defined and specified and in particular:

(a) calculation and analysis are complete;

(b) all main and all other significant elements are delineated;

(c) all tests and trials of all materials and equipment are complete;

(d) Shall take full account of the effect on the Permanent Works of the proposed methods of construction and of the Temporary Works.

(e) Interface Management Plan (IMP).

(5) During the preparation of the Definitive Design, the Contractor shall complete all surveys, investigations and testing necessary to complete the design of the Permanent Works.

(6) The Contractor shall sub-divide the proposed Definitive Design into Design Packages to be submitted in advance of the Definitive Design Submission and to be identified in the Design Submission Programme. The Design Packages are to relate to the significant and clearly identifiable parts of the proposed Definitive Design and shall address the design requirements as described herein. The Design Packages shall facilitate the review and understanding of the Definitive Design as a whole and shall be produced and submitted in an orderly, sequential and progressive manner.

(7) Separate Definitive Design Submissions may be prepared for those major elements to be procured by sub-contract and which sub-contracts include design. Where such work is to be procured by the Contractor on the basis of

Outline design, design briefs and performance specifications, such documents may be submitted as Definitive Design Submissions.

(8) Upon issue of the Notice in respect of the Definitive Design Submission, the Contractor shall complete the design in all respects and produce the Construction Working Drawings, the purpose of which is to illustrate all the Permanent Works and to be the drawings governing construction.

(9) Construction Reference Drawings shall fully detail the construction of the elements covered by the Definitive Design and shall show in full the Works to be constructed.

C3 REQUIREMENTS DURING CONSTRUCTION PHASE

(1) The principal requirements relating to design during the Construction Phase are the production of Working Drawings, the preparation of technical submissions as required under the Contract, the compilation of the Final Design and the production of the As-Built Drawings.

(2) Working Drawings shall be prepared as required under the Contract. They shall be endorsed by the Contractor as being in accordance with the Detailed design.

(3) The Contractor shall endorse the submissions required under the Contract that "all effects of the design comprising the submission on the design of adjacent or other parts of the Works have been fully taken into account in the design of these parts."

(4) At least 3 months but not more than 6 months prior to the anticipated date of substantial completion of the Works, the Contractor shall submit the Final Design to the Engineer.

(5) The Final Design is the design of the Permanent Works embodied in:

(a) the latest revisions of the documents comprised in the Definitive Design, taking account of comments in the schedules appended to Notices of No Objection;

(b) the latest revisions of the Construction Reference Drawings;

(c) the calculations (see Clause C11 herein);and

(d) Coordinated interfaces and such other documents as may be submitted by the Contractor at the request of the Engineer to illustrate and describe the Permanent Works and for which a Notice has been issued.

(6) The Contractor shall maintain all records necessary for the preparation of the As- Built Drawings. Upon completion of the Works or at such time as agreed to or required by the Engineer, the Contractor shall prepare drawings which, subject to The Engineer's Notice shall become the As-Built Drawings. All such drawings shall be endorsed by the Contractor as true records of the construction of the Permanent Works and of all temporary works that are to remain on the site. The Contractor shall also show the locations of utilities exposed, relocated, diverted, new or retained.

C4 DESIGN INTERFACES WITH INTERFACING CONTRACTORS

(1) The Contractor shall co-ordinate all design and installation work with the various Interfacing Contractors as described in Appendix 19 of this Part 2, section VI.

(2) The Contractor shall note that a Master Interface Matrix and Interface Coordination Sheets refer Appendix 19, have been developed for the Mumbai Metro Line-3. The matrix identifies the lead Interfacing Contractor who shall coordinate the interfaces for all Interfacing Contractors, and the Interface Coordination Sheets describe the details of the interfaces.

(3) Appendix 19 contains the requirements of the Interface Management Plan (IMP) to be prepared and implemented by the Contractor. The IMP will identify the mechanism by which the Contractor and the Interfacing Contractors will work together to coordinate the design, and construction, of the various elements of the Project works. The Contractor shall review and update the IMP on a monthly basis.

(4) The Employer and Engineer will hold Project Quarterly Review Meetings (QRM), at three monthly intervals. The Contractor shall attend these QRM and shall report the progress of his works and the state of his interface with other Interfacing Contractors

and shall provide the Engineer with the necessary assistance and information for conducting the QRM. Refer to Clause A18 of Sub-division-A of this Part 2, Section VI Employer's Requirements.

C5 DESIGN SUBMISSIONS

C 5.1 PRELIMINARY SUBMISSION:

General

The Preliminary submission shall submit the following documents required for preparation of the definitive design. It shall also include:

a) the quality assurance plan for design
b) a review of the outline design criteria
c) the submission of design manuals
d) the submission of proposed software
e) the preliminary Track and equipment layouts and details
f) the preliminary maintenance analysis
g) the preliminary off site testing recommendation
h) the submission of specifications proposed for the Track and Civil Work
i) the identification of design codes and standards
j) the CAD procedures
k) preliminary Track layout
l) an alignment review
m) the preliminary construction methodology
n) the design submission programe (update)
o) the Transportation management plan
p) the utility diversion plan
q) proposed site surveys, existing surveys and other field surveys
r) a review of permanent land and site requirement
s) the preliminary monitoring plan
t) The preliminary reinstatement drawings.

C 5.1.1 PRELIMINARY DESIGN/DRAWING SUBMISSION:

This design will be based on ODS as given in Section VI (2) and Tender drawings. This will be based on site survey and consideration of best fit alignment available from civil contractor.

C5.2 DEFINITIVE DESIGN SUBMISSION

General

The Definitive Design Submission shall be a coherent and complete set of documents properly consolidated and indexed and shall fully describe the proposed Definitive Design. In particular, and where appropriate, it shall include, but not be limited to, the following:

(a) the dimensions of all major features of Track structural elements and members;

(b) all materials;

(c) the layout and typical details of reinforcement in Track slab concrete structure including Twin block sleepers

(d) the locations and nature of all relevant joints and connections and details thereof;

(e) standard details;

(f) provisions and proposals for construction interfacing with the Interfacing Contractors;

(g) Construction method statement and details for Track Structure under existing structures including removal of obstruction and any necessary under pinning.

(h) Noise & Vibration Mitigation: The employer has carried out the study for vibration on MML 3 Route and based on this the assessment of vibration attenuation required at receiver has been assessed. The vibration attenuation required has been given in the section VI (1) B Clause B2.

(i) Structural design calculation of Track slab, Twin block system and Derailment guard.

(1) Drawings

The Definitive Design Submission shall include drawings that shall illustrate the proposed Definitive Design and in particular shall include, but not be limited to, the following;

(a) General arrangements of all required for Track Structure application and construction.

(b) elevations and perspectives

(c) layouts and details of structural elements;

(d) associated fittings;

(e) slopes and earthworks;

(f) structural and surface drainage;

(g) access roads and temporary road works;

(h) pumping systems for concreting

(i) existing and proposed utilities;

(j) Road works and works related to traffic management

(k) Signaling Interface drawings

(l) Embedded items

(m) Consolidated Design Drawings

(2) DOCUMENTS

(a) **Contract Specification**

The Specification included in the Contractor's Technical Proposals together with the Outline Design Specification and Outline Construction Specifications shall be amplified so as to specify comprehensively the design and construction of the Permanent Works.

(b) **Design Manual**

The Design Manual shall incorporate all design requirements, standards, codes, loading cases, permissible movements and deflections, limit states, design stresses and strains, material properties and all other documents or matters which are relevant to and govern the design. The Design Manual shall refer to all materials, codes and standards used, making clear their specific applications.

The Design Manual shall be produced so that it can be used by those involved in the preparation or review of the design of the Permanent Works as a comprehensive reference text and efficient working document. In addition a Durability Approach and Assessment Report (DARR) as per the provisions in the Outline Design Specification shall form part of the Design Manual.

(c) **Interface Design Report on Interfacing Contractors**

This will include the following:

Details of the design and construction of the Works adjacent to other contracts, Details of provisions for the Interfacing Contractors, indicating arrangements for accesses, fixings, casting-in, , supports, plinth /Track slab/Transition slab/ twin block and the like; updated interface management plan relating to design integration and co-ordination.

(d) **Testing and Commissioning Report**

Details of proposals for testing and commissioning procedures for all relevant Track Structure elements and equipment contained in the Permanent Works.

(e) **Maintenance Report**

A report updating the Statement of Maintainability in the Contractor's Technical Proposals and detailing maintenance routines necessary for the achievement of the required lives of the various Track structure elements of the Works.

(3) SUPPORTING DOCUMENTS

The Definitive Design Submission shall be accompanied by the following documents, which will be considered by the Engineer in his assessment of the Definitive Design Submission. Where relevant or required, these documents shall be accompanied by a design note stating clearly how information has been used in the design of the Permanent Works.

(a) **Ballast**

The contractor will submit the specification of Ballast to be used

(b) **Survey Report**

A report on all survey work undertaken by the Contractor, including checks on, co-ordinates and setting-out. Updated and survey drawings shall also be included.

(c) **Utilities Report**

A report giving details of arrangements and working methods in respect of the utilities, including protection measures, support measures, diversions, reinstatements and programme allowances required for transportation of P-way material and construction material .

(d) **Temporary Works Design Report**

A report which provides sufficient information on the design of the Temporary Works to allow the Engineer to assess their effects on the Permanent Works and to enable these to be taken into account in the assessment of the Definitive Design.

(e) **Construction / Installation Analysis Report**

A report containing a stage-by-stage construction / installation sequence for all track structures /equipment. **Construction Method Statement**

Various reports which provide sufficient information on the methods of track construction and Contractor's Equipment to allow the Engineer to assess their effects on the Permanent Works and to enable these to be taken into account in the assessment of the Definitive Design. Refer Form No 5.

(f) **Works Programme Review**

(i) The Contractor shall, prior to submitting the Definitive Design Submission, review the Works Programme against the current version of the Design Submission Programme.

(ii) In the event that the Contractor considers that there are any discrepancies or inconsistencies between the Design Submission Programme and the Works Programme, the Contractor shall submit with the Definitive Design Submission his proposed revisions to the Works Programme such that the discrepancies or inconsistencies are removed.

(iii) The Contractor shall provide details of submissions of the Construction Reference Drawings and the proposed Working Drawings and their anticipated timing during the Construction Phase and shall identify information required from or actions to be undertaken by the Engineer or others which are necessary to permit the completion of the design of the Permanent Works and the Working Drawings. Desired Dates for the receipt of such information or for the completion of such actions required by the Contractor shall be included with appropriate justification.

(g) **Report on the Use of Works Areas**

A report updating the proposals from those contained in the Contractor's Technical Proposals for the use of Works Areas, site security and their reinstatement, detailing the station accesses and access facilities.

(4) NOTICES ON DEFINITIVE DESIGN SUBMISSION

The Contractor may make Definitive Design Submissions and seek separate Notices in respect of:

(a) The temporary works for construction of the underground track works.

(b) Major elements as identified under Clause C2 (6) herein.

C6 DESIGN SUBMISSIONS - CONSTRUCTION REFERENCE DRAWING SUBMISSIONS

(1) The Construction Reference Drawings shall be derived directly from the Definitive Design and shall detail and illustrate in full the Permanent Works. The Construction Reference Drawings shall form part of the Working Drawings to be used for construction purposes.

(2) Prior to any Construction Reference Drawings Submission, the Contractor shall prepare a full list of Construction Reference Drawings in order to demonstrate, to the satisfaction of the Engineer, that such Construction Reference Drawings will be sufficient in extent to cover the construction of the whole of the Permanent Works.

(3) Unless otherwise required by the Engineer, the Construction Reference Drawings need not include bar bending schedules, bar reference drawings, as well as other schedules or erection drawings which are to be provided by the Contractor during the Construction Phase.

(4) The Construction Reference Drawings shall include Combined Drawings and Consolidated Design Drawings which shall clearly define the scope, interrelationships and provisions for of all aspects of the track Works.

C7 DESIGN SUBMISSIONS – CONSTRUCTION PHASE

(1) On the issue of a Notice in respect of the Construction Reference Drawings the Contractor shall produce the proposed Working Drawings. The Working Drawings shall include the Construction Reference Drawings, which may be supplemented by further drawings developed in accordance with the Construction Reference Drawings such as site sketches, bar bending schedules, bar reference drawings, fabrication, construction erection sequences material list with accompanying specification, and the like. All such drawings shall comply with the requirements of the Contract.

(2) Prior to submission of the proposed Working Drawings, the Contractor shall endorse the appropriate original paper drawings as "Good for Construction". If the Engineer so requires, the endorsed original shall be submitted to the Engineer who shall, if he has no objection to the contents of the submission, further endorse the original by stating that he has no objection to the proposed working Drawings. On the endorsement by the Engineer, the original will forthwith be returned to the Contractor as the Working Drawings Contractor.

(3) Only the Working Drawings endorsed as in C7 (2) above or those that the Engineer has expressly stated as not requiring his endorsement shall be issued to the Site. The Construction of the Works shall be strictly in accordance with these Working Drawings.

(4) The Contractor shall finalize details of the proposed method of construction and submit such finalized details to the Engineer for a Notice. The proposed method shall have no adverse effects on the partially completed Permanent Works and shall ensure the Works are statically and, if appropriate, aerodynamically stable.

(5) The Contractor shall undertake and submit a stage by stage construction sequence and the effect of any Temporary Works and the Contractor's Equipment on the Permanent Works. This analysis shall be in sufficient detail to demonstrate that the Contractor's proposals are safe and have no adverse effects upon any parts of the Permanent Works.

(6) Hard copies of the As-Built Drawings, endorsed by the Contractor, shall be submitted to

the Engineer for a Notice of No Objection in accordance with Clause 5.6 of Part III GCC and in electronic format using a commercially available CAD program.

C8 DESIGN SUBMISSIONS – ASSESSMENT PROCEDURES

(1) Submissions of Design Data shall be made and assessed by the Engineer within 28 days of the date of submission, or as otherwise stated in Section VII. The form and detail of the assessment shall be as determined by the Engineer and will not release or remove the Contractor's responsibility for the design under the contract.

(2) The issue of a Notice shall be without prejudice to the issue of any future Notices.

(3) The Contractor shall, prior to the submission of the Design Data, obtain all required statutory approvals that relate to that submission including, where appropriate, the approval of the Concerned Government Authorities and utility undertakings, and demonstrate that all required approvals have been obtained.

(4) All submissions shall be accompanied by two original copies of a `Design Certificate' as set out in Attachment C1 hereto and signed by the Contractor, the Lead Designer and the Lead Design Checker.

C9 DESIGN SUBMISSION PROGRAMME

(1) The Contractor shall prepare the Design Submission Programme which is to set out fully the Contractor's anticipated programme for the preparation, submission and review of the Design Packages, the Definitive Design Submission and the Construction Reference Drawings Submissions and for the issue of Notices in relation thereto.

(2) The Design Submission Programme shall:

(a) be consistent with and its principal features integrated into the Works Programme, and show all relevant Key Dates;

(b) identify dates and subjects by which the Engineer's decisions should be made;

(c) make adequate allowance for periods of time for assessment by the Engineer and other review bodies;

(d) make adequate allowance for the design and development of specialist works;

(e) include a schedule identifying, describing, cross-referencing and explaining the Design Packages into which the Contractor intends to divide the Definitive Design and Construction Reference Drawings; and

(f) Indicate the Design Interface and Co-ordination periods for the Project and Interfacing Contractors.

(3) The Contractor shall submit the Design Submission Programme to the Engineer within thirty (30) days of the Commencement Date and thereafter up-dated versions thereof at intervals of not more than one (1) month throughout the Design Phase.

C10 PROGRAMME FOR SUBMISSIONS DURING THE CONSTRUCTION PHASE

In accordance with Clause A4 of Sub-division A of Part 2, section VI the Employer's Requirements - General, the Contractor shall identify submissions required during the Construction Phase.

C11 CALCULATIONS

(1) Unless otherwise required by the Engineer, calculations relevant to the Definitive Design and Construction Reference Drawings shall be submitted for assessment with the respective Design Packages or Submissions. The above calculations shall have been certified by the Contractor's Lead Designer and Lead Design Checker before submitting to the Engineer. The Engineer may require the submission of applicable software including in-house software programmes/ worksheets developed by the Contractor and/or designer, computer input and programme logic for his assessment prior to the acceptance of the computer output.

(2) The Contractor shall prepare and submit a comprehensive set of calculations for the Definitive Design in a form acceptable to the Engineer. Should the design of the Permanent Works be revised thereafter and such revision renders the calculations as submitted obsolete or inaccurate, the Contractor shall prepare and submit the revised calculations.

(3) Similarly, the Contractor shall submit such further calculations as have been prepared in connection with the Construction Reference Drawings.

(4) Calculations to be included as part of the submission herein shall comprise the up-to-date calculations in respect of the Definitive Design, the Construction Reference Drawings and such further calculations which the Contractor has prepared during the production of Working Drawings.

(5) Copies of EXCEL spreadsheets and computer model data files sufficient to regenerate the model and re-run the analysis should be submitted together with the calculations to the Engineer.

(6) The Contractor shall submit all calculations necessary to support proposals relating to the construction methods.

C12 DOCUMENT REQUIREMENTS

(1) Drawings shall be prepared generally to A1 size, but to ISO AO size where appropriate. Appendix 7 of this Part 2, section VI defines the Drawings and CAD Standards required for drawing preparation and submittal.

(2) The Contractor shall submit 6 copies of his design and/or drawings for assessment by the Engineer. After the receipt of a Notice of No Objection from the Engineer, the Contractor shall submit 6 copies of design and/or drawing for the use of the Engineer.

(3) The submission of drawings may be by CAD Media files and Appendix 7 of this Part 2, section VI specifies the drawing submission requirements for CAD Media files.

ATTACHMENT C1
DESIGN CERTIFICATE

This Design Certificate refers to Submission No. ...…… which comprises:

[*Design Package No. ..../the Definitive Design Submission/Construction Reference Drawings Submission No. ..../Technical Submission No. ....] in respect of:

[Description of the Permanent Works to which the submission refers]

The contents of this submission are scheduled in Section A below.

The documents scheduled in Section B below, for which a Notice of No Objection has been issued, are of relevance to this submission.

LEAD DESIGNER'S STATEMENT

We certify that:

(a) the design of the Permanent Works, as illustrated and described in the documents scheduled in Section A below, complies with the Employer's Requirements, Outline Design Specifications, Outline Construction Specifications & other Contract provisions, local regulations and standards and ..... [*see note 1below*];

OR (in the case of a Definitive Design Submission in respect of those elements identified under Clause C2 (6) of the Employer's Requirements -Design):

a. the outline designs, design briefs and performance specifications of those elements of the Permanent Works as illustrated and described in the documents scheduled in Section A below comply with the Employer's Requirements , Outline Design Specifications, Outline Construction Specifications & other Contract provisions and ..... [*see note 1below*];

OR (in the case of a submission of documents that do not strictly comply with previous documents for which a Notice of No Objection has been received):

a. the design of the Permanent Works, as illustrated and described in the documents scheduled in Section A below, complies with the Employer's Requirements , Outline Design Specifications, Outline Construction Specifications & other Contract provisions and ..... [see note 1 below] except in the following respects:

(i) ..... (to be completed by Contractor/Designer)

(ii) ..…. (etc.)

(b) A detailed review and design check has been undertaken and completed to confirm the completeness, adequacy and validity of the design of the Permanent Works as illustrated and described in the documents scheduled in Section A below;

(c) all necessary and required approvals relating to the design of the Permanent Works, as illustrated and described in the documents scheduled in Section A below, have been obtained and copies of such approvals are annexed in Section C below;

(d) All effects of the design comprising the submission on the design of adjacent or other parts of the Works have been fully taken into account in the design of those parts.

Signed by 'Authorized Representative' (for Designer)

Name

Position / Designation Date

LEAD DESIGN CHECKER'S CERTIFICATION

We certify that the Work described in Section A of this certificate has been checked by us, and meets all the requirements of the Contract.

Signed by 'Authorized Representative' (for Design Checker)

Name

Position / Designation Date

CONTRACTOR'SCERTIFICATION

This Certifies that all design has been performed utilizing the skill and care to be expected of a professionally qualified and competent designer, experienced in work of similar nature and scope. This further certifies that all works relating to the preparation, review, checking and certification of design has been verified by us and that the design meets all the requirements of the Contract and has been accepted by us vide Clause 4.1 of GCC

Signed by 'Authorized Representative' (for Contractor)

Name Position/Designation Date

Note1

The Contractor shall insert one of the following, as applicable:

(i) the Contractor's Technical Proposals

(ii) The Contractor's Technical Proposals and Design Packages Nos. ..... For which a Notice of No Objection has been issued.

(iii) Design Packages Nos. ....….. For which a Notice of No Objection has been issued if such Design Packages develop and amplify the Contractor's Technical Proposals.

(iv) The Definitive Design

Section A

Submission no. .... Comprises the following: Drawings: *(Title, drawing number and revision)*

Documents: *(Title, reference number and revision)* others:

Section B

Documents for which a Notice of No Objection has been issued and which are of relevance to this Submission No.....

Document: submitted with

[*Design Package No……/	) *The Contractor is required to*
The Definitive Design Submission No……/	) provide *this information in* Construction
Reference Drawings Submission No...../	) respect *of each document in* Technical
Submission No……/	) *Section B*
Date of Issue of Notice of No Objection	)

(Delete as appropriate)*

Section C

[Contractor to attach copies of necessary and required approvals from statutory bodies etc.]

MUMBAI METRO LINE 3

TENDER DOCUMENTS

Part 2

Section VI (1)

EMPLOYER'S REQUIREMENTS

GENERAL SPECIFICATION

SUB-DIVISION – D. TRACK CONSTRUCTION

July 2019

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D 1 CONTRACTOR'S SUPERINTENDENCE

The Contractor shall submit a Staff Organization Plan to the Engineer in accordance with Clause A15 of this Part 2, section VI. This plan shall be updated and resubmitted whenever there are changes to the staff. The plan shall show the management structure and state clearly the duties, responsibilities and authority of each staff member.

D 2 CHECKING OF THE CONTRACTOR'S TEMPORARY WORKS DESIGN

The Contractor shall, prior to commencing the construction of the Temporary Works, submit a certificate to the Engineer, based on the `Design Certificate' enclosed as Attachment C1 in Section C signed by the Designer and the Lead Design Checker, certifying that the Temporary Works have been properly and safely designed and checked, and that the Contractor has checked the effect of the Temporary Works on the Permanent Works and has found this to be satisfactory.

D 3 THE SITE

Works Areas are those areas identified in Appendix 2A of this Part 2, section VI and on the Employer’s Drawings.

D 3.1 Use of the Site

1. The Site or Contractor's Equipment shall not be used by the Contractor for any purpose other than for carrying out the Works, except that, with a Notice from the Engineer, the Site or Contractor's Equipment such as batching and mixing plants for concrete and bituminous materials may be used for the Work in connection with other Contracts under the Employer.

2. Entry to and exit from the Site shall be controlled by 24 hour security and shall be only available at the locations for which the Engineer has given a Notice. Notice will only be given after the Contractor has provided evidence that he has obtained the necessary approvals from the relevant authorities.

3. The security will be kept by 24hrs at site office and stores – depot

D 3.2 Access to the Site

1. The Contractor shall make his own arrangements, subject to a Notice from the Engineer, for any further access required to the Site.

2. In addition, the Contractor shall ensure that access to every portion of the Site is continually available to the Engineer.

3. Following the handover of the Works site to the contractor, the contractor will be responsible

for all matters relating to security and safety therein. Access to the Site by the Contractor shall be in accordance with any procedures, requirements and conditions defined in Appendix 9 of this Part 2, section VI.

4. The Contractor shall be responsible for ensuring that any access or egress through the Site boundaries are controlled such that no disturbance to residents or damage to public or private property occurs as a result of the use of such access or egress by its employees and sub-Contractors.

D 3.3 Barricades and Sign boards

1. The Contractor shall erect barricades as per tender drawing with gates around his areas of operations to prevent entry by unauthorized persons to his Works and/or Site Areas and necessary identity cards /permits should be issued to all of his workers and staff by the Contractor. The Contractor shall submit a proposal for barricades/gates around the complete perimeter of all Works areas for which the Engineer shall give a Notice.

2. Painting of the barricades shall be carried out to the standard design of MMRC
As directed by the Engineer, Contractor shall carry out re-painting of the entire barricades on an annual basis or sooner as required by the Engineer.

3. No work shall commence in any Works Area until the Engineer has issued a Notice signifying that he is satisfied that the barricades installed by the Contractor are sufficient to prevent, within reason, unauthorized entry. Project signboards shall be erected for such period as the Engineer has given his Notice, after the date for commencement of the Works.

4. The types, sizes and locations of project signboards shall be agreed with the Engineer before manufacture and erection. Other advertising signs shall not be erected on the Site.

5. A Notice of No Objection from the Engineer shall be obtained before hoardings, fences, gates or signs are removed. Hoardings, fences, gates and signs which are to be left in position after the completion of the Works shall be repaired and repainted as instructed by the Engineer.

6. Hoardings, barricades, gates and signs shall be maintained in clean and good order by the Contractor until the completion of the Works, whether such hoardings, fences, gates and signs have been installed by the Contractor or by others and ownership of all such items transferred to the Contractor during the period of the Works. All the fencing, hoardings, gates and signs etc. shall be mopped a minimum of once a week and thoroughly washed once a month.
7. All hoardings, barricades, gates and signs installed by the Contractor shall be removed by the Contractor upon the completion of the Works, unless otherwise directed by the Engineer.

8. Hoarding/ barricades can be reused after removing from one place to other locations / sites provided they are in good condition and a Notice is issued by the Engineer.

9. Damaged/worn-out barricades /hoardings shall be replaced by the Contractor within 24 hours. The Engineer‘s decision regarding need for replacement shall be final and binding.

D 3.4 Clearance of the Site

All Temporary Works which are not to remain on the Site after the completion of the Track Works shall be removed prior to completion of the work as instructed by the Engineer. The Site shall be cleared and reinstated to the lines and levels and to the same or better condition as existed before the Works started except as otherwise stated in the Contract.

D 4 SURVEY

1. The Contractor shall establish his own site grid including the benchmarks, Traverse points, primary and secondary survey control points in the vicinity of the Site areas and relate the construction of the Track Works. The Contractor shall also coordinate and interface with the adjacent Contractors of adjacent contract packages for the Project to ensure that there is no discrepancy of alignment both horizontal and vertical caused due to survey control points, bench marks or coordinate system at contract boundaries with the adjacent Contractors for compatibility.

2. Before the Contractor commences the setting out of the Track Works, the Engineer will provide a drawing showing the position of each survey reference point and bench mark, together with the co-ordinates and/or level assigned to each point, that were used in developing the Tender Drawings, for information only. The Contractor shall carry out detailed survey to check the proposed alignment maintaining vertical and horizontal clearances. In case of any differences from the Employer's drawings or data, the Contractor shall bring these to the Notice of the Engineer immediately and submit his proposals for correction. The Engineer shall either, issue a Notice, modify or ask the Contractor to resubmit the proposals within a period of 14 days. The Contractor shall satisfy himself that there are no further conflicts between the data given and the survey control/reference points & bench marks established by him and all the conflicts (including with the survey data of adjacent Contractors) have been satisfactorily resolved. All such proposals for correction prepared by the Contractor and all such rectification works undertaken by the Contractor to resolve/eliminate all such differences/discrepancies/conflicts in survey data of the Employer/adjacent contractor and the Contractor shall not entitle the Contractor for any claims or extension of Contract schedules and all the necessary works in this regard shall be done by the Contractor without any cost or time implications to the Employer. The Contractor shall also establish and provide all subsidiary setting out points, monuments, and the like which may be necessary for the proper and accurate setting out and checking of the Track Works.

3. The Contractor shall carefully protect all the survey reference points, bench marks, setting out points and the like from any damages and shall maintain them and promptly repair or replace any points damaged from any causes whatsoever.

4. The setting up of the accurate Contractor survey reference points and maintaining them shall be the responsibility of the Contractor. The Contractor shall check the survey reference points every three months to ensure that these survey points continue to remain consistent with the benchmarks.

D 5 OCCUPATIONAL SAFETY,HEALTH AND ENVIRONMENTAL REQUIREMENTS

The Contractor shall comply with the conditions and requirements stipulated in the Occupational Health, Safety & Environment (OHS&E) Plan contained in **Appendix 20 of this Part 2, Section VI(1)** - Employer's Requirements in Part 4,(OHS&E) Manual Section 10 .

D 6 OTHER SAFETY MEASURES

1. The Contractor shall take all reasonable precautions and select appropriate tools, equipment and installation methods to avoid causing a nuisance arising from his operations and shall minimize inconvenience to the public and other staff working on the site.

2. The Contractor shall prevent dust from rising as a result of his activities and shall take all necessary dust control and suppression measures.

3. The Contractor shall be responsible for the security of the Site at all times during the term of this Contract. The Contractor shall control all entry and exit to and from the Site for his personnel, personnel from the Engineer, Interfacing Contractors, Sub-Contractors and suppliers, by pedestrians and for all vehicles. All of the Contractor's personnel shall be required to carry an identity/security card or pass which provides a positive photo identification and they shall be required to show the pass when entering or leaving the Site. This shall apply to all personnel on the Site including, but not limited to, the Contractor's staff, all Interfacing Contractors, Sub-Contractors staff, Suppliers, Consultants, etc. and the staff of the Engineer. Provision shall be made for issue of visitors' passes for other personnel authorized to enter the Site as visitors. Visitors on Site shall be escorted by appropriate Site based personnel at all times.

D 6.1 Protection of the Work

The finished works shall be protected from any damage that could arise from any activities on the adjacent site/works.

D 7 CARE OF THE WORKS

1. Unless otherwise permitted by the Employer's Representative all work shall be carried out in dry conditions.

2. The Works, including materials for use in the Works, shall be protected from damage due to water. Water on the Site and water entering the Site shall be promptly removed by temporary drainage or pumping systems or by other methods capable of keeping the Works free of water. Silt and debris shall be removed by traps before the water is discharged and shall be disposed of at a location or locations to which the Employer's Representative has given a Notice.

3. The discharge points of the temporary systems shall be as per the Notice of the Employer's Representative. The Contractor shall make all arrangements with and obtain the necessary approval from the relevant authorities for discharging water to drains, watercourses, etc. The relevant work shall not be commenced until the approved arrangements for disposal of the water have been implemented.

4. The methods used for keeping the Works free from water shall be such that settlement of, or

damage to, new and existing structures do not occur.

5. Measures shall be taken to prevent flotation of new and existing structures.

D 7.1 Protection of the Works from Weather

1. Work shall not be carried out in weather conditions that may adversely affect the Works unless proper protection is provided to the satisfaction of the Engineer.

2. Permanent Works, including materials for such Works, shall be protected from exposures of weather conditions that may adversely affect such Permanent Works or materials.

3. During construction of the Works storm restraint systems shall be provided where appropriate. These systems shall ensure the security of the partially completed and ongoing stages of construction and in all weather conditions. Such storm restraint systems shall be installed as soon as practicable and shall be compatible with the right of way, or other access around or throughout the Site.

4. The Contractor shall, at all times programme and order progress of the Works and make all protective arrangements such that the Works can be made safe in the event of storms.

D 7.2 Protection of the Work

The finished works shall be protected from any damage that could arise from any activities on the adjacent site/ works.

D 8 DAMAGE AND INTERFERENCE

D 8.1 Work shall be carried out in such a manner that there is no damage to or interference with:

(a) Drainage systems;
(b) structures (including foundations), roads, or other properties;
(c) public or private vehicular or pedestrian access;
(d) monuments, trees, graves or burial grounds other than to the extent that is necessary for them to be removed or diverted to permit the execution of the Track Works, as approved by statutory authorities etc.

D 8.2 The Contractor shall inform the Engineer as soon as practicable of any items which are not stated in the Contract to be removed or diverted but Which the Contractor considers need to be removed or diverted to enable the Works to be carried out. Such items shall not be removed or diverted until a Notice from the Engineer to such removal or diversion has been obtained.

D 8.3 Items which are damaged or interfered with as a result of the Works and items which are removed to enable work to be carried out shall be reinstated to the satisfaction of the Engineer and to the same or better condition as existed before the work started and with minimum time loss.

D 8.4 Utilities

1. Refer to Appendix 12 of this Part 2, section VI.

2. Any claims by Utility Agencies due to damage of utilities by the Contractor shall be borne by the Contractor.

D 8.5 Structures, Roads and Other Properties

1. The Contractor shall immediately inform the Engineer of any damage to structures, roads or other properties at handover of the site(s) or during the Contract duration.

D 9 WORK ON ROADS

D 9.1 Traffic Management Plan

The Contractor shall develop a detailed Traffic Management Plan for the work under the contract. The purpose is to develop a Traffic Management Plan to cope with the traffic disruption as a result of construction activities by identifying strategies for traffic management on the roads and neighborhoods impacted by the construction activities, which shall be submitted to the Employer's Representative for his Notice of No Objection. The Contractor shall implement the Traffic Management Plan throughout the whole period of the Contract.

D 9.2 Principles for Traffic Management

1. The basis for the Plan shall take into consideration four principles:
2. to minimize the inconvenience of road users and the interruption to surface traffic through the area impacted by the construction activities;
3. to ensure the safety of road users in the impacted area;
4. to facilitate access to the construction site, and to maintain reasonable construction progress.
5. to ensure traffic safety at each construction site.

D 9.3 Approval for Temporary Traffic Arrangements and Control

The Contractor shall make all arrangements with and obtain the necessary approval from the transport authorities and the Police Department for temporary traffic arrangements and control on public roads. In the event that the Contractor, having used its best endeavors, fails to secure the necessary approval from the transport authorities and the Mumbai Traffic Police Department for temporary traffic arrangements and control on public roads, then the Engineer will use its best endeavors to assist the Contractor to secure such approval but without responsibility on the part of the Engineer to do so.

D 9.4 Temporary Traffic Arrangements and Control

(1) Temporary traffic diversions and pedestrian routes shall be surfaced and shall be provided where work on roads or footpaths obstruct the existing vehicular or pedestrian access. The relevant work shall not be commenced until the approved temporary traffic arrangements and control have been implemented.

(2) Temporary traffic arrangements and control for work on public roads and footpaths shall comply with the requirements of the Mumbai Traffic Police. Copies of documents containing such requirements shall be kept on the Site at all times.

(3) Temporary traffic signs, including road marking, posts, backing plates and faces, shall comply with the requirements of the Mumbai Traffic Police and should be in accordance with the requirements of Ministry of Surface Transport. All overhead traffic management signs that are fixed to bridges and gantries shall be illuminated at night. Pedestrian routes shall be illuminated at night to a lighting level of not less than 50 lux.

(4) Adequate number of traffic marshals shall be deployed for smooth regulation of traffic.

(5) Temporary traffic arrangements and control shall be inspected and maintained regularly, both by day and night. Lights and signs shall be kept clean and legible. Equipment which are damaged, dirty, incorrectly positioned or not in working order shall be repaired or replaced promptly.

D 9.5 Particulars of Temporary Traffic Arrangements and Control

1. The following particulars of the proposed temporary traffic arrangements and control on public roads shall be submitted to the Engineer for his Notice of No Objection, at least 28 days before the traffic arrangements and control are implemented:

   (a) Details of traffic diversions and pedestrian routes;

   (b) Details of lighting, signage, guarding and traffic control arrangements and equipment;

   (c) Any conditions or restrictions imposed by Mumbai Traffic Police or any other relevant authorities, including copies of applications, correspondence and approval.

2. Where concrete barriers are used to separate flows of traffic, the barriers shall be in a continuous unbroken line. No gaps shall be left between any sections of the barrier.

3. Site perimeter fencing and barriers along the roadway, shall have flashing amber lights positioned on the top of them every 50 meters apart and at every abrupt change in location. Directly below the flashing light shall be fixed, in the vertical position, a white fluorescent light with a waterproof cover.

D 9.6 Use of Roads and Footpaths

1. Public roads and footpaths on the Site in which the work is not being carried out shall be maintained in a clean and passable condition.

2. Measures shall be taken to prevent the excavated materials, silt or debris from entering gullies on roads and footpaths; entry of water to the gullies shall not be obstructed.

3. Surfaced roads on the Site and leading to the Site shall not be used by tracked vehicles unless protection against damage is provided.

4. Contractor's Equipment and other vehicles leaving the Site shall be loaded in such a manner that the excavated material, mud or debris will not be deposited on roads. All such loads shall be covered or protected to prevent dust being emitted. The wheels of

all vehicles shall be washed when necessary before leaving the Site to avoid the deposition of mud and debris on the roads.

D 9.7 Reinstatement of Public Roads and Footpaths

Temporary diversions, pedestrian access and lighting, signing, guarding and traffic control equipment shall be removed immediately when they are no longer required. Roads, footpaths and other items affected by temporary traffic arrangements and control shall be reinstated to the same condition as existed before the work started or as permitted by the Engineer immediately after the relevant work is complete or at other times permitted by the Engineer

The Contractor shall submit his design for the reinstatement to the relevant authorities and obtain their prior approval to carrying out the work. Reinstatement works shall include, but not be limited to, the following:

i. Parking bays
ii. Footpath and Kerbs
iii. Road Signage
iv. Street Lighting
v. Landscaping
vi. Traffic Lights and Control Cable
vii. Road painting

D 9.8 Access

Alternative access shall be provided to all premises if interference with the existing access, public or private, is necessary to enable the Contractor's Works to be carried out. The arrangements for the alternative access shall be as agreed by the Engineer and any concerned agency or management. Unless agreed otherwise, the permanent access shall be reinstated as soon as practicable after the Work is complete.

D 9.9 Protection of the Adjacent Structures and Works

The Contractor shall take all necessary precautions to protect adjacent and structures, and works being carried out by others adjacent to and within the Site, from the effects of vibrations, undermining and any other earth/ground movements or the diversion of water flow arising from its work.

D 10 SITE ESTABLISHMENT

D 10.1 Engineer's Site Accommodation

(1) Within 30 days of the Commencement Date, the Contractor shall provide and maintain site accommodation for the Engineer's staff as set out in Appendix 13 and at a location given a Notice by the Engineer. The accommodation shall be retained until 90 days after the issue of a Taking-over certificate for the Works by the Engineer.

(2) The Contractor shall submit details of the site accommodation layout to the Engineer for a Notice, prior to establishing the accommodation

(3) The accommodation shall be cleaned and serviced daily and security shall be provided 24 hours a day, 7 days per week. Full capacity stand-by power shall be available during periods when main power is unavailable. The Contractor shall also provide Uninterrupted Power Supply equipment to the computer facilities provided by the Engineer in the site accommodation.

D 10.2 Site Laboratory

The Contractor shall provide, erect and maintain in a clean, stable and secure condition a laboratory, equipped for the routine testing of concrete, soil and rock samples and for the storage and curing of concrete cubes or cylinders. This laboratory shall be located at the Contractor's principal work site or at a location issued a Notice by the Engineer. Detailed requirements for this laboratory are set out in Appendix 14 of this Part 2, section VI.

D 10.3 Contractor's Site Accommodation

(1) The Contractor shall provide and maintain its own site accommodation at locations issued a Notice by the Engineer. Offices, sheds, stores, mess rooms, garages, workshops, latrines and other accommodation on the Site shall be maintained in a clean, stable and secure condition and shall comply with the requirements of Attachment D1 of this section. Under no circumstances is living accommodation to be provided on the Site to the Engineer The Contractor shall comply with the requirements of Appendix 13 of this Part 2, section VI.

D 10.4 Latrines and Wash places

(1) The Contractor shall provide latrines and wash places for the use of its personnel and all persons who will be on the Site. The size and disposition of latrines and wash places shall accord with the numbers and dispositions of persons entitled to be on the Site, which may necessitate their location on structures and, where necessary there shall be separate facilities for males and females. The capacities and layout shall be subject to a Notice from the Engineer. The Contractor shall arrange regular disposal of effluent and sludge in a manner that shall be in accordance with local laws/regulations.

(2) The Contractor shall be responsible for maintaining all latrines and wash places on the Site in a clean and sanitary condition and for ensuring that they do not pose a nuisance or a health threat. The Contractor shall also take such steps and make such provisions as may be necessary or directed by the Engineer to ensure that vermin, mosquito breeding etc. are at all times controlled.

D 10.5 Site Utilities and Access

1. The Contractor shall be responsible for providing water, electricity, telephone, sewerage and drainage facilities for the Engineer site accommodation, Contractor’s site offices, structures and buildings and for all site laboratories and all such services that are necessary for satisfactory performance of the Works. The Contractor shall make all arrangements with and obtain the necessary approval from the relevant civil and utility authorities for the facilities.

2. The Contractor shall note that their requirements for the supply and provision of power and water services will not be met fully by the interfacing Contractors, as given in Appendix 19 of this Part 2, section VI.

3. The Contractor shall be responsible for provision of adequate power supply for his works for Flash Butt Welding RCC work, Ventilation and other work requiring heavy consumption of power and water for which contractor shall make their own arrangement.

4. The tunnel ventilation will be arranged by Contractor for their labor and supervisor to work in the tunnel.

5. Access roads and parking areas shall be provided within the Site as required and shall be maintained in a clean, acceptable and stable condition. For lengths of roadway longer than 100 m and where vehicle movements exceed one hundred (100) movements/day and heavy commercial vehicle are to ply the Contractor shall provide paved surfacing of adequate thickness and quality to the satisfaction the Engineer.

6. Any operation of the Works that interferes with the inspection of the Works and/or the checking of lines and levels shall be temporarily stopped at the request of the Engineer until the checking is complete.

D 10.6 Submission of Particulars

1. The following particulars shall be submitted to the Engineer for his Notice of No Objection not more than fifty six (56) days after the Commencement Date of the Works:

   a. drawings showing the layout within earmarked area for the Contractor's offices, project signboards, principal access and other major facilities
   b. required early in the Contract, together with all service utilities;
   c. Drawings showing the details to be included on the project signboards and diversion boards.

2. Drawings showing location of stores, storage areas, concrete batching plants and other major facilities and their access roads/paths shall be submitted to the Engineer for his Notice as early as possible but in any case not less than twenty eight (28) days prior to when such facilities are intended to be constructed on the Site. Incase adequate land is not available for Batching plant, Ready-mix concrete will be permitted

D 11 SECURITY

(1) The Contractor shall be responsible for the security of the Site for the full time the Site is in its possession, as per Clause D 3.1 of these Employer's Requirements – Construction (Sub-division D). The Contractor shall set up and operate a system whereby only those persons entitled to be on the Site can enter the Site. To this end, the Contractor shall, with a Notice from the Engineer, erect a security fence/barricade, with a minimum height of 2m, around the site areas, with only specific points at which entry through the fence/barricade can be effected, and shall provide gates or movable barricades at such points of entry and thereby maintain a twenty four hours a day, seven days a week security guard and such other security personnel and patrols elsewhere as necessary to maintain security.

(2) The Contractor shall maintain all site boundary fences in a first class condition, and shall

so arrange site boundary fences and security measures that the drainage arrangement is not affected. . Notices shall be displayed at intervals around the Site to warn the public of the dangers of entering the Site.

(3) During the progress of the Works the Contractor shall maintain such additional security patrols over the areas of the Works as may be necessary to protect his own and his Sub-Contractor's work and equipment and shall co-ordinate and plan the security of both the Work under this Contract and the Work of others having access to and across the Site and the Works.

(4) In order to operate such a security system it will be necessary to institute the issue of unique ID passes to personnel and vehicles entitled to be on the Site, and which may need to be separately identifiable according to the shifts being worked on Site. The Contractor shall at the outset determine, together with the Engineer, a system and the design of ID passes to suit the requirements of the foregoing and to suit the methods of work to be adopted by the Contractor.

(5) The Contractor shall at all times ensure that the Engineer has an up to date list of all persons entitled to be on the Site at any time. The Contractor shall also introduce a system for issuing passes to any visitors or persons/vehicles belonging to agencies other than Employer/ Engineer/Interfacing Contractors who may have to visit the site in connection with work

(6) The Contractor shall liaise with the Contractors responsible for the other Projects and other Interfacing Contractors and ensure that coordinated security procedures are operated, in particular in respect of vehicles permitted to pass through the Site and/or the adjacent sites.

(7) Security and checking arrangements as felt necessary shall be provided with

(8) Advice and help of the Police.

D 12 TESTING

D 12.1 General

(1) The Contractor shall provide and perform all forms of testing procedures applicable to the Track Works and various Track components and the interfacing of the Track Works with the other project works and shall conduct all necessary factory, site and acceptance tests.

(2) All testing procedures shall be submitted at least thirty (30) days prior to conducting any Test. The Testing procedures shall show unambiguously the extent of testing covered by each submission, the method of testing, the Acceptance Criteria, the relevant drawing (or modification) status and the location.

(3) The testing Procedures shall be submitted, as required, by the Contractor during the duration of the Contract to reflect changes in system design or the identification of additional testing requirements.

(4) The Engineer shall have the facilities for monitoring all tests and have access to all testing records. Ample time shall be allowed within the testing programmes for necessary alterations to equipment, systems and designs to be undertaken, together with re-testing prior to final commissioning.

(5) The Contractor is reminded that at some point, the High Voltage Power Supply system will be energized and the additional precautions for the safety of staff and co-ordination of activities after power-on shall be anticipated.

(6) All costs associated with the Testing shall be borne by the Contractor, unless otherwise specified, including the services of any specialized personnel or Independent assessors. The Contractor shall also bear any expenses incurred due to re-testing caused by defects or failure of Track equipment to meet the requirements of the Contract in the first instance.

(7) Unless a Notice is issued by the Engineer, the personnel engaged on testing shall be independent of those directly engaged in the design or installation of the same equipment and Track structure.

(8) All testing equipment shall carry an appropriate and valid calibration labels.

D 12.2 Batches, Samples and Specimens for Ballastless Track

(1) A batch of material is a specified quantity of the material that satisfies the specified conditions. If one of the specified conditions is that the material is delivered to the Site at the same time, then material delivered to the Site over a period of a few days may be considered as part of the same batch if in the

(2) Opinion of the Engineer there is sufficient proof that the other specified conditions applying to the batch applies to all of the material delivered over the period.

(3) A sample is a specified quantity of material that is taken from a batch for testing and which consists of a specified amount, or a specified number of pieces or units, of the material.

(4) A specimen is the portion of a sample that is to be tested.

D 12.3 Samples for Testing

1. Samples shall be of sufficient size and in accordance with relevant Standards to carry out all specified tests.

2. Unless agreed otherwise by the Engineer samples taken on the Site shall be selected by, or taken in the presence of; the Engineer and shall be suitably marked for their identification. An identification marking system should be evolved at the start of works in consultation with the Engineer.

3. Samples shall be protected, handled and stored in such a manner that they are not damaged or contaminated and such that the properties of the sample do not change.

4. Samples shall be delivered by the Contractor, under the supervision of the Engineer, to the specified place of testing. Samples on which non-destructive tests have been carried out shall be collected from the place of testing after testing and delivered to the Site or other locations as instructed by the Engineer.

5. Samples which have been tested may be incorporated in the Permanent Works provided that:

   (a) the sample complies with the specified requirements;

   (b) the sample is not damaged; and

   (c) The sample is not required to be retained under any other provision of the Contract.

6. Additional samples shall be provided for testing if in the opinion of theEngineer:

   a. Material previously tested no longer complies with the specified requirements; or

   b. Material has been handled or stored in such a manner that it may not comply with the specified requirements.

7. The Contractor shall be responsible for all on-site and off-site testing and for all in-sit testing. All appropriate laboratory tests shall be carried out in the Contractor's laboratory, unless otherwise permitted or required by the Engineer. Where the laboratory is not appropriately equipped and/or staffed for some tests, or if a Notice has been issued by the Engineer, tests may be carried out in other laboratories provided that:

   a. they are accredited for the relevant work to a standard acceptable to the Engineer; and

   b. Particulars of the proposed laboratory are submitted to the Engineer for a Notice.

8. Unless agreed otherwise by the Engineer in-situ tests shall be done in the presence of the Engineer.

9. Equipment, apparatus and materials for in-situ tests and laboratory compliance tests to be carried out by the Contractor shall be provided by the Contractor. The equipment and apparatus shall be maintained by the Contractor and shall be calibrated before the testing starts and at regular intervals as permitted by the Engineer. The equipment, apparatus and materials for in-the situ tests shall be removed by the Contractor as soon as practicable after the testing is complete.

10. The Contractor shall be entitled in all cases to attend the testing carried out in the Employer's or other laboratories, to inspect the calibration certificates of the testing machines and to undertake the testing on counterpart samples. Testing of such samples shall be undertaken in laboratories and particulars of the laboratory proposed shall be submitted to the Engineer for his Notice of No Objection prior to the testing.

11. Attendance on tests, including that by the Engineer, Contractor and Designer, shall be as laid down in the Quality Assurance procedures.

D 12.4 Compliance of Batch

1. The results of tests on samples or specimens shall be considered to represent the whole batch from which the sample was taken.

2. A batch shall be considered as complying with the specified requirements for a material if the results of specific tests for the specified properties comply with the specified requirements for the properties.

3. If additional tests are permitted or required by the Engineer but separate compliance criteria for the additional tests are not stated in the Contract, the Engineer shall determine if the batch complies with the specified requirements for the material on the basis of the results of all tests, including the additional tests, for every property.

D 12.5 Records of Tests

1. Records of in-situ tests and laboratory compliance tests carried out by the Contractor shall be kept by the Contractor on the Site and a report shall be submitted to the Engineer within seven (7) days, or such other time stated in the Contract or in the Quality Assurance Programme, after completion of each test. In addition to any other requirements, the report shall contain the following details:

   (i) material or part of the Works tested;
   (j) location of the batch from which the samples were taken or location of the part of the Works;
   (k) place of testing;
   (l) date and time of tests;
   (m) weather conditions in the case of in-sit tests;
   (n) technical personnel supervising or carrying out the tests;
   (o) size and description of samples and specimens;
   (p) method of sampling;
   (q) properties tested;
   (r) method of testing;
   (s) readings and measurements taken during the tests;
   (t) test results, including any calculations and graphs;
   (u) specified acceptance criteria; and
   (v) Other details stated in the Contract.

2. Reports of tests shall be signed by the Project Manager or his assistant, or by another representative authorized by the Contractor.

3. If requested, records of tests carried out by the Engineer shall be given to the Contractor.

D 12.6 Production Tests (At Factory)

1. Should the Works include any Track component not previously proven in service the Contractor shall undertake a thorough testing of the same at pre-production stage to the satisfaction of the Engineer. The Contractor shall identify any component in this category that differs significantly from that already in service elsewhere. . The contractor will also arrange for factory visit by Employer representative / Engineer

2. All P-Way materials, components, sub-assemblies, unit assemblies shall be subject to testing and certification. Notification of these tests shall be submitted to the Engineer thirty (30) days in advance of carrying out any tests. The Engineer will then determine which items, if any, may be accepted based on previous supply or experience.

3. Factory Tests shall include but not be limited to:

   a Physical inspection
   b Dimension check
   c Output check
   d Operational performance
   e Full Load test
   f Flash-over test
   g Insulation test
   h Soak test
   i Non-destructive test to assess integrity or strength of parts

4. Where processor based equipment is to be used then the Manufacturing Test shall include also verification of software used in this application.

D 12.7 Post Installation Tests (Onsite)

1. During and on completion of the installation, the Contractor shall undertake test in a progressive sequence and in accordance with the overall testing programme. These tests shall culminate in functional tests to verify the correct operation of all Track components and, where appropriate, correct response to the respective function.

2. Following satisfactory completion of these Tests, the Contractor shall prepare the installation for official demonstration in the presence of the Engineer.

D 12.8 Acceptance Tests

1. The Contractor shall prepare and organize a comprehensive programme of acceptance Tests to demonstrate to the Engineer that all Track Components and equipment's defined under the Contract meet the specified performance requirements in all respects.

2. These Tests shall be conducted by the Contractor in the presence of the Engineer.

D 12.9 Integrated System Tests

The Contractor shall submit to the Engineer requirements and procedures, in respect of the Contractor's scope of work for Integrated Track System Tests in conjunction with the Interfacing Contractors to demonstrate that the complete Track structure provided under the Contract is fully operational and meets the specified performance criteria. The conducting of these Integrated System Tests, by the Contractor and the Interfacing Contractors, shall include a period of Test running.

D 12.10 Trial Running

1. Following satisfactory completion of the acceptance Tests and the Integrated System Test the Employer will commence an extended period of trial running to prove all technical systems of Track are in operation, to the satisfaction of the CRS, and to allow all technical systems to settle and to train staff in working procedures.

2. The Contractor shall allow for attendance in respect of the Contractor's scope of work over the whole of this period, which may be expected including maintenance and repair activities and also further opportunity for technical staff training.

D 13 RECORDS

D 13.1 Drawings Produced by the Contractor

(1) Drawings produced by the Contractor including drawings of site layouts, Temporary Works, etc., for submission to the Engineer shall generally be to ISO A1 size. They shall display a title block showing the information detailed in Appendix 7 of this Part 2, section VI. The number of copies to be submitted to the Engineer shall be as stated in the Contract, or as required by Engineer.

D 13.2 Progress Photographs

(1) The Contractor shall provide monthly progress photographs which have been properly recorded to show the progress of the Track Works to the Engineer. The photographs shall be digital and taken on locations agreed with the Engineer to record the exact progress of the Works. The number and size shall be as required in Appendix 5 of this Part 2, section VI.

(2) The Contractor shall mount each set of each month's progress photographs in a separate album of a type to which the Engineer has given a Notice, and shall provide for each photograph two typed self-adhesive labels, one of which shall be mounted immediately below the photograph and one on the back of the photograph. Each label shall record the information detailed in Appendix 5 of this Employer’s Requirements.

(3) All photographs shall be taken by a skilled photographer using a digital single- lens reflex camera of at least 6 megapixels, whose name and experience shall be submitted to the Engineer for his Notice of No Objection. Processing shall be carried out by a competent processing firm to the satisfaction of the Engineer.

(4) The Contractor shall ensure that no other photography is permitted on the Site without a Notice from the Engineer. The Contractor should be aware of the local regulations and conditions with regard to Photography in some "RESTRICTED AREAS' in Mumbai

D 13.3 Records of Wage Rates

The Contractor shall keep monthly records of the average, high and low wage rates for each trade/tradesman employed on the Site and records shall be made available to the Engineer during inspection.

D 14 MATERIALS

(1) P.Way Materials and other Components for inclusion in the Permanent Way Track Works shall be new unless the Engineer has issued a Notice otherwise. Preference shall be given to local materials where available..

(2) Certificates of tests by manufacturers which are to be submitted to the Engineer shall be current and shall relate to the batch of P.Way material delivered to the Site. Certified true copies of certificates may be submitted if the original certificates could not be obtained from the manufacturer.

(3) Parts of materials which are to be assembled on the Site shall be marked to identify the different parts.

(4) P.Way Materials which are specified by means of trade or proprietary names may be substituted by materials from a different manufacturer which have received a Notice from the Engineer, provided that the materials are of the same or better quality and comply with the specified requirements.

(5) Samples of materials submitted to the Engineer for information or Notice shall be kept on the Site by the Contractor in a secure dry storage room and shall not be returned to the Contractor or used in the Permanent Track Works unless the Engineer has issued a Notice of No Objection. The samples shall be used as a means of comparison which the Engineer shall use to determine the quality of the materials subsequently delivered. Materials delivered to the Site for use in the Permanent Track Works shall be of the same or better quality as the samples which have received a Notice.

D 14.1 Provision ofBallast for Ballasted Track:

(1) The Contractor shall be responsible for the provision of submitting the sample of ballast required required for the Track Works and test results., A Notice of No Objection will only be given after the Contractor has provided evidence that the Contractor is legally authorized to extract material from the source.

D 15 PROVISIONS FOR INTERFACING WITH OTHER CONTRACTORS

(1) The Contractor shall carry out all reasonable Track works, necessary for the project in coordination of the Interfacing Contractors in terms of Appendix 19 System Interface Management at Design Construction, Testing and Commissioning stage. These works shall include, but not be limited to, Joint setting of Points and Crossing with Signaling, drilling holes, casting plinths, casting in components and forming holes in pre-cast elements etc...

(2) The Contractor shall make all reasonable provisions to accommodate the fastenings, fittings and fixings of the Interfacing Contractors. Such provisions will be notified by the Interfacing Contractors and the Engineer during design interface. The interface responsibilities of the Contractor and the Interfacing Contractors are identified at Appendix 19 of this Part 2, section VI.

(3) Contractor

(a) Prior to handing over areas of the site to the Interfacing Contractors who have requested such, the Contractor shall perform the following tasks:

i. Identify all the Interfacing Contractors and agencies requesting areas of the site and meet with each of them to fix and agree on their request (area size, duration required, services, special requirements, access to track, access to road, etc.) Refer to Part 2, section VI appendix 2A for minimum requirements.

ii. Prepare the arrangements of the site as necessary, for concerned technical staff, machinery and other equipment's required for the joint working with Interfacing Contractors.

(b) Each Interfacing Contractor shall take over responsibility of the safety and security of its own work area as well as other structures within.

(4) The Employer and Engineer will hold Project Quarterly Review Meetings (QRM) at three monthly intervals. The Contractor shall attend these QRM and shall report the progress of his works and the state of his interface with other Interfacing Contractors and shall provide the Engineer with the necessary assistance and information for conducting the QRM. Refer to Clause A18 of Sub-division A of these Employer's Requirements.

D 16 RESTORATION OF AREAS DISTURBED BY CONSTRUCTION

1) Unless otherwise directed by the Engineer, any areas disturbed by the construction activity, either inside or outside the Project Right of Way or Site Areas, shall be reinstated as follows:

a) All areas affected by the construction work shall be reinstated to their original condition, or better, with new materials, including but not necessarily limited to, al structures, sidewalks, parking lots, access roads, adjacent roads, and

b) Adjacent properties and landscaping. Grass cover shall be provided for any bare earth surface areas, along with proper provisions for surface drainage.

c) Landscaping design must be submitted to the relevant authorities and match the remaining areas. In addition the Contractor shall carry out the design and construction for all works areas and will submit his proposals to the relevant authorities, having obtained approval before commencement of works.

D 17 ATTACHMENT D1

CONTRACTOR'S LABOUR CAMP

1. EMPLOYER WILL NOT PROVIDE QUARTERS FOR CONTRACTOR'SLABOUR

The Employer will not provide living accommodation for the use of the Contractor or any of his staff or labor employed on the Works. Living accommodation shall not be established on any land provided to the Contractor by the Employer.

2. PROVISION OF LABOUR CAMP

(1) If necessary the Contractor, shall, at his own expense, make adequate arrangements for the housing, supply of drinking water and provision of bathrooms, latrines and urinals, with adequate water supply, for his staff and workmen directly or through Sub-Contractors employed on the Works at the location authorized by the Engineer. No labor camp shall be allowed at any work site or any unauthorized place.

(2) The Contractor at his own cost shall maintain all campsites in a clean and sanitary condition. The Contractor shall obey all health and sanitary rules and regulations, and carry out at his cost all health and sanitary measures that may from time to time be prescribed by the Local/Medical Authorities and permit inspection of all health and sanitary arrangements at all times by the Employer, Engineer and the staff of the local municipality or other Authorities concerned. Should the Contractor fail to provide adequate health and sanitary arrangements these may be provided by the Employer and the cost recovered from the Contractor.

(3) The Contractor shall at his own cost, provide First Aid and Medical facilities at the Labor Camp and at work sites on the advice of the Medical Authority in relation to the experience, and number of the Contractor's staff and workmen, employed directly or through Sub-Contractors.

(4) The Contractor shall at his own cost, provide the following minimum requirements for fire precautions:

a. Portable Fire Extinguishers.
b. Manual Fire Alarms.
c. Water Supply for use by the Fire Service.

(5) The Contractor at his own cost shall provide necessary arrangements for keeping the camp area sufficiently illuminated to avoid accidents to the Workers. He should also ensure that electrical installations are done by Trained Electricians. These installations shall be maintained and daily maintenance records must be made available for inspection of the Engineer.

3. CAMP DISCIPLINE

1 The Contractor shall take requisite precautions, and use his best endeavors to prevent any riotous or unlawful behavior by or amongst his workmen, and others, employed directly or through Sub-Contractors. These precautions shall be for the preservation of the peace and protection of the inhabitants and security of property in the neighborhoods of the Works. In the event of the Employer requiring the maintenance of a Special Police Force at or in the vicinity of the site, during the tenure of the Work, the expenses thereof shall be borne by the Contractor and if paid by the Employer, shall be recoverable from the Contractor.

2 The sale of alcoholic drinks or other intoxicating drugs or beverages upon the Work, in any labor camp, or in any of the buildings, encampments or tenements owned or occupied by, or within the control of, the Contractor or any of his employees directly or through Sub-Contractors employed on the Work, shall be forbidden, and the Contractor shall exercise his influence and authority to secure strict compliance with thiscondition.TheContractorshallalsoensurethatnolabororemployeesare permitted to work at

the site in an intoxicated state or under the influence of drugs.

3 The Contractor shall remove from his camp such labor and their families, who refuse to accept protective inoculation and vaccination when called upon by the Medical Authority. Should Cholera, Plague or any other infectious disease break out, the Contractor shall at his own cost burn the huts, bedding, clothes and other belongings of, or used by, the infected parties. The Contractor shall promptly erect new huts on healthy sites as required by the Employer, within the time specified by the Employer, failing which the Work may be done by the Employer and the cost recovered from the Contractor.

4. LABOUR ACCOMMODATION

(1) The Contractor shall provide living accommodation that is equal to or exceeds the minimum criteria established in the following sub-sections, needed to house his staff, workers employed directly or through Sub-Contractors. The buildings shall be constructed so as to have a minimum life of not less than the length of the Contract.

(a) The roofs shall be watertight and laid with suitable non-flammable materials permissible for residential use under local regulations and for which a Notice from the Engineer has been obtained.

(b) Each hut shall have suitable ventilation. All doors, windows, and ventilators shall be provided with security leaves and fasteners. Back to back units must be avoided.

(c) The minimum height of each unit shall be 2.10m and shall have separate cooking place.

(d) Suitable number of common toilets/bath facilities shall be provided.

5. WATER SUPPLY

(1) The Contractor shall provide an adequate supply of water for the use of laborers in the Camp. The provision shall not be less than two gallons of pure and wholesome potable water per head per day for drinking purposes and three gallons of clean water per head per day for bathing and washing purposes. Where piped water supply is available, supply shall be at stand posts and where the supply is from wells or river, tanks of plastic, metal or masonry shall be provided. The Contractor shall also at his expense make arrangements for the provision and lying of water pipelines from the existing mains wherever available and shall pay for all the fees and charges therefore.

6. DRAINAGE

(1) The Contractor shall provide efficient arrangements for draining away spillage water so as to keep the camp neat and tidy. Surface water shall be drained away from paths and roads and shall not be allowed to accumulate into ditches or ponds where mosquitoes can breed.

7. SANITATION

(1) The Contractor shall make arrangements for conservancy and sanitation in the labor camps according to the rules and regulations of the Local Public Health and Medical Authorities.

(2) The Contractor shall provide a sewage system that is adequate for the number of residents in the camp, and which meets the requirements of the Municipality Authorities.

MUMBAI METRO LINE 3

TENDER DOCUMENTS

Part 2

Section VI (1)

EMPLOYER'S REQUIREMENTS

GENERAL SPECIFICATION

SUB-DIVISION – E.

INSPECTION, TESTING AND COMMISSIONING

July 2019

TABLE OFCONTENTS

E1 INSPECTION, TESTING AND COMMISSIONING

1.1 General Requirements

1.1.1 All materials, goods, equipment and manufacturing processes for the Works shall be subject to inspection and the witnessing of tests in accordance with the Conditions of Contract and as stated in this Section E.

1.1.2 The Contractor shall perform an inspections and tests applicable to the Works and as required by the Specifications.

1.1.3 The Contractor shall provide all associated documentary records of completed tests.

1.1.4 The inspections and tests shall be divided into stages as follows:

1) Factory Acceptance Tests, carried out before shipping of equipment;
2) On Site Testing; and
3) Integrated Testing and Commissioning.

1.1.5 Unless agreed in writing by the Engineer. Key Personnel engaged on testing shall be suitably qualified and independent of those directly engaged in the design and installation of the same equipment.

1.1.6 The inspection and issuing of a Notice for work or equipment by the Engineer shall not relieve the Contractor from its obligations, responsibilities and liabilities to complete the Works in accordance with the Contract, nor relieve him of any of his obligations, responsibilities and liabilities under the Contract.

1.2 Test Plan

1.2.1 Within thirty (30) days of the Commencement Date, the Contractor shall present for a Notice from the Employer's Representative, a Preliminary Test Plan showing in as much detail as possible the tests anticipated to ensure a safe and reliable operation of the Works and the integration of the Works with the rest of the Metro Rail system, together with an indication of the periods in which the various stages of testing will be carried out.

1.2.2 The Preliminary Test Plan shall include lists of all Factory Acceptance Tests and on site tests.

1.2.3 The Preliminary Test Plan shall be amplified into a detailed Test Plan to be submitted for a Notice from the Employer's Representative, to include, but not be limited to, the following:

1) Identify the date on which the Contractor proposes to conduct each of these listed tests;
2) Describe the nature and purpose of each test;
3) State the location at which the test is to be conducted;
4) Identify the interfaces with the Civil Contractors and all Interfacing Contractors that require their attendance and/or support;
5) Identify the Contractor's requirements and schedule for the Engineer's staff to operate equipment during Integrated Testing and Commissioning and Trial Running.
6) Commissioning plans; and
7) Integrated Testing and Commissioning schedule

1.2.4 The Test Plan shall be subject to approval and/or comment by the Commissioner and any additional tests and/or trials specifically ordered by the Commissioner shall also be carried out by the Contractor, at the Contractor's cost.

1.3 Test Procedures

1.3.1 The Contractor shall give the Engineer a minimum of Thirty (30) days' notice in writing of all required inspections and tests for factory acceptance test and 15 days' time for other tests as given in clause E1 1.1.4, giving details of the exact date, time and place

of inspections and tests as well as other necessary information such as anticipated time.

1.3.2 Test procedures shall show unambiguously:

1) the extent of testing covered by each submission;
2) the method of testing and test requirements;
3) the relevant drawing (or modification) status, iv) the location of testing;
4) the safety management during test;
5) test personnel qualification requirement;
6) test parameters to be measured;
7) constraints to be applied during the test;
8) defined pass/fail criteria;
9) format of the raw data for processing by the Contractor;
10) certificated test instrumentation and test circuitry to be used during the test;
11) pro-forms to facilitate easy manual handwritten entries during the execution of the tests; and
12) Consequential procedure or action when test is failed.

1.3.3 Test procedures shall be amended during the duration of the Contract to reflect changes in design *or* the identification of additional testing requirements.

1.4 Costs of Testing

1.4.1 All costs associated with testing, including electrical power costs up to commencement of Trial Running, shall be borne by the Contractor, including the services of any specialized personnel or independent assessors, which may be required.

1.4.2 Should an agreed test not be feasible as proposed due to lack of preparation, negligence or material and/or equipment being presented in a state which is clearly not acceptable, all costs incurred by the Engineer for repeated inspections and/or witnessing shall be borne by the Contractor.

1.5 Equipment for Testing

1.5.1 Equipment, apparatus and materials for in-situ tests and laboratory compliance tests shall be provided by the Contractor.

1.5.2 The equipment and apparatus shall be properly maintained by qualified staff and shall be calibrated before testing starts and at regular intervals as agreed by theEngineer.

1.5.3 The equipment, apparatus and materials for in situ tests shall be removed by the Contractor as soon as practicable after testing is complete.

1.5.4 All test equipment shall carry an appropriate and valid calibration label.

1.5.5 The copy of certification report of test equipment shall be attached with test reports.

1.6 Use of Outside Laboratory

1.6.1 The Contractor shall be responsible for all on-site and off-site testing and for all in situ testing.

1.6.2 All appropriate laboratory tests shall be carried out in laboratories selected by the Contractor provided that they are accredited for the relevant work and given a Notice by the Engineer.

1.7 The Engineer Attendance at Tests

1.7.1 The Engineer may or may not attend any scheduled tests, solely at his discretion.

1.7.2 The Contractor shall ensure that all Inspections and tests are carried out in the presence of, and supervised by, the Contractor's Quality Assurance team. Contractor shall forward to the

Engineer, copies of the inspection and test results, reports and/or readings.

1.7.3 The Contractor shall proceed with the shipment of the manufactured equipment upon satisfactory completion of the inspections and tests.

1.7.4 The Contractor shall be fully responsible for any rescheduling of inspections and tests where the Engineer is unable to attend for whatever reason.

1.8 Records of Tests

1.8.1 Within 10 days after completion of any individual test, all necessary information regarding the test shall be submitted in a report for the Engineer Notice.

1.8.2 When the test procedure is such that a manuscript copy of the test record is made at the time of the test, a copy shall be given to the Engineer at that time or at the earliest opportunity, but definitely within 3 days of the test, if the test has not been witnessed by the Engineer.

1.8.3 On completion of each test or group of tests, the Contractor shall provide a test report within 10 days detailing:

1) The numbers and types of tests which are required by the Specification and the results to be achieved;
2) The tests actually carried out and the results actually achieved; and
3) Confirmation of pass and failure, with if necessary, a schedule of further tests or actions to be carried out by the Contractor lo ·achieve compliance with the Specification and design documents.

1.8.4 In addition to any other requirements, the test report and its supporting documentation are to be retained by the Contractor, which shall be available for the Engineer's inspection and/or audit at any time, and shall contain the following details:

(1) Material or part of the Works tested;
(2) Location and size of the batch from which the samples were taken or the location of the part of the Works;
(3) Reference to test procedures and test schedules;
(4) Place of testing;
(5) Date and time of tests;
(6) Weather conditions in the case of onsite tests;
(7) Technical personnel supervising and/or carrying out the tests with their signatures
(8) Interface partners providing attendance and/or witnessing the tests with their signatures;
(9) Properties tested;
(10) Use of test equipment with copy of its ·certification report;
(11) Method of testing;
(12) Readings and measurements taken during the tests;
(13) Test results, Including any calculations and graphs;
(14) Specified acceptance criteria;
(15) Action when test is failed; and
(16) Other details required by the Contract.

1.8.5 All test reports shall be signed by the Contractor and shall include copies of the actual handwritten results using the Performa from the test procedures.

1.8.6 Subsequent computer entry of previously handwritten results will not be acceptable. Computer generated data will only be permitted where automatic data logging has been necessary to carry out the test and is required in the test procedure, which has received a Notice from the.

1.8.7 If the Engineer objects to the content of any results, records or reports, the Engineer shall notify the Contractor in writing of such objection within 21 days from the date of receipt of- the testing data and any associated analytical reports.

1.8.8 In the event that the Engineer 'and the Contractor are unable to resolve a disagreement regarding the content of any record or report, the Engineer and the Contractor shall appoint an independent party to submit a report on the content of any such record or report.

1.8.9 This appointment shall be the subject of prior mutual agreement by the Engineer and the Contractor; if no agreement can be made then the Engineer shall appoint the Independent party.

1.8.10 The cost of such an independent party investigation shall be borne by the Contractor The results of the test report, as issued by the independent party, shall be deemed to be final and binding on all parties and shall settle the dispute for the purposes of this Contract.

1.9 Inspection and/or Witnessing of Tests during Manufacture and Assembly

1.9.1 The Contractor shall provide access for the Engineer to monitor all tests and have access to all test records at any time.

1.9.2 Ample time shall be allowed within the test plan for necessary alterations to equipment, systems and designs to be undertaken together with retesting prior to final commissioning.

1.9.3 All tests shall be carried out by the Contractor in the presence of, and supervised by, the Contractor's QA/QC team. The Engineer may attend, at his discretion.

1.9.4 The Engineer shall provide adequate notice ·for such inspections and access shall be made available by the Contractor, at his cost.

1.9.5 The Engineer shall have the right to request the Contractor to perform additional testing and/or retesting where the results of the original tests are unsatisfactory, Incomplete, corrupted, inconclusive or demonstrate that the equipment or system under test failed to meet the requirements of the Contract, and that all costs associated with such retesting shall be the responsibility of the Contractor, Including any costs associated with the Engineer s attendance.

1.9.6 In accordance with the results, if necessary, ·the Contractor shall modify the relevant design, manufacturing and test procedure for consequential works.

1.10 Type Tests or Qualification Test

1.10.1 If the Contractor includes any equipment or function which has not previously been proven in service, the Contractor shall undertake thorough type testing of preproduction units, in order to obtain a Notice from the Engineer.

1.10.2 The Contractor shall identify in its design submissions *any* equipment or function in this category, or equipment that differs significantly from that already in service elsewhere, for the issuance of a Notice from the Engineer .

1.10.3 Type tests shall be carried out on specific items to ensure that they perform their intended functions when subjected to all permutations and combinations of external conditions as defined in their design criteria.

1.11 Factory Acceptance Tests

1.11.1 All materials such as Rails, Fastening System, Twin block, resilient material etc., components, subassemblies, unit assemblies,) shall be subject to factory acceptance tests.

1.11.2 Notification of these tests shall be submitted to and as requested by the Engineer thirty (30) days in advance of the carrying out any test, together with information on any previous testing which relates to the items being tested.

1.11.3 The Engineer will then determine whether to witness such tests or which, if any, items may be accepted based on previous supply or experience.

1.11.4 Factory acceptance tests shall be comprehensive tests to verify that the manufactured equipment fulfils the Contract requirements, including, but not limited to, the following:

(1)Physical inspection;
(2) Dimension check;
(3) Electrical check;
(4) Calibration;
(5) Interface check including input, output and protocol when necessary; and
(6) Operational performance including full functional testing to the Approved design documents.

1.12 On Site Testing

1.12.1 During and on completion of installation, the Contractor shall undertake onsite testing of all material in a progressive sequence and In accordance with the overall testing programme.

1.12.2 All onsite testing is to be carried out under the overall supervision and control of the Contractor's QA/QC & Engineer team with all required skilled labor force & measurement equipment's for measuring the onsite Track parameters, which may be monitored and audited by the Engineer.

1.12.3 The Contractor shall provide the Engineer with all details of its test requirements and schedule for the testing of the Works. The Contractor's QA/QC Manager and the Chief Interface Co-ordinate shall also manage and coordinate these requirements with all Interfacing Contractors, with the assistance of the Engineer, if necessary.

1.12.4 Should a defect be found in the Works during one of the tests, the Contractor's QA/QC & Engineer team shall decide if the defect is a Minor Fault, or if it must be rectified before testing can be continued, otherwise the material will be replaced

1.12.5 On the basis of this information, the nature of the defect shall be explained in detail to the Engineer, for issue of a Notice for the continuation of the testing.

1.12.6 Following completion of these tests including retests following rectification of any minor faults, to the satisfaction of the Engineer, the Contractor shall prepare the Works for Integrated Testing and Commissioning.

1.13 Integrated Testing and Commissioning

1.13.1 The Contractor, in conjunction with all Interfacing Contractors, shall submit to. The Engineer for his Notice, the requirements and procedures for Integrated Testing and Commissioning.

1.13.2 These tests are to clearly demonstrate that the completed Works are fully operational, meet the specified performance criteria, function In a coordinated and Integrated manner with each other and with the works provided by all Interfacing Contractors and operate Without any adverse effects on the surrounding environment.

1.13.3 The content of these Integrated System Tests shall include a period of test running.

1.13.4 Integrated Testing and 'Commissioning shall begin after complete subsystem testing has been carried out on all subsystems and defects found have been rectified, and a Notice issued by the Engineer.

1.13.5 The Contractor shall prepare and submit to the Engineer for a Notice, the procedures it proposes to adopt to test the interfaces and compatibilities between all subsystems.

1.13.6 In particular Integrated Testing and Commissioning shall include tests to demonstrate correct performance of the Works under worst case operational conditions.

1.13.7 The Integrated Testing and Commissioning period shall include sufficient time to rectify

and re-test any problem areas discovered without diminishing the time allowed for Trial Running.

1.14 Trial Running

1.14.1 Following completion of the Integrated Testing and Commissioning, for which the Engineer issued a Notice, and after all major defects found during the tests have been rectified, a three months period of Trial Running shall commence to demonstrate that the System can operate safely and reliably under simulated revenue service conditions.

1.14.2 During these tests all Interfacing Contractors, assisted by the Operator and the Maintenance Contractor, shall demonstrate that all procedures for normal, degraded and emergency operations and maintenance activities perform as expected with respect to the Works, and the Contractor shall be in attendance and take such actions as necessary to prove the design, integrity and safety of the Works.

1.15 Completion of Testing & Completion certificate

1.15.1 Upon successful completion of the integrated System Testing and Trial Running and demonstration of RAM requirement successfully as per Appendix 22, the Contractor shall apply for the Performance Certificate, in accordance with the Conditions of Contract.

1.16 RAMS Demonstrations

1.16.1 The requirements relating to Maintainability and Safety shall be demonstrated during the Trial Running

1.16.2 It is unlikely that the requirements relating to Reliability and Availability can be fully demonstrated during the Trial Running and these shall therefore be fully demonstrated throughout the Defect Liability Period

1.16.3 In conjunction with the Contractor's System Safety Plan, to which the Engineer has issued a Notice, the Contractor shall develop a Track Safety Case and submit for the Engineer's Notice.

1.16.4 RAMS cases shall include, but not be limited to, the following:

(1) demonstrations that representative elements of the track work system can be adjusted, repaired or changed within the non-service period available for maintenance;

(2) Identification of necessary materials, plant, facilities, resources, support equipment, Operator staffing and coordination Items.;

(3) Identification of administration and control during the period;

(4) Description of philosophy, policy, methodology and pass/fail criteria;

(5) Detail of procedures, data format to collect and analysis;

(6) Duly completed Forms as required by Appendix22

(7) Final conclusion and report for the demonstration.

Manpower plan required for maintenance,

1.16.5 On completion of Trial Running the Contractor shall deliver up to the Engineer copies of all manufacturing drawings, schedules and software for all components, as well as all As Built Drawings, for which the Engineer shall Issue a Notice.

Prior to commencement of Revenue Service the Contractor shall deliver up to the Engineer copies of all As-built drawings, as shall have been amended or updated since the completion of Trial Running of the Contract.

E2 MAINTENANCE

2.1 The Contractor shall provide a maintenance support plan that shall include such items as**:**
(1) Procedures periodical maintenance & inspection
(2) Technical manuals,
(3) Training requirements,
(4) Procedures for removal and replacement of components,

E3 MANUALS

The Manual will be provided as per Clause A16 (4) of Section VI(1) A

E4 SUPPLY OF SPARES, SPECIAL TOOLS AND TESTING EQUIPMENT

4.1 Definition of Spare Parts and Consumables

4.1.1 Consumables mean all parts or materials that have a known short life expectancy or the material is consumed (such as welding portions and lubricating oils).

4.1.2 Spares mean all parts that may fail in a random manner (such as rail clips) where the failed item may be replaced by a new one taken from stock.

4.1.3 Spare parts also includes "emergency spares" for items where no failures are predicted in the lifetime of the system but which may be rendered unusable through accidental damage or other external influence and where such failure would seriously impact track structure

4.2 Scope of Supply

4.2.1 A stock of permanent way materials will be supplied under the Contract as per Schedule 1 & 2 of Section IVB – Pricing document, which together with any materials remaining surplus at completion of the track work construction and installation, will be held by the Employer's Maintenance Contractor as spares.

4.3 Quantities of Spare Parts and Consumables

4.3.1 The estimate shall contain the following information as a minimum:

(i) Names, addresses, telephone numbers and other particulars of manufacturers and their local representatives;
(ii) Type Number, Serial Number (where appropriate) and Drawing Numbers;
(iii) Full description of spares including a note whether it is sealed unit or an assembly or sub-assembly which can be broken down into component parts;
(iv) Quantity installed in the system;
(v) Expected consumption rates;
(vi) Overall dimensions and weight including minimum packing (if any) for storage space purposes;
(vii) Interchangeability or otherwise with similar parts;
(viii) Normal manufacturing and shipment lead times; and
(ix) Shelf life.

4.4 Special Tools, Testing and Diagnostic Equipment's:

4.4.1 The Contractor shall provide adequate sets of Special Tools, Testing and Measuring Equipment required during maintenance. The list of such equipment, together with the details and description of such equipment, shall be included in the technical package of the Tender submission. The List shall cover the minimum requirements which should be supplied by the contractor as listed out in Appendix 25.

4.4.2 All items of Special Tools and equipment supplied by the Contractor, shall be accompanied by all necessary drawings, manuals and full operating instructions to enable them to be used by suitably skilled (but not necessarily specially trained) personnel in a non-hazardous manner and to achieve the desired result in terms of accuracy and quality. Each set of equipment will be provided with individual sets of these drawings, manuals and full operating instructions.

E5 TRAINING AND TRAINING AIDS

5.1 Training Objective

The Contractor shall be required to arrange training to the Employer's staff in respect of design, manufacture, construction, and equipment provided under the Contract. The Employer's staff will include management, operation, technical and instructional personnel. The Contractor shall train, or shall arrange training for, the Employer's staff who shall be nominated by the Employ.er.

The Contractor shall train the Employer's Staff as follows:

(1) In sufficient detail so that the staff can appreciate, understand and monitor the technical, operational, maintenance aspect of the track structure.

(2) Thoroughly so that the staff can maintain the track structure.

The Contractor shall train or shall arrange training for the Employer's staff at all levels, covering all aspects of the operation, maintenance and management of the System.

Primary Importance is the training of Employer's Training Staff and staff responsible for Construction & Maintenance, These Employer's Training Instructors will also be responsible for Implementing on-the-job training and skill enhancement training programmes for the Employer's staff.

5.2 Training Periods

The Contractor shall propose appropriate man-months of training for all levels of the Employer's personnel, with a narrative explaining the reasons for each type and duration of training, which shall be submitted to the Engineer for a Notice. All training courses will be conducted in English and/or Hindi. Certain staff / Engineer will be trained in training institute etc. as given in Clause A16 of the Section VI (1)

5.3 Training Instructors

The training instructors provided by the Contractor shall be fully qualified and experienced engineers, who have a good knowledge of the English language. They will have had experience of training Engineers and technicians to the required level on similar topics and will be fully familiar with the Equipment supplied or installed.

Before any of-the Contractor's training instructors is appointed, the Contractor shall submit detailed curriculum vitae for each training instructor for a Notice from the Engineer.

Should, in the opinion of the Employer's Representative, any of the Contractor's training instructors not be considered to be competent or not to have suitable qualifications, experience, attitude or aptitude for carrying out the training courses for whatever reason, the Contractor shall remove the said person and replace him as soon as possible with an acceptable substitute.

Where training of the Employer's staff requires secondment to the Contractor, or his Sub-Contractors, all such trainees shall be properly supervised and monitored by a qualified training supervisor to ensure that each trainee has the best opportunity to benefit from the theoretical and practical experience.

5.4 Training Courses

The Contractor shall be responsible for the safety, health and welfare of trainees when under training. Accordingly an explanation of the safety rules and codes shall form part of a general Induction course to be given by the Contractor and where necessary the Contractor shall issue a rule book for which the trainee shall sign indicating his acceptance and understanding thereof.

The Contractor shall provide a training plan that shall include as a minimum

(1) Schedule of training course;
(2) Objectives;
(3) Syllabus;
(4) Format of course;
(5) Training facilities required or to be provided;
(6) List of training materials and documentation;
(7) Examination procedures;
(8) Training Instructors' qualifications; and
(9) Course evaluation methods.
(10) Training Institute where training to be provided.

The Contractor shall make full and appropriate use of multi-media and computer techniques in the design and delivery of training packages. This shall include all necessary teaching aids as well as technical literature, manuals, photographs, drawings, video and films, models and all other Instructional materials as may be necessary for the training of the personnel. Such materials, other than videos, films and reproducible materials prepared specifically for the trainees shall be retained by the Contractor at the end of each training programme.

The Contractor shall provide all training material that shall include as a minimum:-

(1) Course agenda;
(2) Objectives;
(3) Lesson plans;
(4) Outline presentations;
(5) Equipment Software manuals.
(6) Training aids including that on the video film media; and
(7) Computer based training requirements

5.5 Training Methods

5.5.1. As a general guide training shall be based upon a "two-stage" concept:

5.5.2. Stage one shall consist of training in the basic concepts and principles. These shall include system configuration and specification, preventive maintenance procedures and repair concepts, trouble shooting and emergency procedures. The training shall consist of class room (theory) training; computer based inter-active training and mock-up training (where required).

5.5.3. Stage two shall consist of "hands-on" site-based practical training on preventive and corrective maintenance, including safety and operating procedures.

5.5.4. The Contractor shall also include the training of the staff in the correct procedures of maintenance and repair of different equipment based on the Training Manual supplied against the contract.

5.6 Training Equipment

In general, the Contractor shall use Equipment specifically set aside for training purposes. However, he may use, for the training of the Employer's staff, subject to a Notice from the Engineer , Equipment being installed, tested or commissioned when no other such Equipment is available. The Contractor shall not use spare parts from assemblies for this purpose.

Any special or protective clothing required by the trainees shall be provided by the Contractor, free of charge.

Personal items of clothing shall be of new issue and will be retained by the trainee on completion of the training course.

5.7 Monitoring

Throughout the training programmes, the Employer and the· Engineer shall have free access to all training sessions to monitor the progress of the trainees and the Contractor's training instructors.

To ascertain that the objectives of the courses have been achieved, the Contractor shall set periodical theoretical and practical tests for the trainees. The results of these tests together with a report on the trainees' general attitude; ability, technical knowledge, and aptitude and attendance record shall be forwarded at regular intervals to the Employer, who may also require the submission of additional reports in special cases.

Methods for monitoring progress shall include; but will not necessarily be limited to:

(1) Theoretical tests and systems of assessment;
(2) Practical test pieces and objective systems of assessment:
(3) Progress reports.

Records of the· progress of trainees shall be kept up-to-date and shall be made available to the Employer and/or Engineer for examination when required.

Copies of the records of individual trainees showing all test results and reports of progress shall be sent to the Employer and tl.1e Engineer on completion of each training course.

5.8 Training Location and Facilities

The training shall be carried out at such locations where the greatest benefit for trainees may be gained. This may be in India, abroad, at places of manufacture, assembly or testing, or at such other locations as may be necessary. All places of training shall be subject to the Engineers Notice. Details of the facilities to be· provided shall be included with the detailed training programmes submitted by the Contractor.

5.9 Training Manual

The Contractor shall to provide one colored original and five colored copies of the Training Manual for use by the Employer' for conducting in-house training. The Manuals shall cover all requirements specified in the Contract.

5.10 Administration

The Contractor shall:

(1) Be responsible for the reception of, and hotel and travel arrangements for the Employer's and Engineer 's monitoring staff and trainees, whether in India or any other country, including all costs and expenses associated with such.

(2) Be responsible for the general welfare of trainees under his control.

5.11 Transfer of Training Aids

After completion of the training, all training aids and materials used shall become the property of the Employer to enable further training to take place.

E6 PACKAGING, STORAGE, SHIPPING AND DELIVERY

6.1 Storage, Packing and Protection of Equipment

6.1.1 The Contractor shall be fully responsible for the provision and maintenance of acceptable storage facilities for the materials or equipment to be used for the carrying out of the Works.

6.1.2 All equipment shall be delivered to the Site in new condition, properly packed and protected against damage due to handling, adverse weather or other circumstances and, as far as practicable, shall be kept in packing cases and/or under protective coverings until required for use.

6.1.3 All packaging procedures shall be submitted to the Engineer for notice.

6:1.4 all empty cases, materials, crates, or packages shall be removed from the Site by the Contractor within 1 week of their being emptied.

6.1.5 Spare parts shall be suitably packed for storage without deterioration and shall be clearly identified, showing the following information, without any need to unwrap the packaging:

(1) Ownership
(2) Shelf life.
(3) Type of storage.
(4) Description of item and part number.
(5) Serial number if applicable
(6) Inspection certificate number and batch number; that is the number allocated by the Contractor's Inspector at the time of manufacture or packing.

6.1.6 Each case, crate or package shall be of robust construction and suitable for the intended purpose. Packaging materials those are likely to suffer deterioration in quality as a result of exposure to environmental conditions, likely to be met during transit from the factory of origin to the Site, or during storage, shall not be used.

6.1.7 The contents of each case, crate or package shall be protected against the harmful effects of ingress of water by enclosing them within a heavy duty waterproof membrane, and adding a suitable desiccant substance (e.g. Silica gel) to the case, crate or package.

6.1.8 Each case, crate or package shall be clearly and indelibly marked with the address, Contract number, the Employer's name, 'right way up', opening points and other markings as necessary to permit materials to be readily identified and handled during transit and when received at Site.

6.1.9 Each case, crate or package shall contain a comprehensive packing list showing the delivery number, numbering of the batch, mark, size, weight and contents together with any relevant drawings.

6.1.10 A second copy of the packing list shall be enclosed in a watertight enclosure on the outside of each case, crate or package. Distribution of additional copies of each packing list shall be in accordance with the requirements of the Employer.

6.1.11 all items heavier than 100 kg shall be marked on the outside of the case to show the gross and net weights, the points for slinging and where the weight is bearing.

6.1.12 Care shall be taken to prevent movement of ·equipment within containers by the provision of bracing, straps and securing bolts as necessary.

6.1.13 Bags of loose items shall be packed in cases and shall be clearly identified by well secured metal labels on which the quantity and name of the part and its index or catalogue number have been stamped.

6.1.14 Details of cases, crates, packages, containers, etc., intended to hold important or valuable or delicate items of equipment or materials shall be submitted to the Engineer for a Notice,

6.1.15 The Contractor shall prepare, protect and store, in a manner acceptable to the Employer, all equipment and materials so as to safeguard them against loss or damage from repeated handling, climatic influences and all other hazards arising during shipment or storage on or off the Site.

6.1.16 Secure and covered storage shall be provided by the Contractor for all equipment and materials except as otherwise agreed by the Engineer as being suitable for open storage.

6.1.17 The Contractor shall accomplish necessary and periodical maintenance activities to ensure all equipment in storage will remain fit for use.

6.1.18 The Contractor shall suitably protect, encase or cover up, as may be appropriate, all new plant and equipment against damage due to building operations, adverse weather or other causes up to the start of Revenue Services.

6.2 Equipment Identification and Labelling

6.2.1 The Contractor shall indelibly label all equipment and materials of the Works to show, as a minimum, its identity, type, version, and function.

6.2.2 In general, all labels shall be in Hindi and English language. Where appropriate, such labels shall conform to accepted national or international standards.

6.2.3 Equipment identification and rating labels may be in English only where the equipment is only accessible to authorized maintenance staff.

6.2.4 All labelling shall correspond to the Schedules and diagrams to be provided as part of the As-Built Drawings.

6. 2.5 Identification and labelling shall be In accordance with Appendix 10, as well as the Employer's Asset Management Scheme.

6.3 Shipping

6.3.1 The Contractor shall notify the Engineer ten days in advance of any expected shipment

date and give further notification of the actual shipment date and routing when such information is subsequently established. This shall complement the inspection requirements prior to delivery as specified herein.

6.3.2 Two copies of packing lists and quality certificates shall be· attached to each case or package to be shipped. A copy of packing lists and quality certificates shall be sent to the Engineer after each package for the Works, the equipment, spare parts and other items to be shipped have been shipped.

6.3.3 The Contractor shall clear the Works to be supplied under the Contract through Mumbai customs/Indian sea port in accordance with all Government of India Enactments. The Employer shall provide all support for the clearance.

6.4 Delivery

6.4.1 The Contractor shall deliver all equipment, plant and materials for the Works, and all items to be supplied under the Contract, to the Site.

6.4.2 The Contractor shall unload all equipment, plant and materials for the Works and all items to be supplied under the Contract at the designated delivery point for use or storing them.

6.4.3 Any part of equipment, plant and materials for the Works or any item to be supplied under the Contract that is damaged in transit shall not be considered as delivered until repairs or replacements have been made and all necessary spare parts or items have been delivered to the Site.

6.4.4 All documents, manuals, drawings and other deliverables shall be delivered to an address to be designated by the Employer ·or the Engineer in writing.

6.4.5 The Contractor shall store and secure all equipment, plant, spare parts and other items until the same have been inspected and are considered delivered at the designated point by the Engineer .

6.4.6 The Contractor shall remove temporary fittings required for shipment and re- assembly of equipment and shall complete this prior to the equipment or parts thereof being inspected and before they are considered delivered

6.4.7 An item shall be considered delivered when all damage has been repaired and all documentation and post-delivery preparation have been completed to the satisfaction of the Engineer.

Mumbai Metro Rail Line 3

BIDDING DOCUMENTS

EMPLOYER'S REQUIREMENTS

GENERAL SPECIFICATIONS

Part 2

Section VI (1)
Sub-Division F

APPENDICES LIST

July 2019

APPENDICES

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APPENDIX 2B	CONTRACT KEY DATES AND ACCESS DATE
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APPENDIX 4	PROJECT CALENDAR AND PROGRAMME REQUIREMENT.
APPENDIX 5	MONTHLY PROGRESS REPORTS.
APPENDIX 6	QUALITY ASSURANCE.
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APPENDIX 9	RAILWAY ENVELOPE ACCESS AND TAKING OVER.
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MUMBAI METRO LINE 3
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EMPLOYER'S REQUIREMENTS
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Part 2

Section VI (1)
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Appendix 1

Tender Drawings List

July 2019

List of Tender drawings

SR.NO	DRAWING NO.	DRAWING TITLE			
I. GENERAL DRAWING LIST					
1		TRACK WORKS BOUNDARY 10B& 10 C PACKAGES MML3 (TRACK FROM)			
2		SCHEMATIC TRACK LAYOUT.			
3		WORK AREA FOR TRACK WORK PACKAGE 5 (10B& 10C)			
4		WORK AREA FOR TRACK WORK PACKAGE 6 (10C)			
5		WORK AREA FOR TRACK WORK PACKAGE 7 (10C)			
6		AREA DISTRUTION FOR DEPOT WORK PRIORITY			
7		TRACK FORM ADOPTED IN MUMBAI METRO LINE-3			
II. ALIGNMENT-(HORIZONTAL & VERTICAL)					
S.NO	**DRAWING NO**	**CHAINAGE**		**REVISION**	**DRAWING TITLE**
		FROM	**TO**	**REV**	
UGC-05 (SHEET 2 TO 7)					
1	MM3-GC-AL-GD-5020002	20600	20880	R4	HORIZONTAL & VERTICAL ALIGNMENT
2	MM3-GC-AL-GD-5020003	20880	21620	R4	BKC STATION
3	MM3-GC-AL-GD-5020004	21620	22360	R4	HORIZONTAL & VERTICAL ALIGNMENT
4	MM3-GC-AL-GD-5020005	22360	23100	R4	VIDYA NAGARI STATION
5	MM3-GC-AL-GD-5020006	23100	23840	R4	SANTA CRUZ STATION
6	MM3-GC-AL-GD-5020007	23840	24392	R5.1	MID VENTILATION SHAFT
UGC-06 (SHEET 1 TO 6)					
1	MM3-GC-AL-GD-6020001	24500	25220	R5.2	HORIZONTAL & VERTICAL ALIGNMENT
2	MM3-GC-AL-GD-6020002	25220	25960	R5	CSIA DOMESTIC STATION
3	MM3-GC-AL-GD-6020003	25960	26700	R5	HORIZONTAL & VERTICAL ALIGNMENT
4	MM3-GC-AL-GD-6020004	26700	27440	R5	HORIZONTAL & VERTICAL ALIGNMENT
5	MM3-GC-AL-GD-6020005	27440	28180	R5.1	SAHAR ROAD STATION
6	MM3-GC-AL-GD-6020006	28180	28700	R5.1	CSIA INTERNATIONAL STATION
UGC-07 (SHEET 1 TO 6)					
1	MM3-GC-AL-GD-7020001	28800	29480	R5.2	HORIZONTAL & VERTICAL ALIGNMENT
2	MM3-GC-AL-GD-7020002	29480	30220	R5.2	MAROL NAKA STATION
3	MM3-GC-AL-GD-7020003	30220	30960	R5.2	MIDC STATION
4	MM3-GC-AL-GD-7020004	30960	31700	R5.2	MIDC STATION
5	MM3-GC-AL-GD-7020005	31700	32440	R5.2	SEEPZ STATION
6	MM3-GC-AL-GD-7020006	32440	33051	R5.2	HORIZONTAL & VERTICAL ALIGNMENT
DEPOT LAYOUT & AAREY STATION					
1	MM3-GC-DTR-GD-8-D03-2001-I			REV I	DEPOT LAYOUT & AAREY STATION

III. SPACE PROOFING DRAWINGS		
SL. NO.	**DRAWING NO.**	**DRAWING TITLE**
1.	MM3-GC-SP-GD-0222001	PROPOSED TANGENT TRACK TUNNEL INDICATIVE CSD WITHOUT CROSS PASSAGE
2.	MM3-GC-SP-GD-0222002	PROPOSED CURVED TRACK TUNNEL INDICATIVE CSD WITHOUT CROSS PASSAGE
3.	MM3-GC-SP-GD-0222003	PROPOSED TANGENT TRACK TUNNEL INDICATIVE CSD WITH INTERMEDIATE CROSS PASSAGE
4.	MM3-GC-SP-GD-0222004	PROPOSED CURVED TRACK TUNNEL INDICATIVE CSD WITH INTERMEDIATE CROSS PASSAGE
5.	MM3-GC-SP-GD-0222005	PROPOSED TANGENT TRACK TUNNEL INDICATIVE CSD WITH CROSS PASSAGE AND SUMP
6.	MM3-GC-SP-GD-0222006	PROPOSED CURVED TRACK TUNNEL INDICATIVE CSD WITH CROSS PASSAGE AND SUMP
IV PRELIMINARY TRACK STATION LAYOUT (SHOWING TURNOUTS)		
1.	MM3-GC-TR-GD-0 1010020	PRELIMINARY TRACK LAYOUT AT BKC STRATION
2.	MM3-GC-TR-GD-0 1010021	PRELIMINARY TRACK LAYOUT AT SAHAR ROAD STATION
3.	MM3-GC-TR-GD-0 1010022	PRELIMINARY TRACK LAYOUT AT AAREY STATION
V.TRACKWORK STRUCTURAL DRAWINGS ON MAINLINE		
1	MML3-TRW-DWG-GEN-0002	ABBREVIATION AND LEGENDS
2	MML3-TRW-DWG-GEN-0031	TYPICAL CROSS SECTION OF BOOTED TWIN BLOCK TRACK SYSTEM IN TUNNEL (STRAIGHT) – ATTENUATION LEVEL-2 (HA)
3	MML3-TRW-DWG-GEN-0032	TYPICAL CROSS SECTION OF BOOTED TWIN BLOCK TRACK SYSTEM IN TUNNEL (CURVE R 50ORN) – (WITHOUT DERAILMENT GUARD) HIGH ATTENUATION (HA)
4	MML3-TRW-DWG-GEN-0034	TYPICAL CROSS SECTION OF BOOTED TWIN BLOCK TRACK SYSTEM IN TUNNEL (CURVE R <500M) – (WITH DERAILMENT GUARD) HIGH ATTENUATION (HA)
5	MML3-TRW-DWG-GEN-0051A (REV B)	TYPICAL CROSS SECTION OF TRACK STRUCTURE INCLUDING DRAINAGE IN UG STATIONS WITH RCC UPSTAND AT SUMP
6	MML3-TRW-DWG-GEN-0051B (REV B)	TYPICAL CROSS SECTION OF TRACK STRUCTURE INCLUDING DRAINAGE IN UG STATIONS WITH RCC UPSTAND AT SUMP
7	MML3-TRW-DWG-GEN-0051C (REV B)	TYPICAL CROSS SECTION OF TRACK STRUCTURE INCLUDING DRAINAGE IN UG STATIONS WITH RCC UPSTAND IN BETWEEN SUMP
8	MML3-TRW-DWG-GEN-0051D (REV B)	TYPICAL CROSS SECTION OF TRACK STRUCTURE INCLUDING DRAINAGE IN UG STATIONS WITH RCC UPSTAND IN BETWEEN SUMP
9	MML3-TRW-DWG-GEN-0051E (REV B)	TYPICAL PLAN OF TRACK STRUCTURE INCLUDING DRAINAGE WITH RCC UPSTAND.
10	MML3-TRW-DWG-GEN-0037	TYPICAL CROSS SECTION OF BOOTED TWIN BLOCK TRACK SYSTEM IN CUT & COVER (CURVE R50OM) – (WITHOUT DERAILMENT GUARD) HIGH ATTENUATION (HA)
11	MML3-TRW-DWG-GEN-0039	TYPICAL CROSS SECTION OF BOOTED TWIN BLOCK TRACK SYSTEM IN CUT & CURVE (CURVE ≤ 500M) – (WITH DERAILMENT GUARD)
12	MML3-TRW-DWG-GEN-0041	TYPICAL PLAN OF BOOTED TWIN BLOCK TRACK SYSTEM IN TUNNEL (STRAIGHT) – HIGH ATTENUATION (HA)
13	MML3-TRW-DWG-GEN-0042	TYPICAL PLAN OF BOOTED TWIN BLOCK TRACK SYSTEM IN TUNNEL (CURVE R 500M) – (WITHOUT DERAILMENT GUARD) HIGH ATTENUATION (HA)
14	MML3-TRW-DWG-GEN-0046	TYPICAL PLAN OF BOOTED TWIN BLOCK TRACK SYSTEM IN CUT & COVER (STRAIGHT) – HIGH ATTENUATION (HA)
15	MML3-TRW-DWG-GEN-0047	TYPICAL PLAN OF BOOTED TWIN BLOCK TRACK SYSTEM IN CUT & COVER (CURVE R 500M) – (WITHOUT DERAILMENT GUARD) HIGH ATTENUATION (HA)

SL. NO.	DRAWING NO.	DRAWING TITLE
16	MML3-TRW-DWG-GEN-0086	PLAN OF TRANSITION SLAB (BALLASTLESS TO BALLASTED TRACK) AT DEPOT APPROACH
17	MML3-TRW-DWG-GEN-0087	CROSS SECTION OF TRANSITION SLAB (BALLASTLESS TO BALLASTED TRACK) AT DEPOT APPROACH
18	MML3-TRW-DWG-GEN-0093A	PLAN OF TRANSITION SLAB AT AAREY STATION APPROCH
19	MML3-TRW-DWG-GEN-0093B	PLAN OF TRANSITION SLAB AT AAREY STATION APPROCH
20	MML3-TRW-DWG-GEN-0093C	PLAN OF TRANSITION SLAB AT END OF AAREY STATION APPROCH
21	MML3-TRW-DWG-GEN-0094	LONGITUDINAL SECTION OF TRANSITION SLAB AT EITHER SIDE OF AAREY STATION
22	MML3-TRW-DWG-GEN-0095A	PLAN OF TRANSITION SLAB AT END OF AAREY STATION
23	MML3-TRW-DWG-GEN-0095B	PLAN OF TRANSITION SLAB AT END OF AAREY STATION
VI. SOD DRAWINGS		
1	FIG.MMRC-1 MM3-GC-SOD-GD-0161001	KINEMATIC ENVELOPE: AT GRADE AND ELEVATED SECTION ON LEVEL OR CONSTANT GRADE TANGENT TRACK
2	FIG.MMRC-1A MM3-GC-SOD-GD-0163001	KINEMATIC ENVELOPE: 3.2m WIDE CAR, STANDARD GAUGE, AT GRADE AND ELEVATED SECTION ON LEVEL OR CONSTANT GRADE TANGENT TRACK AT PLATFORM
3	FIG.MMRC-1 TNL MM3-GC-SOD-GD-0161002	KINEMATIC ENVELOPE: UNDERGAROUND SECTIONS (TUNNELS) ON LEVEL OR CONSTANT GRADE TANGENT TRACK
4	FIG.MMRC-1A (TNL) MM3-GC-SOD-GD-0161002	KINEMATIC ENVELOPE: 3.2m WIDE CAR, STANDARD GAUGE UNDERGROUND SECTIONS ON LEVEL OR CONSTANT GRADE TANGENT TRACK AT PLATFORM
5	FIG.MMRC-2 MM3-GC-SOD-GD-0163001	STRUCTURE GAUGE : AT GRADE AND ELEVATED SECTIONS ON LEVEL OR CONSTANT GRADE TANGENT TRACK
6	FIG.MMRC-2 (BOX TNL) MM3-GC-SOD-GD-016300	STRUCTURE GAUGE : UNDERGRAOUND SECTIONS (RECTANGULAR BOX STRUCTURE) ON LEVEL OR CONSTANT GRADE TANGENT TRACK
7	FIG.MMRC-2 (CIRCULAR TNL) MM3-GC-SOD-GD-0163003	STRUCTURE GAUGE : UNDERGRAOUND SECTIONS (RECTANGULAR BOX STRUCTURE) ON LEVEL OR CONSTANT GRADE TANGENT TRACK
8	FIG.MMRC-3 MM3-GC-SOD-GD-0165001	SHIFT OF THE CENTRE OF CIRCULAR TUNNEL DUE TO ROTATION OF TUNNEL FOR CANT
9	FIG.MMRC-4 MM3-GC-SOD-GD-0164001	CANT EFFECT ON STRUCTURE GAUGE : AT GRADE OR ELEVATED SECTIONS
10	FIG.MMRC-4 (BOX TNL) MM3-GC-SOD-GD-0164002	CANT EFFECT ON STRUCTURE GAUGE : UNDERGRAOUND SECTIONS (RECTANGULAR BOX TUNNEL)
11	FIG.MMRC-5 MM3-GC-SOD-GD-0162002	CANT EFFECT ON KINEMATIC ENVELOPE: AT GRADE OR ELEVATED SECTIONS
12	FIG.MMRC-5 TNL MM3-GC-SOD-GD-0162002	CANT EFFECT ON KINEMATIC ENVELOPE: UNDERGROUND SECTIONS
13	FIG.MMRC-6 MM3-GC-SOD-GD-0166001	EFFECT OF VERTICAL CURVES ON STRUCTURAL GAUGE
14	FIG.MMRC-7 MM3-GC-SOD-GD-0169001	STRUCTURE GAUGE : AT GRADE SECTION WITH ONE SIDE PLATFORM ON LEVEL OR CONSTANT GRADE TANGENT TRACK
15	FIG.MMRC-8 MM3-GC-SOD-GD-0167001	STRUCTURE GAUGE : UNDERGRAOUND SECTIONS (TUNNEL) WITH ONE SIDE PLATFORM ON LEVEL OR CONSTANT GRADE TANGENT TRACK
16	FIG.MMRC-9 MM3-GC-SOD-GD-01610001	STRUCTURE GAUGE : ELEVATED STATION WITH ISLAND PALTFORM ON LEVEL OR CONSTANT GRADE TANGENT TRACK
17	FIG.MMRC-10 MM3-GC-SOD-GD-0168001	STRUCTURE GAUGE : UNDERGRAOUND SECTIONS (TUNNEL) WITH ISLAND PLATFORM ON LEVEL OR CONSTANT GRADE TANGENT TRACK
18	FIG.MMRC-11 MM3-GC-SOD-GD-01611001	STRUCTURE GAUGE : AT GRADEAND ELEVATEDSTATION ON LEVEL OR CONSTANT GRADE TANGENT TRACK
19	FIG.MMRC-12 MM3-GC-SOD-GD-01612001	RDSO SK – 91146 WORN WHEEL PROFILE

SL. NO.	DRAWING NO.	DRAWING TITLE
VII. DEPOT DRAWINGS		
1	MM3-GC-DTR-GD-8-D03-2001-I	TRACK LAYOUT MAIN LINE TEST BALLAST CUSHAN BIFURCATION - AAREY DEPOT LAYOUT
2	MM3-GC-TR-GD-0 101 0013	TYPICAL CROSS SECTION OF EMBEDDED TRACK
3	MM3-GC-TR-GD-0 101 0013A	TYPICAL CROSS SECTION OF EMBEDDED TRACK AT JACK PIT LOCATION IN MAINTENANCE WORK SHOP AND CENTRAL STORE
4	MM3-GC-TR-GD-0 101 0013B	TYPICAL CROSS SECTION OF EMBEDDED TRACK AT DELIVERY TRACK LOCATION
5	MM3-GC-TR-GD-0 101 0014	TYPICAL DRAWING FOR WASHABLE PLANT
6	MM3-GC-TR-DDC-0 101 0005	CROSS SECTION OF BALLASTED TRACK
7	MM3-GC-TR-GD-0 101 0026	TYPICAL DRAWING OF INSULATED TRACK ON PEDESTAL
8	MM3-GC-TR-GD-0 101 0027	TYPICAL CROSS SECTION OF PIT TRACK
9	--	CROSS SECTION OF MULTIPLE TRACK BALLASTED IN DEPOT
10	MML3-TRW-DWG-GEN-0083	TYPICAL DRAWING OF PSC SLEEPER FOR STANDARD GUAGE FOR BALLASTED TRACK IN DEPOT
11	MM3-GC-TR-GD-0 101 0006	TYPICAL CROSS SECTION OF LEVEL CROSSING
VIII. CROSS PASSAGES		
1	MML3-TRW-DWG-GEN-0052	TYPICAL PLAN OF DRAIN ARRANGEMENT AT CROSS PASSAGE
2	--	DRAWING OF PATHWAY AT CROSS PASSAGE & WALKWAY TO STATION
IX. INTERFACE DRAWINGS AT CUT AND COVER STATIONS		
1	MML3-TRW-DWG-GEN-0051A (REV C)	TYPICAL CROSS SECTION OF TRACK STRUCTURE INCLUDING DRAINAGE IN UG STATIONS WITH RCC UPSTAND AT SUMP
2	MML3-TRW-DWG-GEN-0051B (REV B)	TYPICAL CROSS SECTION OF TRACK STRUCTURE INCLUDING DRAINAGE IN UG STATIONS WITH RCC UPSTAND AT SUMP
3	MML3-TRW-DWG-GEN-0051C (REV B)	TYPICAL CROSS SECTION OF TRACK STRUCTURE INCLUDING DRAINAGE IN UG STATIONS WITH RCC UPSTAND IN BETWEEN SUMP
4	MML3-TRW-DWG-GEN-0051D (REV B)	TYPICAL CROSS SECTION OF TRACK STRUCTURE INCLUDING DRAINAGE IN UG STATIONS WITH RCC UPSTAND IN BETWEEN SUMP
5	MML3-TRW-DWG-GEN-0051E (REV B)	TYPICAL PLAN OF TRACK STRUCTURE INCLUDING DRAINAGE WITH RCC UPSTAND.
X. TURNOUTS,SWITCHES AND CMS CROSSINGS		
1	MML3-TRW-DWG-GEN-0061	TYPICAL TRACK LAYOUT FOR TURNOUT 1:7 (R190)
2	MML3-TRW-DWG-GEN-0062	TYPICAL TRACK LAYOUT FOR TURNOUT 1:9 (R300)
3	MM3-GC-TR-GD-0 101 0015	TYPICAL DRAWING OF CMS CROSSING

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Appendix-2A

WORKS AREAS

July 2019

WORKS AREAS

(1) The Site and works Areas will be made available to the Contractor at different times and for various duration as shown on the Schedule of Access Dates in Appendix 2B. These Site and works Areas are illustrated in the Tender Drawings. Should there be any discrepancies in the definition of the extent of these Sites and Works Areas between the descriptions in this Appendix 2A and the Employer's Drawings, the Employer's Drawings shall prevail.

(2) The Employer may, however, give to the Contractor access to portions of the Site and Works Areas earlier than the time stated in Appendix 2B and the Contractor shall accept them. The Contractor shall not be entitled to any additional payment for early access of any portion of the Site or works Areas.

(3) The descriptions of the Site and Works Areas given below are indicative and the Contractor shall satisfy himself as to the exact nature of the various Site and works Areas and the extent of works to be carried out prior to the execution of the Permanent Works or making use of the area as working space and/or for temporary site facilities at their own cost.

(4) The Contractor shall submit to the Engineer for a notice of no objection, a written proposal for the use and occupation of these Site and works Areas at least 6 week prior to the programmed use of the requested areas. The availability of Site and works Areas will only be permitted for the actual duration of the permanent and temporary works within the particular Site and works Areas. The Contractor shall comply with the Employer's Requirements as stated in - regarding the use of the works Areas.

(5) The Contractor is deemed to have acquainted himself with the actual location and conditions of the Site and allow for any contingency with regard to the means of access and any special Site restrictions including making good all works disturbed or damaged to match with the existing.

(7) The Contractor shall propose controlled access points to the Site and works Areas from the existing roads in different periods for a notice from the Engineer. The Employer shall not construct any temporary roadways which may be necessary to afford access to his Site and working Areas. Such temporary roads will be constructed by contractor at their own cost.

(8) The Contractor shall ensure that all approved accesses shall not impose any constraints and hazard to existing establishments or to other works by Interfacing Contractors. If such accesses are required to be relocated, deleted or closed as may be directed by the Engineer, the Contractor shall do so at his own costs and time.

(9) The Contractor shall maintain at all times all existing roads, road traffic, road accesses, traffic junctions, pedestrian routes and access to existing buildings within the Site and works Areas during all stages of the traffic diversion schemes he may propose for the execution of the Works. The Contractor shall submit his proposal, for a notice from the Engineer, after having received approval from all Relevant Authorities, for the provision of temporary accesses required at any existing building(s) to ensure continuation of access for the public and to facilitate construction of the Works.

(10) Unless otherwise noted, the Contractor shall protect all existing buildings and structures, either located within or adjacent to, the Site and works Areas to the satisfaction of the Engineer.

(11) If any land and/or right of way, other than the Site and works Areas shown on the Employer's Drawings, is required by the Contractor for the purpose of the execution of the Works, such as for temporary diversion, ground treatment, storage, site offices for the Contractor or the Engineer, etc., the same shall be arranged by the Contractor at his own risk and cost. The Employer where feasible may at his discretion assist the Contractor in this respect.

(12) Schedule of Site Access Dates:

The table given in **Appendix 2B** sets out the access dates when site areas are available together with the dates by which they must give access to the other interfacing contractor. The Contractor shall take these dates into account in his Works Program.

(13) Provision of Facilities and Access for Interfacing Contractors.

a) All Site Areas shall be handed back to the Employer, with the exception of the fenced area and access for the Interfacing Contractor, within 28 days from the date of issue of the Taking over Certificate. Prior to returning any Site Areas to the Employer, the Contractor shall carry out the following works:

(i) Construct all Permanent Works within the area in accordance with the requirements of the Contract;
(ii) Reinstate the area to its original condition, when it was taken over, or better, except where the Contract requires construction of Permanent Works;
(iii) Propose final modifications / changes to the area, at locations where it is not possible or desirable to reinstate the area to its original condition, to the satisfaction of the Engineer, and form the area to the agreed lines and levels, and carry out such other works as may be required by the Engineer;
(iv) Removal of all rubbish, debris and other materials.

(14) STANDARD ENGINEERING CONDITIONS FOR WORK AREAS

The following standard engineering conditions apply to all Works Areas:

i) Formation

(a) The Works Areas shall be formed to the levels that the Engineer has issued a notice for. No such levels shall be amended without a notice from the Engineer.
(b) The Works Areas shall be surfaced in a manner agreed with the Engineer, compatible with their intended use, and, in particular, footpaths and roadways connecting facilities shall be clearly defined. Measures shall be taken to the satisfaction of the Engineer to ensure all areas are properly drained and kept free of standing water.
(c) The removal, diversion or reinstatement elsewhere as may be required of any existing works or installation whatsoever within the Works Areas shall be carried out to the satisfaction of the Engineer.

ii) Roads & Parking

(a) Space shall be provided within the Works Areas for parking, loading/unloading and maneuvering of motor vehicles.
(b) Any damage done to the adjoining public roads and fixtures and properties (public or private) shall be made good to the satisfaction of the Engineer.

iii) Drainage & Sewerage

(a) All storm or rainwater from the Works Areas including any access roads there to

shall be conveyed to the nearest stream course, catch-pit, channel or storm water drain as required by the Engineer. All temporary and permanent works shall be carried out in such a manner that no damage or nuisance are caused by storm water or rain water to the adjacent property.

(b) No drain or watercourse shall be used without a notice issued from the Engineer.

(c) Damages or obstructions caused to any watercourse, drain, water-main or other installations within or adjoining the Works Areas shall be made good to the satisfaction of the Engineer.

(d) Treatment and disposal of sewage and wastewater from the Works Areas shall be provided to the satisfaction of the Engineer.

(e) The clearance of Environmental Dept of Govt. of Maharashtra and other statutory authorities as applicable shall be obtained.

iv) Buildings

(a) No permanent structures other than those required for the Permanent Works shall be temporarily permitted on the Works Areas.

(b) Electricity, water, telephone and sewerage shall be provided by the Contractor, as required, for all temporary buildings.

(c) No public supply potable water shall be used for heating, cooling and humidification purposes, or vehicle washing without a notice from the Engineer.

(d) The clearance certificate from Electrical Inspector and other relevant statutory authorities as applicable shall be obtained.

(e) The Fire clearance certificate from Fire authorities and other statutory authorities as applicable shall be obtained.

v) Pedestrian Access

Every existing pedestrian access throughout the Works Areas shall be maintained in a usable condition at all times to the satisfaction of the Engineer including lighting, signing and guarding.

vi) Fencing

The Works Areas shall be secured against unauthorized access at all times. In particular fencing or the like shall be maintained, removed and re-erected in the new location wherever and whenever a Works Area is relinquished in stages.

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Appendix-2B

CONTRACT KEY DATES & ACESS DATE

July 2019

CONTRACT MM3-CBS-TWK- 10C

CONTRACT KEYDATES

Schedule of Key Dates

1. Contract Key Dates and Milestones

The Contract Key Dates and milestones are placed below contract data in Part-3, Section VIII.

Notes on Key Dates:

i. The achievement of a Key Date shall be subject to the issuing of a Notice of No Objection from the Engineer.

ii. The achievement of a Key Date shall require completion of all the works specified for achievement of the Key Date.

iii. The achievement of Key Dates shall be read in conjunction with the access requirements for Interfacing Contractors. Such key dates are milestones.

iv. The access and order for completion of the Works shall be coordinated among the Interfacing Contractors in the development of the Track Related Installation Programme (TRIP).

v. Mumbai Metro Line 3 Project, Phase 1 Revenue Service includes Aarey Depot and the corridor from Aarey Station to Bandra Kurla Complex Station (including).

vi. Mumbai Metro Line 3 Project, Phase 2 Revenue Service includes Phase 1 and the extended corridor from Bandra Kurla Complex Station to Cuffe Parade Station.

vii. The Key Dates should be read in conjunction with a tentative plan showing the various areas of Aarey Depot, i.e. Area-1 to Area-5 as shown in the Drawings Appendix 1. The TWK-10C Track Contractor shall coordinate and agree with the Aarey Depot civil contractor on the exact boundary of these areas in Aarey Depot for achievement of the Key Dates.

viii. Notwithstanding the twin tunnel structure lengths stated in the Key Dates which are approximate only, the TWK-10C Track Contractor shall coordinate with the underground civil contractors (UGC-05 to UGC-07) for the demarcation of their contracts and the exact lengths of stations, twin tunnel structures, ramp section and any intermediate shafts for achievement of the Key Dates.

2. Schedule of Access Dates

The Schedule of Access dates are placed below contract data after Key Dates in Part-3, Section VIII.

Notes on Access Dates:

i. The Access Dates should be read in conjunction with a tentative plan showing the various areas of Aarey Depot, i.e. Area-1 to Area-5 as shown in the drawing in section VI(4) .The Track Contractor shall coordinate with the Aarey Depot civil contractor on the exact boundary of these areas in Aarey Depot for achievement of the Key Dates.

ii. Notwithstanding the twin tunnel lengths as stated in the Access Dates which are approximate only, the Track Contractor shall coordinate with the underground civil contractors (UGC-05 to UGC-07) for the demarcation of their contract boundary and the exact lengths of stations, twin tunnel structures, ramp cross section and any intermediate shafts.

iii. The contractor is advised to note that the access for lowering the rails will be available at the spacing of approx 4.0 Km at following station: BKC, Mid Ventilation shaft (in between Santa Cruz station and CSIA Domestic station), Sahar Road station, Pali ground Shaft (in between Marol station and MIDC station), Ramp (In between SEEPZ and Aarey station) tentatively. At these locations the one opening of approx 20*5 m will be provided for lowering the 13 m rail, flash butt welding plant and other construction material for construction purpose for limited period. Suitable access for concrete work will be provided at all other stations.

iv. Notwithstanding the Access Dates and corresponding extent of access , the Track Contractor may be given access to various locations in phases as required according to his approved works programme for completion of the Works under the Contract.

v. Notwithstanding the stated access to various locations in this Appendix 1, the access dates represent the dates by which the TWK-10C Track Contractor will be given shared access to various locations jointly with other Interfacing Contractors of the Project (including TWK-10B OCS, STPT, etc) for carrying out system installation and testing. Notwithstanding that access to some locations in Aarey Depot and the main line (at grade section) at Aarey Depot areas are given assuming after OCS foundation installation, the TWK-10C Track Contractor may have to work in parallel with the OCS Contractor if they are still completing their OCS foundation installation. The sequence of access shall be coordinated among the Interfacing Contractors for the agreement of a Track Related Installation Programme (TRIP).

vi. The stated access to underground sections of underground civil contracts may not be given in continuous sequence from one end to the other end but may be given in parts based on the actual work sequence of underground civil contractors for achieving their contracts key dates. The TWK-10C Track Contractor is required to plan and complete track work with actual sequence of access to be coordinated with the underground civil contractors.

vii. The lengths of underground sections that are stated to be made available in the Access Dates are approximate only and estimated based on the work sequence of underground civil contractors for achieving their contracts key dates at the time of preparing this Appendix. These may vary depending on the actual work sequence and progress of the underground civil contractors. The TWK-10C Track Contractor shall interface and maintain close liaison with the interfacing underground civil contractors for agreeing on the actual extent and sequence of such access including any earlier access where possible or late access where necessary.

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APPENDIX - 3

GENERAL PROJECT OVERVIEW

July 2019

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1. Project Genesis and Main Stakeholders

1.1 General

Mumbai is the financial hub of India and is at the heart of commercial and trade activities of the country where in excess of 21 million people live. Public Transport is the most preferred option for the citizens. The existing suburban rail system is under extreme pressure and the existing bus system has a limited capacity for providing feeder services to Suburban railways.

There are many constraints to expand the existing roads and rail network capacity and many pockets in the Island City and surrounding suburbs are not served by rail based mass transport system. In order to provide rail based mass transit facility to people residing in the areas not connected by existing Suburban Rail System and to enable them to reach the stations within the walking distance of 0.5 km to1 km, with proper interchange facilities, the metro master plan has been prepared.

In order to improve the overall traffic and transportation scenario in Mumbai and to cater the future travel needs, the Government of Maharashtra (GOM) through Mumbai Metropolitan Regional Development Authority (MMRDA) has undertaken several studies and has identified that the Metro Rail model as the most efficient, economically viable and environment friendly mass transport system. In major cities around the world the use of the Metro Rail mode of transportation has increased exponentially.

In 2004, Delhi Metro Rail Corporation (DMRC) prepared a Metro Master Plan for Mumbai to resolve the current traffic congestion status and also to increase mobility and efficiency across the Region. This master Plan proposed a total of 9 Metro Rail corridors of length 146.5 km which consisted of Phase I (3 Lines: 2005-2011), Phase II (2 Lines: 2011-2016) and Phase III (4 Lines: 2016-2021).

The revision of Phase I was initiated by a request from the Ministry of Civil Aviation, Government of India and Mumbai International Airport Pvt. Ltd. (MIAL) to the Government of Maharashtra in June 2008. In September 2009, it was decided by the National Facilitation Committee that the Metro access development to the MIAL International Terminal by combining Line 3 (Phase I) and Line 6 (Phase III) should be prioritized as a part of Phase I project.

The proposed Mumbai Metro Line 3 (MML3) connecting Colaba-Bandra-Santacruz Electronic Export Processing Zone (SEEPZ) is completely underground with a corridor length of about 33.5 km. The construction of this line will involve tunnelling (both by Tunnel Boring Machine (TBM) and New Austrian Tunnelling Method (NATM), station construction (both by cut and cover and, NATM), Temporary TBM launching/Retrieval/mucking shaft construction including a permanent ventilation shaft, ramp and the Car Depot in Aarey Colony.

The entire length of 33.5 km underground MML 3 as envisaged in the DPR consists of 26 underground stations and 1 at-grade station in the Car Depot. The alignment connects the city's Heritage Precincts, Major Business Districts, the suburbs, the Domestic and International Airport and other modes of public transport including the sub-urban railways and bus.

The Mumbai Metro Line 3 shall be brought into operation in different stages and this will be decided later.

Under the Services of the General Consultant the works have been divided into 7 packages, of around 4 kilometres of tunnel and 3 to 4 stations, and Tenders have been called and received for the 7 Design and Build Contracts for underground Tunnels and Stations.

1.2 General Consultant (GC) – Employer's Representative

A consortium comprising AECOM, EGIS, PADECO and Louis Berger has been engaged as the General Consultants (GC) to provide comprehensive general consultancy services including provision expert technical inputs to facilitate decision making by MMRC at various stages of project execution. The GC will assist MMRC in completing the Project works so as to achieve Revenue Operation in a timely manner while achieving the required standards of safety, quality and financial control.

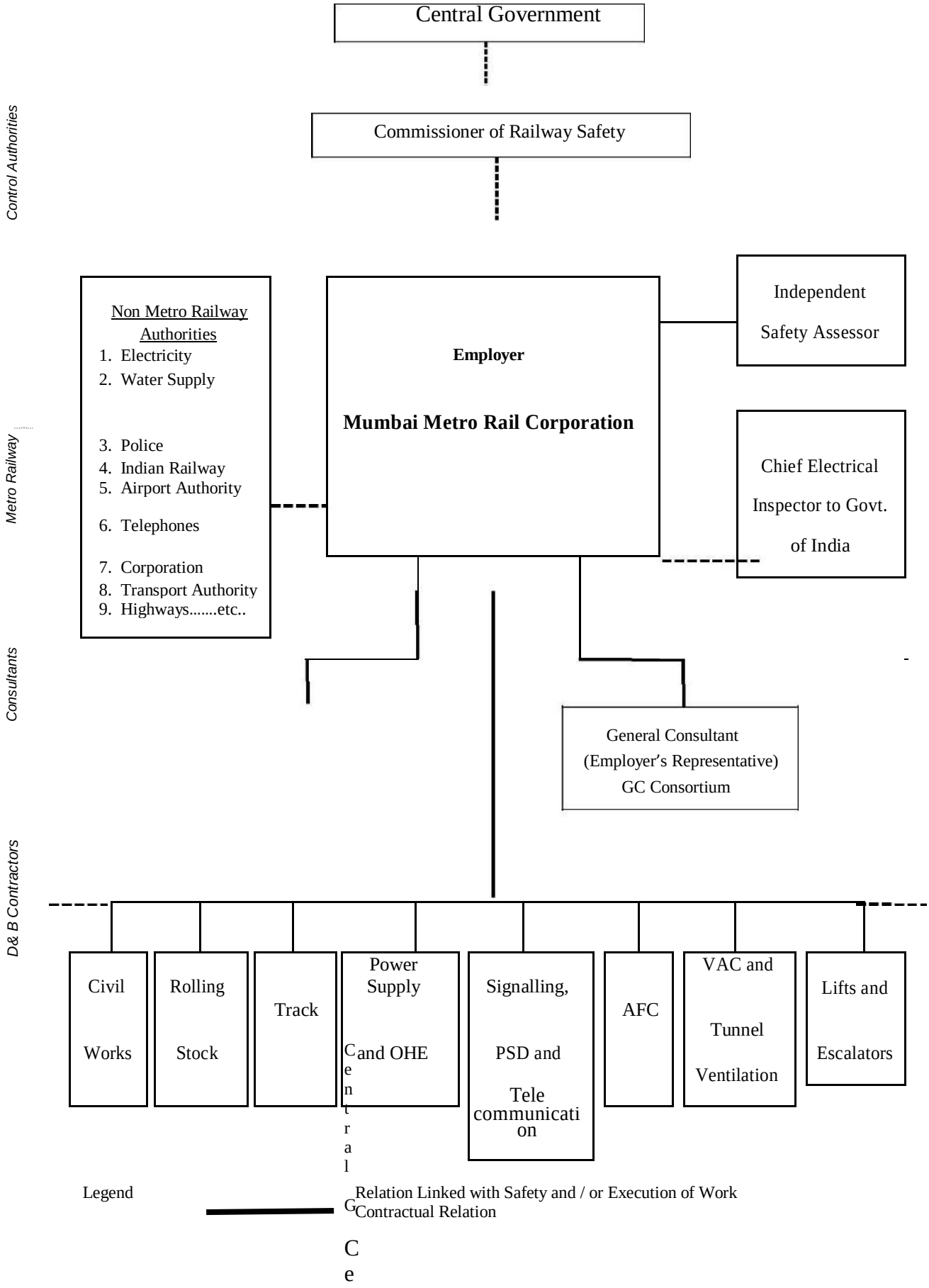
GC will be involved at all stages of the project design, procurement, construction, testing and commissioning of the Mumbai Metro Rail Line 3, including all civil engineering works, structures, tracks, signals, telecom facilities, traction arrangements, air conditioning and ventilation, rolling stock, maintenance depots, stations, operation control centre, offices, station integration areas, bridges, flyovers, elevated, surface and underground sections over the project routes, integration with other modes of transport, etc. During all stages of project execution, the GC will represent MMRC and function as the Employer's Representative (ER) and also known as Project Manager.

1.3 Design and Build (D&B) Contractors

D&B Contractors are the agencies for executing the Project under the general supervision of the Employer's Representative (ER)

All role playing constituents of the Project and the stakeholder general organisation is given below. The number of D&B Contractors will be approximately 20.

Mumbai Metro Rail Line 3 – Stakeholder General Organisation



1.4 Role of Stakeholders

The following stake-holders have been identified, along with the roles they have to play in the project:

Organisation	Role
Mumbai Metropolitan Regional Development Authority (MMRDA)	1. Release of land owned by MMRDA at various places. 2. Coordination required for corridor alignment and station location in tune with MMRDA's master plan
Maharashtra State Electricity Board (MSEB)/Tata Power Company Limited / Reliance Infrastructure Limited, Bombay Suburban Electric Supply & Transport Undertaking (B.E.S.T.)	1. Provision of Power through sub-stations to Metro Rail Line 3 for traction and auxiliary power systems. 2. Power supply to D&B contractors for operating equipment during construction. 3. Diversion of power-lines.
Mumbai Metropolitan Water Supply and Sewerage Board (MMWSSB)	1. Diversion of Metro-water pipe lines 2. Diversion of sewer lines. 3. Provision of water supply for the project
Maharashtra Pollution Control Board	Concurrence on the method of construction-waste disposal and coordination on pollution hazard management
Mumbai Traffic Police	Traffic diversion and management during construction phase
Municipal Corporation of Greater Mumbai (MCGM)	Coordination with MCGM Officials to get permissions for construction of Metro station / ventilation shaft / pedestrian subways etc. Coordination related to the improvement proposals/maintenance works schedule for the MCGM to ensure uninterrupted movement of manpower, equipment, material, muck to and from MML-3work sites by planning diversions from the work/maintenance areas on Mumbai City Roads
Airports Authority of India (AAI)	Clearance required for locating elevated section in the air-funnel region near the air port
Indian Railway	1. Coordination on interchange station at Mumbai Central. 2. Connectivity between suburban railway stations and Mumbai Metro Rail to complement each other

Organisation	Role
B.E.S.T.	1. Coordination on bus stops vis-a-vis Metro stations 2. Feeder bus routes to Metro stations
Chief Electrical Inspector to Govt. of India	Inspection, testing and final approval of Power Supply, OHE and other Electrical Installations for energization for commencement of the metro service
Commissioner of Railway Safety (CRS)	Inspection, testing and final approval for commencement of the metro service

1.5 Contract Packages and Associated Scope of Work:

A preliminary list of D & B Contract list is given below for information only.

A total of about 17 major contract packages for this Project are being arranged. It comprises 7 packages for underground stations and tunnels including ventilation air-conditioning, lift & escalators, depot, and 8 packages for systems including depot equipment.
The following table provides a summary of the various contract packages:

1.	UGC-01	Design And Construction Of Underground Section Including Four Underground Stations At Cuffe Parade, Vidhan Bhavan, Churchgate And Hutatma Chowk And Associated Tunnels Together With Two Tunnel Sidings At Cuffe Parade.
2.	UGC-02	Design And Construction Of Underground Section Including Four Underground Stations At C.S.T, Kalbadevi, Girgaon And Grant Road And Associated Bored Tunnels.
3.	UGC-03	Design And Construction Of Underground Section Including Five Underground Stations At Mumbai Central, Mahalakshami, Science Museum, Acharya Atre Chowk And Worli And Associated Bored Tunnels.
4.	UGC-04	Design And Construction of Underground Section Including Three Underground Stations At Siddhi Vinayak, Dadar and Shitladevi Temple And Associated Tunnels.
5.	UGC-05	Design And Construction Of Underground Section Including Four Underground Stations At Dharavi, B.K.C. Vidya Nagari and Santa Cruz and Associated Tunnels Together With Two Tunnel Sidings At B.K.C.
6.	UGC-06	Design And Construction Of Underground Section Including Three Underground Stations At CSIA Domestic Airport, Sahar Road And CSIA International Airport And Associated Bored Tunnels.
7.	UGC-07	Detailed Design and Construction of Underground Section Including Three Underground Stations At Marol Naka, MIDC And SEEPZ And Associated Bored Tunnels together with A Ramp For the Depot

		Connection.
8.	DEP	Design and Construction of Depot
9.	RST	Design & manufacture, supply, testing and commissioning of Rolling Stock including training on operation and maintenance to operation personnel for the Project.
10.	TWK 02 &03	Track Works
11.	PSS	Power supply system and Over Head Equipment
12	OCS	Overhead Catenary System
13.	STPT	Signalling, Platform Screen Doors and Telecommunications
14.	AFC	AFC Equipment
15.	TVS 01 to 03	Design and Construction of Tunnel Ventilation & Environmental Control System (3 packages)
16.	LET 01 to 05	Design and Construction of Lifts and Escalators for all the Stations (5 packages)
17.	DPE	Depot Equipment / Machines *

2. Metro Network

2.1 Mumbai Metro Rail Line 3 Corridor

The proposed corridor for Mumbai Metro Rail Line 3 (Colba – Bandra – SEEPZ – Aarey) is shown in the following diagram.

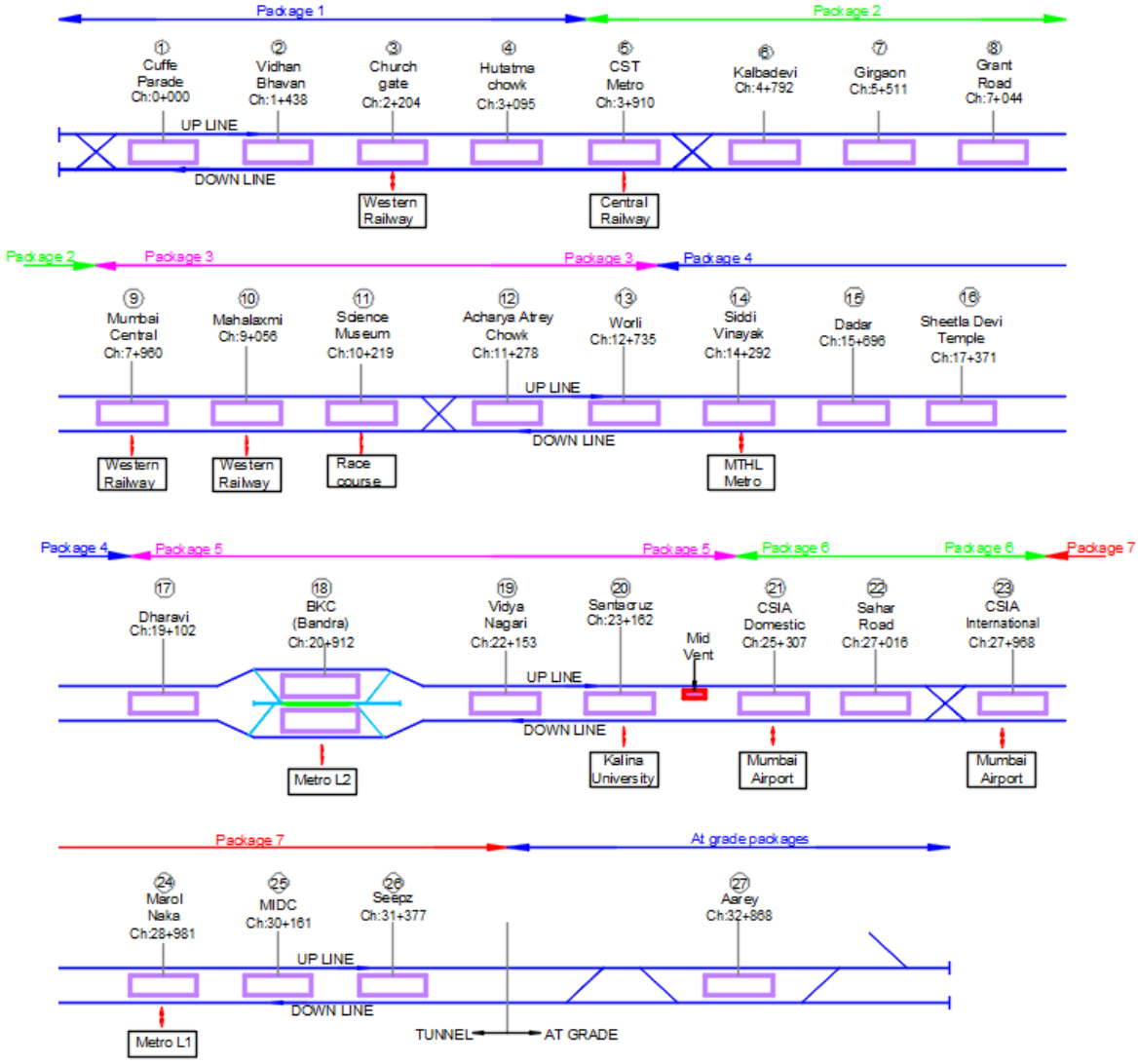
2.2 Route Description

The metro corridor (Colaba – Bandra – SEEPZ – Aarey) generally follows a North – South axis. It is intended to facilitate commuter travel from South Mumbai to the Airport via the Mahim – Bandra Kurla Complex (BKC). It will also provide direct access to the economic hubs such as BKC, MIDC Industrial Estate, SEEPZ and Aarey, including famous landmarks such as Kalina University and Mahalaxmi.

The metro corridor is approximately 32.9 km long. It is broadly divided into six sections as indicated in the table below. The entire metro corridor will be constructed underground, except Aarey and the Depot.

2.3 Track Layout

The schematic track layout of Mumbai Metro Rail Line 3 is shown below. It will consist of twin tracks at standard gauge (1435mm), with separate tunnels (twin bore) for each track.



The signalling and train control system shall allow trains to run in the reverse direction along both the Up and Down Lines during:

- Degraded mode operations. If a section of the line has to close, revenue services can continue on either side using emergency crossovers.
- Maintenance periods. A temporary single track section allows one tunnel section to be closed to railway traffic, while the other tunnel section can continue operating revenue services (albeit with a reduced frequency), through bi-directional running.

2.4 TRAIN OPERATION PLAN

2.4.1 General

Mumbai Metro Rail Line 3 shall commercially operate from Aarey Milk Colony to Colaba (Cuffe Parade). It shall serve a total of 27 stations. The Depot will be located at Aarey Milk Colony.

Mumbai Metro Rail Line 3 will be operated progressively in Two (2) phases:

1) Phase I : Aarey Milk Colony – Bandra (BKC),
2) Phase II : Phase I + Bandra (BKC) – Colaba (Cuffe Parade).

The three (3) operating phases are described below.

Train service patterns are being planned as follows

1. Principle service : Colaba (Cuffe Parade) – Bandra (BKC) – Aarey Milk Colony
2. Extra service : Colaba (Cuffe Parade) - Bandra (BKC)

When extra services are running between Colaba and Bandra, they will be inserted in between each principle service, one following the other. This is to create a symmetric operating pattern with even headways.

2.5 Service Particulars

Mumbai Metro will operate commercial services every day of the year from 05 h until 24 h midnight. Timetables are being prepared based on Weekdays (Mondays to Saturdays), Sundays and Public Holidays. In addition, a reduced frequency airport service is being planned to operate from 24 h until 02 h. No revenue services are proposed between 02 h to 05 h, which are reserved for maintenance of infrastructure and fixed equipment. If additional time is required for maintenance, including injecting trains before the start of revenue services, then Mumbai Metro Rail Line 3 is also being designed to allow the airport service to continue operating along temporary single track sections (one tunnel section is closed for maintenance, the other tunnel section will remain operational with bidirectional running, the trains will use the scissor crossovers installed along the line to change tracks).

Ultimately Mumbai Metro is being designed to accommodate up to a maximum of 72,000 Passengers Per Hour Per Direction (PPHPD).

Peak hours on Weekdays (Mondays to Saturdays)–morning peak 0800 h to 1100 h evening peak 1730 h to 2030 h.

Off peak hours : These will be adapted according to the morning and evening peak hours, with transition times between the two periods.
It is envisaged that Mumbai Metro Line 3 will start operating with 6 car trains (approximately 1775 passengers' capacity at 6 pax /m^2). Later on, operations will then move on to 8 car trains (approximately 2377 passengers' capacity).

The train configurations (8 cars) and headways (peak and off-peak) for Operating Phases I, and II are still being finalized.

3. Metro System Features

3.1 Salient Features : The salient features of this project are shown in the table below

Sr. No.	Features Line 3
1	Gauge (Nominal): 1435 mm
	Route Length (Between Dead Ends) : Colaba-Bandra-SEEPZ then to Aarey Milk Colony approximately 35 km.
3	No. of Stations: 27 stations (26 Stations UG and 1 Station At-Grade)
4	Max. Design Speed: 95 km/h
	Max. Operating Speed: 85 km/h
5	Traction Power System
	(a) Traction System voltage: 25kV AC
	(b) Source of Power Supply: OCS System
6	Rolling Stock
	(a) 3.20 m wide with stainless steel or aluminum body
	(b) Maximum Axle Load: 17 t
	(c) Maximum Length of the cars: 22.6 m
	(d) distance between bogie centers as 14.750-/+0.350 m
	(e) Number Max of cars per train: 8
	Headway (Target of 72 000 PPHPD) (Single loop service from Cuffe parade to Aarey milk colony)
	(a) 275 seconds for year 2020 – 31 X 8 car trains in operation + Spares
	(b) 200 seconds for year 2031 - 42 X 8 car trains in operation + Spares

7	(c) 170 seconds for year 2045 – 49 X 8 car trains in operation + Spares
8	Signaling
	CBTC GOA4 for year 2020 and Operated to GOA2 with driver to open/close train doors during peak hours.
9	AFC
	a) Contactless Smart Card – For multiple journeys.
	b) Contactless Smart Token – For Single Journey
	TVS/ECS
	Tunnel Ventilation
	(a) Tunnel ventilation and Track exhaust systems utilizing the Tunnel Ventilation Fans (TVF).
	(b) Tunnel ventilation system with Saccardo nozzle to push smoke to the TVF exhaust point for fire emergency scenarios.
	(c) Under-Platform Supply Systems (UPSS) consist of Air Handling Units which can provide cool air into the Track for hot days.
	Environmental Control System
	(a) Chilled water cooling system for public areas, offices and plant rooms.
	(b) Station smoke exhaust system to use TVF plants.
11	Escalators and Elevators (Lifts) at Stations
12	Signage - To be Advised

4. Road Traffic Management during Construction

Construction in congested cities is a challenge of its own kind and even if it lasts only during construction it may alter significantly the perception of the need of the project for the inhabitants if dealt with inappropriately. The position of construction site and access for material delivery and extraction have to be considered carefully and planning traffic diversions for construction activity is a major challenge. Construction of underground metro corridor and stations beneath existing road corridor is planned to be done through cut and cover and New Austrian Tunnelling method (NATM). The approach would be to cause minimum disturbance

to existing traffic. It is proposed to get consent from all the stake holders' viz., project authorities, Mumbai Municipal Corporation officials, traffic police, and representatives of road users and NGOs working in the field so that the traffic diversion proposed shall be acceptable to the stakeholders. A Traffic Management Plan is to be developed by the Contractor and approval sought from the Traffic Police Department.

5. Construction of Mumbai Metro Rail

The construction of Mumbai Metro Rail Line 3 consists of the following:

6.1. Under Ground Tunnel & Stations

6.2. Depot at Aarey

6.3. System

i. Rolling Stock
ii. Track
iii. Power Supply & Overhead contact system
iv. Signaling, Train Control System-PSD-Telecommunication
v. Automatic fare Collection System
vi. Tunnel Ventilation System and Environmental system
vii. Lifts & Escalators
viii. Depot equipment
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APPENDIX 4

PROGRAMME REQUIREMENTS AND PROJECT CALENDAR

July 2019

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PROGRAMME REQUIREMENTS & PROJECT CALENDAR

1. GENERAL

1.1. **Purpose of Programme;** to provide the Employer's Representative with progress status reports for managing, monitoring and coordinating the awarded contracts during their execution within the overall multi-contract project schedule.

1.2. The Contractor shall programme his work at all times to meet the Key Dates and the Access Dates stated in the Contract, and the specified interface periods for the design and installation of the Works with those of the Interfacing Contractors. The Tenderer/ Contractor shall during the progress of the Works constantly monitor his progress against the programmes described below.

1.3. The Contractor shall include in all programmes his work obligations towards shared access, shared Site areas and other coincident or adjacent work areas with regard to all interfacing parties.

1.4. The Works Programme, and all more detailed or revised versions, shall be submitted to the Employer's Representative for his notice in accordance with the provisions of the Conditions of Contract.

2. METHODOLOGY

2.1. The computerized Critical Path Method (CPM) network using the Precedence Diagramming Method (PDM), has been selected by the Employer as the technique for contract management system and in coordinating the multi-contract project. This technique shall also be employed by the Contractor in preparing their Construction Stage programme submissions.

2.2. Unless otherwise agreed by the Employer's Representative, all programmes submitted by the Contractor shall be produced using computerized Critical Path Method (CPM) Networks developed implementing the Precedence Diagramming Method (PDM) with Cost Loaded Charts and Tables, using the required software stated in Clause 3 below.

The Contractor shall implement and use throughout the duration of the Contract, a computerized system to plan, execute, maintain and manage the planning, design, pre-construction, construction, and sub-contracts in executing the CPM scheduling by PDM. The reports, documents and data provided shall be an accurate representation of the current status of the Works and of the work remaining to be accomplished; shall provide a sound basis for identifying problems, deviations from the planned works, and for making decisions; and shall enable timely preparation of the same for presentation to the Employer's Representative.

3. PROGRAMME MANAGEMENT SOFTWARE

CPM programming software used shall be Primavera Project Planning (P6)/Microsoft Projects (MSP) Program or latest version. Scheduling software and relevant instruction manuals, licensed for use in connection with the contract, shall be provided by the Contractor according to the Employer's specifications. The Contractor shall supply the Employer's Representative with 2 user licenses, including manuals and approved training of the software and any subsequent versions thereof at no extra cost.

4. POST CONTRACT AWARD

4.1. The Contractor shall develop the Programme included with his submission, into the Initial Works Programme including an outline Narrative Statement and submit within 4 weeks of the Commencement Date and a more detailed version within 7 weeks of receiving the Employer's Representative's notice of no objection to the proposed Initial Works Programme. Refer Clause 6.0.

4.2. The first Three Month Rolling Programme shall be submitted within 4 weeks of the Commencement Date and all subsequent editions shall accompany the Monthly Progress Report. The Monthly Progress Reports shall also include a Programme Update as described below. These programmes shall subsequently be updated as described below. Refer Clause 9.0.

4.3. Following the Contractor's Initial Works Programme submission but in any case no later than 21 weeks from the Commencement Date of the Contract, the contractor shall submit a detailed **Works Programme** suitably amended to take into account the programmes of Interfacing Contractors. It is the Contractor's responsibility to ensure timely co-ordination with the Interfacing Contractors to review, revise and finalise his Initial Works Programme so as not to affect the progress of the Works and/or the works of the Interfacing Contractors. The resubmitted Works Programme when given a Notice by the Employer's Representative shall form the baseline programme which shall solely be used for monitoring and evaluating all facets of the Contractor's performance including, but not limited to, actual progress and the effects of variations and delays. The Contractor shall monitor his own performance against the Baseline Programme on a weekly basis and shall prepare and submit to the Employer's Representative written and computerised monthly reports including all supporting data. As the work progresses, it may be necessary to update/ revise the Baseline programme, but such updating shall only be carried out with the prior consent of the Employer's Representative or when directed by them.

4.4. For the Initial & Detailed Works Programme submission, one (1) colour original and five (5) colour copies, with two softcopies on separate DVDs, each of the following programmes and reports shall be submitted to the Employer's Representative:

1. Programme: Baseline CPM Network
2. Programme: Baseline Milestone based Cost Activity Schedule
3. Baseline Schedule Report
4. Narrative Statement
5. Baseline Physical Progress Report
6. Baseline Resource Charts

4.5. The Employer's Representative shall review and comment on the Contractor's programmes and information submitted under this Clause. The Employer's Representative will issue his Notice or otherwise of the submissions within 4 weeks.

4.6. The Employer's Representative shall require the Contractor to re-submit within 2 weeks if he is of the opinion that the programmes and information submitted by the Contractor is unlikely to meet the Contract key dates.

4.7. Notwithstanding the above, the Employer's Representative may at any time during the course of the Contract require the Contractor to reproduce the computer-generated Baseline Schedule

Report described above to reflect actual activity dates and generate schedules based upon "what if" statements. The initial computer-generated report after receiving the Employer's Representative's Notice will serve as the base against which the contract progress will be measured. Any changes to the Report reflected in subsequent Baseline Schedule Reports shall also require the Employer's Representative's consent.

4.8. Failure to include any element of work required for performance of the Contract shall not relieve the Contractor from completing all works required under the Contract to achieve the original or any extended key completion date.

5. WORKS PROGRAMME

5.1. The Works Programme shall detail the full scope of the works taking into account the complex nature and different phases of the contract, and shall be accompanied by detailed supporting information to demonstrate through the sequence and duration of the activities that the plans are achievable and realistic and that the works to be undertaken can meet the requirements of the contract.

5.2. The Works Programme shall be a computerized Critical Path Method (CPM) network developed using the Precedence Diagramming Method (PDM) and shall be present in bar chart and time-scaled network diagram format to a weekly or monthly time scale.

5.3. Tasks in the Works Programme shall be sufficiently detailed to describe activities and events that include, but are not limited to, the following:

1. Key Dates, Access Dates including Works Areas, any interface and handover dates;
2. All physical work to be undertaken in the performance of the Contract obligations, including Temporary Works;
3. The requested date for issue of any drawings or information by the Employer's Representative;
4. Preparation, submission and review of Design Documents showing all items where review by the Employer's Representative is required;
5. Submission of design deliverables as required by the contract;
6. Incorporation of principal aspects of the Sub-Programmes and Supplementary Programmes as referred to in Chapter 2;
7. Due time allowance for review by the Employer's Representative of the Contractor's submissions, as well as the subsequent amendment and re-submission by the Contractor in the design review and comment process;
8. Due time allowance for complying with requirements of all Government Departments and all others whose consent, permissions, authority or licence is required prior to the acceptance of the design and subsequent execution of any work;
9. Order, procurement, manufacture, delivery, testing and installation of major materials and the delivery and/or partial delivery date on-Site of principal items of Contractor's Equipment;
10. Any software development requirements and Validation time frames;
11. Any off-site work such as manufacture or pre-fabrication of materials or components;
12. Preparation and submission for review of mock-ups and prototypes;

13. Design and installation of temporary construction facilities;
14. Interface periods with the Interfacing Contractors or utility undertakings;
15. Design, supply and/or construction activities of sub-contractors;
16. All testing in various stages, commissioning and integrated testing (including time to wait for proceeding integrated testing and commissioning necessary with other interface systems as required by the contract);
17. Any system safety requirement, RAMS requirement, and statutory approval and final certification as defined in the contract prior to commissioning.
18. Training;
19. Any outside influence which will or may affect the Project;
20. Mobilization and demobilization;
21. Weather allowance.

5.4. The Works Programme shall show achievement of all Key Dates.

5.5. Activity descriptions shall be unique, describing precisely the type of works to be performed. Any activity creating an imposed time or other constraint shall be fully defined by the Contractor.

5.6. The Works Programme shall be organized in a logical work-breakdown-structure including work stages and phases, and shall clearly indicate the critical path(s).Each activity in the Works Programme shall be coded to indicate:

1. Activity ID and Activity Code which structure should be agreed with the Employer's Representative.
2. The Employer's Representative may request additional activity coding to the extent available without restraint to the Contractor's utilisation of the programme software. When requested, the Contractor shall add the required additional coding to the Programme. The Contractor shall use additional code fields as requested to comply with the requirements and for the use of the Contractor.

5.7. Activity duration shall not exceed thirty (30) days, unless otherwise consented to by the Employer's Representative, except non-construction activities such as submittals, submittal reviews, procurement and delivery of materials or equipment. The Contractor shall submit a Programme/Project Calendar cross reference clearly indicating the allowance for holidays.

5.8. The Works Programme, in each submission, shall be accompanied by an Activity Report and a Narrative Statement as described below in both electronic and hard copy format (time scale logic diagrams in A1 size, reports in A4 size).

5.9. **Activity Report** shall list all activities, and events in the Works Programme, sorted by activity identification number.

The Activity Report shall include the following for each activity and event:

1. Activity identification number and description,
2. Duration expressed in Days,
3. Early and late start& early and late finish dates. Planned start and finish dates,
4. Calculated total float and free float,
5. Predecessor and successor(s), accompanying relationships and lead/lag duration,

6. Imposed time or date constraints,
7. Calendar.

5.10. **Narrative Statement**

The Narrative Statement shall be a comprehensive statement of the Contractor's plan and approach for the execution of the Works and the achievement of key dates, handover dates, submission dates and any intermediate dates. It shall incorporate outline method statements in respect of major items of work including construction sequences and primary items of plant, Construction Equipment, Temporary Works and the like. It shall fully explain the reasons for the main logic links in the Programme and include particulars of how activity durations are established. This shall include estimated quantities, production rates, hours per shift, work days per week and a listing of the major items of Construction Equipment planned for use on the project. Activities, which may be expedited by use of overtime or additional shifts, shall be identified and explained. A listing of holidays, and other special non-work days being used for the computer reports shall be included.

Supporting information and an accompanying narrative for the Programme that details the basis and assumptions upon which the programme has been drawn shall be prepared and submitted as detailed (but not limited to) below:

1. A narrative description of the sequence of all sections of the Works and in particular a detailed identification and description of the critical path activities. The narrative shall be supported by sketches illustrating the planning sequences of construction phase of works;
2. Marked up plans detailing the routes and sequence of delivery and installation;
3. An overall manpower forecast detailing individual trades and other sub-contract / indirect labour, commissioning teams in terms of the daily number of workers planned to be engaged. The formats for these forecasts shall be in accordance with the Employer's Representative's requirements;
4. Typical cycle time analysis;
5. Planned production outputs for all major activities and areas of Works;
6. List of major items of plant and equipment that are required to be procured identifying the required lead times;
7. Accumulative curves and histograms showing the planned weekly figures for each principal quantity, major item of equipment and major power trades;
8. Any programme constraints, giving details of the constraints and substantiation thereto;
9. Total float listing in order of total float;
10. Daily and weekly working hours, holidays and shift patterns;
11. Other information that the Employer's Representative may request;
12. the deployment of Contractor's Equipment and labour;
13. the production rates used in determining duration;
14. the shifts assumed in determining duration;
15. the breakdown of labour requirements by trades;
16. the schedules of quantities used in developing the programme, to the extent that such information is not provided elsewhere;

17. interfaces with the Employer's Representative and Interfacing Contractors and other constraints; and
18. any assumptions used in the programme.
19. The Programme Narrative Statement shall be in sufficient detail to enable the duration, leads and lags in the logic diagram to be reconciled and substantiated, and to enable the projected levels of labour (by trade) and staff and flows of goods, materials and equipment to be substantiated.

5.11. **Physical Progress 'S' Curve**

The Contractor shall also submit at the end of every month, for inclusion in the Monthly Progress Report as stated in Appendix 5 of Part 2 , a forecast Cumulative Physical Progress 'S' curve based on the time-phased distribution of cost in the CPM Network Logic Diagram, expressed in percentage terms and plotted with the early and late dates. This 'S' curve shall be generated from the computerised CPM Network Logic Diagram.

5.12. **Resources**

The Contractor shall provide on the submission of the Baseline programme full resource details for major activities. These shall include

1. Major manpower trades
2. Number of items of major plant and equipment
3. Principal quantities
4. Other details as appropriate or required by the Employer's Representative.

The Contractor shall also Resource Charts, generated from the Contractor's CPM Network Diagram, showing the anticipated manpower and main Construction Equipment usage during the execution of the Project.

As an additional monitoring facility, indicator resources shall be assigned to relevant activities for the major items of work. Resource indicators may be input as a daily rate, expected required rate, or as an activity total in the relevant units. These are purely indicative quantities and do not form part of contract.

All submissions of proposed Works Programmes subsequently, after approval of the Initial Works Programme, shall include the actual physical progress of work and forecast of the remaining work. Actual progress shall be stated in percent complete, remaining duration, and actual start and finish dates for each activity in the Works Programme.

6. INITIAL WORKS PROGRAMME

The Initial Works Programme submitted under Clause 5.1 need not include the full details given under Clause 5 above. It should be a condensed version with combined activities of longer duration but must show clearly how the requirements of the Contract are to be achieved. The outline Narrative Statement shall be in sufficient detail to clearly show the Contractor's intention.

Within 7 weeks of the Employer's Representative's consent to the Initial Works Programme, the Contractor shall submit to the Employer's Representative an expanded and more detailed version of the Initial Works Programme containing all of the information and detail required under Clause 5 above. Such submission shall make use of the Tender Programme submitted earlier but refined to include the best estimates of dates for the work of Interfacing Contracts which has impact on the Contractor's programme.

Such programmes shall be amended subsequently to incorporate the actual dates/ schedule of the affecting contracts. It is the Contractor's responsibility to ensure timely co-ordination with the Interfacing Contractors to finalise the Initial Programme, without affecting progress of the work.

7. WORKS PROGRAMME REVISIONS

7.1. The Contractor shall immediately notify the Employer's Representative in writing of the need for any changes in the Works Programme, whether due to a change of intention or of circumstances or for any other reason. Where such proposed change affects timely completion of the Works or any other Key Date the Contractor shall within fourteen (14) days of the date of notifying the Employer's Representative submit for the Employer's Representative's Notice its proposed revised Works Programme and accompanying Narrative Statement. The proposed revised Works Programme shall show the sequence of operations of any and all works related to the change and the impact of changed work or changed conditions.

7.2. If at any time the Employer's Representative considers the actual or anticipated progress of the work reflects a significant deviation from the Works Programme, he may request the Contractor to submit a proposed revised Programme which together with an accompanying Activity Report and Narrative Statement, shall be submitted by the Contractor within fourteen (14) days after the Employer's Representative's instruction. The proposed revised Works Programme shall show the sequence of operations of any and all work related to the change and the impact of changed work or changed conditions.

7.3. All activities that have negative float must be analysed by the Contractor to identify the impact on the timely completion of the Works or on the achievement of Key Dates.

8. THREE MONTH ROLLING PROGRAMME

8.1. The Three Month Rolling Programme shall be an expansion of the current Works Programme showing the activities completed in the last month and the activities that are in progress or will start within the next three (3) months. The Three Month Rolling Programme shall provide more detail of the Contractor's plan, organisation and execution of the work within these periods. The Contractor shall expand each activity planned to occur during the next three (3) month period, if necessary, to a daily level of detail.

8.2. The Three Month Rolling Programme shall be developed as a Critical Path Method (CPM) network, and shall be presented in bar chart and time-scaled network diagram format. Bar charts shall be presented on A4 sheets and time-scaled networks diagrams A1 size. Tasks in the programme shall be derivatives of and directly related to tasks in the approved Works Programme. One (1) colour original and five (5) colour copies, with two softcopies on separate DVDs, of the schedule shall be submitted.

8.3. The Contractor shall describe the discrete work elements and work element inter-relationships necessary to complete all works and any separable parts thereof including work assigned to sub-contractors.

8.4. Activity duration shall not exceed two (2) weeks unless otherwise notice given by the Employer's Representative.

8.5. Each activity in the Three Month Rolling Programme shall be coded, or described so as clearly to indicate the corresponding activity in the Works Programme.

8.6. The Three Months Rolling Programme shall require the Employer's Representative's Notice

for payment purposes.

9. THREE MONTH ROLLING PROGRAMME REVISIONS AND UPDATE

9.1. The Three Month Rolling Programme shall be a progress update of the accepted Baseline Programme. The Three Month Rolling Programme shall be extended forward each month as described under Clause 8 above. Each submission of the Three Month Rolling Programme shall be accompanied by a Programme Analysis Report, describing actual progress to date, and the forecast for activities occurring over the next three-month period.

9.2. If the Three Month Rolling Programme is at variance with the Works Programme, the Programme Analysis Report shall be accompanied by a supporting Narrative Statement describing the Contractor's plan for the execution of the activities to be undertaken over the three month period, including programme assumptions and methods to be employed in achieving timely completion.

9.3. The Contractor shall revise the Three Month Rolling Programme or propose revisions of the Works Programme in accordance with Clause 8, or both, from time to time as may be appropriate to ensure consistency between them.

10. FIVE WEEK ROLLING PROGRAMME

Once a week, on a day mutually agreed to by the Employer's Representative and the Contractor, a meeting will be held to assess progress by the Contractor during the previous work week. The Contractor shall submit a construction schedule listing activities completed and in-progress within the previous week and the activities scheduled for the succeeding five weeks based on the detailed Works Programme. One (1) colour original and five (5) colour copies, with two softcopies on separate DVDs, of the schedule shall be submitted on A3 sized paper.

The Five Week Rolling Programme shall be in bar chart programme format. The activities shown shall be a complete amplification of the activities in the Three Month Rolling Programme and shall show breakdown of work in sufficient detail and on a room by room / area by area and day to day basis. The Five Week Rolling Programme shall be a working programme with sufficient data for reporting, monitoring, measuring, and evaluating the Contractor's progress of the Works and manpower deployment to site. All activities shall be referenced back to the 3-month rolling programme through the Activity ID. Activities that were scheduled to be completed but remain not completed shall be captured by the 5-week rolling programme notwithstanding that it may have fallen outside of the 5-week cycle. However, activity bars need not be shown for such activities to retain the 5-week cycle in the activity bar area. The Five Week Rolling Programme shall be submitted every Monday morning on a weekly basis. The percentage completion shall be agreed by the Employer's Representative

The Five Week Rolling Programme need not be computer generated and does not require a detailed programme analysis report. Any activity exceeding one week in duration shall be divided into sub-activities, the duration of which shall not exceed one week

The first Five Week Rolling Programme shall be submitted within 2 weeks of the contract Effective date, in colour on A3 paper.

11. PROGRAMMING PERSONNEL

The Contractor shall submit, as part of its Staff Organisation Plan, the names and experience and any required information for the staff to be employed on Works Programming. The principal Works Programmer shall hold reputable professional qualifications acceptable to the Employer's Representative including at least five (5) years relevant experience in programming civil engineering works. Others in the group shall have at least three (3) years' experience in such work. The programmers shall be employed by the Contractor full time on the Contract until the completion or such earlier time the Employer's Representative may give his consent.

12. PROJECT CALENDAR

For the Project, the Contractor shall adopt 7 days a week calendar, identical calendar for the purpose of programming and execution of Works. Official documents shall be transacted during 5 days week - Monday through Friday, except for National (Govt. of India) Holidays. For Project purposes, a week begins at 0001 hours on a Monday and ends at 2359 hours on a Sunday. The completion of an activity or the achievement of an event when given a week number shall be taken to mean midnight on the Sunday at the end of the numbered week. An access date or activity start date when given as a week number shall be taken to mean 0001 hours on a Monday of the Numbered week.

13. PROGRAMME AND REPORT SUBMISSION FORMAT

The Contractor shall submit one (1) original and five (5) copies in colour, and two softcopies on separate DVDs, of all submissions to the Employer's Representative. All submissions shall be in A0, A1, A3 or A4 size as specified in Volume 3 Employer's Requirements or other Volumes of the Contract Documents, except as may otherwise be instructed by the Employer's Representative.

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APPENDIX 5
Monthly Progress Report

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1. MONTHLY PROGRESS REPORT

1.1 The Contractor shall submit to the Employer's Representative one (1) colour original and five (5) colour copies, with two softcopies on separate DVDs, of the Monthly Progress Report. This Report shall be submitted by the last day of each calendar month and shall account for all work actually performed from 26th day of the last month and up to and including the twenty-fifth (25th) day of the month of the submission.

1.2 The Report shall be typed, printed and bound. It shall be supported by graphics and photographs as specified in Clause 10 of this Appendix 5 of section VI (1) F. It shall be submitted in a format to which the Employer's Representative shall have given his consent. Unless the Employer's Representative directs otherwise, the Contractor's Monthly Report shall contain sections/sub-sections for, but not limited to, the topics described in this Appendix.

1.3 The Contractor shall include in the Monthly Progress Report a record of monthly progress of various major Works on Site in the form of colour photographs with appropriate annotations and dates stated.

1.4 The Contractor shall deliver daily to the Engineer, a report as to the number of workers, plant and equipment employed on the works in each trade, etc. and a log of delivery notes for all goods and materials delivered to the Site. This information shall be summarised as a monthly return for the Monthly Progress Report.

The Contractor's Monthly Progress Reports shall include sections relating to the following activities:

2. FINANCIAL STATUS

2.1 A narrative review of all significant financial matters, and actions proposed or taken in respect to any outstanding matters.

2.1 A spread sheet summarising each activity, the budget, costs incurred during the period, costs to date, costs to go (including potential variations), cost forecast (total of costs to date and costs to go) and cost variance (difference between cost forecast and budget).

2.1 A spreadsheet indicating the status of all payments due and made.

2.1 A report on the status of any outstanding claims. The report shall in particular provide interim updated accounts of continuing claims.

3. PHYSICAL PROGRESS

3.1. The introduction shall briefly summaries the progress that has been made during the past month and how the actual progress relates to the planned progress in accordance with the Works Programme.

3.2. It shall describe the status of work performed, significant accomplishments, including critical items and problem areas, corrective actions taken or planned and other pertinent activities, and shall, in particular, address interface issues, problems and resolutions.

3.3. It shall include a simplified representation of progress measured in percentage terms compared with percentage planned as derived from the Works Programme.

3.4. Physical Progress S-Curve

3.5. The Physical Progress S-Curve shall be in the form of a graph, which compares the actual progress with the planned progress in terms of percentage to show the project performance.

3.6. The value of the physical progress achieved shall be assessed as the aggregate of the values of those activities which are separately identified on the Works Programme and which are:

(1) In the opinion of the Employer's Representative, wholly completed;

(2) In progress, provided that the value attached to each such activity shall be agreed with the Employer's Representative. Notwithstanding any value agreed with the Employer's Representative shown on the S-Curve, the S-Curve shall not be used for the purpose of Progress Payment Claim.

4. PROGRAMME UPDATE

Programme updating shall include:

The monthly Programme Update which shall be prepared by recording actual activity completion dates and percentage of activities completed up to the twenty-fifth (25th) of the month together with estimates of remaining duration and expected activity completion based on current progress. The Programme Update shall be accompanied by an Activity Report and a Narrative Statement. The Narrative Statement shall explain the basis of the Contractor's submittal:

a) Early Work and Baseline Submittals – explains determination of activity duration and describes the Contractor's approach for meeting required Key Dates as specified in the Contract.

b) Updated Detail Programme Submittals – state in narrative the Works actually completed and reflected along Critical Path in terms of days ahead or behind allowable dates. Specific requirements of narrative are:

If the Updated Detailed Works Programme indicates an actual or potential delay to Contract Completion date or Key Dates, identify causes of delays and provide explanation of Work affected and proposed corrective action to meet Key Dates or mitigate potential delays. Identify deviation from previous month's critical path.

Identify by activity number and description, activities in progress and activities scheduled to be completed.

Discuss Variation Order Work Items, if any.

The Programme Status which shall:

(a) Show Works Programme status up to and including the current report period, display Cumulative progress to date and a forecast of remaining work.

(b) Be presented as a bar-chart size A3 and as a time-related logic network diagram on an A1 media, including activity listings;

(c) Schedules of all significant activities tabulated in order of earliest starting date showing the following:

i. The actual start dates for activities which have commenced together with the scheduled start date for each activity and the time lapse;
ii. the actual completion dates for activities which have finished together with the scheduled finish date for each activity and the time lapse;
iii. the forecast and scheduled start dates for activities scheduled; the forecast and scheduled completion dates for activities which have commenced;
iv. the percentage completion of each activity started but not completed;
v. the total float of each activity not completed;
vi. Any known delays to activities.

(d) The Activity Variance Analysis which shall analyse activities planned to start prior to or during the report period but not started at the end of the report period as well as activities started and/or completed in advance of the Works Programme.

(e) The programme analysis report, in accordance with Engineer's Requirement.

The Resource Chart to show the actual resources mobilised for the works against the baseline figures in the Baseline Resource Charts

5. KEY DATES STATUS

A report on the status of all Key Dates due to have been achieved during the month and forecasts of achievement of any missed Key dates, and those due in the next month**.**

6. THREE MONTH ROLLING PROGRAMME

Include a copy of the 3-month Rolling Programme for that reporting period.

7. PLANNING, DESIGN AND CO-ORDINATION

7.1 Details of co-ordination of interface activities started or completed during the month and shall include for internal co-ordination within the Contractor's own multi-disciplinary team as well as external co-ordination with the Employer's Representative, other Interfacing Contractors, authorities and the like;

7.2 A schedule of all submissions and consents/approvals obtained/outstanding;

7.3 Details of design and drawing progress, including design interface coordination, started or completed during the month as related to the Temporary Works, Permanent Works and Shop drawings.

7.4 Updated Drawing Register;

7.5 Details of the progress of off-site activities such as design, production and/or fabrication of any components or materials;

a) Corrective actions either taken by or to be taken by the Contractor to maintain completion dates, including details of any changes made or to be made to the Works Programme to achieve this objective;

b) Contractor's organisation and resources;

c) Status of operation manual, maintenance manual, training manual, and other manuals as required by the contract.

d) Details of any other items, which the Employer's Representative or the Contractor, shall consider to be necessary or desirable from time to time.

8. PROCUREMENT REPORT

8.1 A summary of all significant procurement activities during the month, including action taken to overcome problems, and details of any outstanding actions.

8.2 A report listing major items of plant and materials, which will be incorporated into the Works. The items shall be segregated by type as listed in the Specifications and the report should show as a minimum the following activities:

(1) Purchase order date - scheduled/actual;

(2) Manufacturer/supplier and origin;

(3) Letter of credit Issued date;

(4) Manufacturer/supplier shipment date - scheduled/actual;

(5) Method of shipment;

(6) Arrival date in India- scheduled/actual;

(7) Analysis of any delay happening/anticipated with proposal for corrective measures.

9. CONSTRUCTION WORK AND TESTING

9.1 A review of all Construction work progress activities during the month.

9.2 Summaries of all Construction work outputs during the month together with forecasts for the next month.

9.3 Report on all works installation and erection on site during the month.

9.4 Review of all testing activities (both at site or at the manufacture's premises) during the month

10. PHOTOGRAPHS

10.1 Two sets of photographs shall be provided with the Monthly Progress Report in colour and shall be submitted in the following manner and format.

10.2 Digital colour photographs shall be 10cm x 15cm (4-inch x 6-inch), glossy prints, mounted in protective clear plastic folders and contained in a lever-arch binder. The electronic files shall also be provided in ".jpg" format on CD-ROM. The photographs and electronic files shall be identified by a brief narrative indicating:

(1) Contract number
(2) A unique sequential number based on an agreed drawing numbering system
(3) Specific location and subject of photograph
(4) Date and time of photograph

10.3 Each month the Contractor shall propose and the Employer's Representative will confirm the number of photographs to be supplied so as to accurately record progress on all parts of the works. The number of photographs shall not be less than 30 per set unless otherwise agreed by the Employer's Representative.

11. SYSTEM SAFETY

A review of all system safety activities during the month, which include as a minimum, as below:

a) The status of system safety activities with respect to the Project and its schedule.
b) Identified hazards for which adequate mitigation has yet to be provided, in the form of an updated Hazard Log.
c) Safety issues discussed with the Employer.
d) System safety incidents which have occurred on the Project since the last report

12. SITE SAFETY

A review of all safety aspects during the month including reports on all accidents, actions proposed to prevent further occurrence and safety performance to-date, including results of all audits undertaken during the reporting period.

13. ENVIRONMENTAL

A review of all the environmental issues during the past month to include all monitoring reports, mitigation measures undertaken and activities to control environmental impacts, including results of all audits undertaken during the reporting period.

14. QUALITY

A review of all major quality issues and non-conformances during the month including the quality control register and reports on actions proposed to prevent further occurrence as specified at Appendix 6, Part 2 to include results of all audits undertaken during the reporting period.

15. INTERFACE COORDINATION

A review of the progress of Interface coordination issues during the month highlighting significant outstanding issues and a reference to the interface coordination sheets (to be annexure to the monthly progress report) and associated deliverables.

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Appendix 6

QUALITY ASSURANCE FORMS

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Mumbai Metro Rail Corporation

1. Request for Inspection (RFI) Form

REQUEST FOR INSPECTION (RFI) (*Detail area to be Inspected)*	
Client:	Contractor:
RFI No:	Date:
We request you kindly arrange for the inspections / checking for the following Works. *(Provide brief description of the salient details of the Contract No)*	
Contract Item No: Specification Clause No: ITP/Hold Point details:	*(Specific area and detail that are requested to be inspected)*
1.Chainage/location: Brief Description of Works:	Safety Precautions taken: Yes/No Check list to be enclosed: Yes/No
Requested by: Name:	Position:
Date & Time:	Signature:
Comments / Recommendations of Employer's Representative	

Employer's Representative OBJECTION / NOTICE OF NO OBJECTION: *(Provide details if OBJECTION)*
Received Copy by Contractor's Representative: Name: Position: Date & Time: Signature:

Note: R.F.I. to be submitted at least 24 HRS prior to inspection.

Mumbai Metro Rail Corporation

2. Transmittal Form

Name		Transmittal Ref no.	
Contract no.		Date of Submission	
Sign			
Project Manager / His representative name			

Stages of submission –

Design	Execution	Test

We submit:

☐ Plans ☐ Specification ☐ Separately Via _____

☐ Work plan & Methodology ☐ BOQ

☐ Design criteria & Studies ☐ Report ☐ Items (specify)n_____

☐ Calculation ☐ Print

☐ Drawings ☐ Samples Others_____

SUBJECT:			
Date of document	**No. of Copies**	**Document reference**	**Revision**

These are transmitted as checked below (tick appropriate)

For information	1st submission	Re-submission with correction
Others		

Remarks Issuing Identity

	The document (s) hereby submitted have been properly reviewed according to our QA system, to confirm its completeness,

	accuracy, adequacy and validity
	Name
	Sign
	Date

Copies to	**ACKNOWLEDGMENT OF RECEIPT**
1	Date
2	Sign
3	Name

Mumbai Metro Rail Corporation

3. Document Submission Report (DSR) - status

STATUS SHEET

Contract No. _____ DSR code _____

Ref of letter /Transmittal _____ Discipline _____

Received letter date _____ Assessor _____

Discipline co-ord/leader _____

SUBJECT:						
List of documents submitted						
No	**Document reference**	**Revision**	**Date**	**Notification**		
				A	**B**	**C**
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						

Definition of notification:

A. Objection. A complete resubmission is required

B. No Objection with comments.

C. Notice of No Objection

Area of deficiencies	Comment No. (Note)	
	Repeated Comment	New Comment
	No of comment in PR*	No of comment in NS*
	PR=Partial Resubmission	NS=Next Submission

Discipline Leader

Name	Position	Date	Sign.

The comments are given to ensure the submission conforms to the Contract provisions

Mumbai Metro Line 3

4. Document Submission Report (DSR) - Comments

Contract No.:-		Discipline :-		Area of Deficiency (1) 1. Design not complying with functional requirement. 2. Detail incomplete 3. Detail not submitted 4. Undesirable design features 5. Conflict data 6. others	Status of comments (2) A- Resubmission B- Partial resubmission C- Notice of No objection
Contract submission		Assessor			Comment status P= Pending H= On hold C = Closed
Date revd		Designate discipline coordinator			
DSR code		Team leader			

No	C/S doc ref			Project Manager Comments	Issue		Area of deficiency (1)	Status (2)	Contractors/Suppliers Answers	Comment Status	Closure	
	Ref./ Code	Rev.	Page No,		Format	Funda-mental				By contractor	PM	Date
1												

Mumbai Metro Rail Line 3

BIDDING DOCUMENTS

EMPLOYER'S REQUIREMENTS

GENERAL SPECIFICATIONS

Part 2

Section VI (1)
Sub-Division F

Appendix 7

BIM, DRAFTING, AUTOCAD AND BENTLEY SOFTWARE

July 2019

Table of Contents

1 Building Information Modelling (BIM)

The Employer shall provide the BIM model to all the System Contractors for their reference, review, updates and further 3d modelling of The Systems as per the BIM Implementation plan, BIM Execution plan and various BIM Modelling Guidelines, necessary to make the system models required to extract working drawings and Asset Information Model for asset management purposes. The track contractors shall engage in ongoing 3D review process throughout the duration of the Project. The process may include regular meetings where both the BIM Coordinators from all parties and relevant design decision making. The Project Manager may attend when necessary.
Upon award of the system Contract, the Design Model developed up to Tender award by the Employer shall be provided to successful system contractor(s) for reference.

During Construction stage, the Final Design Model shall be revised and maintained by the Track Contractors and together with the revised working drawings that are derived from the revised final Design Model, be issued to the system contractor(s) for reference and development of Common Asset Management System Model at every issuance of revised working drawings, upon the Project Manager's request or as per the BIM Execution plan or at least on a weekly basis if there are any changes within the week.
As-built models of Architecture, Civil and Structure works as well as Building Services works under the Track Contract shall be developed, verified and finalized by the Track Contractors and submitted to the Project Manager and the relevant system Contractors.
The System Contractor shall ensure that Asset management BIM Deliverables are required to meet the quality assurance guidelines as stated in the BIM Implementation plan, BIM Execution Plan and Various Modelling Guidelines. Any deviation of quality assurance guidelines shall be outlined in the BIM Execution Plan for the Project Manager's review and a notice of no objection. The System Contractor shall provide the complete details of all the assets to be installed (Including Spares) in the project, for Asset Management Purpose in the form of excel sheets. The Contractor shall supply one (1) user licence including manuals and complete training . The software shall include but not limited to Revit, Navis works or equivalent.

Note: At implementation stage, the directives will be issued by the employer, Hardware standalone for 2 users will be given by track contractor to Employer and maintained by the Track contractor.

2 Tender Drawings

2.1 The Employer’s Drawings assist in describing the scope of the Works in general and clarify constraints, interface arrangements and the conceptual nature of the finished structures/system outline.

2.2 The Contractor shall carefully check all Employers’ Drawings and advise the Engineer of discrepancies, omissions, errors or ambiguities should any be found.

2.3 Dimensions shall not be obtained by scaling from the Employer's Drawings. Dimensions that are not shown or are not calculable from dimensions shown on Employer's Drawings shall be obtained from the ENGINEER.

3 AUTOCAD & BENTLEY

Programming software used shall be AUTO CAD for all drawings & BENTLEY for alignment of track etc., of latest version. Scheduling software and relevant instruction manuals, licensed for use in connection with the contract, shall be provided by the Contractor according to the Employer's specifications. The Contractor shall supply the Employer's Representative with 2 user licenses , including manuals and approved training of the software and any subsequent versions thereof at no extra cost.

This Document outlines the data input procedures between the General Consultant (GC) and Contractors. The data input procedures must be coordinated and the key parameters used to form AUTOCAD & BENTLEY data files must be standardized. The production & exchange of electronic data and hard copies shall comply with the requirements furnished in this document.

4 Objectives

The main objectives of the AUTOCAD & BENTLEY software are as follows:

(a) To ensure that the AUTOCAD & BENTLEY data files produced for Project particularly alignment are coordinated and referenced in a consistent manner.
(b) To provide the information and procedures necessary for a AUTOCAD & BENTLEY user from one discipline or external organization to access (and use as background reference), information from a AUTOCAD & BENTLEY data file prepared by another discipline or external organization.
(c) To standardize the information contained within AUTOCAD & BENTLEY data files which may be common to more than one discipline such as drawing borders, title boxes, grid lines etc.
(d) To establish procedures necessary for the management of AUTOCAD & BENTLEY data files.
(e) To ensure all contractors use 'Model space' and 'Paper space' in the production of their AUTOCAD & BENTLEY files

5 General Standards

5.1 Terminology

Physical Data – Graphics which represent the physical entities of a project. These include elements such as stairs, walls, columns, doors, trees etc. These entities are unaffected by the scale factor of the particular sheet file.

Notational Data – Graphics which contain annotation, dimensions, schedules, targets, notes etc. These elements are created based on the scale factor of the particular sheet file they serve; this will ensure consistent height and composition of all text.

Data Files – AUTOCAD & BENTLEY drawing files which maintain the unique data for a particular plan, section, elevation etc. for a particular discipline. Data files may contain physical as well as notational data.

Sheet Files – AUTOCAD & BENTLEY drawing files which represent specific plotted documents and can easily be used to make plots. These files hold no drawing information except for drawing borders and titles which are to be added in Paper Space. One or more data files may be attached to a sheet file as a block in order to compose documents for plotting.

5.2 Types of drawings

5.2.1 'Design drawings' mean all drawings except shop drawings and as-built drawings.

5.2.2 'Working drawings' are design drawings of sufficient detail to fully describe the Works and adequate to use for construction or installation.

5.2.3 Site drawings and sketches are drawings, often in sketch form, prepared on site to describe modifications of the Working drawings where site conditions warrant changes that do not invalidate the design.

5.2.4 'Shop drawings' are special drawings prepared by the contractor of various items within the Works to facilitate construction and installation.

5.3 Software standard

Files to be saved in AUTOCAD & BENTLEY current available version and should be compatible to other possible versions in use.

5.4 Units

All data is to be entered in metric units (meters). The level of precision is to be set at 0.000 (meters). The units are to be set in as Decimal with a precision of 0. 000.Angle measurements are to be set in as Decimal with a precision of 0.000.

5.5 World co-ordinate system

All data is to be saved in the World Coordinate System (WCS) and the view set to it. No User Co-ordinate System (UCS) is to be used unless specifically agreed upon by the entire team. The project origin is to be set to 0,0,0 in the WCS. The datum for GTS levels will be established after the site survey is completed

5.6 Revisions

All data is to be saved in the World Coordinate System (WCS) and the view set to it. No User Co-ordinate System (UCS) is to be used unless specifically agreed upon by the entire team. The project origin is to be set to 0,0,0 in the WCS. The datum for GTS levels will be established after the site survey is completed.

5.7 AUTOCAD & BENTLEY data transfer media and format

5. 7. 1 When AUTOCAD & BENTLEY data is received & transmittal between the General Consultant and the Contractor, the media shall be as follows:

a Data Exchange Format - AUTOCAD & BENTLEY latest or current available version
b Operating System –Windows Vista/XP/7/10 or latest
c Data Transfer Media
    i. 12cm Compact Disc (8 to 16 GB) is highly preferred
    ii. Portable USB hard disk (return to the Contractor upon data transfer) with software.

5. 7. 2 All storage media like Compact Disc must be labelled on the data shield with:
Name of Company
a Project Title
b Drawing Filenames (for diskettes only)
c Diskette No. / Total No. of diskettes or CD No. / Total No. of CDs
d All media shall be submitted with a completed Form (CAD Data sheet) or Letter

5. 7. 3 The Contractor must ensure the supplied media is free from virus / malwares / Ransomwares etc.

5. 7. 4 If AUTOCAD & BENTLEY data is created using UNIX, archive commands must be un-rooted and should be made compatible to be used with Microsoft based Operating Systems and Softwares.

6 Naming standard

6.1 Layer naming Standards

All AUTOCAD & BENTLEY elements shall be placed on the layers allocated for each different discipline. The layer naming convention to be adopted by the Contractor shall be submitted for acceptance and inclusion within these standards.

6.2 Drawing numbering standards

Each drawing shall be uniquely referenced by a drawing number and shall define both the current status and revision of the drawing. The current status of each drawing shall be clearly defined by the use of a single letter code as follows:

- P - Preliminary Design Drawing
- D - Definitive Design Drawing
- C - Construction Reference Drawing
- W - Working Drawing
- B - As-Built Drawing
- E - Tender Drawing

7 Graphic Standards

7.1 Line types

Standard Line types are preferred for all exchanged data. The Line types are used by the Contractor shall be submitted for acceptance and inclusion within these standards.

7.2 Line thickness and colour

To assist plotting by other users, the following colour codes will be assigned to the following line thickness / pen sizes.

Colour	Code No	Line Thickness
Red	10	0.18
White	7	0.25
Yellow	2	0.35
Brown	34	0.5
Blue	130	0.7
Orange	30	1.0
Green	3	1.4
Grey	253	2.0

7.3 Text Style and Fonts

With the exception of project standard title blocks and borders, all text used in drawings is to be the Arial. The Text heights to be used for the Drawing are:

- 2.5 mm: Notes
- 3.5 mm: Dimensions & Special Notes
- 5.0 mm: Normal titles
- 7.0 mm: Major titles

As drawings are prepared in A1 size but reduced copies will be delivered in A3 size, the minimum height is 3.5 mm. In general, no custom fonts will be accepted in drawing files unless they have been coordinated and have been incorporated into the project standard font file.

7.4 AUTOCAD & BENTLEY dimensioning

Automatic AUTOCAD & BENTLEY Dimensioning will be used at all times. Any dimensional change must involve the necessary revision to the model space file. If the AUTOCAD & BENTLEY Quality Control Checks find that the revisions have not been correctly carried out, the rejection of the entire AUTOCAD & BENTLEY submission will result.

7.5 Drawing scales

AUTOCAD & BENTLEY files shall be prepared at full scale 1=1 where 1 is equal to 1 meter. Authorized scales are: 1/50000; 1/25000; 1/10000; 1/5000; 1/2000; 1/1000; 1/500; 1/200; 1/100; 1/50; 1/25; 1/20; 1/10; 1/5; 1/1

7.6 Block libraries, block and block names

1) All Construction Industry symbols produced as AUTOCAD & BENTLEY Cells shall typically conform to British Standard BS1192 - part 3.
2) All Blocks created shall be Primitive (i.e. NOT Complex) and shall be placed Absolute (i.e. NOT Relative).
3) The Contractor's specific block libraries shall be transmitted to GC together with an associated block library list containing the filename (max. 6 characters) and block description. The Contractor shall ensure that the library is regularly updated and circulated to all other users, together with the associated library listing.

4) All Blocks of a common type, symbols or details should initially be created within a AUTOCAD & BENTLEY "Model Space File" specifically utilized for that purpose. These files will be made available on request by GC.
5) All Blocks created will typically be 2D unless 3D is specifically requested. In both instances they shall have an origin at a logical point located within the extents of each Block's masked area or volume.

7.7 Prototypes drawings

The master prototype drawing "Civil – Template.dwt" incorporating standards for line types, text styles etc. is to be used as the standard drawing.

7.8 Location plan

1. Location Plan is an area map that graphically illustrates the general location, by technical area
2. Where the construction is planned.
3. All drawing sets are required to have a Location Plan.
4. Locate this plan on the Title Sheet in the upper right hand corner of the sheet.
5. Show enough of the surrounding areas (streets, buildings, structures, etc.) to clearly identify the project location.

7.9 Title block

Title block will be composed of two parts.

First, a block containing the attributes of the drawing: Titles, numbers, dates …and a table with the list of all Xref used to produce the drawing.

The second part will be a reference file containing the non-amendable objects of the drawing: Frame, logos, Project name ….

- These two parts will be set in the paper space, at scale 1=1 mm.
- The block will not be split.
- The reference file of the Title Block will not be merged.
- Only one title block in one file is permitted.
- One File = One Document = One Title block

Annex A – Design Certificate

This Design Certificate refers to Submission No. ...…… which comprises:

[*Design Package No. .... /the Definitive Design Submission/Installation Reference Drawings Submission No. .... /Technical Submission No. ....] in respect of:

[description of the Permanent Works to which the submission refers]

The contents of this submission are scheduled in Section A below.

The documents scheduled in Section B below, for which a Notice of No Objection has been issued, are of relevance to this submission.

LEAD DESIGNER'S STATEMENT

We certify that:

(a) the design of the Permanent Works, as illustrated and described in the documents scheduled in Section A below, complies with the Employer's Requirements, Outline Design Specifications, Outline Construction Specifications & other Contract provisions, local regulations and standards and ..... [*see note 1 below*];

OR (in the case of a Definitive Design Submission in respect of those elements identified under Clause C2(6) of the Employer's Requirements - Design):

a. The outline designs, design briefs and performance specifications of those elements of the Permanent Works as illustrated and described in the documents scheduled in Section A below comply with the Employer's Requirements, Outline Design Specifications, Outline Construction Specifications & other Contract provisions and ..... [*see note 1 below*];

OR (in the case of a submission of documents that do not strictly comply with previous documents for which a Notice of No Objection has been received):

b. The design of the Permanent Works, as illustrated and described in the documents scheduled in Section A below, complies with the Employer's Requirements, Outline Design Specifications, Outline Construction Specifications & other Contract provisions and ..... [see note 1 below] except in the following respects:
   (i) ..... (to be completed by Contractor/Designer)

(b) A detailed review and design check has been undertaken and completed to confirm the completeness, adequacy and validity of the design of the Permanent Works as illustrated and described in the documents scheduled in Section A below;

(c) all necessary and required approvals relating to the design of the Permanent Works, as illustrated and described in the documents scheduled in Section A below, have been obtained and copies of such approvals are annexed in Section C below;

(d) all effects of the design comprising the submission on the design of adjacent or other parts of the Works have been fully taken into account in the design of those parts.

Signed by 'Authorised Representative' (for Designer)

Name _____
Position / Designation _____
Date _____

LEAD DESIGN CHECKER'S CERTIFICATION

We certify that the Work described in Section A of this certificate has been checked by us, and meets all the requirements of the Contract.

Signed by 'Authorised Representative' (for Design Checker)

Name _____
Position / Designation _____
Date _____

CONTRACTOR'S CERTIFICATION

This Certifies that all design has been performed utilising the skill and care to be expected of a professionally qualified and competent designer, experienced in work of similar nature and scope. This further certifies that all works relating to the preparation, review, checking and certification of design has been verified by us and that the design meets all the requirements of the Contract and has been accepted by us vide Clause 20 of GCC
+
Signed by 'Authorised Representative' (for Contractor)

Name. _____
Position/Designation. _____
Date _____

Note 1
The Contractor shall insert one of the following, as applicable:
(i) the Contractor's Technical Proposals
(ii) the Contractor's Technical Proposals and Design Packages Nos. ..... for which a Notice of No Objection has been issued.
(iii) Design Packages Nos. .... ….. for which a Notice of No Objection has been issued if such Design Packages develop and amplify the Contractor's Technical Proposals.
(iv) The Definitive Design

Section A

Submission no. .... comprises the following:
Drawings: *(Title, drawing number and revision)*
Documents: *(Title, reference number and revision)*
Others: _____

Section B

Documents for which a Notice of No Objection has been issued and which are of relevance to this Submission No. _____....
Document: _____
submitted with
[*Design Package No. ……./) *The Contractor is required to* the Definitive Design Submission No……./) *provide this information in* Construction Reference Drawings Submission No. .... /) *respect of each document in* Technical Submission No..……/) *Section B*

Date of Issue of Notice of No Objection)
(Delete as appropriate)*

Section C

[Contractor to attach copies of necessary and required approvals from statutory bodies, etc.]

Mumbai Metro Rail Line 3
BIDDING DOCUMENTS

EMPLOYER'S REQUIREMENTS
GENERAL SPECIFICATIONS

Part 2

Section VI (1)
Sub-Division F

Appendix-8

TEMPORARY POWER SUPPLY

July 2019

TEMPORARY POWERSUPPLY

1. INTRODUCTION

The Conditions for supply of electricity by the Contractor to Interfacing Contractors are given under Clause 2 of this Appendix.

2. ELECTRICAL SUPPLY CONDITIONS

2.1. Work on Site

(a) The Contractor shall nominate a representative whose name and qualifications shall be submitted in writing to the Engineer for review not later than 4 weeks before the appointment and who shall be solely responsible for ensuring the safety of all temporary electrical equipment on Site. The Contractor shall not install or operate any temporary Site electrical systems until this representative is appointed and has commenced duties.

(b) The name and contact telephone number of the representative having been reviewed with a notice of no objection by the Engineer shall be displayed at the main distribution board for the temporary electrical supply so that he can be contacted in case of an emergency.

(c) Schematic diagrams and the details of the equipment for all temporary electrical installations shall be submitted by the Contractor, and these diagrams together with the temporary electrical equipment shall be submitted to the Engineer for a notice.

(d) All electrical installation work on Site shall be carried out in accordance with the requirements laid down in BS 7375 and the Specification. All work shall be supervised or executed by qualified and suitably categorized electricians, who are registered as such under the Electricity Ordinance 1990 / Electricity (Registration) Regulations 1990.

2.2. Electrical General

Temporary electrical Site installations and distribution systems shall be in accordance with:-

(1) Indian Electricity Rules
(2) The Power Companies' Supply Rules;
(3) Electricity and its subsidiary Regulations;
(4) IEE Wiring Regulations (16^{th}Edition);
(5) BS 7375 Distribution of Electricity on Construction and Building Sites;
(6) BS 4363 Distribution Assemblies for Electricity Supplies for Construction and Building Sites; and
(7) Any other applicable national standards

2.3. Materials, Appliances and Components

All materials, appliances and components used within the distribution system shall comply with BS 4363 and BS 7375 Appendix A and shall be inspected and approved by the Engineer before being used or operationalised at site

2.4. Design Considerations

1. Distribution equipment utilized within the temporary electrical distribution system shall incorporate the following features:-

(a) flexibility in application for repeated use;

(b) suitability for transport and storage;

(c) robust construction to resist moisture, dust and damage; and

(d) safety in use.

2. All cabling shall be run at high level whenever possible and be firmly secured to ensure they do not present a hazard or obstruction to people and equipment.
3. The installation on Site shall allow convenient access to authorized and competent operators to work on the apparatus contained within.

2.5. Mains Voltage

1. The Site mains voltage shall be as per the Electricity Authority, 415V / 3 phase 4 wire system.
   (a) Single phase voltage shall be as per the Electricity Authority,240V supply.
   (b) Reduced voltages shall conform to BS7375.
2. Types of Distribution Supply
   The following voltages shall be adhered to for typical applications throughout the distribution systems:
   a) fixed plant - 415V/ 3phase;
   b) movable plant fed by trailing cable - 415V / 3phase;
   c) installations in Site buildings - 240V/1phase;
   d) fixed flood lighting - 240V/ 1phase;
   e) portable and hand held tools - 240V/1phase;
   f) Site lighting (other than flood lighting) - 240V/1 phase;and
   g) Portable hand-lamps (general use) - 240V/1phase.
3. The required permissions from local Environmental Authorities/Pollution Control Board or any other relevant Authority shall be obtained by the Contractor for using DG sets for power supply.
4. Protection of Circuits
   a) Protection shall be provided for all main and sub-circuits against excess current, under and over voltage, residual current and earth faults. The protective devices shall be capable of interrupting (without damage to any equipment or the mains or sub-circuits) any short circuit current that may occur.
   b) Distribution and sub distribution electrical panels shall have a degree of protection not less than IP65.
   c) Discrimination between circuit breakers, and fuses shall be in accordance with:-
      (i) BS88;
      (ii) BS EN 60898;and
      (iii) BS7375;
      (iv) Any other appropriate Indian Standards.

2.6. Earthing

1. Earthing and bonding shall be provided for all electrical installations and equipment to prevent the possibility of dangerous voltage rises and to ensure that faults are rapidly cleared by installed circuit protection.
2. Earthing systems shall conform to the following standards:-
   (a) IEE Wiring Regulations (16thEdition);
   (b) BS7430;
   (c) BS 7375;and
   (d) IEEE Standard 80 Guide for Safety in AC Substation Grounding.
   (e) IS:3043

2.7. Plugs, Socket Outlets and Couplers

Low voltage plugs, sockets and couplers shall be colour coded in accordance with BS 7375, and constructed to conform to BS EN 60309. High voltage couplers and 'T' connections shall be in accordance with BS3905.

2.8. Cables

1. Cables shall be selected after full consideration of the conditions to which they will be exposed and the duties for which they are required. Supply cables up to 3.3 KV shall be in accordance with BS6346.
2. For supplies to mobile or transportable equipment where operation of the equipment subjects the cable to flexing, the cable shall conform to one of the following specifications appropriate to the duties imposed on it:
   (a) BS 6708 flexible cables for use at mines and quarries;
   (b) BS 6007 rubber insulated cables for electric power and lighting; and
   (c) BS 6500 insulated flexible cords and cables.
3. Where low voltage cables are to be used, reference shall be made to BS 7375. The following specifications shall also be referred to particularly for underground cables:-
   (a) BS 6346 for armored PVC insulated cables; and
   (b) BS 6708 Flexible cables for use at mines and quarries.
4. All cables which have a voltage to earth exceeding 65V (except for supplies from welding transformers to welding electrodes) shall be of a type having a metal sheath and/or armour which shall be continuous and effectively earthed. In the case of flexible or trailing cables, such earthed metal sheath and/or armour shall be in addition to the earth core in the cable and shall not be used as the sole earth conductor.
5. Armoured cables having an over sheath of polyvinyl chloride (PVC) or an oil resisting and flame retardant compound shall be used whenever there is a risk of mechanical damage occurring.
6. For resistance to the effects of sunlight, overall non-metallic covering of cables shall be black in colour.
7. Cables which have applied to them a voltage to earth exceeding 12V but not normally exceeding 65V shall be of a type insulated and sheathed with a general purpose or heat resisting elastomer.
8. All cables which are likely to be frequently moved in normal use shall be flexible

cables.

9. The cables used shall be joint free. If a joint is unavoidable at certain location, the same shall be formed by skilled/certified person only and the material used for this purpose shall be subject to approval of the Engineer.

Flexible cables shall be in accordance with BS 6500 and BS7375.

2.9. Lighting Installation

1. Where Site inspection of the Works is required during the nights, the Lighting circuits shall be run separate from other sub-circuits and shall be in accordance with BS 7375 and BS 4363.
2. Voltage shall not exceed 55V to earth except when the supply is to a fixed point and where the lighting fixture is fixed in position.
3. Luminaries shall have a degree of protection not less than IP 54. In particularly bad environments where the luminaries are exposed to excesses of dust and water, a degree of protection to IP 65 shall be employed.
4. The Contractor shall upgrade the lighting level to a minimum of 200 lux by localized lighting in all areas where required by the Engineer.
5. Mechanical protection of luminaries against damage by impact shall be provided by use of wire guards or other such devices whenever risk of damage occurs.
6. All light fixtures shall be fixed on appropriate pedestals when not fixed with mounting base on the structures.

2.10. Electrical Motors

1. Totally enclosed fan cooled motors to BS 4999: Part 105 shall be used.
2. Motor control and protection circuits shall be as stipulated in BS 6164. Emergency stops for machinery shall be provided.

2.11. Inspection and Testing

Electrical installations on Site shall be inspected and tested in accordance with the requirements of the IEE Wiring Regulations (16^{th}Edition).

2.12. Identification

Identification labels of a type reviewed with a notice of no objection by the Engineer shall be affixed to all electrical switches, circuit breakers and motors to specify their purpose

2.13. Maintenance:

1. Strict maintenance and regular checks of control apparatus and wiring distribution systems shall be carried out by an electrician (duly qualified to carry out the said checks) to ensure safe and efficient operation of the systems. The Contractor shall submit for a notice by the Engineer details of his maintenance schedule and maintenance works record.
2. All portable electrical appliances shall be permanently numbered (scarf tag labels or similar) and a record kept of the date of issue, date of the last inspection carried out and the recommended inspection period

Mumbai Metro Rail Line 3

BIDDING DOCUMENTS

EMPLOYER'S REQUIREMENTS

GENERAL SPECIFICATIONS

Part 2

Section VI (1)

Sub-Division F

APPENDIX-9

RAILWAY ENVELOPE ACCESS AND TAKING OVER

July 2019

1. RAILWAY ENVELOPE ACCESS AND TEMPORARY TAKING OVER BY CONTRACTOR

RAILWAY ENVELOPE TAKING OVER

1. The Railway Envelope is defined as per Section VI (1) F Appendix 18 SOD.
2. The conditions for Temporary handover of the Railway Envelope are as follows:
   a. At the time of handing over the Railway Envelope, the Contractor shall have executed all necessary works on the structure and all other work within the Railway Envelope, including the installation of all equipment and shall ensure that the Envelope is complete, secure, safe for the operation of trains, and has the Engineer In Charge's and Engineers in Charge Notice of No Objection for effective handover.
   b. From the Railway Envelope handed over date any access to the Railway Envelope by the Contractor shall be in accordance with any procedures, requirements and conditions as defined in the Contractor
3. The conditions for access to the Railway Envelope after handing Over are as follows:
   a. Access to the Railway Envelope after Taking Over will be controlled by the Engineer in charge and priority will be given to the testing and trial running of rolling stock and other operating components associated with the railway. Access will be given to the Contractor and to other contractors by the Engineer In Charge for inspecting, maintaining, adjusting and repairing, by prior arrangement and for limited periods.
   b. At the time of Taking Over, the Contractor shall provide the Engineer In Charge with the name of, and twenty-four (24) hour contact procedure for, the individual charged in liaison with the Engineer In Charge. The Contractor shall give two weeks notice of his desired track possessions, and this appointed liaison officer shall attend, when requested, the appropriate meetings where track possession allocations will be made by the Engineer In Charge. It may be necessary for the Contractor's work to be carried out intermittently or at night if suitable possessions cannot be given during its preferred hours. During all such operations the Contractor will be fully responsible for safety of men, equipment and works.
   c. After the Taking Over, and prior to the completion of the Project, the Project Contractors will be undertaking the following activities:
      i. laying of tracks and other connected equipment
      ii. undertaking acceptance tests, Integrated System Tests and test running:
      iii. undertaking trial running: which will increase as the trials proceed until full operating frequencies are reached.

   The Contractor shall take into account the Project Contractors' activities and train

operations in planning and programming its Works.

4. Prior to the substantial completion of the Project, the Railway Envelope will be handed over back to the Contractor for Completing Test on Completion activities final adjustment, tightening, touching up or cleaning.

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Appendix 10

MUMBAI METRO ASSET LABELLING SCHEME

July 2019

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1 Introduction

1.1 Overview of System

For the MML3 project, there is a need to standardize the site identification, equipment identification as well as cable identification practices, to ensure that a uniform practice is followed by all parties on the project, while referring to sites, equipment and cables in various design and execution drawings. This would also require standardization of documentation required to be submitted at the time of commissioning of the system. This should cover various disciplines and associated sub-systems.

1.2 Brief Description of functions to be provided

All parties connected with the project have to follow the broad principles outlined in this document. While this gives broad principles for various disciplines and sub-systems, using the telecom system as an example (with details of likely changes for other systems), at the detailed sub-system and detailed equipment level, the concerned design contractors have to propose the detailed identification scheme within the broad guidelines and field lengths explained herein and get the detailed scheme submitted for Notice of No-objection from the employer at the detailed design stage.

1.3 General Locations

The scope of this specification covers the equipment and cables installed at equipment rooms of stations, at site locations (indoor &outdoor) at the same site/location, at line-side locations, intra-site &inter-site cabling etc. Sub-assemblies, components, and intra-equipment cabling will be identified as per vendor's standard methodology.

2 Identification Methodology to be followed at Design Stage

2.1 Site Identification

2.1.1 General Principles

The sites to be identified could be a station with or without interlocking, maintenance depots, operational control centre, traction sub-stations, traction sectioning posts, traction sub-sectioning posts, High Voltage Receiving Stations, Ventilation Shafts etc. For the sake of uniformity, a 5-digit alphabetic code, which rhymes with the popular description of that location is proposed. All sites having a passenger interface will start with 'MM', so that they are clearly identified as part of Mumbai Metro; this will be especially useful at inter-change stations on the existing rail network like Mumbai Central etc. Sites not having direct passenger interface but used only for operational or maintenance purposes, will also have a 5-digit alphabetic code, which is a combination of station code and purpose for which the site is used; these will not have the prefix 'MM'.

2.1.2 Proposed site codes for stations and internal sites of MMRL

Item no.	Site Description	Site Identification Code
1		
2		
3		

For any geographical location not mentioned above, a code following the same rules shall be proposed and submitted to the Project Manager for Notice of No-objection.

2.2 Equipment Labelling Scheme

2.2.1 General Principles

a. The idea is to assign a unique identification code for all main equipment used in the project (other than sub-assemblies and components), to facilitate ease of identification at site for the maintenance personnel and also for creation of asset data base in the computerized NMS /GIS system. The site identification code, detailed location identification code, asset area (department/agency responsible for its maintenance), sub-system code within the asset area, equipment type code, serial number (if there is more than one of the same type at the same location), zone code in which it is located (if applicable) and a suffix code indicating whether it is a Main/Stand-By asset, will be part of the equipment identification, in the following format

S(5AN)/L(4AN)/AA(4AN)/SS(4AN)/ETC(4AN)/SN(3N)/ZC(1N)/SUF(1AN)

Wherein,
S - stands for site identification code 5- digits alpha-numeric
L - stands for detailed location code -4 digits alpha-numeric
AA (asset area) - stands for department/agency responsible for maintenance-4 digits alpha-numeric
SS - stands for broad sub-system code within the asset area- 4 digits' alpha-numeric (blanks to be added in the beginning, where necessary, to maintain a uniform length of 4 digits),
ETC - stands for equipment type code within the particular asset area-4 digits' alpha-numeric (blanks to be added in the beginning, where necessary, to maintain a uniform length of 4 digits)
SN - stands for serial number of the equipment of the same type at the same detailed location-3 digits numeric
ZC - stands for number of the zone to which the equipment belongs-1 digit numeric (applicable for assets like speakers, clocks, lights, fans etc.)
SUF - stands for suffix denoting equipment usage like main/stand-by-1digit alpha-numeric.

b. Where a particular field is not applicable for an equipment, the code will have zeroes for the length of the field. The code is explained below in the context of telecommunications.

2.2.2 Application of the proposed numbering scheme for telecommunication equipments:

a. S will be assigned based on the methodology explained in section 2.1.2 above. For equipments located at intermediate locations (between stations for example), the site code will be:
C1 (or 2) U (or D)KM/Traction Mast Number(of the nearest mast) in this C1 or C2 will denote MMRL Corridor Number, U for up line, D for down line (train direction), Km will be Kilometer in ascending order (whole number) of that location from the reference point and Traction Mast number will be the last two digits of the nearest mast number.C2/U/16/15 will denote a site in between stations(as it starts with C followed by a numeric).located on up line of corridor 2 at km 16 between kms 16&17 close to traction mast number 15.Between two kilometer posts, traction masts are numbered 1,3,5,7 etc. on up line and 2,4,6,8 on down line.

b. L will be allocated as under:

L will be 0 for basement or below road level in case of elevated stations or for above road level for underground stations, 1 for road/street level, 2 for concourse level, 3 for platform level. In case of multi-storeyed building like OCC, the first digit can denote floor level, based on the above principles. The last three digits of detailed location code will denote specific location at that level namely PF1, PF2, CP1 (cross passage 1 or 2), CER (communication equipment room), SER (Signaling equipment room), SCR (station control room), BC1(booking counter 1), HP1(passenger help point 1), FA1(fire alarm point 1), ASS (aux sub-station) etc.

c. AA will be allocated as under:
   1) SIGL for signals
   2) TELE for telecoms
   3) AFCS for automatic fare collection
   4) HVAC for high voltage distribution system other than traction
   5) HVTR for high voltage distribution system -traction
   6) PEDC for machinery& plant working off dc supply
   7) PEAC for machinery &plant working off ac supply
   8) LGHT for lighting system
   9) BMSY for building management system
   10) RGST for rolling stock system
   11) TRSC for Traction Scada System
   12) TRKS for track maintenance incl. Tunnels, Ramp and At- Grade
   13) ITSS for IT support system
   14) ADMN for administration set-up

d. SS for telecoms systems (as an example) will be assigned as under:(sub-systems that are less than 4-character length, will have corresponding blank spaces in the beginning to have a total of 4 characters).

   1) FOTS for the Fiber Optic Transmission System

2) TEL for the Telephone System
3) TDS for the Time Distribution System
4) RAD for the Radio System
5) PAS for the Public Address System
6) PIDS for the Passenger Information Display System
7) CCTV for the Closed Circuit Television System
8) ACID for the Access Control & Intrusion Detection System
9) HPS for the Help Point System
10) VRS for the Voice Recording System
11) FRS for the Fault Reporting System
12) UPS for the Uninterruptable Power Supply

e. ETC for telecoms (as an example) will be as under:
1) OFDF – Optical Fiber Distribution Frame equipment
2) ROU – Routers
3) SWCH - switches
4) MODM -modems
5) TRML - terminal
6) SRVR - server
7) MIC - microphone
8) SPK - speaker
9) AMPR - amplifier
10) CLK - clock
11) WS – work station
12) JB – Cable Junction Box
13) CJ – cable joint
14) MDF- main distribution frame
15) PB/PS -push button/switch
16) DU- display unit
17) TX- transmitter
18) RX- receiver
19) BS- base station
20) LCX- leaky co-axial cable
21) FRMW- firmware

f. SN can be a 3 digit numeric from 001 to 999 depending upon the serial number of the device of the same type at the same detailed location code (same previous codes).
g. ZC can be a single digit code from 0 to 9 depending upon the physical zone number of which the equipment is a part.
h. SUF will be M if it is the main equipment and S if it is the spare/stand-by equipment.
i. Wherever ZC, SUF are not applicable, corresponding zeroes will be entered at the appropriate places.
j. As an example, CMSAN/3SCR/TELE/HMIS/ MIC/001/0/0, will denote a microphone with serial no 1, forming part of Human Machine Interface sub-system of telecoms asset area, located in SCR's room on platform level of the metro station.

2.3 Cable numbering & Labelling Requirements

2.3.1 General Principles (control cables and communication cables)

a. Cables can be for
   1) intra-rack wiring,
   2) inter-rack /inter-equipment/inter-device wiring within same indoor site
   3) do-from indoor location to outdoor
   4) Between locations at the same site
   5) wiring from a site to a line-side location (located between two sites)
   6) wiring from one site to another.

b. For intra-rack wiring, the nomenclature and labelling standards as prescribed by the supplier as per details to be indicated in the accompanying detailed documentation, will apply.

c. For cabling coming under categories 3.3.1 (a) 2 to 5, the cable identification will have the format LA-CS-SN-LB, wherein
   1) LA stands for detailed equipment code of equipment at 'A' end, as per the principles explained in section 3.2 above (33 digits)
   2) CS stands for cable service type, based on end-use to which the cable is put to. It will be a 4digit alpha-numeric code as under:
      a. LVAC- low voltage power cable ac
      b. LVDC- low voltage power cable dc
      c. HVAC- high voltage power cable ac
      d. CCNS- cable for control applications, screened type
      e. CCNU-cable for control applications, un-screened type
      f. CDAS- cable for data applications, screened type
      g. CDAU-cable for data applications un-screened type
      h. CAUS- cable for audio signals, screened type
      i. CAUU- cable for audio signals, un-screened type
      j. CQDS- cable quad type screened
      k. CQDU- cable quad type unscreened
      l. COFC- cable optical fiber cable type
      m. CERT- cable for earthing purposes
   3) SN will be a single digit numeric indicating the serial number of cables having identical service type, if laid between the same two detailed equipments (that is where LA and LB are identical for the two cables and they also have the same cable service type)
   4) LB will be the detailed equipment code at 'B' end, served by the cable. The format and coding arrangement will be similar to LA.
   5) Example:

      CMSKO/3CER/TELE/OPLT/ MDF/001/0/0
      CQDS-I
      C2/U/12/13/TELE/OPLT/TELW/001/0/0,

      will denote a lone screened quad cable running between MDF1 of operational telephone system located at CER in platform level of the station to a lone wall-mounted telephone

forming part of operational telephone sub-system of telecoms, located on up line of corridor 2 near traction mast no.13 beyond km 12.

2.3.2 General principles (High Voltage and LT feeder cables)

a. For traction feeder cables and High Voltage feeder cables, the designations will be the same as used on relevant sub-station HT diagrams.

b. For low tension feeder and distribution cables, the cable identification will have the same format of LA-CS-SN-LB as in the case of control and communication cables, with the difference that cable service type will have the fields vvvv/cable service code/xxxc/yyy in which vvvv is the voltage rating of the cable in volts or kilovolts, cable service code will be as explained in section 3.3.1, xxx is the number of cores and yyy is diameter in mm or cross-sectional area in mm square. For example, CS can have a code33kv/HVAC/3.5C/185, if it is a cable used in 33kv high voltage distribution circuit, and is having 3.5 cores of 185mm diameter.

2.3.3 Cable Labelling Requirements

a. The purpose of labelling is to ensure that cables can be readily identified on site, without reliance on record drawings or electrical testing. It should be possible to make a positive identification without having to trace any cable through barriers, ducts or other obstructions. It is to be noted that labelling is required to facilitate identification and inspection of cables, but is not to be relied upon for work which requires the cable to be dead. Before any such work a positive identification with a detector shall be made, to ensure that it is safe to handle the cable.

b. Cables shall be marked at suitable locations throughout their length to allow ease of identification but as a minimum at every termination point and prior to cabinet entry and after strip back within a cabinet. As a minimum, cables should be marked at least at the two ends. Cables shall also be marked at cable pulling points and at joints (where applicable).

c. Cables should also be labelled at the point of entry into and exit from any area; thus if passing through ducts or a wall or other barrier, the cable shall be labelled adjacent to the entry or exit point. On a long and continuous run, the labelling scheme should be such that cables are labelled at least once in 500 metres.

d. Where there are a number of cables in a run, then all should be labelled at the same location. Thus if a cable joins a run via a duct and is required to be labelled, then other cables in the run should also be labelled at the same point.

e. The markings on the cables should contain the details explained in section 3.3.1(c)5 above.

f. The details of the circuit in which each cable conductor is used as well as details of spare conductors should also be indicated at site through appropriate tags affixed to the relevant conductor, at each joint/ termination of the cable. The design of the tags, the system of lettering and the method of fixing should be submitted for Notice of No-objection from the Employer's Representative before-hand.

2.3.4 Type of Labelling system and method of fixing

The labels shall be of LSOH materials, of a durable nature and legible when dirty. The system shall be suitable for retrospective fitting on all types of cable and should not rely on adhesive for fixing. The label shall be fitted to the cable by means of an appropriate sized non-detachable mechanical fastener. Designation numerals and letters shall be not less than 6mm high for cables up to 45mm diameter and not less than 10mm high for cables over 45mm diameter.

2.4 Equipment, Cable and Cable-Routing Records

2.4.1 List of Documents to be maintained and forming part of assurance handover documentation

a. Equipment Schedule
b. Cable and Routing Schedule
c. Cable Routing Plans
d. Cable Schematic (cable block diagram)
e. Cable Routing assurance check sheet (at cable terminations, joints and pulling points)

2.4.2 The contents of the documents listed in section 3.4.1 are explained below:

2.4.3 Equipment Schedule

Site Identification Code	Site Name	Detailed equipment code including Serial No, zone code, Main/stand-by code	Equipment Lay-Out Plan reference	Notes

2.4.4 Cable and Routing Schedule

Site Identification Code	Cable Description				Starting From (description of equipment, junction box, joint, cable termination point, as the case may be)	Ending at (description of equipment, junction box, joint, cable termination point, as the case maybe)	Site Identification Codes of Cable Pulling Points(CPP) en-route in serial order from cable starting end	Distance of each CPP from Cable Starting End	Notes
	Complete Cable Identification Code (as per Section 3.3.1)	Cable service Type and Manufacturing Details	Cable Length (as per design)	Cable Length (actual)					

2.4.5 Cable Routing Plans

This should show in a diagram, the horizontal alignment of various cables in a duct, the relevant distances and details of fixed structures en-route to facilitate easy identification at site. Should cover the full length of the cable/cables. The drawing should conform to standard specifications of the employer.

2.4.6 Cable schematic (cable block diagram)

This should show in a diagram (as per standard specifications of the employer) the relevant details of connection to all equipment (from starting point up to the end connections), duly

bringing out the details of cables used in between, the details of utilization/spares in each cable, the location of cable joints and terminations en-route (with relevant distances) etc. The details should be sufficient to locate and trace the relevant conductors while trouble-shooting an equipment and to restore by substituting with spares in the cables. The details of the circuit in which each cable conductor is used as well as details of spare conductors should also be indicated at site through appropriate tags affixed to the relevant conductor, at each joint/ termination of the cable.

2.4.7 Cable Routing Assurance Check Sheet (at cable terminations, joints and pulling points)

This should show in a tabular form, the cable identification codes (at terminations, joints and cable pulling points) as well as circuit correspondence particulars of each core/pair in the cable (at each termination point and joint) and a positive confirmation against each entry that the site conditions as well as the labels and tags provided at site, correctly correspond to the description as per design documents. This document should be prepared and got verified by the installing and testing staff at the time of cable laying/jointing/terminating as the case may be.

2.4.8 The format and form design of the documents listed at section 3.4.1 should be got approved from the employer in advance, before actual preparation of the documents.

2.5 Interfaces

Not Applicable as this specification covers the identification methodology, labelling requirements and documentation to be submitted by various contractors for their portion of the work.

3 Performance requirements

Not Applicable.

4 Summary of Interfaces

Not Applicable.

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Appendix 11

CURVE AND GRADIENT DETAILS

July 2019

Contents

1. UP LINE CURVE DETAILS

	CURVE NO.		18/19-ULC 01	18/19-ULC 02	18/19-ULC 03	19/20-ULC 01	20/21-ULC 01	20/21-ULC 02
UGC 05	COORDINATE OF APPEX	EASTING	274122.551	274062.974	273997.896	273447.559	273480.854	273405.718
		NORTHING	2109131.21	2109238.326	2109375.596	2110421.93	2111363.19	2111548.092
	DEFLECTION ANGLE		1°49'37''	3°43'03''	2°22'40''	29°46'8''	24°08'26''	12°24'23''
	RADIUS		1450	1300	1300	315.35	400	380.35
	TRANSITION LENGTH		20	20	20	55	45	45
	CURVE LENGTH		26.232	64.346	33.953	108.844	123.532	37.356
	CANT		30	35	35	115	100	95
	CANT DEFFICIENCY		29	31	31	96	67	80
	OPERATING SPEED		85	85	85	75	75	75
	EQUILIBRIUM		59.00	66	66	211	167	175

	CURVE NO.		20/21-ULC 03	21/22-ULC 01	21/22-ULC 02	21/22-ULC 03	22/23-ULC 01	22/23-ULC 02
UGC 06	COORDINATE OF APPEX	EASTING	273302.14	274439.775	274552.834	275114.377	276029.315	276139.072
		NORTHING	2112153.51	2112770.288	2113313.49	2113510.301	2113514.578	2113513.025
	DEFLECTION ANGLE		71°14'38"	49°46'41"	58°55'41"	19°02'49"	1°04'43"	0°56'41"
	RADIUS		535	345	380	380	3000	3100
	TRANSITION LENGTH		40	60	60	60	25	25
	CURVE LENGTH		625.24	239.732	330.825	66.323	31.478	26.11
	CANT		85	105	110	110	0	0
	CANT DEFFICIENCY		57	88	90	90	29	28
	OPERATING SPEED		80	75	80	80	85	85
	EQUILIBRIUM		142	193	199	199	29	28

UGC 07	CURVE NO.		**23/24-ULC 01**	**23/24-ULC 02**	**24/25-ULC 01**	**24/25-ULC 02**	**24/25-ULC 03**	**25/26-ULC 01**	**25/26-ULC 02**	**26/27-ULC 01**	**26/27-ULC 02**
	COORDINATE OF APPEX	EASTING	276930.358	276816.712	276786.019	276711.837	276748.531	275968.527	275992.734	276585.898	276730.396
		NORTHING	2113514.873	2113983.005	2114458.556	2114650.181	2115049.497	2115254.647	2115677.635	2116513.667	2116776.32
	DEFLECTION ANGLE		103°30'42''	9°57'10''	17°28'10''	26°24'45''	80°30'53''	78°32'23''	32°04'49''	6°32'18''	69°08'04''
	RADIUS		287	650	250	315.35	282	325.35	245.35	700	260
	TRANSITION LENGTH		60	60.65	55	50	55	40	55	30	40
	CURVE LENGTH		458.5	52.912	21.225	95.372	341.279	405.982	82.373	49.881	273.723
	CANT		110	70	110	105	115	90	110	65	80
	CANT DEFFICIENCY		92	62	90	79	91	64	94	43	84
	OPERATING SPEED		70	85	65	70	70	65	65	80	60
	EQUILIBRIUM		202	132	200	184	206	154	204	108	164

2. DOWN LINE CURVE DETAILS

UGC 05	CURVE NO.		**18/19-DLC 01**	**18/19-DLC 02**	**18/19-DLC 03**	**19/20-DLC 01**	**20/21-DLC 01**	**20/21-DLC 02**
	COORDINATE OF APPEX	EASTING	274145.361	274090.059	274007.36	273472.508	273505.846	273412.585
		NORTHING	2109143.159	2109258.718	2109392.834	2110409.727	2111352.188	2111567.258
	DEFLECTION ANGLE		1°40'54''	6°05'06''	3°54'58''	29°46'08''	25°28'8''	13°44'05''
	RADIUS		1550	800	830	300	515.35	365
	TRANSITION LENGTH		20	30	30	55	45	45
	CURVE LENGTH		25.494	54.962	26.729	100.869	184.083	42.496
	CANT		30	60	55	105	95	100
	CANT DEFFICIENCY		25	47	48	88	71	82
	OPERATING SPEED		85	85	85	70	85	75
	EQUILIBRIUM		55	107	103	193	166	182

UGC 06	CURVE NO.		**20/21-DLC 03**	**21/22-DLC 01**	**21/22-DLC 02**	**21/22-DLC 03**	**22/23-DLC 01**	**22/23-DLC 02**	**22/23-DLC 03**	**22/23-DLC 04**
	COORDINATE OF APPEX	EASTING	273315.632	274451.142	274566.095	275103.201	275764.28	275863.772	276132.15	276233.473
		NORTHING	2112133.946	2112749.571	2113301.872	2113490.119	2113493.209	2113498.454	2113499.709	2113492.115
	DEFLECTION ANGLE		71°14'38"	49°46'41"	58°55'41"	19°02'49"	2°45'0"	2°45'0"	4°33'14"	4°25'11"
	RADIUS		530	350	364.65	480	1400	1500	650	650
	TRANSITION LENGTH		40	60	60	50	30	30	25	25
	CURVE LENGTH		619.023	244.076	315.038	109.566	37.194	41.994	26.661	25.14
	CANT		85	120	115	100	45	45	55	55
	CANT DEFFICIENCY		58	97	93	78	16	12	34	34
	OPERATING SPEED		80	80	80	85	85	85	70	70
	EQUILIBRIUM		143	217	208	178	61	57	89	89

UGC 07	CURVE NO.		**23/24-DLC 01**	**24/25-DLC 01**	**24/25-DLC 02**	**24/25-DLC 03**	**25/26-DLC 01**	**25/26-DLC 02**	**26/27-DLC 01**	**26/27-DLC 02**
	COORDINATE OF APPEX	EASTING	276889.883	276832.632	276727.452	276765.006	275984.569	276007.806	276590.544	276761.872
		NORTHING	2113493.649	2114380.665	2114652.364	2115061.036	2115266.299	2115672.352	2116493.689	2116767.481
	DEFLECTION ANGLE		93°33'33''	17°28'10''	26°24'45''	80°30'53''	78°32'23''	32°04'49''	3°19'08''	65°54'55''
	RADIUS		277	265.35	300	297.35	310	230	1200	250
	TRANSITION LENGTH		55	40	50	55	40	55	25	40
	CURVE LENGTH		397.317	40.905	88.296	362.849	369.941	73.779	44.513	247.609
	CANT		115	90	110	110	90	120	40	90
	CANT DEFFICIENCY		94	71	83	85	71	98	31	80
	OPERATING SPEED		70	60	70	70	65	65	85	60
	EQUILIBRIUM		209	161	193	195	161	217	71	170

3. GRADIENT CURVE DETAILS:

VERTICAL ALIGNMENT DETAILS (Up Line)						
Element	Chainage		Gradient	Vertical Curve		Length
	Start	End		Radius (m)	Type	(Meters)
Package-5						
Circular	20926.198	20947.811		-4500	Hog	21.613
Linear	20947.811	21781.831	0.000%			834.020
Circular	21781.831	21804.826		-3500	Hog	22.995
Linear	21804.826	22231.354	-0.657%			426.528
Circular	22231.354	22291.254		2500	Sag	59.900
Linear	22291.254	22425.573	1.739%			134.319
Circular	22425.573	22469.047		-2500	Hog	43.474
Linear	22469.047	22734.394	0.000%			265.347
Circular	22734.394	22765.606		-3000	Hog	31.212
Linear	22765.606	23100.689	-1.040%			335.083
Circular	23100.689	23150.968		1800	Sag	50.279
Linear	23150.968	23429.088	1.753%			278.120
Circular	23429.088	23472.912		-2500	Hog	43.824
Linear	23472.912	23729.449	0.000%			256.537
Circular	23729.449	23755.208		-10000	Hog	25.759
Linear	23755.208	24235.753	-0.258%			480.545
Circular	24235.753	24258.247		-5000	Hog	22.494
Linear	24258.247	24355.771	-0.707%			97.524
Package-6						
Linear	24500	25113.312	-0.707%			613.312
Circular	25113.312	25139.132		2500	Sag	25.820
Linear	25139.132	25748.079	0.325%			608.947
Circular	25748.079	25770.851		-7000	Hog	22.772
Linear	25770.851	26066.416	0.000%			295.565
Circular	26066.416	26088.514		-6000	Hog	22.098
Linear	26088.514	26406.409	-0.368%			317.895

VERTICAL ALIGNMENT DETAILS (Dn Line)						
Element	Chainage		Gradient	Vertical Curve		Length
	Start	End		Radius (m)	Type	(Meters)
Circular	20945.251	20966.758		-4500	Hog	21.507
Linear	20966.758	21825.095	0.000%			858.337
Circular	21825.095	21848.199		-3500	Hog	23.104
Linear	21848.199	22272.381	-0.660%			424.182
Circular	22272.381	22332.279		2500	Sag	59.898
Linear	22332.279	22466.942	1.736%			134.663
Circular	22466.942	22510.338		-2500	Hog	43.396
Linear	22510.338	22774.031	0.000%			263.693
Circular	22774.031	22805.264		-3500	Hog	31.233
Linear	22805.264	23123.212	-1.041%			317.948
Circular	23123.212	23168.788		1700	Sag	45.576
Linear	23168.788	23460.902	1.640%			292.114
Circular	23460.902	23501.898		-2500	Hog	40.996
Linear	23501.898	23762.644	0.000%			260.746
Circular	23762.644	23787.651		-10000	Hog	25.007
Linear	23787.651	24282.849	-0.250%			495.198
Circular	24282.849	24307.151		-5000	Hog	24.302
Linear	24307.151	24391.760	-0.736%			84.609
Linear	24500	25096.360	-0.736%			596.360
Circular	25096.36	25122.980		2500	Sag	26.620
Linear	25122.98	25725.632	0.329%			602.652
Circular	25725.632	25747.000		-6500	Hog	21.368
Linear	25747	26045.336	0.000%			298.336
Circular	26045.336	26068.200		-6500	Hog	22.864
Linear	26068.2	26401.839	-0.352%			333.639

Circular	26406.409	26432.367		2500	Sag	25.958	Circular	26401.839	26427.738		2500	Sag	25.899
Linear	26432.367	27468.723	0.670%			1036.356	Linear	26427.738	27441.864	0.684%			1014.126
Circular	27468.723	27492.173		-3500	Hog	23.450	Circular	27441.864	27465.812		-3500	Hog	23.948
Linear	27492.173	27917.575	0.000%			425.402	Linear	27465.812	27889.652	0.000%			423.840
Circular	27917.575	27951.355		-3000	Hog	33.780	Circular	27889.652	27924.364		-3000	Hog	34.712
Linear	27951.355	28240.391	-1.126%			289.036	Linear	27924.364	28204.331	-1.157%			279.967
Circular	28240.391	28269.707		1900	Sag	29.316	Circular	28204.331	28233.685		1900	Sag	29.354
Linear	28269.707	28389.833	0.417%			120.126	Linear	28233.685	28365.580	0.388%			131.895
Circular	28389.833	28412.765		-5500	Hog	22.932	Circular	28365.58	28386.916		-6500	Hog	21.336
Linear	28412.765	28708.932	0.000%			296.167	Linear	28386.916	28681.262	0.000%			294.346
Package-7													
Linear	28800	28858.212	0.000%			58.212	Linear	28800	28863.585	0.000%			63.585
Circular	28858.212	28890.742		-7000	Hog	32.530	Circular	28863.585	28890.641		-6500	Hog	27.056
Linear	28890.742	28944.393	-0.465%			53.651	Linear	28890.641	28958.319	-0.416%			67.678
Circular	28944.393	28974.564		2500	Sag	30.171	Circular	28958.319	28986.185		2500	Sag	27.866
Linear	28974.564	29458.349	0.742%			483.785	Linear	28986.185	29503.857	0.698%			517.672
Circular	29458.349	29480.613		-3000	Hog	22.264	Circular	29503.857	29524.809		-3000	Hog	20.952
Linear	29480.613	29789.813	0.000%			309.200	Linear	29524.809	29888.178	0.000%			363.369
Circular	29789.813	29821.873		1500	Sag	32.060	Circular	29888.178	29920.310		1550	Sag	32.132
Linear	29821.873	30743.548	2.004%			921.675	Linear	29920.31	30810.027	2.044%			889.717
Circular	30743.548	30774.606		-1500	Hog	31.058	Circular	30810.027	30841.123		-1500	Hog	31.096
Linear	30774.606	31043.262	0.000%			268.656	Linear	30841.123	31096.916	0.000%			255.793
Circular	31043.262	31065.692		-4500	Hog	22.430	Circular	31096.916	31119.664		-4500	Hog	22.748
Linear	31065.692	31360.899	-0.498%			295.207	Linear	31119.664	31409.968	-0.506%			290.304
Circular	31360.899	31390.055		2500	Sag	29.156	Circular	31409.968	31439.612		2500	Sag	29.644
Linear	31390.055	31961.121	0.668%			571.066	Linear	31439.612	31999.229	0.680%			559.617
Circular	31961.121	31987.833		-4000	Hog	26.712	Circular	31999.229	32026.437		-4000	Hog	27.208
Linear	31987.833	32254.39	0.000%			266.557	Linear	32026.437	32294.882	0.000%			268.445
Circular	32254.39	32275.61		2700	Sag	21.220	Circular	32294.882	32315.118		8100	Sag	20.236
Linear	32275.61	32599.908	0.786%			324.298	Linear	32315.118	32553.456	0.250%			238.338
Circular	32599.908	32640.092		1500	Sag	40.184	Circular	32553.456	32600.944		1500	Sag	47.488
Linear	32640.092	32975.266	3.465%			335.174	Linear	32600.944	33000.100	3.416%			399.156
Circular	32975.266	33027.24		-1500.023	Hog	51.974	Circular	33000.1	33051.336		-1500	Hog	51.236

Note: The Chainages of Vertical Curve are based on Jumping chainages of each civil packages . These chainages will get revised after the alignment is freezed

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APPENDIX-12

UTILITIES

July 2019

1. DEFINITIONS:

Utilities are defined as public utilities above or below ground and include all live water-mains, water wells, power cables, street lights, transformers, telephone posts, telecommunication cables, sewers, storm water drains and the like shown on the Employer's Drawings OR are uncharted and are therefore not shown on the Tender Drawings.

Responsibility of the Contractor.

The Contractor shall ensure that the utilities are not damaged while working track work. In case of damage the contractor will immediately inform the Engineer and the Utility Agencies of any and will get it restored and he will be fully responsible for restoration including penalty and any legal action from the utility agency if any. The provision of Clause D8.4 Section VI (1) D will be followed.

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Appendix-13

SITE ACCOMMODATION FOR THE ENGINEER

July 2019

SITE ACCOMODATION FOR THEENGINNER

The Contractor shall provide Site Accommodation (total area approx. 144m^2) for the Engineer Staff according to the following schedule of offices:

Type	No. of Staff	Area m^2	Total Area m^2
Track Expert / Chief Track Engineer	1	15	**15**
Track Engineer Office	2	10	**20**
Site Inspector (Track) Common Office	4	6	**24**
General Office / Reception Area	-	10	**10**
Rest Rooms with 2 single bed including washroom & toilet	-	12	**12**
2 Nos. of washroom/toilet	-	5	**10**
Kitchen / Pantry	-	6	**6**
Meeting Room	-	25	**25**
Circulations		22	**22**
Total			**144**

1. Offices shall be accessible only from a corridor within the building. The corridor and reception area entrances shall be provided with an external double door.
2. Materials for the construction shall be new, robust and durable. The building shall be weatherproof, vermin proof, well insulated thermally and acoustically. Internal walls shall be soundproofed. Electrical power and lighting, including all fixtures and fittings, power, telecoms and internet sockets, shall be provided to each room, including air conditioning to maintain the internal temperature within the range of 20 to 24 degrees Celsius at all times. A standby generator shall also be provided and installed with an automatic switchover.
3. Internal doors shall be flush, fitted with door closers, mortise locks with keys and lever handles.
4. External doors shall be a pair of solid core doors, external quality, hung on heavy duty hinges, one leaf fitted with barrel bolts top and bottom and the other leaf fitted with a Yale or similar lock.
5. Windows, of area not less than 10% of the floor area, shall be provided to all rooms, securely barred, fitted with blinds and having opening sections fitted with locks and mosquito screens.
6. The building shall be provided with a continuous water supply and drainage to Kitchen, Washroom and Toilets. The Toilets shall be equipped with low level suites and be adequately ventilated through the ceiling.
7. The Kitchen/Pantry shall be fitted out with a 2 drainer stainless steel double sink unit, hot water heater, work top with cupboards under, tiling above the sink and worktop and wall mounted cupboards.
   Fire and Safety regulations shall be complied with and fire fighting equipment shall be provided in accordance with the recommendations of the MaharashtraFire Services.
8. The Contractor shall provide, erect and maintain appropriate name boards as specified, for each of the offices. The wording shall be agreed with the Engineer.
9. The Contractor shall provide protective clothing and safety equipment for 12 persons, comprising, as a minimum – Safety Helmets, Safety Harness, Steel-toed construction shoes/boots(sizestobenotified),Day-Glowaistcoat,Industrialsafetygoggles,Industrialgloves, Breathing Masks and Filters, Ear protectors, Heavy weight suits (sizes to be notified), Lamps

(with batteries), etc… as required by the Engineer.

10. The Contractor shall provide an adjacent shaded hard standing parking area.
11. The Contractor shall arrange for upkeep, service and security of the offices and compound. These to be thoroughly cleaned and rubbish and waste to be removed at least once per day.
12. The Contractor shall provide the Pickup and Drop vehicle for the Engineer staff for the transportation to sites and offices
13. The Contractor shall submit a detailed office layout plan showing all relevant details of these site offices, not limited to that described above, which will require a notice from the Engineer.
14. Furniture will be provided by contractor including storages for record.
15. One laptop 2 Desk top , One Printer + Scanner, Internet Connectivity, and Stationery Item as required will be provided by contractor .Meeting rooms will be Air-conditioned Aarey-BKC.,

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Appendix-14

CONTRACTOR'S SITE LABORATORY

July 2019

CONTRACTOR'S SITE LABORATORY

1. SITE LABORATORY

1.1. The Site Laboratory shall be approximately 250 m^2 in area. It shall consist of the following accommodation:

1	concrete laboratory	60 m^2 floor area
1	office	15 m^2 floor area
1	store room	10 m^2 floor area
1	kitchen	10 m^2 floor area
	Storage Area	140 m^2 floor area
	Toilets, changing room &shower	Sufficient for 6 persons 15 m^2

1.2. The remainder of the 250 m^2 shall consist of storage area for concrete cube curing tanks. The laboratory, office, etc., shall be in one building; the curing tank and storage building may be in a separate building, but if so it shall be adjacent to the laboratory building and connected to it by a level, weatherproof passageway. In addition, an area of covered hard standing of 50 m^2 for motor vehicles shall be provided adjacent to the laboratory.

2. STANDARD OFCONSTRUCTION

2.1. The laboratory shall be constructed to the best Engineering practice and the Engineer shall issue a notice of no objection. Two independent telephone lines with two extensions each shall be provided for the laboratory. Telephones shall be located in areas as agreed with the Engineer.

2.2. A covered water tank with minimum capacity of 2000 litres shall be installed, as a source of constant water pressure (15 kPa minimum) for each laboratory.

2.3. In the case of sinks used for washing samples, adequate trapping and/or separatingdevicesshallbeprovidedtoensuretheproperfunctioningofthefacility.

3. FURNISHINGS AND FIXTURES

The Contractor's site laboratory shall be provided with the required furnishings and fixtures.

4. LABORATORY EQUIPMENT

4.1. The laboratory equipment, as listed below, shall be issued a notice from the Engineer. The Contractor shall submit for the Engineer's notice within 2 weeks of the Commencement Date the name of the supplier he intends to use for each piece of apparatus together with the relevant catalogue and catalogue number.

4.2. The layout of the equipment in the testing laboratory shall require a notice of no objection from the Engineer. The equipment shall be maintained to accuracy appropriate to the required testing methods with routine calibration by an accredited organization as recommended by the appropriate Authority. The Equipment shall also be calibrated after maintenance or relocation.

4.3. The Contractor's site laboratory shall be equipped with the following material testing equipment as a minimum. The nature and quantity of equipment required for testing may be varied by the Engineer depending on the detail of the Contractor's Design and Construction methods or for any other reason which he deems to be valid and necessary for the proper control of quality, all at the Contractor's cost:

1) **Sieve Analysis**	
Sieve shaker (portable)	1unit
Coarse sieves In Sizes from 100mm to10mm	1sets
Fine Sieves (#4, #8, #16, #30, #40, #50, #100, #200each)	1set
Pans &Covers	As required
2) **Specific Gravity and Absorption of Coarse Aggregate**	
Wire basket,200 mm dia.	5No
Heavy duty suspension balance, 20 kg x 1 gm. With accessories for weight in water	1set
Suitable water container	1No
3) **Unit Weight of Aggregate**	
Balance, 100 kg. Capacity with 10 gm precision	1No.
Tamping rod 16mm diameter x 600mmlong	1No.
Measuring containers (3, 10, 15, 30litres)	1each
4) **Flakiness and Elongation**	
Flakiness gauge, elongation index	1set
Soundness Test	
Sodium sulphate	25kgs
Soaking tank	1No.
Balance, Capacity 3 kg., Sensitivity 0.1gm.	1set
Sieves :Coarse	1set
Fine	1set
5) **Concrete**	
Buckets for concrete sampling	12Nos.
Slump cone	12Nos.
Tamping rod	12Nos
Base plate	12Nos.
Mixing pan for concrete	2Nos.
Scoop for general purpose	2Nos.
Concrete thermometer	1No.
Concrete cylinder mould, 150mm *300mm; 100mm*300mm	10 each
Concrete cube mould, 100mm cube &150mmcube	10 each
Adjustable spanners for dismantling cubemoulds	6No.
Capping set	2Nos.
Capping compound	As required
Concrete curing tank with capacity for 270 cubes, temperature controlled, with circulation system drain and lockable cover	5Nos.
Schmidt test hammer	1No.
Compression testing machine (simple hand-operated)	1No. Mould
oil	As required
Temperature chart recorder	1No.
6) **Miscellaneous**	
Vernier calipers to measure up to200mm,	

With longated jaws	5Nos.
Steel rule, 300mm long graduated	2Nos.
Rubber gloves	10pr.
Cotton working gloves	20pr.
First aid kit	1set
Wire brush	6No.
Steel tape, 3m, 5m,30m	3each
Ballpein hammer,1kg	2Nos.
Paint scraper. Approx.100mmwide	8Nos.
Float, steel Approx. 280mm x120mm	8Nos.
Sack barrow	1No.
Shovel: Square Mouthed	2Nos.
: Round Mouthed	2Nos.
24-wheel trolley, heavy duty, approx. 0.7m x 1.0mwith long pneumatic tyred type	1No.
Wheelbarrow, rubber tyred	1No.
Comprehensive tool kit. To include screw drivers, pliers, claw hammer, multi-grips, spanners(adjustable)	1No.
Type NR Schmidt Hammer and tester with recording device	1No.
Testing Anvil for Schmidt Hammer test (SHT)	1No.
Chart recording paper for SHT	10PktsC
over meter for detecting metal objects to depth of100mm below the surface of non-magnetic objects	3No.
Noise meter	1No.
RCPT testing Machine for Concrete	1No.
Permeability testing Machine for Concrete	1No.

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Appendix – 15

COMMON GLOSSARY OF ACRONYMS

July 2019

MUMBAI METRO RAIL LINE 3

COMMON GLOSSARY OF ACRONYMS

	Issuing entity	Discipline	Area	Document No	Revision Index
	GCC	**220**	**000**	**0900016**	**B**

Acronym	Definition
A	Amp
AAI	Airports Authority of India
AAR	Association of American Railroads
AAS	Architectural Stabling Aarey Milk Colony
AASHTO	American Association of State Highway and Transportation Officials
AC	Alternating Current
ac or AC	Alternating current
ACB	Air Circuit Breaker
ACIDS	Access Control and Intrusion Detection System
ACOS/ATW	Automatic Change Over Switch/ Automatic Transfer switch.
ADC	Assumption Dependency and Caveat
ADPCM	Adaptive Differential Pulse Code Modulation
ADS	Application Data Sheet
AES	Architectural Elevated Stations
AFC	Automatic Fare Collection
AFFL	Above Finished Floor Level
AFILS	Audio Frequency Induction Loop System
AFTC	Audio Frequency Track Circuit
AFTC	Audio Frequency Track Circuits
AGC	Automatic Gain Control
AHU	Air Handling Unit
AIS	Association of information system
ALARP	As Low As Reasonably Practicable
AMS	Auxiliary Main Substation
AMT	Auxiliary Main Transformer
ANSI	American National Standards Institute
AO	Authorized Officer
APFC	Automatic Power Factor Control
API	Application Program Interface
AR	Audit registers
ARD	Architectural Depot
AREMA	American Railway Engineering and Maintenance-of-way Association
ARS	Automatic Route Setting
ASCII	American Standard Code for Information Interchange
ASD	Aspirating Smoke Detector
ASE	Aarey Stabling Equipment
ASHRAE	American Society of Heating, Refrigerating & Air Conditioning Engineers
ASP	Audio and Selection Panel
ASS	Auxiliary Substation
ASTM	American Society for Testing and Materials

ASTS	Automatic Source Transfer System
AT	Auxiliary Transformer
ATB	Automated Ticket and Boarding Pass
ATC	Automatic Train Control
ATD	Auto Tensioning Device
ATD	Automatic Train Driving Mode
ATM	Automatic Teller Machine
ATO	Automatic Train Operation
ATP	Automatic Train Protection
ATR	Automatic Train Regulation
ATS	Automatic Train Supervision
AUS	Architectural Underground Stations
AVM	'Add Value' Machine
BAT	Battery
BCC	Back-up Control Centre
BER	Buried Earth Rail
BIM	Bulk Initialization Machine
BIS	Bureau of Indian Standards
BMS	Building Management System
BO	Booking Office
BOCWA & BOCWR	Building and Other Construction Workers Act 1996 & Building and Other Construction Workers Rules 1998
BOQ	Bill Of Quantities
BRE	Building research Establishment
BS	British Standard
BSC	Base Station Controller
BSD	Building Service Depot
BSI	British Standards Institute
BSP	British Standard Pipe threads
BSS	Building Service Underground Stations
BTS	Base Transceiver Station
BWA	Balance Weight Assembly
C&C	Cut and Cover
CA	Concessionary Agreement
CAE	Chief Safety Engineer
CATC	Continuous Automatic Train Control
C-ATS	Central Automatic Train Supervision system
CB	Circuit Breaker
CBD	Central Business District
CBI	Computer Based Interlocking
CBN	Communications Backbone Network
CBS	Colaba-Bandra-Seepz
CBTC	Communication Based Train Control
CC	Central Computers
CCD	Charge Coupled Device

CCF	Control Centre of the Future
CCHS	Central Clearing House System
CCITT	International Telegraph and Telephone Consultative Committee (Comité Consultatif Internationale de Télégraphique et Téléphonique)
CCL	Communication Certification Laboratory
CCST	Credit Card Sized Ticket
CCT	Contract
CCTV	Closed Circuit Television
CDM	Clean Development Mechanism
CDR	Call Data Record
CE	CommunautéEuropéenne
CEB/FIP	Comite Euro – Internationale du Beton (Euro- International Concrete committee) and Federation Internationale de la
CEE	Civil Elevated East Construction
CENELEC	European Committee for Electro technical Standardization(ComitéEuropéen de NormalisationElectrotechnique)
CER	Communication Equipment Room
CES	Civil Elevated East Stations
CEW	Civil Elevated West Construction
CFB	Call Forwarding On Busy
CFNR	Call Forwarding No Reply
CGP	Clean Gas Panel
CIBSE	Chartered Institution of Building Services Engineers
CIC	Chief Interface Coordinator (of the Contractor)
CIE	International Commission on Illumination
CIF	Common Interchange File
CIS	Call Intercept System
CISPR	The International Special Committee on Radio Interference (Comite International Special des Perturbations Radioelectriques)
CLIP	Calling Line Identification Presentation
CLIR	Calling Line Identification Restriction
CMD	Control Train Driving Mode
CMS	Cable Management System
CMS	Cast Manganese steel Crossing
COLP	Connected Line Identification Presentation
COLR	Connected Line Identification Restriction
COM	Telecommunication
CORBA	Common Object Request Broker Architecture
COS	Change Over Switch
COTS	Commercially off the Shelf
CP	Control Panel
CPT	Cone Penetration Test
CPTU	To be clarify
CPU	Central Processing Unit

CPWD	Central Public Works Department
CRT	Cathode Ray Tube
CS	Control Superintendent
CSA	Civil Stabling Aarey
CSC	Contactless Smart Card
CSD	Combined Services Drawing
CSN	Civil Underground Stations
CSO	Comity Service Organizations
CST	Contactless Smart Token
CT	Current Transformer
CTC	Centralized Traffic Control
CTCSS	Continuous Tone-Coded Squelch System
CTI	Computer Telephone Integration
CTR	Customer Transaction Records
CUG	Closed User Groups
CVD	Civil Depot
CVMS	Central Voice Mail System
CVRS	Central Voice Recording System
CVT	Civil Underground Tunnels
CW	Contact Wire
CW	Call Waiting
CWD	Civil Depot
CWK	Civil Works
CWR	Continuously Welded Rail
CWS	Civil Elevated West Stations
D&B	Design and Built
dB (A)	Decibel (A-Weighted)
dB	Decibel
DBFOT	Design, Build, Finance, Operate, Transfer
dBm	Decibel relative to 1 milliwatt
DBR	Design Basis Report
DC	Direct Current
dc or DC	Direct current
DCC	Depot Control Centre
DCL	Document Control
DDA	Disability Discrimination Act
DDC	Detailed Design Contractor
DDF	Digital Distribution Frame
DDI	Direct Dial In
DDO	Direct Dialling Out
DEE	Depot Equipment
DEP	Depot
DES	Data Encryption Standard
DET	Depot Equipment

DG	Diesel Generator
DG or GEN	Diesel Generator
DHCP	Dynamic Host Configuration Protocol
DLL	Dynamic Link Library
DLP	Defects Liability Period
DLT	Direct Line Telephone
DMC	Driving Motor Car
DMD	Depot Manual Driving mode
DMI	Drive Machine Interface
DMO	Direct Mode Operation
DMRC	Delhi Metro Rail Corporation
DNS	Domain Name Servers
DofP	Delegation of Financial Power
DOO	Driver Only Operation
DOORS	Dynamic Object-Oriented Requirements System
DP	Double Pole
DPNSS	Digital Private Network Signalling System
DPP	Development Project Proposal
DPR	Detailed Project Report
DRACAS	Defect Reporting And Corrective Action System
DS	Disconnect Switch
DSD	Driver Safety Device
DSM	Data Security Module
DSO	Depot Security Office
DT	Driving Trailer Car
DT	Dispatcher Terminal
DTC	Driving Trailer Car
DTM	Direct Tendering Method
DTO	Driverless Operation
DTS	Data Transmission System
DVA	Digital Voice Announcer
DVAS	Digital Voice Announcement System
DVR	Digital Video Recorder
E&M	Electrical & Mechanical
EAL	Evaluation Assurance Level
EBD	Emergency Braking Distance
EBU	European Broadcasting Union
EC	Engineering Controller
ECMS	Equipment Control and Monitoring System
ECR	Electrical Control Room
ECS	Environmental Control Systems
ECSE	ECS Elevated
EDS	Equipment Development System
EFO	Excess Fare Office

EFT	Electronic Funds Transfer
EI	Electronic Interlocking
EIA	Energy Information Administration
EIG	Electrical Inspector of Government
EIRENE	European Integrated Railway Enhanced radio Network
ELCB	Earth Leakage Circuit Breaker
ELT	Elevated Section & Station
EMC	Electro Magnetic Compatibility
EMI	Electromagnetic Interference
EMR	Emergency Mode
EMS	Element Management System
EmT	Emergency Telephone
EMV	Eurocard MasterCard Visa
EN	Euro Norm (European) Standard
EOD	Equipment Operational Data
EOI	Expression Of Interest
EP	Electro-Pneumatic
EPABX	Electronic Private Automatic Branch Exchange
EPBM	Earth Pressure Balance (tunnelling) Machine
EPROM	Erasable Programmable Read Only Memory
ERTMS	European Rail Traffic Management System
ES	Earthing Switch
ET	Electrification Telephone
ETCS	European Train Control System
ETD	Extended Trunk Dialling
ETP	Effluent Treatment Plant
ETSI	European Telecommunications Standards Institute
EVC	European Vital Computer
EXW	Ex-Works
FAHU	Fresh Air handling Units
FAT	Factory Acceptance Tests
FC	Fare Collection
FCAPS	Fault, Configuration, Accounting, Performance and Security
FCU	Fan Coil Unit
FFT	Fast Fourier Transform (Method)
FIDS	Flat-Panel Interactive Display System
FIFO	First In First Out
FM	Factory Manuals
FM	Frequency Modulation
FMEA	Sub-System Failure Mode and Effect Analysis
FMECA	Failure Modes, Effects and Criticality Analysis FMECA
FO	Fiber Optic
FOCS	Flexible Overhead Contact System
FOTS	Fiber Optic Transmission System

FP	Feeding Post
FPS	Fire Protection System
FR	Fire Resistance
FRACAS	Failure Reporting, Analysis and Corrective Action System
FRLS	Flame Retardant Low Smoke Emission
FRLSOH	Fire Retardant Low Smoke Zero Halogen
FRLSZH	Flame Retardant Low Smoke Zero Halogen
FRP	Fiber Reinforced Plastic
FRS	Functional Requirements Specification
FSSD	Fire Safety and Shelter Department
FT	Fixed Terminal
FTN	Fixed Telecommunications Network
FTP	File Transfer Protocol
FTS	Fixed Telephone System
FW	Finish Works
GAME	Globalement Au Moins Equivalent / Overall At Least Equivalent
GC	General Consultant for MML3
GCC	General Conditions of Contract
GCIM	General Consultant Interface Manager
GHz	Giga Hertz
GI	Geotechnical Investigation
GIS	Gas Insulated Switchgear
GLAP	Gate line Attendant's Point
GMT	Gross Million Ton
GOA	Grade of Automation
GoI	Government of India
GOM	Government of Maharashtra
GoTN	Government of Tamil Nadu
GPH	General Purpose Hand-portable
GPRS	General Packet Radio Service
GPS	Global Positioning System
GS	General Specifications
GSM-R	Global System for Mobile communications – Railways
GTKM	Gross Tonne Kilometres
GUI	Graphical User Interface
H/P	Hand Portable
HDHC	Hard Drawn High Conductivity
HDLC	High-level Data Link Control
HDPE	High Density Poly Ethylene
HFDM	Human Factors Delivery Manager
HMI	Human Machine Interface
HMPD	Head of MMRC Procurement Department
HMRL	Hyderabad Metro Rail Limited
HP	Help Point

HPTS	Help Point Telephone System
HRC	High Rupture Capacity
HSE	Health and Safety Executive
HT	High Tension
HV	High Voltage (as per Indian Electricity Rules)
HVAC	Heating, Ventilation and Air Conditioning
HVS	High Voltage Substation
Hz	Hertz
I/C or i/c	Incoming
I/F	Interface
IABSE	International Association for Bridge and Structural Engineering
IC	Interim Consultant
ICS	Interface Coordination Sheet – Monthly report
ID	Identity
IDC	Insulation Displacement Connection
IDL	Interface Definition Language
IE	Indian Electricity Rules
IE	Independent Engineer
IEC	International Electro technical Commission
IECC	Integrated Electronic Control Centre
IED	Intelligent Electronic Device
IEE	Institution of Electrical Engineers
IEEE	Institute of Electrical and Electronics Engineers
IES	Illumination Engineering Society
IFA	Invitations For Application
IFAT	Integrated Factory Acceptance test
IFE	Invitations for Enlistment
IFPQ	Invitations for Pre-Qualification
IFT	Invitations For Tender
IGBT	Insulated Gate Bipolar Transistor
IHA	Interface Hazard Analysis
IMP	Interface Management Plan
IMPG	Interface Management Programme
INC	Incident Mode
INR	Indian Rupees
IOL	Insulated Overlap
IOR	Interoperable object reference
IOT	Interoperability Testing
IP	Ingress Protection
IP	Internet Protocol
IR	Indian Railways
IRC	Indian Roads congress
IRS	Indian Railway Standards
IS	Indian Standard

ISA	Independent Safety Assessor
ISDN	International Services Digital Network
ISHRAE	Indian Society of Heating, Refrigerating & Air Conditioning Engineers
ISM	Industrial, Scientific and medical band
ISO	International Organization for Standardization
IST	Interface Support Team
IST TL	Interface Support Team Leader (Project Rail Systems Manager, a Member of the Project Management Team, discharges this function.)
IT	Information Technology
ITA	Instruction To Applicant
ITC	Instruction To Consultant
ITL	Integral Transversal Link
ITSO	Integrated Transport Smartcard Organisation
ITT	Instruction To Tenderer
ITU-T	International Telecommunications Union- Telecommunications Standardization sector
IVR	Installation Verification Record
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
JVCA	Joint Venture Consortium of Association
km	Kilometre
Kmph	Kilometers per hour
KPI	Key Performance Indicator
kV	Kilo Volt
kVA	Kilo volt-amp
kW	Kilowatt
LA	Lightening Arrester
LAE	Lifts and escalator
LAN	Local Area Network
LBS	Load Break Switch
LCD	Liquid Crystal Display
LCP	Local Control Panel(s)
LCS	Least Cost Selection
LCX	Leaky Coaxial Cable
LD	Line Director
LDA	Location Dependent Addressing
LEC	Lifts and Escalators
LED	Light Emitting Diode
LLRU	Lowest Level Replaceable Unit
LOI	Letter Of Invitation
LOMA	Limit of Movement Authority
LPC	Loss Prevention Council
LRU	Lower Replaceable Unit

LSC	Local Sequential Control
LSZH	Low Smoke Zero Halogen
LT	Low Tension
LTM	Limited Tendering Method
LV	Low voltage
LWR	Long Welded Rail
M&E	Mechanical & Electrical
MAN	Metropolitan Area Network
MAP	Main Alarm Panel
MAPLE	General Consultant as Mumbai AECOM Padeco Louis Berger Egis as GC
MASS	Maximum Safe Speed
MBER	Mean Bit Error Rate
Mbps	Megabits per second
MC	Motor Car
MCB	Miniature Circuit Breaker
MCBF	Mean Cycle Between Failures
MCBJ	Mean Cycle Between Jam
MCC	Motor Control Centre
MCCB	Molded Case Circuit Breaker
MCF	Master Configuration File
MD	Managing Director Mumbai Metro Rail Corporation (MMRC)
MDB	Main Distribution Board
MDBF	Mean Distance Between Failures
MDF	Main Distribution Frame
MEP	Mechanical and Plumbing
MET	Main Earth Terminal
MFCP	Main Fire Control Panel
MHz	Megahertz
MIL	Master Interface Log
MIM	Master Interface Matrix
MIP	Mobility Impaired Person
MIS	Management Information System
MMDR	Metro Mumbai Director Rail
MMI	Man Machine Interface
MMIS	Maintenance Management Information System
MML3	Mumbai Metro Line 3
MMR	Mumbai Metro Region
MMRC	Mumbai Metro Rail Corporation
MMRCL	Mumbai Metro Rail Corporation Limited
MMRDA	Mumbai Metropolitan Regional Development Authority
MMS	Maintenance Management System
MMWSSB	Mumbai Metropolitan Water Supply and Sewerage Board
MNCP	Main Networked Control Panel
MNRR	Module of Non Resettable Registers

MOM	Minute Of Meeting
MOR	Ministry Of Railways
MOS	Mean Opinion Score
MOSRTH	Ministry of Shipping, Road Transport and Highways
MOUD	Ministry Of Urban Development
MPD	MMRC Procurement Department
MPE	M&P Elevated
MPEG	Motion Picture Experts Group
MPR	Monthly Progress Report
MPT	Mobile Protection Terminal
MRT	Metro Rail Transport
MRTS	Metro Rail Transit System
MS	Mild Steel
ms	millisecond
MS	Middleware Server
MSC	Master Switching Centre
MSS	Manual of Specification and Standards
MSS	Maximum Safe Speed
MTBF	Mean Time Between Failure
MTC	Metropolitan Transport Corporation
MTTR	Mean Time To Repair
MV	Mechanical Ventilation
MV	Medium voltage
N	Neutral
N/A	Not Applicable
NBC	National Building Code (of India)
NC	Normally Closed
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NGO	Non-Governmental Organizations
NGR	Neutral Grounding Resistor
NMS	Network Management System
NO	Normally Open
NOA	Notification of Award
NOB	Non Objection of Bidder
NONO	Notice of No Objection
NS	Neutral Section
NSS	Network Switching Sub-system
NTO	Non automated train operation
NTP	Network Time Protocol
NVR	Network Video Recorder
O&M	Operation & Maintenance
O&SHA	Operating and Support Hazard Analysis
O/C	Over Current

O/G or o/g	Outgoing
OA	Officer Accommodation
OCC	Operation Control Centre
OCS	Overhead Contact System
OEM	Operation & Maintenance
OFDF	Optical Fiber Distribution Frame
OHE	Overhead Equipment
OHLE	Overhead Line Equipment
OLE	Object Linking & Embedding
OLTC	On Load Tap Changer
OMC-R	O & M Centre – Radio
OMC-S	O & M Centre – Switching
ONAF	Oil Natural Air Forced
ONAN	Oil Natural Air Natural
OOG	Out of Gauge
OPC	Overhead Protection Conductor
OPC	OLE for Process Control
OPH	Operational Purpose Hand portable
OTE	Over Track Exhaust
OTM	Open Tendering Method
PA	Public Address
PA/VA	Public Address/Voice Alarm
PABX	Private Automatic Branch Exchange
PAL	Phase Alternation by Line
PAS	Public Address System
PAT	Partial Acceptance Test
PBX	Private Branch Exchange
PC	Personal Computer
PCB	Pollution Control Board
PCC	Particular Condition of contracts
PCI	Payment Card Industry
PCM	Pulse Code Modulation
PD	Project Director
PDB	Power Distribution Board
PDH	Plesiochronous Digital Hierarchy
PDS	Proposal Data Sheet
PEC	Proposal Evaluation Committee
PF or pf	Power Factor
PFRS	Project Functional Requirements Specification
PGP	Pretty Good Privacy
Ph	Phase
PHA	Preliminary Hazard Analysis
PHPDT	Peak Hour Passengers Per Direction Trip
PIC	Passenger Inter Communication

PID	Passenger Information Display
PIDS	Passenger Information Display System
PIN	Personal Identification Number
PIS	Passenger Information System
PKI	Public Key Infrastructure
PLC	Programmable Logic Controller
PM	Project Manager as Employer's Representative
PMD	Protected Manual Driving Mode
POC	Proposal Opening Committee
POS	Power Supply
PP	Power Panel
PRC	Primary Reference Clock
PS	Particular Specification
PS&T	Power Supply & Traction
PSB	Platform Supervisor Booth
PSC	Prestressed Concrete Sleeper
PSD	Platform Screen Doors
PSPDN	Public Switched Public Data Networks
PSS	Power Supply System (Includes SCADA)
PST	Power Supply & Traction (Includes OCS & SCADA)
PSTN	Public Switched Telephone Network
PSU	Power Supply Unit
PT	Potential Transformer
PTCC	Power and Telecommunication Consultants Committee
PTD	Portable Ticket Decoder
PTFE	Polytetrafluoroethylene
PTI	Positive Train Indication
PTR	Playback and Training Centre
PTT	Press To Talk
PTZ	Pan, Tilt and Zoom
PVC	Poly Vinyl Chloride
PWD	Public Works Department
PZT	Points Zone Telephone
QC	Quality Criteria
QCACS	Quality Criteria Access Control system
QCCCTV	Quality Criteria CCTV
QCCS	Quality Criteria Commercial Speed
QCDM	Quality Criteria Doors Movements
QCDT	Quality Criteria Departure on Time
QCEC	Quality Criteria Emergency Communication
QCOCC	Quality Criteria Operation Control Centre
QCOMC	Quality Criteria Operations and Maintenance Communication
QCPAS	Quality Criteria PAS
QCPID	Quality Criteria PID

QCPSD	Quality Criteria Platform Screen Doors
QCPSS	Quality Criteria Power Supply System
QCRST	Quality Criteria Rolling Stock
QCSCS	Quality Criteria SCADA System
QCSI	Quality Criteria Signalling System
QCSI	Quality Criteria Signalling System
QCTE	Quality Criteria Train Evacuation
QCTPD	Quality Criteria Traction Power Distribution
QCTW	Quality Criteria Track Work
QCUS	Quality Criteria Unexpected Stops
QFTA	Quantitative Fault Tree Analysis
QMS	Quality Management System
QoS	Quality of Service
QSIG	Q Signalling
RA	Registration Agent
RAID	Redundant Array of Independents Disks
RAL	Reichsausschuss für Lieferbedingungen
RAM	Reliability Availability Maintainability
RAMS	Reliability Availability Maintainability and Safety
RASTI	Rapid Speech Transmission Index
RBC	Radio Block Centre
RCC	Reinforced Cement Concrete
RCP	Radio Control Panel
RDSO	Research Designs & Standards Organization
RDT	Reliability Demonstration Test
RDW	Radio Dispatch Workstation
RE	Railway Electrification
RE	Resident Engineer as General Consultant Discipline Key Chief Engineer
RF	Radio Frequency
RFID	Radio Frequency Identification
RI	Ride Index
RJ	Return Journey
RJIS	Rail Journey Information System
RJT	Return Journey Ticket
RMDT	Reliability, Maintainability Demonstration Testing
RMU	Ring Main Unit
ROCS	Rigid Overhead Contact System
ROM	Read Only Memory
ROW	Right of Way
RP	Repeater Panel
RPR	Resilient Packet Ring
RRSTP	Rapid Ring Spanning Tree Protocol
RS	Replication Server
RSS	Rectifier Sub-station

RST	Rolling Stock
RTU	Remote Terminal Unit
RTV	Response Threshold Value
RVS	Rendezvous Point
S&C	Signalling and Communications
S&T	Signalling and Telecommunications
S&TC	Signaling and Train Control system
S/N	Signal to Noise Ratio
SA	Service Available
SAA	Atreya Chowk Station
SAL	Sub Alarm panel
SAM	Aarey Milk Colony Station
SAM	Security Access Modules
SAP	Sub Alarm panel
SAP	Station Announcement Point
SAP	Safety Assurance Plan
SAPROF	Special Assistance for Project formulation (for Japan Bank for International cooperation)
SAT	System Acceptance Test
S-ATS	Station Automatic Train Supervision System
SB	Switch Board
SBA	BKC Bandra Station
SBD	Safe Braking Distance
SC	Station Controller
SC1	CSIA International Airport Station
SC2	CSIA Domestic Airport Station
SCADA	Supervisory Control and Data Acquisition
SCB	CBD Station
SCC	Special Conditions of Contract
SCG	Churchgate Station
SCIL	Safety Critical Items List
SCP	Cuffe Parade Station
SCR	Station Control Room
SCS	CST Metro Station
SCU	Station Control Unit
SDA	Dadar Station
SDH	Dharavi Station
SDH	Synchronous Digital Hierarchy
SDS	Short Data Service
SEE	Easter Express Highway Station
SEJ	Switch Expansion Joint
SEM	Structural, Electrical and mechanical
SER	Signalling Equipment Room
SF6	Sulphur Hexafluoride
SFSRTS	Standard for Fire Safety in Rapid Transit Systems

SGG	Girgaon Station
SGR	Grant Road Station
SHA	System Hazard Analysis
SHC	Hutatma Chowk Station
SHE	Safety, Health and Environment
SHL	System Hazard Log
SI	Section Insulator
SI	Site Investigation
SIF	Source Interchange Format
SIG	Signalling, Train Control
SIL	Safety Integrity Levels
SIM	Subscriber Identity Module
SINAD	Signal plus Noise plus Distorsion (ratio)
SIP	Session Initiation Protocol
SJ	Single Journey
SJH	Jogeshwari Station
SJT	Single Journey Ticket
SKD	Kalbadevi station
SKM	Kanjur-Marg Station
SLA	Service Level Agreement
SM	Security Module
SMA	Moral Naka Station
SMC	Mumbai Central Station
SMC	Station Master's Console
SMI	MIDC Station
SML	Mahalaxmi Station
SMS	Station Management System
SNTP	Simplified Network Time Protocol
SOD	Schedule of Dimensions
SOP	Schedule of Powers
SOR	Stations Operations Room
SP	Sectioning and Paralleling Post
SP	Service Provider
SPDT	Single Pole Double Throw
SPK	Speaker
SPL	Sound Pressure Level
SPT	Signal Post Telephone
SRS	System Requirements Specification
SS	Sub Sectioning Post
SSC	Santacruz Station
SSD	Sheetla Devi Station
SSE	SEEPZ Station
SSG	Station Signage
SSHA	Sub-System Hazard Analysis

SSHI	Sub-System Hazard Identification
SSM	Science Museum Station
SSP	Sub Sectioning and Paralleling Post
SSPP	System Safety Program Plan
SSR	Sahar Road Station
SSS	Single Source Selection
SSSAP	Sub-System Safety Assurance Plan
SSU	Synchronisation Supply Units
SSV	Siddhi Vinayak Station
SSYS	Station Security System
STD	To be clarify
STI	Speech Transmission Index
STM	Standard Telecom Mode
STN	Station
STO	Semi-automated Train Operation
STP	Signaling, Train Control, PSD, communications
STS	Station Signage
STT	Single Trip Ticket
SV	Stored Value
SVB	Vidhan Bhawan Station
SVN	Vidyanagari Station
SWC	Systems Wide Contractor
SWO	Worli Station
SWS	Traction Switching Station
T&C	Testing and Commissioning
TAL	Trip Achievement Level
TAPI	Telephony Application Programming Interface
TBA	To Be Advised
TBM	Tunnel Boring Machine
TC	Traffic Controller
TC	Trailer Car
TCCP	Train Cab Communication Panel
TCF	Technical Construction File
TCP/IP	Transmission Control Protocol/Internet Protocol
TCU	Trans-Coder unit
TD	Train Describer
TDR	Train Data Recorder
TDS	Time Distribution System
TDST	Tender Data Sheet
TEC	Tender Evaluation Committee
TECC	Telecommunication Equipment Control Centre
TEL	Telephone System
TEP	Track Earthing Panels
TER	Telecommunication Equipment Room

TES	Trackway Exhaust System
TETRA	Terrestrial Trunked Radio
TEW	Tunnel Earth Wire
THID	Ticket Hall Information Display
THSCU	Ticket Hall Station Control Unit
TIA	Telecommunications Industry Association
TIMS	Train Information Management System
TIN	Tax Identification Number
TIS	Ticket Issuing System
TMN	Telecommunications Management Network
TMO	Time Mode Override
TMS	Train Management System
TNEB	Tamil Nadu Electricity Board
TNS	Three phase and Neutral system
TO	Train Operator
TOC	Train Operating Company
TOD	Ticket on Departure
TOM	Ticket Office Machine
TOR	Term Of Reference
TOS	Tender Opening Sheet
TP	Ticket Processing. (Fare processing module)
TPC	TATA Power Company
TPP	Technical Project Proposal
TPS	Traction Power Substation
TR	Power Transformer
TR	Ticket Reader
TRCP	Train Radio Control Panel
TSC	Technical Sub-Committee
TSDB	Train Services Database
TSN	Tender Serial Numbers
TSR	Train Service Regulator
TSS	Traction power Sub Station
TSTM	Two Stage Tendering Method
TT	Traction transformer
TTRS	Time to Return to service
TVF	Tunnel Ventilation Fan
TVM	Ticket Vending Machine
TVS	Tunnel Ventilation System
TWK	Track Work
U/V	Under voltage
UD	Usage Data
UDP	User Datagram Protocol
UGC	Underground Civil
UHF	Ultra High Frequency

UIC	Union Internationale des Chemins de Fer (International Union of Railways)
UMTS	Universal Mobile Telecommunications System
UPAS	Under Platform Air Supply
UPS	Uninterruptible Power Supply
UR	User Requirement
UTC	Universal Time Coordinated
UTO	Unattended train operation
UTP	Unshielded Twisted Pair
UTX	Undertrack Crossing
VA	Voice Alarm
VAC	Ventilation and Air Conditioning
VAT	Value-Added Tax
VCB	Vacuum Circuit Breaker
VCC	Vehicle Communication Controller
VCP	Ventilation Control Panel
VDC	Volt Direct Current
VDE	Verband der Elektrotechnik (German Association for Electrical, Electronic and Information Technologies)
VDU	Video Display Unit
VESDA	Very Early Smoke Detection and Alarm
VGCS	Voice Group Call Service
VID	Visual Information Display
VLAN	Virtual Local Area Network
VMS	Voice Mail System
VRS	Voice Recording System
VS	Virtual Server
VSD	Variable Speed Drive
VT	Voltage Transformer
VTS	Video Transmission System
VVVF	Variable Voltage Variable Frequency
WAN	Wide Area Network
Wi-Fi	Wireless Fidelity
Wi-Max	World Interoperability for Microwave Access
WLAN	Wireless Local Area Network
WN	Working Note
WTI	Winding Temperature Indicator
WTO	World Trade Organization
XDR	External Data Representation
XLPE	Cross Linked Poly Ethylene
HA	High Attenuation
TBS	Twin Block Sleepers
N&V	Noise and Vibration

Mumbai Metro Rail Line 3
BIDDING DOCUMENTS

EMPLOYER'S REQUIREMENTS
GENERAL SPECIFICATIONS

Part 2

Section VI (1)
Sub-Division F

Appendix -16

EARTHING AND BONDING

July 2019

Table of Contents

1. INTRODUCTION

1.1 Scope

1.1.1 The purpose of this Policy is to define the requirements for the Earthing and Bonding of the electrical power supply systems and other parts of the Metro system to ensure, as far as possible:

i) The protection from electrical shock of all personnel on or using the Metro system

ii) Minimizing the electrical interference between the electrical power supply and other electrical and electronic systems.

iii) The protection of electrical equipment from a breakdown of electrical Insulation

iv) Minimizing electrolytic corrosion effects arising from normal operating AC traction currents or fault currents flowing to and from the general mass of earth.

1.1.2 It should be understood that no Single section can be taken alone as being complete in itself. In the implementation of this Earthing policy has to be taken as a whole ensuring interface and integration of all systems comprising the Metro system.

1.1.3 The Contractor / Contractors shall develop the designs in compliance with this policy which shall require a Notice of no objection from the Engineer prior to commencing any such works.

1.1.4 The Contractor shall coordinate his designs for Earthing, Bonding, Lightning Protection and Stray Current Corrosion Control as required with all Interfacing Contractors.

1.1.5 Reference in this or other documents to Grounding or Bonding etc shall be taken to be synonymous with 'Earthing"

1.1.6 “Mean Earth Terminal (MET) will be provided at both end of stations and the Earthing & Bonding for Track work will be provided by Track contractor to discharge Earthing to this MET.”

1.2 Legislation and Standards

1.2.1 Earthing, Bonding, lightning and corrosion protection shall be in accordance with applicable requirements related to the Metro systems, this Earthing and Bonding Policy shall be designed, installed and tested in full compliance with the relevant standards and codes listed below:-

a) European Standard EN50122-1 - 'Railway Applications Fixed Installations Protective provisions relating to electrical safety and Earthing'.

b) European Standard EN50122-2 - 'Railway Applications - Protective provisions against the effects of stray currents traction systems

c) British Standard 7361, Part 1 - Cathodic Protection - Code of Practice for Land and

Marine Applications.

d) International Union of Railways Codes (UIC) 605 'Protection from Corrosion' - Measures to be taken on catenaries to reduce the risk on adjacent piping and cable systems.

e) BS 7671 - Requirements for Electrical Installations

f) IEC 60364 - Electrical Installations of Buildings

g) IEC 61312 - Protection Against Lightning

h) IEC 61024-1; Protection of Structures against Lightning, Part 1: General Principles.

i) IEC 61024-4; Series protection against lightning electromagnetic impulses for structure with electrical and electronic systems.

j) IEC 61000-5 Edition1, Electromagnetic Compatibility (EMC) Part5

k) BS 7430 - Code of Practice for Earthing.

l) ANSI/IEEE 80 - Earthing of Substations

m) IS—3043--EARTHING & IS: 2309 - LIGHTNINGPROTECTION

n) BS-1013---SUBSTATIONEARTHING

o) NFPA-- 780-- LIGHTNINGPROTECTION

p) IEEE- 1100—EARTHING OF ELECTRONIC EQUIPMENT EN- 50122-2 Insulation from Earth

q) EARTH RESISTANCE VALUES (ETI/PSI/EARTHING OF RDSO) RDSO's Code No: ET1/PS I /120 (2/91) Code of practice for Earthing of Power Supply Installation for 25kV ac single phase traction system

r) European Standard EN50121-1 -Railway Applications – Electromagnetic compatibility - General'.

s) European Standard EN50121-4 - Railway Applications – Electromagnetic compatibility – Emission and immunity of the Signalling and telecommunications apparatus'.

t) European Standard EN50121-5 - Railway Applications – Electromagnetic compatibility – Emission and immunity of fixed power supply installations and apparatus'.

u) RDSO/SPN/144/2004 Safety and reliability requirement of electronic Signalling equipment,

v) Local Codes. These may however conflict with International Codes/Standards in which case discussion and agreement with the Engineer will be required.

2. CATEGORIES OF EARTHING

2.1 General Requirement

2.1.1 A low impedance path to earth is required for all the Earthing and Bonding systems described in this policy

2.1.2 The Earthing system shall be sized to suit the application and be capable of carrying full fault or load currents as appropriate. The Earthing system provided at any location may be common to two or more categories of Earthing.

2.1.3 Earthing and Bonding is required under one or more of the following categories.

2.1.4 To establish a low impedance path to earth a grid of rods (Mat or Farm) shall be buried under the station, TSS and or Ancillary building floor. To allow correct designs the ground conditions must should first be noted and earth resistivity measured and the grid system designed according to the results. Due allowance shall be made for the fact that conditions may vary throughout the year due to seasonal weather

2.1.5 A network of low impedance Bonding / Earthing conductors shall then be provided to all areas of the Metro as required by this policy

2.2 Neutral Earthing

2.2.1 Connection to earth at one point of the star point of all MV / LV Delta Star Transformers (33 kV / 415 3 p). This will be in each of 2 ASSs or the secondary winding of all single phase traction transformer (110 kV/25 1p) which will be located away from the Station Building in the traction bulk supply substation to ensure a low impedance path to earth for earth fault or load currents

2.3 Protective (Frame) Earthing

2.3.1 Connection to earth at one or more points of the non-current-carrying parts of electrical equipment to ensure that, in the event of a failure of insulation or other inadvertent connection between current and non-current- carrying parts, appropriate protection devices operate and no dangerous potential difference occurs between the non-current-carrying parts of the equipment and the general mass of earth or adjacent equipment

2.4 Adjacent Metallic Structures

2.4.1 All fixed metallic equipment or structures not intended for carrying electrical current shall be connected to the Earthing and Bonding grid.

2.5 Mitigation of Interference Effects (EMI / EMC)

2.5.1 The connection to earth of the metallic screen of screened cables intended and usually used for light current signal and control cables. This connection to earth of the screens of any

light current cables will, in general, be confined to one end in order to avoid circulating currents in the screen causing interference

2.5.2 Each System discipline contractor will determine the solution to be adopted in these cases.

2.6 Treatment of unearthed systems

2.6.1 Unearthed/ Double Insulated systems where all the current carrying conductors are fully insulated from earth at all points are acceptable. However special care needs to be taken during design and installation when considering this type of system. A Notice of No Objection from the Engineer will generally be required

2.7 Lightning Protection of buildings and structures

2.7.1 This shall be by the provision of an un-insulated low impedance conductor, from the high points of all outdoor structures from lightning arrester (spike) to separate and individual earth electrode system which shall be capable of disconnection for testing. This cable shall run in as straight a line as possible down from the high point of the structure with the minimum of bends. All individual structures shall be protected in accordance with the applicable standards. The following structures are immediately apparent but this may not be exhaustive list -Station Ancillary Buildings, every Entrances from Surface to Concourse, every OHLE poles outside, Station and Depot buildings, Vent shaft Buildings, TSS building

3. TREATMENT OF AC POWER SUPPLIES

The policy is to provide independent standalone earth farm/Mats at each of the TSS substations, Auxiliary substations (ASS) and ancillary building, Depot and at other locations as required.

3.1 The earth resistor shall be below 1ohm and be independent but can be multiple-interconnected by provision of Bonding connections, cable sheaths, cable armoring etc. to adjacent earth farms to form an comprehensive earth mat embracing the whole of the Metro system

3.2 The Earthing and Bonding of the Supply Companies incoming HV power supply cables must be agreed with the Supplying Authority and carried out as agreed. An Engineers Notice of No Objection shall be required.

3.3 Traction return current circuit System

The Traction Power Supply return current will be generally by the running rails into the nearest Station earth mat.

4. OVERALL EARTHING POLICY FOR THE MUMBAI METRO LINE -3 UNDERGROUND

4.1 Tunnels

4.1.1 A continuous earth conductor (TEC) shall be installed through all the tunnels to connect the earth bus bars in each ASS of adjacent stations and or vent shafts providing a comprehensive overall earth network.

4.1.2 The TEC earth bar shall be installed at low level in the tunnels on the brackets provided

4.1.3 The reinforcing bars of all the NATM, cut and cover cast in situ concrete shall be bonded together by their very nature and shall be connected to the TEC.

4.1.4 The first stage base concrete of the tunnel and 2nd stage Track slab or plinth will be installed and fixed by means of connecting reinforcement. This reinforcement will be connected to the TEC at every cross passage but always every 250 m. At each tunnel entrance to the station boxes the reinforcing rods of the uppermost reinforcement layer shall bonded together and connected to the ASS earth bus bar.

4.1.5 For bored tunnels, the precast concrete segments, are individually reinforced and are not bonded together. Due to the watertight membrane separating the inner from the outer shell, the bored tunnel structure is not regarded to be effective for Earthing purposes. Because of the small distances between reinforcement of individual segments, the inner tunnel shell is regarded to be potentially conducive for higher voltages. Therefore protective provisions against unintended transfer of dangerous potential shall be required. In these tunnel sections

An overhead protective conductor (OPC) shall be installed within the pantograph zone and all rigid bar OHLE or ROCS supports shall be connected to the OPC

The OPC shall be bonded to the TEC at distances not exceeding 250m.

All other metallic non conducting structure will be connected to the TEC

4.2 Stations and Ancillary Buildings

4.2.1 All Station buildings shall be provided with 3 earth bus bars located as described below and sized to suit the application of loads and fault levels etc.

i) LV Neutral Earth Bar located in each of 2 ASS rooms

ii) Clean earth for electronic equipment located in each of 2 ASS rooms

iii) Traction system return located either in one or both ASS roomsor in the undercroft as convenient.

iv) The ROCS protective conductor (OPC) shall be connected to the traction earth in item iii above at either end of the Station box

v) All LV switch boards, equipment frames etc. and all other non-conducting parts shall be connected to the item i above

vi) All non-conducting electronic equipment and screens etc. shall be connected to item ii above.

4.2.2 The earth risers cables of 185 sq. mm XLPE minimum shall be brought from the earth mat up

through the basement floor or wall to each of the ASS rooms as described above

4.2.3 10 connection shall be made from the Earth mat/ mats (to be provided by the Civil Contractor) in the Station Box that shall ensure that the potential rise is limited to safe limits above water earth. The following connection from the earth mat shall be provided to 3 separate earth bars and these connection shall be insulated XLPE minimum 185mm^2.

i) 2 cables of adequate size for both ASS Neutral Earths in 4.2.1-i

ii) 2 cables of adequate size for clean earths in both ASS 4.2.1-ii

iii) 2 cables of adequate size for Traction earth as item 4.2.1-iii

4.2.4 The 3 earth mat / mats in the station box may all be bonded together

4.2.5 An earth mat / Grid shall be provided by the Civil Contractor as described above under the Ancillary Buildings and connected to an earth bar within the Ancillary building to provide a neutral and frame earth as in 4.2.1-i

From the earth bar in the ASSs or Ancillary Building provided by Civil Contractor above, the MEP Contractor shall provide flat strip bare copper / hot dipped GI bars to distribute the frame earths to all :-

a) Every platform / concourse Power Distribution room

b) Every Station Control Room complex, AFC zone,

c) Every Ticket Office, excess fares office etc.

d) Every Escalator and Lifts control cabinets

e) Every TVS / AHU plant and equipment room

f) All Ancillary Building levels and rooms

g) Other locations where an Earthing / Bonding connection for non-conducting metal work is required will be provided by each individual Project Contractor

Any distribution of Earthing required beyond the above nominated locations shall be provided by the other Project Contractors responsible for the provision of their particular equipment.

4.3 **Lightning Protection**

4.3.1 Every Lightning conductor shall ensure that the potential rise is limited to safe levels above water earth and shall consist of rods inclusive of electrode pits and heavy duty cover and 95 sq.mm bare stranded copper wire laid 300mm below ground level.

4.3.2 Each lightning conductor system shall be independent of all other systems and the earth connection shall be made up of lengths of 1.8m, 16mm diameter copper bonded steel rods coupled together as required with bronze coupling and copper wire joints are by exothermic weld and shall be inspected and approved by the Engineer before backfilling.

5. MAIN LINE AND DEPOT EXTERNAL TRACK WORK

5.1 In order to ensure electrical safety and prevent the potential of the running rails rising to excessive potentials above the structure earth, Bonding shall be provided by the power supply contractor at an appropriate number of locations from the running rails to the TEC or BEC and from the OPC or AEC to control the rail potential to safe levels.

5.2 The Main Line track work and the depot external track work shall be electrically isolated from each other by the use of insulation joints boundary

6. DEPOT WORKSHOP TRACK WORK

6.1 Earth mats/ Grids shall be provided by the Civil Contractor as appropriate in the Depot generally as described above in locations to be confirmed during the design.

6.2 The running rails and traction return system of the Mumbai Metro Line-III Project within the depot workshops shall be solidly bonded to the traction return earth. If a depot building has an OCL, then the measures as described for passenger stations shall be applied.

6.3 All individual Earthing installations and conductive parts of the depot and workshop area shall be equipotential bonded to a flat strip distributed earth conductor as described in 4.2.5 above

6.4 All major workshop equipment including under train wash, floor wheel lathe, wheel press and all other major fixed maintenance equipment will be provided with earth terminals for direct Earthing using the flat strip GI above and distributed around the buildings

6.5 The traction return rails for the depot workshop and the wheel lathe pit lane shall be electrically isolatable from the main line by means of insulated rail joints.

7. ELEVATED SECTION OF LINE

7.1 The traction return current circuit of the Mumbai Metro Line-III Project will use the rail and the following return current conductors:

- Buried Earth Cables BEC to substitute for TEC
- Aerial Earth Cables (AEC) to substitute for OPC

7.2 Every OHE mast shall be connected to an isolated and individual lightning earth pit etc.provided by the PS&T Contractor directly below each mast as described above in 4.3

8. INTERFACES

8.1 The following SOW / Interfaces shall be provided by those listed below and further described in App 19

- a-Earth Mat and earth bar in both ASS and Ancillary Building by Civil Contractor-
- b-Designs of mat etc. for Stations by PS&T Contractor
- c-Design of mat for ancillary Building by MEP Contractor

- d-TEC by MEP Contractor
- e-Neutral earth by MEP Contractor
- f-Distributed earth from ASSs by MEP Contractor
- g-Lightning Protection of station & buildings by MEP Contractor
- h- OPC and AEC by PS&T Contractor

9. EARTHING OF COMMUNICATION AND CONTROL SYSTEMS

General

9.1 Two separate clean earths' bars are provided by the Civil Contractor in both Station ASSs and the Ancillary Building of value not exceeding 1 Ohms required for Signaling and Telecommunication, PSD and AFC. Distribution from the ASSs / Ancillary Building earth bars to all equipment requiring a clean earth shall be provided by the S&T, PSD, AFC Contractors terminated to suit the equipment all at Stations, Tunnels, Ancillary Buildings, Depot and OCC.

9.2 General Frame earths will be provided by the MEP Contractor into the areas and rooms listed above

10. SERVICES TO METRO PREMISE

10.1 Metallic service (I.e. water, gas, waste water etc.) pipes entering or leaving the Metro system premises, both over and underground, are to be provided with an insulated insert at the point of entry, and then all internal metallic works pipe work etc. within the Metro system is to be bonded to the local Metro earth system.

10.2 Where both plastic and metal pipes are used, all lengths of exposed metal pipes, or those connected to taps or apparatus, are to be bonded to the local earth system

11. SMALL METALLIC COMPONENTS

10.3 All non-conducting metal work in the Station / Tunnels and Ancillary buildings are to be bonded to an earth conductor in accordance with the relevant regulations. E.g. Hand rails, Architectural features etc.

10.4 Miscellaneous Equipment / Depot Fencing

All metallic equipment and fencing associated with the Metro system and other equipment which is connected to it, gates posts etc. shall be to be earthed to an appropriate earth system TEC, AEC etc.

Mumbai Metro Rail Line 3
BIDDING DOCUMENTS

EMPLOYER'S REQUIREMENTS
GENERAL SPECIFICATIONS

Part 2

Section VI (1)
Sub-Division F

Appendix 17

TRANSIT SYSTEM TEST, COMMISIONING AND OPENING OF PUBLIC CARRIAGE OF PASSENGERS REQUIREMENTS

July 2019

TABLE OF CONTENTS

1. General Presentation

1.1. Document objectives – Phased Revenue Service.

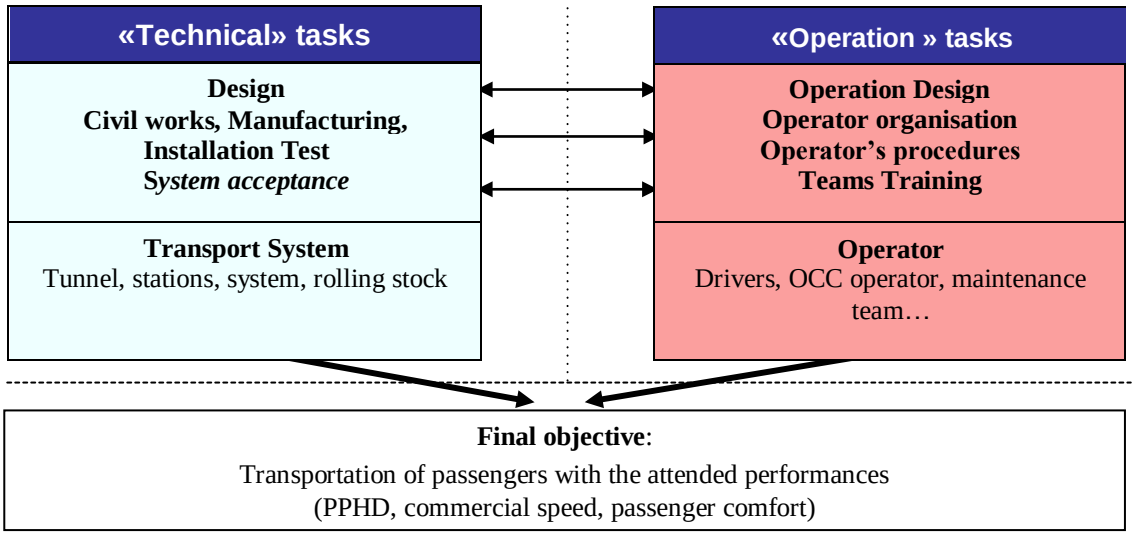
This document describes the phases of tests & commissioning process for the Transit System as a whole (clause-2). It contains schedules used for testing and commissioning including blank operation.

This document presents sequence of tests to perform during overall tests and commissioning as described in strategy of tests. (Clause4).

MML3 project will commence operation for revenue service in 2 phases (see clause 5), each phase will require compliant with the process detailed below.

Important note: several design requirements regarding the infrastructure (station, tunnel) and several safety criteria shall be checked, demonstrated or validated through Working notes or Calculation notes. Although part of the overall system acceptance process such proof are not dealt in this document that is only limited to testing in a general and extended sense.

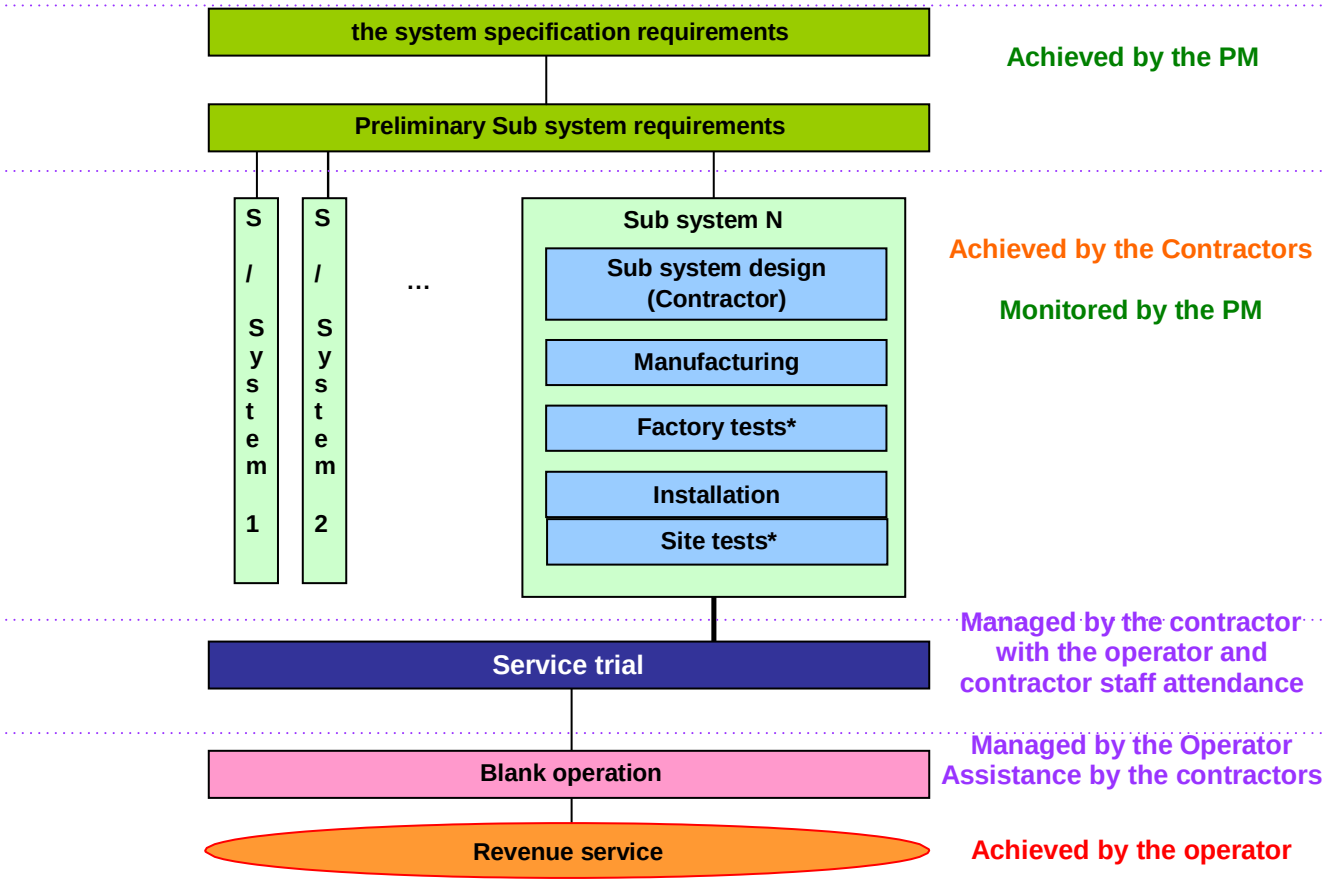
1.2. MML3 Project Process



The global project objective is the transportation of passengers with the attended performances. For that is necessary:

a. To design and build all the necessary elements of the transport system
b. To check and validate the function units (test and commissioning)
c. To put in place an operation team able to use the metro system and insure the forecasted transportation of passengers.

1.3. MML3 Project sequences and associated responsibilities



*Including liaising with interfacing contractors

2. Inspection, Testing & Commissioning and Trial Run Objective and Guidelines

2.1. Inspection

The objective of this activity is to ensure that the execution of equipment installation is carried out by the Contractor in compliance with:

- Approved Systems Installation Management Plan
- Approved Technical specifications,
- Approved Standards and regulations, Working drawings,
- Approved Installation drawings,
- Approved Systems Installation Method Statements,
- Hygiene and Safety rules, and
- Approved general program and quality.

The Engineer will proceed with inspection of the implementation of all systems, from Factory tests results analysis till deployment on site.

2.1.1. Factory acceptance tests

Factory Acceptance tests shall be carried out before shipment to Site for any constructor' supplied material, components and equipment to verify that the components are fit for its intended use and otherwise complies with relevant specifications stipulated by the design and operational requirements.

2.1.2. Systems Installation Sequence

The Contractor shall ensure that:

- The Contractor Installation Sequence is consistent with the delivery schedule of technical rooms from Civil Works and that Punch Lists on the Technical rooms conditions handed-over for System Installation are issued and maintained by the Contractor when applicable,
- The Contractor Installation Sequence takes into account interfaces with other sub-systems,
- The Contractor Installation Sequence is consistent with the Depot and Power Supply requirements for receiving the first train sets.

2.1.3. Systems Installation Supervision

Basically, the Engineer will supervise conformity with approved Installation Drawings and Method Statements prepared by the Contractor and previously approved by the Engineer.

This will be the case for all Systems including: Rolling Stock, Signalling, Telecom and OCC, AFC, PSD, Power supply, Track, E&M, fire safety

2.1.4. Systems Installation Progress Meetings

Systems Installation Progress Coordination Meetings will be chaired by the Engineer and held with key site personnel of the Contractor and Subcontractors and Engineer at least every two weeks.

Agenda items for each meeting shall include:

- On site and off site physical progress including off shore work during the current period as compared to forecast;
- Scheduled progress - the Contractor will be required to submit a five week rolling-work schedule of future work activities derived from the Contractor's project construction schedule;
- Contractor Work Plan - Discussion of installation methods, interfaces with Civil Works, labour/equipment requirements, schedule of Contractor deliverables, and schedule of requirements from systems installation management;
- Problem Issues - Outstanding design approval requests, design clarification issues, outstanding claims issues if any;
- Quality Control/Inspection Issues; Factory Tests issues, shipments and
- Safety Issues.

2.2. Subsystem Tests

The Contractor shall undertake from time to time, or cause to be undertaken, such periodic and item specific testing as may be required to ensure conformity of the component parts of the Project with their specifications ("Subsystem Tests"). Subsystem Tests shall take place prior to the Integration Tests and the Commissioning Tests.

The Contractor shall submit for approval to the Employer's Representative the Testing and Commissioning Plan identifying the testing program requirements which will be applied to each completed Rolling Stock and to appropriate sections of the Traction Electrification Power System, Overhead Contact System, Track work, Signaling System, Communications and Control Systems, etc. in order to achieve the Employer's Requirements.

2.3. Tests results

In the event that any subsystem fails the required tests, the Contractor shall institute corrective measures and re-tests the subsystem to demonstrate compliance with the Employer's Requirements. The Contractor will keep the Engineer informed of the dates, times and locations of the subsystem tests to be performed to enable the Employer, the Engineer and other appropriate personnel to be present and witness the tests. Personnel to be involved in the actual operations and maintenance of the system after the dates of issuance of the Certificate of Taking-Over may participate in witnessing and assisting in the conducting of the tests.

As soon as the test data for any subsystem test and analyses has been made available to the Contractor, it shall provide to the Engineer such data and analysis... The Engineer will review and state whether or not the subsystem complies with the Employer's Requirements. The Engineer will review all subsystems Test Reports from the Contractor to attest to the Employer successful completion. Upon successful completion of all these subsystem tests, the System Integration Tests shall be conducted.

2.4. Systems Integration Tests

The purposes of the Integrated System Test & Commissioning phase are to:

- Validate the completion of the integration of the Sub-System with the other Sub-systems supplied and External parties
- Prepare the global system to undertake the System Performance Verification /Test Running of the System, operating with running trains in its final environment and infrastructure constructed.

During these tests the system shall be operated in a mode as close as possible to normal operation. This will allow verifying that operational requirements have been taken into account.

The Testing and Commissioning Plan will identify the testing program requirements which will be applied to the Integration Tests. Integration Tests shall include a period of static tests and a period of dynamic tests using electrically powered trains moving on the mainline.

In the event that any Integration Tests fails the required tests, the Engineer will review the Contractor corrective measures and witness re-test to demonstrate compliance with the Employer's Requirements.

2.5. Commissioning Tests

The Contractor shall undertake testing of the products implemented as a part of the commissioning process to verify that the subsystems and systems as a whole are operating in such a manner as to meet the requirements of the Technical Documents. Such testing is collectively referred to as the Commissioning Tests.

The Engineer will review and approve all Commissioning Test programs prepared by the Contractor.

The Contractor Testing and Commissioning Plan shall identify the Commissioning Test Program that is required to demonstrate the satisfactory operation of the part of the Projects in accordance with the Employer's Requirements. Separate acceptance tests will be required for the various elements and subsystems which will make up the Project.

The Commissioning Tests shall include tests to operate the lines according to the normal operating schedule for a period of time with appropriate stop and dwell times to simulate normal operation conditions. Utilization of spare Rolling Stock in accordance with normal operating procedures shall be permitted.
The Commissioning Tests shall also include tests of the "Degraded Modes" operation identified in the contract documents.

In the event of failure of any of the Commissioning Tests to achieve the acceptance criteria identified in the Testing and Commissioning Plan, Engineer will review the Contractor corrective measures and witness re-test to demonstrate compliance with such acceptance criteria.

The Contractors shall keep the Engineer informed of the date and commencement time of each Commissioning Test, which tests shall not be undertaken until all Subsystem Tests and all Systems Integration Tests have been satisfactorily performed.

2.6. Trial Run

This period corresponds to the progressive putting into operation of the integrated System. The start of this period should also match the end of the training of the Operator staff, which means that the Operating Procedures have previously been completed and validated.

All day-to-day operation conditions shall be met according to the timetables so as to assess the performance of the System, in both Normal and Degraded Modes of Operation.

During the Trial Run, trains without carrying passengers shall be operated as if they are providing normal passenger services. This will ensure that the required standards of

operational safety and reliability can be achieved through the performance of the railway system and the preparedness of staff.
Moreover, Trial Run exercises shall be conducted to provide a simulated environment for the testing and verification of operation and emergency procedures.

Key objectives of the Trial Run are:

- to exercise full timetable working;
- to exercise service during degraded operations;
- to test the adequacy and effectiveness of all emergency procedures;
- to ensure the customer service facilities are well prepared, with appropriate trained staff and effective systems in place;
- to allow hands-on experience for Operation and Maintenance staff and emergency service personnel to familiarize with the system equipment provided, in such a way that both normal and abnormal scenarios can be dealt with safely and efficiently;
- to test adequacy and effectiveness of the staff training and the operation and maintenance procedures;
- to prepare the moving to System Performance Demonstration

2.6.1. Normal and Degraded Modes of Operation

The purpose of the Trial Run is to run trains to manage the stations in the revenue service conditions without passengers and to operate equipment in prevailing conditions.
During this "Trial Operation" period, the Contractor shall assist Operation and all the manpower involved in the system operation (managers, engineers, OCC operators, station staff, maintenance teams... etc.) will be present according to the duty rosters so as to operate normally during the revenue service shifts, equipment and trains in compliance with the safety, operating rules and procedures.

At the end of the Trial Run period, MMRC operator will be able to apply the prescriptions described in the various users' guides, operating manuals, operating rules and procedure documents related to the equipment of the system.

3. Testing and Commissioning (T&C) process

The content of this Appendix complement Chapter 9, Testing and Commissioning requirements and the Technical Specification Part 2, Section VI-(2).
The tests objectives are to check that the design requirements (functional, performance, operational and technical) of the sub systems and of the global transport system have achieved the contractual and specification requirements.

The contractor shall

a) Prove that his sub-system is compliant with his contractual requirements and specifications, including interfacing with other subsystems.

b) Check that the entire system as a whole is compliant with the overall system and performances objectives and requirements. The Contractor shall assist PM and the Employer (assisted by the PM) to ensure the requirements are obtained.

c) shall prove that the system is safe for operation and shall provide all procedures and adequate document to the operator for safe operation of the Transit system as a whole.

This process includes various steps, in which each project actor has a different role to play.

3.1. Test definition

Test phases	definition	Reference in this document	Contractual designation according to JBIC
Manufacturing tests and Factory Acceptance Tests	Tests achieved in factory	See clause 3.5.2	Tests and Inspection Pre-Commissioning
Installation tests	Tests achieved to check the performance of each sub-system	See clause 3.6.1.1	
Partial acceptance tests		See clause 3.6.1.2	
System acceptance tests		See clause 3.6.1.3	
Integration testing and commissioning	Interfaces tests	See clause 3.6.1.4	
Service trial (or overall system tests)	Global tests of the transport system	See clause 3.6.2	
Issue of Completion Certificate	Taking over of the whole installations by the Employer	See clause 3.6.3	Completion certificate
Blank operation	Operation without passenger (operator's training)	See clause 3.6.4.2	Guarantee tests Commissioning Ref (GC clause 25)
Regular Service Verification	Period to verify the RAM performances	See clause 3.6.4.3	

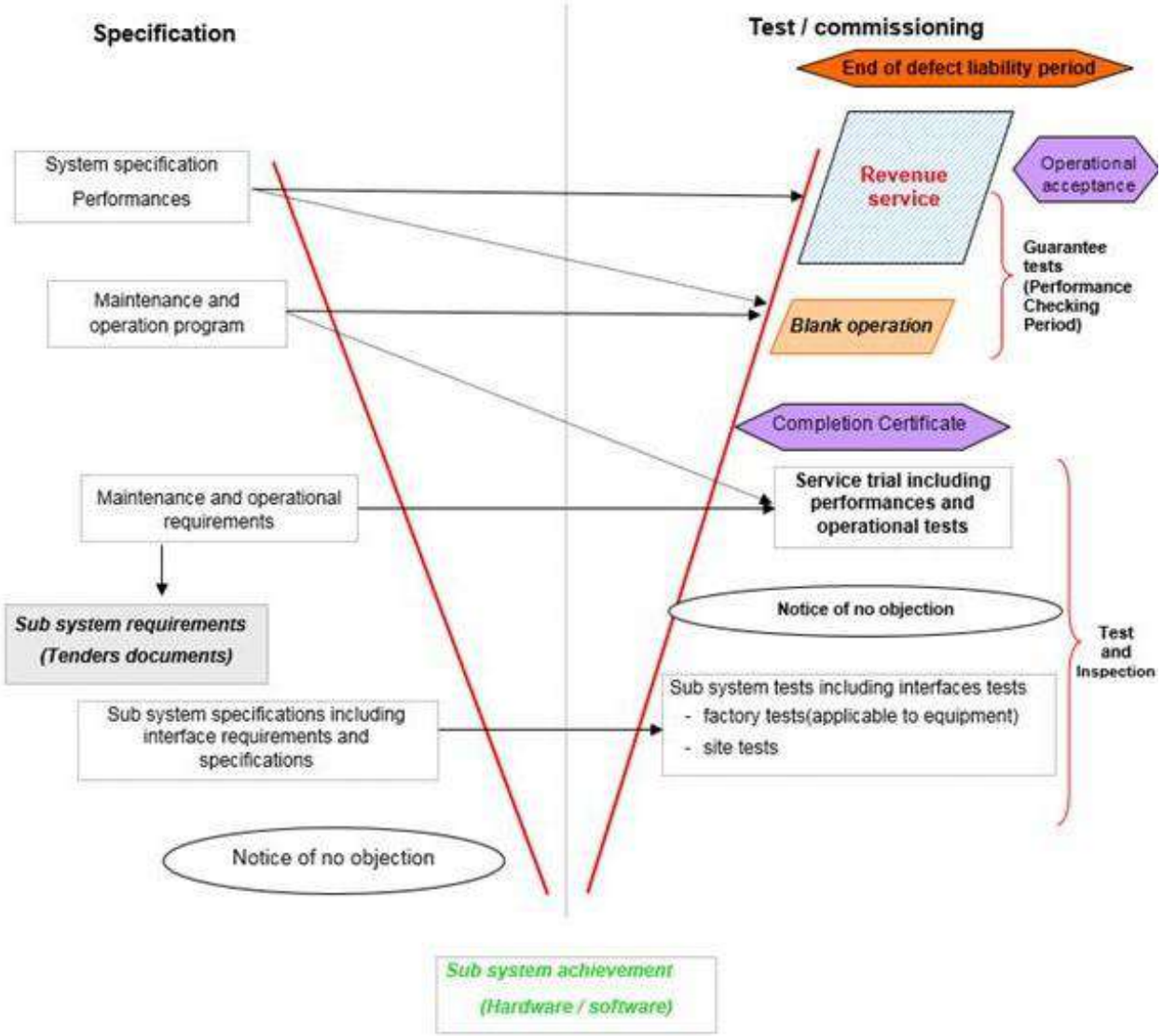
The tests and inspections are the final step in order to prove the quality control process of each project actor (contractors, Employer, Project Manager). They include all tests leading to the issue of Completion Certificate, including tests at factory and tests on site.

Except for Service Trial, these tests are achieved by contractors, monitored by PM. Procedures concerning them are included in particular Testing and Commissioning plans submitted to PM. For each inspection or test, a report/record is prepared, countersigned by PM if he witnessed it, or forwarded to PM for information.

The Service Trial is achieved by PM and with the assistance of other interested parties as part of the Commissioning Team.

After the issue of Completion certificate, guarantee tests are performed by the Employer with the assistance of the contractors, to ensure the facilities attain the functional requirements. At the end of guarantee tests, the operational acceptance occurs. A certificate can be issued if requested by the contractor.

3.2. Specification – Validation process (V-cycle)



3.3. Test typology

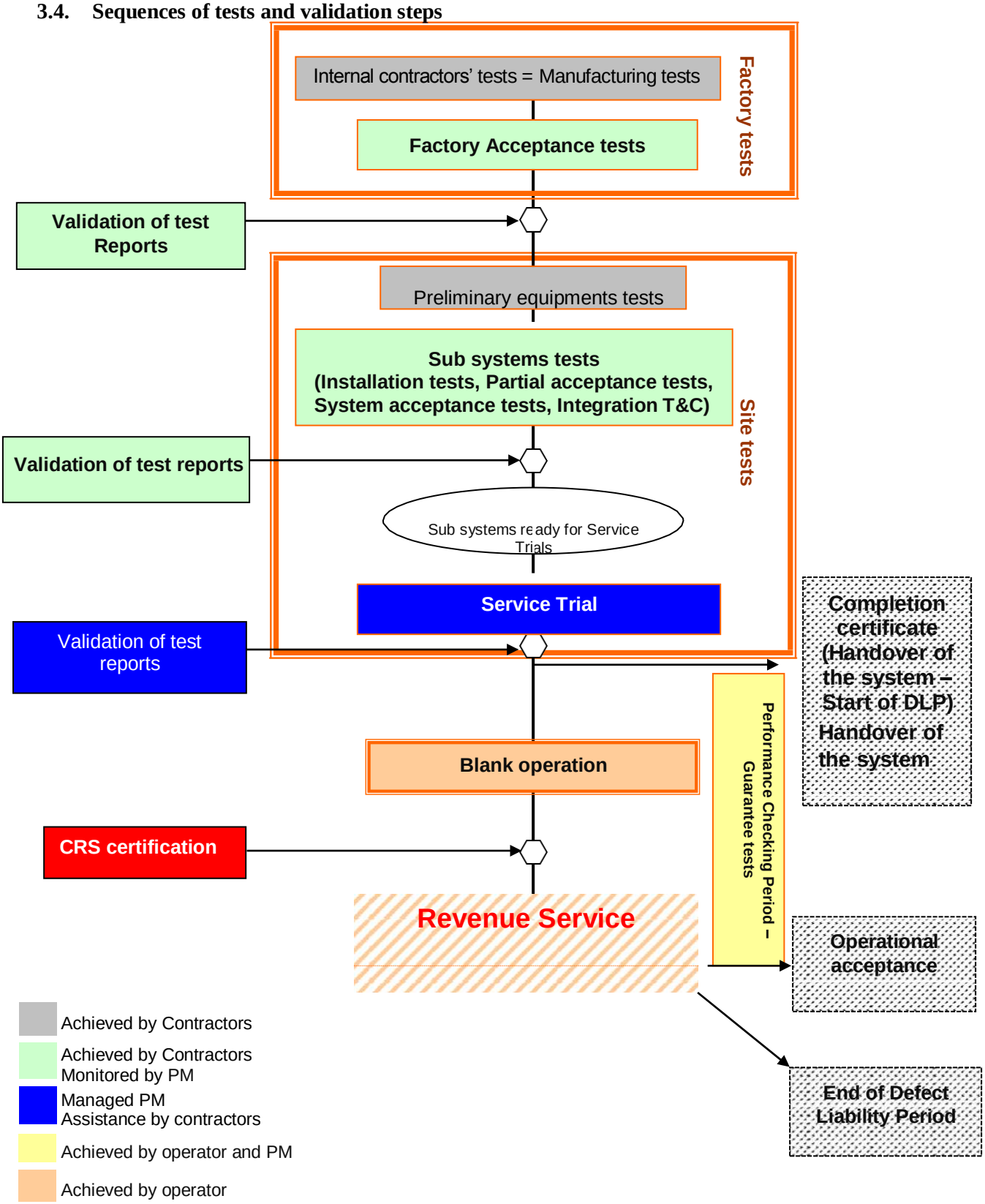
The system validation consists on a pyramid-shaped process composed of a logical series of complementary test.

This process starts by tests and checks in factory (factory tests), continues by on-site tests and finished in operation phase (performances checking).

The list below gives the tests «typology» leading to the Transit System acceptance of the works:

1. Factory tests
   - A) Unit tests
     - i) Type tests
     - ii) Routine tests
     - iii) Functional and operational tests
   - B) Integration tests
     - i) Platform tests
     - ii) Test on test track (rolling stock…)
2. Site test
   - A) Sub system tests
     - i) Installation tests
     - ii) Sub system tests static and dynamic (partial and system acceptance tests)
     - iii) Integration Testing and Commissioning (interfacing tests)
   - B) Service trial (Overall system tests)
3. Blank operation
4. Regular Service verification (Performances checking)

3.4. Sequences of tests and validation steps



3.5. Tests at factory

3.5.1. Internal contractor's tests

Before factory acceptance tests, the contractors shall test their sub-system in order to guaranty the success of the factory acceptance tests.

To describe them, the contractor shall submit a Manufacturing Testing Plan, included in Procurement, Manufacturing, Delivery and Manufacturing Testing Plan.

Each contractor shall keep the results of such tests which can be audited by the PM at any time.

3.5.2. Factory acceptance tests

The objective of such tests is to check the compliance of the manufactured equipment with the technical and functional specifications and with the standards.

Test procedures

a. The test procedures shall be written by the contractor in the Factory Acceptance Test Plan (which is part of the Inspection, Testing and Commissioning Plans).
b. These procedures are submitted to the PM for notice of no objection.

Tests execution

The factory tests shall be achieved by the contractor and monitored by the PM

At the end an acceptance report shall be signed by the contractor and notice of no objection will be issued by the PM that will enable the equipment to be delivered to the site.

Factory acceptance tests consist on:

a) The type tests

The objectives are to check that the design of equipment is compliant to technical and functional specifications. They include mechanical, environmental, electrical test (where appropriate).

(Type tests applied to the first equipment, routine tests applied to the others)

Unless specified otherwise they are not required if a certified evidence is shown that they have been performed successfully within last 5 years.

b) Functional and operational tests

Those tests are to check full compliance with each functional and operational requirement.

c) Factory integration tests

Some interfaces between subsystems needs to be tested in factory (signalling and telecommunication, rolling stock and on-board signalling equipment…).

During this phase the different sub-system will be connected together in order to test the functions achieved by the group of equipment.

This platform (group of equipment) will enable notably to test the compliance with operational criteria, ergonomic criteria of the man machine interfaces.

Those tests are essential as they shall prove the capacity of the subsystem to operate as an integrated system prior to be delivered to the site, and shall prevent each contractor to spend unnecessary time and resources on site to correct design/manufacturing based defects.

d) First Article Inspection (FAI)

FAI are performed on a component built using production processes, tooling and manpower and shall evaluate component and system maintainability.

e) Other Factory Acceptance Tests

These tests, if any, are described in Particular Specifications Volume 4, and might include routine tests (tests of each train or equipment at the end of manufacture phase).

3.6. Tests on site

1) The objectives of such tests are to prove that:
   a) The equipment was not damaged by the transportation, delivery process
   b) The installation of the equipment is compliance with specifications and drawings.
   c) System and equipment operate properly in site environmental and operational conditions, according to the functional, technical and operational specifications.
2) The following issues shall be covered
   a) The installation
   b) The sub-system tests (for each sub-system) including the interfaces tests
   c) The service trial (overall system tests)

3.6.1. Installation and site Sub-system tests

The objective of such test is to check the compliance of the subsystem with the technical and functional specifications and with the standards. Additionally, the contractor shall test the interfaces with others sub-system in order to check the interface specifications, like forecasted in the contract.

a) Test procedures
   i) The test procedures shall be written by the contractor in the plan corresponding to each phase (which is part of the Inspection, Testing and Commissioning Plans).
   ii) These procedures are submitted to the ER for notice of no objection.

b) Tests execution

The sub-system tests shall be achieved by the contractor and monitored by PM.

At the end an acceptance report shall be signed by the contractor and the notice of no-objection issued by the PM.

When all the sub-system tests will be performed successfully, the system test will be able to start.

This test phase includes (see Employer's requirements – general specifications")

i) Installation tests
ii) Partial acceptance tests
iii) System acceptance tests
iv) Integration testing and commissioning

3.6.1.1. Installation tests

The Installation Tests phase is defined as being the final stage of assembly/installation. During this phase, the Contractor shall perform static testing of components and/or systems in preparation for Partial Acceptance Testing.

3.6.1.2. Partial acceptance tests

Partial Acceptance Tests are defined as the performance of functional tests of sections, areas, or stages of a system.

3.6.1.3. System acceptance tests

System Acceptance Tests are defined as the tests undertaken to demonstrate that the Works in its entirety is capable of functioning in accordance with the specified requirements in the Contract in all respects, including internal interfaces.

The System Acceptance Tests may commence before remote operations capability (if any) is fully functional. However, the remote operations capability must be in place before the System Acceptance Tests can be considered to be completed. On satisfactory completion of the System Acceptance Tests, the tested items will be considered available for Integration Testing & Commissioning.

3.6.1.4. Integration testing and commissioning

Integration Testing & Commissioning are defined as the final tests to be undertaken before the commencement of Service trial. The Integration Testing & Commissioning shall refer to all tests with interfacing contractors, including third parties, to demonstrate the full compatibility between all interfacing systems/contractors. On satisfactory completion of the Integrated Testing & Commissioning, the tested items will be considered available for Service trial.

Those tests are managed by the interface leader contractor, in accordance with Contractor Interface Management Plan.

3.6.2. Service Trial (overall System tests)

3.6.2.1. Presentation

When all the sub-systems will be tested with success it will be possible to start the service trial tests.

The trial service objectives are to:

1. Prove the Overall System (all the sub-systems working together) operation is correct in normal mode, and degraded modes.

   This part is the "cross functions tests" of the system

2. Prove that the system is fully operational: easy to operate for the operator staff: OCC operators, driver, and easy to maintain.

   This part is the "tests of ability to operate" of the system

3. Check also several Overall System performances such as commercial speed, minimal headway…. At this time, the first RAMS assessment will be done

   This part is the "performance tests" of the System

   To achieve these System tests the contractors shall:

   - **Ensure the availability and readiness of each sub-system (**but at this moment the sub-systems continue to be under the contractor's responsibility)
   - Provide technical assistance to the project Manager (PM) in order to enable the PM to manage and complete the system tests

   Test procedures

   The test procedures shall be provided by the PM.

   Tests execution

The service trial shall be achieved by the PM with an assistance of the contractors, as part of the Commissioning team. The contractors shall foresee adequate staff to cover these services within the contract obligation.

3.6.2.2. Cross functions

The main cross functions to be tested are the following;

These functions involve several sub-systems; they will test in normal and degraded mode.

No.	Cross function	Sub cross functions
1	Passengers movements between stations	- Train movement (automatic route control, train mission, traffic regulation…) - Boarding passengers - Train/passengers movement in case of emergency (tunnel evacuation…)
2	Passenger movements in station	- Entry / Exit of the station - Access and exit of the platform - Movement in case of emergency evacuation
3	Energy management	- Management of general power supply of the lines - Management of the traction current - Management of station power supply
4	Communication and passengers services	- Communication in the stations (video, public address…) - Communication in the trains (video, public address…) - Ticketing - Access to people with restricted mobility
5	Operation management	- Management of OCC equipment - Management of station equipment - Service start up for the line (train preparation, line preparation, energy reconfiguration, first train of operation in the morning…) - End of service for the line (train stabling, station closing,) - Timetable compilation and daily operation records
6	Maintenance management	- Management of maintenance tasks along the line - Management of maintenance tasks in the stations - Management of maintenance tasks in the depot - Management of maintenance tasks of trains (tow / push procedure for a train…) - Management of maintenance tasks of sub-stations

3.6.2.3. "Ability to operate" the System.

In order to prove we have to operate all the system functions (cross function) will be achieved by checking the system at the operator disposition is easy to operate.

Agent in interface	Operation criteria	Tests
OCC operator	Organization of the OCC Workstation ergonomics Man machine interface ergonomics: • Information readability • Alarm display and priority • System control when dealing with alarms • Control panel: visibility and completeness of the information - In case of OCC failures • Capability to continue to operate (how long to transfer to back up OCC) • How difficult is it to stop the traffic? • Difficulty and time to restart the system - Capability to manage important incidents (passengers evacuation in tunnel, train failure in the tunnel, energy failure)	Test of these criteria during normal and degraded mode by checking the facility to operate and measuring some time to do some operation Simulate an OCC failure and check the situation according to the criteria
Driver	- Driver desk ergonomics in all modes • In ATO mode • In ATP mode • In manual mode - Easiness to shift from a mode to another and control of mode - Visibility of the way side signalisation - Quality of the communication with the OCC - Possibility for immediate on-board diagnostic of a malfunction	
Staff in station	• Quality of the communication with the OCC , multiple call situations	
Maintenance staff	- Quality of the computer Aided maintenance System	
Other	In a general way, we shall test the system capability to deal with important incident • Evacuation in line • Evacuation in station • Tow of a failed rake • Failure of OCC • Energy power failure	Simulate an incident in an operation configuration as close as possible from actual revenue service

3.6.2.4. Performance tests

(1) Speed performances:

a) Commercial speed for normal service and partial services
b) Commercial speed of a train set under load
c) Run time of a manual driving train set
d) Time of turn back for the terminus and for the partial terminus

(2) Headway:

a) Test of the minimal headway it may be not possible to perform this test because the number of the train will not be sufficient. However, this test will be performed on partial section of the network considered as critical

(3) Energy:

a) Test under load: it may not be possible to do this test for all the line because the number of the trains set will not be sufficient. In this case this performance test will be done by electrical section.

b) Test of the traffic behaviour when suppressing one sub-station

(4) Remote control and remote indication:

Under load (all sub system and many trains in operation), measure the time of taking in to account of remote controls and the time of transmission of remote indications

(5) RAM performances:

During the test phase all the failures and malfunction will be noted in order to have a first overview of the RAM performances, in particular the duration of some maintenance intervention will be measured.

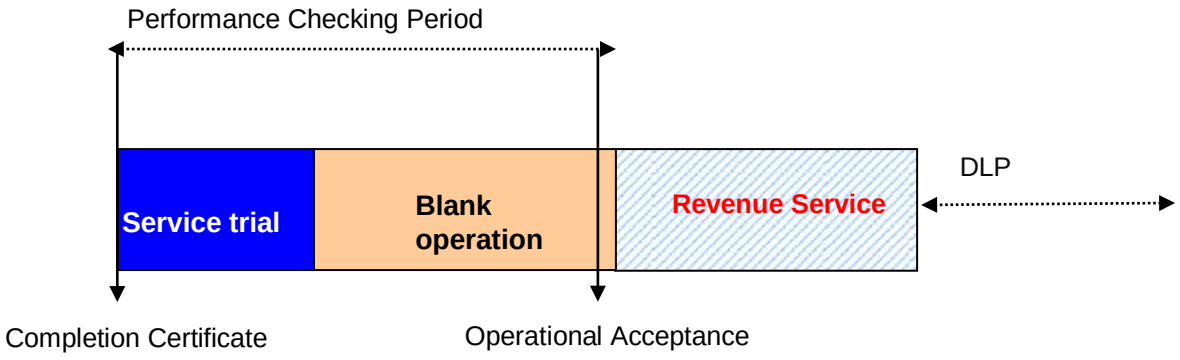
3.6.3. Completion Certificate

Only when all the sub system tests, all integration tests and all the overall system tests are completed successfully will the service trial ends. Then it will be possible to issue the Completion Certificate of each sub-system or contract,

Then the formal transfer of the system from the contractor to the Employer will be possible the taking over from Contractors to the Employer (and from Employer to Operator). This will allow the Employer to run the blank operation and start the revenue service checking, both of them being an integrated part of the guarantee tests.

3.6.4. Performances checking period

3.6.4.1. Introduction



This is only a principle sketch.

The performance checking period is the period between the issue of the completion certificate, and the operational acceptance. Tests performed during this period are called guarantee tests.

The Defects Liability Period begins from the commencement of the revenue services for 24 months.

The duration of the Performance Checking Period (=Operational Commissioning) and the duration of the defects liability period will be precisely defined in each contract in the specification.

During blank operation and the beginning of revenue service (period duration depending on the contract) the operational performances will be measured in order to check if they are compliant to the contract. These performances are depending on each contract; these are mainly:

- RAM performances
- Operation performances (whenever relevant)

  During this period the global performances shall be increasing in order to reach the required objectives.

  Each contractor shall provide a methodology to enable to follow the evolution of its own sub-system performance.

  A group composed of the operator and the contractors insure the follow- up of these performances, under the supervision of the Employer.

  If necessary special test or controls will be made to improve this follow-up

  At the end of this period, subject to lead to the expected performances, an operational acceptance report is written for the considered sub-system.

  The Operational Acceptance will be granted only after successful completion of the blank operation and performance checking period.

  In case of failure of guarantee tests, refer GCC clause 28.2 & 28.3.

3.6.4.2. Blank operation

Blank Operation is a period starting right after Completion Certificate issued where operator operates and maintains Rail network system without passengers. Blank operation period is included in performance checking period.

During blank operation the Operation and Maintenance staff will operate the line in an exact same way they will operate it during the revenue service except that there is no passengers. This period will allow the O&M staff to

- Check that its organisation is fit for purpose and make necessary adjustments:
- Confirm that the system is able to operate and propose necessary adjustments,
- Train itself to implement O&M procedures under various circumstances including interfaces with external bodies (emergency services, fire brigade public utilities services...)

3.6.4.3. Revenue service

The passenger transportation shall start after the successful completion of the blank operation and after delivering of the CMRS certificate.
This certificate relies on the safety case provided by each contractor.

3.7. Resolution of non-performance or poor performance level discovered during T&C

While the construction is reaching its completion the correction of the as built equipment may become impossible besides it may be required to recheck the full equipment interface when a non-performance is detected in order to appraise the effective impact of the poor performance as revealed through the T&C process.

The resolution is no different from the non-compliance process applicable to the contract, except that the planning does not allow the redesign. Thus the Project Manager may propose to the Employer to keep the project running on schedule providing that a safe level of operation can be achieved and propose a contingency plan in order to perform outstanding tasks and correct at a later stage through retrofit and retest of the defective equipment or item.

Sub - system (functional unit)

The sub system included in each of the contract will be tested individually as a functional unit.

Contracts may include more than one sub system. For example, the station contracts featuring the station construction include as well the provision for the building services to provide lighting, low voltage distribution and water related services.

Within each contract, each sub system function shall be tested individually (subsystem) to demonstrate the work completion and the compliance to the performance criteria. Within each contract each sub system function shall also be tested in relation to other interfacing subsystems (whether internal or external to each contract) to demonstrate the capacity of the said subsystem to operate in its environment (integrated tests and commissioning).

Main functional units within each contract are defined in particular specifications.

4. Strategy of the tests

The T&C strategy for the Project will be based on progressive (i.e. increasing level of complexity and/or size) commissioning of testing package and/or area as mentioned and defined below.

4.1. Testing area

A Testing area/Commissioning area is defined as a basic geographical section of a system which constitutes an independent, consistent, functional and isolated assembly.

Examples of testing area:

i) All signalling equipment and material which are held in one signalling room or all trackside equipment which are monitored or controlled by one signalling room.

ii) All Catenary materials and equipment between two kilometric points.

iii) One rake unit

The division of a system or sub-system into testing area will allow using this splitting of the system for the Site acceptance test at subsystem level as soon as the installation is completed for the related equipment.

It is important that the testing area are independent from each other and when added all together will constitute the whole system. Thus the test can run independently at first level then progressively progress through the integration to the final full System level. The splitting of the System / Subsystem into testing area will be proposed and agreed into the System and Subsystem Test and Commissioning Plans.

Testing area will be proposed by contractors for PM notice of no objection together with the T&C Plan for each contract.

4.2. Overall integration testing on site

The generic sequence of testing is proposed hereafter to detail how integration is progressing among all different construction contracts. As a principle the integration is working progressively through the system level in order to reach the full system.

At the initial construction stage these test packages are divided through the type of work and through the contractual construction contracts (Civil, track systems…) and the location along the line (equipment at one stop or from one place to another).

The principle that is proposed for the integration at the T&C is to progress with the integration by testing the portion of line in between two stops and the facilities available at the stop. Thus gradually the full line will be integrated.

The table here below illustrates a typical sequence of event (for information only) and shows the progression of the integration of all systems for a section of track from one stop to the next.

Overall integration sequence

Test Sequence/Sequence order	Contract impacted	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7	Stage 8	Stage 9	Stage 10
Station Building											
Station Building	Civil Works Contract										
Inspection and compliance check											
Utilities and safety											
Auxiliary power and LV Distribution											
Access control system											
Security and fencing											
Ambient air renewal and HVAC											
Emergency smoke extraction											
Firefighting / Escape route provisions											
Fire Detection											
Earthing Bonding stray current (Lightning)											
Lighting											
Drainage and water											
Passenger Services											
Fare collection (Gates + TVM)											
Public information Commercial desk											
Vertical transport (Escalator & lift for MIP)											
Public address and sound distribution + PID											
Passenger emergency help point											
Passenger rest area, furniture, signage											
PSD (if applicable)											
Local integration											
Local supervision from station control room											
Section station N to Station N+1											
Track bed / Tunnel/ Viaduct											
Inspection and compliance check											
Sub-system completion and compliance											

Overall integration sequence

Test Sequence/Sequence order	Contract impacted	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7	Stage 8	Stage 9	Stage 10
Track inspection and compliance											
OHL insulation continuity and compliance											
Power supply (33kV network...)											
Signalling and Telecom cables											
Signal and beacon											
Radio cover and functions											
Power on along track section 33 kV and 25 kV traction power											
Power on 25kV traction power											
Overall integration											
Centralised supervision from operation control centre											
Transportation Test											
Rolling Stock inspection and Test (For Memory)											
Traction available	All										
Signalling available	All										
Trail running station N to N+1	All										

Once the line is fully tested, overall system tests (service trial) will demonstrate the full line performances (trip time, headway, energy consumption…)

5. Commissioning stages (Phase 1 and 2)

The MML3 construction allows two main phases in the first phase of the implementation.

- Phase 1: Aarey to BKC
- Phase 2: Phase 1 + BKC to Cuffe Parade

During Phase 2 period, Phase 1 will be in operation

So the tests & commissioning shall be achieved without any metro traffic disruption and Safeguarding the operation safety.

The contractors shall identify (according to the operator) all the critical points and take any measures to be compliant to these requirements; in particular, many tests will be performed at night.

The control command of these tests will be achieved in the test and commissioning room located in the OCC building.

6. Operator involvement during T&C

The operator will be involved progressively from the site acceptance test until the revenue service.

The basic concept is that the operator staff is first involved as a witness during the site acceptance test of all equipment; this will help the effective training of the operator staff. During this stage the operator staff will only be present as a witness to the test carried out by the contractor, all equipments are operated by the contractor staff.

During the dynamic tests on site all work position of the operator might be handled by the operator as part of the operator contract. The contractors will however keep full responsibility of the tests progress and achievement. This means that rakes may be driven by the operator drivers and that Control rooms might in effect be operated by the operator. The contractor staff shall attend and witness any of these tasks and keep full responsibility of the tests progress and achievement.

During the blank operation the operator staff will be fully organised and ready to operate and will work as for the revenue service. The contractor's staff may witness any of the test programs.

7. Opening of Metro for Public Passenger Carriage

7.1 The Contractor shall complete the relevant documents pertinent to their specific contract and submit to the Project Manager for Notice of No Objection. The documents shall be submitted in the timescales in accordance with the contract schedule and as determined by the Project Manager.

7.2 The Contractor shall comply with the requirements of

i) The 'Procedure for Safety Certification and Technical Clearance', refer to Research Design and Standard Organisation (RDSO) document February 2015.

ii) The Opening of Metro railway for Public Carriage of Passengers Rules date 18th April 2013.

8. Reference: As per RDSO safety manual (Feb 2015) (www.rdso.org)

9. Forms for completion by respective system discipline

Note: Forms I to XX shall be completed using the pro formal format Size 11, Font, Arial.

Form I Permanent way Abstract
Form VII Station & Station Sites
Form VIII Brief Particulars of Rolling Stock
Form IX Brief Particulars of Traction Installations
Form X Power Supply Installation Abstract
Form XI Restricted Overhead Equipment Clearance Abstract
Form XII Electrical Crossing Over Metro Railway Tracks Abstract
Form XIII Not Used
Form XIV Ventilation, Smoke Management and Fire Safety Measures In Tunnels and Stations
Form XV Brief Particulars of Signalling and Train Control Systems
Form XVI Verification Certificate
Form XVII Infringements of Moving and Fixed Dimensions
Form XVIII Not Used
Form XIX Certificate (Speed Restrictions)
Form XX Certificate (Signalling Equipment)
Annex–A Validation of signalling and Interlocking Installations Signalling and Train control
Annex-B Validation of signalling and Telecommunication

10. Index Plan & Section sheets, completion drawings etc. shall include;

10.1. Index Plan & Section details

10.2. Completion Drawings of Bridges/viaducts showing details of Structure, Loading Standards adopted

10.3. Completion Drawings of Tunnels

10.4. Diagrammatic Plan of Station yards showing layout of Tracks, Turnouts, Gradients, of any Signals and Interlocking installed

10.5. Implantation Diagrams of Overhead Equipment Masts/overhead Current Collection System as applicable

11. System Safety Case Provision

11.1. Design Safety Case

11.2. Construction Safety Case

11.3. Test and Commissioning Safety Case

12. Plans & Associated Provisions

12.1. RAM plan

12.2. RAM assessment report

12.3. RAM reviews

12.4. Maintenance plan

12.5. System Safety Assurance Plan

12.6. Software Safety Plan

12.7. Hardware Safety Plan

12.8. Preliminary Hazard Analysis (PHA)

12.9. Hazard Log

12.10. System Hazard Analyses (SHA)

12.11. Failure Modes and Effects Analyses (FMEA)

12.12. Fault Tree Analysis (FTA)

12.13. Operating and Support Hazard Analysis (O&SHA)

12.14. Interfaces Hazard Analysis

12.15. Compatibility studies

12.16. Configuration management and control Plan

12.17. Configuration review sheets

12.18. Hardware safety studies

12.19. Software safety studies

12.20. List of the safety components and equipment's

12.21. List of safety critical points

12.22. List of the safety tests plans and procedures

12.23. Software and Hardware Safety Certificates

Safety requirements for operation and maintenance.

13. Form I – Permanent Way Abstract

Contract No:
Section : Mumbai Metro Rail Line 3
Length: Gauge: mm

EXAMPLE TO BE MADE SPECIFIC

1. The permanent way consists of UIC 60 E1 (UIC 60)1080 grade HH, head hardened new rails of reinforced concrete slab of make 13/ 18 meters long, continuously welded and laid on Pre-cast twin block sleepers and embedded in concrete slab. The track on main line, underground, rails supported on base plate at a spacing 700 mm C/C with fastening system.

2. The remaining track at grade is laid with rails using the elastic fastening system prevalent on Indian Railways shall be used duly ensuring the Inspection protocol for fastening components laid down for IR fastening system of indigenous make and 50 mm stone ballast with minimum cushion of 300 under the Mono block PSC sleepers.

3. All the turnouts to be negotiated are 1 in 9 curved switches and 1 in 7 with thick web switches. Certified that tested and approved new Permanent way Materials have been used in this section and comply with the accepted specifications.

Note. - (a) A Brief description to be given of the rails, fastening, Sleepers and ballast provided. Details of dimensions of rails, fittings etc.

(b) In the case of new rails and fish plates manufactured in India, the name of producer must be given. If they are imported, the name of the country of origin must be indicated.

(c) A certificate shall be submitted by the Chief Engineer that the materials are tested and approved quality and comply with the accepted specification.

14. Form VII – Station and Station Sites

Contract No:
Section : Mumbai Metro Rail Line 3
Length: Gauge: mm

Name of Station	Kilo meter age from fixed point	Inter station distance	Remarks

15. Form VIII – Particulars of Rolling Stock

Contract No:

Section: Mumbai Metro Rail Line 3

Length: Gauge: mm

S. No.	Description	Details	Remarks
(1)	(2)	(3)	(4)
1	Rolling Stock features a) Composition b) Train Control System c) Max^{mm} Design Control d) Max^{mm} Operational Speed e) jerk Rate f) Maximum Tractive Effort		
2	Physical Dimensions a) Car Weight b) Length over Body c) Maximum Width over body d) Height of Floor from TOR e) Total Height		
3	Bogie Details a) Bogie Wheel base b) Distance between Bogie Centre's c) Wheel Diameter d) Type of Suspension		
4	Braking Details a) Type of Braking System b) Maximum Braking effort c) Service Braking effort* *From maximum operational speed to stand still, for fully loaded train on level tangent track d) Parking Brake		
5	Electro Magnetic effect on Environment a) Electro Magnetic Interference		
6	Safety Features a) Communication between operator and passengers b) Provision of Dead Man Handle c) Fire Prevention, detection and suppression system d) Other Safety Features		

Certified that the design has been checked for being within the Kinematic Envelope (KE) at all conditions.

16. Form IX – Particulars of Traction Installations

Contract No: Mumbai Metro Rail Line 3
Section : Gauge: mm
Length:

Over Head Equipment:

1. Salient Features of the Design specially covering following aspects:-

   a) Current carrying Capacity of the system

   b) Boundaries like wind speed, Tension, Temperature Range.

   c) Speed Potential

   d) Protection arrangements

   e) Power supply System

2. Certificate that all warning boards and notices as per statutory requirements have been provided at specified locations.

17. Form X – Power Supply Installation Abstract

Contract No:
Section : Mumbai Metro Rail Line 3
Length: Gauge: mm

S. No.	Type of Switching Stations	Total Nos	Locations and Nearest Station	Remarks
1)	Traction Sub-stations and feeding Stations			
2)	Sectioning and Paralleling stations			
3)	Sub-Sections and paralleling Stations			
4)	Booster transformer stations			
5)	LT supply transformer stations			
6)	Track Cabins			

18. Form XI - Restricted Over Head Equipment Clearance Abstract

Contract No:
Section : Mumbai Metro Rail Line 3
Length: Gauge: mm

A. Over line Structure

S. No.	Location of over line Structure	Type of Structure	Clearance from RL to bottom of Structure	Height contact wire below the Structure	Whether Catenary is anchored on freely running below / above the Structure	Minimum static Clearance between 25kv live parts and earth	Remarks

B. Location of overhead electrical structures where specified 2m working clearances not available

S. No.	Locations	Type of Nearest Earthen part	Actual distance between live part and earth	Remarks

19. Form XII - Electrical Crossing Over Metro Railway Tracks Abstract

Contract No:
Section : Mumbai Metro Rail Line 3
Length: Gauge: mm

S. No.	Location	Bridge Technical Particulars Including Voltage	Whether with guards or w/o guards	Owned by	Whether Clearance as per the regulations for electrical Xing's available	Remarks

20. Form XIV – Ventilation, Smoke Management and Fire Safety Measures in Tunnels and Stations

Contract No:
Section : Mumbai Metro Rail Line 3
Length: Gauge: mm

1. Salient Features of the design covering following aspects : -

a) Emergency ventilation and smoke management system in tunnels and stations;

b) Emergency Evacuation procedure from tunnels or stations

c) Fire detection / Suppression system in tunnels or stations;

d) Fire alarm and public address system in emergencies;

e) Emergency lighting and power supply;

f) Access routes for firefighting personnel.

2. Certified that all test certificates from equipment suppliers and commissioning authorities are in order and clearances from statutory authorities have been obtained

21. Form XV – Particulars of Signalling and Train Control Systems

Contract No:
Section : Mumbai Metro Rail Line 3
Length: Gauge: mm

Signalling and Train Control Systems

Note: The following points are examples only and are to made specific by the Contractor

1. Continuous Automatic Train Control System has been provided on Cuffe parade to Aarey Milk Colony section for movements of trains between stations and between the depot and running lines

2. The Continuous Automatic Train Control System works on the principle of utilizing high resolution Train location determination, independent of Track circuits/Axle Counters, with continuous high capacity bidirectional Train to wayside data communications and Train borne and wayside processors capable of implementing vital functions ensuring safe movement of trains by continuously generating a sage operating envelope defined by the limit of Movement Authority and the Maximum Safe Speed.

3. The Continuous Automatic Train Control System provides the following modes of train operation

i) UTO
ii) ATO
iii) ATP or Supervised
iv) RM
v) ROS
vi) Cut-Out
vii) Automatic Turn Back

4. Train Operation on main lines is controlled from Operation Control Centre which normally operates under automatic Train Control System with routes being set and trains interval regulated by computer control. Facility for manual setting of routes and individual operation of point if required has also been provided. Automatic Train Supervision system at Operations Control Centre monitors and controls train operation. The System is to be designed for Unattended Train Operation (GOA 4) so that the Employer has the choice of going with GOA 2 or GOA 4 operation.

5. A Local Control Panel has been provided in the station control room to enable the Traffic Controller to hand over control of the signals at specific station if required

6. Cuffe Parade, CST Metro , Science Museum , Siddhi Vinayak , Bandra BKC , Sahar Road and Aarey Milk Colony Stations on the sections have been provided with Computer based Interlocking System

7. A Digital Mobile Train Radio Communication System based on Terrestrial Trunked Radio Specifications has been provided on the section to provide radio communication between traffic controller, depot controller and the train operator (in GOA 2 mode)

22. Form XVI – Verification Certificate

Contract No:
Section : Mumbai Metro Rail Line 3
Length: Gauge: mm

I do hereby certify:

a) that the moving and fixed dimensions for Mumbai Metro Rail Line 3 have in every case been worked to. Also that these dimensions will be observed in future and that no work or structure infringing the dimensions will hereafter be permitted without the sanction of the Central Government

b) that each bridge or viaduct conforms to the approved standard of loading without exceeding the maximum permissible stress on the available material of any member or portion of the structure.

c) that every coaching vehicle constructed or procured for the use of the metro railway has been provided with electro-pneumatic/regenerative/ air brake and effective means of communication between passengers and the Train Operator (in GOA 2 mode)

d) that the metro railway shall be worked as per the system specified in the Delhi Metro Railway General Rules , 2002

e) that the DC / AC electric traction equipment can be used for the public carriage of passengers without danger to the public and that the Rules for the Design and Inspection of equipment for Electric Traction as per Chapter X of the Rules for Opening of Delhi Metro Railway for Public Carriage of Passengers, 2002 have been complied with

f) that the Signalling and telecommunication equipment have been installed in accordance with the approved instructions and they are safe for passing traffic

g) that adequate facilities for handicapped passengers have been made available at the stations and in the trains

h) that……..has been delegated to accompany the commissioner for Metro railway safety on his inspection and all information supplied or engagements entered into by him shall bear my authority.

	Signature with of the Chief Executive		
	Officer (Contractor)		

23. Form XVII - Infringements of Moving and Fixed Dimensions

Contract No:
Section : Mumbai Metro Rail Line 3
Length: Gauge: mm

S. No.	Location	Name of Structure which infringes	Prescribed dimensions with chapter and item No.	Existing actual Dimensions	Amount of Infringement	Reasons for Infringement	Authority Under which infringement Permitted	Restrictions / Precautions to be adopted

24.	**Annex A - Validation of Signalling and Interlocking Installations Signalling and Train Control**

Form XIX – Certificate (Speed Restriction)

Certified that it is safe to use (particulars of the equipment) at the station/ on the section of the metro railway with the following precautions:

1……
2……
3……

Chief Signal and
Telecommunicatio
n Engineer

Note: The application should be scrutinized by the Commissioner of Railway Safety who, if satisfied, will communicate his sanction to the metro railway administration, in case he is not fully satisfied, he will give his comments and recommendation for suitable further action.

The Contractor shall comply with the requirements and recommendation for Signalling and train control systems vide Chapter IX of Rule for opening of Delhi Metro Railway for public carriage of passenger, 2002. The following requirements shall be validated.		
SIGNAL		Answer
1	Do the Signals comply with the requirement as laid down in Mumbai Metro Rail Line 3 General Rules?	
2	Have all the signal posts been placed on the left side of the track of the approaching train to which they refer? If otherwise, for what reason??	
3	Are all running signals controlling placed in such a position and at such a height above rail level so they can be clearly seen by the drivers in sufficient time and be readily distinguished by night or by day from subsidiary signals (in GOA 2 mode)?	
4	In case of controlled signals, can the signals by freely returned to danger by either of the controlling agencies?	
5	Are signals not commissioned have their aspects covered and the cover displaying two crossed white bars on a black back ground, the bars not being less than 30 cms x 10 cms?	

POINTS

1	Are the locking of facing points such that the points cannot be or become unlocked while a train is passing over them, i.e., electrically controlled by axle counter?	
2	Are detectors (internal/external) fitted to all facing points and do they efficiently detect with switches the signals controlling the movement of train over them?	

3	Are switches adjusted to come tight against stock rails? Does the insertion of 5mm obstruction piece between the switch and stock rails 150mm from the toe of the switch prevent the points being locked and prevent signal being taken 'OFF', the giving of which is preceded by the locking of points?	

STATION CONTROL ROOM

1	Are all signals, points and axle counter electrically/electronically repeated on the Station Control Panel / Work station as and where provided?	
2	Is the Station Controller provided with necessary means the stopping of train at his station?	
3	Have instructions for working been issued to all staff and included in Metro Railway Working Instructions and are they correct and efficient?	

TESTS IN STATION CONTROL ROOM

It is essential that the interlocking of all signals with points must be so effected as to ensure the following conditions, which may be tested from the Station Control Panel or Work Station.

1	Is it possible to take off conflicting signals at the same time?	
2	Is it possible to take off a signal unit:	
a.	all points on the running line including overlap are correctly set and the points locked where required?	
b.	all points, giving access to the running line from sidings are set against the running line?	
OPERATION CONTROL CENTRE		
Are all signals, points and axle counter electrically / electronically repeated on the Operation Control or Work Station as and where provided?		
CAB SIGNAL		
1	Are the various modes of train control clearly distinguishable on the Driver's Man Machine Interface (MMI)?	
2	Under Cab Signalling System of working, is Automatic Train Protection System able to bring the train to a stop before an obstruction?	

25.	**Annex B - Validation of Signalling & Train Control, Platform Screen Doors and Telecommunication.**					
Contract No:						
1	The Contractor shall comply with the requirements and recommendation for Signalling and telecommunication installation in accordance with the instructions issued for the installation of Signalling and Telecommunication equipment in 25 Kv 50 Hz AC or other traction system as adopted					
	If not, in what respect the arrangements provided fall short of them?					
	STATEMENT OF DEVIATION – Signalling & Train Control, Platform Screen Doors and Telecommunication Systems					
	Description	**Existing**	**Prescribed**	**Deviation /**	**Remarks**	**Approval /**
		Parameters	**Parameters**	**Infringement**		**Sanction**
	Signal					
	Points					
	Cables					
	Electric Signalling Equipments					
	Batteries					
	Earthing					
	Mobile Train Radio					
	Communications					
	General Safety					

Mumbai Metro Rail Line 3

BIDDING DOCUMENTS

EMPLOYER'S REQUIREMENTS

GENERAL SPECIFICATIONS

Part 2

Section VI (1)
Sub-Division F

Appendix 18

SCHEDULE OF DIMENSION
July 2019

SCHEDULE OF DIMENSIONS

FOR

STANDARD GAUGE
(1435 mm)

(FOR 3200 mm WIDE STOCK)

JANUARY 2018

MUMBAI METRO RAIL CORPORATION LTD

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LIST OF APPENDIX

LIST OF FIGURES

PREAMBLE

The schedule of dimensions for Standard Gauge Mumbai Metro Line 3 Corridor has been prepared based on following factors:

1. The Kinematic Envelope has been adopted for the 3200 mm wide rolling stock and 4048 mm (pantograph in locked down condition) high rolling stock. The track and vehicle maintenance shall conform to the clearances indicated therein during the period these stocks are in operation.

2. The clearances are based on the assumption that windows are sealed and doors are closed during movement/operation.

3. Track shall be maintained to the tolerances taken for calculation of kinematic envelope.

4. The Structure Gauge indicated in SOD shall not be violated under any circumstances except for platform coping, Platform Screen Doors (PSD) and hand railing in back of house of platform edge.

5. The Kinematic Envelope(s) indicated in SOD shall not be violated under any circumstances.

6. The vehicle Kinematic Envelope at a speed of 70 Kmph for the platform area shall be applied within confines of stations. At all other locations, the kinematic envelope corresponding at85kmph operation speed shall be used for determining the Structure Gauge. The Design speed is set with 95 Kmph.

7. The maximum operating speed through station platforms shall be limited to 70 Kmph and at all other locations 85 Kmph, subject to speed restriction.

8. No vertical curve shall be provided in platform area.

9. The SOD is applicable for Ballastless track on main line and Ballasted/Ballastless track in the Depots.

10. No work/work men are allowed during operations of trains.

MUMBAI METRO LINE 3

SCHEDULE OF DIMENSIONS

STANDARD GAUGE (1435 mm GAUGE)

(FOR 3200 mm WIDE STOCK)

INTRODUCTION

The dimensions given in this are to be observed in all new works and alterations to existing works on 1435 mm gauge (STANDARD GAUGE)and 3200 mm wide Rolling Stock, unless prior sanction has been obtained from the Railway Board through the Commissioner of Railway Safety to execute works which infringe this Schedule Of Dimensions.

This Schedule of Dimensions is applicable to Underground, At-grade and Elevated Sections of Mumbai Metro Line 3 (MML3) which shall be with 25 kV, AC Traction system and Over Head current collection. The rolling stock shall be 3200 mm wide with sealed windows and doors closed while in motion.

The Underground system may be with a Circular Tunnel or Rectangular Box or of any other suitable shape while elevated system may be with suitable over ground structure such as viaducts. Both Underground and Elevated system shall have suitably designed Ballastless track. For At-Grade and Depot tracks may be Ballasted track /Ballastless track.

The Schedule of Dimensions (SOD) has been divided into five chapters as under

CHAPTER 1----------	GENERAL
CHAPTER 2 ----------	STATION
CHAPTER 3----------	ROLLING STOCK
CHAPTER 4----------	ELECTRIC TRACTION
CHAPTER 5 ----------	PLATFORM SCREEN DOORS

CHAPTER 1
GENERAL

1.1. SPACING OF TRACKS

1.1.1. Minimum distance, centre to centre of tracks without any structure between tracks for tangent (straight) track for:

(a) Under Ground sections……. 3800 mm
(b) Elevated sections……3900mm
(c) At-grade sections……3900mm

Note:

See Appendix 1 for minimum track centres on curves.

1.2. CURVES

1.2.1. Minimum radius of curves (horizontal)

On main running lines:	
a) Underground sections	200 m
b) Elevated and at-grade sections	120 m
Depot and other lines	100 m
At passenger platforms	1000 m

1.2.2. Check rail / Restraining rail

Check rail /Restraining rail shall be provided on curves on main line in the case that the radius is 190 m or less duly considering the limits given in 1.2.1. Check rail/ Restraining rail shall not be mandatory for curves in depots, yards and non-passenger lines where speed is less than 25 kmph. The clearance between the check/restraining rail and running rail shall be suitably decided by the Metro Authority.

1.2.3. Minimum radius of vertical curve

Minimum radius of vertical curve:	1500m

1.3. GRADIENT

1.3.1 Maximum gradient shall be 4%. This maximum value has to be compensated according to Notes (ii) below.

Notes:

(i) There will be no change of gradient in transition portion of curves.

(ii) The gradient will be compensated for curvature at the rate of 0.04% per degree of curve.

1.3.2 Maximum permissible gradient on turnouts

i) On ballasted track	0.25%
ii) On ballastless track	3.0 %

Notes:

(i) There shall be no change of gradient (i.e. vertical curve) on and within 15.0 m (desirable)/3.0 m (minimum) of any turnout on Ballastless track. In case of Ballasted track, there shall be no change of gradient on and within 30 m of any turnout.

(ii) There shall be no horizontal curve within 15.0 m (desirable)/3.0 m (minimum) of any turnout on Ballsated Track and 30 meters of any Turnout on Ballasted Track.

(iii) Turnout shall normally be installed on straight track. In exceptional situations, turnout may take off from curve provided that the radius of lead curve (main line as well as diverging line) is not less than 190 m. The negotiability of rolling stocks on such turnout must be certified by

rolling stock supplier and confirmed through oscillation trial and a suitable speed restriction should be imposed on main and/or diverging line based on track geometry and other considerations, if required. In case of turnout installed on curved track, the minimum distance for commencement of vertical curve or another horizontal curve shall be 15 m for Ballastless Track. Turnout shall not be laid on transition curve.

(iv) The limit of turnout for above purposes shall be taken from Stock Rail Joint (SRJ) to end (i.e. heel) of crossing for Ballastless Track. For Ballasted track, it shall be from SRJ to last common sleeper behind end of crossing.

(v) The maximum permissible gradient on turnout and the location of turnout with respect to vertical/horizontal curves in vicinity shall be confirmed from rolling stock supplier for the negotiability of rolling stock.

(vi) The above stipulations shall also be applicable for turnout to be laid outside station limit, if any.

1.4. BUILDINGS AND STRUCTURES

1.4.1 Minimum horizontal distance from centre of track to any structure for heights above rail level on level/constant grade tangent track shall be as below:

(a) ELEVATED and AT-GRADE SECTIONS

Height from rail level		Horizontal distance from centre line of track
(i)	Up to 25 mm (*)	0 mm vert. clearance from 577.5 mm to 946.5 mm
(ii)	25 mm to 65 mm	1450 mm increasing to 1585 mm
(iii)	65 mm to 200 mm	1585 mm increasing to 1745 mm
(iv)	200 mm to 880 mm	1745 mm increasing to 1903 mm
(v)	880 mm to 1095 mm	1903 mm
(vi)	1095 mm to 1130 mm	1903 mm increasing to 1938 mm
(vii)	1130 mm to 2030 mm	1938 mm
(viii)	2030 mm to 3300 mm	1938 mm decreasing to 1875 mm
(ix)	3300 mm to 3736 mm	1875 mm decreasing to 1540 mm
(x)	3736 mm to 6250 mm	1540 mm

(*) No clearance is allowed in the wheel/rail contact area.
Also refer to FIG. MMRC-2

(b) UNDER GROUND SECTIONS

(i) CIRCULAR TUNNELS

Height from rail level		Horizontal distance from centre line of track
(i)	Up to 25 mm (*)	0 mm vert. clearance from 577.5 mm to 946.5 mm
(ii)	25 mm to 65 mm	1450 mm increasing to 1585 mm
(iii)	65 mm to 200 mm	1585 mm increasing to 1720
(iv)	200 mm to 305 mm	1720 mm
(v)	305 mm to 880 mm	1720 mm increasing to 1849 mm
(vi)	880 mm to 1095 mm	1849 mm
(vii)	1095 mm to 1130 mm	1849 mm increasing to 1875 mm
(viii)	1130 mm to 2030 mm	1875 mm
(ix)	2030 mm to 3346 mm	1875 mm decreasing to 1815 mm
(x)	3346 mm to 3738 mm	1815 mm decreasing to 1390 mm
(xi)	3738 mm to 4620 mm	1390 mm
(xii)	4620 mm to 4970 mm	1390 mm decreasing to 0 mm along arc R=2800 mm

(*) No clearance is allowed in the wheel/rail contact area.
Also refer to FIG. MMRC-2 (CIRCULAR TNL)

(ii) RECTANGULAR BOX TUNNELS

Height from rail level		Horizontal distance from centre line of track
(i)	Up to 25 mm (*)	0 mm vert. clearance from 577.5 mm to 946.5 mm
(ii)	25 mm to 65 mm	1450 mm increasing to 1585 mm
(iii)	65 mm to 200 mm	1585 mm increasing to 1720 mm
(iv)	200 mm to 305 mm	1720 mm
(v)	305 mm to 880 mm	1720 mm increasing to 1849 mm
(vi)	880 mm to 1095 mm	1849 mm
(vii)	1095 mm to 1130 mm	1849 increasing to 1875 mm
(viii)	1130 mm to 2030 mm	1875 mm
(ix)	2030 mm to 3346 mm	1875 mm decreasing to 1815 mm
(x)	3346 mm to 3738 mm	1815 mm decreasing to 1390 mm
(xi)	3738 mm to 4838 mm (min.)	1390 mm

(*) No clearance is allowed in the wheel/rail contact area.
Also refer to FIG. MMRC-2 (BOX TNL)

Notes for (a) and (b) above:

i) Extra clearance shall be provided for curves as laid down at Para 1.7.
ii) The term ‘structure’ covers any item including light ones like ladders, isolated posts, cables etc. erected alongside the track.
iii) Minimum lateral clearance for OHE masts for tangent track shall be2150 mm from centre line of nearest track.
iv) For passenger platform & PSD refer to Para 2.2.1 to 2.2.3 of Chapter 2.

1.5. KINEMATIC ENVELOPE

The kinematic envelope for level or constant grade tangent track, refer to:
a) FIG. MMRC-1 and MMRC -1A for At-grade and Elevated Sections
b) FIG. MMRC-1(TNL) and MMRC-1A (TNL) for Underground Sections

1.6. STRUCTURE GAUGE

1.6.1 Underground Sections

The Structure Gauge (Fixed Structure Line) has been arrived at by allowing a minimum clearance of 100 mm to kinematic envelope and minimum electrical clearance of 270 mm from 25 kV live parts conforming to the stipulations in Chapter 4 of this SOD.

Refer to FIG. MMRC-2 (BOX TNL) and FIG. MMRC-2 (CIRCULAR TNL) for structure gauge for underground sections (outside station) with Ballastless track for level or constant grade tangent track.

Note:

Extra clearance shall be provided for curves as laid down at Para 1.7.

1.6.2 Elevated Sections

The Structure Gauge (fixed structure line) has been arrived at by allowing minimum clearance of 150 mm to kinematic envelope and minimum electrical clearance of 270mm from 25 KV live parts conforming to the stipulations in Chapter 4 of this SOD.

For Structure Gauge on Elevated sections (outside station) with Ballastless track for level or constant grade tangent track, refer to FIG. MMRC-2.

Note:

Extra clearance shall be provided for curves as laid down at Para 1.7.

1.6.3 At-Grade Sections

The Structure Gauge (Fixed Structure Line) has been arrived at by allowing minimum clearance of 150 mm to kinematic envelope and minimum electrical clearance of 270mm from 25 kV live parts, conforming to stipulations in Chapter 4 of this SOD.

For Structure Gauge on At-grade sections (outside stations) on level or constant grade tangent track, refer to FIG. MMRC-2.

Note:

Extra clearance shall be provided for curves as laid down at Para 1.7.

1.7. EXTRA CLEARANCES ON CURVES

Following are the extra clearances considered for curves.

Abbreviations used in Para 1.7:

C is the distance between centres of bogies in meters,
C_1 is the coach (vehicle) length in meters,
R is the radius of curve in meters,
Ca is the cant applied in mm,
h is the height from rail level in mm and
g is the distance between centres of rails in mm

1.7.1 Inside of Curve

(A) CURVATURE EFFECT

i) Mid throw at the centre of the vehicle = V (in mm) = $125 \times C^2/R$
ii) Clearance due to gauge widening on curves

For values of items i) and ii) above, refer to Appendix 2.

Note:

Lateral shift of 32mm due to nosing is included in kinematic envelope for tangent track (and as a result included in Structure Gauge also) shall be subtracted from the total extra clearance worked out as at Para 1.7.1(A) i) & ii) above for inside of a curve in case the value of mid throw (V) is equal to or greater than 32mm. In case the value of mid throw (V) is less than 32mm, the curvature effect shall be due to widening of the gauge only. (The Mid throw minus 32.0 mm shall be taken as zero). Refer please also to Appendix 2.

(B) CLEARANCE FOR SUPER ELEVATION

(a) Under Ground (Box Structures), At-Grade and Elevated Sections

The lean 'L' due to cant at any point at height 'h' above rail level is given by:

L = Ca x h/g (all in mm)

For values of structure gauge (E_1) for inside of a curve with cant effect only, refer to:

(i) Appendix 4 (BOXTNL) & FIG. MMRC 4 (BOX TNL) for box structures of underground sections;
(ii) Appendix 4 & FIG. MMRC 4 for At-Grade and Elevated sections.

(b) Circular Tunnels

In the case of circular tunnel, the cant is provided by raising the outer rail and suitably shifting the centre of the circular tunnel towards inside of curve and upwards. This has same effect as assuming rotation of the circular tunnel about mid-point of top of inner rail resulting in shift of Tunnel centre laterally towards inside of curve and also vertically upwards.
The Rigid OCS shall also be rotated with the tunnel so as to be along the centre line of canted track.

For values of horizontal and vertical shifts of centre of circular tunnel for different values of cant, refer to Appendix 3 & FIG. MMRC-3.

(C) CLEARANCE FOR VERTICAL CURVE (VERTICAL THROW):

Vertical throw V_1 and V_2 (in mm) for vertical curve shall be calculated as under:

V_1 (with vehicle centre in sag or vehicle end on summit) = $125 \times C^2/R$
V_2 (with vehicle centre on summit or vehicle end in sag)
= $(125 \times C_1^2/R)-(125 \times C^2/R)$
Values of vertical throw due to vertical curves of different radii are given in Appendix 6 & FIG. MMRC- 6.

1.7.2 Outside of Curve

(A) CURVATURE EFFECT

i) End throw at the end of vehicle = V_O (in mm)
= $[125 \times C_1^2/R]-[125 \times C^2/R]$

ii) Clearance due to gauge widening on curves

iii) Additional nosing due to gauge widening on curves

The values of items i) to iii) are shown in Appendix 2

(B) CLEARANCE FOR SUPER ELEVATION

(a) Under Ground (Box Structures), At-grade and Elevated Sections
The lean 'L' due to cant at any point at height 'h' above rail level is given by:
L = (-) Ca x h/g (all in mm)
-Ve sign indicates relief due to cant or reduction in clearance required.

Note:

Full relief for lean due to cant (Ca) is to be taken into account only for calculation of track spacing without any structure between tracks. In case there is a structure adjacent to track, relief for lean is to be taken into account only if the cant provided is greater than 50 mm and shall be limited to a value = (Ca - 50) X h/g.

Values of Structure Gauge (F_1) on outside of curve with cant effect only, refer to:

I) Appendix 4 (TNL) & FIG. MMRC-4 (TNL) for underground sections (RECTANGULAR BOX)
II) Appendix 4 & FIG. MMRC- 4 for At-Grade and Elevated sections

(b) Circular tunnels

In the case of circular tunnel, the cant is provided by raising the outer rail and suitably shifting the centre of the circular tunnel towards inside of curve and upwards. This has same effect as assuming rotation of the circular tunnel about mid-point of top of inner rail resulting in shift of tunnel centre laterally towards inside of curve and also vertically upwards.

The Rigid OCS shall also be rotated with the tunnel so as to be along the centre line of canted track.

For values of horizontal and vertical shifts of centre of circular tunnel for different values of cant, refer to Appendix 3 & FIG. MMRC-3.

(C) CLEARANCE FOR VERTICAL CURVE (VERTICAL THROW)

The provisions at Para1.7.1 (C) above shall be applicable in this case also.

1.8 MINIMUM TRACK SPACING ON CURVES

Underground, At-grade and Elevated Sections:

The worst case will be when the end of a bogie carriage on the inner track is opposite the Centre of a similar carriage on the outer track.

1.8.1 Without any structure between tracks.

The minimum track spacing on curves without any structure between tracks shall be the sum of the following:

i) (E + F),
ii) T_1 (extra lateral clearance due to curvature on inside of curve)
iii) T_2 (extra lateral clearance due to curvature on outside of curve)
iv) Minimum clearance between adjacent kinematic envelopes stipulated is as under:
   a) 200 mm for under-ground sections
   b) 300 mm for At-Grade and Elevated sections

Where:

'E' is the distance from vertical axis of Centre line of canted track to canted kinematic envelope on inside of curve at a height 'h' (from rail level) for a given cant (Appendix 5 & FIG. MMRC-5 for At-Grade and Elevated and Appendix 5 (TNL) & FIG. MMRC -5 (TNL) for underground tunnels) and

'F' is the distance from vertical axis of Centre line of canted track to canted kinematic envelope on outside of curve at a height 'h'(from rail level) for a given cant (refer to Appendix 5 & FIG. MMRC -5 & Appendix 5 (TNL) & FIG. MMRC-5 (TNL).

Notes:

i) The value of 'F', calculated from the formula at Appendix 5&FIG. MMRC-5and Appendix 5 (TNL) & FIG. MMRC 5 (TNL) includes full relief due to cant.

ii) The sum of 'E' and 'F' for same height (which are with cant effect only), shall be the maximum of values calculated for various heights from rail level.

For values of E, F, $T_1$and T_2, refer to the Appendices as shown below:

SECTIONS		**FOR E & F**	**FOR T_1&T_2**
		APPENDIX	APPENDIX
I)	Underground	5 (TNL)	2
II)	At-grade and Elevated	5	2

1.8.2 With a structure between adjacent tracks

The minimum track spacing on curves with a structure between tracks shall be the sum of the following:

i) ($\mathbf{E_1}$ +$\mathbf{T_1}$) Minimum clearance to the structure from centre line of track on inside of curve (for outer track)
ii) ($\mathbf{F_1}$ +$\mathbf{T_2}$) Minimum clearance to the structure from centre line of track on outside of curve (for inner track)
iii) Width of structure between adjacent tracks (measured across the tracks).

Where:

$\mathbf{E_1}$ is the horizontal distance from vertical axis of centre line of track to canted Structure Gauge on inside of curve for a given cant,

$\mathbf{F_1}$ is the horizontal distance from vertical axis of centre line of track to canted Structure Gauge on outside of curve for a given cant,

$\mathbf{T_1}$ is extra lateral clearance due to curvature on inside of curve and

$\mathbf{T_2}$ is extra lateral clearance due to curvature on outside of curve

Notes:

a) The values of '**E_1**'and '**F_1**'for a given cant Ca, shall each be the maximum of values at different heights of structure from rail level. In case the cant provided is greater than 50 mm on inner track**,** the value of **F_1** shall be for the cant of (Ca-50) mm**.** In case the cant provided is 50 mm or less on inner track, the value of F_1shall be for zero cant.

b) Minimum track spacing, so worked out with a structure between the adjacent tracks as per Para 1.8.2 shall not be less than that calculated as per Para 1.8.1 for tracks without any structure between adjacent tracks.

For values of **E_1**, **F_1**, **T_1** AND **T_2**, refer to the Appendices as shown in table below:

SECTIONS	**FOR E_1 & F_1** APPENDIX	**FOR T_1&T_2** APPENDIX
I) Underground	4 (Box TNL)	2
II) At-grade and Elevated	4	2

1.9 CANT AND CANT DEFICIENCY

A) Maximum cant on curves = 125 mm
B) Maximum cant deficiency = 100 mm

1.10 PATHWAY/WALKWAYS

(i) Minimum width of Pathway/walkways 552mm
(ii) Minimum height of Pathway/walkways 1000mm
(iii) Maximum height of Pathway/walkways 1200mm
FIG. MMRC-2, MMRC-2 (BOX TNL) & MMRC-2 (CIRCULAR TNL)

Note:

Extra clearances shall be provided for curves as laid down at Para 1.7:

(i) Maximum and minimum heights of pathway/walkway on curves are meant above inner rail.
(ii) No structure, other than signalling and minor signalling equipment post, shall be permitted within the minimum width of pathway/walkway.
(iii) Minimum clearance to pathway/walkway at the nearest edge from kinematic envelope shall be 100 mm for underground sections and 150mm for At-Grade and Elevated sections.
(iv) Pathway/Walkway could be used by metro inspection group only in non-operation periods and for evacuation of passengers in emergency.

1.11 DERAILMENT GUARD

a) Derailment guard shall be provided inside/outside of running rail on elevated as well as in tunnel having multiple tracks and at-grade section at locations specified by the Metro railway. For single track tunnel, location for providing derailment guard is given in note. In tunnels, the derailment guard should preferably be provided inside the track, so that it permits less sway of coach towards tunnel wall in case of derailment.

Notes:

In case of single track tunnel, the derailment guards shall be provided:

1. Entry of tunnel: 200 m from tunnel portal outside the tunnel to 50 m inside the tunnel.

2. Exit of tunnel: 50 m from inside of tunnel portal to 200 m outside the tunnel.

3. In curved track having radius 500 m or less including transition portion but excluding locations where check rail is provided.

4. Covering locations of all important installations e.g. location of any sub-station or hazardous structures inside the tunnel, etc. damage to which in the assessment of metro rail administration can result into serious loss of life or/and infrastructure as a result of derailment in tunnel.

The above is subject to the condition that metro railway shall carry out the risk assessment analysis for derailment in tunnels and ensure that the maintenance practices in the maintenance manual are as per the risk assessment mitigation plan.

b) The lateral clearance between the running rail and the derailment guard shall be 210 ±30 mm. In case of Double Resilient Base Plate Assembly Fastening System as approved by MoR, the lateral clearance between running rail and the derailment guard shall be 250 ± 20 mm. It shall not be lower than 25 mm below the top of the running rail and should be clear of the rail fastenings to permit installation, replacement and maintenance.

c) Derailment guard shall be designed such that in case of derailment:

   (i) The wheels of a derailed vehicle under crash load, moving at maximum speed are retained on the viaduct or tunnel.

   (ii) Damage to track and supporting structures is minimum.

   The detailed design calculations of derailment guards along with detailed structural drawings shall be furnished for record.

CHAPTER 2
STATION

2.1 SPACING OF TRACKS AT STATIONS

Minimum spacing of tracks at station on straight and on curve of radius of 1000 m and flatter, without any structure between tracks

At-grade, elevated and under-ground stations……4100 mm

2.2 PLATFORMS

2.2.1. Maximum horizontal distance from centre of track to face of passenger platform coping for tangent track

(i) For At grade and elevated: 1680 mm vide FIG. MMRC-1A

(ii) For Underground: 1670 mm vide FIG. MMRC-1A (TNL)

2.2.2. Minimum horizontal distance from centre of track to face of passenger platform coping for tangent track

(i) For At grade and elevated: 1670 mm vide FIG.MMRC-1A

(ii) For Underground: 1660 mm vide FIG. MMRC-1A (TNL)

Notes:

a) Platform faces shall be flared away smoothly from the centre line of the track at either end for a distance of 1500 mm so as to give from centre of track area/at platform end so as to give from centre of track a minimum dimension :

Dimension:

- 1795 $\pm$ 5 mm for Under Ground stations
- 1785 $\pm$ 5 mm for At-Grade and Elevated stations

b) For additional clearance for platforms on curves, refer to Para 2.7.

2.2.3. Height above rail level for passenger platform:

	Maximum	**Minimum**
(a) At-Grade……	1085 mm	1075 mm
(b) Elevated/Under Ground……	1095 mm	1085 mm

2.2.4. (i) Minimum horizontal distance of any isolated structure on a passenger platform from the edge of coping except PSD:

At-grade/Elevated……2500 mm

Underground……2000 mm

(ii) Minimum horizontal distance of any continuous structure on a passenger platform from the edge of coping except PSD:

At-grade/Elevated ……..…..3000 mm

Underground……2500 mm

NOTES:

a) The Platform Screen Door (PSD) may be installed at platform as per design of PSD but shall have a minimum clearance of 10mm from kinematic envelope.

b) The structure on the platform is treated as isolated if the length along the platform length is 2000 mm or less. Any structure having a length exceeding 2000 mm is treated as continuous structure. The clocks/mirrors/CCTV/signage/screens etc. shall not be

considered structures and shall be located at a minimum horizontal distance 1000 mm from platform edge /coping with minimum height of 2000mmfrom top of platform.

c) For platform structure setting-out dimensions at stations, refer to FIG. MMRC-7 and FIG. MMRC-9 for At-Grade /elevated station and FIG. MMRC-8 and FIG.MMRC-10 for underground station. No fixed structures should infringe the Structure Gauge except for designated railway operational structures. Designated railway operational structures include platform coping, platform screed door, hand railing in back-of-house platform edge, track access gates. Such designated railway operational structures should not infringe the kinematic envelope under any circumstances.

2.2.5. For Structure Gauge at stations, refer to following appendices:

a.	For Under Ground Station (Tunnel)	FIG. MMRC-8 & FIG. MMRC-10
b.	For At-Grade with One Side Platform	FIG. MMRC-7
c.	For Elevated Station with Island Platform	FIG. MMRC-9
d.	For Structure Gauge At-Grade and Elevated Station	FIG. MMRC-11

2.3 TRACK GRADIENT IN PLATFORM

(a)Maximum Gradient	1 In 400
(b) Desirable	Level

Note: There shall be no change of gradient in platform line.

2.4 INTERLOCKING AND SIGNAL GEAR

Maximum height above rail level of any part of interlocking or signal gear on either side of centre of track subject to the restrictions embodied in note below shall be as under:

For At-Grade And Elevated Stations:

• From 577.5 mm to 946.5 mm from C. L. of Track	0 mm
• From C.L. of Track to 577.5 mm and from 946.5 mm to1450 mm	25 mm
• From 1450 mm to 1585 mm	25 mm rising to 65 mm
• From 1585 mm to 1745 mm	65 mm rising to 200 mm

For Under Ground Stations:

• From 577.5 mm to 946.5 mm from C. L. of Track	0 mm
• From C.L. of Track to 577.5 mm and from 946.5 mm to1450 mm	25 mm
• From 1450 mm to 1585 mm	25 mm rising to 65 mm
• From 1585 mm to 1720 mm	65 mm rising to 200 mm

Note:

Except for check rails of ordinary and diamond crossings, or wing rails and point rails of crossings leading to snag dead ends, or such parts of signaling gear as are required to be actuated by the wheels, no gear or track fittings shall project above rail level for a distance of 229 mm outside and 140 mm inside the gauge face of the rails.

2.5 POINTS & CROSSINGS

2.5.1.	Maximum clearance of check rail opposite nose of crossing	44 mm
2.5.2.	Minimum clearance of check rail opposite nose of crossings	41mm
2.5.3.	Minimumclearance between switch rail and stock rail at heel of switch rail.	52 mm
2.5.4.	Maximum clearance of wing rail at nose of crossing	44 mm
2.5.5.	Minimum clearance of wing rail at nose of crossings	41mm
2.5.6.	Minimum clearance between toe of open switch and stock rail	160mm
2.5.7.	Minimum radius of curvature for slip points, turnouts and crossover roads (mainline)	190 m
2.5.8.	On depot lines, the turnouts and diamond crossings shall be of the following types or flatter	140 m radius

(a) 1 in 7 type Turnout
(b) Scissor cross-over of 1 in 7 type consisting of 4 turnouts and 1 diamond crossing
(c) 1 in 7 derailing switches / 1 in 7 type symmetrical split turnout

2.5.9.	Diamond crossings not to be flatter than	1 in 4.5

Notes:

a) The above restrictions shall not apply to moveable diamond crossings
b) There must be no change of superelevation (of outer over inner rail), between points 18 metres outside toe of switch rail and nose of crossings respectively, except in the case of special crossing leading to snag dead-ends or under circumstances as provided for in item 2.6 below.

2.5.10. Minimum length of tongue rail: 9000mm

2.6 SUPERELEVATION AND SPEED ON CURVES WITH TURNOUTS OF CONTRARY AND SIMILAR FLEXURE

2.6.1. Main line:

Subject to the permissible run through speed based on the standard of interlocking, the equilibrium super elevation, calculated for the speed of the fastest train may be reduced by a maximum amount of 100mm without reducing speed on the main line.

2.6.2. Turnouts

i) Curves Of Contrary Flexure
The equilibrium super elevation(**S**) in mm should be = $(1510/127)*(V^2 / R)$
Where, R = radius of turnout in meters and V is speed on turnout in Kmph.
The permissible negative super elevation on the turnout is specified with 100 mm.

ii) Curves of Similar Flexure
The question of reduction or otherwise of super elevation on the main line must necessarily be determined by the administration concerned. In the case of a reverse curve close behind

the crossing of a turnout, the super elevation may be run out at the maximum of 1 mm in 440 mm.

2.7 ADDITIONAL CLEARANCE FOR PLATFORMS ON CURVES

The additional clearance for platforms on curves is shown At Appendix 7.

Notes:

(i) As the minimum radius of curve for stations is 1000 meters, there will be no gauge widening at stations on passenger platform line.

(ii) Platforms located in curves shall be filled with a gap filler to reduce safety risk at the Platform Train Interface (PTI). The maximal stepping distance of 75 mm has to be maintained by way of fillers of material elastic in nature and flexible to allow train contact without any adverse effect on passenger safety and stability of trains.

CHAPTER 3
ROLLING STOCK

3.1 PASSENGER ELECTRIC MULTIPLE UNITS

1. (a) length of the coach body: (Maximum including end fairings) — 22010 mm

   (b) The maximum width of the vehicle — 3200 mm

   (c) Height of coach body (maximum with pantograph in lock down position) — 4048 mm

2. (a) Distance between bogie centers — 14750±350mm
   (b) Maximum distance apart between any two adjacent axles — 12900 mm

Note:

Fittings on the end of a vehicle, such as step iron, brake/drainage pipes, electrical connection, cables or boxes, vestibule or gangway, fairings etc. Need not be kept within the prescribed maximum permissible length of the car body, but may project beyond the end of body to a reasonable extent.

3. Kinematic Envelope for level tangent track
   - (i) For Underground Sections — FIG. MMRC-1 (TNL)
   - (ii) For At-Grade and Elevated Sections — FIG. MMRC-1
   - (iii) For Underground Section at platform — FIG. MMRC-1 A (TNL)
   - (iv) For At-Grade and Elevated Sections at Platform — FIG. MMRC-1A
   - (v) Same Pantograph Shall Be Used For Underground and Elevated Corridors.

4. (a) Minimum clearance from rail level with fully worn wheel and under fully loaded condition for bogie mounted equipment in worst condition*. — 75 mm
   * Worst condition means wheels with maximum tread wear and primary springs with maximum deflection in static condition.

   (b) Minimum clearance from rail level under fully loaded condition for body mounted equipment in worst condition*. — 102 mm
   * Worst condition means deflated secondary air spring, wheels with maximum tread wear and primary spring with maximum deflection in static condition.

   (c) Minimum clearance from rail level, under dynamic conditions of fully loaded vehicle, with maximum tread wear and primary spring with maximum deflection, with the exception of wheels and their attachments to (vide note below). — 50 mm

Note:

A tyre or an attachment to a wheel or sand pipes or wheel/track lubrication nozzle in line with the wheel may project below the minimum height of 50 mm from a distance of 51 mm inside to 216 mm outside of the gauge face of the wheel.

5. Incline of Tread / Wheel Profile — FIG. MMRC-12 (RDSO Sk-91146)
6. Wheel
   - a) Maximum wheel gauge back to back distance — 1360 mm
   - b) Minimum wheel gauge back to back distance — 1358mm

7.	a)	Maximum diameter on the tread measured at 63.5mmfrom the wheel gauge face	860 mm
	b)	Minimum diameter on the tread measured at 63.5mm from the wheel gauge face	780mm
8.	a)	Minimum projection for flange of new wheel measured from tread at 63.5 mm from the wheel gauge face	28.5 mm
		For profile as per Sk-91146	
	b)	Maximum projection for flange of worn wheel measured from tread at 63.5 mm from the wheel gauge face	34 mm
9.	a)	Maximum thickness of flange of wheel measured from wheel gauge face at 13 mm from outer edge of flange	29.4mm
	b)	Minimum thickness of flange of wheel Measured from wheel gauge face at 13 mm from outer edge of flange.	25 mm
10.	Minimum width of wheel		127 mm
11.	Floor Height		
	a)	Maximum height above rail level for floor of any unloaded vehicle	1130mm
	b)	Minimum height above rail level for floor of fully loaded normal vehicle	1100mm
12.	a)	Maximum height of centre coupler above rail level for unloaded vehicle	815mm
	b)	Minimum height of centre coupler above rail level for fully loaded vehicle	740mm
13.	Maximum length over couplers		23000mm
14.	Length of rigid wheel base for single bogie		2200mm to 2600m

3.2 LOCOMOTIVES AND ENGINEERING SERVICE VEHICLES

Other items of rolling stock, viz. shunting locomotives, OHE maintenance and inspection cars, emergency re-railing van, track machines, etc., used on MML3 Metro System(where these cars would be plying)will conform with the Kinematic Envelope of the Passenger Electric Multiple Units as shown in FIG. MMRC- 1(TNL) and FIG. MMRC- 1A (TNL) for Underground sections and FIG. MMRC-1 and FIG. MMRC-1A for At-grade and Elevated sections.

CHAPTER 4
OVERHEAD ELECTRIC TRACTION 25 KV/AC 50 CYCLES PER SECOND

Note:

Wherever electric traction is in use, special precautions must be taken to maintain following clearances:

4.1 ELECTRICAL CLEARANCES FOR UNDER GROUND

4.1.1 Minimum height from rail level to the underside of wearing copper / metal conductor of rigid OCS (Overhead Contact System):

In Tunnel ……4318 mm

Note:

(a) Location of level crossing from the exit point of the tunnel will take into consideration the OHE height of 4318 mm at the tunnel exit and the permissible contact wire gradient.

(b) In the depot deck portion, if rigid OCS is provided and the track is ballastless, the electrical clearances laid down at Para 4.1.1 to 4.1.4 shall be applicable.

(c) For location of rigid OCS in circular tunnel with canted track, refer to para1.7.1 (B)-b and 1.7.2 (B)-b.

(d) It shall be ensured that environment level inside the tunnel is controlled suitably so that no extra air clearance, over and above the minimum separation prescribed in Para 4.1.3 and 4.1.4 on account of pollution, fog etc. is required.

4.1.2 Stagger of Rigid OCS Conductor in Tunnels shall not be more than

(a) On Straight ……±200 mm
(b) On Curves ……..±300 mm

4.1.3 Prescribed minimum clearance between live parts of contact lines and the earthed bodies of structures.

Air clearance between bodies of the earthed structures and live un-insulated parts of contact lines, feeders and current collectors for 25 KV shall be as per IEC 60913 as below:

	Condition	Minimum Clearance Between Live Parts And Structures	Absolute Minimum Dynamic Clearance Between Live Parts And Structures
A)	Long Duration (Static)	270 mm	-
B)	Short Duration (Dynamic)	170 mm	150 mm*

*in exceptional cases and considering operating in climatic conditions (Ref: IEC 60913)

4.1.4 Prescribed minimum clearance between live parts of contact lines and the earthed bodies of vehicles.

Minimum air clearance between bodies of vehicles and the live un-insulated parts of the contact line or feeders for 25 KV shall be as below:

	Condition	Clearance (mm)
A)	Long Duration (Static)	290 mm
B)	Short Duration (Dynamic)	190 mm

4.1.5 Maximum width of pantograph under dynamic condition.

The Kinematic Envelope for the underground system with ballastless track is shown in FIG. MMRC-1(TNL). The pantograph adopted should be such that its actual half KE width does not exceed 820 mm and 980 mm at the top and bottom respectively in pantograph raised condition for a contact wire height of 4318 mm to fulfil electrical clearance as per item 4.1.3.

Note:

These limits would not apply to special locations like insulated overlaps and out of run wires.

4.2 ELECTRICAL CLEARANCES FOR AT-GRADE AND ELEVATED SECTIONS

4.2.1 Minimum vertical clearance (under worst condition of temperature, wind etc.) between any live part of the Overhead Equipment or Pantograph and parts of any fixed structure (earthed or otherwise) or moving loads:

	Condition	For Flexible OHE
(I)	Long Duration (Static)	320 mm
(Ii)	Short Duration (Dynamic)	270 mm

Note:

A minimum vertical distance of 340 mm shall normally be provided between rolling stock and contact wire to allow for a 20 mm temporary rising of the tracks during maintenance for ballasted track . Wherever the clearance required for track maintenance exceeds 20 mm, the vertical distance between rolling stock and contact wire shall correspondingly be increased.

4.2.2 Minimum lateral clearance (under worst condition of temperature, wind etc.) between any live part of the Overhead Equipment or Pantograph and parts of any fixed structure (earthed or otherwise) or moving loads:

	Condition	For Flexible OHE
(I)	Long Duration (Static)	320 mm
(Ii)	Short Duration (Dynamic)	220 mm

4.2.3 Height of contact wire:

Minimum height from rail level to the underside of live conductor wire:

i. In tunnel portal to Ramp area……..……..… …...4388 mm
ii. Under the bridges…….…….…….4640mm(approx)
iii. In the open (Elevated & At-grade sections) ……...5000mm
iv. At Level Crossings……...…….…….5500 mm
v. In Running and carriage sheds wherever staffs are expected to work on the roof of rolling stock…… 5500 mm
vi. In depot.……..……5500 mm

Note:

On curves, all vertical distances specified in items 4.2.3 above, shall be measured above level of the inner rail, increased by half the super-elevation.

4.2.4 Maximum variation of the live conductor wire on either side of the centreline of the track under static conditions:

i. On Straight ……...±200 mm
ii. On Curves……±300 mm

Note:

These limits would not apply to special locations like insulated overlaps and out of run wires.

4.2.5 Maximum Width of Pantograph Collector :

The kinematic envelope with the size of pantograph adopted shall be within the kinematic envelope shown at FIG. MMRC-1

CHAPTER 5
PLATFORM SCREEN DOORS

5.1 PLATFORM SCREEN DOORS SETTING OUT DIMENSIONS

Minimum Platform Screen Door Width	Min 2000 mm
Minimum Platform Screen Door Height From Platform Level	Min 1500mm (Partial Height) Min 2100 mm(Full Height)
Minimum Platform Threshold offset from track centreline—straight track (Underground)	1660 mm
Minimum Platform Threshold Offset From Track Centreline – Straight Track (At Grade/ Elevated)	1670 mm
Minimum Platform Screen Door Panel Offset From Track Centreline – Straight Track (a) For Underground (b) For At Grade /Elevated	 1695 mm 1705 mm

Note:

(a) Assumed plus/minus 300 mm stopping accuracy.
(b) Curve track through station to be considered separately.
(c) Platform Screen Doors are considered as designated railway operational structures. Therefore, PDS may infringe the Structure Gauge, but does not infringe the station Kinematic Envelope and having minimum clearance of 10 mm from Kinematic Envelope to Platform Screen Door.

APPENDIX 1

PERMISSIBLE SPEED, CANT AND MINIMUM TRACK SPACING ON CURVES.

UNDER GROUND (TUNNELS), AT-GRADE AND ELEVATED SECTIONS

(REFERENCE: PARA 1.1)

			MINIMUM DISTANCE BETWEEN	
RADIUS		**MAXIMUM**	**ADJACENT TRACKS**	
OF	**CANT**	**PERMISSIBLE**	**See note (a)**	
CURVE		**SPEED**		
			UNDER GROUND	**AT-GRADE AND ELEVATED**
meters	mm	kmph	mm	Mm
3000	**15**	**85**	**3800**	**3900**
2800	**15**	**85**	**3800**	**3900**
2400	**20**	**85**	**3800**	**3900**
2000	**20**	**85**	**3800**	**3900**
1600	**25**	**85**	**3800**	**3900**
1500	**30**	**85**	**3800**	**3900**
1200	**35**	**85**	**3800**	**3950**
1000	**45**	**85**	**3800**	**3950**
800	**55**	**85**	**3850**	**4000**
600	**70**	**85**	**3850**	**4000**
500	**85**	**85**	**3850**	**4000**
450	**100**	**85**	**3900**	**4000**
400	**115**	**85**	**3900**	**4050**
350	**125**	**80**	**3950**	**4050**
300	**125**	**75**	**4000**	**4100**
260	**125**	**70**	**4000**	**4100**
230	**125**	**65**	**4050**	**4150**
200	**125**	**60**	**4100**	**4200**
150*	**0**	**35**	**4200**	**4300**
120*	**0**	**30**	**4300**	**4400**
100*	**0**	**25**	**4300**	**4400**

Notes:

(a) The track spacing shown in the table above is without any column/structure between two tracks and is with equal cant for both outer and inner tracks.
(b) Track spacing shown in Table above is not applicable to stations which should be calculated depending on specific requirement.
(c) Figures for any intermediate radius of curvature may be obtained adopting value of sharper curve.
(d) Cant provided is limited to desirable value of 125 mm
(e) Maximum cant deficiency is 100 mm.
(f) * The curves of100 to 150 meters radii are used in depot and depot connections.

APPENDIX 2

EXTRA HORIZONTAL SHIFT ON CURVES (CURVATURE EFFECT]
INSIDE OF CURVE

REFERENCE PARA 1.7.1

RADIUS (meters)	MID-THROW (28500/R) (mm)	NOSING INCLUDED IN K.E/STRUCTURE GAUGE FOR TANGENT TRACK (mm)	EXTRA GAUGE TOLERANCE ON CURVES (mm)	EXTRA HORIZONTAL SHIFT'ON CURVE (mm)	REMARKS
R	(V)	(N)	(G)	(T_1)	G), EXTRA GAUGE TOLERANCE ON CURVES SHARPER THAN 1000 M RADIUS: 9 mm FOR CURVES WITH RADIUS SHARPER THAN 500 M AND 5mm FOR CURVES WITH RADIUS OF 500 M TO LESS THAN 1000M. T_1=V-N+G V EQUAL TO OR GREATER THAN (N) **T_1 = G for V<(N)**
100	285	32.0	9.0	262	
120	237.5	32.0	9.0	215	
150	190.0	32.0	9.0	167	
175	162.9	32.0	9.0	140	
200	142.5	320	9.0	120	
230	123.91	32.0	9.0	101	
260	109.61	32.0	9.0	87	
300	95.0	32.0	9.0	72	
350	81.4	32.0	9.0	58	
400	71.3	32.0	9.0	48	
450	63.3	32.0	9.0	40	
500	57.0	32.0	5.0	30	
600	47.5	32.0	5.0	21	
700	40.7	32.0	5.0	14	
800	35.6	32.0	5.0	9	
900	31.7	32.0	5.0	5	
1000	28.5	32.0	0.0	0	
1200	23.8	32.0	0.0	0	
1500	19.0	32.0	0.0	0	
1600	17.8	32.0	0.0	0	
2000	14.3	32.0	0.0	0	
2400	11.9	32.0	0.0	0	
2600	10.2	32.0	0.0	0	
3000	9.5	32.0	0.0	0	

Mid Throw (in mm) Vo= ($125xC^2$)/R = 28500/R, where 'C' is the distance between bogie centres = 14.750+0.350=15.100 m OR 14.750-350=14.400m.
Worst Case will be with C=15.100 m; R is the radius of curve

OUTSIDE OF CURVE

REFERENCE PARA 1.7.2

RADIUS (meters)	END-THROW (34635/R) (mm)	EXTRA GAUGE TOLERANCE ON CURVES (mm)	EXTRA NOSING DUE TO EXTRA GAUGE TOLERANCE (mm)	EXTRA HORIZONTAL SHIFT'ON CURVE (mm)	REMARKS
R	Vo	G	(EN)	T2	(G), EXTRA GAUGE TOLERANCE ON CURVES SHARPER THAN 1000 M RADIUS: 9 mm FOR CURVES WITH RADIUS SHARPER THAN 500 M AND 5mm FOR CURVES WITH RADIUS OF 500 M TO LESS THAN 1000M. **T_2=Vo +G+EN EN=G x 0.2555555**
100	346.4	9.0	2.3	358	
120	288.6	9.0	2.3	300	
150	230.6	9.0	2.3	242	
175	197.9	9.0	2.3	209	
200	173.2	9.0	2.3	184	
230	150.58	9.0	2.3	162	
260	133.21	9.0	2.3	145	
300	115.5	9.0	2.3	127	
350	99.0	9.0	2.3	110	
400	86.6	9.0	2.3	98	
450	77.0	9.0	2.3	88	
500	69.3	5.0	1.3	76	
600	57.7	5.0	1.3	64	
700	49.5	5.0	1.3	56	
800	43.3	5.0	1.3	50	
900	38.5	5.0	1.3	45	
1000	34.6	0.0	0.0	35	
1200	28.9	0.0	0.0	29	
1500	23.1	0.0	0.0	23	
1600	21.6	0.0	0.0	22	
2000	17.3	0.0	0.0	17	
2400	14.4	0.0	0.0	14	
2800	12.4	0.0	0.0	12	
3000	11.5	0.0	0.0	12	

End Throw (in mm) Vo= (125 x $C1^2$') /R - ($125xC^2$)/R = 34635/R, where 'C' is the distance between bogie centres = 14.750 + 0.350=15.100 m
OR 14.750 - 0.350 = 14.400 m.
Worst case will be with C=14.400 m, 'C1' is length of coach in meters: 22.010 m and 'R' radius of curve in meters.

APPENDIX 3

Shift of the Centre of Circular Tunnel Due To Rotation of Tunnel to provide for cant

(WITH D_1 =630mm)

REFER TO FIG. MMRC-3 AND PARA No. 1.7.1 (B)(b)

Cant	sin α= cant/1510	Angle α	tan θ= (r-D1)/(g/2)	Angle θ	Lateral Shift of Tunnel centre=X	Vertical Shift of Tunnel centre=Y
mm		Degrees		Degrees	mm	mm
125	0.08278	4.74846	2.87417	70.8159	182	55
120	0.07947	4.55811	2.87417	70.8159	175	53
115	0.07616	4.36782	2.87417	70.8159	167	51
110	0.07285	4.17757	2.87417	70.8159	160	49
105	0.06954	3.98736	2.87417	70.8159	153	47
100	0.06623	3.79720	2.87417	70.8159	145	45
95	0.06291	3.60708	2.87417	70.8159	138	43
90	0.05960	3.41701	2.87417	70.8159	131	41
85	0.05629	3.22696	2.87417	70.8159	123	39
80	0.05298	3.03696	2.87417	70.8159	116	37
75	0.04967	2.84699	2.87417	70.8159	109	35
70	0.04636	2.65705	2.87417	70.8159	101	33
65	0.04305	2.46714	2.87417	70.8159	94	30
60	0.03974	2.27725	2.87417	70.8159	87	28
55	0.03642	2.08739	2.87417	70.8159	80	26
50	0.03311	1.89756	2.87417	70.8159	72	24
45	0.02980	1.70774	2.87417	70.8159	65	22
40	0.02649	1.51795	2.87417	70.8159	58	19
35	0.02318	1.32817	2.87417	70.8159	51	17
30	0.01987	1.13840	2.87417	70.8159	43	15
25	0.01656	0.94865	2.87417	70.8159	36	12
20	0.01325	0.75891	2.87417	70.8159	29	10
15	0.00993	0.56917	2.87417	70.8159	22	7
10	0.00662	0.37945	2.87417	70.8159	14	5
5	0.00331	0.18972	2.87417	70.8159	7	2
0	0	0.00000	2.87417	70.8159	0	0

Remarks

a. The cant is provided by rotating the outer rail which will mean, rotating the tunnel about the midpoint of the top of inner rail.

b. Lateral shift of the centre of tunnel (X) towards the inside of tunnel = X

$$X = \left[2 \times (r - D_1) \div (\sin\theta) \times \sin\frac{\alpha}{2}\right] \times \cos(90 - \theta - \alpha/2)$$

c. The vertical shift of the centre of the tunnel Upwards = Y

$$Y = \left[2 \times (r - D_1) \div (\sin\theta) \times \sin\frac{\alpha}{2}\right] \times \sin(90 - \theta - \alpha/2)$$

- **'r' is Internal Radius of Circular Tunnel =2800 mm**
- **D_1 =Depth from Invert of Circular Tunnel to Rail Top Level =630 mm**
- **α = Angle of Rotation $\alpha=\sin^{-1}$(cant/g)**
- **θ= Angle Subtended by line joining top of two rails and the line joining midpoint of top of inner rail and the centre of circular Tunnel**

$\theta=\tan^{-1}[(r-D1)/(g/2)]=70.8159$

Distance between Centre to Centre of Rails (g) = 1510mm

APPENDIX 4

CANT EFFECT ON STRUCTURE GAUGE
AT-GRADE OR ELEVATED SECTIONS

REFER TO FIG. MMRC-4 AND PARA No. 1.7.1 (B) (a) &1.8.2 (b)

Cant	Alpha Degree	Alpha Radians	Sin Alpha	Cos Alpha	Tan Alpha	h= 200		ab= 1745		h= 880		ab= 1903		h= 1130		ab= 1938		h= 2030		ab= 1938		h= 3300		ab= 1875		h= 3736		ab= 1540		h= 6250		ab= 1540	
						E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2
125	4.7485	0.0829	0.0828	0.9966	0.0831	1756	1722	406	117	1969	1824	1097	782	2025	1838	1349	1028	2099	1763	2246	1925	2142	1595	3506	3196	1844	1225	3913	3658	2052	1017	6419	6164
120	4.5581	0.0796	0.0795	0.9968	0.0797	1755	1724	398	121	1967	1827	1088	786	2022	1842	1340	1032	2093	1771	2238	1930	2131	1607	3499	3201	1832	1238	3907	3662	2032	1038	6413	6168
115	4.3678	0.0762	0.0762	0.9971	0.0764	1755	1725	390	124	1964	1830	1080	790	2018	1846	1332	1037	2087	1778	2229	1934	2121	1618	3491	3205	1820	1251	3900	3665	2012	1060	6407	6172
110	4.1776	0.0729	0.0728	0.9973	0.0730	1755	1726	382	127	1962	1834	1071	794	2015	1851	1323	1041	2081	1785	2221	1938	2110	1630	3483	3210	1808	1264	3893	3669	1991	1081	6401	6176
105	3.9874	0.0696	0.0695	0.9976	0.0697	1755	1727	373	131	1960	1837	1063	798	2012	1855	1315	1045	2074	1792	2212	1943	2100	1641	3475	3214	1796	1276	3887	3672	1971	1102	6394	6180
100	3.7972	0.0663	0.0662	0.9978	0.0664	1754	1728	365	134	1957	1841	1054	802	2009	1859	1306	1049	2068	1799	2204	1947	2089	1652	3467	3219	1784	1289	3880	3676	1951	1123	6388	6184
97	3.6831	0.0643	0.0642	0.9979	0.0644	1754	1729	360	136	1956	1843	1049	804	2007	1861	1301	1052	2064	1804	2199	1950	2083	1659	3462	3221	1777	1297	3876	3678	1938	1135	6385	6187
95	3.6071	0.0630	0.0629	0.9980	0.0630	1754	1729	357	137	1955	1844	1045	806	2005	1863	1297	1053	2062	1806	2195	1952	2079	1664	3459	3223	1772	1302	3873	3679	1930	1144	6382	6188
90	3.4170	0.0596	0.0596	0.9982	0.0597	1754	1730	349	141	1952	1847	1037	810	2002	1867	1289	1057	2056	1814	2187	1956	2068	1675	3451	3227	1760	1315	3866	3683	1910	1165	6376	6192
85	3.2270	0.0563	0.0563	0.9984	0.0564	1753	1731	340	144	1950	1850	1028	814	1999	1871	1280	1062	2049	1821	2178	1960	2058	1686	3443	3232	1748	1327	3859	3686	1889	1186	6369	6196
80	3.0370	0.0530	0.0530	0.9986	0.0531	1753	1732	332	147	1947	1854	1020	818	1995	1875	1271	1066	2043	1828	2170	1964	2047	1698	3435	3236	1736	1340	3852	3689	1869	1207	6363	6200
75	2.8470	0.0497	0.0497	0.9988	0.0497	1753	1733	324	151	1944	1857	1011	822	1992	1879	1262	1070	2036	1835	2161	1969	2037	1709	3427	3240	1724	1353	3845	3692	1849	1228	6356	6203
70	2.6570	0.0464	0.0464	0.9989	0.0464	1752	1734	316	154	1942	1860	1002	826	1988	1884	1254	1074	2030	1842	2153	1973	2026	1720	3418	3245	1712	1365	3838	3696	1828	1249	6350	6207
60	2.2773	0.0397	0.0397	0.9992	0.0398	1752	1736	299	161	1936	1867	985	834	1981	1892	1236	1082	2017	1856	2135	1981	2005	1742	3402	3253	1687	1390	3824	3702	1787	1290	6336	6214
55	2.0874	0.0364	0.0364	0.9993	0.0364	1751	1737	291	164	1934	1870	976	838	1978	1896	1227	1086	2011	1863	2127	1986	1994	1754	3394	3257	1675	1403	3817	3705	1767	1311	6329	6217
50	1.8976	0.0331	0.0331	0.9995	0.0331	1751	1737	283	167	1931	1873	968	842	1974	1900	1219	1090	2004	1870	2118	1990	1983	1765	3385	3261	1663	1415	3810	3708	1746	1332	6323	6221
45	1.7077	0.0298	0.0298	0.9996	0.0298	1750	1738	274	170	1928	1876	959	845	1971	1903	1210	1094	1998	1877	2109	1994	1973	1776	3377	3265	1651	1428	3803	3711	1726	1353	6316	6224
40	1.5179	0.0265	0.0265	0.9996	0.0265	1750	1739	266	174	1926	1879	950	849	1967	1907	1201	1098	1991	1884	2101	1998	1962	1787	3369	3269	1638	1440	3795	3714	1705	1374	6309	6227
35	1.3282	0.0232	0.0232	0.9997	0.0232	1749	1740	258	177	1923	1882	941	853	1964	1911	1192	1102	1985	1890	2092	2002	1951	1798	3360	3273	1626	1453	3788	3717	1684	1395	6302	6230
30	1.1384	0.0199	0.0199	0.9998	0.0199	1749	1741	250	180	1920	1885	933	857	1960	1915	1183	1106	1978	1897	2083	2006	1940	1809	3352	3277	1614	1465	3781	3720	1664	1416	6294	6233
25	0.9486	0.0166	0.0166	0.9999	0.0166	1748	1741	241	184	1917	1888	924	861	1956	1919	1174	1110	1971	1904	2074	2010	1929	1820	3343	3281	1602	1478	3773	3722	1643	1436	6287	6236
20	0.7589	0.0132	0.0132	0.9999	0.0132	1747	1742	233	187	1914	1891	915	865	1953	1923	1166	1114	1965	1911	2065	2014	1919	1831	3335	3285	1589	1490	3766	3725	1623	1457	6280	6239
15	0.5692	0.0099	0.0099	1.0000	0.0099	1747	1743	225	190	1912	1894	906	869	1949	1927	1157	1118	1958	1918	2057	2018	1908	1842	3326	3289	1577	1503	3759	3728	1602	1478	6272	6242
10	0.3794	0.0066	0.0066	1.0000	0.0066	1746	1744	217	193	1909	1897	898	872	1945	1930	1148	1122	1951	1925	2048	2022	1897	1853	3317	3293	1565	1515	3751	3731	1581	1499	6265	6245
5	0.1897	0.0033	0.0033	1.0000	0.0033	1746	1744	208	197	1906	1900	889	876	1942	1934	1139	1126	1945	1931	2039	2026	1886	1864	3309	3296	1552	1528	3744	3733	1561	1519	6258	6247
0	0.0000	0.0000	0.0000	1.0000	0.0000	1745	1745	200	200	1903	1903	880	880	1938	1938	1130	1130	1938	1938	2030	2030	1875	1875	3300	3300	1540	1540	3736	3736	1540	1540	6250	6250

REFER TO FIG. MMRC-4
All dimensions are in mm
Where:

g= 1510
h= Height above rail level measured perpendicular to plane of track.
$E_1 = [ab + (h \times \text{Tan } \alpha)] \times \text{Cos } \alpha$
$F_1 = [Ab - (h \times \text{Tan } \alpha)] \times \text{Cos } \alpha$
$H_1 = (Ca / 2) + (h / \text{Cos } \alpha) + (Ab - h \times \text{Tan } \alpha) \times \text{Sin } \alpha$
$H_2 = (Ca / 2) + (h / \text{Cos } \alpha) - (ab + h \times \text{Tan } \alpha) \times \text{Sin } \alpha$
ab=Ab = Distance from centre line of vehicle to Structure Gauge for Tangent track at height "h" from rail level.

APPENDIX 4 (BOX TNL)

CANT EFFECT ON STRUCTURE GAUGE
UNDERGROUND SECTIONS (RECTANGULAR BOX TUNNEL)

REFER TO FIG. MMRC-4 (BOX TNL) AND PARA No. 1.7.1 (B) (a) &1.8.2 (b)

Cant	Alpha Degree	Alpha Radians	Sin Alpha	Cos Alpha	Tan Alpha	h= 305		ab= 1720		h= 880		ab= 1851		h= 1130		ab= 1875		h= 2030		ab= 1875		h= 3346		ab= 1815		h= 3738		ab= 1390		h= 4838		ab= 1390	
						E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2
125	4.7485	0.0829	0.0828	0.9966	0.0831	1739	1689	509	224	1917	1772	1093	786	1962	1775	1344	1033	2037	1701	2241	1930	2086	1532	3547	3247	1695	1076	3903	3673	1786	985	4999	4769
120	4.5581	0.0796	0.0795	0.9968	0.0797	1739	1690	501	227	1915	1775	1084	790	1959	1779	1335	1037	2030	1708	2233	1935	2075	1543	3540	3251	1683	1089	3897	3676	1770	1001	4993	4772
115	4.3678	0.0762	0.0762	0.9971	0.0764	1738	1692	493	231	1913	1779	1076	794	1956	1783	1327	1041	2024	1715	2224	1939	2065	1555	3532	3256	1671	1101	3891	3679	1754	1018	4987	4776
110	4.1776	0.0729	0.0728	0.9973	0.0730	1738	1693	484	234	1910	1782	1068	798	1952	1788	1319	1045	2018	1722	2216	1943	2054	1566	3524	3260	1659	1114	3884	3682	1739	1034	4981	4779
100	3.7972	0.0663	0.0662	0.9978	0.0664	1736	1696	468	240	1905	1789	1051	805	1946	1796	1302	1053	2005	1736	2200	1951	2033	1589	3509	3268	1634	1139	3872	3688	1707	1067	4969	4785
105	3.9874	0.0696	0.0695	0.9976	0.0697	1737	1695	476	237	1908	1785	1059	802	1949	1792	1310	1049	2012	1729	2208	1947	2043	1578	3517	3264	1647	1127	3878	3685	1723	1050	4975	4782
95	3.6071	0.0630	0.0629	0.9980	0.0630	1736	1697	460	244	1903	1792	1042	809	1942	1800	1293	1057	1999	1744	2191	1956	2022	1601	3501	3273	1622	1152	3866	3691	1692	1083	4963	4788
90	3.4170	0.0596	0.0596	0.9982	0.0597	1735	1699	452	247	1900	1795	1034	813	1939	1804	1285	1061	1993	1751	2183	1960	2011	1612	3493	3277	1610	1165	3859	3694	1676	1099	4957	4792
85	3.2270	0.0563	0.0563	0.9984	0.0564	1734	1700	444	250	1898	1799	1025	817	1936	1808	1276	1065	1986	1758	2175	1964	2000	1624	3485	3281	1598	1177	3853	3696	1660	1115	4951	4795
80	3.0370	0.0530	0.0530	0.9986	0.0531	1734	1701	436	253	1895	1802	1017	821	1932	1812	1268	1069	1980	1765	2166	1968	1990	1635	3477	3285	1586	1190	3846	3699	1644	1132	4945	4798
75	2.8470	0.0497	0.0497	0.9988	0.0497	1733	1703	428	257	1892	1805	1008	824	1929	1817	1259	1073	1974	1772	2158	1972	1979	1647	3470	3289	1574	1203	3840	3702	1629	1148	4939	4800
70	2.6570	0.0464	0.0464	0.9989	0.0464	1732	1704	419	260	1890	1808	1000	828	1925	1821	1251	1077	1967	1779	2150	1976	1968	1658	3462	3293	1562	1215	3833	3705	1613	1164	4932	4803
65	2.4671	0.0431	0.0430	0.9991	0.0431	1732	1705	411	263	1887	1811	991	832	1922	1825	1242	1081	1961	1786	2141	1980	1957	1669	3454	3297	1550	1228	3827	3707	1597	1180	4926	4806
50	1.8976	0.0331	0.0331	0.9995	0.0331	1729	1709	387	273	1879	1821	966	843	1911	1837	1216	1092	1941	1807	2116	1992	1925	1703	3429	3309	1513	1265	3807	3715	1549	1229	4906	4814
45	1.7077	0.0298	0.0298	0.9996	0.0298	1728	1710	379	276	1876	1824	957	847	1908	1840	1208	1096	1935	1814	2107	1996	1914	1714	3421	3313	1501	1278	3800	3717	1534	1245	4900	4817
40	1.5179	0.0265	0.0265	0.9996	0.0265	1727	1711	370	279	1874	1827	949	851	1904	1844	1199	1100	1928	1821	2099	2000	1903	1726	3413	3317	1489	1290	3794	3720	1518	1261	4893	4819
35	1.3282	0.0232	0.0232	0.9997	0.0232	1727	1712	362	283	1871	1830	940	854	1901	1848	1191	1104	1922	1827	2090	2003	1892	1737	3405	3321	1476	1303	3787	3722	1502	1277	4886	4822
30	1.1384	0.0199	0.0199	0.9998	0.0199	1726	1714	354	286	1868	1833	932	858	1897	1852	1182	1108	1915	1834	2082	2007	1881	1748	3396	3324	1464	1315	3780	3725	1486	1294	4880	4824
25	0.9486	0.0166	0.0166	0.9999	0.0166	1725	1715	346	289	1865	1836	923	862	1893	1856	1173	1111	1908	1841	2073	2011	1870	1759	3388	3328	1452	1328	3773	3727	1470	1310	4873	4827
20	0.7589	0.0132	0.0132	0.9999	0.0132	1724	1716	338	292	1862	1839	914	865	1890	1860	1165	1115	1902	1848	2065	2015	1859	1771	3380	3332	1439	1340	3766	3729	1454	1326	4866	4829
15	0.5692	0.0099	0.0099	1.0000	0.0099	1723	1717	330	295	1860	1842	906	869	1886	1864	1156	1119	1895	1855	2056	2019	1848	1782	3371	3335	1427	1353	3759	3732	1438	1342	4859	4831
10	0.3794	0.0066	0.0066	1.0000	0.0066	1722	1718	321	299	1857	1845	897	873	1882	1867	1147	1123	1888	1862	2047	2023	1837	1793	3363	3339	1415	1365	3752	3734	1422	1358	4852	4834
5	0.1897	0.0033	0.0033	1.0000	0.0033	1721	1719	313	302	1854	1848	889	876	1879	1871	1139	1126	1882	1868	2039	2026	1826	1804	3354	3342	1402	1378	3745	3736	1406	1374	4845	4836
0	0.0000	0.0000	0.0000	1.0000	0.0000	1720	1720	305	305	1851	1851	880	880	1875	1875	1130	1130	1875	1875	2030	2030	1815	1815	3346	3346	1390	1390	3738	3738	1390	1390	4838	4838

REFER TO FIG. MMRC-4 (BOX TNL)
All dimensions are in mm

Where:

g= 1510
h= Height above rail level measured perpendicular to plane of track.
$E_1 = [ab + (h \times \text{Tan } \alpha)] \times \text{Cos } \alpha$
$F_1 = [Ab - (h \times \text{Tan } \alpha)] \times \text{Cos } \alpha$
$H_1 = (Ca / 2) + (h / \text{Cos } \alpha) + (Ab - h \times \text{Tan } \alpha) \times \text{Sin } \alpha$
$H_2 = (Ca / 2) + (h / \text{Cos } \alpha) - (ab + h \times \text{Tan } \alpha) \times \text{Sin } \alpha$
Ab=Ab = Distance from centre line of vehicle to Structure Gauge for Tangent track at height "h" from rail level.

APPENDIX 5

CANT EFFECT ON KINEMATIC ENVELOPE AT-GRADE OR ELEVATED SECTIONS

REFER TO FIG. MMRC-5 AND PARA No. 1.8.1

Cant	Alpha Degree	Alpha Radians	Sin Alpha	Cos Alpha	Tan Alpha	h= 165		ab= 1585		h= 880		ab= 1749		h= 1130		ab= 1788		h= 2030		ab= 1788		h= 3300		ab= 1725		h= 3736		ab= 1285		h= 4115		ab= 1220		h= 4833		ab= 1220		h= 5018		ab= 880	
						E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2
125	4.7485	0.0829	0.0828	0.9966	0.0831	1593	1566	358	96	1816	1670	1084	795	1875	1688	1337	1041	1950	1614	2234	1938	1992	1446	3494	3208	1590	971	3892	3679	1556	875	4264	4062	1616	816	4980	4778	1292	462	5136	4990
120	4.5581	0.0796	0.0795	0.9968	0.0797	1593	1567	350	99	1813	1674	1076	798	1872	1693	1329	1044	1944	1621	2226	1941	1982	1457	3487	3212	1578	984	3886	3682	1543	889	4259	4065	1600	832	4975	4781	1276	478	5132	4992
115	4.3678	0.0762	0.0762	0.9971	0.0764	1593	1568	343	101	1811	1677	1068	802	1869	1697	1320	1048	1937	1628	2218	1945	1971	1469	3479	3217	1566	997	3881	3685	1530	903	4253	4068	1585	848	4969	4784	1260	495	5128	4994
110	4.1776	0.0729	0.0728	0.9973	0.0730	1593	1569	335	104	1808	1680	1060	805	1866	1701	1312	1052	1931	1635	2210	1949	1961	1480	3472	3221	1554	1009	3875	3687	1517	917	4248	4070	1569	865	4964	4786	1243	512	5124	4996
105	3.9874	0.0696	0.0695	0.9976	0.0697	1593	1570	327	107	1806	1684	1052	809	1862	1705	1304	1055	1925	1643	2202	1953	1950	1491	3464	3225	1542	1022	3869	3690	1503	931	4242	4073	1553	881	4959	4789	1227	529	5120	4997
100	3.7972	0.0663	0.0662	0.9978	0.0664	1592	1571	320	110	1803	1687	1044	812	1859	1709	1296	1059	1919	1650	2194	1957	1940	1503	3457	3229	1530	1035	3863	3693	1490	945	4237	4075	1537	897	4953	4792	1210	546	5115	4999
95	3.6071	0.0630	0.0629	0.9980	0.0630	1592	1571	312	112	1801	1690	1036	816	1856	1713	1288	1063	1912	1657	2186	1961	1929	1514	3449	3232	1518	1047	3857	3695	1476	959	4231	4078	1522	914	4948	4794	1194	563	5111	5000
90	3.4170	0.0596	0.0596	0.9982	0.0597	1592	1572	304	115	1798	1693	1028	819	1852	1717	1280	1066	1906	1664	2178	1965	1919	1525	3442	3236	1505	1060	3851	3698	1463	973	4225	4080	1506	930	4942	4797	1178	579	5107	5002
85	3.2270	0.0563	0.0563	0.9984	0.0564	1592	1573	296	118	1796	1697	1020	823	1849	1722	1271	1070	1899	1671	2170	1969	1908	1537	3434	3240	1493	1073	3845	3700	1450	986	4220	4082	1490	946	4937	4799	1161	596	5102	5003
80	3.0370	0.0530	0.0530	0.9986	0.0531	1592	1574	289	121	1793	1700	1011	826	1845	1726	1263	1074	1893	1678	2162	1972	1897	1548	3427	3244	1481	1085	3839	3703	1436	1000	4214	4085	1474	962	4931	4802	1145	613	5098	5004
75	2.8470	0.0497	0.0497	0.9988	0.0497	1591	1575	281	124	1791	1703	1003	830	1842	1730	1255	1077	1887	1685	2154	1976	1887	1559	3419	3248	1469	1098	3833	3705	1423	1014	4208	4087	1459	978	4925	4804	1128	630	5093	5006
70	2.6570	0.0464	0.0464	0.9989	0.0464	1591	1576	273	126	1788	1706	995	833	1838	1734	1247	1081	1880	1692	2146	1980	1876	1570	3411	3251	1457	1110	3827	3707	1409	1028	4202	4089	1443	995	4919	4806	1112	646	5088	5007
65	2.4671	0.0431	0.0430	0.9991	0.0431	1591	1576	266	129	1785	1709	987	836	1835	1738	1238	1084	1874	1699	2138	1984	1865	1581	3404	3255	1445	1123	3820	3710	1396	1042	4196	4091	1427	1011	4914	4809	1095	663	5084	5008
55	2.0874	0.0364	0.0364	0.9993	0.0364	1590	1578	250	135	1780	1716	971	843	1828	1746	1222	1092	1861	1713	2121	1991	1844	1604	3388	3262	1420	1148	3808	3714	1369	1069	4184	4095	1395	1043	4902	4813	1062	697	5074	5010
45	1.7077	0.0298	0.0298	0.9996	0.0298	1589	1579	235	140	1774	1722	954	850	1821	1754	1205	1099	1848	1727	2105	1998	1823	1626	3372	3270	1396	1173	3795	3719	1342	1097	4172	4099	1363	1075	4890	4817	1029	730	5064	5012
40	1.5179	0.0265	0.0265	0.9996	0.0265	1589	1580	227	143	1772	1725	946	853	1817	1757	1197	1102	1841	1734	2097	2002	1812	1637	3365	3273	1384	1186	3789	3721	1329	1111	4166	4101	1348	1092	4884	4819	1013	747	5060	5013
35	1.3282	0.0232	0.0232	0.9997	0.0232	1588	1581	219	146	1769	1728	938	857	1814	1761	1189	1106	1835	1740	2088	2006	1801	1648	3357	3277	1371	1198	3782	3723	1315	1124	4160	4103	1332	1108	4877	4821	996	763	5055	5014
30	1.1384	0.0199	0.0199	0.9998	0.0199	1588	1581	211	148	1766	1731	930	860	1810	1765	1180	1109	1828	1747	2080	2009	1790	1659	3349	3280	1359	1211	3776	3725	1302	1138	4153	4105	1316	1124	4871	4823	980	780	5049	5015
25	0.9486	0.0166	0.0166	0.9999	0.0166	1588	1582	204	151	1763	1734	921	863	1806	1769	1172	1113	1821	1754	2072	2013	1779	1670	3341	3283	1347	1223	3769	3727	1288	1152	4147	4107	1300	1140	4865	4825	963	797	5044	5015
20	0.7589	0.0132	0.0132	0.9999	0.0132	1587	1583	196	154	1761	1737	913	867	1803	1773	1164	1116	1815	1761	2064	2016	1769	1681	3333	3287	1334	1235	3763	3729	1274	1165	4141	4108	1284	1156	4859	4826	946	813	5039	5016
15	0.5692	0.0099	0.0099	1.0000	0.0099	1587	1583	188	157	1758	1740	905	870	1799	1777	1155	1120	1808	1768	2055	2020	1758	1692	3324	3290	1322	1248	3756	3731	1261	1179	4134	4110	1268	1172	4852	4828	930	830	5034	5017
10	0.3794	0.0066	0.0066	1.0000	0.0066	1586	1584	180	159	1755	1743	897	873	1795	1780	1147	1123	1801	1775	2047	2023	1747	1703	3316	3294	1310	1260	3749	3732	1247	1193	4128	4112	1252	1188	4846	4830	913	847	5029	5017
5	0.1897	0.0033	0.0033	1.0000	0.0033	1586	1584	173	162	1752	1746	888	877	1792	1784	1138	1127	1795	1781	2038	2027	1736	1714	3308	3297	1297	1273	3743	3734	1234	1206	4122	4113	1236	1204	4840	4831	897	863	5023	5018
0	0.0000	0.0000	0.0000	1.0000	0.0000	1585	1585	165	165	1749	1749	880	880	1788	1788	1130	1130	1788	1788	2030	2030	1725	1725	3300	3300	1285	1285	3736	3736	1220	1220	4115	4115	1220	1220	4833	4833	880	880	5018	5018

REFER TO FIG. MMRC-5
All dimensions are in mm

Where:
g = 1510 Rail centre to centre distance
h= Height above rail level measured perpendicular to plane of track.

$E = [ab + (h \times \tan \alpha)] \times \cos \alpha$
$F = [Ab - (h \times \tan \alpha)] \times \cos \alpha$
$H1 = (Ca / 2) + (h / \cos \alpha) + (Ab - h \times \tan \alpha) \times \sin \alpha$
$H2 = (Ca / 2) + (h / \cos \alpha) - (ab + h \times \tan \alpha) \times \sin \alpha$
ab=Ab =Distance from centre line of vehicle to Kinematic Envelope for Tangent track at height "h" from rail level.

APPENDIX 5 (TNL)

CANT EFFECT ON KINEMATIC ENVELOPE
UNDERGROUND SECTIONS

REFER TO FIG. MMRC-5 (TNL) AND PARA No. 1.8.1

Alpha Radians	Sin Alpha	Cos Alpha	Tan Alpha	h= 165		ab= 1585		h= 880		ab= 1749		h= 1130		ab= 1775		h= 2030		ab= 1775		h= 3300		ab= 1715		h= 3727		ab= 1255		h= 4048		ab= 980		h= 4145		ab= 1097		h= 4318		ab= 820	
				E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2
0.0829	0.0828	0.9966	0.0831	1593	1566	358	96	1816	1670	1084	795	1862	1675	1336	1042	1937	1601	2232	1939	1982	1436	3493	3209	1559	942	3881	3673	1312	642	4178	4015	1436	750	4284	4102	1175	460	4434	4298
0.0796	0.0795	0.9968	0.0797	1593	1567	350	99	1813	1674	1076	798	1859	1680	1327	1045	1931	1608	2225	1943	1972	1447	3486	3213	1547	955	3875	3675	1299	655	4173	4017	1423	764	4279	4105	1161	474	4430	4299
0.0762	0.0762	0.9971	0.0764	1593	1568	343	101	1811	1677	1068	802	1856	1684	1319	1049	1924	1615	2217	1946	1961	1459	3479	3217	1535	968	3869	3678	1285	669	4168	4019	1409	778	4274	4107	1146	489	4425	4301
0.0729	0.0728	0.9973	0.0730	1593	1569	335	104	1808	1680	1060	805	1853	1688	1311	1053	1918	1622	2209	1950	1951	1470	3471	3221	1523	980	3864	3681	1272	683	4164	4021	1396	792	4269	4109	1132	503	4421	4302
0.0696	0.0695	0.9976	0.0697	1593	1570	327	107	1806	1684	1052	809	1849	1692	1303	1056	1912	1630	2201	1954	1940	1481	3464	3225	1511	993	3858	3683	1259	696	4159	4023	1383	806	4264	4111	1118	518	4417	4303
0.0663	0.0662	0.9978	0.0664	1592	1571	320	110	1803	1687	1044	812	1846	1696	1295	1060	1906	1637	2193	1958	1930	1493	3456	3229	1499	1005	3852	3686	1246	710	4154	4024	1369	820	4259	4113	1104	532	4413	4304
0.0630	0.0629	0.9980	0.0630	1592	1571	312	112	1801	1690	1036	816	1843	1700	1287	1064	1899	1644	2185	1962	1919	1504	3449	3233	1487	1018	3846	3688	1233	723	4149	4026	1356	834	4253	4115	1090	547	4409	4305
0.0596	0.0596	0.9982	0.0597	1592	1572	304	115	1798	1693	1028	819	1839	1704	1279	1067	1893	1651	2177	1966	1909	1515	3441	3237	1475	1031	3840	3691	1220	737	4144	4027	1342	848	4248	4117	1076	561	4404	4306
0.0563	0.0563	0.9984	0.0564	1592	1573	296	118	1796	1697	1020	823	1836	1709	1271	1071	1886	1658	2169	1969	1898	1527	3434	3241	1463	1043	3834	3693	1206	751	4139	4029	1329	862	4243	4119	1062	576	4400	4307
0.0530	0.0530	0.9986	0.0531	1592	1574	289	121	1793	1700	1011	826	1832	1713	1262	1074	1880	1665	2161	1973	1887	1538	3426	3245	1451	1056	3828	3695	1193	764	4134	4030	1315	876	4237	4121	1048	590	4395	4308
0.0497	0.0497	0.9988	0.0497	1591	1575	281	124	1791	1703	1003	830	1829	1717	1254	1078	1874	1672	2153	1977	1877	1549	3419	3248	1439	1068	3822	3698	1180	778	4129	4032	1302	890	4232	4123	1033	605	4391	4309
0.0464	0.0464	0.9989	0.0464	1591	1576	273	126	1788	1706	995	833	1825	1721	1246	1082	1867	1679	2145	1981	1866	1560	3411	3252	1426	1081	3816	3700	1167	791	4124	4033	1288	904	4226	4125	1019	619	4386	4310
0.0431	0.0430	0.9991	0.0431	1591	1576	266	129	1785	1709	987	836	1822	1725	1238	1085	1861	1686	2137	1984	1855	1571	3403	3256	1414	1093	3810	3702	1153	805	4119	4035	1274	918	4221	4126	1005	633	4382	4311
0.0364	0.0364	0.9993	0.0364	1590	1578	250	135	1780	1716	971	843	1815	1733	1221	1092	1848	1700	2121	1992	1834	1594	3388	3263	1390	1118	3798	3706	1127	832	4109	4037	1247	945	4210	4130	977	662	4373	4313
0.0298	0.0298	0.9996	0.0298	1589	1579	235	140	1774	1722	954	850	1808	1741	1205	1099	1835	1714	2104	1999	1813	1616	3372	3270	1366	1143	3785	3710	1100	859	4098	4039	1220	973	4198	4133	948	691	4363	4314
0.0265	0.0265	0.9996	0.0265	1589	1580	227	143	1772	1725	946	853	1804	1744	1197	1103	1828	1721	2096	2002	1802	1627	3364	3273	1353	1156	3779	3712	1087	872	4093	4041	1206	987	4193	4134	934	705	4358	4315
0.0232	0.0232	0.9997	0.0232	1588	1581	219	146	1769	1728	938	857	1801	1748	1188	1106	1822	1727	2088	2006	1791	1638	3356	3277	1341	1168	3773	3714	1074	886	4087	4042	1193	1001	4187	4136	920	720	4353	4315
0.0199	0.0199	0.9998	0.0199	1588	1581	211	148	1766	1731	930	860	1797	1752	1180	1110	1815	1734	2080	2009	1780	1649	3348	3280	1329	1181	3766	3716	1060	899	4082	4043	1179	1014	4181	4137	906	734	4348	4316
0.0166	0.0166	0.9999	0.0166	1588	1582	204	151	1763	1734	921	863	1793	1756	1172	1113	1808	1741	2072	2013	1769	1660	3340	3284	1317	1193	3760	3718	1047	913	4076	4044	1165	1028	4175	4139	891	748	4343	4316
0.0132	0.0132	0.9999	0.0132	1587	1583	196	154	1761	1737	913	867	1790	1760	1163	1116	1802	1748	2063	2016	1759	1671	3332	3287	1304	1206	3753	3720	1034	926	4071	4045	1152	1042	4169	4140	877	763	4338	4317
0.0099	0.0099	1.0000	0.0099	1587	1583	188	157	1758	1740	905	870	1786	1764	1155	1120	1795	1755	2055	2020	1748	1682	3324	3290	1292	1218	3747	3722	1020	940	4065	4046	1138	1056	4163	4141	863	777	4333	4317
0.0066	0.0066	1.0000	0.0066	1586	1584	180	159	1755	1743	897	873	1782	1767	1147	1123	1788	1762	2047	2023	1737	1693	3316	3294	1280	1230	3740	3724	1007	953	4059	4046	1124	1070	4157	4143	849	791	4328	4317
0.0033	0.0033	1.0000	0.0033	1586	1584	173	162	1752	1746	888	877	1779	1771	1138	1127	1782	1768	2038	2027	1726	1704	3308	3297	1267	1243	3734	3725	993	967	4054	4047	1111	1083	4151	4144	834	806	4323	4318
0.0000	0.0000	1.0000	0.0000	1585	1585	165	165	1749	1749	880	880	1775	1775	1130	1130	1775	1775	2030	2030	1715	1715	3300	3300	1255	1255	3727	3727	980	980	4048	4048	1097	1097	4145	4145	820	820	4318	4318

REFER TO FIG. No MMRC-5 (TNL)
All dimensions are in mm
Where:
g = 1510 Rail centre to centre distance
h= Height above rail level measured perpendicular to plane of track.

$E = [ab + (h \times \tan \alpha)] \times \cos \alpha$
$F = [Ab - (h \times \tan \alpha)] \times \cos \alpha$
$H1 = (Ca / 2) + (h / \cos \alpha) + (Ab - h \times \tan \alpha) \times \sin \alpha$
$H2 = (Ca / 2) + (h / \cos \alpha) - (ab + h \times \tan \alpha) \times \sin \alpha$
ab=Ab = Distance from centre line of vehicle to Kinematic Envelope for Tangent track at height "h" from rail level.

APPENDIX 6

EFFECT OF VERTICAL CURVES ON STRUCTURAL GAUGE

REFER TO FIG. MMRC-6) AND PARA No. 1.7.1 (B) (c)

Radius of Vertical Curve (Meters)	Vehicle Centre in Sag or Vehicle End on Summit V_1 (mm)	Vehicle Centre on Summit or Vehicle End in Sag V_2 (mm)
1500	19	23
1600	18	22
1700	17	20
1800	16	19
1900	15	18
2000	14	17
2100	14	16
2200	13	16
2300	12	15
2400	12	14
2500	11	14
2600	11	13
2700	11	13
2800	10	12
2900	10	12
3000	10	12
3100	9	11
3200	9	11
3300	9	10
3400	8	10
3500	8	10
3600	8	10
3700	8	9
3800	8	9
3900	7	9
4000	7	9

- **Mid throw (in mm) V1 = (125 x C^2) /R= 28500/R**

  Where 'C' is the distance between bogie centres = 14.750+0.350=15.100m OR 14.750 - 0.350=14.400 m..

  The worst case will be with C=15.100 m

  R is the radius of curve in metres.

- **End Throw (in mm) V2 = (125 x $C1^2$) /R - (125xC^2)/R = 34635/R**

  Where 'C' is the distance between bogie centres = 14.750+0.350=15.100m OR 14.750-0.350=14.400m.

  Worst case will be with C=14.400 m

  'C1' is length of coach in meters = 22.010 m and 'R' is radius of curve in meters.

APPENDIX 7

ADDITIONAL CLEARANCE FOR PLATFORMS ON CURVES
UNDERGROUND, AT-GRADE & ELEVATED STATIONS
EXTRA CLEARANCE

REFER TO PARA No. 2.7

INSIDE OF CURVE									OUTSIDE OF CURVE					
AT CENTRELINE OF BOGIES					AT EDGE OF OPEN COACH DOOR NEAREST TO C.L. OF BOGIES				AT END OF COACH	AT EDGE OF OPEN COACH DOOR FARTHEST FROM C.L. OF BOGIES				
RADIUS	MID THROW (28500/R)	NOSING	Additional Clearance on CURVES (mm) (Rounded off to nearest 1mm)	Additional Clearance (Rounded off to nearest 5mm)	THROW (28498/R)	NOSING =(15.85*0.873/10.97)	Additional Clearance on CURVES	Additional Clearance (Rounded off to nearest 5mm)	End throw (34635/R)	THROW (19340/R)	NOSING =(15.85*9.59/10.97) rounded to next 1mm	Difference between N and N2	Additional Clearance on CURVES	Additional Clearance (Rounded off to nearest 5mm)
R	V	N	(V-N)	(V-N)	V3	N1	V3-(N-N1)	V3-(N-N1)	V0	V4	N2	N-N2	V4-(N-N2)	V4-(N-N2)
Metres	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
1	2.0	3	4a	4	5	6	7a	7	8	9	10	11	12a	12
3000	9.5	15.85	-6	0.0	9.5	1.3	-5.1	0.0	11.3	6.4	13.9	2	4.4	5
2000	14.3	15.85	-2	0.0	14.2	1.3	-0.3	0.0	17.0	9.7	13.9	2	7.7	10
1600	17.8	15.85	2	5.0	17.8	1.3	3.3	5.0	21.3	12.1	13.9	2	10.1	10
1500	19.0	15.85	3	5.0	19.0	1.3	4.4	5.0	21.1	12.9	13.9	2	10.9	15
1200	23.8	15.85	8	10.0	23.7	1.3	9.2	10.0	28.3	16.1	13.9	2	14.1	15
1000	28.5	15.85	13	15.0	28.5	1.3	13.9	15.0	33.9	19.3	13.9	2	17.3	20

NOTES:

1 For outside of curve, the difference between clearance required at coach end that at the farthest door edge is less than 25mm.As half width of coach at ends i.e. at least 25mm less than that at door locations, additional clearance to be provided is additional clearance required at the farthest door edge (column 12)

2 Values of additional clearances (columns 4,7 and 12) are rounded off to the nearest 5mm

3 Negative values of additional clearance are taken as Zero in the columns 4 and 7 with rounded off Figures.

4 Extra clearance for curve:

- **Inside of curve :**

$V = (125C^2 / R)) = 28500/ R$ with $C = 15.10$m for the worst case.

$V_3 = [(125) * (15.1^2 - 4 * 0.873^2) / R] = 28498/R$

$N_1 = N * (x) / (C_1 / 2) = 13 * 0.873/10.97 = 1.03$ mm

Minimum distance (X) for the nearest edge of an open door from centre line of Bogies is 0.873 metre.

Higher of (i) columns 4 and (ii) column 7 shall be adopted

- **Outside of curve**

$V_0 = (125C_1^2/ R- (125C^2 / R) = 34635/R$ for coach and with $C = 14.4$ metres and $C1 = 2 * 10.97$ m

$V_4 = 125 * (19.18 * 19.18 - 14.4 * 14.4) / R = 20064/R$ for farthest edge of end door in open position with

$C_1 = 2 * 9.590 = 19.18$ meters and $C = 14.40$ meters for the worst case.

N_2 = Nosing at the farthest edge of an open door = $N * 9.59/(C_1) = 13 * 9.59 / 10.97$ mm = 11.3 mm

R = Radius of curve in metres

Maximum distance (X) for the farthest edge of open door from centre line of two Bogies = 9.590 m

5 There will be no super elevation on curves in platform Portions.

BIDDING DOCUMENTS

MUMBAI METRO RAIL LINE 3

EMPLOYER'S REQUIREMENTS

GENERAL SPECIFICATIONS

Part 2

Section VI-A

Appendix 19

SYSTEM INTERFACE MANAGEMENT

July 2019

Mumbai Metro Rail Corporation Ltd
Line 3 Transit Office, Wing 'A' North Side of City park 'E'- Block,
Bandra-Kurla Complex,
Bandra (East) Mumbai 400 051, India

MUMBAI METRO RAIL LINE 3

Part 2

Section VI-A

Appendix 19

SYSTEM INTERFACE MANAGEMENT

	Issuing entity	Discipline	Area	Document No.	Revision Index
	GCC	301	P00	16000XX	A

DOCUMENT / DRAWING TECHNICAL VERIFICATION AND REVISION RECORD

PROJECT NAME	**Mumbai Metro Rail Line 3**		
***DOC / NO.**	**GCC-MMR-301-P00-16000XX**	**DATE OF FIRST ISSUE**	**02-07-2019**
***DOC / TITLE**	**System Interface Management Requirement**		

REV No.	DATE OF ISSUE/REV.	DESCRIPTION	PREPARED/ DESIGNED	CHECKED	APPROVED
A	**02-07-2019**	**First Diffusion**	**LR**	**PKC**	**RJM**

TABLE OF CONTENTS

EMPLOYER'S REQUIREMENTS

DESIGN AND CONSTRUCTION INTERFACE MANAGEMENT

1. DEFINITIONS AND ABBREVIATIONS

1.1 **Chief Interface Coordinator (CIC)** means a suitably qualified person, assigned by a Contractor, who is the Team Leader responsible for administrating, monitoring, managing, supervising and resolving all interface issues between Interfacing Contractors for the Mumbai Metro Line 3 Project.

1.2 **General Consultant Interface Manager (GCIM)** means the responsible person, assigned by the PM who is the main coordinatorof all project interfaces with **RE** and contractors **CIC**. He shall coordinate the overall technical point of the project from the point of view of proper integration of a System and Civil Work in all technical and operational areas to ensure delivery of safe and coherent metro system. He shall attend co-ordination meetings with all project contractor's **CIC**, and communicate issues & concerns relating to co-ordination, approvals and systems & Civil interfaces.

1.3 **Combined Services Drawings (CSD)** means the drawings produced by the Civil Work Contractor, showing the locations, sizes and details of all of the Contractor's equipment, cable containment, pipes, etc. These drawings are to be used to enable all equipment, pipes, cables, etc. to be installed without conflict and to enable future changes or modifications to be performed without impacting the existing installation.

1.4 **Interface** means the region of interaction across the common boundary between two adjacent but separately managed and controlled parts of the Project. The co-ordination and management of the interaction regions is necessary to ensure that the overall scope and definition of the Project works is complete and seamless across all such boundaries.

1.5 **Interfacing Contractors** means any of the following whose activities or the works they are engaged to carry out in any way or at any time affect or are affected by the Works:

a. Project Contractors and design or specialist consultants engaged on the Project from time to time by the Employer, the Government of Republic of India, the Government of Maharashtra or the utility providers;
b. Utility providers;
c. Developers or franchisees appointed on the Project from time to time by the Employer;
d. Subcontractors of any tier of the contractors within category (a) above, and contractors and subcontractors of any tier of utility providers, developers and franchisees within categories (b) and (c) above;
e. Provided that the definition shall exclude the Contractor and his subcontractors of any tier in relation to the Works and in any other capacity which would otherwise fall within categories (a) to (d) above in relation to other works.

1.6 **Interface Co-ordination Sheet (ICS)** means a document produced by the Contractor which defines the integration and interfaces between his contract and the Interfacing Contractors employed on the Project.

1.7 **Interface Management Programme (IMPG)** means the programme produced by the Contractor, developed and updated on a quarterly basis, which describes the sequence and timing of each of the Interfacing Contractor's scope of work, and clearly describes dependencies between his Works and the work of the Interfacing Contractors.

1.8 Interface Management Plan (IMP) means the Report prepared by the Contractor, developed and updated on a quarterly basis that provides a clear description of his interfaces both sequentially and technically as specified in the Contract. The report will be reviewed in accordance with this procedure and is a pre-requisite to the PM's Notice of No Objection.

1.9 Interface Sheet (IS) means the specification document developed by the Lead Contractor for the interfacing part of his project on the basis of, and by integrating into his design, the information provided by the Interfacing Contractors in accordance with the interface agreements as contained in the **ICS**. The Interface sheet needs to be agreed upon by both the Lead Contractor and the Interfacing Contractor's before it is submitted to the **PM** for Notice of No Objection.

1.10 Master Interface Log (MIL) is an electronic Log of identified interfaces maintained by the Interface Supporting Team (**IST**) in the format given in **Attachment D**, showing (among others) updated status and priority rating of each interface agreement, by its unique serial number, for the purpose of monitoring the progress of Interface agreements from inception to close-out.

1.11 Master Interface Matrix (MIM) means the document developed by the **PM**, which may be updated, and/or expanded to include additional Interfacing Contractors, by the PM as the Project progresses. The purpose of the Master Interface Matrix is to allocate which Interfacing Contractors are the lead party(s) for each contract. Inline with TWK 03 Contract, Contractor has to develop their own Interface Matrix & to be submitted to PM for NoNO.

1.12 Interface Specification Form (ISF) is a form, which shall be used for exchanging the information from one party to another. Information may includes the drawings, for acceptance, inputs required from/by other part etc. these information may/may not be as per Interface activitites mentioned in Interface sheets or some other inofrmations.

1.13 Confirmation of Coordiantion Form (CCF) is a form, which shall be used for closing the particular interface activity in interface sheet. It will include the reference of ISFs and shall contain technical drawings/documents no.

1.14 Resident Engineer (RE) means the General Consultant Discipline Key CAhief Resident Engineer, who is in charge of the monitor progress in interface agreements of his contractor with other interfacing contractors, on site in accordance with the IMP/IMPG and resolve interface issues which the interfacing contractors are unable to resolve among themselves. He shall identify interface issues that cannot be resolved at his level and alert the GCIM about them in the course of his day-to-day interactions with the GCIM for taking further action. He shall pursue the matter till the required information is exchanged in time.

1.15 Structural, Electrical and Mechanical Drawings (SEM) means those drawings produced by the Civil Work Contractor, showing the locations, sizes and details for all structural openings, plinths, embedments, sumps, floor chases, etc. required for the installation of all equipment, cable trays, pipes, etc.

1.16 Zone of Interface means where two or more components of the railway provided by two or more Interfacing Contractors combine to provide a single element.

Acronyms and abbreviation will appear immediately after the first time the words are used. Thereafter, only the acronym or abbreviation will be used in the Appendix 19.

Acronym	Description
CIC	Chief Interface Coordinator (of the Contractor)
CSD	Combined Services Drawing
GC	General Consultant for MML3
GCIM	General Consultant Interface Manager
ICS	Interface Co-ordination Sheet – Monthly report
IS	Interface Sheet
ISF	Interface Specification Form
IST	Interface Support Team
IST TL	Interface Support Team Leader (Project Rail Systems Manager, a Member of the Project Management Team, discharges this function.)
IMP	Interface Management Plan
IMPG	Interface Management Programme
MIM	Master Interface Matrix
MIL	Master Interface Log
MMRC	Mumbai Metro Rail Corporation
MOM	Minute Of Meeting
PM	Project Manager as Employer's Representative
RE	Resident Engineer as Project Manager's Representative
SEM	Structural Electrical and Mechanical Drawings

2. INTRODUCTION

2.1 Interface and co-ordination of the Works will include the co-ordination of all design, technical and programming matters with the various Interfacing Contractors to achieve fully co-ordinated construction and installation of the facilities.

2.2 This **Appendix 19** describes the Contractor's responsibilities with regard to interface management and co-ordination with those Interfacing Contractors and who are responsible for undertaking work, which interfaces with the Contract. The Contractor's responsibility for interface co-ordination shall include currently defined Interfacing Contractors and those who shall be identified in the future. This responsibility is not limited to a particular number of Interfacing Contractors.

2.3 The Contractor's responsibility for interface co-ordination shall include identification of Interfacing Contractors, subcontractors, including subcontractors within his own Contract.and those who shall be subsequently identified during the course of the Contract for whom the Contractor will need to interface and coordinate the Works. This in no way detracts from the fact that the Contractor remains solely responsible for identifying, liaising, and co-ordinating with all Interfacing Contractors in relation to the Works.

2.4 The **PM** will monitor and oversee the interface Management activities by the contractor and will specifically provide direction or information in the following circumstances.

a) When the interfacing contract has not yet been awarded.

b) When common agreement cannot reached between the interfacing parties.

c) When it is in the interest of the project programme, quality or safety to issue direction.

Direction or information provided by the employer's representative where ever necessary, shall not in any way relieve the contractor of his full responsibility to ensure the correctness, accuracy and suitability of the interface implementation and required specification.

2.5 The Contractor shall at all times use his best endeavours to resolve all interfaces applicable to the Contract and shall be proactive in seeking out interface issues and their solutions.

2.6 The Contractor shall ensure that all of the above Interface requirements are included in his Interface Management Plan, refer to Clause 6 of this **Appendix 19**. Flow chart illustrating the process of Interface Management as **Attachment A** and Flow chart illustrating the process of interface activities as **Attachment B** of this **Appendix 19**.

2.7 The Contractor's internal sub-contractors' and suppliers' interfaces are the sole responsibility of the Contractor and are not covered in this **Appendix 19**. However, the Contractor shall co-ordinate and manage these interfaces in such a way as to identify and cater for the requirements of the Interfacing Contractors and domestic interfaces, including but not limited to, the avoidance of clashes and sequencing of Works. The Contractor shall compile an internal **IMP** for his own use, a copy of which shall be furnished to the **PM** on request at any time.

3. CO-ORDINATION

3.1 Contractor's Co-ordination Responsibilities

The Contractor shall co-ordinate with the **PM** (**GCIM** and/or **RE**) and shall be required to attend meetings on issues appertaining to Government authorities and utility agencies regarding the services/facilities to be provided by them for the project.
The Contractor shall ensure that the work of all Interfacing Contractors can be carried out in accordance with the Interface Management Plan prepared by the Contractor.

3.2 Site Co-ordination & Attendance

This clause describes what the Civil Work Contractor shall do.

3.2.1. The Civil Work Contractor shall, at his own cost, provide all attendance on and co-ordination with Interfacing Contractor. The following items are not a comprehensive or exhaustive list of the co-ordination or interface attendance items to be provided for the Interfacing Contractor's use, but are intended to provide an outline of the content of amenities, services and facilities for which the Civil Work Contractor is responsible:

a) Single point of contact for meetings, actions, planning, scheduling and co-ordinating.

b) Site access
The Civil Work Contractor shall co-ordinate with the Interfacing Contractor and provide access and use of temporary access roads to and from and within the Site. The Civil Work Contractor shall co-ordinate all vehicle movements, deliveries and other activities with the Interfacing Contractor so as to ensure conflicts of use will be controlled on and around the Site.

c) Storage and Accommodation area

The Interfacing Contractor will require limited temporary site accommodation and storage areas. The Civil Work Contractor shall agree with the Interfacing Contractor access and areas for storage and temporary site accommodation prior to their commencing work on Site.

d) Work space requirement and sequence of Works

e) Shared use of Civil Work Contractor's scaffold

The Civil Work Contractor shall co-ordinate with the Interfacing Contractor and provide free use and shared access of his erected scaffolding, ladders and hoists should they be available at the time the Interfacing Contractor requires to use them. Notwithstanding this requirement, the Civil Work Contractor shall at all times remain responsible for the management of safety and the maintenance of such scaffolding, ladders and landings. The Civil Work Contractor will not be required to adapt or erect access scaffolds specifically for the use of Interfacing Contractor.

If the Interfacing Contractor erects and uses his own scaffold he will be required to adhere to the Civil Work Contractor's safety rules and access routing for equipment and materials. The Civil Work Contractor shall ensure that all scaffolds of Interfacing Contractor are erected in a safe manner and are subject to permits for use issued by the Contractor.

f) Setting out control points

g) Access Openings

The Civil Work Contractor will form all penetrations and delivery openings and subsequently close them (either temporary or permanent) for access to rooms or areas for the delivery of equipment and materials.

h) The Civil Work Contractor will be required to install all temporary and permanent lifting hooks and beams shown Temporary lighting requirements 100 lux minimum.

i) Temporary power and water supplies have to be provided at agreed locations around the Site for the Interfacing Contractor's use.

j) Water tightness

All rooms and areas handed over to Interfacing Contractor shall be in a watertight condition and maintained as such.

k) Ensure all electrical supplies both temporary and permanent have the correct testing and commissioning certification.

l) Waste management and disposal.

m) Appropriate protection to finishes, walls, floors, ceilings and equipment using polythene, hardboard, steel plates etc.

n) Programme agreement for mobilizing and demobilizing.

o) Firefighting and supply and maintenance of fire extinguishing equipment and devices pursuant to the Civil Work Contractor's obligations.

p) Construction interface co-ordination management of penetrations in structures, embedded and cast-in items, etc.

q) Temporary Drainage

The Civil Work Contractor shall provide, operate and maintain all necessary temporary drainage, sumps, silt traps and sump pumps to collect and dispose of wastewater from Interfacing Contractor construction processes including installation, testing and commissioning activities.

r) Sanitation facilities
The Civil Work Contractor shall provide all sanitation facilities and the disposal of waste. No unauthorised sanitation facility will be allowed on the Site.

s) Making good and fire stopping of penetrations.

t) Lifting apparatus and hoists
The Civil Work Contractor will be required to install all temporary and permanent lifting hooks and beams shown on the drawings and the Specification required for installation and/or maintenance purposes. The Civil Work Contractor will be responsible for the testing and labeling of all apparatus. The Civil Work Contractor will be required to make available any lifting or hoist apparatus on Site as required by the Interfacing Civil Work Contractor at agreed times and duration for their use. The Civil Work Contractor shall be responsible for the maintenance testing and operational management of hoists. The Civil Work Contractor shall make available his cranes for lifting equipment or materials for Interfacing Contractor.

u) Health and Welfare Facilities
The Civil Work Contractor shall allow Interfacing Contractor use of his health, welfare and mess facilities, and temporary background lighting. He shall liaise with the Interfacing Contractor to determine their planned and actual manning levels and ensure that sufficient facilities are provided prior to them commencing work on Site. The facilities shall be maintained on Site until the Interfacing Contractor has completed its Works and demobilised or such earlier time as the **PM** may direct.

3.2.2. The Civil Work Contractor is deemed to have ascertained for himself the full scope of his responsibilities and obligations under the Contract in terms of attendance on and co-ordination with Interfacing Contractor and shall not be entitled to any additional payment, Cost or extension of time for completion should he have failed to do so.

3.2.3. The Civil Work Contractor shall make due allowance for providing Attendance, including power and other utilities supplies, throughout all phases of the Interfacing Contractor work including testing and commissioning and where supplies to various Interfacing Contractors need special consideration during testing and performance trials under peak load conditions.

4 INTERFACE

4.1 Co-Ordination of Contractor's Scope of Work

In accordance with the requirements of the Conditions of Contract and other specified requirements**,** the Contractor shall co-ordinate his own work with that of all Interfacing Contractors and ensure that the design, construction, installation and testing requirements of the Interfacing Contractors are incorporated into the Civil Work Contractor's co-ordinated plans, programmes and Works. The Contractor shall proactively seek out interface issues and solutions.

In addition to the Civil Work Contractor's obligations to the Interfacing Contractors contained elsewhere in the Contract, the Civil Work Contractor shall provide / handover occupation or access as required, to the Interfacing Contractors to those parts of the Works which are subject to Key Dates by the required Key Dates to be provided by track contractor..

The Civil Work Contractor shall complete those parts of the Works, which are subject to Key Dates, by the required Key Dates that are specified in the contract data Part-3, Section VIII and **Appendix 2B** of Section VI(1)F Part 2 – Employer's Requirements of this Contract. Those

parts of the Works subject to Key Dates shall be completed to a state whereby any Interfacing Contractor can immediately commence his works without the need to make any change, addition or modification to the Contractor's Works.

4.2 Interfacing Contractors

4.2.1 The Interfacing Contractors will require interface and co-ordination for information, programming, drawings acceptance, handover etc. as shown on the Interface Co-ordination Sheet enclosed in **Attachment F** of this **Appendix 19**.

However, the Contractor should note the Interface Co-ordination Sheet shown herein has been compiled by the **PM** (and **GCIM**/**RE**), and is therefore given as example only.

The Contractor's responsibilities in this respect are in no means restricted by the details listed in such sheets and no warranty is given by the Employer or the **PM** that all interfaces and Interfacing Contractors have been included in such. The Contractor is to confirm and verify all of the details included in the Interface Co-ordination Sheets, and his review should ensure that all interfaces have been included.

The Contractor shall take overall responsibility for the Interface Co-ordination Sheets, which must be submitted to the **PM** (and **GCIM**/**RE**) for a Notice of No Objection.

4.2.2 The Master Interface Matrix (**MIM**), enclosed in **Attachment E**, assigns the Contractor which has been designated as the Lead party(s) for each interfacing contractor. The **MIM** has been developed by the **PM** (and **GCIM**), which he may update and/or expand at any time to include additional Interfacing Contractors, and the Contractors lump sum price for Interface Management shall be deemed to include any such additional works related to interfacing.

4.2.3 The Contractor shall expand the **IM** and the **ICS** for additional subcontractor system interfaces. Those additional subcontractors system Interfaces should include interaction areas between different systems in the same project contractor scope. In that case the Contractor shall take overall responsibility for its own **IM** and **ICS** and shall submit the expandable **IM** and **ICS** to the **PM** (and **GCIM**/**RE**) for approval.

4.2.4 The leading Interfacing Contractor shall be responsible for administrating, monitoring, managing, supervising and resolving all interface issues between all Interfacing Contractors. Any expansion during the course of the works should be done by the Lead Interfacing Party.

4.2.5 In a situation when the Lead Contract has not yet been awarded and the Interfacing contractor has commenced work, the **PM** (and **GCIM**) will perform the co-ordination activities including preparation of tentative **ICS**/**IS**, with the express understanding that they may undergo changes as and when the Lead Contractor commences his work on being awarded the Contract etc.

4.2.6 Where an interfacing contract has yet to be awarded, the Lead Contractor shall proceed with the co-ordination activities (including preparation of **ICS** and Interface specification) as instructed by the **PM** until such time when the Interfacing Contractor is available.

4.3 Interfacing Contractors - Communications and Information Exchange

4.3.1 GENERAL

a) The Contractor shall communicate, co-ordinate and exchange information directly with the Interfacing Contractors and the Contractor shall keep the **PM** (and **GCIM**/**RE**) advised at all times. Information necessary to fulfil the Contractor's interface obligations shall be directly requested and obtained from the Interfacing Parties, and

receipt acknowledged. Conversely, the Contractor shall provide directly to the Interfacing Contractors information within the Contractor's scope that is required by them.

b) All requests for information, acknowledgement of receipt of information, and any official communication between the Contractor and the Interfacing Contractors shall be made in writing, with a copy to the **PM** for his information. The **PM** (and **GCIM**/**RE**) shall be invited to attend all interface meetings between the Contractor and the Interfacing Contractors. Irrespective of whether these meetings were attended by the **PM** or not, the contractor's monthly progress report to **PM** shall invariably include the details of all interface meetings held and decisions arrived.

c) The Contractor's programme shall allow time for the availability of necessary interface information from the Interfacing Contractors and in this regard the Contractor shall, where required, proceed on a late start basis to allow adequate time for others to provide required information and thereby achieve design process compatibility.

d) The Contractor shall allow for the fact that many of the design and construction activities for the different contracts will be proceeding concurrently. In the event that certain interface information is not forthcoming at the time targeted, the Contractor shall be responsible to resolve the matter with the relevant Interfacing Contractor without recourse to the **PM**, and where necessary develop alternative interim arrangements such that the interface information is accommodated at a later date.

e) Definitive dates for transfer of information and particular interface actions shall be confirmed between the Contractor and the Interfacing Contractors.

4.3.2 INTERFACING FUNCTIONS

The Interfacing Contractors are responsible for, but not limited to, the following;

a) The management of Contract to Contract Interfaces as required;
b) Preparing the Interface Management Plan and subsequent procedures;
c) Preparing their Interface Management Programmes in accordance with this procedure and submitting these to the Interfacing Contractors for concurrence;
d) Preparing the Interface Management Programmes and submitting these to the **PM** for a Notice of No Objection;
e) Preparing their Interface Co-ordination Sheets and Interface Specifications and issuing same to the relevant Interface Contractors and **PM**;
f) Co-ordinating with the relevant Interface Contractors to establish coordinated **CSD** & **SEM** Drawings;
g) Maintaining their **ICS** updated continuously and attaching it to their Monthly Progress Report submitted to the **PM** in accordance with the requirements of the Contract and this **Appendix 19.**

4.3.3 DOCUMENTATION REVIEW

The Contractor shall, as a minimum:

a) Review those portions of the Specification and Drawings relevant to the interface and transmit such information to the Interfacing Contractors;

b) Co-ordinate and co-operate with Interfacing Contractors on all Site related matters including, but not limited to, Site access and occupation, attendance, safety, verification of work compatibility, survey control, etc.
c) Review the interface information received and agree in writing with the Interfacing Contractors that the interface information is adequate for that stage of that activity.

4.3.4 DESIGN STAGE

The design interface is an iterative process, thus throughout the design process, the Contractor shall be responsible for coordinating his own design with Interfacing Contractors to develop interface designs in conjunction and co-operation with the designers of Interfacing Contractors. These interface designs will be monitored and have to be given Notice of No Objection by the **PM**, but the Contractor shall work directly with the Interfacing Contractors to develop designs which are mutually acceptable to all parties.

The Contractor shall, immediately upon Contract Award, gather all necessary information and develop his design to a level where meaningful interaction can take place as soon as the Interfacing Contractors are available.

4.3.5 INTERFACE DESIGN CHANGE PROCESS

The Contractor shall establish an interface design change process to ensure that:

a) All proposed changes for a specific interface are reported, recorded and resolved;
b) Proposed changes are fully evaluated;
c) Internal/External communications and distribution paths are properly defined.

4.3.6 CONSTRUCTION / INSTALLATION SATGE

During construction the Contractor shall, when a construction item is ready for field inspection, advise the Interfacing Contractor in advance to verify compatibility with the Interfacing Contractor's needs.

The Contractor shall:

a) Advise the Interfacing Contractors in writing when the as-constructed interface-related work can be inspected, and provide the necessary Site access and occupation;
b) Request in writing and obtain from the Interfacing Contractors, interface information required for that stage of the Contract;
c) Agree in writing with the Interfacing Contractors on the adoption of any applicable comments on the constructed work;
d) Agree that any testing and commissioning for works can be carried out in accordance with the Interface Management Plan;
e) Conduct on-Site inspections of the work elements, and give comments in writing to the Interfacing Contractors;
f) Agree in writing with the Interfacing Contractors that the as-constructed work meets the interface requirements;
g) Where the execution of work by Interfacing Contractors depends upon the Contractor's site management or upon information to be given by the Contractor, the Contractor shall provide the Interfacing Contractors with the required services

or the correct and accurate information required to enable the Interfacing Contractors to meet thier programme for the construction or installation of their works.

4.3.7 TEST & COMMISSIONING STAGE

The Contractor shall co-ordinate all of his testing and commissioning activities with the Interfacing Contractors. Interface commissioning shall demonstrate that the delivered interface meet the requirement of both lead and follower contractor as per the Design and Construction & Installation stages in Interface sheet.

Successful completion of all interface commissioning shall prove its readiness for commissioning of the overall contract scope and completion of the overall Metro-rail Project, prior to handover to the Employer for their commercial operation.

4.3.8 MAINTENANCE STAGE

The Contractor shall co-ordinate all of his maintenance activities with the interfacing contractors. Important interface issues, daily maintenance should be jointly identified with interfacing contractor.

4.4 Resolution of Co-Ordination Difficulties

When the Contractor identifies interface co-ordination difficulties, the Contractor shall review the pertinent points of each Interfacing Contractor to determine possible compatible solutions in terms of sequence, timing and technical details. The Contractor shall then meet with the relevant Interfacing Contractor(s) to determine solutions, which are mutually acceptable to each Interfacing Contractor and advise the **PM**.

Where an acceptable solution has not been identified, the Contractor shall advise the **PM** in writing of the problems encountered. If, in the opinion of the PM, an interface is not proceeding satisfactorily, then the **PM** will review the matter, and establish a co-ordinated plan directing the Contractor and the Interfacing Contractor(s) on the required action. In the event that no agreement can be made between the Contractor and the Interfacing Contractor(s), the **PM** shall determine the requirements to the best of his knowledge, and his determination shall be final and binding on the Contractor and the Interfacing Contractor(s).

4.5 Interface Performance

The Contractor's performance in relation to his compliance with the interface requirements under the Contract shall be assessed by the **PM** three months after the Commencement Date and thereafter at three monthly intervals. The assessment will be in the form of an audit of the Contractor's interface management system. This audit will assess the Contractor's compliance with the responsibilities delineated in this **Appendix 19** and elsewhere as related to interface management and the preparation of the Interface Management Plan (**IMP**) and

Programme and other documentation and procedures associated with Interface Management and Co-ordination.

The Contractor will be notified of non-conformances from the audit, which will require rectification. Where, in the opinion of the **PM**, the Contractor has failed to rectify a non-conformance within a reasonable period from the date of notification, this may lead to non-payment of any lump sums, until such time as the non-conformance has been rectified to the satisfaction of the **PM**, refer sub-clause below.

The Contract allows for continuous audits of the Contractor's compliance with his Interface Management Plan and the requirements of this **Appendix 19** of Part 2 Employer's Requirements, and any extreme or continuing failures shall result in a negative audit report, which may lead to non-payment of the relevant payment item in the Preliminaries section of the Pricing Document. The decision of the **PM** in this regard shall be final.

5 CONTRACTOR'S INTERFACE MANAGEMENT SYSTEM

5.1 Interface Management System

The Contractor shall establish and maintain an Interface Management System to identify, control and monitor the interfaces of the Contract, which shall include, but not be restricted to, the following:

a) Establishment and maintenance of an Interface Management Team suitably qualified and experienced in co-ordination and interface management in relationship with the **GCIM**.

b) Provision, as one of his Key Personnel, of a Chief Interface Co-ordinator, to head the Interface Management Team, suitably qualified and experienced as noted in **Section VI(1)A** of this Part 2 Employer's Requirements, with the responsibility, experience and authority to resolve interface matters in accordance with the Contract. The Chief Interface Co-ordinator (**CIC**) will develop a monitoring and reporting procedure to be implemented by his team for the duration of the Contract.

c) Implement and maintain a strict monitored control of information transfer to the Interfacing Contractors, the Employer and the **PM** utilising the official channels of communication.

d) Provide a comprehensive interface schedule of Interfacing Contractors, including specialist domestic interfaces (i.e. specialist testing and commissioning engineers) identifying all interfacing activities and timetables of events.

e) Arrange all internal and external interface meetings. The **PM** may arrange regular meetings to monitor the status of interfaces, and may require special meetings asthat are necessary to resolve specific issues. The Contractor's Interface Management Team will be required to attend such meetings. The Contractor may request assistance from the **PM** (and **GCIM/RE**) to arrange meetings on particular subjects.

f) Providing the **PM** (and **GCIM/RE**) with all information and/or details of interfaces, including copies of all correspondence and material.

g) Providing the **PM** (and **GCIM/RE**) with access to information for the purpose of conducting audits on the interface system and for confirming that interface co-ordination is proceeding consistently with the Project requirements.

h) Establish interface dates for information, documentation, access or works completion requirements.

5.2 Interface Management Team

The Contractor's Interface Management Team will undertake and fulfil the following tasks:

a) Provide timely interface information when requested, anticipating the information needs of the Interfacing Contractors and transmitting such information as soon as it is available.
b) Pro-actively keep the Interfacing Contractors informed of any development of the Works related to the interfaces. Communicating and co-operating with the Interfacing Contractors to identify and resolve potential interface problems.
c) Advise the Interfacing Contractors on potential problems related to the interfaces, together with proposed solutions likely to be acceptable to Interfacing Contractors and which meet the needs of the Project.
d) Arrange and/or attend meetings with the Interfacing Contractors as necessary to resolve interface issues.
e) During each stage of the Contract, the Contractor shall directly communicate and co-ordinate with Interfacing Contractors as necessary to achieve a fully co-ordinated construction/installation.
f) Contractor shall issue true records of all interface meetings, with appropriate actions and attendance lists, to all Interfacing Contractors, whether in attendance or not, and to the **PM** (and **GCIM/RE**), within 3 days of the meeting. Minutes of meetings shall be signed by all parties in attendance, signifying their agreement to the contents thereof, before being formally issued by the Contractor.

The authority and responsibilities of all personnel involved in the Interface Management Team must be clearly defined in the **IMP**.

6 INTERFACE MANAGEMENT PLAN & INTERFACEMANAGEMENT PROGRAMME

6.1 General

The Contractor shall prepare the proposed Interface Management Plan and proposed Interface Management Programme, in accordance with clause 6 and based on the formats noted in **Attachments H**, to which the PM issues a Notice of No Objection. The Interface Management Plan (**IMP**) and Interface Management Programme (IMPG) shall completely define the Contractor's programme and methodology for interface co-ordination and management, whilst complying with all Key Dates stated in the Appendix to Tender and/or **Appendix 2B** of this Part 2 Employer's Requirements.

Subsequently they shall be kept up to date and submitted on a quarterly basis to the PM for scrutiny and Notice of No Objection, and a summary of the principal issues shall be included in each Monthly Progress Report. The Contractor shall note that each submission of these documents is subject to regular audits and the issue of a Notice of No Objection by the PM.

6.2 Interface Management Plan (IMP)

The Interface Management Plan is that document which describes the Contractor's interface management in terms of providing a clear description of each of the interfaces, both technically

and sequentially, and represents an account of how the Contractor proposes to achieve co-ordination of the Works. The description shall completely detail the Contractor's work scope and interface with each of the Interfacing Contractors in terms of technical description, sequence and timing for each of the elements required to achieve a coordinated design. The Contractor shall demonstrate how potential interface conflicts can be eliminated by design simplification. This document is also required to demonstrate that the co-ordinated design and construction details described therein fully comply with the needs of others, and agreement in writing of these details by the Interfacing Contractors will be a pre-requisite to the **PM** issuing a Notice of No Objection. In this step, the **IMP** shall be submitted to the **PM** for approval with this Notice of No Objection.

Refer to **Attachment L** – Guidance Notes for the Preparation of **IMP**.

6.3 Interface Management Programme (IMPG)

The Interface Management Programme describes the sequencing and timing of each of the Interfacing Contractor's scope of work, clearly describing the interdependencies for all stages of the work between the Contractor's works and that of the Interfacing Contractors and complementing the Interface Management Plan, whilst complying with all Key Dates stated in the Appendix to Tender and/or **Appendix 2B** of this Part 2 Employer's Requirements.

The programme shall be structured to detail each of the primary zones of interface and the principal elements of the design and of the works requiring interfacing contribution from others. This Interface Management Programme shall also be related to the Contractor's Works Programme and shall show the sequences and timing agreed with the Interfacing Contractors to the necessary degree of detail to clearly illustrate each of the interfaces to be undertaken.

Targets to receive or supply information shall also be shown, with due allowance being given for the design process of others. Information relating to Contractual Key Dates and information exchange dates shall be shown for both the Contractor and the Interfacing Contractors to demonstrate a matching of design processes.

A record of these interfaces, with current status and agreed dates for information transfer, site inspections, access, occupation, handover, etc. shall be maintained and also identified on the **ICS**, refer Clause 7 below.

Refer to **Attachment K** - Guidance Notes for the Preparation of **IMPG**

6.4 Requirements For The Interface Management Plan & Interface Management Programme

The Interface Management Programme (**IMPG**) shall be a process-driven programme in a format to be agreed with the **PM**. The **IMPG** shall incorporate the key activities from both the Interfacing Contractors' and Contractor's Works programmes that will enable the Contractor to demonstrate that any Interface is being correctly managed and will result in fully co-ordinated construction / installation of works.

The Interface Management Plan and Interface Management Programme shall:

a) Follow the outline structure, numbering system, and related procedures in a format to be agreed with the **PM** (and **GCIM/RE**).
b) Be co-ordinated with the Interfacing Contractors to ensure compatibility of interface identification and definition.

c) Comply with the Key Dates stated in the Appendix to Tender and/**or Appendix 2B** of this Part 2 Section VI-A Employer's Requirements.
d) Be transmitted to the Interfacing Contractors concurrently with submittals to the PM.
e) Support the Works Programme to which the PM has given a Notice of No-Objection.
f) Address each zone of interface i.e., train stabling, trackwork external, trackwork internal, signalling and telecommunications facilities, operation and control rooms, staff accommodation, external works etc. related to each design submission and stage of design or construction / installation.
g) List all relevant interfaces in detail, their status, and the corresponding source(s) of information.
h) Include interface information transfer dates which have been agreed by the Interfacing Contractors.
i) Accommodate comments and input required by the PM.
j) Include an account of how the interfaces are being managed.
k) Identify the latest information regarding agreements with the Interfacing Contractors and transfers of information.
l) Review and address the design, supply, installation, testing & commissioning programme of the Interfacing Contractors to ensure that the Key Dates of each contract can be achieved, and highlight any programme risks requiring management attention.
m) Identify any problems related to co-ordination with Interfacing Contractors.

6.5 Interface Specification Form.

6.5.1 The Interface Specification form enclosed in **Attachment C**, and associated drawings shall specify the proposed method and schedule for verifying the interface integrity, the individual equipment/system performance and the combined system performance.

The Interface Specification shall include a programme of tests to demonstrate the performance and integrity of the integrated system.

6.6 Interface Sheets

The interface sheets developed by the **PM** (**GCIM**) are attached in **Appendix-19** – **Attachment N**. The attached interface sheets are not final. They are indicative in nature and do not relieve the Contractor's obligation to identify any new interface to meet contract requirements. The interface sheets, which the Contractor develops, shall be used as a basis to establish the Interface Specification. Any revision to the Interface Specification shall be mutually agreed between the Contractor and Interfacing Contractors, with submission to the **PM**, and shall specifically -

a) Understand the design requirements of each party and associated constraints;
b) Determine the detailed interface works to be performed during the various stages and
c) Agree on the interface works in reference to respective scope, with any agreements reached to be formally documented in Interface Minutes of Meetings, including an actions item list.

6.5.2 The Interface Contractors shall mutually identify and agree the Interfaces that will exist between them using the Interface Co-ordination Sheets, the format of which is contained in **Attachment F part 1**. These interfaces shall be expanded, if required, to include all, and any other, interfaces that develop during the execution of the Project.

6.5.3 The Interfacing Contractors shall mutually agree upon the information to be exchanged and shall develop a unique Interface Specification for each interface identified. A sample Interface Specification form is provided in **Attachment C**.

The **ICS**s will be tracked and monitored using an **ICS** Register to be compiled by the Contractor. This register will track the progress of the **ICS** from inception through to closure and final processing by the Contractor, prior to transmittal to the PM as a complete Integrated Design.

Each interface shall have a unique reference number to enable the Interface to be readily identified and tracked and monitored.

6.7 Contractor's Submissions

6.6.1 On commencement of the contract, Master Interface Matrix (MIM) and the Interface sheets in the Contract Documents shall be used as the reference documents from which the Contractor develops his Interface Management Plans (**IMP**) and Interface Management Programme (**IMPG**). The Contractor has to provide to the **PM** the following, as per the due date(s) mentioned below.

a) **CV** of **CIC** subject to Notice of No Objection by **PM** (30 days)
b) Interface Management Plan (**IMP**) (45 days)
c) Interface Management Programme (**IMPG**) 3 month rolling program updated monthly (45 days)
d) Interface Co-ordination Sheets (**ICS**) – monthly progress report pertaining to interface matters (45 days)
e) Confirmation of Co-ordination form (45 days), after signed by both the parties
f) Interface Sheets (45 days)

6.6.2 The **PM** shall review the Contractor's interface submissions and issue Notice of No Objection for those sections that comply with the contractual requirements of Interface Management and recommend changes to any sections that do not meet Employer's Requirements. The Master Interface Log (**MIL**) is updated by **PM**/**GCIM** (**IST)** with the sections of the Contractor's **IMPG** that receive a Notice of No Objection. A sample Master Interface Log example is provided in **Attachment D**.

6.6.3 To receive a Notice of No Objection, the Contractor's Interface Management Programme (**IMPG**) and Interface Management Plan (**IMP**) shall meet the Employer's requirements on Interface Management - **Appendix 19** of Part 2 Section VI A.

6.6.4 The **PM**/**GCIM** is responsible for the overall implementation and maintenance of the interface management process throughout the project life cycle by developing and implementing interface management work processes, capturing the necessary interface agreements, monitoring progress, ensuring that schedule requirements are maintained and pointing out any change requests that may arise out of interface requirements.

6.8 Monitoring the Progress of Interface Agreements

6.7.1 The Chief Interface Coordinator (**CIC**) of the Lead Contractor convenes regular Interface Meeting with the Interfacing Contractor to progress the Interface issues by keeping track of activities required to be performed towards facilitating the needed exchange of information. The Lead Contractor writes the Minutes of Meeting, actions oriented and systematically review the last Minutes of Meeting to confirm agreement, check progress, prior to examining new items.

6.7.2 The **PM/GCIM** (**IST TL**) and his delegates monitor the status of the interface agreements on a regular basis by having periodical (weekly or monthly) meetings with the concerned persons. The Interface Agreements with a `Critical' rating are prioritized and rigorously monitored.

6.7.3 When the Interfacing Contractor receives the requested information by the required date and considers it acceptable, to close a particular interface item/location Lead Contractor will record in the confirmation of co-ordination form for the interfacing element and send it to the Interfacing Contractor/s for agreement. The mutually agreed Interface Specification is then submitted to **PM** for Notice of No Objection.

6.7.4 To close a particular significant phase or portion, Lead Contractor will record in the Interface Sheets and send it to the Interfacing Contractor's for agreement. The mutually agreed Interface Sheets is then submitted to **PM** for Notice of No Objection. If **PM** raises any objection, the Lead Contractor re-works the Interface Sheets, in consultation with the Interfacing Contractor, and re-submits to **PM** for Notice of No Objection. After issue of Notice of No Objection, the Interface Agreement is recorded as `closed' in the Interface Databases of both the Contractors as well as in the **MIL**. The closed interfaces are omitted from future interface agreement reporting.

6.7.5 The **PM/GCIM** shall prepare Status Reports from the Master Interface Log (**MIL**) on the progress of the Interface Agreements as part of the Monthly Progress Reports to the **Employer**.

6.7.6 **PM/GCIM** shall check the physical interfaces on site as necessary to make sure that they are progressing according to the agreements made by the Interfacing Contractors and report to the **PM/GCIM**.

7 INTERFACE CO-ORDINATION SHEET (ICS)

7.1 The Contractor's Interface Co-ordination sheet, the format of which is shown in **Attachment F** Part 1 of this Appendix, is required to be used by each of the Interfacing Contractors to record all of the Contract Interfaces. The Contractor shall ensure that each Interfacing Contractor provides input and maintains the **ICS** continually updated as required in this **Appendix 19**.

7.2 The Contractor shall ensure that the Interfacing Contractors demonstrate their co-ordination efforts as required by the Contract. To achieve this, the Contractor and the Interfacing Contractors shall identify their interface requirements which shall be input into the interface documents i.e. **IMP**, **IMPG**, **ICS** etc. by the Contractor.

7.3 The Contractor shall monitor the **ICS** to ensure that, as the Interface progresses, the records show the appropriate Status (refer status codes indicated in Part 3 of **Attachment F** of this Appendix) as agreed with the Interfacing Contractors. The Contractor will be responsible for confirming the "Closing Out" of each **ICS** record, whilst ensuring that throughout the interface process all Interfacing Contractors have agreed to the following:

a) The receiving Interfacing Contractor has received and accepted the Interface being recorded.
b) All Interfacing Contractors have recorded the interface record as "Proposed Close Out".
c) The Confirmation of Co-ordination form in **Attachment G** has been updated and signed by the relevant Interfacing Contractors, refer clause 7.4 below.

7.4 When documents are exchanged for review/comment with Interfacing Contractors, the originator preparing these documents should ensure that they are accompanied by the Confirmation of Co-ordination form in **Attachment G**. When the Interfacing Contractor

returns these documents with comments to the originator, they should be returned with the Confirmation of Co-ordination form duly completed, confirming co-ordination and agreement or comment as appropriate, as a record of them having coordinated the interface item. This Confirmation of Co-ordination is to be transmitted to the **PM,** upon signing by the Interfacing Contractor(s), for Notice of No Objection with the appropriate Template **Attachment H-** Review and Comment on all Design / Interface Submittals. The Rank (B, Ma, Mi) is categorised into blocked, major & minor categories.

7.5 The **PM** will obtain approval from **MMRC** on every Main Feature of the final designs / drawings with respect of the following "Approval for Notice of No Objection".

8 CO-ORDINATION DRAWINGS

8.1 General

For the purpose of achieving a Project which is fully co-ordinated with respect to civil, structural, architectural, building services, electrical, mechanical works and interface elements, and to ensure compatibility between different facilities and services, and adequate space requirements, all drawings are to be reviewed and co-ordinated by the Civil Work Contractor.

The Civil Work Contractor will provide and issue detailed Interface Working Drawings in terms of items such as; special arrangements, space allocation, cast in items, primary and secondary fixings, grouting of equipment/plinths, drill and fix brackets, embedded and cast-in items and the like.

The drawings shall be prepared by the Civil Work Contractor, reviewed and validated by the Contractor for its own Interface in accordance with the ICS. The Civil Work Contractor shall also include composite cross-sections and layouts, which show the spatial requirements of all Interfacing Contractors and identify items to be finalised, defined, or resolved.

8.2 Combined Services Drawing (CSDs) And Structural E&M Drawings (SEMs)

The Civil Work Contractor's **CSD**s and **SEM**s must be clear and sufficiently detailed to unambiguously show the intent of the subject services and the corresponding structure / facility allowances. While these drawings do not have to duplicate all of the details of the Drawings, they must include plans sections and elevations as required to clearly illustrate the compatible relationship between the different disciplines. Specifically, the drawings will include wall elevation drawings at 1:50 scale (or larger where required) indicating all openings, access panels, reinforcement zones, embedded and cast-in items and the like, and shall be submitted to the **PM** for a Notice of No Objection.

The **CSD**s shall show the intended locations, routes and spatial relationships of the individual **E&M** services, Building Services systems, and installations, Depot Equipment, Core Systems installations and other installations, fully co-ordinated with each other and the civil structural and architectural work. The **CSD**s shall also clearly indicate that effective cable co-ordination has been achieved in terms of cable location or cable trays and the trunking and cable routing.

The **SEM**s shall show all civil, structural, and architectural requirements for the **E&M** services, Building Services systems and installations, Builder's works and the Core Systems and other installations.

Where Builder's works are required by the Interfacing Contractors, the drawings, details, specification notes and catalogue information and the like shall be obtained by the Civil Work

Contractor from these Interfacing Contractors indicating the builder's work to be incorporated into the Works. The Civil Work Contractor shall include details of such Builder's works in the **SEM**s and Method Statements as appropriate.

Builder's work comprises, but is not limited to, the following:

a) Construction of plinths, bases, builders bund walls and the like;
b) Placing and fixing of holding down bolts, lifting beams and hooks and other supporting items;
c) Supply, fabrication installation, protection, fixing and finishing of supporting steelwork, for equipment and associated accessories;
d) Casting in of edgings, angles in recesses, ducts, conduit, pipes etc;
e) Fixing equipment and associated, brackets, cable containment and fixtures;
f) Forming of penetrations, sleeves, access panels, holes, chases, recesses, openings in accordance with the Civil Work Contract.

The **CSD**/**SEM**s shall also be used for the purpose of co-ordinating with the Interfacing Contractors and shall be continuously updated to reflect the latest interface co-ordination. Copies of the **CSD**/**SEM** drawings shall be included in submittals to the **PM** (and **GCIM**/**RE**).

Where the **CSD**s or **SEM**s do not fully co-ordinate with the Site conditions the Civil Contractor shall co-ordinate and propose a solution to the problem. All proposed solutions shall be issued to the PM as Project Manager.

8.3 Interface Drawings

For the Interface Drawings, the Contractor shall prepare in diagrammatic format for each interface the demarcation of scope of responsibilities between the Contractor and each of the Interfacing Contractors. The Contractor shall submit all Drawings with interface requirements for a Notice of No Objection from the PM. Any proposed deviation to the Construction Specification or Drawings shall be identified and justified with design documentation, details and drawings. The submission shall also identify all interface requirements. The contractor should develop own interface drawings with detailed design and dimensions and submit the same to other interfacing contractor.

8.4 As Constructed Drawings

Upon completion of the Works the Civil Work Contractor shall submit all Combined Services Drawings, Structural **E&M** Drawings, and Interface Demarcation Drawings showing the final "As Constructed" status of the Works related to these drawings.

9 ATTACHMENTS

Attachment A – Flow Chart for Process of MML3 Contractor's Interface Management

Attachment B - Flow Chart for Progress Monitoring of Interface Agreements

Attachment C - Interface Specification Form

Attachment D - Master Interface Log (MIL) – Example – Revision A

Attachment E - Master Interface Matrix (MIM) - Revision F

Attachment F Part 1 - Interface Co-ordination sheet - Example

Attachment F Part 2 - Interface Co-ordination Sheet – Contract Codes – Revision A

Attachment F Part 3 - Interface Co-ordination Sheet – Status Codes

Attachment G - Confirmation of Co-ordination Form

Attachment H - Review and Comment on all Design / Interface Submittals Template

Attachment K - Guidance Notes for the Preparation of Interface Management Programme

Attachment L - Guidance Notes for the Preparation of Interface Management Plan

Attachment M – Interface Sheet (Template)

Attachment N –Indicative Interface Sheets List for contract MM3-CBS-TWK -03

N1 Indicative Interface Sheet for Track Work (TWK-03) and Depot Equipments (DEQ)

N2 Indicative Interface Sheet for Track Work (TWK-03) and Depot Civil Works Station(DPT)

N3 Indicative Interface Sheet for Track Work (TWK-03) and Depot Civil Works (DPT)

N4 Indicative Interface Sheet for Track Work (TWK-03) and Overhead Contact System (OCS)

N5 Indicative Interface Sheet for Track Work (TWK-03) and Power Supply System (PSS)

N6 Indicative Interface Sheet for Track Work (TWK-03) and Rolling Stock (RS)

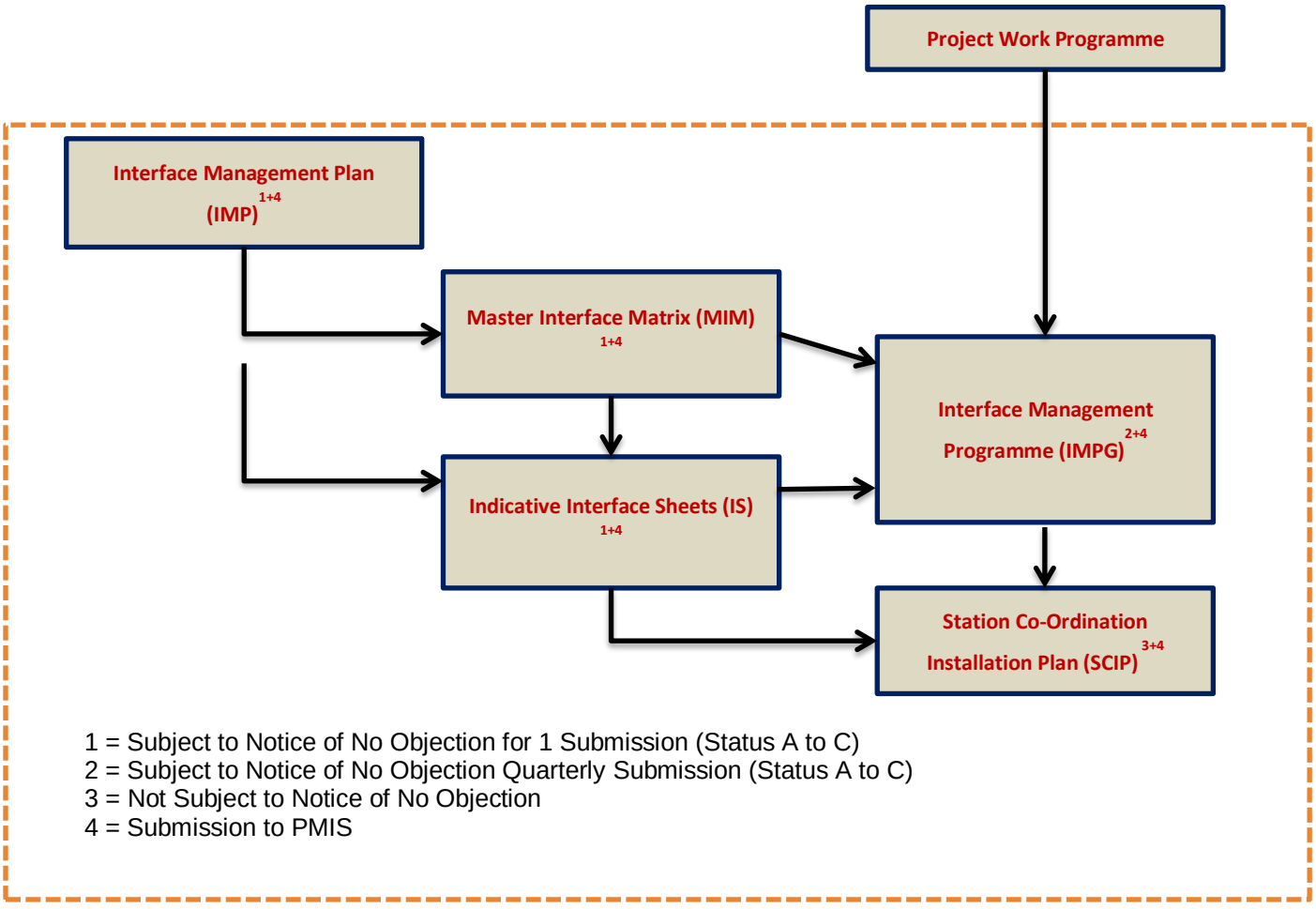
N7 Indicative Interface Sheet for Track Work (TWK-03) and Signaling & Train Control, Platform Screen Doors and Telecommunication

N8 Indicative Interface Sheet for Track Work (TWK-03) and Track Work (TWK-02)

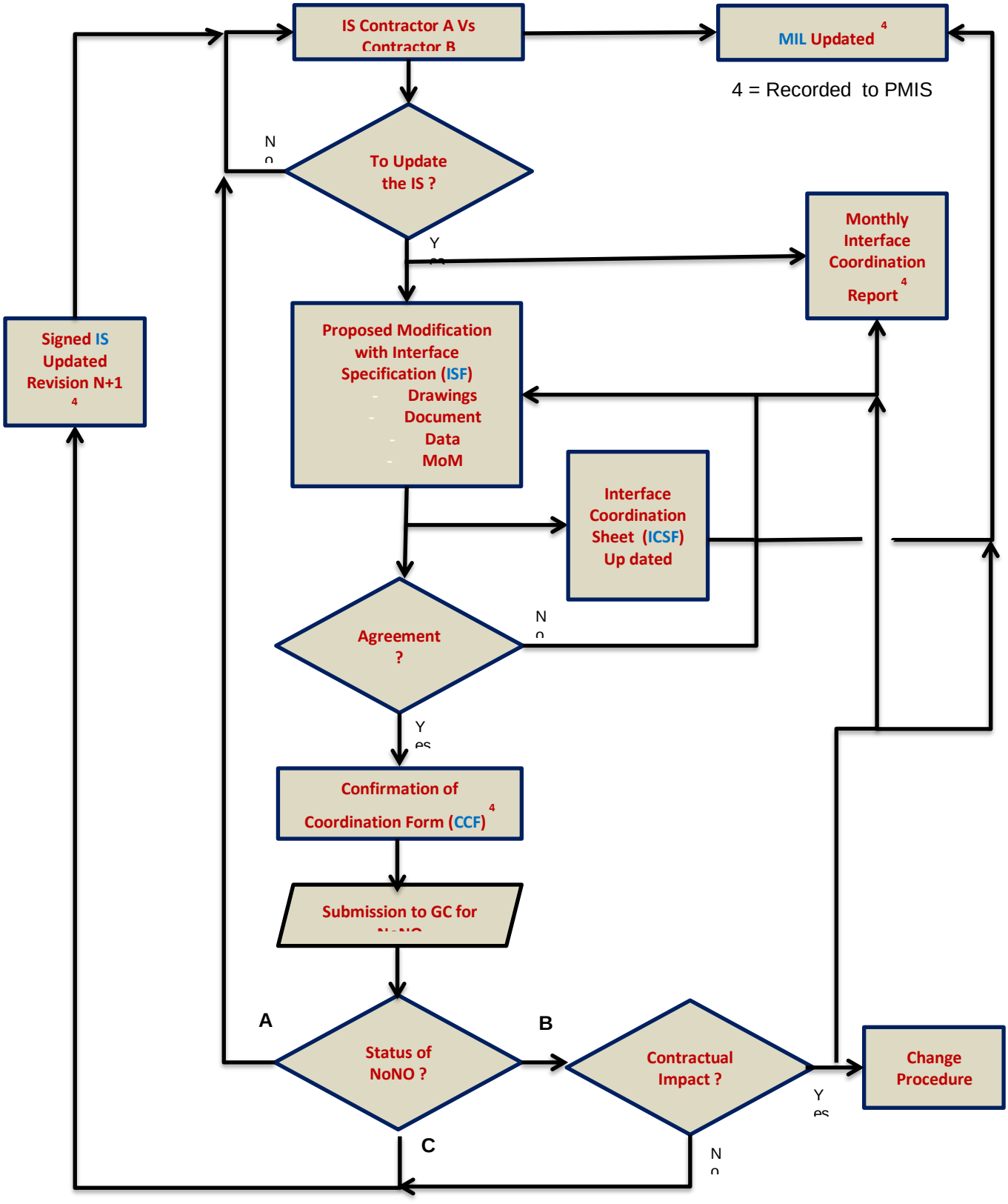
N9 Indicative Interface Sheet for Track Work (TWK-03) and Underground Civil (UGC 05,06 & 07)

N10 Indicative Interface Sheet for Track Work (TWK-03) and Asset Management System (AMS)

Attachment A - Process of MML3 Contractor's Interface Management



Attachment B - Flow Chart for Process of MML3 Contractor' s Interface Activities



Attachment C - Interface Specification Form

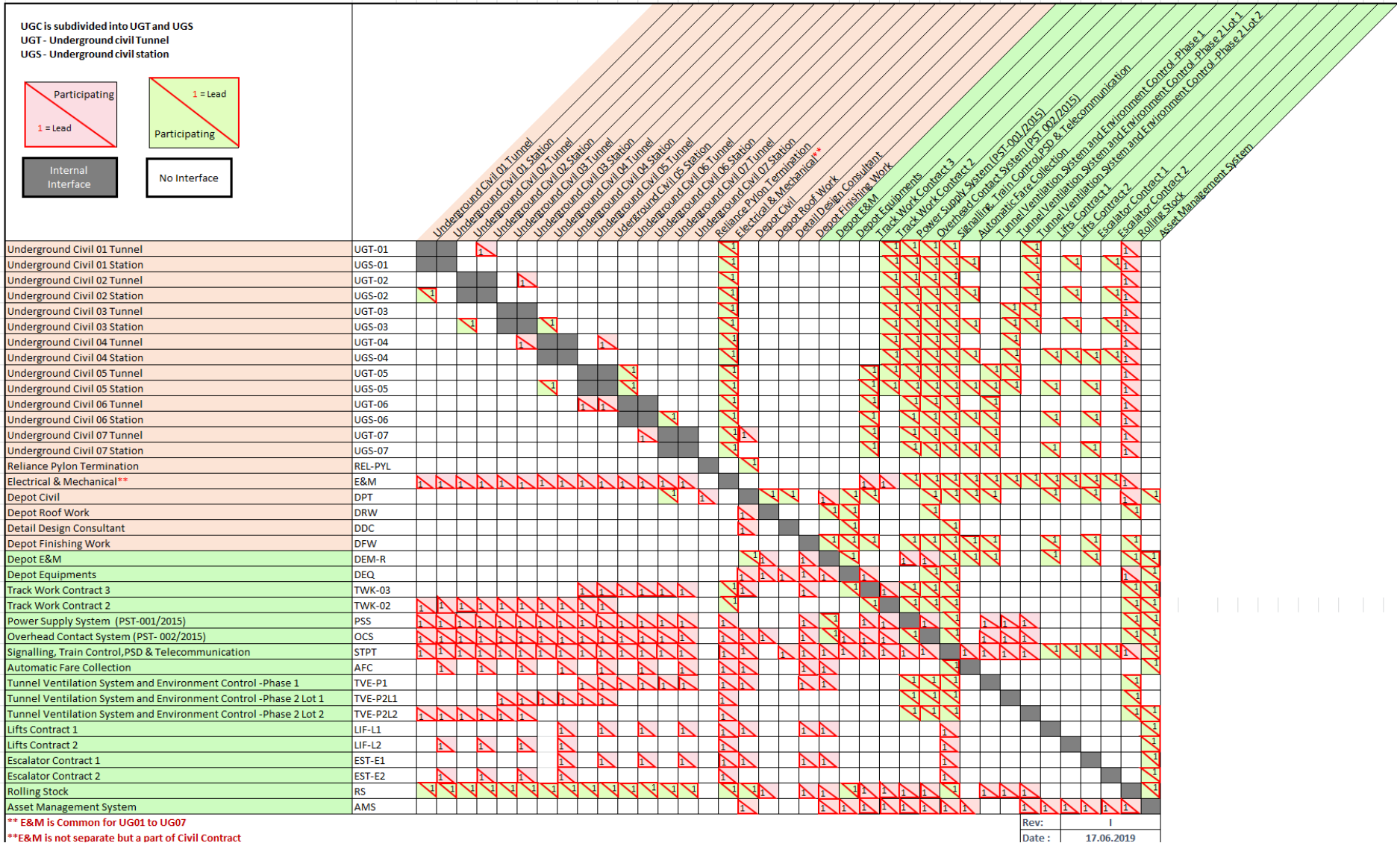
<table>
<tr><td colspan="3">INTERFACE SPECIFICATION</td><td colspan="3">Ref: to create</td></tr>
<tr><td></td><td>Contract Designation</td><td>Contractors Sequence Number</td><td>Date of Issue</td><td colspan="2"></td></tr>
<tr><td>Initiating Contractor</td><td></td><td></td><td colspan="3">Interface Manager Signature</td></tr>
<tr><td>Responding Contractor</td><td></td><td></td><td colspan="3">Interface Manager Signature</td></tr>
<tr><td>Interface Specification Required for;</td><td colspan="2"></td><td>Response Required by;</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Reviewed by;

Design Sections</td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td></td><td></td><td>Station Arch. / Building Services</td><td colspan="2"></td></tr>
<tr><td colspan="6"><u>Description of the Interface</u></td></tr>
<tr><td colspan="4"><u>Specific Details of the Interface</u></td><td colspan="2"><u>Location</u></td></tr>
<tr><td colspan="6">Drawings / Specifications Attached</td></tr>
<tr><td colspan="2">Title</td><td colspan="2">Drawing / Specification Ref.</td><td colspan="2">Drawing Issue</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Document</td><td>Name</td><td>Date</td><td colspan="3">Document References (if any)</td></tr>
<tr><td>Prepared by:</td><td></td><td></td><td colspan="3"></td></tr>
</table>

Attachment D - Master Interface Log (MIL) – Example – Revision A

Seq No	Rev. No.	Interface Item Number	Stage	Location	Contract A	Name	Contract B	Name	Status	Interface Coordination Date	Proposed Close out Date	Actual Close out Date	CCF Ref. No.	Updated this Civil Master Interface Log Rev:C6 during the Civil Interface meeting Date: 03.06.2019
1	R0	UT(II)/US-01	Design	CST	UGC-01 shall provide to UGC-02 all the details and parameters necessary for provision of soft eye in the Head wall of CST Metro Station	UGC-01	UGC-02 Shall provide the required soft eye in the Head wall of CST metro station duly ensuring the overall compatibility with Station design	UGC-02	COR		February 2019			TBM arrival dates should be confirmed by PMs. UGC 01 stated that they will be able to give tentative TBM arrival dates, as the TBM launch dates are delayed.Tentative TBM arrival dates will be shared by 15th Mar 18 - The tentive dates of TBM arrival shared with GC by letter UGC01-GCC-LET-000320-A00 (end april programme will be completed) Soft Eyes head wall + Permantent Structure Design with details of filling between head wall and soil are still pending from UGC02. date of submission 15th May 2018. The date are confirmed 05-07-2018: UGC-02 stated that Soft Eyes head wall + Permantent Structure Design with details of filling between head wall and soil will be shared on 15 July 2018. 31.07.2018: Drawings awaited from UGC-02 03.08.2018: UGC 02 stated that they will be able to share this drawing by 15th Sep 18
2	R0	UT/US-02	Design	CST	UGC-01 shall design any ground improvement/treatement required outside the station wall depending upon his chosen tunneling scheme in consulatation with UGC-02 during interfaceing and sharing the required information details with him.	UGC-01	UGC-02 shall design station walls to be compatible with the tunneling scheme and arrangements including any ground treatement of the contractor A. The station wall shall be designed by UGC-02 to accept the break-in of the UGC-01 TBM in CST metro station.	UGC-02	COR		12/30/2018			Ground treatment is ok. It will be review at the contrsucton stage when retriaval of TBM to take place. Tentative dates of TBM arrival is already submitted to GC for Information. UGC 01 is updating the Interface Management Programme for submission to GC by 10/6/18. The relevent dates will be shared with UGC 02 by 15/6/18. 05.07.2018: UGC -01 stated that as per updated Interface Management Program the TBM activities shall continue between July 2018 to May 2020, starting from Cuffe Parade to CST for retrivial TBM 03-09-2018 : No change 08-10-2018: Tentative arrival TBM date is May 2020 **12-11-2018 : subject can be temporary closed, which will be reopen at the construction stage** **10-12-18** **Temporary closed**

Attachment E - Master Interface Matrix (MIM) – Revision I



Attachment F Part 1 - Interface Co-ordination sheet- Example

Interface Co-ordination Sheet:EAS-05 / AC 01

Elevated stations contractor A
Viaduct Corridor - 1 Contractor B

PROVISIONS AS PER THE INTERFACE SHEET				**INTERFACE IMPLEMENTATION**	
NO	**Project Stage**	**Interface point-Lead**	**Interface Point- Participating**	**Status**	**Action/Progress records &Follow-ups**
Sheet 2 – MMRC Station					
2	Design Stage	Contractor A (Lead Contract) shall furnish the details of Viaduct Lighting mast locations and loading details to Contr actor-B (Lead Contract)	Contract B (Participating Contract) shall collect the loading particulars of Viaduct lighting mast of various locations. Shall design and provide the details of foundations	Pending	**Past Activity** **Activity during the Month** 1 meeting during the Month **Major Decisions** A. Contract A shall fix cable trays by anchor fasteners B. Contract A to submit mutually agreeable method statement by 15th Dec 2010 **Open Issue**
3	Design Stage	Contractor-A(Lead Contract)shall request fitting/mounting arrangement s to install cable containme nt for signal, telecom and LV & Lighting cables	Contractor-B(Participating Contract) shall include in viaduct design	Pending	**Past Activity** 3 Minutes of Meeting **Activity during the Month** 1 meeting 10th December **Major Decisions** A. Contract A shall fix cable trays by anchor fasteners B. Contract A to submit mutually agreeable method Statement by 15th Dec 2010 **Open Issue**

Attachment F Part 2 - Interface Co-ordination Sheet-Contract Codes – Revision A

The following table provides the Interfacing Party Contract codes to be used when preparing / updating the Contractors Interface Co-ordination Sheet, which should be prepared on the basis of a separate Excel spreadsheet for each Interfacing Party.

Interface Party Codes	
AFC	Automatic Fare Collection
AMS	Asset Management System
DDC	Detail Design Consultant
DEM	Depot E&M
DEQ	Depot Equipments
DFW	Depot Finishing Work
DPT	Depot Civil
EST-E1	Escalator Contract 1
EST-E2	Escalator Contract 2
LIF-L1	Lifts Contract 1
LIF-L2	Lifts Contract 2
OCS	Overhead Contact System
PSS	Power Supply System
REL-PYL	Reliance Pylon Termination
RS	Rolling Stock
SSS	Station Security System
STPT	Signalling,Train Control, PSD & Telecommunication
TVE – P1	Tunnel Ventilation System and Environment Control -Phase 1
TVE – P2L1	Tunnel Ventilation System and Environment Control –Phase 2 Lot 1
TVE – P2L2	Tunnel Ventilation System and Environment Control -Phase 2 Lot 2
TWK - 03	Track Work Contract 3
TWK - 02	Track Work Contract 2
UGC	Underground Civil (01 to 07)

Notes :

1 Depot Equipment may be subdivided into individual items of equipment in which case Contractors will be notified of designated interfacing codes.
2 Other document coding should be in accordance with the requirements of the Contract and as agreed with **PM**.

Attachment F Part 3 - Interface Co-ordination Sheet- Status Codes

The following table describes the Interface Status with codes to be used in preparing /updating the Interface Co-ordination sheet.

Interface Status Codes & Meanings		
Interface Status	**Code for Log**	**Description of Status**
To be coordinated	TBC	Both Contractors' have not agreed the conditions for this interface
Coordinated	COR	Both Contractors' have agreed that the interface is valid
Not coordinated	NCOR	One Contractor does not agree the conditions for this interface
Received	REC	The Contractor responsible for the design/construction element has received the information/documents required
Provided	PRO	The Contractor responsible for providing the information/documents to progress the design/construction element has provided the documents to the Interfacing Party
Accepted	ACP	The Contractor has accepted the proposed Interface Design or Construction element
Not Accepted	NACP	Either of the Contractors have not accepted the proposed Design/Construction element
Propose closeout	PCO	Both Contractors' have accepted the proposed Interface Design or Construction element and no other requirements are outstanding Both Parties can agreed to sign the Confirmation of Co-ordination Form
Closed out	CO	The final Interface Documentation together with Confirmation of Co-ordination Form has been sent to the Interface Co-ordination Manager for closing the interface
Superseded	SUP	The Interface design or construction element has been superseded

Attachment G – Confirmation of Co-ordination Form

Mumbai Metro Rail Project		
Ref No.		
CONFIRMATION OF CO-ORDINATION		
CONTRACT:		**TRANSMITTAL No.:**
TITLE:		
ACTIVITY NO.:		
GENERAL DESCRIPTION:		
SIGNATURE OF INTERFACING CONTRACTORS:		

	Interfacing Contractor	**Authorized Name**	**Signature**	**Date Reviewed**	**Comment**
1					
2					

Signatures above confirm that this design document has been reviewed as part of the co-ordination process.

NOTE: Where Contractors are not in agreement with the details on this submission, they are to comment above and advise the interfacing party in question requesting accommodation of the requirement and advise the PM under separate cover and report progress in Monthly Report / Co-ordination Meetings.

Attachment H-Review and Comment on all Design / Interface Submittals Template

SUBMISSION REVIEW REQUEST No.

SRR of Ref Document

CONTRACT:

Column **"Comment status"** contains **(Open/closed with date) + Rank(B, Ma ,mi)** and is filled in by PM

Interface Reference No.			**Date of submission**	
Type of Reference			**Revision:**	
Subject / Title			**Date of Review**	
	GC Review Status			
Review without objection ☐		**Review without objection, subject to** ☐	**Rejected** ☐	
Reviewer: Date: Signature:			Checker: Date: Signature:	

Column **"Comment status"** contains **(Open/closed with date) + Rank (B, Ma, Mi)** and is filled in by GC

Page No. / Paragraph No.	**GC comments**	**Contractor's Reply**	**Comment status**

Ranks:

1 B – Blocked
2 Ma – Major
3 Mi – Minor

Attachment K - Guidance Notes for the Preparation of Interface Management Programme.

1. The programme shall be prepared and submitted in bar chart format.
2. The bar chart shall be formed by activities grouped by major Zones of Interface.
3. The detail of each bar chart activity shall demonstrate the Contractor's understanding of the scope of work of any Interfacing Contractor who is to supply input to the Contractor, in order for him to achieve an integrated coordinated design.
4. The bars shown on the bar chart shall be annotated with details of the information expected from the Interfacing Contractors and highlight any target dates to receive or produce information.
5. Information relating to contractual milestone dates shall be shown on both the Contractor's and Interfacing Contractor's schedules.
6. The prime purpose of the document is to assist with ensuring that a coordinated design, construction, testing and commissioning is achieved. This document shall be forwarded to Interfacing Contractors for comment and agreement on a regular basis.
7. A complementary table of activities and dates should be prepared for ease of reference.

Attachment L - Guidance Notes for the Preparation of Interface Management Plan.

The purpose of this Plan is to demonstrate how the Contractor proposes to achieve a fully coordinated design, which is compatible with that design carried out by Interfacing Contractors.

This document shall describe each of the component parts, within Zones of Interface, of the design, which require input from Interfacing Contractors. The descriptions should include details relating to the inputs required from both the Contractor and Interfacing Contractor, to achieve a fully coordinated design. The document should also be complementary to the IMPG, which details the proposed schedule and timings of each of the interfacing activities.

This document shall also detail the proposed interfacing requirements to be met by all Interfacing Contractors. The Contractor shall ensure that this document is acceptable to the Interfacing Contractors and that they are able to comply with all of its requirements. This is to be achieved by document exchanges and discussions to achieve agreement of documents.

The Plan shall therefore:

i) Detail each of the component parts of the Project, which require the input of Interfacing Contractors to achieve a coordinated design. It shall describe the various disciplines and detail the technical input from others that will be required to achieve a coordinated design.
ii) Cover the whole duration of the Works and be complementary to the **IMPG**, which details the proposed/agreed schedule and timings.
iii) Be given by the Contractor to other Interfacing Contractors for their information and agreement.
iv) Be developed in association with the process of increasing knowledge of the design and shall reflect the agreements reached by the Contractor and the Interfacing Contractors as the Project progresses. The Plan shall be updated on a quarterly basis to reflect this developing status.

The Status of any interface at any point in time shall be identified by one of the following conditions;

(i) To be co-ordinated

(ii) Co-ordinated
(iii) Not co-ordinated
(iv) Received
(v) Provided
(vi) Accepted
(vii) Not accepted
(viii) Propose closeout
(ix) Closed outSuperseded

Attachment M–Interface Sheet (Template)

Mumbai Metro Interface Sheet	**Contract A (Lead Contract)**	**Name of Contract**	**Contract B(Participating Contract)**	**Name of Contract**	***Sheet # : Number/max***	***Rev : A1*** ***Date :***
Approved by : ((name(s) and signature(s))	*Discipline A*		*Discipline B*		*Last changes :*	
PM issued by :	*Name of writer, position, signature for discipline A*		*Name of writer, position, signature for discipline B*			
PM Checked by :	*Name of checker, DCL, signature for discipline A*		*Name of checker, DCL, signature for discipline B*			
Interface description brief / Key elements (time schedule, physical, functional):						
Contract A(Lead Contract)	**DESIGN STAGE**		Contract B(Participating Contract)			
Title ***Interface A Name/Interface B-Number***: detail ***Interface A Name/Interface B-Number=Number+1***: detail			**Title** ***Interface A Name/Interface B-Number***: detail ***Interface A Name/Interface B-Number=Number+1***: detail			
Reference documents:			*Reference documents:*			
Contract A(Lead Contract)	**CONSTRUCTION / INSTALLATION STAGE**		Contract B(Participating Contract)			
Interface A Name/Interface B-Number=Number+1: detail			***Interface A Name/Interface B-Number=Number+1***: detail			
Reference documents:			*Reference documents:*			
Contract A(Lead Contract)	**TEST & COMMISIONNING STAGE**		Contract B(Participating Contract)			
Interface A Name/Interface B-Number=Number+1: detail			***Interface A Name/Interface B-Number=Number+1***: detail			
Reference documents:			*Reference documents :*			
Contract A(Lead Contract)	**MAINTENANCE STAGE**		Contract B(Participating Contract)			
Interface A Name/Interface B-Number=Number+1: detail			***Interface A Name/Interface B-Number=Number+1***: detail			
Reference documents:			*Reference documents :*			

Attachment N - Indicative Interface Sheets for Contract MM3-CBS-TWK-03

SL NO	Description
N1	Indicative Interface Sheet for Track Work (TWK-03) and Depot Equipments (DEQ)
N2	Indicative Interface Sheet for Track Work (TWK-03) and Depot Civil Works Station (DPT)
N3	Indicative Interface Sheet for Track Work (TWK-03) and Depot Civil Works (DPT)
N4	Indicative Interface Sheet for Track Work (TWK-03) and Overhead Contact System (OCS)
N5	Indicative Interface Sheet for Track Work (TWK-03) and Power Supply System (PSS)
N6	Indicative Interface Sheet for Track Work (TWK-03) and Rolling Stock (RS)
N7	Indicative Interface Sheet for Track Work (TWK-03) and Signaling & Train Control, Platform Screen Doors and Telecommunication Systems (STPT)
N8	Indicative Interface Sheet for Track Work (TWK-03) and Track Work (TWK-02)
N9	Indicative Interface Sheet for Track Work (TWK-03) and Underground Civil (UGC 05, 06 & 07)
N10	Indicative Interface Sheet for Track Work (TWK-03) and Asset Management System (AMS)

N1-Indicative Interface Sheet for Track Work (TWK-03) and Depot Equipment (DEQ)

Mumbai Metro Interface Sheet	**Contract A**	**DEQ**	**Contract B**	**TWK-03**	***Rev # :***	**A-2**
					Date:	***17/06/2019***
Approved by *:*	**Depot Equipment (DEQ)** Lead Contract		**Track Work (TWK-03)** Participating Contract		First issue:	
GC issued by :						
Checked by :						

Interface description brief / Key elements (time schedule, physical, functional, ...) :

1.General Interface details between the Track Work Systems (TWK-03) and Depot Equipment

Main interface between Depot Equipment Contract &Track works Contract are the following:

1) Turntables
2) Underfloor wheel lathe
3) Re-railing equipment
4) Electric bogie tractor
5) Shunting locomotive
6) Overhead line maintenance vehicles
7) Rail cum road vehicle
8) Automatic train wash plant
9) Underfloor lifting jack
10) Bogie test stand
11) Bogie wash plant

Contract A (DEQ)	**DESIGN STAGE**	Contract B (TWK-03)
DEQ/TWK-01: Shall take into account track specifications and track design drawings for the depot site and elevated / at grade underground portions, regarding parameters like – type of rail, type of installation, turnouts, gradients, curvatures, water drainage.		**DEQ/TWK-01:** Shall provide to contract A any relevant specifications, design drawings and technical details concerning the track.

Mumbai Metro Interface Sheet	Contract A	DEQ	Contract B	TWK-03	*Rev # :*	A-2
					Date:	*17/06/2019*
DEQ/TWK-02*:* Shall adapt the relevant Depot Special machines & vehicles design to the track design & alignment and shall ensure that the special machines & vehicles are compliant with the track parameters, especially in the relation between Wheel base & Track twist (Twist derailment case) and wheel / rail profile compatibility.			**DEQ/TWK-02***:* Shall inform to contract A with any track evolution and updating.			
Reference documents*:*			Reference documents			
Contract A (DEQ)		**CONSTRUCTION / INSTALLATION STAGE**		Contract B (TWK-03*)*		
DEQ/TWK-03: Shall plan and coordinate the installation of the relevant Depot Special Machines, such as the under –floor wheel lather, the washing machine and turntables, with the progress of track work			**DEQ/TWK-03:** Shall support contract A track works with the installation of the relevant Depot special machines, by making the track available and adequately install it in order to Incorporate/Bear/Connect etc. with the depot special machines & facilities			
Reference documents:			Reference documents:			
Contract A (DEQ)		**TEST & COMMISSIONING STAGE**		Contract B (TWK-03*)*		
DEQ/TWK-04: Shall conduct joint tests demonstrating that Depot special Machines are perfectly adapted to the track network.			**DEQ/TWK-04***:* Shall provide necessary support to Contract A during the tests carried out for demonstrating that Depot special Machines are perfectly adapted to the track work. The tests are scope of work of Contract A			
Reference documents :			Reference documents*:*			
Contract A (DEQ)		**MAINTENANCE STAGE**		Contract B (TWK-03*)*		

Mumbai Metro Interface Sheet	**Contract A**	**DEQ**	**Contract B**	**TWK-03**	***Rev # :***	**A-2**
					Date:	***17/06/2019***
NIL			**NIL**			
Reference documents :			Reference documents*:*			

N2. Indicative Interface Sheet for Track Work (TWK-03) and Depot Civil Works Station (DPT)

Mumbai Metro Interface Sheet	**Contract A**	**TWK-03**	**Contract B**	**DPT**	***Rev # :***	***A2***
					Date:	***17/06/19***
Approved by *:*	**TWK-03(Track Works)** Lead Contract		**DPT (Depot Civil Works station)** Participating Contract		First issue:	
GC issued by :						
Checked by :						

Interface description brief / Key elements (time schedule, physical, functional, ...) :

1.General Interface details between the TWK-03(Track Works)vs DPT (Civil work depot station)

Contract A(TWK-03)	**DESIGN STAGE**	Contract B(DPT-DDC)
TWK/DPT-01: Shall fix chainages of the turnouts / crossover based on the chainage of station centre line furnished by the station building contract.		**TWK/DPT-01**: Shall furnish correct chainage of station centre line.
TWK/DPT-02: Shall provide the rail level		**TWK/DPT-02**: Shall Check the rail level.
TWK/DPT-03: Shall check the same.		**TWK/DPT-03:** Shall ensure that pillars / columns supporting in station structure are located clear of the minimum infringement clearance from centre of track stipulated in the S.O.D. wherever such pillars / column are beyond the platform length.
TWK/DPT-04: Shall provide track drainage consistent with the general drainage arrangement in station area.		**TWK/DPT-04:** Shall design the general drainage system in the station area taking into account track drainage catchment area.

Mumbai Metro Interface Sheet	Contract A	TWK-03	Contract B	DPT	*Rev # :*	*A2*
					Date:	*17/06/19*
TWK/DPT-05: Contract B shall verify with contract A.			**TWK/DPT-05:** Contract A shall ensure that all components of the structure at intersection with ramp/ At Grade are clear of the structure gauge of the S.O.D. with respect to the project rail level.			
Contract A(TWK-03)		**CONSTRUCTION / INSTALLATION STAGE**		Contract B(DPT)		
TWK/DPT-06: Shall jointly check before taking over.			**TWK/DPT-06:** Shall hand over the track installation area in the vicinity of pillars / columns and such obstructions clear of the infringement distances stipulated in the S.O.D.			
TWK/DPT-07: Shall ensure proper drainage compatible to Civil Contract design of drainage.			**TWK/DPT-07:** Shall furnish levels and location of the general drainage system in the station area and ensure track drainage is compatible with general drainage system.			
TWK/DPT-08: Track work contract shall jointly decide the storage space and access for track work as per key Dates of access.			**TWK/DPT-08:** Shall provide storage space for track materials in consultation with track contract and shall permit access to track contract for construction of track as per agreed schedule of access periods.			
TWK/DPT -09: Track contract shall furnish requirement of temporary water supply. But for track construction work the water supply and electricity will be arranged by track contract.			**TWK/DPT-09:** Shall provide temporary water for construction of track on term of mutual agreement to design & construct the water supply scheme in consultation with track contract.			

Mumbai Metro Interface Sheet	**Contract A**	**TWK-03**	**Contract B**	**DPT**	***Rev # :***	***A2***
					Date:	***17/06/19***
TWK/DPT 10: Shall provide survey Data of Track for completion (level and horizontal) of platform			**TWK/DPT 10:** level completes the platform (level and horizontal) according to track.			
Reference documents:			Reference documents:			
Contract A(TWK-03)		**TEST & COMMISSIONING STAGE**		Contract B(DPT)		
NIL			**NIL**			
Reference documents :			Reference documents*:*			
Contract A(TWK-03)		**MAINTENANCE STAGE**		Contract B(DPT)		
NIL			**NIL**			
Reference documents:			Reference documents:			

N3. Indicative Interface Sheet for Track Work (TWK-03) and Depot Civil Works (DPT)

Mumbai Metro Interface Sheet	**Contract A**	**TWK-03**	**Contract B**	**DPT**	***Rev # :***	***A2***
					Date:	***17/06/19***
Approved by *:*	**TWK-03 (Track Works)** Lead Contract		**DPT (Depot Civil Works)** Participating Contract		First issue:	
GC issued by :						
Checked by :						

Main interfaces between Civil Work Depot contract and Track Works 03 contract are the following:

- X, Y, Z track co-ordinates
- Floor finishing
- In pit track supporting posts + embedded track + washing track
- Track drainage
- Temporary water supply during construction
- Time schedule

Contract A(TWK-03)	**DESIGN STAGE**	Contract B(DPT-DDC)
TWK/DPT-01: Shall take into account the depot drawings and pieces of information from contract B and shall design accordingly the track layout within the whole depot.		**TWK/DPT-01**: Shall provide to Contract A the general depot layout, relevant detailed drawings and any pieces of information allowing contract B carrying out the track design within the depot.
TWK/DPT-02: Shall provide to contract B the track depot layout, the drawings of the different types of track laying (outdoor, indoor, on pit, in the washing shed etc.), and principles for track drainage, compacted soil requirements etc., and any track requirements.		**TWK/DPT-02**: Shall take into account track drawings, track requirements, track drainage principles, compacted soil requirements ,pit drawings, including washable apron etc. from contract A for designing the depot.The design of the general drainage system for the depot, including the final formation levels, gradients,

Mumbai Metro Interface Sheet	Contract A	TWK-03	Contract B	DPT	*Rev # :*	*A2*
					Date:	*17/06/19*
			cross slopes, longitudinal cross drainage pipes culverts crossings. Etc. shall be decided by contract B in consultation with contract A.			
TWK/DPT-03: Shall co-ordinate with contract B, shall furnish any track updates, shall take into account observations from Contactor B and shall update the changes, if needed.			**TWK/DPT-03:** Shall co-ordinate with contract A, shall furnish any depot updates, shall take into account observations from Contactor A and shall update the changes, if needed.			
Contract A(TWK-03)			**CONSTRUCTION / INSTALLATION STAGE**	Contract B(DPT)		
TWK/DPT-04: Shall plan and co-ordinate the track works in the depot with the progress of depot works based on mutually accepted programme of works.			**TWK/DPT-04:** Shall plan and co-ordinate the depot works with the progress of track works in the depot based on mutually accepted programmed of works and ensure key dates for access.			
TWK/DPT-04(A) Shall ensure with contract B for gaining access to various location of in depot for executing track work and also for storing the required track material.			**TWK/DPT-04(A)** Shall provide suitable roads for gaining access to various location of in depot for executing track work and also for storing the required track materials.			

Mumbai Metro Interface Sheet	**Contract A**	**TWK-03**	**Contract B**	**DPT**	***Rev # :***	***A2***
					Date:	***17/06/19***
TWK/DPT-05: Contract A shall ensure in respect of track in locations like washing lines, inspection bay, working lines, etc. contract A shall check and ensure the concrete base to the required levels providing suitably dowels for track base plates, shear connectors, etc. as required before taking over from contract B for installing the track work. **TWK/DPT-05(A):** Before commencing the ballasted/slab track work in an area, contactor A shall verify with contract B that the longitudinal and cross drains are completed in that area. Before laying the track, contract B shall provide designed cross slopes on the track formation.			**TWK/DPT-05:** In respect of track in locations like washing lines, inspection bay, working lines, etc. contract B shall complete the concrete base to the required levels providing suitably dowels for track base plates, shear connectors, etc. as required. **TWK/DPT-05(A):** Before handing over the finished formation of depot to contract A for installing slab/ballasted track, contract B shall construct and complete the longitudinal and cross drains forming the drainage network designed by him including up to out flow and any sump etc Contactor B shall excavate the finished formation to the required dimensions and install the drains to proper design levels and with appropriate perforated drain cover on top for entire drainage.			
TWK/DPT-06: Contract A shall request temporary water supply from contract B, However contract A shall make own arrangement of water supply for concreting.			**TWK/DPT-06:** Shall provide temporary water supply during the track works			
TWK/DPT -07: *Shall conduct tests and commissioning of track works..*			**TWK/DPT-07:** Shall provide necessary support to contract A to ensure testing and commissioning of track works..			
Reference documents:			Reference documents:			

Mumbai Metro Interface Sheet	**Contract A**	**TWK-03**	**Contract B**	**DPT**	***Rev # :***	***A2***
					Date:	***17/06/19***
Contract A(TWK-03)		**TEST & COMMISSIONING STAGE**		Contract B(DPT)		
TWK/DPT-08: Shall conduct tests and commissioning of track works.			**TWK/DPT-08:** Shall provide necessary support to Contractor a to ensure testing and commissioning of track works.			
Reference documents :			Reference documents*:*			
Contract A(TWK-03)		**MAINTENANCE STAGE**		Contract B(DPT)		
NIL			**NIL**			
Reference documents:			Reference documents:			

N4-Indicative Interface Sheet for Track Work (TWK-03) and Overhead Contact System (OCS)

Mumbai Metro Interface Sheet	**Contract A**	**OCS**	**Contract B**	**TWK-03**	***Rev # :***	***A2***
					Date:	***17/06/19***
Approved by *:*	**OCS (Overhead Contact System)** Lead Contract		**TWK-03 (Track Works)** Participating Contract		Last changes: 1 item is replaced	
					Contract A	**Contract B**
GC issued by :					-	06
Checked by :					**Additional item:**	-

Interface description brief / Key elements (time schedule, physical, functional, ...) :

1.General Interface details between the Overhead Contact System (OCS) vs Track work

Contract A(OCS*)*	**DESIGN STAGE**	Contract B(TWK-03*)*
OCS/TWK-01: Shall prepare OCS supports numbering system.		**OCS/TWK-01**: Shall provide the chainage details of the track alignment to contract-A.
OCS/TWK-02: Shall design span and stagger of OCS.		**OCS/TWK-02**: Shall provide the horizontal and vertical track alignment drawings including turnouts to contract-A.
OCS/TWK-03:Shall determine the locations and length of OCS Neutral sections.		**OCS/TWK-03**: Shall provide curve and gradient charts for deciding the locations of neutral sections.
OCS/TWK-04:Shall provide the OCS layout drawings & SED drawings including the transition arrangement between the Rigid OCS and flexible OCS		**OCS/TWK-04**:Shall provide the track layout including turnouts in Mainline & Depot.

Mumbai Metro Interface Sheet	**Contract A**	**OCS**	**Contract B**	**TWK-03**	***Rev # :***	***A2***
					Date:	***17/06/19***
OCS/TWK-05: Shall design the OCS mastfoundation in at grade section and depotincluding the details of implantation &foundationheight.			**OCS/TWK-05** Shall check & coordinate with OCS contracter the location of mast foundations and any infringement with the track.			
OCS/TWK-06: Shall provide continuity bonds and cross bonds as per approved design.			**OCS/TWK-06:** Shall connect bonding cables to the track by using CAD welding.			
OCS/TWK-07: Shall advise the designated locations of connections of traction return cables and bonding cables to the track as per the approved scheme.			**OCS/TWK-07:** Shall connect traction return cables and bonding cables to the track by using CAD welding at designated locations as per the approved scheme.			
OCS/TWK-08: Shall specify the cable routing/crossing locations under the track along with conduit sizes.			**OCS/TWK-08**: Shall design suitable openings for the cable crossing accordingly.			
Reference documents*:*			Reference documents*:*			
Contract A(OCS*)*		**CONSTRUCTION / INSTALLATION STAGE**		Contract B(TWK-03*)*		
OCS/TWK -09: Shall ensurethat the details of implantation and foundation are as per design drawings.			**OCS/TWK -09**:Shall check implantation & foundation, as per design drawings.			
OCS/TWK-10: Shall supply all conduits and supports required for cable crossings.			**OCS/TWK-10**: Shall provide suitable openings for cable routing/crossing under the track while constructing plinth /track slab based on the requirements furnished by contract-A			
Reference documents:			Reference documents:			

Mumbai Metro Interface Sheet	**Contract A**	**OCS**	**Contract B**	**TWK-03**	***Rev # :***	***A2***
					Date:	***17/06/19***
Contract A(OCS*)*		**TEST & COMMISSIONING STAGE**		Contract B(TWK-03*)*		
NIL			**NIL**			
Reference documents :			Reference documents*:*			
Contract A(OCS*)*		**MAINTENANCE STAGE**		Contract B(TWK-03*)*		
NIL			**NIL**			
Reference documents:			Reference documents:			

N5-Indicative Interface Sheet for Track Work (TWK-03) and Power Supply System (PSS)

Mumbai Metro Interface Sheet	**Contract A**	**PSS**	**Contract B**	**TWK-03**	**Rev # :**	**A1**
					Date:	**17/06/19**
Approved by :	**PSS (Power supply system)** Lead Contract		**TWK-01 (Track Work)** Participating Contract		Last changes *:*	
GC issued by :						
Checked by :						

General Interface details between the Power Supply System & Track Work (TWK 03)

ContractA PSS (Power Supply System)	**DESIGN STAGE**	**Contract B TWK (TWK-03)**
PS/TWK-01: Contract-A shall collect gradient and curvature data with the corresponding equilibrium/design speed from Contract-B in spreadsheet format in order to conduct the traction power simulation study.		**PS/TWK-01**: Contract-B shall provide gradient and curvature data with the corresponding equilibrium/design speed in spreadsheet format to Contract-A.
PS/TWK-02: Contract-A shall collect the track resistivity value for conducting the traction power simulation study.		**PS/TWK-02**: Contract-B shall provide the track resistivity value to Contract-A.
Reference documents*:*		Reference documents :
ContractA PSS (Power Supply System)	**CONSTRUCTION / INSTALLATION STAGE**	**Contract B TWK (TWK-03)**
NIL		**NIL**

Mumbai Metro Interface Sheet	**Contract A**	**PSS**	**Contract B**	**TWK-03**	**Rev # :**	**A1**
					Date:	**17/06/19**

ContractA PSS (Power Supply System)	**TEST & COMMISIONNING STAGE**	**Contract B TWK (**TWK-03**)**
NIL		**NIL**
Reference documents *:*		Reference documents *:*

Contract A PSS (Power Supply System)	**MAINTENANCE STAGE**	**Contract B TWK (**TWK-03**)**
NIL		**NIL**
Reference documents:		Reference documents :

N6-Indicative Interface Sheet for Track Work (TWK-03) and Rolling Stock (RS)

Mumbai Metro Interface Sheet	**Contract A**	**RS**	**Contract B**	**TWK-03**	**Rev # :**	**A3**
					Date:	**17/06/2019**
Approved by :	**RS (Rolling Stock)** Lead Contract		**TWK (Track Work 03)** Participating Contract		First issue:	
GC issued by :						
Checked by :						

Interface description brief / Key elements (time schedule, physical, functional, ...) :

1.General Interface details between the Rolling Stock (RS) and Track Work (TWK 03)

Contract A (RS)	**DESIGN STAGE**	Contract B (TWK-03)
RS/TWK-01: The Rolling stock has to design according to the given SOD.		**RS/TWK -01:** The Track has to design according to the given SOD.
RS/TWK-02: The Rolling stock contract shall incorporate in his design the requirements to suit track parameters like, curvatures, gradients, track geometry, etc.		**RS/TWK -02:** The Track Work contract shall provide to the Rolling Stock Contract complete details of track geometry, curves, gradients and any other requirement relevant to rolling stock design.
RS/TWK-03: The Rolling stock contract shall give full details of the wheel hardness and take into consideration the Rail hardness and rail characteristics in rolling Stock design. He shall ensure in consultation with the Track Work contract That the hardness of rail and Wheel are compatible to provide optimum service life.		**RS/TWK-03:** The Track Work contract shall provide full details of Rail Hardness and Rail characteristics to the rolling stock contract.. He shall ensure in consultation with the track contract That the hardness of rail and Wheel are compatible to provide optimum service life.
RS/TWK -04: The Rolling stock Contract to design axle load, bogie spacing and similar according to the SOD.		**RS/TWK-04:** The Track Work contract to design track accordingly.

Mumbai Metro Interface Sheet	Contract A	RS	Contract B	TWK-03	Rev # :	A3
					Date:	17/06/2019
RS/TWK-05: The Rolling stock contract shall provide to the track contract details of rolling stock buffers or anti-climbers, car loads without and with passenger loads.			**RS/TWK-05**: The Track Work contract shall be responsible for design, supply and installation of the buffer stops at the end of the tracks at Terminal stations, depots, etc based on the details of buffers or anti-climber,car loads without and with passenger loads furnished by the rolling stock contract.			
RS/TWK-06: The Rolling stock contract shall provide details of evacuation of passengers in front and back of train to ensure their emergency evacuation on the track with free passenger's movement in safety.			**RS/TWK-06:** The Track Work contract shall Design details for evacuation of passengers on the track with free passenger's movement in safety**.**			
Reference documents*:*			Reference documents*:*			
Contract A (RS)		**CONSTRUCTION / INSTALLATION STAGE**		Contract B (TWK-03)		
RS/TWK-07: The Rolling Stock Contract shall check and verify the conformity of the construction / Installation according to the requirement for passenger's evacuation in front of the train.			**RS/TWK-07:** The Track Work contract shall call for meeting regularly the Rolling Stock Contract on site during the construction / Installation phase to check/verify the right feasibility for train evacuation path.			
Reference documents:			Reference documents:			
Contract A (RS)		**TEST & COMMISSIONING STAGE**		Contract B (TWK-03)		
RS/TWK-08: The Rolling Stock Contract shall carry out Testing and Commisioning and pilot trail run test of Rolling Stock in co-ordination with Track Work Contract.			**RS/TWK-08:** The Track Work contract shall provide necessary support to The Rolling stock contract during test and commissioning of the rolling stock and attend pilot trial run test.			
Reference documents :			Reference documents*:*			
Contract A (RS)		**MAINTENANCE STAGE**		Contract B (TWK-03)		
NIL			**NIL**			
Reference documents:			Reference documents:			

N7-Indicative Interface Sheet for Track Work (TWK-03) and Signaling & Train Control, Platform Screen Doors and Telecommunication Systems (STPT)

Mumbai Metro Interface Sheet	**Contract A**	**STPT**	**Contract B**	**TWK-03**	***Rev # :***	***A2***
					Date:	***17/06/19***
Approved by *:*	**STPT (Signaling & Train Control, Platform Screen Doors and Telecommunication Systems)** Lead Contract		**TWK-03 (Track Works)** Participating Contract		First issue:	
GC issued by :						
Checked by :						

Interface description brief / Key elements (time schedule, physical, functional, ...) :

1.General Interface details between the Signaling & Train Control, Platform Screen Doors and Telecommunication Systems (STPT) and Track Work (TWK-03)

Contract A(STPT)	**DESIGN STAGE**	Contract B(TWK-03)
ST/TWK-01: Signaling contract shall furnish to the Track contract the locations and parameters for track mounted equipments (axle counter, cable termination etc.). The locations are jointly decided with Track works contract. These equipments will be fixed by Contract A. For rail drilling contract A has to give adequate instruction to contract B in order to carry out the drilling work.		**ST/TWK-01:** Track contract shall ensure in the design stage that the track materials proposed to be used shall meet with the electrical properties of track equipments used by signaling &Telecom. The locations are jointly decided. The fitting will be done by contract A drill holes in the rails will be performed from contract B according to the instruction of contract A
ST/TWK-02: Signaling contract shall ensure that the details furnished are incorporated in Train Control and Signaling design & must be included in ATP profile.		**ST/TWK-02:** Track contract shall provide the final Track alignment, gradients, and curve details, track layout plans at stations / depots, permissible speeds on curves & Turnouts to the Signaling contract.

Mumbai Metro Interface Sheet	Contract A	STPT	Contract B	TWK-03	*Rev # :*	*A2*
					Date:	*17/06/19*
ST/TWK-03: a) Shall incorporate details of speed limits to be included in ATP Profile. b) Shall take into consideration while designing Signaling system the locations of fouling mark point.			**ST/TWK-03:** a) Shall furnish details on permanent speed limits at all locations. b) Shall furnish details of fouling mark points at crossings.			
ST/TWK-04: Shall furnish exact locations and sizes of all Track side Equipment including Axle counters, Balise, Junction boxes, Point Machine and Signal Post Installation etc., to Track contract.			**ST/TWK-04:** Shall incorporate all Track side Equipment as mentioned by Signal contract in Track geometry design and shall ensure full compliance with the clearances prescribed in the S.O.D.			
ST/TWK-05: a) Shall coordinate with contract B for crossover assemblies. b) Shall design the point machines fixing and connection arrangements (mounting, drilling arrangement) and insulations necessary for stretcher bars for all points on main line and depot. The installation of point machine will be done by contract A. c) Shall install and coordinate with contract B for second drive interface with point machines			**ST/TWK-05**: a) Shall furnish the details of crossover assemblies. (b) The stretcher bar with insulation will be arranged and supplied by contract B and installed. (c) Shall coordinate with Contract A for Second drive interface			
ST/TWK-06: Shall validate the locations of buffer stops in accordance with safe braking distance.			**ST/TWK-06:** Shall furnish the details and locations of buffer stops to be provided on main line and in depot.			

Mumbai Metro Interface Sheet	Contract A	STPT	Contract B	TWK-03	*Rev # :*	*A2*
					Date:	*17/06/19*
ST/TWK-07: Shall furnish the details of S&T equipment rail connections like cad welding, bolt fixing and riveting etc			**ST/TWK-07:** Shall validate the method of S&T connections to S & T equipments on the rail.			
ST/TWK-08: Shall prepare a complete bonding & earthing diagram which includes Track mounted equipment connections, and traction return current path in association with OCS contract.			**ST/TWK-08:** Shall jointly validate the bonding & earthing diagram in association with OCS contract.			
Reference documents*:*			Reference documents*:*			
Contract A(STPT)		**CONSTRUCTION / INSTALLATION STAGE**		Contract B(TWK-03)		
ST/TWK-09: Shall furnish locations and size of the track crossing pipes where signal cables have to cross the track. The pipes and fittings will be installed by Contract A and embedded in concrete by Contract B.			**ST/TWK-09**: Shall embed in concrete track crossings by pipe during track construction duly taking in his installation ownership of installation of pipes carried out from contract A . The details drawing and specifications of such crossings shall be jointly settled by contract B with contract A.			
ST/TWK-10: Shall Furnish required arrangements on track for installation of balise, axle counting sensors etc. and install the same.			**ST/TWK-10:** Shall provide the required arrangement for easy and robust installation of balise, axle counting sensors etc., and assist Signaling contract during installation.			
ST/TWK-11: Signaling contract shall jointly verify the location of the turnouts with Track contract before laying as well as after laying.			**ST/TWK-11**: The Track contract shall lay the Turnouts as per the locations in the Track Layout plan, jointly verified with the Signaling contract before laying as well as after laying.			

Mumbai Metro Interface Sheet	Contract A	STPT	Contract B	TWK-03	*Rev # :*	*A2*
					Date:	*17/06/19*
ST/TWK-12: Shall check the proper gauge, housing of point and operation of switches and opening gap between switches etc., before installing the point machine, jointly with the track contract. After fitting of point machine eventual defects will be jointly rectified.			**ST/TWK-12:** Shall ensure proper gauge, housing of point and operation of switches and opening gap between switches etc without point machines and after fitting of point machine eventual defects will be jointly rectified.			
ST/TWK-13: Signalling contract shall supply the Point machines and install them and also check insulations provided by track contract.			**ST/TWK-13:** Track contract shall install all track assemblies, turnouts, rail fasteners and stretcher bars with insulation. The Track Contract and Signaling contract shall install the Turnouts respectively the Point Machine to ensure mutual Compatibility.			
ST/TWK-14: Shall adjust the point machine for correct operation as per standards.			**ST/TWK-14:** Shall assist the signaling contract in adjusting the point machine for correct operation.			
ST/TWK-15: Shall supply and install cables, termination boxes, junction boxes for axle counters including connection with track in association with Track contract			**ST/TWK-15:** Shall verify the Track connections done by Signaling Contract.			
ST/TWK-16: Shall liaise with Contract B for locations of fouling mark point at crossovers for finalizing movement of authority of train such that no train is stopped in location such that kinematic envelope and			**ST/TWK-16:** Shall furnish the details of location of fouling point as per installation to Contract A and assist in finalizing limit of movement authority at fouling points			

Mumbai Metro Interface Sheet	Contract A	STPT	Contract B	TWK-03	*Rev # :*	*A2*
					Date:	*17/06/19*
structure gauge of passing train is infringed						
ST/TWK-17: Installation of Track side Equipments and Signal Posts - shall provide foundations for all track side equipments like signals, point machines, junction boxes, etc., and installation as per the designated locations and ensure that the clearances from track comply with the S.O.D			**ST/TWK-17:** Shall check that the locations of all track wise Signaling equipments like signals, point machines, junction boxes, etc., clearances from track comply with the S.O.D.			
ST/TWK-18: Track crossing of signal cables - Shall supply all track crossing pipes and supports required for crossing through the plinth / track slab.			**ST/TWK-18:** Shall provide suitable openings for cable crossings while constructing the plinth beam / track slab, if required by the Signal contract based on the details / specification & location furnished by Signaling contract.			
ST/TWK-19: Shall check the locations of buffer stops in accordance with designed breaking distances.			**ST/TWK-19:** Shall supply & install the buffer stops.			
ST/TWK-20: Shall carryout the Joint Testing with track contract immediately after full installation.			**ST/TWK-20:** Joint testing of Points and crossings shall be done with Signaling contract immediately after full installation.			
Reference documents:			Reference documents:			
Contract A(STPT)		**TEST & COMMISSIONING STAGE**			Contract B(TWK-03)	

Mumbai Metro Interface Sheet	Contract A	STPT	Contract B	TWK-03	*Rev # :*	*A2*
					Date:	*17/06/19*
ST/TWK-21: a. Shall carryout electrical insulation tests of rail to rail, rail to sleeper after installation. **b.** Shall carry out electrical insulation tests of all insulated joints at supply stage as well as after installation as necessary.			**ST/TWK-21:** Shall assist Signaling contractor during the checking /testing of electrical insulation of Rail to Rail, Rail to Sleeper and all insulated Joints.			
ST/TWK-22: Verify all the STPT track wise equipments are installed within the permissible limits, as per S.O.D.			**ST/TWK-22:** Conduct joint verification of track side equipments with STPT contractor.			
ST/TWK-23: Test the integrity of all connections of bonding and earthing.			**ST/TWK-23:** Attend and witness the joint test of all bonding and earthing connections.			
ST/TWK-24: Shall carryout the integrated testing & commissioning stage and assist in rectifying all defects pertaining to Track & point operations.			**ST/TWK-24:** Shall carryout the joint integrated testing & commissioning stage and assist in rectifying all defects pertaining to Track & point operations.			
Contract A(STPT)		**MAINTENANCE STAGE**		Contract B(TWK-03)		
ST/TWK-25: Contract A has to confirm to the indications from contract B on urgent manner according to safety rules.			**ST/TWK-25:** Contractor B has to maintain the correct closing of switch rail vs stock rail and keep contract A abreast about the conditions of the above in order to adjust the point machine connections accordingly.			
Reference documents:			Reference documents:			

N8-Indicative Interface Sheet for Track Work (TWK-03) and Track Work (TWK-02)

Mumbai Metro Interface	**Contract A**	**TWK -03**	**Contract B**	**TWK- 02**		**Rev # :**	**A2**
						Date:	**17/06/19**
	Track work (TWK – 03) (**Lead Contract)**		**Track work (TWK -02)** **(Participating Contract)**		Last changes *:*		
GC issued by :							
Checked by :							
Approved by:							

General Interface details between the **Trackwork Contract-10C from Aarey Station to BKC Station (Included)** and **Trackwork Contract-10B from BKC Station (Excluded) to Cuffe Parade Station**

Contract - A (TWK-03)	**DESIGN STAGE**	**Contract-B (TWK-02)**
TWK/TWK-01: Agrees with Contract B an adequate location for the interfacing section in accordance with the principles and chainages given from DDC and GC.		**TWK/TWK-01:** Agrees with Contract A an adequate location for the interfacing section in accordance with the principles and chainages given from DDC and GC.
TWK/TWK-02: Agrees with Contract B the interfacing section of the drainages, the manner and the schedule how and when to connect them to each other in accordance with the principles and chainages given from DDC and GC.		**TWK/TWK-02:** Agrees with Contract A the interfacing section of the drainages, the manner and the schedule how and when to connect them to each other in accordance with the principles and chainages given from DDC and GC.
TWK/TWK-03: Agrees with Contract B the interfacing section of the slab tracks, the manner and the schedule how and when to connect all the constructive elements and components, auxiliary or temporary means as well in accordance with the principles and chainages given from DDC and GC.		**TWK/TWK-03:** Agrees with Contract A the interfacing section of the slab tracks, the manner and the schedule how and when to connect all the constructive elements and components, auxiliary or temporary means as well in accordance with the principles & chainages given from DDC and GC.

TWK/TWK-04: Agrees with Contract B the interfacing section of the rails, the manner and the schedule how and when to connect them in accordance with the principles and chainages given from DDC and GC.	**TWK/TWK-04:** Agrees with Contract A the interfacing section of the rails, the manner and the schedule how and when to connect them in accordance with the principles & chainages given from DDC and GC.
Reference documents:	Reference documents :
Contract - A (TWK-03) **CONSTRUCTION / INSTALLATION STAGE**	**Contract-B (TWK-02)**
TWK/TWK-05: Carries out a joint survey of the Civil Work with Contract B and representatives of Civil Works as witnesses and information holder. The survey has to be extended toward both directions of the two TWK Contracts over an adequate length, according to the purpose of the interface, this length has to be agreed among the two TWK Contractors.The result of the survey shall be recorded for future verification purposes and signed from both Contractors in the form wished from GC and to GC's satisfaction.	**TWK/TWK-05:** Carries out a joint survey of the Civil Work with Contract A and representatives of Civil Works as witnesses and information holder. The survey has to be extended toward both directions of the two TWK Contracts over an adequate length, according to the purpose of the interface; this length has to be agreed among the two TWK Contractors.The result of the survey shall be recorded for future verification purposes and signed from both Contractors in the form wished from GC and to GC's satisfaction.
TWK/TWK-06: Witnesses, inspect and checks the connections realized by Contract B and duly redact a joint protocol about these works together with Contract B.	**TWK/TWK-06:** Realizes the connections with the Track of Contract A and duly redact a joint protocol about these works together with Contract A.
TWK/TWK-07: Witnesses, inspect and checks the rail grinding realized by Contract B until an adequate and with Contract B agreed working length inside its own site (inside of TWK Contractor 02 site) and duly redact a joint protocol about these works together with Contract B.	**TWK/TWK-07:** Carries out the rail grinding until an adequate and with Contract A agreed working length inside the other Contract's site (inside of TWK Contractor 01 site) and duly redact a joint protocol about these works together with Contract A.
Reference documents*:*	Reference documents *:*

Contract - A (TWK-03)	**TEST & COMMISIONNING STAGE**	**Contract-B (TWK-02)**
TWK/TWK-08: Carries out its own tests and commissioning in the interface area by agreeing the witnessing and the inspection of Contract B. The tests and commission will be extended until an adequate length within the site of Contract B as per agreement with Contract B.		**TWK/TWK-08:** Carries out its own tests and commissioning in the interface area by agreeing the witnessing and the inspection of Contract A. The tests and commission will be extended until an adequate length within the site of Contract A as per agreement with Contract A.
TWK/TWK-09: Agrees with Contract B the length of the extension within the site of Contract B in order to duly carry out the contractual performances on Tests and Commissioning.		**TWK/TWK-09:** Agrees with Contract A the length of the extension within the site of Contract A in order to duly carry out the contractual performances on Tests and Commissioning.
Reference documents :		Reference documents :
Contract - A (TWK-03)	**MAINTENANCE STAGE**	**Contract-B (TWK-02)**
NIL		**NIL**
Reference documents: NIL		Reference documents : NIL

N9-Indicative Interface Sheet for Track Work (TWK-03) and Underground Civil (UGC 05,06 & 07)

6. Track and UG Stations (UGC-05)

Contract A: Track (Interface Lead)		Contract B : UG Station & Tunnel/Mid-ventilation shaft (MM3-CBS-UGC-05) (Interface follower)	Sheet 8 : 172
Contract A (Track)	DESIGN STAGE	Contract B(UG-Stations)	
TK/UG-01: Shall fix chainages of the Turnouts / Cross over based on the chainage of Station Centre Line furnished by the Contractor-B . *TK/UG-02*: Shall ensure at design stage *TK/UG-03*: Shall provide Track drainage consistent with the General Drainage arrangement in Station area and agree & provide the Point of interface		*TK/UG-01*: Shall furnish correct chainage of station centre line to Contractor-A. *TK/UG-02*: Shall ensure that the pillars / columns supporting the station structure and all other structures are located clear of the minimum infringement clearances from centre of track as stipulated in the approved S.O.D. *TK/UG-03*: Shall design the General drainage system(overall drainage system) in the Station area taking into account Track Drainage and accept the Point of Interface in the Station/Platform Area.	
Contract A (Track)	CONSTRUCTION / INSTALLATION STAGE	Contract B(UG-Stations)	
TK/UG-04: Shall arrange for taking over after joint verification with Contractor-B . *TK/UG-05*: Shall ensure before taking up track installation work. *TK/UG-06*: Shall jointly decide with the Contractor-B opening requirements, storage spaces and Schedule of Access Periods and ensure implementation based on track construction program.		*TK/UG-04*: Shall hand over to the Track contractor(Contractor-A) the concrete base (duly providing 1st pour concrete, if required, and the shear connectors for track laying within the permitted tolerances) for track structure and the station platform to designated levels / clearances with in the tolerances permitted. *TK/UG-05*: Shall hand over the track installation area in the vicinity of Pillars / Columns and such structures/obstructions clear of the infringement distances stipulated in the approved S.O.D. *TK/UG-06*: Shall provide the required openings in the structures to lower the track materials/plants/equipment including rails for track construction and provide storage space for Track materials in consultation with Track contractor (Contractor-A) and shall permit Access to Track contractor for construction of Track as per agreed Schedule of Access Periods	

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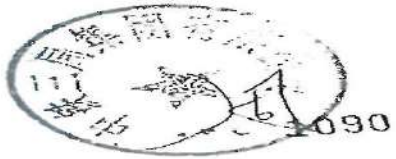
CONTRACT UGC-05

Contract A: Track (Interface Lead)	Contract B : UG Station & Tunnel/Mid-ventilation shaft (MM3-CBS-UGC-05) (Interface Follower)	Sheet # : 1/2
TK/UG-07: Shall furnish details of requirements to Contractor-B . *TK/UG-08*: To check the levels of platform and track base concrete at the time of taking over from Contractor-B and ensure that the heights and clearances from rail level / centre of track are with inacceptable limits as per the approved S.O.D.	*TK/UG-07*: Shall provide Temporary water supplies for construction of Track. Shall design & construct the water supply scheme in consultation with Track Contractor. *TK/UG-08*: Shall ensure that levels of Platform and Track Base Concrete in Station Boxes conform to the Design Levels and Tolerances.Shall furnish completed levels, curvature & cant ,if any, to Track Contractor (Contractor-A)for any adjustment in rail level/alignment while leying Track.	
Contract A (Track)	TEST & COMMISIONNING STAGE	Contract B(UG-Stations)
TK/UG-09:Shall attend and assist in the joint check with concerned interface contractors to ensure that all permanent structures are clear of the structure gauge specified in the approved S.O.D	*TK/UG-09*: Shall attend and assist in the joint check with concerned interface contractors to ensure that all permanent structures are clear of the structure gauge specified in the approved S.O.D	
Contract A (Track)	MAINTENANCE STAGE	Contract B(UG-Stations)
NIL		NIL






7. **Track and UG Tunnel (UGC-05)**

Contract A: Track (Interface Lead)		**Contract B : UG Station & Tunnel/Mid-ventilation shaft (MM3-CBS-UGC-05)** (Interface follower)	*Sheet # : 112*
Contract A (Track)	DESIGN STAGE	Contract B(UG Tunnel)	
TK/UG-01: Shall provide for Track Drainage design system consistent with the general drainage arrangements in the Tunnel and agree & provide the Point of interface in the cross passage/track sump.		*TK/UG-01*: Shall design the general drainage system in the Tunnel taking into account Track Drainage and accept the Point of Interface in the cross passage/track sump.	
Contract A (Track)	CONSTRUCTION / INSTALLATION STAGE	Contract B(UG Tunnel)	
TK/UG-02: Shall arrange for taking over after joint verification with Contractor-B and take up construction of the 2nd Pour concrete in the track above the 1st pour concrete done utilising the provisions of keying / shear connectors done by the Tunnel contractor (Contractor-B) *TK/UG-03*: Shall set the track to the 'monument plates' provided by the civil contractor (Contractor-B) which will be verified prior to laying/ concreting the Track. *TK/UG-04*: Shall provide the track Drainage system in the 2nd pour concrete consistent with the General Drainage arrangments constructed by the Tunnel Contractor(Contractor-B). *TK/UG-05*: To decide openings/way , storage spaces and schedule Access Periods jointly with Tunnel contractor (Contractor-B) and ensure implementation based on Trackconstruction program. *TK/UG-06*:To furnish details of requirment of services to TunnelContractor Contractor-B).		*TK/UG-02*: Shall complete construction of the 1st pour concrete over the slit of the Tunnel to specified levels (in consultation and coordination with Contractor-A) and within permitted tolerances and provide keying /shear connectors for the 2nd pour concrete *TK/UG-03*: Shall provide to the Track contractor 'monument plates' for setting the permanent track to its correct position. *TK/UG-04*: Shall furnish levels/details of the Drainage system in the Tunnel to Track contractor (Contractor-A) duly ensuring that Track Drainage is compatible with the General Drainage system (overall drainage scheme). *TK/UG-05*: Shall provide the required openings/way to take the track materials/plant/equipment underground for track laying and provide storage space for Track materials in consultation with track contractor and to permit access to track contractor for construction of Track as per agreed schedule of Access Periods. *TK/UG-06*: Shall provide services (water, power, and light) for construction of track.To Design and construct water supply schemes for Tunnel Work in consultation with Track Contractor.	

Contract A: Track (Interface Lead)		Contract B : UG Station & Tunnel/Mid-ventilation shaft (MM3-CBS-UGC-05) (Interface follower)	Sheet # : 112
Contract A (Track)	TEST & COMMISIONNING STAGE	Contract B(UG Tunnel)	
TK/UG-07:Shall attend and assist in the joint check with concerned interface contractors to ensure that all permanent structures are clear of the structure gauge specified in the S.O.D		*TK/UG-07*: Shall attend and assist in the joint check with concerned interface contractors to ensure that all permanent structures are clear of the structure gauge specified in the approved S.O.D	
Contract A (Track)	MAINTENANCE STAGE	Contract B(UG Tunnel)	
NIL		NIL	

6. Track and UG Stations (UGC-06)

Contract A: Track (Interface Lead)	Contract B : UG Stations (MM3-CBS-UGC-06) (Interface follower)	Sheet # : 1/2

Contract A(TRACK)	DESIGN STAGE	Contract B(UG-Station)
TK/UG-01: Shall fix chainages of the Turnouts / Cross over based on the chainage of Station Centre Line furnished by the Contractor-B. ***TK/UG-02***: Shall ensure at design stage ***TK/UG-03***: Shall provide Track drainage consistent with the General Drainage arrangement in Station area and agree & provide the Point of interface		***TK/UG-01***: Shall furnish correct chainage of Station centre line to Contractor-A. ***TK/UG-02***: Shall ensure that the pillars / columns supporting the station structure and all other structures are located clear of the minimum infringement clearances from centre of track as stipulated in the approved S.O.D. ***TK/UG-03***: Shall design the General drainage system(overall drainage system) in the Station area taking into account Track Drainage and accept the Point of Interface in the Station/Platform Area.
Contract A(TRACK)	CONSTRUCTION / INSTALLATION STAGE	Contract B(UG-Station)
TK/UG-04: Shall arrange for taking over after joint verification with Contractor-B ***TK/UG-05***: Shall ensure before taking up track installation work.		***TK/UG-04***: Shall hand over to the Track contractor(Contractor-A) the concrete base (duly providing 1st pour concrete, if required, and the shear connectors for track laying within the permitted tolerances) for track structure and the station platform to designated levels / clearances with in the tolerances permitted. ***TK/UG-05:*** Shall hand over the track installation area in the vicinity of Pillars / Columns and such structures/obstructions clear of the infringement distances stipulated in the approved S.O.D.

CONTRACT UGC-06

Contract A: Track (Interface Lead)	Contract B : UG Stations (MM3-CBS-UGC-06) (Interface follower)	Sheet # : 2/2
TK/UG-06: Shall jointly decide with the Contractor-B opening requirements, storage spacesand Schedule of Access Periods and ensure implementation basedon track construction program.	***TK/UG-06***: Shall provide the required openings in the structures to lower the track materials/plants/equipment including rails for track construction and provide storage space for Track materials in consultationwith Track contractor (Contractor-A) and shall permit Access to Track contractor for construction of Track as per agreed Schedule of AccessPeriods.	
TK/UG-07: Shall furnish details of requirements to Contractor-B .	***TK/UG-07***: Shall provide Temporary water supplies for construction of Track. Shall design & construct the water supply scheme in consultation with Track Contractor.	
TK/UG-08: To check the levels of platform and track base concrete at the time of taking over from Contractor-B and ensure that theheights and clearances from rail level / centre of track are with inacceptable limits as per the approved S.O.D.	***TK/UG-08***: Shall ensure that levels of Platform and Track Base Concrete in Station Boxes conform to the Design Levels and Tolerances.Shall furnish completed levels, curvature & cant ,if any, to Track Contractor (Contractor-A) for any adjustment in rail level/alignment while layingTrack.	
Contract A(TRACK)	**TEST & COMMISIONNING STAGE**	Contract B(UG-Station)
TK/UG-09:Shall attend and assist in the joint check with concerned interface contractors to ensure that all permanent structures are clear of the structure gauge specified in the approved S.O.D	***TK/UG-09***: Shall attend and assist in the joint check with concerned interface contractors to ensure that all permanent structures are clear of the structure gauge specified in the approved S.O.D	
Contract A(TRACK)	**MAINTENANCE STAGE**	Contract B(UG-Station)
NIL	**NIL**	

Track and UG Tunnel (UGC-06)

Contract A: Track (Interface Lead)		Contract B : UG Tunnels (MM3-CBS-UGC-06) (Interface follower)	Sheet # : 1/2
Contract A (TRACK)	**DESIGN STAGE**	Contract B (UG-TUNNEL)	
TK/UG-01: Shall provide for Track Drainage design system consistent with the general drainage arrangements in the Tunnel and agree & provide the Point of interface in the cross passage/track sump.		***TK/UG-01***: Shall design the general drainage system in the Tunnel taking into account Track Drainage and accept the Point of Interface in the cross passage/track sump.	
Contract A (TRACK)	**CONSTRUCTION / INSTALLATION STAGE**	Contract B (UG-TUNNEL)	
TK/UG-02: Shall arrange for taking over after joint verification with Contractor-B and take up construction of the 2nd Pour concrete in the track above the 1st pour concrete done utilising the provisions of keying/ shear connectors done by the Tunnel contractor (Contractor-B)		***TK/UG-02***: Shall complete construction of the 1st pour concrete over the sill of the Tunnel to specified levels (in consultation and coordination with Contractor-A) and within permitted tolerances and provide keying /shear connectors for the 2nd pour concrete	
TK/UG-03: Shall set the track to the 'monument plates' provided by the civil contractor (Contractor-B) which will be verified prior to laying/ concreting the Track.		***TK/UG-03***: Shall provide to the Track contractor 'monument plates' for setting the permanent track to its correct position.	
TK/UG-04: Shall provide the track Drainage system in the 2nd pour concrete consistent with the General Drainage arrangments constructed by the Tunnel Contractor(Contractor-B).		***TK/UG-04***: Shall furnish levels/details of the Drainage system in the Tunnel to Track contractor (Contractor-A) duly ensuring that Track Drainage is compatible with the General Drainage system (overall drainage scheme).	
TK/UG-05: To decide openings/way , storage spaces and schedule Access Periods jointly with Tunnel contractor (Contractor-B) and ensure implementation based on Track construction program.		***TK/UG-05***: Shall provide the required openings/way to take the track materials/plant/equipment underground for track laying and provide storage space for Track materials in consultationwith track contractor and to permit access to track contractor for construction of Track as per agreed schedule of Access Periods.	
TK/UG-06: To furnish details of requirment of services to Tunnel Contractor		***TK/UG-06***: Shall provide services (water, power, and light) for construction of	

Mumbai Metro Line 3

CONTRACT UGC-06

Contract A: Track (Interface Lead)	Contract B : UG Tunnels (MM3-CBS-UGC-06) (Interface follower)	Sheet # : 2/2
Contractor-B).	track.To Design and construct water supply schemes for Tunnel Work in consultation with Track Contractor.	
Contract A (TRACK)	TEST & COMMISIONNING STAGE	Contract B (UG-TUNNEL)
TK/UG-07:Shall attend and assist in the joint check with concerned interface contractors to ensure that all permanent structures are clear of thestructure gauge specified in the S.O.D	*TK/UG-07*: Shall attend and assist in the joint check with concerned interface contractors to ensure that all permanent structures are clear of the structure gauge specified in the approved S.O.D	
Contract A (TRACK)	MAINTENANCE STAGE	Contract B (UG-TUNNEL)
NIL	NIL	

6. Track and UG Stations (UGC-07)

Contract A: Track (Interface Lead)	Contract B : UG Stations (MM3-CBS-UGC-07) (Interface follower)	Sheet # : 1/2
Contract A(TRACK)	**DESIGN STAGE**	Contract B(UG-Station)
TK/UG-01: Shall fix chainages of the Turnouts / Cross over based on the chainage of Station Centre Line furnished by the Contractor-B. ***TK/UG-02***: Shall ensure at design stage ***TK/UG-03***: Shall provide Track drainage consistent with the General Drainage arrangement in Station area and agree & provide the Point of interface		***TK/UG-01***: Shall furnish correct chainage of Station centre line to Contractor-A. ***TK/UG-02***: Shall ensure that the pillars / columns supporting the station structure and all other structures are located clear of the minimum infringement clearances from centre of track as stipulated in the approved S.O.D. ***TK/UG-03***: Shall design the General drainage system(overall drainage system) in the Station area taking into account Track Drainage and accept the Point of Interface in the Station/Platform Area.
Contract A(TRACK)	**CONSTRUCTION / INSTALLATION STAGE**	Contract B(UG-Station)
TK/UG-04: Shall arrange for taking over after joint verification with Contractor-B ***TK/UG-05***: Shall ensure before taking up track installation work.		***TK/UG-04***: Shall hand over to the Track contractor(Contractor-A) the concrete base (duly providing 1st pour concrete, if required, and the shear connectors for track laying within the permitted tolerances) for track structure and the station platform to designated levels / clearances with in the tolerances permitted. ***TK/UG-05:*** Shall hand over the track installation area in the vicinity of Pillars / Columns and such structures/obstructions clear of the infringement distances stipulated in the approved S.O.D.

CONTRACT UGC-07

Contract A: Track (Interface Lead)	Contract B : UG Stations (MM3-CBS-UGC-07) (Interface follower)	Sheet # : 2/2
TK/UG-06: Shall jointly decide with the Contractor-B opening requirements, storage spacesand Schedule of Access Periods and ensure implementation basedon track construction program.	***TK/UG-06***: Shall provide the required openings in the structures to lower the track materials/plants/equipment including rails for track construction and provide storage space for Track materials in consultationwith Track contractor (Contractor-A) and shall permit Access to Track contractor for construction of Track as per agreed Schedule of AccessPeriods.	
TK/UG-07: Shall furnish details of requirements to Contractor-B .	***TK/UG-07***: Shall provide Temporary water supplies for construction of Track. Shall design & construct the water supply scheme in consultation with Track Contractor.	
TK/UG-08: To check the levels of platform and track base concrete at the time of taking over from Contractor-B and ensure that theheights and clearances from rail level / centre of track are with inacceptable limits as per the approved S.O.D.	***TK/UG-08***: Shall ensure that levels of Platform and Track Base Concrete in Station Boxes conform to the Design Levels and Tolerances.Shall furnish completed levels, curvature & cant ,if any, to Track Contractor (Contractor-A) for any adjustment in rail level/alignment while layingTrack.	
Contract A(TRACK)	**TEST & COMMISIONNING STAGE**	Contract B(UG-Station)
TK/UG-09:Shall attend and assist in the joint check with concerned interface contractors to ensure that all permanent structures are clear of the structure gauge specified in the approved S.O.D	***TK/UG-09***: Shall attend and assist in the joint check with concerned interface contractors to ensure that all permanent structures are clear of the structure gauge specified in the approved S.O.D	
Contract A(TRACK)	**MAINTENANCE STAGE**	Contract B(UG-Station)
NIL	**NIL**	

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Track and UG Tunnel (UGC-07)

Contract A: Track (Interface Lead)	Contract B : UG Tunnels (MM3-CBS-UGC-07) (Interface follower)	Sheet # : 1/2

Contract A (TRACK)	DESIGN STAGE	Contract B (UG-TUNNEL)
TK/UG-01: Shall provide for Track Drainage design system consistent with the general drainage arrangements in the Tunnel and agree & provide the Point of Interface in the cross passage/track sump. TK/UG-01(A) :Shall determine the track construction depth for the ballastless track on the RCC ramp structure and the ballasted track on formation at the approach of RCC ramp and interface and coordinate with the Contractor-B for determining the base slab level of the ramp.		***TK/UG-01***: Shall design the general drainage system in the Tunnel taking into account Track Drainage and accept the Point of Interface in the cross passage/track sump. TK/UG-01(A) : Shall incorporate the necessary details while designing the ramp structure.
Contract A (TRACK)	CONSTRUCTION / INSTALLATION STAGE	Contract B (UG-TUNNEL)
TK/UG-02: Shall arrange for taking over after joint verification with Contractor-B and take up construction of the 2nd Pour concrete in the track above the 1st pour concrete done utilising the provisions of keying/ shear connectors done by the Tunnel contractor (Contractor-B)		***TK/UG-02***: Shall complete construction of the 1st pour concrete over the sill of the Tunnel to specified levels (in consultation and coordination with Contractor-A) and within permitted tolerances and provide keying /shear connectors for the 2nd pour concrete
TK/UG-03: Shall set the track to the 'monument plates' provided by the civil contractor (Contractor-B) which will be verified prior to laying/ concreting the Track.		***TK/UG-03***: Shall provide to the Track contractor 'monument plates' for setting the permanent track to its correct position.
TK/UG-04: Shall provide the track Drainage system in the 2nd pour concrete consistent with the General Drainage arrangments constructed by the Tunnel Contractor(Contractor-B).		***TK/UG-04***: Shall furnish levels/details of the Drainage system in the Tunnel to Track contractor (Contractor-A) duly ensuring that Track Drainage is compatible with the General Drainage system (overall drainage scheme).
TK/UG-05: To decide openings/way , storage spaces and schedule Access Periods jointly with Tunnel contractor (Contractor-B) and ensure implementation based on Track construction program.		***TK/UG-05:*** Shall provide the required openings/way to take the track materials/plant/equipment underground for track laying and provide storage space for Track materials in consultationwith track contractor and to permit access to track contractor for construction of Track as per agreed schedule of

CONTRACT UGC-07

TK/UG-06:To furnish details of requirment of services to Tunnel Contractor	Access Periods. *TK/UG-06*: Shall provide services (water, power, and light) for construction of	
Contract A: Track (Interface Lead)	**Contract B : UG Tunnels (MM3-CBS-UGC-07) (Interface follower)**	***Sheet # : 2/2***
Contractor-B).	track.To Design and construct water supply schemes for Tunnel Work in consultation with Track Contractor.	
Contract A (TRACK)	**TEST & COMMISIONNING STAGE**	Contract B (UG-TUNNEL)
TK/UG-07:Shall attend and assist in the joint check with concerned interface contractors to ensure that all permanent structures are clear of thestructure gauge specified in the S.O.D	*TK/UG-07*: Shall attend and assist in the joint check with concerned interface contractors to ensure that all permanent structures are clear of the structure gauge specified in the approved S.O.D	
Contract A (TRACK)	**MAINTENANCE STAGE**	Contract B (UG-TUNNEL)
NIL	**NIL**	

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N10-Indicative Interface Sheet for Track Work (TWK-03) and Asset Management System (AMS)

Mumbai Metro Interface Sheet	**Contract A**	**AMS**	**Contract B**	**TWK-03**	***Rev #***	***: A1***
					Date	***17/06/19***
Approved by *:*	**AMS (Asset Management System)** Lead Contract		**TWK-03 (Track Work)** Participating Contract		First issue:	
GC issued by :						
Checked by :						

Interface description brief / Key elements (time schedule, physical, functional, ...) :

1.General Interface details between the Track Work (TWK-03) vs. Asset Management System (AMS)

Contract A (AMS*)*	**DESIGN STAGE**	**Contract B (TWK-03)**
AMS/TWK-01: Shall build up the main Asset Management common platform and interact with Contract B so that Contract B can understand the requests needed for the development and finalization of the AMS.		**AMS/TWK-01:** Shall ensure that the Track Work Asset data will be communicated to the main Asset Management Common Platform in such a manner that that Contract A is then able to thoroughly build up the database requested for the Asset Management System.
Reference documents*:* None		Reference documents*:* None
Contract A (AMS)	**CONSTRUCTION / INSTALLATION STAGE**	**Contract B (TWK-03)**
AMS/TWK-02: Shall provide the connectivity arrangements for Asset Management common platform Software at the design locations decided by MMRC.		**AMS/TWK-02:**Shall coordinate and update data inputs requested for the AMS during the Track installation.
Reference documents: None		Reference documents: None

Mumbai Metro Interface Sheet	**Contract A**	**AMS**	**Contract B**	**TWK-03**	***Rev #***	***: A1***
					Date	***17/06/19***
Contract A (AMS)		**TEST & COMMISSIONING STAGE**		**Contract B (TWK-03)**		
AMS/TWK-03: AMS Contractor shall jointly test with TWK-01 Contractor the functionality of Asset Management System Software according to the inputs received from Contract B.			**AMS/TWK-03:** Shall support Contract A in the final implementation of the AMS until reaching full and tested functionality of the AMS.			
Reference documents : None			Reference documents: None			
Contract A (AMS)		**MAINTENANCE STAGE**		**Contract B (TWK-03)**		
AMS/TWK-04: Shall implement the usage of the AMS during Maintenance stage and interact with Contract B until establishing a full functional methodology for the maintenance process of the AMS.			**AMS/TWK-04:** Shall support Contract A for the establishment of the maintenance process of the AMS.			
Reference documents: None			Reference documents: None			

Mumbai Metro Rail Line 3
BIDDING DOCUMENTS

EMPLOYER'S REQUIREMENTS
GENERAL SPECIFICATIONS

Part 2

Section VI (1)
Sub-Division F

Appendix 20
SAFETY AND HEALTH

July 2019

Table of Contents

STATEMENT OF INTENT

It is the intention of the Mumbai Metro Rail Corporation to build the Mumbai Metro Line-3 in a way that will further raise the standards of health and safety on construction sites to a level that will be recognized as the best in India and comparable to the highest standards achieved worldwide.

This can only be achieved if there is a commitment from all parties involved in the construction and management of the Project, from the most senior level of managers within the MMRC and the Contractors, to the workers on the sites.

This document shall have the full support of all of the MMRC Project Team and any officer failing to give support to it shall be subject to internal discipline.

The Mumbai Metro Rail Corporation shall actively support the efforts and initiatives that are instigated by the Contractors and sub-contractors in their efforts for achieving high standards of health and safety on the Project.

The ingredients that are needed to make and achieve a high standard of health and safety, are well known to most of us, it is however the level of commitment that is demonstrated that shall determine whether or not we succeed.

This manual represents the minimum standards that the Mumbai Metro Rail Corporation will accept on matters of Safety and Health. The Corporation will use its best endeavours to ensure that all of the Contractors employed on the Project achieve these Standards.

Managing Director/MMRC

1. REFERENCES AND DISTRIBUTION OF THIS MANUAL

1.1. References

1.1.1. The procedures in this manual should be read in conjunction with;

(a) The Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules 2007;

(b) The Factories Act, 1948;

(c) Other Laws of India, Regulations, Rules and Codes of Practice on Safety Health and the Environment that may be applicable;

(d) The Conditions of Contract in respect of Health and Safety, that apply to the specific Contract under which the Contractor is employed;

(e) The important Indian Standards and British Standards as applicable to the work of this contract;

1.2. Distribution of this Manual

1.2.1. Copies of this Health and Safety Manual are distributed to all Tenderers for Contracts where this has been shown as a referenced document for the Conditions of Contract, Safety Health and Environment. It will also be issued to all appropriate staff of MMRC and all other persons who have need of it.

2. DEFINITION OF TERMS

2.1. Introduction

2.1.1. The following terms used in this manual are defined as follows and shall be construed accordingly.

(a) Safety means the freedom from unacceptable risks of personal harm, i.e. the avoidance of accidents and incidents.

(b) Health means the physical wellbeing of a person and the freedom from any illness caused due to working conditions.

(c) Hazard means a situation with the potential to cause harm including human injury, damage to property, plant or equipment, damage to the environment, or economic loss.

(d) Risk means the chance of something adverse happening and its severity. It is a combination of the probability, or frequency, of the occurrence of a defined hazard and the magnitude of the consequences of the occurrence.

(e) Foreseeable means that which is likely or possible.

(f) Chief Safety Officer means an officer nominated by MMRC as Chief Safety Officer

(g) Site Safety Plan means the contract specific safety plan that the Contractor has produced from his Outline Safety Plan.

(h) Outline Safety Plan means the contract specific outline safety plan that the Contractor will prepare as part of his tender submission.

(i) Reportable Accident / Incident means an Accident or Incident that is reportable to the Engineer. It shall include all fatalities, major injury accidents, dangerous occurrences and all accidents, which result in incapacity for more than Forty-Eight hours or more immediately following the accident.

(j) Major Injury Accident is defined as:

1) Any fracture, other than to the fingers or toes;

2) Any loss of a limb or part of a limb;

3) Dislocation of the shoulder, hip, knee or spine;

4) Loss of sight (whether temporary or permanent);

5) Penetrating injury to the eye; or

6) Any other injury that:

- Leads to unconsciousness

- Requires resuscitation;
- Requires admittance to hospital for more than 24 hours;
- or which causes more than 10 days' absence from work.

(k) Dangerous Occurrence is defined as:

1) Collapse or failure of lifting appliances or hoist or conveyors or other similar;
2) Collapse or failure of a crane, derrick, winch, hoist or other appliance used in raising or lowering persons or goods or any part thereof (except the breakage of chain or rope slings), or the overturning of a crane;
3) Explosion or fire causing damage to the structure of any room or place in which persons are employed, or to any machine or plant, resulting in the complete suspension of ordinary work;
4) Electrical short circuit or failure of electrical machinery, plant or apparatus, attended by explosion or fire, causing structural damage involving its stoppage or disuse;
5) Explosion of a receiver or container used for the storage at a pressure greater than atmospheric pressure of any gas or gases (including air) or any liquid or solid resulting from the compression of gas;
6) Collapse in whole or part from any cause whatsoever of any roof, wall, floor, structure or foundation forming part of the construction site in which persons are employed;
7) Total or partial collapse of any overburden, face, tip or embankment on the construction site;
8) The overturning of, or collision with any object by any bulldozer, dumper, excavator, grader, lorry or shovel loader, or any mobile machine used for the handling of any substance on the construction site.

3. GENERAL

3.1. Introduction

3.1.1. It is the objective of the MMRC to ensure that the Contract is completed on time, within budget, and to conforming standards of Health and Safety.

3.1.2. This manual has system wide application, and therefore not all of the sections will apply to all Contractors. Each Contractor shall develop his own contract specific Site Safety Plan, which will represent his approach to the management of safety on his work, sites under the Contract with MMRC.

3.1.3. It is the intention of MMRC to levy fines against Contractors who do not comply with the requirements of this Manual. The fines levied will be donated to the MMRC Welfare Fund to assist those who have suffered as a result of this Project. The level of fines to be levied will set out in the Conditions of Contract.

3.2. Purpose of the Manual

3.2.1. This manual has been produced in order to outline the minimum health and safety, standards that shall be required by MMRC during construction of the Mumbai Metro Line-3 Project. Furthermore, the manual has been developed to give guidance and assistance to the respective Contractors in the development and production of their Site Safety Plans, to satisfy the required health and safety standards established by the Contract Conditions and the Employer's Requirements. This manual represents the minimum standards required and each Contractor is encouraged to expand and improve upon it.

3.2.2. This manual is not intended to replace existing standards that are currently in force in India. However, it is intended to support the standards and to highlight to Contractors the areas of concern that shall be addressed in their respective Site Safety Plans in order to establish good health and safety practices.

3.2.3. This document is intended to supplement the Section on Safety Measures as is contained in the

Employers Requirement.

3.2.4. The obligations and requirements for Health and Safety set out within this document are entirely without prejudice and do not derogate from the Contractor's obligations with respect to the Contract and his statutory obligations with respect to Health and Safety.

3.3. Scope of the Manual

3.3.1. The Contractor is fully responsible for the safety of the Works, his personnel, sub- contractors' personnel, the public and all persons directly or indirectly associated with the Works or on or in the vicinity of the Site.

3.3.2. This manual provides relevant information and procedures to assist the Contractor to ensure that his employees and sub-contractors work within a safety-conscious and safety-regulated environment. Compliance with the procedures set out in this manual shall not relieve the Contractor of any of his Statutory Duties or his responsibilities under the Contract.

3.4. Policy Objectives

3.4.1. Every Contract should aim at zero fatal accidents.

3.4.2. Every Contract should aim at zero dangerous occurrences (see section 2.1.1(k) for the definition of 'dangerous occurrence').

3.4.3. Every Contract should aim at an Accident Frequency Rate (AFR) of less than 0.5 per 100,000 hours worked on the Contract.

3.5. Implementation of Policy Objectives

3.5.1. The following general approach has been adopted by MMRC with a view to achieving the policy objectives set out above

(a) Secure a commitment to safe and healthy working practices by all parties involved in the construction process, including consultants, Contractors, sub- contractors, workers' unions, and utility providers.

(b) Develop contract provisions that require Contractors to prepare, implement and monitor safety plans, and ensure that sub-contractors are also obliged to comply with the same. (Copies of the provisions relating to Health and Safety are contained in the Conditions of Contract).

(c) Arrange accident prevention, safety management training for all site staff supervising Contracts.

(d) Establish Site Safety Management Committees to monitor the implementation of safety plans and keep a record of the Meetings of the Committees.

(e) Build up a database of accidents and dangerous occurrences, as defined in Section 9 of this manual, for the purpose of monitoring trends, analysing data, and formulating measures for accident prevention.

(f) Publish this Manual to assist in the administration of construction safety matters of the Employer's contracts.

(g) Oversee the safety performance of the Contractors and sub-contractors to ensure that their duties and responsibilities on health and safety under the Contract, this Manual, and other relevant Employer and Government requirements are fully discharged.

(h) To publish and issue any further instruction / appendices needed for any specific requirement of the Contract

3.6. Responsibility for the Manual

3.6.1. The Directors/Any other nominated officials of MMRC are responsible for ensuring that the contents of this Manual continue to meet the requirements of the MMRC and that they are implemented rigorously.

4. GENERAL DUTIES OF CONTRACTORS AND OTHERS

4.1. Introduction

4.1.1. Securing safe, healthy places of work requires the full co-operation of Contractors and sub-

contractors and the persons employed by them. It is imperative that there is no ambiguity with regard to the responsibilities of any individuals in connection with duties relating to health and safety.

4.1.2. The responsibilities shall be clearly detailed in the Site Safety Plan from the level of the most Senior Manager downwards; these duties shall be explained to the individuals concerned in order to ensure that they clearly and concisely understand them.

4.1.3. Responsibilities for safety, health and the environment shall be allocated amongst others to the following personnel of the Contractors and sub-contractors:

(a) CEO / Managing Director:
(b) Contractor's Representative
(c) Site Agent/Manager:
(d) Engineers:
(e) Safety Officer:
(f) Supervisors:
(g) General Workers

4.2. General Duties of Persons Employed

4.2.1. Every person employed by Contractors and sub-contractors on construction sites are obliged to comply with the general duties imposed on them under the Contract. Every person employed should, not only avoid careless or reckless behaviour, but should also take positive steps to understand workplace hazards. They must follow all necessary safety and environment rules and procedures, and ensure that their acts or omissions at work do not put the health and safety of self or others at risk.

4.3. Contractors and Sub-Contractors Responsibilities

4.3.1. Contractors and sub-contractors are responsible for complying with all statutory and contractual requirements on construction safety, health and environment including the general duties imposed on them under the Laws and Regulations of the Government of India, Government of Maharashtra.

4.3.2. The Employer/The project Manager shall only deal with health and safety matters through the Contractor and shall hold the Contractor responsible for all his and his sub- contractors, actions. All sub-contractors shall be responsible to the Contractor.

4.3.3. All Contractors and sub-contractors shall ensure that an adequate level of competent supervision is maintained at the workplace at all times with all supervisory staff having the relevant knowledge, training, and experience to enable them to supervise the work in a proper manner.

4.3.4. Contractors shall ensure that all sub-contractors are able to demonstrate a successful track record with regard to the management of health and safety. The type of information that shall be requested from the sub-contractors during the tendering/selection process in order to determine their suitability shall include amongst other things the following information relating to their activities over the last five years

(a) Fatal accidents
(b) Major lost time due to accidents
(c) Accidents involving members of the public
(d) Dangerous Occurrences

4.3.5. Contractors and sub-contractors are responsible for submitting written statements on their policies relating to construction safety within fourteen days of a requirement to do so by Employer/Engineer.

4.3.6. Contractors and sub-contractors are responsible for providing comprehensive safety and environment plans for the review by Employer/Project Manager, and for subsequent implementation of the measures detailed in the safety and environment plans.

4.3.7. Contractors and sub-contractors are responsible for the provision of suitably trained and

qualified safety staff to carry out regular safety inspections, safety promotion, and safety audits and for retention of records of all such activities for inspection by Employer/Project Manager.

4.3.8. Contractors and sub-contractors are responsible for providing safety and environment training to all workers and supervisors on site, and for retention of records of such activities for inspection by the Employer/Engineer.

4.3.9. Contractors and sub-contractors are responsible for organizing site safety committees which shall meet at least monthly.

4.3.10. Contractors and sub-contractors are responsible for reporting dangerous occurrences and accidents to the Engineer by the quickest practicable means.

4.4. Discipline

4.4.1. Any major breaches of the Site Safety Plan, relevant Statutory Provisions and Safety Codes, or any other blatant disregard for the health and safety by any person directly or indirectly associated with the works may result in the MMRC exercising their authority in requiring the removal from the Site of the Contractor's Site Manager and/or other personnel.

4.4.2. The Contractors shall develop a system of disciplinary measures and procedures, which shall be implemented immediately that the site activities commence. These measures and procedures should include amongst other things:

(a) The issue of Warning Notices.

(b) The removal from site of personnel who disregard safety instructions.

4.4.3. Any person who is removed from the site for breach of safety measures shall not be allowed to be re-employed on any other MMRC worksite.

5. SAFETY TRAINING AND SAFETY PROMOTION

5.1. Safety Training

5.1.1. Safety Training is an important factor in managing safety on construction sites. All Contractors shall provide as a minimum the following types of training:

5.1.2. Induction Training shall be given to all persons prior to permitting them to go to the worksite. The workers Identification Card should not be issued until this training has been given. This training should include at least the following:

(a) General safety awareness
(b) First aid
(c) Emergency procedures
(d) Use of personal protective equipment
(e) Specific site hazards

5.1.3. Refresher Training shall be conducted at least every three months to ensure that all workers on site are kept up to date with safety requirements on site.

5.1.4. Specific Training shall be provided to persons with safety related tasks, such as Crane Operators, Banksmen, Slingers and Plant Operators etc.

5.1.5. Toolbox Talks shall be conducted so that every worker on site receives at least two toolbox talks every week. These talks should be designed to highlight relevant safety and industrial health issues to the workforce on a regular basis in order to raise their level of awareness. These should be prepared so that they can be presented by the Site Supervisors. Examples of Toolbox Talks are given in Schedule 2 of this Manual.

5.1.6. All training that is carried out shall be formally recorded on dated and signed attendance records, with copies of the records being kept on the sites for inspection by the Engineer. Details of the respective training course programmes shall be produced, on demand or as per intervals prescribed, which include the following information:

(a) Course Title.

(b) Course Duration

(c) Course Content.

(d) Target Audience.

(e) Actual Audience with record of attendance. (Use form SAF 031).

5.1.7. The Contractor shall keep detailed records of all training undertaken, and shall keep such records available for inspection by the Engineer.

5.2. Safety Promotion

5.2.1. The Contractors at each of their sites in the interests of promoting safety awareness amongst the workforce shall devise and implement practical Safety Promotion schemes. The objective of these schemes should be to recognize and reward individuals who continually endeavour to work in a safe manner.

5.2.2. Suggestions for such promotions may include such items as the issue of the following as rewards to individuals for good safety performance:

(a) Key Rings.
(b) T-Shirts
(c) Holdall Bags

5.2.3. Other safety award and safety incentive schemes should be considered

5.2.4. Regular Safety and Industrial Health Poster Campaigns / Billboards / Banners / Glow signs should be devised, with posters displaying safety and industrial health related issues being displayed around the worksites as part of the effort to raise Safety Awareness amongst the workforce. Posters should be in Hindi, English and local language. Posters / Billboards / Banners / Glow signs should be changed at least once a month to maintain their impact.

6. SAFETY INSPECTIONS AND FOLLOW UP ACTION

6.1. Inspections by Contractor’s Safety Supervisory Staff

6.1.1. The Contractor's Representative and supervisory staff are required to carry out weekly site safety inspections and prepare reports of such inspections. Copies of the completed inspection reports shall be kept on site and available for inspection by the Project Manager.

6.1.2. The frequency of the inspections shall be determined by site activities and general conditions. However, the inspections should be conducted at a minimum of once a week. Where high-risk activities are being carried out inspections should be carried at least once daily.

6.1.3. The inspection reports should be discussed with the relevant Site Managers. These shall also be discussed with the sub-contractors and other levels of site management in the Site Safety Meetings as detailed in Section-8 of this Manual.

6.1.4. For each Contract the Contractor shall prepare a comprehensive safety inspection checklist, as a requirement of the Safety Plan. This check-list can then be used for:

(a) Inspections by the Contractor's Safety Officers;

(b) Monitoring of the Contractors' safety inspections by the Site Safety Management Committee.

6.1.5. The Project Manager’ Staff may carry out site safety inspections, which shall be attended by the Contractors' Site Manager and Safety Manager.

6.1.6. In relation to Works Contracts, the insurers providing insurance cover for Contractor's All Risks and Third Party liability may visit the sites with a view to checking whether the Contractors have taken adequate safety precautions against damage to the works.

6.2. Follow up actions

6.2.1. Remedial action to rectify any deficiency identified or unsafe practices discovered during the safety inspections should be implemented immediately. Until the remedial action is taken the task may be discontinued.

6.2.2. In cases where the Project Manager’s staff believe that the Contractor's or sub-contractors'

workmen are using unsafe working methods the Contractor's Representative should be informed by them as soon as possible. If the unsafe activity continues, it shall be reported to the Employer's Chief Safety Officer.

6.2.3. If the Contractor's working method is deemed so unsafe as to represent a risk to life, the Project Manager may require specific actions by the Contractor, such as proposals on preventive/remedial measures, or suspension of relevant portions of the works, and introduction of measures deemed necessary. All such instructions shall be confirmed in writing and shall include a proviso that the issue of the instruction shall not relieve the Contractor of his responsibilities under the Contract or Statutory obligations. The project Manager may also invoke a fine on the Contractor in accordance with Section 4.1.3.

7. CONTACTOR'S SITE SAFETY COMMITTEES

7.1. General

7.1.1. All employees should be able to participate in the making and monitoring of arrangements for safety and health at their place of work. The establishment of site safety committees in which employees and Contractor and sub-contractor management are represented can increase the involvement and commitment of employees. The Contractor shall set up such site safety committees to promote and monitor safety and health on their worksites. A copy of the agenda shall be forwarded to the Project Manager seven days prior to the meeting date, in order that they can decide if it is necessary for them to attend.

7.2. Composition and Functions of Contractor's Safety Committees

7.2.1. The Contractor should form a safety committee for each contract, however should the situation require more than one committee, or the Engineer so requires, additional committees shall be created.

7.2.2. The Terms of Reference for the committee should be as follows;

(a) To monitor the adequacy of the Contractor's Site Safety Plan and ensure its implementation;
(b) To monitor safety inspection reports;
(c) To study accident and incident reports;
(d) To study accident statistics and trends so as to identify unsafe practices and conditions;
(e) To review the emergency and rescue procedures;
(f) To review site safety training;
(g) To promote safety and industrial health on site;
(h) To discuss the Contractor's monthly safety report;
(i) To take follow up actions on minutes of meeting.

7.2.3. The Membership of the committee should be as follows;

7.2.4. The Contractor's most Senior Manager for the Contract. Secretary: The Contractor's Safety Officer

Members: Contractor's and Sub-contractor's management representatives and safety staff. In attendance as and when they wish, Representatives of the Employer and the Engineer, meetings should be held at least once every month.

7.2.5. Minutes of the Site Safety Committee shall be sent to all members within two working days of the meeting. Copies of the minutes should be displayed on notice boards so that employees are kept informed of the Site Safety Committee's activities and decisions.

8. REPORTING OF ACCIDENTS AND DANGEROUS OCCURRENCES

8.1. Contractors Responsibility

8.1.1. All accidents and dangerous occurrences shall be recorded, regardless of whether or not personnel injury occurs.

8.1.2. The Employer and the Project Manager shall be notified by the quickest possible means, for

example by telephone of the following classifications of accidents and incidents and by subsequent written notification within twenty-four hours on the Contractors Accident and Incident Reporting Form (for example of form see Schedule 1):

(a) Fatal Accident
(b) Major Injury Accident (see definition in 2.1.1(j))
(c) Dangerous Occurrence (see definition in 2.1.1(k))
(d) Any Incident Involving a Member of the Public

8.1.3. The Site Safety Officer shall conduct in depth investigations into all fatal accidents, major injury accidents, incidents involving a member of the public, dangerous occurrences, and selected over three-day lost time injury accidents. Copies of these investigations shall be forwarded to the Engineer within seven days of the incident.

8.1.4. The Contractor shall report immediately, orally and in writing, all fatal accidents, and other occurrences requiring reporting, to the police, at the police station in whose jurisdiction the accident occurred.

8.2. Reportable Accidents

8.2.1. An accident shall also become reportable to the Project Manager if it causes incapacity for more than three days excluding the day of the accident. The Contractor must submit a report on form SAF 001 to the Project manager within seven days of the incident.

8.2.2. The following information is required in reporting an accident to the Engineer.

(a) Particulars of the Contractor or Sub-contractor employing the injured person;
(b) Particulars of the deceased or injured person: name, address, occupation, sex, and age;
(c) The date, cause or circumstances of the accident; and
(d) The nature of the injury, stating whether death or incapacity was caused by the injury.

8.3. Dangerous Occurrences

8.3.1. The Project Manager requires that all dangerous occurrences on site must be reported in writing to him within 24 hours, irrespective of whether there are casualties or not. The following information has to be provided:

(a) The time of the occurrence;
(b) Damage to any building, machinery or plant; and
(c) The circumstances in which the accident occurred.

A copy of the standard 'Dangerous Occurrence Report form' SAF 001 (as attached to this Manual) may be used.

8.3.2. If no one is injured, the above notification is sufficient. In the case of death or serious injury, the accident reporting procedure outlined in Section 9.1.2 must also be followed.

8.4. Reporting of Fires by Contractor

8.4.1. The Contractor shall report to the Project Manager all fires which occur on site including any fires that have been extinguished by the Contractor himself, and the Project Manager may send staff to investigate such fires. The following information should be provided:

(a) time of fire;
(b) location of fire;
(c) means of extinguishing the fire;
(d) injury to any person/damage to any property; and
(e) the probable cause of fire.
(f) This action is in addition to reporting the incident to the Chief Fire Officer, and Police in accordance with local regulations.

8.5. Reporting to the Engineer

8.5.1. The Contractor shall duly complete standard forms on dangerous occurrences and accidents as required by the Project Manager to enable the Project Manager to prepare a database on

accident statistics. The Contractor shall deliver to the Project Manager a copy of any statutory reports he submits to the Relevant Authorities.

8.5.2. The Contractor shall send a monthly report to the Project Manager of all accidents and dangerous occurrences whether they are of a serious nature or not.

9. ACCIDENT INVESTIGATION

9.1. General

9.1.1. Investigations should be conducted in an open and positive atmosphere that encourages the witnesses to talk freely. The primary objective is to ascertain the facts with a view to prevent future and possibly more serious occurrences. Accidents are rarely just the fault of the worker. If the worker has not been trained, instructed or properly supervised then the fault may well lie with management.

9.1.2. Accidents and Dangerous Occurrences which result in death, serious injury or serious damage must be investigated by the Contractor immediately to find out the cause of the accident/occurrence so that measures can be formulated to prevent any recurrence. (Refer to the advice contained in 9.2.1 below.)

9.1.3. Near misses and minor accidents should also be recorded and investigated by the Contractor as soon as possible as they are signals that there are inadequacies in the safety management system.

9.2. Recommended actions in incident investigation

9.2.1. It is important after any Accident or Dangerous Occurrence that information relating to the incident is gathered in an organized way. The following steps are recommended;

(a) Take photographs and make sketches
(b) Examine involved equipment, work piece or material and the environmental conditions
(c) Interview the injured, eye-witnesses and other involved parties
(d) Consult expert opinion where necessary
(e) Identify the specific Contractor or Sub-contractor involved.

9.2.2. Having gathered information, it is then necessary to make an Analysis of Incident

(a) Establish the chain of events leading to the accident or incident
(b) Find out at what stage the accident took place
(c) Consider all possible causes and the interaction of different factors that led up to the accident, and identify the most probable cause

Note: The cause of an accident should never be classified as carelessness. The specific act or omission that caused the accident must be identified.

9.2.3. The next stage is to proceed with the Follow-up Action

(a) Report on the findings and conclusions
(b) Formulate preventive measures to avoid recurrence
(c) Publicize the findings and the remedial actions taken

10. ACCIDENT STATISTICS

10.1. Introduction

10.1.1. Accident data, if properly collected and analysed, indicates trends, and can show where and how problems arise. Comprehensive accident information enables accident prevention efforts to be targeted at problem areas.

10.2. Collection of Accident Statistics

10.2.1. The procedures that apply for the reporting and collation of data in respect of accident statistics are set out below.

10.2.2. The Contractors' safety officers are required to send duly completed Report Forms (Refer to Schedule 1 – SAF 002 and SAF 003), to the Project Manager within five days after the end of each month. The Construction Accident Statistics Monthly Report Form must be submitted

even if there are no injuries or dangerous occurrences within the current month.

10.2.3. Man-hours' is defined as the man-hours worked by all persons employed on site. (including site supervisory staff, management staff and clerical staff).

10.2.4. 'Man-days' is defined as the man-days worked by all persons employed on site. (including site supervisory staff, management staff and clerical staff).

10.3. Calculation of man-days lost - Construction Accident Statistics

10.3.1. When calculating the man-days lost for the Construction Accident Statistics Summary Sheet, the following applies:

The number of man-days lost refers to the total number of man-days lost during the reported month due to:

(a) Non-fatal reportable accidents which happened within the reported month

(b) Non-fatal reportable accidents which occurred in previous months.

The day on which the reportable accident occurred should be excluded in calculating man-days lost but public holidays within the injured period should be counted.

10.4. Calculation of Accident Frequency Rate (AFR)

The Accident Frequency Rate (AFR) per 1 million man-hours worked shall be calculated using the following formula

$$\left[\frac{\text{No. of reportable accidents}}{\text{Man-hours worked}} \quad \text{X 1 million} \right]$$

A reportable accident is a Fatality, a Major Injury Accident as defined in 2.1.1(j), and reportable accidents as defined in 2.1.1(i).

11. HAZARD IDENTIFICATION AND RISK ASSESSMENT

11.1. General

11.1.1. The purpose of Hazard Identification and Risk Assessment is to identify all the significant hazards, which may occur during the construction phase, and to rank them according to their severity. Having ranked the risks by severity the Contractor shall then introduce measures to mitigate the effects of that risk.

11.1.2. Prior to the commencement of any potential High-Risk operations the Contractor shall conduct a detailed hazard analysis and risk assessment of the task and shall record his findings on appropriate worksheets. Examples of worksheets SAF 020 may be found in Schedule 2.

11.1.3. The worksheets should then show what measures the Contractor is going to take to reduce the level of risk to acceptable levels.

11.2. Method Statements

11.2.1. As a result of the Hazard Identification and Risk Assessment detailed method statements shall need to be produced for medium and high risk activities including amongst others the following:

(a) Craneage of items in excess of 1 tonne
(b) Erection of steel structures.
(c) Excavations deeper than 2m.
(d) Erection and loading of formwork
(e) Demolition.
(f) Tunnelling operations.
(g) Inflammable materials – the use and storage
(h) Use and storage of explosives

A component part of the detailed method statement shall be the inclusion of the completed Hazard and Risk Worksheet as discussed in Section 11.2 above.

11.2.2. Method Statements will usually be attached to Design Submissions but should be cross-

referenced to the Contractor's Site Safety Plan.

11.2.3. A method statement should contain sufficient information to enable the task to be undertaken safely and should contain as a minimum the following information

(a) Introduction – A brief outline of the Task
(b) Details of the Risks involved
(c) A step by step description of how the task is to be undertaken detailing

- what needs to be done;
- the order in which the task will be carried out;
- what plant or equipment is required;
- who the task will be done by;
- who will supervise the task;
- where will the task take place;
- when will the task take place;
- the precautions which must be taken before the task is undertaken;
- what to do if things go wrong;

11.3. Permits to Work

11.3.1. The Contractor shall develop a permit-to-work system, which is a formal written system used to control certain types of work that are potentially hazardous. A permit- to-work is a document, which specifies the work to be done, and the precautions to be taken. Permits-to-work form an essential part of safe systems of work for many construction activities. They allow work to start only after safe procedures have been defined and they provide a clear record that all foreseeable hazards have been considered. Permits to Work are usually required in high-risk areas as identified by the Risk Assessments.

11.3.2. A permit is needed when construction work can only be carried out if normal safeguards are dropped or when new hazards are introduced by the work. Examples of high risk activities include but are not limited to:

(a) Work close to 25kV overhead Catenary/Contact System.
(b) Entry into Confined Spaces (SAF 010)
(c) Work in Close Proximity to Overhead Power lines and Telecommunication Cables.
(d) Hot Work (SAF 012)
(e) To Dig - where underground services may be located
(f) Work with moving construction locomotives.
(g) Working on Electrical Apparatus (SAF 011)
(h) Work with Radioactive isotopes.
(i) Work at height.

11.3.3. The permit-to-work system should be fully documented, laying down:

(a) How the system works;
(b) The jobs it is to be used for;
(c) The responsibilities and training of those involved; and
(d) How to check its operation;

11.3.4. The permit-to-work form must help communication between everyone involved. It should be designed by the Contractor issuing the permit, taking into account individual site conditions and requirements. Separate permit forms may be required for different tasks, such as hot work and entry into confined spaces, so that sufficient emphasis can be given to the particular hazards present and precautions required.

11.3.5. The permit to work form should contain:

(a) clear identification of who may authorize particular jobs (and any limits to their authority);

(b) clear identification of who is responsible for specifying the necessary precautions (e.g. isolation, emergency arrangements, etc.);

(c) a detailed description of the task clearly identifying the work to be done and the associated hazards;

(d) plans and diagrams be used if appropriate to assist in the description of the work to be done, its location and limitations;

(e) Identification of the hazards and the precautions to be taken;

(f) clear rules about how the job should be controlled or abandoned in the case of an emergency;

(g) the time limitations should be stated;

(h) job specific toolbox talk conducted by the supervisor

11.3.6. A Permit to Work Authorization Form shall be completed with the maximum duration period not exceeding twenty-four hours (for example of a Permit to Work authorization form see Schedule 1)

11.3.7. A copy of each Permit to Work shall be displayed, during its validity, in a conspicuous location in close proximity to the actual works location to which it applies.

11.3.8. A pre-permit activation job specific toolbox talk shall be conducted by the supervisor including amongst others the following.

(a) All identified hazards are explained;

(b) Risk mitigation process clarified;

(c) Method of work explained stressing points (a) and (b) above;

(d) Emergency response procedure is clarified and persons assigned tasks in the event of an emergency;

(e) Personal Protective Equipment (PPE) requirements including PPE serviceability checks and training if required;

All workers and supervision shall attend the toolbox talk and sign the toolbox attendance register. Any person's coming late to the work site shall be given the toolbox talk and sign the attendance register. A copy of the toolbox talk and attendance register shall be displayed as per section 12.3.7 of this manual.

12. EMERGENCY PREPAREDNESS PLANS

12.1. Emergency Situations

12.1.1. Every Contractor shall formulate an Emergency Preparedness Plan for each of his sites. These plans will address foreseeable emergencies that may arise during the construction activities. Examples of activities for which plans should be prepared include amongst other things:

(a) An Accident Which Results in Death or Major Injury. (Major Injury as defined in Section2.1.1(j))

(b) A Serious Fire That Threatens Life.

(c) A Flood That Threatens Life.

(d) Leakage of Any Dangerous Materials or Chemicals.

(e) Leakage / Short Circuit of any Electrical supply.

(f) Major Engineering Failures such as:

- collapse of tunnels or structures
- major utility collapse
- unintended explosions
- subsidence causing damage to structures or services

12.1.2. An Emergency Preparedness plan should include details of the following;

(a) The name, location and phone number of the Emergency Coordinator;

(b) Designated Personnel with locations and phone numbers;

(c) Details of the Emergency Response Team with locations and phone numbers;

(d) Functions of the Emergency Response Team;
(e) The means of Escape;
(f) Communication with the Emergency Services;
(g) Police
(h) Fire Services
(i) Ambulance and Hospital Services
(j) First-Aid Facilities;
(k) Site plans;
(l) Suppliers of emergency equipment such as sump pumps, lighting, craneage, etc.

12.1.3. Copies of the emergency procedures and the Contractor's rescue organization (reviewed without objection by the Engineer) should be displayed at each place of work and notice boards. This information should be reviewed and updated as often as is required, but at least once annually. Drills should be arranged to test the efficiency in mobilizing the necessary personnel and equipment. These Drills should be carried out at least every three months.

12.1.4. Regular joint exercises between the Contractor's rescue teams and the Fire and Emergency Services should also be carried out for the major contracts.

13. SAFETY SIGNAGE

13.1. Safety Signs

13.1.1. All safety signage that is displayed in and around the sites shall be in both local language and English, examples of signs that shall be required shall include amongst others the following:

(a) Wear Safety Helmets /Jacket
(b) Permit to Work areas
(c) Wear Safety Footwear
(d) Wear Hearing Protection
(e) Wear Eye Protection
(f) Danger Electricity
(g) Danger Crane Overhead
(h) Stop Look and Listen
(i) No Smoking
(j) First Aid
(k) No Entry signs
(l) Fire precautions
(m) Emergency Exit from underground works

13.1.2. All safety signs shall comply with the internationally recognized Safety Colours as indicated below:

- Blue : Mandatory
- Yellow : Danger
- Red : Prohibition
- Green : Safe Condition

13.2. References

Indian Standards
IS 9457:1980 : Standard for colours of Safety Signs
IS 12349 1988 : Fire Protection - Safety Signs

14. INDUSTRIAL HEALTH AND WELFARE

14.1. Introduction

14.1.1. Hazards to Health on a construction site can arise from the use of a number of materials, substances and processes if they are not properly controlled. Some of the more serious risks are caused by the inhalation of dusts, fibers, toxic fumes, by the misuse of chemicals, lasers and radioactive isotopes. Excessive vibration and excessive noise can also cause ill health. Many man-days are lost as a result of dermatitis, tenosynovitis, bronchitis and rheumatism.

14.1.2. The Contractor shall be responsible for maintaining healthy working conditions for all his, and his sub-contractors, workers. In particular, he shall pay attention to the effects of noise, dust, air pollution and the use of chemicals. If it is not possible to remove the cause of harm, then suitable and sufficient Personal Protective Equipment (PPE) should be provided to those workers who could be affected.

14.1.3. If the use of PPE is the only means of providing protection the Contractor shall ensure that all the workers affected are properly trained in the use of the PPE and that adequate supervision is provided to ensure its proper use.

14.2. Hazardous Substances

14.2.1. The Contractor shall obtain Material Safety Data Sheets (MSDS) for all substances that are deemed to be hazardous to be used on site. An inventory shall be kept of all such materials with the relevant MSDS and shall be available for inspection by the Project Manager who may require further MSDS's to be obtained.

14.2.2. The Contractor shall conduct an assessment of the substance in relation to its intended usage on site. Particular attention must be given to the actual location of usage as a substance, which is safe for use in the open air, may be extremely hazardous in a confined space. The results of all assessments shall be recorded and method statements produced. (For an example of a Hazardous Substance Assessment Form see Schedule 1).

14.2.3. The objective of the assessment is to establish what precautions and control measures shall be implemented in order that a safe system of work can be established for the use of the substance on site.

14.3. Noise

14.3.1. Industrial deafness is caused by over exposure to high levels of noise from plant, machinery or construction processes. Once a part of a person's hearing has been lost it can never be recovered. Deafness can also lead to further accidents on site with workers being unable to hear warnings and other instructions.

14.3.2. For continuous exposure, i.e. for eight hours in any one-day, the sound level should not exceed 90dB (A). For non-continuous exposure a calculated equivalent continuous sound level (Leq) should not exceed 90dB (A). Workers should not be exposed to sound levels exceeding 90dB (A) unless they are wearing suitable hearing protectors, which effectively reduce the sound level at the user's ear to, or below, 90dB (A).

14.3.3. If peak noise levels exceed 120dB (A) then the wearing of suitable hearing protectors shall be Mandatory.

14.3.4. The Contractor shall carry out noise assessments to establish what noise levels his workers are being exposed to. If excessive noise levels above 90dB (A) are found, then the Contractor shall introduce a noise control programme to protect his workers.

14.3.5. Consideration should always be given first to reducing the noise level at source. Examples of noise reduction methods include;

(a) More efficient silencers on compressors and maintenance of exhaust systems;
(b) Fitting acoustic lining to machinery panels;
(c) Use of Acoustic screens and sheds to protect other workers;
(d) Using noise reduced tools;
(e) Sighting of noisy plant away from the workplace

14.3.6. Where it is not possible to reduce the noise level to which the worker is exposed the Contractor shall provide the workers with suitable and sufficient hearing protection to protect them. The Contractor shall ensure that all the workers affected are properly trained in the use of the

Hearing Protection and that adequate supervision is provided to ensure its proper use.

14.4. Ventilation in Shafts and Tunnels

14.4.1. The Contractor shall assign a Competent Person to perform all air monitoring required to determine proper ventilation and quantitative measurement of potentially hazardous gases. The atmosphere in all underground areas shall be tested quantitatively by the Contractor for toxic gases, dust, vapour, mist, and fumes as often as necessary to ensure that prescribed limits given at 14.4.3 below are met. Quantitative tests for methane shall also be performed in order to determine whether an operation is potentially hazardous. For every test carried out the Contractor shall maintain a record of the air quality, the location, date, time, substances and amount monitored. These records shall be made available to the Engineer on demand.

14.4.2. The ventilation system shall be adequate to maintain circulation of air in all parts of tunnels and shafts and following conditions shall be taken care of:

14.4.3. Air shall be considered unfit for workmen to breathe if it contains any of the following:

(a) Less than 19.5% oxygen by volume.
(b) More than 0.005% carbon dioxide by volume.
(c) More than 0.01% carbon monoxide by volume.
(d) More than 0.001% hydrogen sulphide by volume.
(e) More than 0.005% oxides of nitrogen.
(f) More than 0.5% of methane at any place in the tunnel.
(g) More than 0.0002% of aldehyde.
(h) Any other poisonous gas in harmful amounts.

In addition to the requirements given above, 2 m^3 of fresh air per minute shall be furnished for each brake horsepower of diesel engine used in the tunnel.

14.4.4. The Contractor will ensure the supply of fresh air to all underground work areas in sufficient amount to prevent any harmful accumulation of dust, vapour or gases. The Contractor shall provide at least 6m^3 of fresh air per minute per employee underground.

14.4.5. No inflammable materials or oil and grease shall be stored inside or near the tunnels or shafts and all combustible rubbish from the tunnel or shaft shall be promptly removed. A regular analysis of the gases inside the tunnel should be done with advance of the tunnel.

14.4.6. Tools made of light alloys (such as Al and Mg) are not to be used inside the tunnel. They may cause sparks.

14.4.7. Regular checking of gas (referred at 14.4.3) at the faces shall be done before each shift. This should be carried out using a multi gas detector.

14.4.8. Motive power other than electric, shall not be used without prior authorisation from the Engineer. No petrol engines shall be used underground. Diesel locomotives shall only be used with the prior consent of the Engineer. Diesel engines shall not be used underground unless equipped with a filter that will remove all carbon monoxide and oxides of nitrogen. Such filters shall be tested by the Contractor's chief mechanic and more frequently by the plant operator.

14.5. Toilets

14.5.1. The Contractors shall ensure that an adequate number of toilets are made available at the work sites with the ratio being no less than one toilet for every 50 workers or part thereof. The toilets shall be located so that persons do not have to walk more than five hundred meters to use them.

14.5.2. The toilets shall have adequate water supply and be kept in a clean and tidy condition at all times.

14.6. Drinking Water

14.6.1. The Contractors shall ensure that effective arrangements are made to provide and maintain at suitable points a sufficient supply of wholesome drinking water.

14.6.2. All such points shall be legibly marked "Drinking Water" in local language and English and no such point shall be situated within six meters of any washing place, urinal or latrine.

14.7. Lifting and Carrying of Excessive Weights

14.7.1. All Contractors shall ensure that no worker lifts by hand or carries overhead or over his back or shoulders any material, article, tool or appliances exceeding in weight the maximum limits set out below unless aided by another worker or a mechanical device.

Adult – man 55kg
Adult – female 30kg

14.8. References

Indian Regulation
The Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules 2007: Chapter X - General Safety Provisions

14.9. INDIAN STANDARDS

IS 4756: 1978 Safety Code for Tunnelling works
IS 1179: 1967 Specification for equipment for eye and face protection during welding
IS 2925: 1984 Specification for Industrial Safety Helmets

16.10. BRITISH STANDARDS
BS EN 352: Hearing protectors. Safety requirements and testing 352-1 & 2: 1993: Ear muffs & Ear Plug respectively
352-3: 1997: Earmuffs attached to an industrial safety helmet.

15. WORKING AT HEIGHT

15.1. General

15.1.1. Working at height is the largest single cause of serious accidents in the construction industry and therefore the Contractor shall carry out risk assessments for all work where workers or materials can fall more than two meters.

15.1.2. Where work is being carried out above areas where there is public access such as roads footpaths etc. particular care must be taken to ensure that no materials can fall from the working area.

15.1.3. Edge protection shall be provided at all leading edges or openings where workers or materials can fall more than two meters. Edge protection shall meet the minimum standard of;

a) A main guardrail at least 1 meter above the edge
b) A toe board at least 200 mm high; and
c) An intermediate guard rail or other barrier so that there is no gap more than 470 mm.

15.2. Use of Scaffolds

15.2.1. All scaffolds should be erected and dismantled by workmen who are thoroughly experienced in the erection and dismantling of scaffolding.

15.2.2. All scaffolds should be inspected by a competent person at least every three days after erection and the results of inspections recorded and the records shall be kept available for checking by the Engineer.

15.2.3. Tags shall be fitted to all scaffolds to show whether they are safe for use or not. All Safe for Use tags shall be signed by a senior site engineer from the Contractor.

15.2.4. All scaffolds shall be constructed of sound materials free from patent defect.

15.2.5. The following measures shall be taken;

(a) the scaffold shall be constructed for the correct use (Light or Heavy Duty)
(b) securely fixed to existing structures or adequately buttressed;
(c) the use of barrels, boxes, loose tiles or other unsuitable material shall not be used as supports for working platforms;

(d) all working platforms shall be fully boarded;

(e) all working platforms shall have guard rails at one-meter height and shall also have an intermediate rail at half height;

(f) all working platforms shall be provided with toe boards;

(g) all working platforms shall be kept free of unnecessary obstruction or rubbish

(h) secure ladder access shall be provided;

15.3. Use of Ladders

15.3.1. All ladders shall be of sound construction and shall be free from patent defect.

15.3.2. Ladders should be checked weekly and defective ladders shall be promptly and properly repaired or replaced.

15.3.3. Ladders shall not be used as working platforms but may be used for work of short duration of up to thirty minutes.

15.3.4. Metal ladders shall not be used near or adjacent to overhead power lines unless they have been certified dead under a permit to work system.

15.3.5. Ladders shall;

(a) be secured at the top or footed at the bottom to prevent slippage;
(b) not be used if any rung is missing;
(c) not be used for any other purpose than to provide access;
(d) be set at an angle of seventy-five degrees unless designed for vertical access;

- Part 1) 1987 Safety Code for Scaffolds and Ladders, Part 1, Scaffolds
- IS 3696 (Part 2): 1991Safety Code for Scaffolds and Ladders, Part 2, Ladders IS 13416 (Part 1):1992 Recommendations for preventive measures against hazards in the workplace, Part, Falling material hazards protection
- IS 13416 (Part 2):1992Recommendations for preventive measures against hazards in the workplace, Part 2, Fall protection

(e) all vertical ladders shall be fitted with hoops to prevent falls;

15.4. Safety Harnesses / Fall Arresters

Where it is not possible to provide a safe working platform then the use of safety harnesses may be considered. If safety harnesses are used, they should be of the full body type and secure anchorage points shall be provided and used. Workers must be instructed in the proper use of harnesses.

15.5. References

Indian Regulation
The Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules 2007: Chapter XIX - Ladders and Step Ladders and XXIII about Scaffolds

15.6. INDIAN STANDARDS

- IS 3696

15.7. BRITISH STANDARDS

- BS EN 354:1993: Personal protective equipment against falls from a height Lanyards
- BS EN 355:1993 : Personal protective equipment against falls from a height. Energy absorbers
- BS EN 358:1993 : Personal equipment for work positioning and prevention of falls from a height. Work positioning systems
- BS EN 360:1993 : Personal protective equipment against falls from a height. Retractable type fall arresters
- BS EN 361:1993 : Personal protective equipment against falls from a height. Full body

harnesses

- BS EN 362:1993 : Personal protective equipment against falls from a height. Connectors
- BS EN 363:1993 : Personal protective equipment against falls from a height. Fall arrest systems
- BS EN 364:1993 : Personal protective equipment against falls from a height. Test methods
- BS EN 365:1993 : Personal protective equipment against falls from a height. General requirements for instructions for use and for marking
- BS EN 795:1997 : Protection against falls from a height. Anchor devices. Requirement and testing

16. EXCAVATIONS

16.1. General

16.1.1. Excavation is one of the important phases of any construction activity. Due to insufficient attention to the safety aspects it frequently becomes the cause of many accidents. Contractors are therefore required to plan and execute all excavations in a safe manner.

16.1.2. The Contractor shall ensure that all excavations are supervised by workers with thorough knowledge and experience of excavation work.

16.1.3. The integrity of the excavation and the support system shall be inspected prior to the commencement of any works on a daily basis with the results of the inspections being formally recorded. All such records shall be kept available for inspection by the Engineer.

16.1.4. Where there is the possibility of any ingress of water then pumping sumps shall be established with pumps being readily available for use and additional ladders placed for use in the event of an emergency evacuation.

16.2. Planning

16.2.1. The correct planning of excavations is essential for safety and before digging any excavations Contractors should plan against the following;

(a) Collapse of the sides;
(b) Materials falling onto people working in the excavation;
(c) People and vehicles falling into the excavation;
(d) People being struck by plant;
(e) Undermining nearby structures;
(f) Contact with underground services;
(g) Fumes; and
(h) Make sure the necessary equipment needed such as trench sheets, props, etc., are available on site before work starts.

16.3. General Precautions

16.3.1. The following precautions should be observed;

(a) Prevent the sides and the ends from collapsing by battering them to a safe angle or supporting them with timber, sheeting or proprietary support systems.

(b) Do not go into unsupported excavations.

(c) Never work ahead of the support.

(d) Remember that even work in shallow trenches can be dangerous. You may need to provide support if the work involves bending or kneeling in the trench.

(e) Prevention of materials falling into excavations

(f) Do not store spoil or other materials within one metre of the sides of excavations. The spoil may fall into the excavation and the extra loading will make the sides more prone to collapse.

(g) Make sure the edges of the excavation are protected against falling materials.

(h) Provide toe boards where necessary.

(h) Wear a hard hat when working in excavations.

(i) Take steps to prevent people falling into excavations. If the excavation is 2 m or more deep, provide substantial barriers, e.g. guard rails and toe boards.

(j) Keep vehicles away from excavations wherever possible. Use brightly painted baulks or barriers where necessary.

(k) Where vehicles have to tip materials into excavations, use stop blocks to prevent them from over-running. Remember that the sides of the excavation may need extra support.

16.4. Undermining nearby structures

16.4.1. The following precautions should be taken to prevent the undermining of nearby structures;

(a) Make sure excavations do not affect the footings of scaffolds or the foundations of nearby structures. Walls may have very shallow foundations, which can be undermined by even small trenches.

(b) Decide if the structure needs temporary support before digging starts. Surveys of the foundations and the advice of a structural engineer may be needed.

16.5. Avoiding underground services

16.5.1. The following precautions should be taken to avoid underground services;

(a) Look around for obvious signs of underground services, e.g. valve covers or patching of the road surface.

(b) Use locators to trace any services. Mark the ground accordingly.

(c) Make sure that the person supervising excavation work has service plans and knows how to use them. Everyone carrying out the work should know about safe digging practices and emergency procedures.

(d) Operate a "Permit to Dig" system.

16.6. References

Indian Regulation

The Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules 2007: Chapter XVII - Excavation and Tunnelling Works

16.7. INDIAN STANDARDS

- IS 3764: 1992 Excavation Work – Code of Safety
- IS 13430: 1992 Safety during additional construction to existing buildings – Code of Practice.
- IS 2314: 1986 Steel Sheet Piling sections
- IS 5121: 1969 Safety Code for Piling and Other Deep Foundations

17. LIFTING OPERATIONS

17.1. Lifting Appliances:

17.1.1. The Contractor shall ensure that all lifting appliances, including synchronized mobile jacks, pit jacks, mobile cranes, tower cranes, gantry cranes, launching beams and lorry mounted cranes, prior to being allowed to work on site shall have available for inspection by the Engineer a current Certificate of Inspection issued by a Competent Person approved by MMRC.

17.1.2. All lifting appliances with a lifting capacity of more than one tonne shall, where practicable, be fitted with Automatic Safe Load Indicators and Audible Warning Devices which shall be kept in an operable condition at all times the lifting appliance is in use. Checks should be made to ensure that the Automatic Safe Load Indicator is properly calibrated and is functioning properly.

17.1.3. All lifting appliances shall be maintained in accordance with the manufacturer's instructions

and shall be subject to a regular preventative maintenance programme.

17.1.4. All lifting appliances shall be inspected every three months by a third party competent person approved by MMRC. Certificates of Inspection shall be available with the lifting appliance and a copy shall also be sent to the Project Manager.

17.1.5. The operators of lifting appliances shall conduct daily inspections of their respective lifting appliances with the results of the inspections being recorded and kept available for inspection by the Project Manager.

17.1.6. The Contractor shall ensure that only thoroughly trained and experienced persons aged twenty-one years and over are allowed to operate lifting appliances.

17.2. Lifting Gear:

17.2.1. Lifting Gear includes chain slings, rope slings, or similar gear and a ring, link, hook, plate clamp, shackle, swivel or eye bolt.

17.2.2. The Contractor shall ensure that all lifting gear shall be in good condition and shall be tested and certified every six months, with the Safe Working Load being stamped or clearly displayed upon it. Records of test shall be kept available for inspection by the Engineer.

17.2.3. All lifting gear shall be visually inspected before any use and if any defects are found then it shall be removed from site or dismantled / disabled in order to ensure that it is not used in a defective state.

17.2.4. All lifting gear shall be properly stored and not left lying on the ground where it could be damaged or used in an unsafe manner.

17.3. Lifting Operations:

17.3.1. The Contractor shall ensure that during the course of any lifting operations the following minimum requirements shall be followed:

(a) All lifting operations shall be under the control of a competent "Lifting Supervisor" appointed by the Contractor.

(b) Only thoroughly trained and experienced crane drivers shall be allowed to operate cranes.

(c) Only thoroughly trained and experienced slingers and riggers shall be allowed to sling loads and give directions to crane operators.

(d) A standard code of hand signals shall be adopted for controlling the movements of the crane and both the driver and the signaller shall be thoroughly familiar with the signals.

(e) The driver of the crane shall respond to signals from only the appointed signaller but shall obey the stop signal at any time no matter who gives it.

(f) Before commencing any lifting operations the ground conditions on which the crane is to stand shall be investigated in order to ensure that the load bearing capabilities are adequate.

(g) The weight of the load must be known to the crane driver and the slinger/rigger before lifting commences.

(h) No loads are to be slewed over public areas without stopping pedestrians and vehicles first.

(i) No unauthorized persons are allowed into the lifting zone.

(j) No person is allowed to ride the hook of the crane or the loads being lifted.

(k) Any areas where a minimum clearance of six hundred millimetres from the rear of the slewing kentledge of the crane cannot be achieved and where persons could be trapped against obstacles then a fence shall be erected to prevent access.

(l) All crane hooks shall be fitted with an operable safety catch.

(m) Wherever practicable all loads shall have tag-lines attached in order to ensure that the load can be controlled at all times.

(n) Provision shall be made to ensure that the lifting slings or chains can be safely removed from the loads once they have been landed.

(o) All lifted loads and stacked materials shall be left in a secure and stable condition at all times.

(p) Whenever working close to isolated overhead power-lines the lifting appliances shall be grounded to earth as a secondary precaution against accidental energization.

(q) No close working to any live overhead power-lines is permitted without the operation of a strict Permit to Work system being in place.

17.4. REFERENCES

Indian Regulation
The Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules 2007: Chapter XI - (Lifting Appliances and Gear)

17.5. INDIAN STANDARDS

- IS 807: 1976 Code of Practice for the design, manufacture and testing of cranes
- IS 7293: 1974 Safety Code for working with Construction Machinery;
- IS 13583: 1993 Code of Practice for training of Crane Drivers Part 1 General

20. BRITISH STANDARDS

- BS 7121: Code of practice for safe use of cranes
- BS 7262:1990 Specification for automatic safe load indicators

18. WORK IN CONFINED SPACES

18.1. General

18.1.1. The term 'confined space' has three defining features as, any space;

(a) in which a person can bodily enter;
(b) which has limited entry / egress; and
(c) which is not meant for occupancy.

Generally, it is a place which is substantially (though not always entirely) enclosed with a reasonably foreseeable risk of serious injury from hazardous substances or conditions within the space or nearby.

18.1.2. Some confined spaces are fairly easy to identify, for example, closed tanks and sewers. Others are less obvious but may be equally dangerous, for example closed and unventilated or inadequately ventilated rooms and silos, ducts, culverts, tunnels, boreholes, bored piles, manholes, shafts, excavations, sumps, inspection pits, cofferdams, and building voids.

18.2. The hazards

18.2.1. The most likely hazards are as follows:

(a) Flammable Substances and Oxygen Enrichment;
(b) Toxic Gas, Fume or Vapour
(c) Oxygen deficiency
(d) The Ingress or Presence of Liquids
(e) Presence of Excessive Heat,
(f) Excessive Humidity

18.3. Entry Procedures

18.3.1. Contractors will ensure that no work will be undertaken in Confined Spaces unless a Permit to Work, see Section 11.3, has been prepared and issued.

18.3.2. Only persons who have been thoroughly trained, experienced and are physically fit shall be allowed to work in Confined Spaces.

18.3.3. Persons with any of the following medical conditions shall not be allowed to work in confined spaces:

(a) a history of fits, blackouts or fainting attacks,
(b) a history of heart disease or disorder,
(c) high blood pressure,
(d) asthma bronchitis, or shortness of breath on exertion,
(e) deafness
(f) meniers disease or disease involving giddiness or loss of balance,
(g) claustrophobia or nervous or mental disorder,
(h) back pain or joint trouble that would limit mobility in confined spaces,
(i) deformity or disease of the lower limbs limiting movement.
(j) Chronic skin disease,
(k) Serious defects in eye sight or lack of sense of smell

18.3.4. No smoking shall be allowed in or within 2 metres of the opening to any confined space and suitable warning signs shall be positioned.

18.3.5. Before any confined space work commences the following equipment shall be available for use:

(a) Multi Gas Monitor; or other suitable gas monitoring equipment.
(b) Sufficient sets of Self Contained Breathing Apparatus to enable rescue to be carried out;
(c) Full Body Type Harness for each worker;
(d) Tripod and Lifeline Hoist Rope; for work in situations where a vertical exit from the confined space is required.
(e) Flame-proof lighting. (Hand lamps not more than 24 volts.);
(f) Resuscitation Equipment;
(g) Ventilation Equipment.

The persons involved in the confined space working operations shall need to be thoroughly trained and certified as being competent in the use of the above detailed item of equipment.

18.4. References

- Sections 7A and 36 of the Factories Act 1948

18.5. INDIAN STANDARDS

- IS 11972: 1987 Code of Practice for safety precautions to be taken when entering a sewerage system

19. SITE ELECTRICITY

19.1. General

19.1.1. The Contractor shall nominate a representative whose name and qualifications shall be submitted in writing to the Engineer for review not later than 4 weeks before the appointment and who shall be solely responsible for ensuring the safety of all temporary electrical equipment on Site. The Contractor shall not install or operate any temporary Site electrical systems until this representative is appointed and has commenced duties.

19.1.2. The name and contact telephone number of the representative having been reviewed without objection by the Engineer shall be displayed at the main distribution board for the temporary electrical supply so that he can be contacted in case of an emergency.

19.1.3. The Contractor shall submit schematic diagrams and the details of the equipment for all temporary electrical installations, and these diagrams together with the temporary electrical equipment shall be submitted to the Project Manager for review.

19.1.4. All electrical installation work on Site shall be carried out in accordance with the requirements laid down in the Specification. All work shall be supervised or executed by qualified and suitably categorized electricians.

19.1.5. All Temporary Electrical Site installations and distribution systems shall as a minimum meet

IP44 standards and be in accordance with: -

(a) Indian Electrical Regulations;
(b) The Power Companies' Supply Rules;
(c) BS 7671 Requirements for electrical installation, the IEE Wiring Regulations (16th Edition);
(d) BS 7375 Distribution of Electricity on Construction and Building Sites;
(e) BS 4363 Distribution Assemblies for Electricity Supplies for Construction and Building Sites; and
(f) BS 6164 Safety in Tunnelling in the Construction Industry.

19.2. Design Considerations

19.2.1. Distribution equipment utilized within the temporary electrical distribution system shall incorporate the following features: -

(a) Flexibility in application for repeated use;
(b) Suitability for transport and storage;
(c) Robust construction to resist moisture and damage; and
(d) Safety in use.

19.2.2. All cabling shall be run at high level whenever possible and firmly secured to ensure it does not present a hazard or obstruction to people and equipment.

19.2.3. The installation on Site shall allow convenient access to authorized and competent operatives to work on the apparatus contained within.

19.3. Distribution of supply

19.3.1. The Site mains voltage shall be as the Electricity Utility supplies, 415V 3-phase 4-wire system.

(a) Single-phase voltage shall be as the Electricity Utility supplies, 240V supply.
(b) Reduced voltages shall conform to BS 7375.

19.3.2. The following voltages shall be adhered to for typical applications throughout the distribution systems:

(a) fixed plant - 415V 3 phase;
(b) movable plant fed by trailing cable - 415V 3 phase;
(c) installations in Site buildings - 240V 1 phase;
(d) fixed flood lighting - 240V 1 phase;
(e) portable and hand held tools - 110V 1 phase;
(f) Site lighting (other than flood lighting) - 110V 1 phase; and
(g) portable hand-lamps (general use) - 110V 1 phase.

19.3.3. When the low voltage supply is energised via the Employer's transformer, any power utilized from that source shall be either 415V 3 phase or / 240V. 1 phase as appropriate. The Contractor shall carry out any conversion that may be necessary to enable him to use power from that source.

19.3.4. Protection shall be provided for all main and sub-circuits against excess current, residual current and earth faults. The protective devices shall be capable of interrupting (without damage to any equipment or the mains or sub-circuits) any short circuit current that may occur.

19.3.5. Earthing and bonding shall be provided for all electrical installations and equipment to prevent the possibility of dangerous voltage rises and to ensure that faults are rapidly cleared by installed circuit protection.

19.3.6. Only plugs and fittings of the weatherproof type shall be used and they should be colour coded in accordance with the Internationally recognized standards for example as detailed as follows:

(a) 110 volts : Yellow
(b) 240 volts : Blue

(c) 415 volts : Red

19.4. Cables

19.4.1. Cables shall be selected after full consideration of the conditions to which they will be exposed and the duties for which they are required. For supply cables up to 3.3kV the cable armouring shall be used as the earth return in conditions where the cable is continuously extended and not subject to continuous movement after installation.

19.4.2. For supplies to mobile or transportable equipment where operation of the equipment subjects the cable to flexing, the cable shall conform to one of the following specifications appropriate to the duties imposed on it:

(a) BS 6708 flexible cables for use at mines and quarries;
(b) BS 6007 rubber insulated cables for electric power and lighting; and
(c) BS 6500 insulated flexible cords and cables.

19.5. Maintenance

19.5.1. Strict maintenance and weekly checks of control apparatus and wiring distribution systems shall be carried out by an electrician (duly qualified to carry out the said checks) to ensure safe and efficient operation of the systems. The Contractor shall submit for review by the Engineer details of his maintenance schedule and maintenance works record.

19.5.2. All portable electrical appliances shall be permanently numbered (scarf tag labels or similar) and a record kept of the date of issue, date of the last inspection carried out and the recommended inspection period.

19.6. References

(a) Indian Electrical Regulations;
(b) BS EN 60529 Degrees of protection provided by enclosures (IP Code)
(c) The Power Companies' Supply Rules;
(d) BS 7671 Requirements for electrical installation the IEE Wiring Regulations (16th Edition);
(e) BS 7375 Distribution of Electricity on Construction and Building Sites;
(f) BS 4363 Distribution Assemblies for Electricity Supplies for Construction and Building Sites; and
(g) BS 6164 Safety in Tunnelling in the Construction Industry.

20. WELDING AND CUTTING

20.1. General

20.1.1. Contractors shall ensure that all welding, cutting and gouging is carried out so that the risks are kept at a minimum. There will be some circumstances when Permits to Work will need to be issued, such as

(a) working in tunnels;
(b) welding over areas where others are working;
(c) working in areas with increased fire risks or hazardous environments;

20.1.2. All equipment must be in good condition, properly installed and routinely inspected by a competent person, and records must be kept available for inspection by the Project Manager.

20.1.3. Flexible hoses, cables and connections must be free from damage or risk of damage in service. Cables and hoses shall have adequate carrying capacity.

20.1.4. Welders shall wear the correct personal protective equipment which includes the following;

(a) Face and eye protection with correct grade of shield;
(b) Gauntlet gloves;
(c) Safety footwear

(d) Welders apron or fire retardant overalls;

(e) The atmosphere in the vicinity of work must be known to be safe to breathe and free from flammable gases.

20.1.5. Adequate ventilation and fume extraction must be provided and used as required by the risk assessment and especially in enclosed areas and pits.

20.1.6. Surfaces to be heated by the process must be cleaned of contaminants that may be degraded by heat or give off noxious fumes (e.g. paints, plastics, zinc coating).

20.1.7. Naked flames or high temperature surfaces must not be allowed in the vicinity of volatile solvents.

20.1.8. All moveable flammable materials must be removed from the vicinity of work and fireproof covers placed over all flammable materials that cannot be removed.

20.1.9. During all welding the work piece and any access equipment must be safely secured.

20.2. Oxy-fuel Gas Processes

20.2.1. Handle cylinders carefully, keep outside enclosed areas and secure in an upright position. Keep oxygen cylinders away from fuel gas cylinders where possible.

20.2.2. Flash back arresters shall be fitted to both the fuel gas and oxygen cylinders;

20.2.3. Non return valves shall be fitted to the torch or cutting torch;

20.2.4. Ensure screwed fittings and hoses are correct and keep screwed and sealed surfaces free of contaminants, such as oil and grease.

20.2.5. Close cylinder valves when flame is extinguished.

20.2.6. Ensure any vessel, drum or tank that has contained flammable or toxic substances has been properly cleaned and inspected before subjecting it to hot work.

20.2.7. Checks for gas leaks should be carried out using soapy water.

20.2.8. Remove all torches from enclosed areas when not in use.

20.2.9. Suitable fire extinguisher to be available at all places where hot work is being carried out.

20.2.10. Use firewatchers if there is a possibility of ignition unobserved by the operator (e.g. on the other side of bulkheads).

20.3. Arc Cutting, Gouging and Welding Processes

20.3.1. Connect the welding current return cable to the work piece close to the arc point or to a well electrically conductive support structure in good contact with the work piece. Also, connect the work piece or the support structure to a separate earth terminal.

20.3.2. Take precautions against the risk of increased fume hazards when welding with chrome containing fluxed consumables or high current metal inert gas (MIG) or tungsten inert gas (TIG) processes.

20.3.3. Avoid being in contact with water or wet floors when welding. Use duckboards or rubber protection.

20.3.4. Provide screens to limit exposure of others to glare from arcs.

20.3.5. Use the correct eye and face protection with the correct filter glass.

20.3.6. Use a low voltage open circuit relay device if welding with alternating current in constricted or damp places.

20.4. References

Indian Standards.

- IS 818: 1961 Code of Practice for safety and health requirements in
- electric, gas welding and cutting operations.
- IS 1179: 1967 Specification for equipment for eye and face protection during welding
- IS 5983: 1980 Specification for protective filters for welding, cutting and similar

operations.

- IS 13416 (Part 5) :1994 Preventative measures against hazards at workplaces Recommendations Part 5 Fire Protection

20.5. BRITISH STANDARDS

- BS EN 166:1996 Personal eye-protection. Specifications
- BS EN 169:1992 Specification for filters for personal eye protection equipment used in welding and similar operations
- BS EN 175:1997 Personal protection. Equipment for eye and face protection during welding and allied processes

21. COMPRESSED GASES

21.1. Storage

21.1.1. The Contractor shall ensure that all compressed gases, such as oxygen and fuel gases, are stored in a safe manner in keeping with the following requirements.

21.1.2. When not in use compressed gas cylinders should preferably be stored in the open air in a well ventilated area at ground level on a firm level surface at least 3m away from any cellars, drains, excavations or other hollows where vapour may collect. There should be good access to the area, which should be kept clean and clear of combustible material, including wood, packing materials and vegetation. If any protection is provided to prevent cylinders being exposed to the weather, it should be of non-combustible material and should not inhibit ventilation. The area should not be close to any source of heat.

21.1.3. If storage in the open air is not reasonably practicable, compressed cylinders must be stored in adequately ventilated storerooms. The storeroom must be constructed of non-combustible material

21.1.4. Liquefied Petroleum Gas (LPG) cylinders should be stored separately from oxygen cylinders, other flammable liquids, oxidising materials such as sodium chlorate, and toxic or corrosive substances. Such materials should be kept at least 3 metres away from LPG cylinders.

21.1.5. It is important that the valves of so-called `empty' cylinders are kept closed as well as those of full cylinders and that plugs, shrouds and caps are kept in place on all cylinders. This is necessary not only to prevent the escape of any residual compressed gas into the atmosphere but also to ensure that air is not sucked into the cylinder to form an explosive mixture inside it. All cylinders should be stored with their valves uppermost. Storage of LPG cylinders on their sides is particularly hazardous as in the event of a leaking or inadequately closed valve there is the possibility of leakage of liquid and a consequential release into the atmosphere of far greater quantities of flammable vapour.

21.1.6. The storage area should be enclosed by a fence approximately 2 meters in height. The fence should be made of non-combustible material and should not inhibit natural ventilation, particularly at low level - a wire mesh fence is particularly suitable for this purpose. The fence should have at least two means of exit, which should not be adjacent to each other. The gates should open outwards and not be self-locking. Both exits should be unlocked when persons are within the storage compound. At all times when the site is unattended the storage area should be secured.

21.1.7. On sites where only small quantities of compressed gas are stored (i.e. less than 300 kg) and it is practicable neither to provide an open air storage compound as described in para 21.1.6 nor a properly constructed storage building cylinders may be kept in a lockable wire cage in a safe place in the open air. Only one exit will be necessary providing there is no risk of a person being trapped in the enclosure. The cage should be clearly marked "Highly Flammable and notices prohibiting smoking and naked lights should be displayed.

21.1.8. Suitable portable first aid fire extinguishers shall be positioned in close proximity to the storage area for use in an emergency.

21.2. Handling Compressed Gas cylinders

21.2.1. Cylinders should be handled with care and wherever practicable moved on specially designed trolleys. The valve on a cylinder should not be used for lifting or to lever the cylinder into position. Damage to the valve can result in highly dangerous situations following the escape of gas. For the same reason throwing or dropping cylinders should be prohibited as in such circumstances damage to the valve is even more likely.

21.2.2. Before connecting any cylinder or container of compressed gas to equipment it is essential that all fires, flames or other sources of ignition in the vicinity, including cigarettes and pilot lights, are extinguished. Where practicable cylinders should be changed in the open air. The cylinder should be examined and any damaged or faulty cylinder should NOT be used. No attempt should be made to rectify any fault or damage. The cylinder should be put in a safe place away from other cylinders or combustible materials until returned to the supplier.

21.2.3. If a cylinder is found to be leaking and the leak cannot be stopped, the cylinder should be carefully removed to a well-ventilated open space free from sources of ignition. It should be left with the leak, usually at the valve, uppermost, marked faulty and notices displayed prohibiting smoking or other naked lights. General access should be prevented by barriers or otherwise. The supplier of the cylinder should be informed immediately. Under no circumstances should users attempt to dismantle or repair defective cylinders.

21.3. Regulators

21.3.1. Regulators should be suitable for the gas and pressure in use. Checks for leaks at the regulator nuts should be made only by using soapy water. In the event of a defector of any damage to a regulator, no attempt should be made to repair it. Such repairs should only be carried out by specialists.

21.4. Hoses

21.4.1. Flexible tubing should only be used for final connections to appliances. Flexible hoses should comply with BS 3212, BS 5120 or other nationally recognized standard.

They should be additionally protected or of steel braid reinforced construction wherever they might be subject to damage by abrasion and so sited that they are not exposed to excessive heat. The length of hoses should be kept as short as practicable.

21.5. Training and Instruction

21.5.1. Many accidents involving compressed gas are due to ignorance of simple basic precautions. It is essential that all persons using compressed gas are suitably instructed about the hazards and the precautions to be taken in its use.

21.6. REFERENCES INDIAN STANDARDS

IS 2190: 1992 Code of Practice for the selection installation and maintenance of portable first aid fire extinguishers.

22. MACHINERY

22.1. Machinery Fencing

22.1.1. The Contractor shall ensure that all gears, revolving shafts, flywheels, couplings and other dangerous parts of machinery shall be effectively guarded unless they are so constructed, installed or placed as to be safe as if they were guarded.

22.1.2. Fencing of dangerous parts of machinery shall not be removed while the machinery is in use or in motion. If the fencing is required to be removed for maintenance purposes it shall be replaced before the machine is taken into use.

22.2. Maintenance

22.2.1. The Contractor shall ensure that all machinery used on site is in safe condition and is properly maintained and repaired by duly authorized, thoroughly trained and experienced persons.

22.2.2. No repair to machinery shall be carried out whilst it is in motion unless it is unavoidable.

22.2.3. Maintenance records shall be kept available for inspection by the Project Manager.

22.3. Air Receivers

22.3.1. All Air receivers shall be fitted with a pressure relief valve and shall have the safe working pressure clearly marked upon them.

22.3.2. Every air receiver shall be subject to an annual test, which shall be carried out by a duly authorized person. The results of all tests shall be recorded and the records shall be kept available for inspection by the Project Manager.

22.3.3. The connection couplers on compressed airlines shall be securely fixed together and have safety chains or be wired at the joints in order to ensure that the joints do not come apart when charged with compressed air.

22.4. Woodworking Machines

22.4.1. All woodworking machines shall be fitted with the following guards and devices;

(a) Top Guard;
(b) Riving Knife;
(c) Guards to protect all drive belts etc.;
(d) An emergency stop switch easily accessible by the operator;
(e) A push stick;

22.4.2. Woodworking machines shall be operated only by thoroughly trained and experienced operators.

22.5. Abrasive Wheels

22.5.1. All Abrasive wheel machines shall be fitted with appropriate guards which shall be kept in place at all times the machine is in use.

22.5.2. All abrasive wheel machines shall have the spindle speed clearly marked upon them in revolutions per minute.

22.5.3. Only thoroughly trained and experienced persons are allowed to change the wheels on the machines. Wheels must have inspected and ring tested before mounting to ensure that wheels are free from cracks or defects.

22.5.4. Safety Goggles or Face shields must be worn when grinding or cutting with abrasive wheels.

22.6. References

Indian Standards

- IS 7293: 1974 Safety Code for Working with Construction Machinery

23. HEAVY PLANT OPERATIONS

23.1. General

23.1.1. The Contractor shall ensure that only safe and well-maintained plant and equipment shall be allowed to operate on any of the sites.

23.1.2. All operators of heavy plant such as, earth movers, piling rigs, etc. shall be medically fit, over eighteen years of age and be thoroughly trained and experienced to operate the equipment.

23.1.3. No unauthorized person shall be permitted to ride on plant.

23.1.4. The operators shall conduct daily inspections of their respective items of plant with the results of these inspections being recorded and the records kept available for inspection by the Project Manager.

23.1.5. All mobile heavy plant shall be equipped with at least one 5kg Dry Powder Fire Extinguisher, carried at a suitable position so as to ensure its easy availability.

23.1.6. Whenever heavy plant is operating in congested areas, thoroughly trained and experienced banksmen shall be deployed to control the plant and personnel movement and interface.

23.1.7. Any waste engine oil and filters following any on site servicing and maintenance shall be removed from the sites and disposed of in an environmentally conscious manner at authorized disposal locations.

23.1.8. All drums of fuel oil shall be stored on drip trays or the fuel shall be kept in bonded bulk storage fuel tanks, with quantities stored being kept to a minimum.

23.1.9. The storage areas shall have dry powder fire extinguishers positioned in close proximity to their location for use in an emergency.

23.2. References

Indian Standards

- IS 7293: 1974 Safety Code for Working with Construction Machinery
- IS 2190: 1992 Code of Practice for the selection, installation and maintenance of portable first aid fire extinguishers.

24. TUNNELLING OPERATIONS

24.1. Procedures

24.1.1. The Contractor shall develop safety procedures and methods of working to be adopted during the course of tunnelling operations. These procedures shall include but not be limited to;

(a) Shafts and Tunnels Entry Procedure (Including visitors.)

(b) Blasting operations.

(c) Atmosphere Monitoring (Oxygen Levels, Explosive Gases, Carbon Monoxide, Hydrogen Sulphide, Oxides of Nitrogen, temperature, humidity, dust etc.) See also Section 15.4 of this Manual.

(d) Portal Gantry Crane Operating Procedures.

(e) Emergency Preparedness Plan for the Shaft and Tunnels. (Including liaison with the Emergency Services.)

(f) Work Train Operating Procedure.

(g) Tunnel Boring Machine Cutter Head Chamber Entry procedure.

A detailed method statement as outlined in Section 12.2 METHOD STATEMENTS must be produced by the Contractor, and approved by the Project Manager before the commencement of any tunnelling operations.

24.2. Sanitation and Drinking Water

24.2.1. Unless the worksite is within 500 meters of the portal of the tunnel, sanitation facilities shall be provided. Suitable toilets shall be provided on the scale of one unit for every 50 men on the shift. Toilets shall be effectively and regularly cleaned and disinfectants provided.

24.2.2. At least 5 litres of clean drinking water shall be provided per person employed on the shift. The water shall be sited near the portal and also inside tunnels over 500 meters in length. The water shall be contained in a clean container with a tight fitting lid.

24.2.3. Washing and cleaning facilities shall be provided for all workers near the portal.

24.3. Lighting

24.3.1. The Contractor shall provide adequate lighting at the face and at any other point where work is in progress. A minimum of 50 lux shall be provided at the face, walkways and similar work areas. When mucking is done by tipping wagons running on trolley tracks a minimum of 30 lux shall be maintained. In all other areas the level of lighting shall not be less than 10 lux.

24.3.2. Emergency lighting shall be installed at the working faces and at 100m intervals along the tunnel to help escape workmen in case of accidents.

24.4. Ventilation

24.4.1. The Contractor shall make provision for adequate ventilation of all shafts and tunnels. The

ventilation shall be sufficient to ensure proper dispersal of any dust or fume. (see also Section 15.4)

24.5. Protection against Fire

24.5.1. As far as practicable, combustible materials shall not be used in the construction of any room or recess containing electrical apparatus.

24.5.2. No flammable material shall be stored in any part of the tunnel unless it is contained in suitable flameproof containers.

24.5.3. An adequate supply of suitable first aid firefighting equipment shall be kept at convenient locations throughout the tunnel. This equipment shall be tested at least once a month and records kept available for inspection by the Project Manager.

24.6. Warning Signals

24.6.1. The Contractor shall install a suitable system of warning signals for the movement of plant and materials within shafts and tunnels.

24.6.2. The system shall be checked daily immediately prior to the commencement of tunnelling work under the supervision of a responsible person.

24.6.3. The Contractor shall make detailed emergency warning signals for cases of fire, tunnel collapse etc.

24.7. References

Indian Regulation
The Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules 2007: Chapter XVII - Excavation and Tunnelling Works

24.8. INDIAN STANDARDS

- IS 4756: 1978 Safety Code for Tunnelling Work.
- IS 2190: 1992 Code of Practice for the selection, installation and maintenance of portable first aid fire extinguishers.

24.9. BRITISH STANDARD

- BS 6164: 2001 Code of Practice for safety in tunnelling in the construction industry

25. BLASTING OPERATIONS

25.1. Authorization for Blasting

25.1.1. The Contractor shall ensure that all blasting operations will only be permitted following consultations with the relevant authorities and subsequent issuing of the permission to blast permits. The Engineer must also give his consent in writing before any blasting operations take place.

25.1.2. All blasting shall be conducted under the direct supervision of a Licensed Shot fired.

25.1.3. Risk Assessment and Method Statements

25.1.4. The Contractor shall produce a detailed hazard and risk assessment and an in depth method statement for amongst others the following elements:

(a) Type of explosives to be used.
(b) Anticipated effects of vibration on nearby structures.
(c) Blasting patterns.
(d) Delivery of the explosives.
(e) Transportation and storage of explosives on site.
(f) Drilling and charging of holes.
(g) Warning sirens.
(h) Measurement of Vibration
(i) Provision of sentries.

(j) Use of blast screens.
(k) ALL CLEAR.
(l) Ventilation following blasting.
(m) Atmosphere monitoring.
(n) Procedure for miss-fires.

25.2. References

Indian Regulation
The Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules 2007: Chapter XXVI - Explosives.

25.3. INDIAN STANDARDS

IS 4081: 1986 Safety Code for Blasting and related Drilling Operations

25.4. BRITISH STANDARDS

BS 5607: 1988 Code of Practice for the safe use of explosives in the construction industry.

26. DEMOLITION

26.1. General

26.1.1. The Contractor shall ensure that all demolition works shall be carried out in a controlled manner under the management of experienced and competent supervision.

26.1.2. Prior to any demolition commencing, a survey shall be conducted to identify if there are any hazardous materials present, for example the presence of materials such as asbestos and lead.

26.1.3. If any hazardous materials are found, then consideration shall be given as to whether they shall need to be removed by a Specialist Agency or Sub-contractor prior to the main demolition works commencing.

26.1.4. Before the demolition commences all relevant notifications will need to be given to the local authorities and media.

26.1.5. Measures for protection to the public shall be required to be put into place in order to give protection from any possible falling debris and dust generation.

26.1.6. All power supplies and services shall be disconnected before any demolition work commences.

26.2. 28.2. References

Indian Regulation
The Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules 2007: Chapter XVI – Demolition

26.3. INDIAN STANDARDS

- IS 4130: 1991 Demolition of Buildings – Code of Safety
- IS 13416 (Part 3):1994 Recommendations for preventive measures against hazards in the workplace, Part 3, Disposal of Debris

27. FALSEWORK / FORMWORK

27.1. General

27.1.1. The Contractor shall ensure that all false work / formwork has been properly designed and is suitable for the purpose.

27.1.2. All designed false work / formwork shall be erected in strict accordance to the design.

27.1.3. Prior to the loading and subsequent striking of false work / formwork, permission shall be obtained from the Contractor's Designer and Engineer who shall both inspect and sign off on the structure in person.

27.1.4. Adequate provision shall be made on the working platforms for the concrete placement operations. These shall include locations for vibrators and the unobstructed movement of personnel controlling the rubber hose during the concrete pumping operations or the concrete skip during any skipping operations.

27.1.5. The Contractor should use the following checklist to check that false work / formwork is being used safely;

27.1.6. (a) Have the design and the supports for shuttering and false work / formwork been checked?

(b) Is it being erected safely from steps or proper platforms?
(c) Are the props plumb and properly set out?
(d) Are the bases and ground conditions adequate for the loads?
(e) Are the correct pins used in the props?
(f) Are the timbers in good condition?
(g) Is it inspected by a competent person against the agreed design before permission is given to pour concrete?

27.2. References

Indian Regulation
The Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules 2007: Chapter XXI - Structural frame and Form Work

28. PILING AND DIAPHRAGM WALLS

28.1. General

28.1.1. The Contractor shall prepare safe systems of work and method statements for all work concerned with piling and diaphragm walls. He shall take the following points into consideration.

28.1.2. Any excavated piles or panels shall not be left unattended, unless they are adequately fenced around to prevent accidental entry into the immediate vicinity of the pile or panel.

28.1.3. Because of the use of heavy plant and equipment in generally congested work areas then trained banks men shall be deployed to control the movement of the plant and personnel interface.

28.1.4. All lifting operations shall be conducted in accordance with the requirements as detailed in Section 18 Lifting Operations.

28.1.5. Calcium Oxide shall not be used for stabilizing the excavated spoil as it is an acute irritant, unless an agreed method statement has been produced.

28.1.6. A method statement shall be produced by the Contractor, which details the process for grab retrieval in the event of a grab becoming detached during the course of a pile or panel excavation.

28.1.7. A method statement shall be produced by the Contractor, which details the process for stop end recovery.

28.1.8. Wheel washing facilities shall be available on the sites for washing down the spoil removal trucks and the concrete delivery vehicles.

28.1.9. Bentonite and polymer storage tanks shall be bounded around to retain any unintentional and uncontrolled spillage.

28.1.10. The Contractor shall submit to the Engineer, for approval, proposals for the treatment of Bentonite slurry and its subsequent disposal.

28.1.11. No Bentonite spillage shall be allowed on any roads.

28.1.12. Regular site cleaning shall be carried out at all work-sites.

28.1.13. The Contractor as part of his Emergency Plans shall develop procedures for the collapse of piles and diaphragm walls.

28.2. REFERENCES

Indian Regulation
The Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules 2007: Chapter XXVII – Piling

28.3. INDIAN STANDARDS

- IS 5121: 1969 Safety Code for Piling and other Deep Foundations
- IS 8989: 1978 Safety Code for the Erection of Concrete Framed Structures

29. WORK ADJACENT TO LIVE RAILWAYS

31.1. General

29.1.1. Whenever work is to be conducted in close proximity to the live railways then the following measures shall need to be addressed:

(a) The rules provided for in the Railway's manual shall be followed.

(b) No persons are allowed to encroach onto the railway unless specific authority has been given by the owner.

(c) Adequate protection in accordance with the railway owner's requirements shall be followed. (Provision of Block Inspectors, Flagmen and Lookouts.)

(d) All persons shall wear high visibility clothing at all times.

(e) Any induction training requirements of the railway owner shall be strictly observed

30. WORK ADJACENT TO LIVE ROADWAYS

30.1. General

30.1.1. Whenever working adjacent to any live roadways then the following aspects shall be considered.

(a) Close liaison with the Police and Municipal Authorities.

(b) Production of an agreed traffic management scheme in accordance with the local traffic laws. (Barriers, signs, lights and road markings) this shall include adequate provision for pedestrians.

(c) The provision and wearing of high visibility clothing by all personnel engaged in the activities.

(d) Traffic Marshals shall be appointed and deployed to ensure that all road movement is carried out safely.

31. PERSONAL PROTECTIVE EQUIPMENT

31.1. General

31.1.1. The Contractor shall at all times keep and maintain an adequate supply of suitable personnel protective equipment which shall be readily available for use at all times on the sites, and would include amongst others the following items:

(a) Safety Helmets.
(b) Hearing Protection.
(c) Respiratory Protection.
(d) Eye Protection.
(e) Protective Gloves.
(f) Safety Footwear.
(g) High Visibility Clothing to BS EN 471 Class 3 standard

31.1.2. All sites shall be designated as HARD HAT and SAFETY BOOTS SITES and as such an adequate supply of safety helmets and safety boots shall be kept available for use by all staff, workers and authorized visitors to the sites.

31.1.3. The Contractor shall remove from the site any worker who consistently refuses to wear the appropriate personal protective equipment.

31.2. References

31.3. Indian Standards

- IS 2925: 1984 Specification for Industrial Safety Helmets.
- IS 1179: 1967 Specification for equipment for eye and face protection during welding.
- IS 6994 (Part 1) Standard for Industrial Gloves

31.4. BRITISH STANDARDS

- BS EN 166:1996 Personal eye-protection. Specifications
- BS EN 169:1992 Specification for filters for personal eye protection equipment used in welding and similar operations
- BS EN 175:1997 Personal protection. Equipment for eye and face protection during welding and allied processes
- BS EN 352: Hearing protectors. Safety requirements and testing
  - 352-1 : 1993: Ear muffs
  - 352-2 : 1993: Ear plugs
  - 352-3 : 1997: Earmuffs attached to an industrial safety helmet BS EN 345-1:1993 Safety footwear for professional use
- BS EN 471:2003 High visibility clothing

32. FIRST AID

32.1. First Aid Bases

32.1.1. The Contractor shall establish a First Aid Base, in accordance with the Employer's Requirements, at each of his principal work areas. If during the life of the contract the Contractor's principal work area moves from one location to another, the Contractor shall be required to move his First Aid Base.

32.1.2. If the Contractor operates more than one principal work area, he will be required to have a First Aid Base at each of his principal work areas.

32.1.3. The First Aid Base shall consist of as a minimum;

(a) A treatment room fitted with two treatment couches,
(b) A hand wash basin with running water;
(c) Lockable cupboards to contain sufficient medical supplies;
(d) Bed.
(e) Six Chairs with footrests
(f) Desk and chair.
(g) Six Stretchers (Which can be lifted and lowered by a crane.)
(h) Pillows and blankets.
(i) Refuse containers.
(j) Medical dressings. (Bandages, plasters, antiseptic wipes.)
(k) Eye irrigation sterile solution.
(l) Paper towels.
(m) Disposable gloves.

32.1.4. The first-aid unit shall be provided with air conditioning and shall be kept in a clean and tidy state at all times.

32.2. Medical Staff

32.2.1. A qualified Doctor, Nurse and assistant Nurse shall be in attendance at the first aid base during all times when work is being undertaken on the site.

32.3. Ambulance

32.3.1. A fully equipped ambulance and driver shall be provided at the first aid base during all working

hours. The ambulance shall be equipped with emergency life support equipment suitable for application in construction site accidents.

32.4. First Aid Boxes

32.4.1. Portable first aid boxes will be maintained fully equipped at each local site offices and work locations where 20 or more persons work at a time.

32.4.2. In each site office and location one employee, suitably trained in first aid, should be available at all working hours for the purpose of attending to emergencies.

32.5. References

Indian Regulation
The Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules 2007: Chapter XXVIII - Medical facilities

33. FIRE PRECAUTIONS

33.1. General

33.1.1. The Contractor shall be responsible for supplying and maintaining adequate fire precaution facilities on all his sites. The following minimum standards should be adhered to.

33.1.2. The Contractor shall ensure that specially trained personnel are available to deal with fires due to electrical causes, gas explosions etc.

33.1.3. A good standard of housekeeping shall be maintained at all times on the sites.

33.1.4. No accumulations of rubbish shall be allowed to gather.

33.1.5. Combustible scrap and other construction debris should be disposed off site on a regular basis. If scrap is to be burnt on site, the burning site should be specified and located at a distance no less than 12 meters from any construction work or any other combustible material.

33.1.6. Signage shall be erected at prominent positions showing the correct use of portable first aid fire extinguishers.

33.1.7. Emergency plans and Fire Evacuation plans shall be prepared and issued. Mock drills should be held on a regular basis to ensure the effectiveness of the arrangements.

33.2. Fire Fighting Equipment

33.2.1. At various locations around the site clearly visible fire points shall be established for use in an emergency and each fire point should have available as a minimum the following type of equipment:

(a) Dry Powder Extinguisher.
(b) Water Type Extinguisher.
(c) Bucket of Sand.

33.2.2. Recharging of fire extinguishers and their proper maintenance should be ensured and as a minimum should meet Indian National Standards.

33.2.3. Water supply for firefighting purposes should be provided at the construction site. This may be in the form of static water tank of adequate capacity or a hydrant line with adequate water pressure at outlet points.

33.2.4. Sufficient number of fire hoses with branch pipes should be provided at site so that the fire can be controlled until the arrival the arrival of the Fire Brigade.

33.2.5. The Contractor shall need to give consideration to the provision of adequate fire fighting arrangements within the underground and tunnelling operations including the provision of Fire Service compatible hose connections and emergency lighting.

33.2.6. The Telephone Number of the local fire brigade should be prominently displayed near each telephone on site.

33.2.7. Supervisors and workmen at the site should be trained in the use of firefighting equipment

provided at the site.

33.3. Storage of Flammable Liquids

33.3.1. All flammable liquids shall be kept in a secure fire resistant store protected from electrical sparks welding sparks open flames and smoking.

33.3.2. Only such amounts of flammable liquids should be issued as are required for immediate use. Cans for carrying flammable liquids should be leak proof and having proper stopper and clearly marked "FLAMMABLE LIQUID".

33.3.3. Rags soaked in paints, kerosene and other flammable liquids should be disposed of daily under supervision. Large quantities of such rags should not be allowed to accumulate.

33.3.4. All Diesel fuel storage tanks shall be bounded around in order to control any spillage or leakage that may occur.

33.3.5. "NO SMOKING" signs shall be prominently displayed at all areas where flammable materials are stored.

33.4. 35.4. References

Indian Standards

- IS 13416 (Part 5): 1994 Preventative measures against hazards at workplaces – Recommendations Part 5 Fire Protection
- IS 1646: 1997 Code of Practice for fire safety of buildings (general):
- Electrical Installations
- IS 2190: 1979 Code of practice for selection installation and maintenance of portable first aid fire extinguishers
- IS 12349: 1988 Fire Protection – Safety Signs Also, Part IV of National Building Code of India: 1983

34. SITE PERIMETER HOARDING

34.1. General

34.1.1. The Contractor is required to keep the site as safe and secure as possible at all times, this includes the erection of site perimeter Hoarding which shall also deter trespassers both adult and children alike.

34.1.2. The Contractor shall provide a solid two meter high securely erected fence be installed around the perimeter of the site, with agreed and guarded access and egress points for both personnel and vehicles.

34.1.3. The Site Perimeter Fencing shall be constructed in accordance with the Employer's Requirement and as approved by the Project Manager.

34.1.4. At each entrance to the site the Contractor shall erect a large billboard warning all persons who enter the site that they are required to wear the appropriate Personal Protective Clothing and that no unauthorized access is allowed.

34.1.5. Wherever the fence runs adjacent to the highway with no buffer-zones then the fence shall have traffic warning lights duly affixed to it.

34.1.6. Wherever the fence borders on pedestrian footpaths lighting shall be provided to illuminate the pedestrian routes. The positioning of the fence-line shall not reduce the width of the pedestrian footpath to less than 900 mm in order to be able to accommodate disabled persons in wheelchairs.

34.1.7. Site perimeter fencing shall be washed at least once a month and repainted at least annually.

34.1.8. The site fencing shall need to be inspected on a regular basis in order to ensure that the integrity of the fencing is maintained at all times as far as is practicable.

34.2. References

34.3. Indian Standards

- IS 13430: 1992 Safety During Additional Construction and Alteration to Existing Buildings - Code of Practice
- IS 9457:1980 Standard for colours of safety signs

35. TRAFFIC MANAGEMENT

35.1. General

35.1.1. The Contractor shall ensure that all traffic management schemes shall be in accordance with the agreed schemes following consultation with the Local Traffic Police and the Metropolitan and other Authorities in charge of the area.

35.1.2. Adequate and clear warning signs shall be displayed at appropriate distances before the commencement of the site workings. In addition, prior warning shall be given concerning the location of the approaching site entry and exit points.

35.1.3. All traffic signs, barriers, cones and lighting shall be kept maintained and clean at all times.

35.1.4. Site vehicles exiting the site shall observe caution at all times; if the vehicles are exiting directly onto the live carriageway then they shall be directed by an identifiable Traffic Controller.

35.1.5. Regular inspections of the traffic management schemes shall be conducted by the Contractors in both the daytime and night time hours with the results of these inspections being recorded. These records shall be kept available for inspection by the Project Manager.

35.2. Vehicle Control

35.2.1. Traffic Controllers shall be available for directing vehicles that are exiting the sites directly onto the live carriageways. Any vehicles entering the sites that are required to execute reversing manoeuvres shall do so under the strict control of a trained and designated banksman. (Banksman defined as {reversing assistant} is the skilled person who directs the operation of a crane.)

35.3. Spoil Removal

35.3.1. Only well maintained and licensed vehicles shall be allowed to be used for the removal of excavated spoil from the sites.

35.3.2. All drivers shall be medically fit and in possession of a valid and current driving license.

35.3.3. No vehicles, which are overloaded, shall be allowed to leave the site.

35.3.4. Any vehicles leaving the sites carrying loads which are liable to produce airborne contaminants shall prior to leaving the site securely sheet the load over in order to effectively contain any dispersion during transportation on the public highway.

35.3.5. Vehicles exiting the site directly onto the live carriageway shall do so under the control of the clearly identified Traffic Controller.

35.3.6. Any vehicles that are required to reverse whilst on the site shall do so under the control of a trained banksman.

35.3.7. Any vehicles prior to leaving the site shall have their wheels washed and any loose material removed.

35.3.8. Any spoil that is removed from the work-sites shall be disposed of only at authorized dumping sites.

35.4. References

Indian standards

- IS 4130: 1991 Demolition of Buildings – Code of Safety
- IS 13416 (Part 3):1994 Recommendations for preventive measures against hazards in the workplace, Part 3, Disposal of Debris

36. VISITORS TO SITE

36.1. General

All visitors to site shall report to the Contractors site offices where they shall be issued with appropriate Personal Protective Equipment if they are to go out onto the site work areas. Any visitors going out to the site work areas shall be accompanied at all times by a member of the site personnel.

37. LIST OF SCHEDULES

The following Schedules are given to assist the Contractor's understanding of the Hierarchy of Safety adopted by MMRC and to give additional advice in support of this Manual.

Schedule 1 Sample Safety Forms
Schedule 2 Examples of Toolbox Talks
Schedule 3 Hierarchies of Safety and Industrial Health for MMRC Contracts

SCHEDULE 1

SAMPLE SAFETY FORMS

The purpose of this schedule is to provide a set of standardised forms for the Contractor to use when reporting information to the Engineer. The Contractor is free to adapt the forms for his own use, however when the form is being used to transmit information to the Engineer it must contain, as a minimum, the information shown on the following forms.

List of Forms:

SAF 001	Accident / Incident / Dangerous Occurrence Report Form
SAF 002	Accident Report - Injury Analysis Form
SAF 003	Accident Statistics – Monthly Report Form
SAF 004	Contractor's Monthly Safety Report
SAF 010	Permit to Work –Confined Spaces
SAF 011	Permit to Work –Electrical
SAF 012	Permit to Work – Hot Work
SAF 020	Risk Assessment Work Sheet
SAF 021	Hazardous Substance Assessment Sheet
SAF 030	Site Safety and Emergency Standby Name List
SAF 031	Safety Training Attendance Record
SAF 032	Weekly Fire Fighting Equipment Check List
SAF 033	Scaffold Inspection Check lists
SAF 040	Contractor's Application for Approval of Safety Manager to Work

Table 1 – SAF 001 - ACCIDENT/INCIDENT/ DANGEROUS OCCURRENCE REPORT FORM

MUMBAI METRO RAIL CORPORATION	**SAMPLE SAFETY FORM REFERENCE**:	**SAF -001**
ACCIDENT/INCIDENT/DANGEROUS OCCURRENCE REPORT FORM		**Accident No.**
Name of Contractor		**Contract No.**

Instructions: 1. A copy of this form shall be completed for every Accident and Dangerous Occurrence.

2. It must be signed by a senior site management representative.

3. A copy shall be sent to the Engineer within 24 hours of the Accident.

Part A: Details of Injured Person

Name:_____ Date of Birth:_____ ☐ Male ☐ Female

Address:_____

_____

Job Title :_____ Name of Employer: _____

Part B: Details of The Accident (use additional paper as necessary)

Date:_____ Time:_____ Location:_____

- Describe the task the injured person was doing at the time of the accident:
- Describe in details how the accident happened (Attach, sketch, plan photographs etc.):
- Was any plant or machinery involved yes/no: if yes give details:
- Name of any Witnesses:

Part C: Details of the Inquiry

What was the Injury? (e.g. Fracture, Lacerations) What

Part of the body was injured? ☐ ☐

Was the injury: Fatal ☐ Major Injury ☐ Minor Injury ☐ ☐

Was the injured person sent to; First Aid Doctor Hospital Home

Part D: Certification

I have checked the above information and can confirm that it is a true record of the accident Signed

Safety Officer Date _____ Signed

Project Manager Date _____

Table 2- SAF002 ACCIDENT REPORT-INJURY ANALYSIS FORM

MUMBAI METRO RAIL CORPORATION	SAMPLE SAFETY FORM REFERENCE:	SAF -002
ACCIDENT REPORT- INJURY ANALYSIS FORM		ACCIDENT NO ……
NAME OF CONTRACTOR	CONTRACT NO.	

Name Of Injured Employee **Date of birth : / /** **Male ☐** **Female ☐**

Address: _____

Job Title:

Cause of Accident

01. Machinery ☐	05. Falling objects ☐	09. Gassing poisoning toxic & other substance ☐	13. Miscellaneous ☐
02. Electricity ☐	06. Stepping on or Striking against objects ☐	10. Explosions or fires ☐	
03. Hand Tool ☐	07. Falls of person ☐	11. Handling goods or equipment ☐	
04. Foreign Body in eye ☐	08. Hot or corrosive substances ☐	12. Transport ☐	

Severity of Injury

01 First Aid ☐	03 Three days or less ☐	05 Discharged ☐	07 Fatal ☐
02 Medical Aid ☐	04 Over or three days ☐	06 Detained ☐	08 Days Lost ☐

Nature of Injury

01 Amputation ☐	05 Crush /Compression ☐	09 Foreign Body(eye) ☐	13 Sprain/Strain ☐
02 Cut ☐	06 Contusion /Bruise ☐	10 Foreign Body(other) ☐	14 Inhalation /Ingestion ☐
03 Location ☐	07 Fracture ☐	11 Puncture ☐	15 Concussion ☐
04 Abrasion ☐	08 Dislocation ☐	12 Scald / Burn ☐	16 Others ☐

Part of Body Injured (ENTER IN ORDER OF SERIOUSNESS)

HEAD AND SHOULDER	TRUNK	UPPER EXTREMITIES	LOWER EXTREMITIES
01 Skull ☐☐☐☐	11 Back ☐☐☐☐	18 Shoulder ☐☐☐☐	26 Hip/Buttock ☐☐☐☐
02 Scalp & Forehead ☐☐☐☐	12 Chest ☐☐☐☐	19 Upper arm ☐☐☐☐	27 Thigh ☐☐☐☐
03 Eye ☐☐☐☐	13 Abdomen ☐☐☐☐	20 Elbow ☐☐☐☐	28 Knee ☐☐☐☐
04 Ear ☐☐☐☐	14 Groin ☐☐☐☐	21 Forearm ☐☐☐☐	29 Shank ☐☐☐☐
05 Nose ☐☐☐☐	15 Respiratory System ☐☐☐☐	22 Wrist ☐☐☐☐	30 Ankle ☐☐☐☐
06 Mouth, teeth, jaw ☐☐☐☐	16 Digestive System ☐☐☐☐	23 Hand & Figures ☐☐☐☐	31 Heel/Sole/Instep ☐☐☐☐
07 Face &Cheek ☐☐☐☐	17 Others ☐☐☐☐	24 Thumb ☐☐☐☐	32 Toes ☐☐☐☐
08 Neck &Shoulder ☐☐☐☐		25 Others ☐☐☐☐	33 Others ☐☐☐☐
09 Brain ☐☐☐☐			
10 Others ☐☐☐☐			

Unsafe Conditions

01 Rough Slippery ☐	06 Improper dress ☐	11 Inadequate procedure ☐	15 Overloading ☐
02 Design effect ☐	07 Improper guard ☐	12 Inadequate aisle space job methods, exits etc. ☐	16 Poor House Keeping ☐
03 Worn frayed ☐	08 Improper ventilation ☐	13 Unsafe planning & / or layout ☐	17 No unsafe conditions ☐
04 No protective gear ☐	09 Improper illumination ☐	14 Unsafe Process or Poor House Keeping ☐	
05 Defective protective gear ☐	10 Improper procedure of job traffic or process operation ☐		

Personal Factor

01Attitude	02 Knowledge or skill person	03 Physical Defects	04 Unsafe Act by another
05 No unsafe personal factor			

Unsafe Act

01 Operating without authority	05 Using unsafe equipment	09 Failure to use safe at fire or	
02 Failure to secure or warn/ hands instead of posture personal protective equipment	06 Taking unsafe position or	10 Horseplay,	
03 Making safety devices equipment / or equipment's	07 Operating or working at	11 No unsafe act dangerous Equipment mixing	
04 Working on moving or unsafely	08 Unsafe loading, placing		

How would a similar accident be avoided?
What has been done to prevent similar accidents?
Comments:

Safety Officer	**Sign:**	**Name:**	**Date:**
Project Manager	**Sign:**	**Name:**	**Date:**

Table 2 – SAF 003 - ACCIDENT STATISTICS – MONTHLY REPORT FORM

MUMBAI METRO RAIL CORPORATION	**SAMPLE SAFETY FORM REFERENCE:**	**SAF-003**

ACCIDENT STATISTICS – MONTHLY REPORT FORM

NAME OF CONTRACTOR	**CONTRACT NO**

REPORT FOR MONTH ENDING: _____

COMMENCEMENT DATE: **SCHEDULED COMPLETION DATE:**

	ACCIDENT STATISTICS SUMMARY	**FOR MONTH**	**CUMULATIVE**
1.	Number of Man hours Worked		
2.	Number of Man days Worked		
3.	Number of Reportable Fatal Accidents		
4.	Number of Reportable Non-Fatal Accidents		
5.	Number of Dangerous Occurrences		
6.	Number of Man hours Lost		
7.	Number of Man days Lost		
8.	Number of Reportable Accidents per 100,000 Man hours Worked= [(3) + (4)] x 100,000 = (1) Accident Frequency Rate		
9.	Average Number of Worker Daily		

REMARKS: { _____ }

Signed: Safety Officer: Date: / /

Signed: Project Manager: Date: / /

NOTE: This form must be completed and returned to the Engineer within 5 days after the end of each month.

Table 3 – SAF 004 - CONTRACTORS MONTHLY SAFETY REPORT

MUMBAI METRO RAIL CORPORATION	SAMPLE SAFETY FORM REFERENCE:	SAF -004

CONTRACTORS MONTHLY SAFETY REPORT

NAME OF CONTRACTOR	CONTRACT NO.

This report which shall be submitted to the Engineer within five days of the end of each month consists of two sections; Part A. and Part B.

PART A: Accident Statistics

1. Accident Statistics which shall be presented in the format shown on the Accident Statistics Monthly Report Form (SAF 003)
2. Highlights of serious accidents which have occurred during the Month.
3. Details of any Fires which have occurred during the Month.

PART B: Safety Activities

1. Safety Committee. An extract of the salient points of the last month's meeting and any action taken.
2. Details of Tool Box Talks held during the month to include:
    a. numbers up to date,
    b. total number of workers attending each talk,
    c. the safety topics covered,
3. Details of any other training provided either on site or by attendance to outside courses such as First-Aid, Crane Operator, Singer/Rigger's etc.
4. Safety promotion undertaken during the month, poster campaigns, competitions, etc.
5. Details of Safety Inspections carried out during the month. This information should show internal inspections and inspections by any outside bodies.
6. Details of Emergency Evacuation drills or exercises carried out during the month including the involvement, if any, of outside bodies.
7. Any other relevant information.

Table 4 – SAF 010 - PERMIT TO WORK – CONFINED SPACES

MUMBAI METRO RAIL CORPORATION	SAMPLE SAFETY FORM REFERENCE:	SAF -010

PERMIT TO WORK – CONFINED SPACES

NAME OF CONTRACTOR	CONTRACT NO

PERMIT NO. CF….. DATE / /

PART 1. ISSUE

Issue to (Name of Person)_____ Section _____

Details of Confined Space _____

Location _____

Work to be carried out

Results of Confined Space Testing: _____

Oxygen Content _____ Explosive Gas _____ LEL

Toxic Gas 1: _____ Toxic Gas2: _____

Date and Time Tests Conducted _____

Type and Model of Equipment used _____

Precautions Required _____

I hereby declare that the above Confined Space is safe to enter without the use of breathing apparatus, provided the conditions of this permit and the requirements of the Company Safety Rules and observed.

THIS PERMIT ONLY VALID FOR THE PERIOD SPECIFIED, WHICH MUST NOT EXCEED 24HOURS

Date: _____ Time of Issue: _____ Date: _____ Time of Expiry _____

Signed _____

Being the Authorised Person (Confined Spaces)

PART 2. RECEIPT

I hereby declare that work by myself, or by any person under my control in the above Confined Space shall be carried out in accordance with the conditions of this permit and the requirements of the company Safety Rules. All persons permitted to enter the Confined Space have been or will be informed of when the safe period for entry will expire.

Signed _____ Time _____ Date _____

Being the Competent Person (Confined Spaces)

PART 3. CLEARANCE CERTIFICATE

I declare that all persons under my charge have been withdrawn and warned that it is no longer safe to work in the Confined Space detailed above, and that all gear, tools and other equipment have been removed.

Signed _____ Time _____ Date _____

Being the Competent Person (Confined Spaces)

PART 4. CANCELLATION

I acknowledge receipt of the clearance of the Permit

THIS PERMIT IS NOW CANCELLED

Signed _____

Being the Authorized Person (Confined Spaces)

Time _____ Date _____

Table 5 – SAF 011 - PERMIT TO WORK – ELECTRICAL

MUMBAI METRO RAIL CORPORATION	SAMPLE SAFETY FORM REFERENCE:	SAF –011
Name of Contractor	**Contract No.**	

PERMIT TO WORK – ELECTRICAL

PERMITNO. E:_____Date_____

Part 1: Issue

Issue to_____

I hereby declare that it is safe to work on the following apparatus which is dead, is isolated from all live conductors and is connected to earth

_____

_____ The apparatus is efficiently connected to earth at the following points _____

The following is the work to be carried out on the Apparatus.

_____

_____ Caution Notices are posted at _____

Special Keys required for access to enclosures

Special Precautions to be taken

_____

This permit is valid only for the specified period which must not exceed 24 hours

Signed_____ being an Authorized Person Possessing authority to issue a Permit for the work specified above.

Time of issue_____ Date_____Time of Enquiry_____

Part 2: Receipt

I hereby declare that I accept responsibility for carrying out the work on the apparatus detailed on this permit, and that no attempt will be made by me, or by the men under my control to carry out work on any other apparat us.

Signed _____ Time _____ Date_____

Part 3: Clearance Certificate

I hereby declare that the work for which this permit was issued is now suspended /completed and that all men under my charge have been withdrawn, and warned that it is no longer safe to work on the apparatus specified on this permit and that gear, tools and temporary earthing connections are all clear.

I acknowledge return of authorized Key Nos _____ Signature of person responsible for issue of permit_____

Time _____ Date_____

Table 6 – SAF 012 - PERMIT TO WORK – HOT WORK

MUMBAI METRO RAIL CORPORATION	SAMPLE SAFETY FORM REFERENCE:	SAF -012

PERMIT TO WORK – HOTWORK

NAME OF CONTRACTOR	CONTRACT NO.

PERMIT NO. HW: Date

Part 1: Issue

Issue to (Name of person) Details Section

of Hot Work

Location

Work to be carried out

I hereby declare that the above Hot Work is safe to carry out and that all appropriate fire precautions are in place including the issue of additional 5 kg Dry Powder Extinguisher on site and that all Company Safety Rules have been observed.

Date: Time of Issue Time of Expiry

~~This permit is valid~~ only for the period specified ~~which must not exceed 24~~ hours

Signed Time Date

Being the Authorized Person (Hot Work)

Part 2: Receipt

I hereby declare that the work by myself, or by any person under my control or the above Hot Work shall be carried out in accordance with the conditions of this certificate and the requirements of the company Safety rules. All persons permitted to work on this Hot Work have been or will be informed of when the safe period for entry will expire.

Signed Time Date

Being the Competent (Hot Work)

Part 3: Clearance

I declare that all Hot Work under my control has now been stopped and the area has been checked out found clear of any risk of fire and that all tools and other equipment have been removed.

Signed Time Date

Being the Competent (Hot Work)

Part 4: Cancellation

I acknowledge receipt of the clearance of this Certificate. This

certificate is now cancelled

Signed

Being the Authorized Person (Hot Work)

Time Date

Table 7 – SAF 020 - RISK ASSESSMENT WORK SHEET

MUMBAI METRO RAIL CORPORATION				**SAF-020**
RISK ASSESSMENT WORKSHEET				
NAME OF CONTRACTOR		**CONTRACT NO.**		**DATE:**
OPERATION:			**METHOD STATEMENT Ref:**	**PAGE OF :-**
HAZARDS	**RISKS**	**DEGREE**	**CONTROL**	

Table 8 – SAF 021 - HAZARDOUS SUBSTANCES ASSESSMENT SHEET

MUMBAI METRO RAIL CORPORATION	SAMPLE SAFETY FORM REFERENCE:	SAF -021

HAZARDOUS SUBSTANCES ASSESSMENT SHEET

NAME OF CONTRACTOR	CONTRACT NO.

To be completed at Commencement and Revised Periodically and Updated as required

Generally Assessed (For use outside or in well ventilated areas)				Others Specific assessment required	
1 ☐	Cement	24 ☐	Butyl Mastic	47 ☐	**SPECIFY:**
2 ☐	Lime	25 ☐	Sealants Acrylic	48 ☐	
3 ☐	Plaster	26 ☐	Sealants Mastic	49 ☐	
4 ☐	Artex	27 ☐	Primers Mastic	50 ☐	
5 ☐	Sand	28 ☐	Solvents Elastomeric	51 ☐	
6 ☐	Aggregates	29 ☐	Sealants Elastomeric	52 ☐	
7 ☐	Plasticisers	30 ☐	Primers Elastomeric	53 ☐	
8 ☐	Retarders	31 ☐	Solvents Hot Mastic	54 ☐	
9 ☐	Rapid Hardeners	32 ☐	Sealants Bitumastics	55 ☐	
10 ☐	Colouring / Mortar	33 ☐	Coated Road Stone	56 ☐	
11 ☐	Curing Agents Rapid	34 ☐	Contact Adhesives	57 ☐	
12 ☐	Diesel / Gas Oil	35 ☐	Contact Solvents	58 ☐	
13 ☐	Engine Oils	36 ☐	Softwoods	59 ☐	
14 ☐	Hydraulic Oils	37 ☐	Hardwoods Fiber	60 ☐	
15 ☐	Shutter Oils	38 ☐	boards		
16 ☐	Greases	39 ☐	Paints /		
17 ☐	Pipe Lubricants	40 ☐	Primers Paint		
18 ☐	Epoxy Mortars	41 ☐	Solvents Brush		
19 ☐	Epoxy Adhesives	42 ☐	Cleaners		
20 ☐	Epoxy Sealant	43 ☐	Bleaches		
21 ☐	Epoxy Primers	44 ☐	Brick Cleaner		
22 ☐	Epoxy Solvents	45 ☐	Concrete Cleaner		
23 ☐	Epoxy Cleaners	46 ☐	Liquified Petroleum Gas		

Completed by:_____ Sign:_____ Name:_____

Title:_____ Date: _____

(√- TICK AS APPLICABLE)

Table 9 – SAF 030 - SITE SAFETY AND EMERGENCY STAND BY NAME LIST

MUMBAI METRO RAIL CORPORATION	**SAMPLE SAFETY FORM REFERENCE:**	**SAF -030**
SITE SAFETY AND EMERGENCY STAND BY NAME LIST		
Name of Contractor	**Contract No.**	
The following persons have been appointed to be our representatives on site for all site safety emergencies.		

Name of Representative	**Position**	**Office Tel. No.**	**Home Tel. No.**	**Mobile No.**

Project Manager:_____ Name: _____

Signature:_____ Date:_____

Table 10 – SAF 031 - SAFETY TRAINING ATTENDANCE RECORD

MUMBAI METRO RAIL CORPORATION	**SAMPLE SAFETY FORM REFERENCE:**	**SAF -031**
SAFETY TRAINING ATTENDANCE RECORD		
NAME OF CONTRACTOR		**CONTRACT No.**
Title of Course:_____ Date:_____ Course Reference No._____ Duration:_____ Name of Trainer (s) _____		

No.	**Name**	**Section /Sub-contractor**	**Signature**
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			
19.			
20.			
21.			
22.			
23.			
24.			

CONFIRMED AS CORRECT BY:

SIGNATURE:_____ (SAFETY MANAGER) DATE: / /

SIGNATURE:_____ (PROJECT MANAGER) DATE: / /

Table 11 – SAF 032 - WEEKLY FIRE FIGHTING EQUIPMENT CHECK LIST

MUMBAI METRO RAIL CORPORATION		**SAMPLE SAFETY FORM REFERENCE:**		**SAF -032**	
WEEKLY FIRE FIGHTING EQUIPMENT CHECKLIST					
NAME OF CONTRACTOR			**CONTRACT NO**		
SITE/ LOCATION			**DATE OF CHECK / /**		
FIRE POINT NUMBER	**EXTINGUISHERS IN GOOD ORDER**		**ACCESS TO EXTINGUISHERS**		**SIGNAGE**	
	YES	**NO**	**CLEAR**	**OBSTRUCTED**	**CORRECT**	**INCORRECT**
COMMENTS:						
CHECK CARRIED OUTBY: **NAME : _____ SIGNATURE : _____ POSITION : _____ DATE: / /**						

Table 12 – SAF 033 - SCAFFOLD INSPECTION CHECKLIST

MUMBAI METRO RAIL CORPORATION	SAMPLE SAFETY FORM REFERENCE:	SAF -033
SCAFFOLD INSPECTION CHECK LIST		
NAME OFCONTRACTOR:	CONTRACT No.	DATE: / /

Work commencement–Date_____/_____/_____

Location and description of scaffold, etc. and other plant or equipment inspected	Date of inspection	Result of inspection	Signature of Person
1	2	3	4

SHORT CHECK LIST – ATTACH INSPECTION CHECK THAT YOUR SCAFFOLDING DOES NOT HAVE FAULTS

	Week	1	2	3	4
FOOTING STANDARDS	Soft and uneven				
	No base				
	No sole boards				
	Undermined				
	Not plumb				
	Jointed at same Ht.				
	Wrong Spacing				
	Damaged				
	Not level				
	Joint in same bays				
	Loose				
	Damaged				

	Week	1	2	3	4
RACING FAÇADE & LEDGER PUTLOGS AND TRANSOMS COUPLINGS	Some missing				
	Loose				
	Wrong Fittings				
	Wrongly Spaced				
	Loose				
	Wrongly Supported				
	Wrong fitting				
	Loose				
	Damaged				
	No check couplers				
	Wrong Spacing				
	Wrong couplings				
	Weak Support				

	Week	1	2	3	4
TILES BOARDING GUARDS RAILS& TOE BOARDS LADDERS	Some missing				
	Loose				
	Bad boards				
	Trap Boards				
	Incomplete				
	Insufficient				
	Supports				
	Wrong Height				
	Loose				
	Some Missing				
	Damaged				
	Insufficient Length				
	Not tied				

SIGNATURE _____ NAME_____DATE / /

Table 13 – SAF 040 - CONTRACTOR'S APPLICATION FOR SAFETY MANAGER TO WORK

MUMBAI METRO RAIL CORPORATION	**SAMPLE SAFETY FORM REFERENCE:**	**SAF -040**
CONTRACTOR'S APPLICATION FOR SAFETY MANAGER TOWORK FOR CONTRACT.....		
NAME OF CONTRACTOR	**CONTRACT NO.**	
GENERAL PARTICULARS Name :_____ (In Block Capitals) Date of Birth:		

SCHEDULE 2

EXAMPLES OF TOOL BOX TALKS

The purpose of the following Toolbox Talks is give guidance on the subject matter to be covered during the talk. The talk should be given to groups of workers no greater than twenty in number by their supervisor. Each talk should last between ten and fifteen minutes. An attendance sheet of each talk should be kept showing who presented the session, the workers who attended, and the duration. Form SAF 031 Safety Training Attendance Record should be used for this purpose.

The following list shows the subjects that can be covered, but not limited to:

1. Personal Points (listed below)
2. Personal Protective Equipment
3. Manual Handling
4. Hand Tools
5. Woodworking Machinery
6. Ladders
7. Cartridge Tools
8. Compressed Air
9. Oxygen
10. Compressed gas Cylinders
11. Drilling Machines
12. Pre-permit activation job specific tool box talk
13. Excavation
14. Electrical safety
15. Situational awareness
16. Other topics

Table 14 - TOOL BOX TALK NO 1

MUMBAI METRO RAILCORPORATION	**TOOL BOX TALK NO1**
PERSONAL POINTS	
a) Never take chances. b) Carry out the instructions you have been given. c) If you do not know or understand -Ask. d) If you see an unsafe condition - Rectify it or report it. e) If you have an accident make sure you report it and get it properly attended to. f) Obey all safety signs and rules. g) Do not distract others or "horseplay" around h) Only operate plant and equipment that you are authorized to. i) Never operate machinery unless all the guards are in place. j) Always wear the protective clothing and equipment that you have been provided with. k) Keep your work place clean and tidy. Look after your tools, don't leave them on the ground where they can be damaged or where people can fall over them.	

SCHEDULE 3

OSHE MONTHLY AUDIT MEASUREMENT CRITERIA

(Model Answers)

Points will be objectively awarded by Contractor based upon site safety and environmental conditions

Scoring will be as follows:

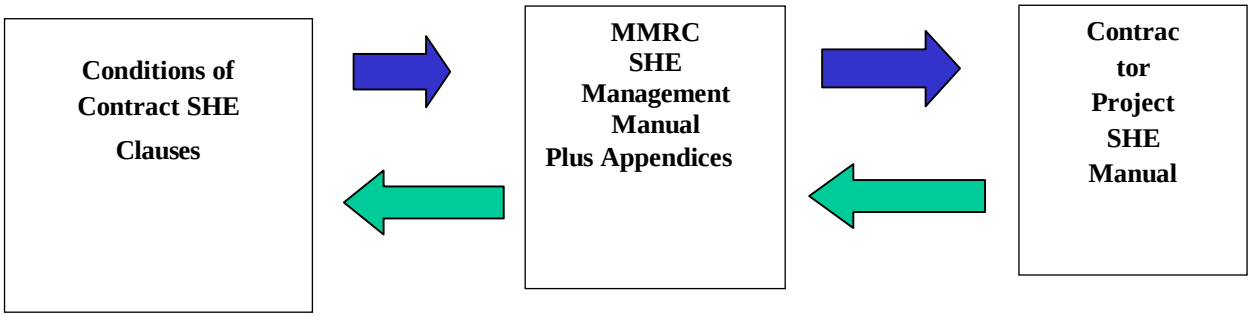
Excellent	(E) = 10,
Good	(G) = 8,
Average	(A) = 7,
Insufficient	(IS) = 2, 4 or 6
Non-Compliance	(NC) =0

All non-compliances within the heavy bordered areas will receive an Action Notice at the required level. All Suspended Operations Notices will be referred to the Project Manager, who will visit site within 24 hours to carry out further safety inspections.

Any non-applicable topic and the corresponding "possible score" will not be marked and the score will be calculated by recognizing the relevant possible score as being 100% and the actual score as a percentage of this.

Table 15 - HIERARCY OF SAFETY HEALTH & ENVIRONMENTAL FOR MMRC CONTRACTORS

HIERARCY OF SAFETY HEALTH & ENVIRONMENTAL FOR MMRCCONTRACTORS



Enforceable
With Financial Implications

Code of Practice Enforceable
through Conditions of Contract

Contractor Implementation Manual
For - Contractors and Engineer

Mumbai Metro Rail Line 3
BIDDING DOCUMENTS

EMPLOYER'S REQUIREMENTS
GENERAL SPECIFICATIONS

Part 2

Section VI (1)
Sub-Division F

Appendix 21

OPERATION AND MAINTENANCE DOCUMENTATION

July 2019

Table of Contents

OPERATION AND MAINTENANCE DOCUMENTATION

1. General

1.1 The Contractor shall submit a submission programme. The submission program shall identify all submissions to be furnished, submission titles, submission numbers and target submission dates.

1.2 The Contractor shall provide configuration management to ensure that the system is correctly configures. The Contractor shall ensure that a configuration control program is maintained. The programme shall ensure that the configuration of each item is recorded and maintained at the same level during the life of the Contract and Defects Liability Period.

1.3 The Contractor shall submit a Project Management Plan to the Engineer for review. The Project Management Plan shall identify the persons to be responsible and the methods and arrangement to carry out the Project Management.

1.4 The Contractor shall supply Operation and Maintenance documentation in respect of the Track work Systems including depot Track under the systems Contract in accordance with the requirements of the following clauses, except where expressly specified otherwise in the Contract.

1.5 As well as submitting the Operation and Maintenance Manuals the Contractor shall submit a Health and Safety Manual in accordance with Part 4 and Appendix 20 for the operation and maintenance work on Site and in Depot.

1.6 Except where otherwise stated, the Contractor shall provide one electronic copy, 5 bound copies and one unbound copy of all documentation. The unbound copy will be used by the Employer / OMC for reproduction purposes.

1.7 All documentation shall be written in concise and plain English language. The content shall be sufficient to provide adequate guidance on all features of the design which impact on the operation, maintenance and repair of the railway systems including depot equipment.

1.8 The Operation and Maintenance Manuals shall fully describe the overall operation of all Systems.

1.9 The Operation and Maintenance Manuals shall contain no irrelevant or ambiguous information and shall relate specifically to this Contract. The Operation and Maintenance Manuals shall be prepared in a user-friendly manner that permit finding complete sets of information and instructions for a given system or component quickly.

1.10 Owing to the workshop type environment that the Operation and Maintenance Manuals will be used in the manuals shall be produced using quality / heavy duty products (i.e. quality paper, plastic sealed binders, opaque covers, laminated sheet).

2. Operation Manuals

2.1 The Operation Manuals shall provide detailed instructions for the operation of all types Track work Systems including depot Track. These manuals will be produced with due regard to the qualification of personnel who shall be required to refer to them. These documents will be issued as controlled documents and should therefore be collated and numbered in proper order corresponding to the contents and index pages. Nomenclature of equipment, diagrams and figure numbers or units shall be consistent throughout the text. In order to comprehend the text, diagrams, drawings, sketches and actual photographs shall be added where necessary. All manufacturers' literature identification codes or

stamp markings shall be omitted. Precautions and warnings regarding the safety of life and equipment shall be included where applicable.

2.2 Familiarization of Operation and Maintenance manual.

The contractor shall provide instructions including:

a) Basic functions
b) Operation Instructions
c) Table listing locations and quantities
d) Special options or unusual features not normally supplied.

2.3 Content Structure

The Contractor shall arrange all documentation in accordance with the following guidelines for all Operation and Maintenance Manuals:

a) The first Section shall be an overview of the functions provided by the systems.
b) All functions shall be described and all operator input clearly defined.
c) All system operating sequences shall be explained.
d) All indications and alarms shall be described together with the appropriate operator response.
e) Descriptions of indications and operator inputs shall be accompanied by pictures or screen shots of the control interface.
f) Lengthy technical descriptions of the systems in sections on operator input shall be avoided and if required shall be segregated into an appendix for reference.
g) Relevant system block diagrams, drawings, flow charts etc. shall be provided where this assists understanding of the text and the significance of the equipment alarms and status indications.
h) Paper size shall be A4 and if necessary with folded A3.

2.4 Contents of Operation Manuals

The Contractor shall prepare operation manuals for all System, rolling stock, maintenance vehicles, equipment and machines of the relevant contracts. The operation manuals shall contain followings, but not be limited to:

a) Safety regulations for operation excluding train operation;
b) Instruction of operation;
c) Explanation of the system out line, structure of the system indicating relation of each subsystem and/or equipment, faculty of system/subsystem/equipment;
d) List of equipment and parts with identification codes and illustration indicating structure;
e) Guide to failure detection;
f) Instruction of daily cleaning, checking and adjustment;
g) Contact address in emergency;
h) Route.

3. Maintenance Manuals

3.1 The Maintenance Manuals shall provide detailed instructions for the maintenance of Track work Systems including depot Track. These manuals shall be produced with due regard to the qualification of personnel who shall be required to refer to them. These documents will be issued as controlled documents and should therefore be collated and numbered in proper order corresponding to the contents and index pages. Nomenclature of

equipment, diagrams and figure numbers or units shall be consistent throughout the text. In order to comprehend the text, diagrams, drawings, sketches and actual photographs shall be added where necessary. All manufacturers' literature identification codes or stamp markings shall be omitted. Precautions and warnings regarding the safety of life and equipment shall be included where applicable.

Manuals shall be clearly identified as being:

a) First line scheduled maintenance
b) First line recovery/corrective maintenance
c) Second line maintenance
d) Software maintenance

3.2 Content Structure

The Contractor shall arrange all documentation in accordance with the following guidelines for all Operation and Maintenance Manuals:

a) The first Section shall be an overview of the functions provided by the systems.
b) All functions shall be described and all operator input clearly defined.
c) All system operating sequences shall be explained.
d) All indications and alarms shall be described together with the appropriate operator response.
e) Descriptions of indications and operator inputs shall be accompanied by pictures or screen shots of the control interface.
f) Lengthy technical descriptions of the systems in sections on operator input shall be avoided and if required shall be segregated into an appendix for reference.
g) Relevant system block diagrams, drawings, flow charts etc. shall be provided where this assists understanding of the text and the significance of the equipment alarms and status indications.
h) Paper size shall be A4 and if necessary with folded A3.

3.3 Kinds of Maintenance Manuals

The Contractor shall prepare maintenance manuals for all Railway Systems, Depot and Workshop Equipment, Infrastructure Maintenance Vehicles as followings, but not be limited to:

a) Safety regulations for maintenance work;
b) Inspection or maintenance regulation in accordance with the Indian regulations and the Tender Documents;
c) Inspection and repair standard and/or criteria;
d) Inspection and repair methods;
e) Operation manuals for inspection equipment, instrument, tester and tool;
f) Data management system for logging asset status, inspection and repair record;
g) Quality assurance system data base for tracing maintenance history.

4. Submission Requirement

4.1 Contact details during the maintenance period shall include;

a) Name of supplier organization for maintenance
b) Name of supplier person(s) for maintenance
c) Telephone number(s) for maintenance

d) Email address(es) for maintenance

4.2 The Contract shall include records of amendment in each submission with the following detailed:

a) Revision history and status of the submissions;
b) Description on changes for each revision;
c) The Contractor's signature for authorization of the submission indicating proper design check has been carried out before the submitting to the Engineer.
d) The revision status and date of preparation of the submission shall be clearly indicated at the header of each page of the submission.
e) The first submission shall be revision 0 and subsequent revision shall be A, then B, so on and so forth.
f) 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;
    i) Submission number
    ii) Submission title
    iii) Revision history
    iv) Status of Engineer's response for each revision
    v) Submission dates and dates of return from the Engineer for each revision
    vi) Current status

4.3 Levels of submission

The Contract shall adopt top-down approach and submit submissions of the following levels in a logic sequence for the review of the Engineer;

a) System level related submission
b) Equipment level related submission
c) Installation design related submission
d) Design calculations
e) Management plans and procedures
f) Approval certificates
g) Miscellaneous submission

4.4 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 all other Interface Contracts.

4.5 Equipment level related submission shall show the specification on electrical, mechanical and functionality of the equipment/materials employed for the system and the subsystems.

4.6 Installation design related submissions shall include;

(a) The installation methods and procedures for different types of installation activities
(b) Drawings showing the equipment locations and positions, subsystems coverage, capacity, size, weight etc.
(c) Schematic and wiring diagrams
(d) Cable core plan and numbering scheme
(e) Equipment mounting details

(f) Configuration data, parameters and setting
(g) Cable route drawings
(h) Layouts in equipment racks, in equipment rooms, trackside, concourse, platform and all other equipment locations

4.7 Design calculations shall demonstrate the performance of the system and subsystems.

4.8 The Contractor shall submit a copy of certificates from relevant parties and authorities as required including equipment calibration certificates from manufactures and laboratories.

4.9 Preventative Maintenance Information (First Line Scheduled Maintenance)

4.9.1 Preventive maintenance information shall include but not limited to the following

column	column title
A	PM ACTIVITY
B	SYSTEM
C	SUBSYSTEM
D	SUBSUBSYSTEM
E	PERIODIC REQUIREMENT
F	SITE LOCATION
G	DETAILED LOCATION
H	RELATED PART NUMBER
I	MAINTENANCE MANUAL DOC NAME
J	MAINTENANCE MANUAL DOC NUMBER
K	MAINTENANCE MANUAL SECTION
L	MAINTENANCE MANUAL PARAGRAPH
M	AS-BUILT DRAWING NUMBER

Note: For common glossary of acronyms in this document refer Appendix-15.

4.9.2 For each equipment item requiring preventive maintenance, The Contractor shall include preventive table(s) in each O&M Manual.

4.9.3 For each O&M Manual, The Contractor shall create soft copy EXCEL files, each formatted identically, with the preventative maintenance activities listed above. The soft copy preventative maintenance files shall be included with each O&M Manual.

4.9.4 The Contractor may provide a different list format provided the list format is the identical for each of the systems.

4.9.5 The purpose of the soft copy preventative maintenance files is import to a maintenance management database provided by others.

4.10 Corrective Maintenance Information.

4.10.1 The Corrective Maintenance information shall contain but not limited to the following details in Table of Replaceable Parts including the following. The Contractor shall provide a simple text-only spread sheet of Lowest Replaceable Units (LRU). Each row of the spread sheet shall list one LRU.

Column	Column title
A	MML3 PART NAME
B	ASSET MGT NUMBER (APDX-14)
C	SYSTEM
D	SUBSYSTEM
E	SUBSUBSYSTEM
F	OEM NAME OF PART
G	OEM PART NUMBER
H	OEM NAME
I	OEM PART SUPPLIER
J	OEM SUPPLIER WEBSITE
K	OEM SUPPLIER EMAIL
L	OEM SUPPLIER TELEPHONE
M	OEM SUPPLIER CITY STATE COUNTRY
N	OEM SUPPLIER EST DELIVERY TIME
O	ALT-1 NAME OF PART
P	ALT-1 PART NUMBER
Q	ALT-1 NAME
R	ALT-1 PART SUPPLIER
S	ALT-1 SUPPLIER WEBSITE
T	ALT-1 SUPPLIER EMAIL
U	ALT-1 SUPPLIER TELEPHONE
V	ALT-1 SUPPLIER CITY STATE COUNTRY
W	ALT-1 SUPPLIER EST DELIVERY TIME
X	ALT-2 NAME OF PART
W	ALT-2 PART NUMBER
Z	ALT-2 NAME
AA	ALT-2 PART SUPPLIER
AB	ALT-2 SUPPLIER WEBSITE
AC	ALT-2 SUPPLIER EMAIL
AD	ALT-2 SUPPLIER TELEPHONE
AE	ALT-2 SUPPLIER CITY STATE COUNTRY
AF	ALT-2 SUPPLIER EST DELIVERY TIME
AG	LRU LISTED IN PM ACTIVITY
AH	PERIODIC REPLACEMENT REQUIREMENT
AI	LRU MAINTENANCE MANUAL DOC NAME
AJ	LRU MAINTENANCE MANUAL DOC NUMBER
AK	LRU MAINTENANCE MANUAL SECTION
AL	LRU MAINTENANCE MANUAL PARAGRAPH
AM	LRU AS-BUILT DRAWING NUMBER

4.10.2 For each equipment item with replaceable parts, The Contractor shall include replaceable

parts table(s) in each O&M Manual.

4.10.3 For each O&M Manual, The Contractor shall create soft copy EXCEL files, each formatted identically, with the replaceable part details listed above.

4.10.4 The Contractor may provide a different list format provided the list format is the identical for each of the systems.

4.10.5 In addition to the details listed above, each replaceable part shall include the assigned asset management number per Appendix 10.

4.10.6 The soft copy replaceable part files shall be included with each O&M Manual.

4.10.7 The purpose of the soft copy replaceable part files is import to a maintenance management database provided by others.

5. As built Documentation

5.1 The as-built documentation shall describe the system as installed and provide sufficient information for the O&M Company staff maintainers and other users to execute their responsibilities. All documentation shall be submitted for review by the Engineer, and shall include (but not be limited to):

(a) Operation and Maintenance Manuals
(b) Configuration Data Tables
(c) As-built drawings

5.2 The configuration data table shall be prepared for each individual subsystem and on an item-by-item basis as well as on location basis.

5.3 The as-built drawings shall show the as-built details of the works and the Information contained on the drawings shall include but not be limited to:

a) Arrangement drawings for all sub-systems and individual items of equipment;
b) Installation and fixing drawings for all sub-systems and individual items of equipment;
c) Interface drawings for all sub-systems and individual items of equipment;
d) Schematic drawings for all electrical, pneumatic, hydraulic, water and drainage systems;
e) Sizes, material and finish of all fixtures and threads;
f) Manufacturer's code, drawing and reference numbers;
g) Wiring diagrams to appropriate Standards including internal wiring of sealed unit items;
h) Setting dimensions and tolerances; and
i) Bill of materials.

6. Trouble Shooting procedures including

a) Trouble Symptoms
b) Diagnostic Methods
c) Isolating Faults
d) Schematic and/or Block Diagrams for Fault Diagnosis
e) Diagnostic Test Equipment user manual

Mumbai Metro Rail Line 3
BIDDING DOCUMENTS

EMPLOYER'S REQUIREMENTS
GENERAL SPECIFICATIONS

Part 2

Section VI (1)
Sub-Division F

Appendix 22

RELIABILITY, AVAILABILITY AND MAINTAINABILITY
(Version C)

July 2019

TABLE OF CONTENTS

1. ABBREVIATIONS

CA	Concession Agreement
COD	Commercial Opening Date
DLP	Defect Liability Period
FMECA	Failure Mode Effects and Criticality Analysis
FMEA	Failure Mode Effect Analysis
FTA	Fault Tree Analysis
FRACAS	Failure Reporting, Analysis & Corrective System
FRB	Failure Review Board
IE	Independent Engineer
IRA	Independent RAM Assessor
Kmph	Kilometres per hour
MMRC	Mumbai Metro Rail Corporation
MEP	Mechanical, Electrical & Plumbing
MKBSAF	Mean Kilometres between Service Affecting Failure
MSS	Manuals of Specification & Standards
MTBSAF	Mean Time between Service Affecting Failures
MTTR	Mean Time to Repair / Restore
Non-SAF	Non- Service Affecting Failures
OCS	Overhead Contact System
O&M	Operation & Maintenance
PHPDT	Peak Hour Peak Direction Traffic
PSS	Power Supply System
RAM	Reliability, Availability and Maintainability
RAMS	Reliability, Availability, Maintainability and Safety
RST	Rolling Stock
SAF	Service Affecting Failure
S&TC	Signaling & Train Control System
STPT	Signaling Train Control, Platform Screen Door and Telecommunication

2. DEFINITIONS

Term	Definition
Apportionment	A process whereby the RAMS elements for a system are sub-divided between the various items which comprise the system to provide individual targets
Availability	The ability of a product/equipment/system to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval assuming that the required external resources are provided.
Component	The elements (sub-assemblies or any lower order elements of the sub-assemblies) of the Sub-system are referred in this document as component.
Commissioning	A collective term for the activities undertaken to prepare a system or product prior to demonstrating that it meets its specified requirements
Compliance	A demonstration that a characteristic or property of a product satisfies the stated requirements.
Contractor	The Sub-system supplier's such as RST supplier, S&TC supplier etc. are referred to as Contractors in this document.
Corrective maintenance	The maintenance carried out after fault recognition and intended to put a product into a state in which it can perform a required function
Down Time	The time interval during which a product is in a down state.
Environmental Stress Screening	Environmental stress screening (ESS) refers to the process of exposing a newly manufactured or repaired product or component to stresses such as thermal cycling and vibration in order to force latent defects to manifest themselves by permanent or catastrophic failure during the screening process. The surviving population, upon completion of screening, can be assumed to have a higher reliability than a similar unscreened population.
Failure Rate	Number of failures per time, distance or cycle
Maintainability	The probability that a given maintenance action, for an item under given conditions of use can be carried out within a stated period of time interval when the maintenance is performed under stated conditions and using stated procedures and resources.
Missed Trip	Trip which has not been started until the scheduled time of departure of the next following trip (failure to be dispatched) or a trip which is terminated before it reaches the end station of its scheduled service (withdrawal from service)
Operational Availability	The availability that considers administrative & logistic delay times in addition to the down time due to both preventive & corrective maintenance. For Mumbai Metro System, Operational Availability does not consider the preventive maintenance as no preventive maintenance shall be performed during the traffic hours thus not affecting the primary purpose of the Mumbai Metro system to carry passengers safely.
Preventive maintenance	The maintenance carried out at pre-determined intervals or according to prescribed criteria and intended to reduce the probability of failure

	or the degradation of the functioning of an item
Service Punctuality	It is defined as the percentage of the total number of scheduled trips for a day that completes its scheduled journey within 1 (one) minute of the expected journey time.
Service Reliability	It is defined as the percentage of the total scheduled trips per day that are not missed. [Refer definition of missed trip].
Reliability	The probability that an item can perform a required function under given conditions for a given time interval.
Reliability Growth	A condition characterised by a progressive improvement of a reliability performance measure of an item with time
Repair	That part of a corrective maintenance in which manual actions are performed on an item.
Restore	That event when an item regains the ability to perform a required function after a fault
System	All the subsystems which, working together, deliver the complete Mumbai Metro Line-3. System represents "Mumbai Metro Line-3".
Sub-system	A group of components working together within the Mumbai Metro Line-3 to contribute to satisfying specified Mumbai Metro Project operational requirements. The Subsystems that form the Mumbai Metro System are alignment & track, stations, S&TC, PSS, OCS, AFC, COM, RST etc.
Sub-Contractor	Supplier of a particular component
Trip	A trip is a journey of a train from its planned starting station to the planned end station of its planned service

3. DOCUMENT REFERENCES

Following documents and standards are referred while preparing this System Level RAM Plan.

[1]. Detailed Project Report

[2]. EN 50126-1: Railway Applications – The specification and Demonstration of Reliability, Availability, Maintainability & Safety (RAMS) – Part 1: Basic Requirements & Generic Process

[3]. EN 50126-3: Railway Applications – The specification and Demonstration of Reliability, Availability, Maintainability & Safety (RAMS) – Part 3: Guide to the application of Rolling Stock RAMS

4. MUMBAI METRO RAIL SYSTEM

4.1 Project Background

4.2 Metro System Description

4.2.1 The metro line 3 comprises of 33.6 Km long underground metro rail with 26 underground and one at-grade stations. The traction system will be 25 KV single phase, 50Hz, AC overhead traction system. The track will be standard gauge.

4.2.2 There will be one depot at Aarey Colony to stable, maintain and despatch the trains. OCC will be housed in depot complex. Backup control system will be at BKC station complex.

4.2.3 The Signalling and Train Control will be communication based on the mainline. Initially trains will be operated with train operator on board but S&TC system shall be designed so that later it can be upgraded to Unattended Train Operation (UTO) with ultimate design headway of 90 seconds.

4.2.4 The depot signalling system will be SSI lines operation will be controlled with GoA4 UTO

4.2.5 The S&TC System shall support operation of different train consist i.e. 8 cars and an 8 car configuration during revenue hours.

4.2.6 The Signalling and Train Control System for the revenue lines shall be controlled from centralised OCC which shall be located at Aarey Colony. The OCC location shall also house Administrative Offices of Employer.

4.2.7 The Rolling Stock will be 3.2-metre-wide, aluminium/ steel body coaches, air conditioned.

4.2.8 The Trains shall be operated continuously such that the first Train in each direction shall depart no later than 0500 hours and the last Train shall terminate not earlier than 2330 hours at the frequency specified provided that on Sundays the duration of services may be reduced by 4 (four) hours.

4.2.9 The Trains in each direction shall be operated such that the difference between arrival time of two Trains at any Station shall not exceed 3 (three) minutes; provided that such difference may be increased, subject to a maximum of 15 (fifteen) minutes, depending upon the number of Users in the respective hour.

4.2.10 The average speed of train movement from terminal to terminal during any hour of the day, including stops at the Stations, shall not be less than 34 (thirty-four) kilometres per hour, stops at the Stations shall not be less than 20 (twenty) seconds each in safety reports.

4.2.11 The normal service headway shall be 120 seconds at peak time. The signalling system shall be designed for 90 seconds headway.

4.2.12 The trains shall be capable of sustaining a maximum service speed of 85 KMPH with a civil speed of 95 KMPH.

4.2.13 The passenger trains shall be of 8-car configuration (DT+M+M+M+M+M+M+DT) in system reports.

5. INTRODUCTION

5.1 Objective

5.1.1 The objective of this document is to describe the process, tools and techniques to be used for the implementation of RAM in Mumbai Metro Line3 project, as a minimum.

5.1.2 Further its intent is to provide instructions and guidelines to the Contractors of Mumbai Metro in order to align the Sub-system RAM Plans with the overall RAM plan of the System to achieve the specified RAM performance targets. This document also specifies minimum criteria for System and Sub-system RAM acceptance.

5.2 Scope of the Document

5.2.1 This document describes the minimum RAM process requirements for the System and Sub-systems. The Contractor's shall implement the relevant standards as mentioned in this document to achieve its Contractual RAM performance.

5.2.2 The safety aspect of RAMS is out of the scope of this document. The same shall be described in a separate System level document.

5.3 Limitations, Assumptions & Facts

5.3.1 The RAM performance targets for Mumbai Metro are specified in terms of Service Punctuality

5.3.2 Operation Control Centre (OCC), Depot Control Centre (DCC) & Depot Sub-systems (excluding depot equipment) are not considered as separate Sub-systems for the purpose of RAM implementation.

5.3.3 The Preventive Maintenance works shall be carried out during the non-traffic hours. Hence system down time due to preventive maintenance shall not be taken into account while performing RAM analysis for SAF. Thus the availability calculation related to SAF shall not consider the down time due to Preventive maintenance.

5.3.4 Further any failure occurring during Preventive Maintenance shall not be considered for the purpose of RAM analysis & demonstration for SAF unless it has subsequent effect on the normal operation of the Sub-system or System.

5.3.5 For all conversion purpose between the time and kilometre, the average speed of the train shall be considered as 34 Kmph unless there is a change in the operational plan which shall be communicated to the respective Contractors.

6. RAM PRINCIPLES, METHOLOGY & STANDARDS

6.1 Railway RAM Introduction

6.1.1 Railway RAM is a characteristics of a system's long term operation & is a major contributor to the quality of the service provided by the Railway Operating Organization

6.1.2 It is characterized as the qualitative and quantitative indicator of the degree that the system, or the Sub-systems and components comprising that system, can be relied upon to function as specified and to be both available and safe.

6.1.3 The goal of the railway system is to achieve a defined level of rail traffic in a given time, safely. Railway RAM describes the confidence with which the system can guarantee the achievement of this goal.

6.1.4 RAM in railway is achieved by the application of established engineering concepts, methods, tools and techniques throughout the life cycle of the system.

6.2 RAM Policy

6.2.1 The RAM policy for Mumbai Metrorail Line 3 System is to provide RAM Assurance for the Mumbai Metro System through implementation of an effective RAM Management program to ensure that the Mumbai Metro System are planned, designed and delivered to the required level of Reliability, Availability & Maintainability standards.

6.3 RAM Assurance Principles

The Contractors shall follow the RAM principles as mentioned below while designing & developing the Metro System/Sub-system.

6.3.1 The Sub-systems and equipment shall be engineered to maximise system Availability during traffic hours, to minimise the amount of maintenance required and to ensure that any maintenance can be easily and quickly carried out, and at minimum cost.

6.3.2 Proven Systems: So far as is reasonably practicable, proven systems shall be adopted with a known and high degree of reliability.

6.3.3 Fault Tolerance & Graceful Degradation: So far as is reasonably practicable, systems shall be designed such that service can be maintained in the presence of faults. Subsystems and components whose failure can significantly impact on RAM performance shall be backed up by simpler Sub-systems or components that permit continuous operation of the Mumbai Metro operation.

6.3.4 Recovery: Provision shall be made to recover from any credible fault while minimising disruption to passenger service.

6.3.5 Condition Monitoring & Diagnostics: Diagnostic systems shall be used to detect, or where practicable, anticipate faults. Such systems shall, where it is practicable, be used to reduce requirements for preventive maintenance, to reduce overall costs, and improve reliability.

6.3.6 Maintenance Scheduling: No regular preventive maintenance will be necessary to infrastructure (civil works or trackside electrical and mechanical systems) during traffic hours.

6.3.7 Isolation for Maintenance: Systems that require preventive maintenance shall be able to be isolated so that such maintenance can be carried out during normal service. If this is not practicable (and this can be demonstrated), then they shall be designed such that preventive maintenance can be carried out during non-traffic hours.

6.3.8 Preventive Maintenance: Systems shall be designed to optimise preventive maintenance, whilst achieving the high in-service availability. Condition-based or reliability centred maintenance shall be adopted where practicable in preference to scheduled maintenance.

6.3.9 Unscheduled Maintenance: Systems shall be designed to allow quick restoration to service following faults.

6.4 RAM Methodology

6.4.1 It is planned to design, install and commission the Rail Systems by dividing the same into various sub-systems as below. The tenders will be awarded as separate packages for the following Sub-System.

- RST : Rolling Stock
- STPT : Signalling & Train Control, Platform Screen Door and Telecommunication
- AFC : Automatic Fare Collection
- PSS : Power Supply & SCADA
- OCS : Overhead Contact System
- MEP : Mechanical, Electrical & Plumbing Sub-systems
- ECS/TVS : Tunnel Ventilation System
- Lift/ Escalators
- Depot Equipment : Depot Equipment Sub-systems
- Track : Track Structure System
- Depot Equipment : Depot Equipment Sub-systems

6.4.2 The individual Contractors shall ensure the achievement of the RAM performance of their respective Sub-systems.

6.4.3 The RAM activities shall be considered as an integral part of the design and development process. The Contractors shall ensure participation of their System Assurance organization in all engineering reviews

6.4.4 All engineering submissions at any level shall be considered as incomplete without the performance of specified RAM activities and without the submission of RAM documents.

6.4.5 RAM performance targets shall be considered as Key Performance Indicators for the Sub-systems which Contractors need to comply. Non-compliance to any of the RAM requirements and short fall to achieve the required RAM performance level shall attract penalties as specified in the contract documents of Sub-systems.

6.4.6 During consideration of precedence in the control of system hazards, the Contractors shall take account of human limitations as an engineering constraint. The Contractors shall take actions to satisfy requirements in the following order of precedence:

- Incorporation of fail-safe or vital features which would allow the system to transfer from a high loss or risk mode to a lower loss or risk mode upon the occurrence of a critical failure; and

- Reduction of the probability of occurrence of a failure by increased component reliability or by provision of supervised redundant components.

6.5 RAM Standards

6.5.1 Latest edition of the following mandatory standards shall be implemented by the Contractor for the successful implementation of RAM to the System and Sub-system.

- EN 50126-1: Railway Applications – The specification and Demonstration of Reliability, Availability, Maintainability & Safety (RAMS) – Part 1: Basic Requirements & Generic Process

- EN 50126-3: Railway Applications – The specification and Demonstration of Reliability, Availability, Maintainability & Safety (RAMS) – Part 3: Guide to the application of Rolling Stock RAMS

- EN 50128: Railway Applications - Communications, signalling and processing systems - Software for railway control and protection systems

- EN 50129: Railway Applications - Communications, signalling and processing systems - Safety related electronic systems for signalling

6.5.2 EN 50128 & EN 50129 shall be implemented for all Sub-systems and shall not be limited to communication, signalling & processing systems.

6.5.3 Apart from the above mentioned mandatory standards, it is recommended to follow the latest editions of the mentioned below;

- IEC 61025: Fault Tree Analysis

- IEC 61078: Analysis techniques for dependability: Reliability block diagram and Boolean methods

- IEC 60812: Analysis techniques for system reliability – Procedure for failure modes and effects analysis (FMEA)

- BS 5760, Part 5: Reliability of systems, equipment and components. Guide to failure modes, effects and criticality analysis (FMEA and FMECA)

- MIL-STD-1629A: Procedure for performing a Failure Mode Effect and Criticality Analysis

- MIL STD 471-A: Maintainability Verification / Demonstration / Evaluation

- IEC 60300-3-5: Dependability management - Part 3-5: Application guide – Reliability test conditions and statistical test principles.

7. GENERAL RAM REQUIREMENTS

The Contractor shall produce a Sub-system RAM plan that integrates the RAM assurance elements in all phases of the Works and incorporates a disciplined approach to evaluate the Sub-system design. The Sub-system RAM Plan shall be approved by MMRC.

7.1.1 The Sub-system RAM plan shall be developed specifically for the Sub-system under the respective Contract and shall address in particular RAM engineering analysis, which shall ensure a high degree of failure-free operation and minimize down time during revenue service operations, preventative and corrective maintenance

7.1.2 The Contractor shall submit a compliance matrix with all phases and tasks to be performed, as detailed in the Sub-system RAM plan and Program of the Contractor.

7.1.3 The Sub-system RAM plan shall also be applied to sub-Contractors and shall be carried out during the engineering, manufacture, installation, testing and commissioning phases of the Works and its operation.

7.1.4 The Sub-system RAM plan shall define the Contractor's approach, procedures and schedules for conducting the Reliability Engineering, Availability Engineering, Maintainability Engineering.

7.1.5 Human Factors Engineering shall be considered as an integral part of RAM Assurance and shall be considered and reflected within the Sub-system RAM plan.

7.1.6 The Contractor shall pro-actively engineer the systems to meet the Availability, Reliability and Maintainability performance requirements specified for the Project and demonstrate that the requirements have been met by the Sub-systems installed.

7.1.7 The Contractor shall make recommendations for re-engineering or modifications necessary to assure compliance with specified requirements including redundancy, utilization of high reliability components, built-in self-diagnostics and "self-healing"; utilization of in-service status displays to enhance fault isolation and test; easy accessibility and quick disconnect connectors; and, the use of mechanical keying to reduce errors during installation and repair.

7.1.8 The Contractor shall use warning devices and systems which are audio/visual portion of a vital system in which the human is the responder.

7.1.9 In the process the potential hazards to Safety, Availability, and Reliability and Maintainability performance should be minimized where design options permit.

7.1.10 The Sub-system RAM plan shall provide a sound basis for acceptance of the RAM performance; progress information; confidence that the engineering is proceeding with a low risk of failing to meet the performance requirements; information that will aid the planning of work schedules; and part of the foundation of the safety case for operation of the line.

7.1.11 In the event that Employer retains the services of an additional Independent RAM Assessor, the Contractor shall coordinate with the Independent RAM Assessor and provide all documentation requested by them to carry out their obligations.

8. RAM ORGANIZATION

8.1 Project RAM Organization Chart

The overall Mumbai Metro RAM organization structure is shown in the below figure. The roles and responsibility of each party are described in section 8.3.

Director (Systems) and Executive Director/ General Managers of MMRC
GC: Interface expert, Chief Interface Engineer, Chief RAMS Engineer, RAMS Engineer, Discipline Key Experts
Contractor's RAM Managers

(Figure: Mumbai Metro Line3 RAM Organization)

8.2 Organizational Requirements for RAM

8.2.1 The following Sub-systems are considered as the core Sub-systems of the Mumbai Metro System due to the fact that they have the potential to create a Service Affecting Failure.

- Rolling Stock
- Signalling & Train Control
- Overhead Contact System
- Power Supply & SCADA
- Track systems
- Data Transmissions System (Communication)

8.2.2 Since these are the SAF contributing Sub-systems, these Sub-systems need focused RAM approach implementation throughout the development

8.2.3 The RAM organization of these Sub-systems shall have at least one dedicated RAM Engineer who shall have implemented the RAM strategy for the relevant Sub-system in at least one Metro/railway project environment.

8.2.4 Alternatively, the Contractors may hire the service of a professional RAM consultant for the entire scope of the RAM work.

8.2.5 In either case, approval of Project Manager will be required from GC.

8.2.6 An appropriate degree of independence shall be provided to the RAM role in the project such that the RAM aspects of the project shall not get diluted in the environment of constant challenges of project cost reduction and time schedule achievement.

8.2.7 For all other Sub-systems, the Contractors shall appoint appropriate RAM Engineer to fulfil the contractual RAM obligations.

8.3 Roles & Responsibility

- **Contractors RAM Organization:** Prepare Sub-system level RAM documents to implement the RAM process on time & in line with the process explained in the System RAM plan & industries good practices.

- Perform RAM Review of appropriate Sub-system level specification, design, manufacturing, testing and commissioning documents prior to submission of the same to MMRC to ensure that the RAM aspects of the Sub-systems are implemented in these document.

- A key responsibility of the RAM organisation shall be to ensure that there is a feedback from the RAM studies at the design stages, in order to eliminate or reduce weak points that could have an adverse effect on the final RAM performance.

8.3.1 RAM Organization: GC

- Prepare the Mumbai Metro System level RAM Plan.

- Review and approve Sub-system RAM submissions from Contractors to make sure that they are as per the contractual RAM requirements.

- Review and approve Sub-system specification, design, manufacturing, testing and commissioning document as submitted by the Contractors to ensure that the Sub-system meets the required RAM performance level.

- Co-ordinate and support the audit and assessment as conducted by the external auditors and regulatory agencies.

9. CONSIDERATION OF FAILURES FOR RAM STUDY

9.1 Service Affecting Failure (SAF)

9.1.1 A failure is considered as SAF when either of the following occurs due to the effect of the failure.

- The arrival of the train at the terminal station is delayed by more than one minute compared to its scheduled time table.
- Missed trip as per time table

9.1.2 A single SAF can create multiple numbers of trip delays or missed trips. For calculation of Service Punctuality, the actual number of trip delays and trip losses shall be considered irrespective of the number of SAF.

9.1.3 However, for calculation of Sub-system RAM performance, in the above case, only one failure shall be considered. In this case the down time shall be calculated as the time difference between the start of the failure which caused the first delayed trip and the time when the Sub-system is restored after the last delayed trip due to the same failure i.e. time duration during which the normal operation is not available. If the sub-system failure causes a trip loss, then the down time shall be calculated as the time duration during which the normal schedule trips are affected due to the failure.

9.1.4 Withdrawal of a train from mainline shall be considered as a missed trip. The same shall be considered in the calculation of Sub-system RAM performance.

9.1.5 If a SAF of a Sub-system is caused by an existing SAF, then the latter SAF shall not be considered for the purpose of RAM analysis & demonstration, provided the SAF of the latter Sub-system can be rectified within the time period during which the first Sub-system was down due to the said SAF.

9.1.6 However, if the latter Sub-system is unable to recover from its failure prior to the recovery of the Sub-system that failed first, thus affecting RAM performance further, the SAF shall be considered and will be charged to the latter sub-system.

9.1.7 Failure caused by vandalism and other unexpected conditions by Act of God, such as flooding, earth quake, land slide etc. shall not be considered as SAF.

9.1.8 Additionally, any failure that causes a train withdrawal shall be considered as a SAF in the missed trip category.

9.2 Non - Service Affecting Failure (Non-SAF)

9.2.1 All other failures which do not fall under the clause 9.1 are referred as Non-Service Affecting Failures.

9.2.2 Non SAF shall also be reported, investigated and corrective action taken and record shall be maintained.

10. CONTRACTUAL RAM TARGETS FOR SYSTEM & RAM APPORTIONMENT

10.1 System RAM Target

10.1.1 The punctuality for the day, calculated at the terminal Stations with respect to the time table, shall be more than 98.5%. If the arrival of a train at the terminal Station is delayed by more than 1 (one) minute, it will be deemed to have lost punctuality.

10.1.2 The target for Availability of Track System Shall be 99.6 %

10.1.3 The target for Reliability of Track System Shall be 99.8 %

10.1.4 Apart from the above mentioned quantitative RAM requirement, there are qualitative RAM requirements specified in technical specifications.

10.2 RAM Apportionment & Sub-system Targets

10.2.1 For core Sub-systems as specified in clause 8.2.1, the RAM performance targets shall be specified in terms of MTBSAF / MKBSAF, MTTR, % Availability. These targets shall be based on benchmarking against established similar metro systems. The subsystem RAM targets are specified in respective technical specifications.

10.2.2 A System modelling & simulation shall then be carried out to verify that, with these specified targets for the Sub-systems, the RAM performance target of Mumbai Metro as specified in section 10.1 shall be achieved.

10.2.3 For all other Sub-systems and for the core Sub-systems as well, RAM performance targets shall be specified for Non-SAF after benchmarking these Sub-systems with similar Metro Systems, to manage and control the Non-SAFs.

10.2.4 The RAM targets of the Sub-systems shall be mentioned in the respective Technical Specification of the Sub-systems.

11. SUB-SYSTEM RAM ACTIVITIES

This section describes the list of RAM activities to be performed by all Contractors, unless otherwise specified, at different stages of the project life cycle. These are the minimum requirements and the Contractor shall implement the relevant RAM standards as described in this document.

11.1 Project Feasibility

11.1.1 No Sub-system related RAM activities are envisaged at this stage.

11.2 Invitation for Tenders

11.2.1 No Sub-system related RAM activities are envisaged at this stage.

11.3 Contract Negotiation & Award

11.3.1 The Contractor shall review the RAM performance requirements as specified in the Tender documents by MMRC and may like to discuss with MMRC for further clarification.

11.4 Design & Implementation

11.4.1 Sub-System RAM Plan:

The Contractor shall prepare detail level Sub-system RAM Plan during preliminary design stage, in line with the System RAM plan and relevant standards. The Sub-system RAM plan shall include as a minimum;

- Sub-system RAM Assurance Requirements
- Procedures to perform the specific tasks necessary to meet RAM requirements;
- Responsibilities of personnel directly associated with RAM assurance policies and implementation of the programme;
- RAM assurance organization; and
- Identification of the authority dedicated to the RAM assurance organization and the relationship between the assurance organization and other organizational components.
- Sub-system RAM acceptance criteria

11.4.2 Sub-System RAMS Apportionment:

The Contractor shall perform RAM apportionment to components of the Sub-systems including hardware & software if any. The apportionment shall be done to the lowest level of functional unit or Line Replaceable Units (LRU). Where practicable, the apportionment shall be based on established standard and actual data rather than assumptions / judgments.

11.4.3 FMECA / FMEA & FTA:

- The Contractor shall identify and quantify the ways in which the works for which they are responsible could fail to provide the intended level of service in terms of RAM.

- The effects on the system of single and co-incident multiple failures shall also be addressed.

- The effects of human errors and errors arising from interfaces with other items of equipment shall be addressed as an integral part of the analysis.

- Software / Firmware FMECA & FTA shall be conducted for Sub-systems consisting of software as a core component.

- Design considerations shall take priority over operational procedures while mitigating the identified failure modes. Where ever operational & maintenance measures are considered as a means to mitigate the failure modes, such measures shall be mentioned specific to the failure mode under consideration. Further all such measures will be submitted to and reviewed by the Operation & Maintenance Contractor.

- The Contractor shall identify and segregate the service affecting failures modes from non-service affecting failure modes. For each of the service affecting failure modes, the Contractor shall suggest the immediate measure to be taken during traffic hours to restore the service to normal as soon as possible. A list of Reliability Critical Items and Maintainability Critical Items shall be identified.

- To standardize the FMECA across the Mumbai Metro project a common FMECA / FMEA template shall be provided to all Contractors for carrying out the analysis. The risk ranking process shall be specific to the Sub-system and hence shall be proposed by the Contractor for MMRC's review & acceptance.

- The first draft of the FMECA / FMEA shall be submitted along with the preliminary design documents. The FMECA/FMEA shall be a living document and shall be updated regularly.

11.4.4 RAM Modelling, Simulation, Analysis and Prediction:

- The Contractor shall perform RAM modelling, simulation, & analysis to predict the achievement of the RAM performance targets.

- The RAM analyses of each Sub-system shall be done up to the point of interface with other systems.

- Reliability block diagrams, using computerized applications that has the capability to perform a dependable statistical simulation & analysis, shall be developed which show each equipment element that is essential to the performance of the system, including element inter relationships. Block diagrams shall be revised to keep current with design iterations.

- The Contractor shall provide Reliability prediction and apportionment in accordance with established techniques or standard or properly documented and verifiable field failure data for identical or similar equipment. The standards used or the source of field data shall be identified.

- Quantitative Maintainability assessments to all significant functional levels of the system, subsystems or equipment shall be allocated. Maintainability analyses

during engineering, development and testing shall be used to evaluate the degree of achievement of the maintainability requirements. The Contractor shall identify the standards by which these allocations are made. The maintainability assessment shall address all methods by which equipment can be restored to a specified condition using a minimum of resources.

- The Contractor shall develop predictions to judge the adequacy of the proposed engineering to meet quantitative Maintainability requirements and shall identify design features requiring corrective action during early stages of engineering and development.

- The Contractor shall co-ordinate results of RAM Assurance analysis with each engineering discipline, particularly as the results affect engineering and hardware development.

- The Contractor shall document instances where evaluations or analyses indicate an unresolved problem area and formulate appropriate recommendations as well as maintain records, which show that follow-up action has been taken to resolve the problem.

- Following the RAM analysis, the Contractor shall provide the list of recommended spares based on the outcome of the RAM analysis.

- The RAM Analysis report shall be submitted to MMRC along with each formal design submissions.

11.4.5 Failure Reporting Analysis Corrective Action System (FRACAS)

- A FRACAS database shall be established in the early design stage and shall be used throughout the design, manufacturing, factory testing, interface testing, integrated testing, commissioning & DLP.

- The FRACAS shall provide a documented history of any problems and failures and their associated corrective actions as well as detailing of how and why each problem arose, or failure occurred.

- The FRACAS shall be implemented for monitoring the safety and RAM performance of the equipment, from the design (where changes may result from conclusions of the predictive analysis), through testing and commissioning and into operation.

- The FRACAS shall be used to monitor the performance of components and to identify patterns of failures so that corrective action can be taken to improve both current and future systems.

- The FRACAS shall be of an electronics application type and shall be capable of generating different kinds of reports for management reporting and RAM analysis purpose.

- The FRACAS database of the Contractor shall be compatible with that of the Operator such that the data and reports from the Contractor's FRACAS database can be easily imported into the Operator's FRACAS database by the Contractor.

- All failures, whether chargeable or non-chargeable shall be maintained in the FRACAS and none of the failures shall skip the FRACAS database at any stage of the Sub-system development.

- Failure Review Board (FRB) shall be formed within the Contractor's organization to review major chargeable failures encountered during different stages of the testing & commissioning. The FRB shall be active till the end of the DLP. The Contractor shall participate in the FRB meetings organized by MMRC at different stages of the Project and during DLP period to discuss and accept the failure resolution and the Contractor's responsibility towards the same.

11.4.6 RAM Demonstration Test Plan

- At the end of detailed design stage the Contractors shall produce a RAM demonstration test plan for the review and approval of MMRC. As a minimum, the RAM demonstration test plan shall include the following:

- A statement of the RAM targets
- RAM Demonstration strategy & method of demonstration
- A statement of the duration of the test, including its extension if targets are not met
- The method for determining whether targets have been met
- Failure data collection
- Participation in the FRB
- Failure analysis and allocation of failures to the appropriate contractor or other party
- Statistical analysis of the failure records
- Assessment against the criteria in the RAM demonstration test procedure
- Records of the MTTR
- Analysis of whether the subsystem has met, or is predicted to meet, the RAM targets
- Method for the maintainability demonstration
- List of the components that will be covered in the maintainability demonstration

11.5 Manufacturing, Construction & Installation Stage:

11.5.1 During the manufacturing, installation and construction, individual components shall be tested to establish whether they are likely to be able to achieve the overall RAM targets established for the equipment at the beginning of the design process.

11.5.2 Component Reliability Development/Growth Testing (pre-production):

- The Contractor shall conduct pre-production testing to provide a basis for identifying, informing and resolving majority of reliability problems early in the development stage,

and incorporating corrective action to prevent recurrence, and verification of their effectiveness, prior to commencement of production

- Corrective actions shall focus on critical failure modes, but all frequent failures modes, regardless of their criticality must also be considered as important to improving basic reliability.

11.5.3 Component Reliability Acceptance Testing (production):

- The Contractor shall undertake reliability acceptance testing with the purpose of assessing equipment performance, and where necessary implementing corrective action, before commencement of the Defects Liability Period (DLP).

- Feedback from this testing should be fully recorded by the Contractor, using the failure reporting mechanism (FRACAS) and feed back into the design and/or RAM assessments.

11.5.4 Component Maintainability demonstration:

- The Contractor shall demonstrate that the required maintainability of the components & Sub-systems will be achieved through the medium of a demonstration of repair times (MTTR).

- The process can be expedited by injection of faults on equipment. The sample size and test duration shall be determined statistically.

11.5.5 The requirements as stated in clauses 11.5.1 to 11.5.5 may be waived of for those Components for which the Contractor can demonstrate by a sensitivity analysis or other means that the impact of such Components on reliability and maintainability will be insignificant.

11.5.6 Component reliability tests as mentioned above for certain case may be waived if these were carried out earlier on equipment of identical design, witnessed by a reputed organization, and the service performance of such equipment was found to be reliable. The Contractor shall submit the certificates or other evidences in this regard to MMRC for review. The waiver of type test is entirely at the discretion of MMRC.

11.5.7 The Contractor shall establish maintenance related tools and equipment requirement for the Sub-systems.

11.6 Testing, Commissioning & Trial Run

11.6.1 The testing procedures shall ensure that all the critical failure modes as identified during the FMECA / FMEA are addressed through proper test cases. A traceability matrix shall be developed such that these critical failure modes are traced back to the corresponding test cases. All failure modes shall be considered as critical failure modes unless the Contractor demonstrates by a sensitive analysis or other means that the impact of a failure mode on reliability and maintainability will be insignificant.

11.6.2 Sub-system RAM performance demonstration shall start from the trial run stage. The Contractor shall demonstrate the RAM performance targets as mentioned in their respective

TS, at the end of the trial run. A trial run period of 30 to 45 days for RAM demonstration is envisaged at this point of time.

11.6.3 Initial level Sub-system maintainability demonstration shall be carried out through fault injection techniques or otherwise within the actual O&M environment.

11.7 Defect Liability Period

11.7.1 RAM targets during COD and final RAM targets shall be specified in the Technical Specifications of Employers requirement of respective package (part 2. VI (1)).

11.7.2 The demonstration plan shall be prepared such that, the Sub-systems shall demonstrate continuous improvement in RAM performance.

11.7.3 The Contractor shall analyse the failures observed and determine the achieved RAM of the Sub-system.

11.7.4 Should a defect/failure arise, then the Contractor shall perform the failure investigation and carry out corrective action, if necessary.

11.7.5 The Contractor shall employ suitable mechanisms (e.g. FRACAS) and establish FRB to support the RAM demonstration. The Contractor shall also participate in the FRB meetings organized by MMRC during DLP period to discuss and accept the failure resolution and its responsibility towards the same.

11.7.6 The report shall provide evidence that the RAM targets have been achieved or are predicted to be achieved, or not achieved, and shall include any supporting calculations relevant to the demonstration.

11.7.7 In addition, the Contractor shall submit quarterly return giving summary of concerned monthly reports to keep track on the RAM performance, and to determine the effectiveness of the corrective action, if any, on a regular basis.

11.7.8 MMRC may like to go for a partial operation i.e. with reduced fleet size and section of alignment etc. The contractor shall align its RAM demonstration plan in line with the operational plan.

11.8 Operation & Maintenance (Post Sub-system DLP)

11.8.1 No RAM related tasks are envisaged for the Sub-systems at this stage of the project.

12. RAM ACTIVITIES FOR DIFFERENT TYPES OF SUB-SYSTEMS

12.1 This clause describes the RAM process rigor for different types of Sub-systems based on their functional criticality. It is understood that all the requirements as mentioned in section 11 and the requirements as per the relevant standards may not be fully applicable to all sub-systems.

12.2 Hence for the purpose of clarity in application of the different RAM process to different Sub-systems, the Sub-systems are divided into three groups. The grouping of the Sub-systems is presented below as in table below.

SUB-SYSTEM CATEGORIZATION FOR RAM TASK		
Sl No.	**Sub-systems**	**Category**
1	Rolling Stock (Train)	A
2	Signaling & Train Control	A
3	Track System	A
4a.	Overhead Contact System	A
4b.	Power Supply System	A
5a.	Data Transmission System	A
5b.	Telephone System	C
5c.	Radio System	C
5d.	CCTV System	C
5e.	Passenger Information Display System	C
5f.	Clock System	C
5g.	Access Control & Intrusion Detection System	C
5h.	Public Address System	C
5i.	Voice Recording System	C
5j.	Fault Reporting System	C
5k.	Office Automation & Information Technology	C
6a.	Station Computer Systems	B
6b.	Automatic Gates	B
6c.	Ticket Vending Machines	B
6d.	Ticket Office Machines	B
6e.	Excess Fare Office	B
6f.	Portable Ticket Analyser	C
6g.	Central Computer Facility	B
7a.	Lift	B
7b.	Escalator	B
7c.	MEP: Fire Protection Systems	B
7d.	MEP: Fire Detection & Alarm	B
7e.	MEP: Public Health Engineering Sub-systems	C
7f.	MEP: Electrical Systems including DG & UPS	B
7g.	MEP: Ventilation & Air Conditioning	C
7h.	MEP: Building Management Systems (BMS)	B
8a.	Train Wash Plant	B
8b.	Rail Car Lifting System	B
8c.	Under floor Wheel Lathe	B

8d.	Under frame Cleaning Plant	B
8e.	Overhead Electric Travelling Cranes (EOTs)	C
8f.	Rail Mounted Vehicles	B
8g.	Bogie Drop Pits	B
8h.	Other Depot Equipment	D

12.3 Failure in a Group a Sub-system has the potential to affect the train Service Punctuality.

12.4 Failure in Group B Sub-systems does not affect or have negligible effect on the train punctuality but these Sub-systems are critical from the metro operation point of view.

12.5 Failure in Group C Sub-systems does not affect the punctuality and comparatively minimal impact on the normal operation of the Mumbai Metro operation.

12.6 Failure in Group D Sub-systems has the least impact on metro operation.

12.7 Table below shows the customized RAM tasks for the above mentioned group of Sub-systems.

MINIMUM RECCOMENDED RAM REQUIREMENTS			
RAM Requirement	**Category - A & B**	**Category - C**	**Category - D**
Sub-system RAM Plan	YES	YES	OPTIONAL
Quantitative Target	YES	OPTIONAL	OPTIONAL
Qualitative Targets	YES	YES	OPTIONAL
RAM Apportionment	YES	OPTIONAL	OPTIONAL
FMEA	YES	YES	OPTIONAL
FMECA	YES	OPTIONAL	OPTIONAL
FTA	YES	OPTIONAL	OPTIONAL
Reliability & Maintainability Critical Item List	YES	YES	OPTIONAL
RAM Modelling, Simulation, Analysis & Prediction	YES	OPTIONAL	OPTIONAL
RAM Testing (Component) / Certificates	YES	OPTIONAL	OPTIONAL
FRACAS	YES	OPTIONAL	OPTIONAL
RAM Demonstration	YES	OPTIONAL	OPTIONAL

13. SUB-SYSTEM RAM SUBMISSIONS

13.1.1 The Contractors shall submit the documents as mentioned in the following table and in line with section 12 at different stages of the project for the review and approval of MMRC.

Reliability, Availability & Maintainability Submissions (Contractor)					
Sl No	Deliverables	Design & Implementation	Construction & Installation	Testing, Trial Run & Commissioning	Defect Liability
1	Sub-system RAM plan	P	U	U	-
2	Sub-system RAM Apportionment Report	P	-	-	-
3	RAM Analysis Report (Preliminary & Detailed)	P	U	U	U
4	FMECA / FMEA / FTA	P	U	U	U
5	Reliability & Maintainability Critical Item List	P	U	U	U
6	Traceability Matrix	P	U	U	-
7	Failure Management System (FRACAS) Plan	-	P	U	U
8	List of recommended Spares & Tools	P	U	U	U
9	Component RAM Testing Plan / Report / Certificate	-	P	U	-
10	Sub-system RAM demonstration Plan	P	U	U	U
11	Sub-system RAM demonstration Report	-	-	P	U
12	Monthly(Quarterly) RAM Report (Regular)	-	-	-	P

P: Produce, U: Update, R: Review, "- ": Not Applicable

14. SYSTEM RAM ACTIVITIES

14.1.1 This section describes the RAM activities to be performed by MMRC and/or Operator at different stages of the project execution. The Contractors shall assist MMRC in completing these activities on time by timely completion of the Sub-system related RAM activities and thus delivering the Sub-system specific RAM deliverables on or before time.

14.2 Invitation for Tenders

14.2.1 MMRC shall perform RAM apportionment / analysis of the specified Service Punctuality to derive the Sub-system targets.

14.2.2 A detail level System RAM plan shall be prepared that shall include qualitative and quantitative RAM requirements for the overall System.

14.2.3 The System Plan shall include high level RAM requirements, RAM Management Plan, RAM acceptance criteria and RAM demonstration plan for the Systems and Sub-systems.

14.3 Contract Negotiation & Award

14.3.1 MMRC shall discuss with the potential Contractors any queries raised by them on RAM performance requirements.

14.4 Design & Implementation

14.4.1 Based on the RAM Modelling, Simulation, Analysis and Prediction conducted by the individual Contractors, MMRC shall integrate and analyse the System RAM Prediction.

14.4.2 MMRC shall review & may audit the Sub-system RAM activities of the Contractors which include RAM critical design deliverables.

14.4.3 The operator shall establish his FRACAS before start of the Integrated System testing & commissioning. All failures of integrated testing, trial running, commissioning, Sub-system DLP and operation shall be managed through operator's FRACAS. [This is in addition to the FRACAS requirements as stated in section 11.4.]

14.5 Manufacturing, Construction & Installation Stage:

14.5.1 No specific System related RAM task is envisaged at this stage except monitoring of the Contractor's Sub-system RAM activities.

14.6 Testing, Commissioning & Trial Run

14.6.1 MMRC shall review, witness & monitor the Sub-system specific RAM tasks carried out at this stage.

14.6.2 MMRC shall determine the service punctuality achieved by monitoring and analyse the actual number of trips which are delayed by more than 1 minute.

14.6.3 MMRC shall demonstrate a level of Service Punctuality before the start of the commercial operation and at the end of the DLP of all Sub-systems, during a tentative trial period of 30 to 45 days. A detailed System RAM Demonstration plan shall be prepared.

14.7 Defect Liability Period (of Sub-systems)

14.7.1 MMRC shall continue to monitor the achieved level of service punctuality from the Sub-contractors RAM demonstration reports apart from monitoring the Sub-system RAM performance.

14.7.2 MMRC shall monitor the RAM demonstration till the end of the DLP period of all Sub-systems and for the duration thereafter. The service punctuality shall be monitored on a continuous basis and the operator shall provide the monthly reports of the same.

14.7.3 Service Punctuality at any point of time shall be calculated as the ratio of "total number of trips delayed at the terminating station by more than one minute" to "total number of scheduled trips". The calculation shall be done at monthly intervals considering a moving average of 3 months of operation.

14.8 Operation & Maintenance (Post Sub-system DLP)

14.8.1 RAM Performance Monitoring

- RAM performance monitoring shall continue throughout the O&M period and shall be performed by Operator.
- Real time failure data shall be collected from the Mumbai Metro O&M and the same shall be analysed using statistical techniques to evaluate the RAM performance of the system.
- Necessary mitigation actions may be taken should the RAM performance of system not meet the desired performance level.
- Operator shall utilize FRACAS and develop suitable organisation structure with the FRB to sustain the achievement of the RAM performance targets throughout the operation period.

14.8.2 Modification & Retrofit

- In case of modification and retrofit activities, based on the level of modification and retrofit an appropriate RAM plan shall be developed which shall take care of the necessary RAM activities to be repeated which has already been taken care during system development & commissioning phases.

15. SYSTEM RAM DELIVERABLES

15.1.1 MMRC and/or Operator shall produce the following RAM documents.

Reliability, Availability & Maintainability Deliverables (MMRC/Operator)						
Sl No	Deliverables	Invitation for Tender & Contract Award	Design & Implementation	Construction & Installation	Testing, Trial Run & Commissioning	Defect Liability
1	System RAM Plan	P	U	U	U	-
2	RAM Requirements for Sub-systems (As part of Contract Document)	P	-	-	-	-
3	Preliminary System RAM Analysis & Apportionment Report	-	P	-	-	-
4	Failure Management System (FRACAS) Plan	-	P	-	-	-
5	System RAM Demonstration Plan	-	P	U	U	U
6	System RAM Demonstration Report	-	-	-	P	U

P: Produce, U: Update, R: Review, "- ": Not Applicable

16. RAM ACCEPTANCE CRITERIA

16.1.1 The Contractor shall carry out all RAM related activities and submit appropriate documents as evidence of these activities to MMRC on a timely manner for successful implementation of the RAM.

16.1.2 As a minimum, the Contractor shall comply with the RAM requirements as mentioned in this System RAM plan.

16.1.3 RAM shall be integrated into the Sub-system design & development process. Failure to complete RAM activities on time shall be considered as non-compliance to the RAM plan.

16.1.4 The Contractor shall present a compliance matrix that shall trace the design to the contract documents, to demonstrate that all qualitative RAM requirements are considered while designing the Sub-system.

16.1.5 The Contractor shall support in the System level RAM demonstration test.

16.1.6 The Sub-systems shall achieve the level of RAM performance target as mentioned in their respective TS after the completion of the trial run and before the start of the revenue service.

16.1.7 The Contractors shall submit regularly all RAM monitoring and growth reports and shall demonstrate a continuous growth in RAM performance (predetermined targets) starting from trial run till DLP. Intermediate RAM targets, starting from COD till DLP, shall be specified to the Contractor which the Contractor shall achieve.

16.1.8 The overall System shall be able to demonstrate the RAM performance target as mentioned.

17. CONTROL OF SUB-CONTRACTORS

17.1.1 The Contractor shall devise an appropriate Sub-contractor RAM management plan in order to maintain the quality and RAM of the supply from the sub-Contractor. The Sub-contractor RAM management plan shall be a part of the Sub-system RAM plan.

17.1.2 Appropriate RAM requirements that are specified in this System RAM plan for the Sub-system shall also be applicable to the Sub-contractors.

17.1.3 The Contractor shall conduct regular audits and assessment of the sub-Contractor to monitor the RAM performance of the supplies.

18. RAM AUDITS & ASSESSMENTS

18.1.1 MMRC/GC may conduct RAM audit on the Contractors and sub-Contractors RAM activities to ensure the integrity of the RAM management process and may undertake technical review in various phase of the Project.

18.1.2 Access to all relevant design and production information will be required by MMRC/GC. The Contractor shall make available all relevant documents for the RAM auditor to review.

18.1.3 Throughout the project life cycle the IRA shall be auditing the RAM activities of the MMRC/GC and its Contractors to ensure the integrity of the RAM management process.

18.1.4 A similar auditing process shall be established by the Contractors to audit the RAM activities performed by the Sub-contractors

APPENDIX: FMECA TEMPLATE

FAILURE INFORMATION								Failure Detection			Failure Effects				EXISTING RISK CONTROL				
Sl. No	FMECA ID	System / Sub-system	Item Name / Functional identification	Operating Mode	Function	Failure Mode	Failure Cause	Detectable means to Operator	Detectable means to Maintainer	Built-in Test Function	Sub-system (Local)	Transit System	Safety	Reference Hazard ID	Failure Rate	Data Source	Chargeable Failure	Service Disruption Time	Existing Design Safeguard
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			

INITIAL RISK			ADDITIONAL RISK CONTROL						RESIDUAL RISK			Immediate Action During Traffic Hours	Follow up Action During Non-Traffic Hours	STATUS	REMARKS	CHANGE CONTROL (DATE)
Frequency	Severity	Risk Index	Additional Design Controls	Owner	Evidence of Additional Risk Control through design	Operational & Maintenance Control	Owner	Evidence of Additional Risk Control through Operation & Maintenance	Frequency	Severity	Risk Index					

Mumbai Metro Rail Line 3
BIDDING DOCUMENTS

EMPLOYER'S REQUIREMENTS
GENERAL SPECIFICATIONS

Part 2

Section VI (1)
Sub-Division F

Appendix 23

DOCUMENT IDENTIFICATION AND NUMBERING

July 2019

Table of Contents

1. Purpose

The purpose of this procedure is to describe the principles set in the identification and numbering process for project-wide documents, which is mandatory in terms of Quality Assurance. This procedure shall ensure that each document establishes its identity and number built on a one-structure alpha-numerical code which is uniform, unique and consistent.

2. Scope and Administrator

This Procedure is applicable for all documents and records project-wide, which is not limited to:

- Correspondences and Letters
- Documents - Internal and external
- Reports
- Procedures
- Method Statements
- Drawings
- Manuals
- Publications

The procedure administrator is the Document Controller and is the initial point of contact for all queries related to this Procedure. Document Controller is finally responsible for numbering of all documents covered by this procedure. Although so, the owner/ author of respective document shall correctly identify and mark all fields of the numbering system except the unique sequence/ serial number.
Unique sequence number shall be generated and released necessarily only by the Document Controller.

3. Document Identification and Numbering

Identification and numbering of all documents are broadly classified under the following Document-types:

- Type A: Letters, Correspondences, Reports and Procedures
- Type B: Minutes of Meeting
- Type C: Drawings

3.1 Letters, Correspondences, Reports and Procedures

Following table describes the identification and numbering process of Type A Documents (Letters, Correspondences, Reports and Procedures), denoted by series of characters like Letters (L) Digits (N) and Letters/ Digits (X)
Identified and referred as: LLL-LLL-LLL-XXX-NNNNNN-L(N)
Where,

Field	Format	Field Designation	Description of Field
1	LLL	Issuing Entity	Identifies Initiator/Author/Owner of the Doc. (refer Annexure A, Field-1)
2	LLL	Issued To	Identifies Doc. to whom it is primarily sent to (refer Annexure A, Field-2)
3	LLL	Discipline	Identifies Discipline of the Team initiating the Doc.(refer Annexure A, Field-3)
4	XXX	Area	Identifies Package/ Stations/ Corridor concerned to (refer Annexure A, Field-4)
5	NN	Year	Identifies last two digits of the calendar year, (refer Annexure A, Field-5)
6	NNNN	Unique Sequence Number	Sequential number generated by DC (refer Annexure A, Field-5)
7	L(N)	Revision Index	Identifies Revision and Version of the Doc./ Record (refer Annexure A, Field-6 & Annexure D)

The covering letter, if any, shall assume the same number as the document it represents.

3.2 Minutes of Meeting

Following table describes the identification and numbering process of Type B Documents (Minutes of Meeting), denoted by series of characters like Letters (L), Digits (N), Letters/Digits (X), and an additional field "MOM" after the first field.

Identified and referred as: LLL-LLL-LLL-XXX-NNNN-NNN
Where,

Field	Format	Field Designation	Description of Field
1	LLL	Chairing Entity	Identifies Entity who chaired the Meeting (refer Annexure B, Field-1)
2	LLL	MOM	Identifies the Document is Minutes of Meeting (refer Annexure B, Field-2)
3	LLL	Discipline	Identifies discipline topic covered in Meeting (refer Annexure B, Field-3)
4	XXX	Area	Identifies Package/ Station/ Corridor/ Geographical Location concerned to (refer Annexure B, Field-4)
5	NN	Year	Identifies last two digits of the calendar year (refer Annexure B, Field-5)
6	NN	Month	Identifies two digits of the Months (refer Annexure B, Field-5)
7	NNN	Unique Sequence Number	Sequential number generated by DC (refer Annexure B, Field-5)

3.3 Drawings

Following table describes the identification and numbering process of Type C Documents

(Drawings), denoted by series of characters like Letters (L) Digits (N), Letters/Digits (X) and short keywords.

Identified and referred as: LLL-LLL-XXX-NNNN-NNN-L(N)
Where,

Field	Format	Field Designation	Description of Field
1	LLL	Issuing Entity	Identifies Initiator/Author/Owner of the Drawing (refer Annexure C, Field-1)
2	LLL	Discipline	Identifies Discipline of Drawing (refer Annexure C, Field-2)
3	XXX	Area	Identifies Package/ Station/ Corridor/ Location to (refer Annexure C, Field-3)
4	NNNN	Unique Sequence Number of the Drawing Set	Sequential number generated by DC for the Drawing Set (refer Annexure C, Field-4)
5	NNN	Drawing Sheet Numbers	Identifies individual drawing sheet, within a set of Drawing, meaning sheet-numbers (refer Annexure C, Field-5)
6	L(N)	Revision Index	Identifies Revision of the Drawing (refer Annexure C, Field-6)

The cover letter of the Drawings, if any, shall assume the same number as the drawing it represents without drawing sheet numbers (Field 5).

3.4 Revision and Version Control

For revisions and versions - the format allows for a combination of two characters - a sequent number (N) for internal revision within the entity and a version letter (L) for each new version outside the entity.

When the creation of the document is going on, after each modification the number is incremental from A0, A1, A2, A3 ... and once it is final, it becomes only A.

If some modifications are made after issuance, it becomes B0, B1, B2, B3 … until finalized to culminates as B.

A record of Revision/Version Control is inserted at the beginning of the document to keep the history and details of every revision and version, as to how the document changed over time. It is important that the system is applied systematically and consistently, particularly as document gets updated by different persons, at different times. These records reflect the most up-to-date version of a document, whilst providing also information of which documents were ‘in force’ at a particular date. The last author should be contacted for further information on the updation and the changes marked.

The process of ‘Revision and Version Control Record’ is managed through the template provided in Annexure D.

3.5 Building a Document Number

An understanding of this procedure and with reference to attached Annexures will help identify the document, and once identified a document can be accurately numbered. The following example illustrates how a typical document is identified and numbered:

Example to identify and build a Document Number

Let us take an example of a document, say '**Monthly Project Report**' of February 2016. By this, the document is understood and identified as follows:

- The document type is "Letters, Correspondences, Reports, Procedures and Records", which is Document-type A, therefore, refer Annexure A

  This Monthly Report is originated from Maple => Issuing Entity = **GCC**

- The Report is sent to MMRCL
  => Issued To = **MMR**

- The discipline concerned is Project Control Management
  => Discipline = **PCM**

- The Report is concerned for the entire project, all packages
  => Area = **P00**

- The Report is for the month of February 2016 means year 2016
  => Issued Year = **16**

- Then author/owner gets the latest unique sequence number from the Document Controller, say for example 45
  => Unique Sequence Number = **0045**

- This is the first issue => Revision Index = **A0**

Thus the document becomes **GCC–MMR–PCM–P00–160045–A0**

4. Annexures

Annexure	Description of Contents	Remarks
A	Field Codes for **Doc-type A** (Letters, Correspondences, Reports and Procedures)	Specific alpha-numerical codes are listed in Annexure A, B and C. Codes shall be carefully identified from these Annexures while building up the numbering process
B	Field **Doc-type B** (MOM)	
C	Field Codes for **Doc-type C** (Drawings)	
D	Revision and Version Record (Example)	Used to record revisions and versions

ANNEXURE A
Field Codes for Document-type A (Letters, Correspondences, Reports and Procedures)

Field 1 and 2 Entity Codes		Field 3 Discipline Code		Field 4 Area Code				Field 5 Document Number			Field 6 Revision Index	
Code	Entity	Code	Discipline	Code	Area Designation	Code (Contd)	Area Designation (Contd)	Code	Year	Unique Seq. No.	Release	Unique Seq. No
LLL-LLL		NNN		XXX			XXX	NN		NNNN	L	(N)
						SBA	BKC					
AAA	All Entities	AAA	All Disciplines	AAA	All Areas	SVN	Vidyanagari	15	2015		A & B	1,2,3....
AAO	Others	AAO	Others	AAO	Others	SSC	Santacruz	16	2016	0001		
						SC1	CSIA T1	17	2017	to		
MMR	Mumbai Metro Rail Corp. Ltd	PMG	PM - General	P00	All Packages	SSR	Sahar Road	18	2018	9999		
GCC	MAPLE Consortium	COD	Contract Admin	P01	Package 01	SC2	CSIA T2	19	2019			
		PCM	Project Control Management	P02	Package 02	SMA	Marol Naka					
AAB	All Contractor/Supplier	COS	Construction Safety	P03	Package 03	SMI	MIDC					
TBA	Contractor/Supplier 1	QAS	Quality Assurance	P04	Package 04	SSE	SEEPZ					
TBA	Contractor/Supplier 2	ENV	Environmental	P05	Package 05							
TBA	Contractor/Supplier 3	RRL	R&R and Land Acquisition	P06	Package 06	T00	Entire Corridor					
TBA	Contractor/Supplier 4	RIS	Risk	P07	Package 07	CPV	Beginning of Corridor/Cuffe Parade → Beginning of Vidhan Bhavan					
TBA	Contractor/Supplier 5	MAG	Maple Admin - General			VBC	Beginning of Vidhan Bhavan → Beginning of Churchgate					
TBA	Contractor/Supplier 6	HRS	HR	D00	All Depots	CGH	Beginning of Churchgate → Beginning of Hutatma Chowk (Flora Fountain)					
TBA	Contractor/Supplier 7	ITE	IT	D01	Depot 01	HCC	Beginning of Hutatma Chowk → Beginning of Mumbai CST					
TBA	Contractor/Supplier 8	FIN	Finance	D02	Depot 02	CSK	Beginning of Mumbai CST → Beginning of Kalbadevi					
TBA	Contractor/Supplier 9, etc...	PRE	Public Relation	D03	Depot 03	KDG	Beginning of Kalbadevi → Beginning of Girgaon					
		TRG	Training			GGG	Beginning of Girgaon → Beginning of Grant Road					
		STK	Stakeholders	S00	All Stations	GRM	Beginning of Grant Road → Beginning of Beginning of Mumbai Central					
		SEC	Security	SCP	Cuffe Parade	MCM	Beginning of Mumbai Central → Beginning of Mahalaxmi					
				SVB	Vidhan Bhavan	MLS	Beginning of Mahalaxmi → Beginning of Science Museum					
		CVG	Civil – General	SCG	Churchgate	SMA	Beginning of Science Museum → Beginning of Acharya Atrey Chowk					
		ARP	Architecture Station Planning	SHC	Hutatma Chowk	AAW	Beginning of Acharya Atrey Chowk → Beginning of Worli					
		TUN	Tunnelling	SCS	Mumbai CST	WOS	Beginning of Worli → Beginning of Siddhivinayak Temple					
		GEO	Geotechnical	SKD	Kalbadevi	STD	Beginning of Siddhivinayak Temple → Beginning of Dadar					
		STR	Structural	SGG	Girgaon	DAS	Beginning of Dadar → Beginning of Shitla Devi Temple					
		UTL	Utility	SGR	Grant Road	SDD	Beginning of Shitla Devi Temple → Beginning of Dharavi					
		TRP	Transportation Planning	SMC	Mumbai Central	DHB	Beginning of Dharavi → Beginning of BKC					
		DEC	Design Civil	SML	Mahalaxmi	BAV	Beginning of BKC → Beginning of Vidyanagari					
		NAT	NATM	SSM	Science Museum	VNS	Beginning of Vidyanagari → Beginning of Santacruz					
		CAC	Cut and Cover	SAA	Acharya Atrey Chowk	SCC	Beginning of Santacruz → Beginning of CSIA (Domestic)					
		LAS	Launch shaft	SWO	Worli	C1S	Beginning of CSIA (Domestic) → Beginning of Sahar Road					
		MEP	MEP	SST	Siddhivinayak Temple	SRC	Beginning of Sahar Road → Beginning of CSIA (International)					
				SDA	Dadar	C2M	Beginning of CSIA (International) → Beginning of Marol Naka					
		SYG	Systems – General	SSD	Shitla Devi Temple	MAM	Beginning of Marol Naka → Beginning of MIDC					
		SYI	System Integration	SDH	Dharavi	MIS	Beginning of MIDC → SEEPZ (1SE)/End of Corridor					
		AFC	Automatic Fare Collection									
		STPT	Signalling, Train Control & PSD									
		LET	Lifts & Escalators									
		PSS	Power Supply System									
		OCS	Overhead Contact System									
		TVE	TVS & ECS									
		RST	Rolling Stock									
		TRW	Track Works									
		RCD	Railcar Depot									
		WSP	Workshop									
		DEQ	Depot Equipment									
		TOP	Train Operation									
		DES	Design System									
		RAM	RAMS									
		SIG	Signage									
		MNT	Maintenance									

ANNEXURE B
Field Codes for Document-type B (Minutes of Meeting)

Field 1		Field 2
Chairing Entity		MOM
Code	Entity	
LLL		LLL
AAA	All Entities	
AAO	Others	
MMR	Mumbai Metro Rail Corp. Ltd	
GCC	MAPLE Consortium	
AAB	All Contractor/Supplier	
TBA	Contractor/Supplier 1	
TBA	Contractor/Supplier 2	MOM
TBA	Contractor/Supplier 3	
TBA	Contractor/Supplier 4	
TBA	Contractor/Supplier 5	
TBA	Contractor/Supplier 6	
TBA	Contractor/Supplier 7	
TBA	Contractor/Supplier 8	
TBA	Contractor/Supplier 9, etc…	

Field 3	
Discipline Code	
Code	Discipline
NNN	
AAA	All Disciplines
AAO	Others
PMG	PM - General
COD	Contract Admin
PCM	Project Control Management
COS	Construction Safety
QAS	Quality Assurance
ENV	Environmental
RRL	R&R and Land Acquisition
RIS	Risk
MAG	Maple Admin - General
HRS	HR
ITE	IT
FIN	Finance
PRE	Public Relation
TRG	Training
STK	Stakeholders
SEC	Security
CVG	Civil – General
ARP	Architecture Station Planning
TUN	Tunnelling
GEO	Geotechnical
STR	Structural
UTL	Utility
TRP	Transportation Planning
DEC	Design Civil
NAT	NATM
CAC	Cut and Cover
LAS	Launch shaft
MEP	MEP
SYG	Systems – General
SYI	System Integration
AFC	Automatic Fare Collection
STPT	Signalling, Train Control & PSD
LET	Lifts & Escalators
PSS	Power Supply System
OCS	Overhead Contact System
TVE	TVS & ECS
RST	Rolling Stock
TRW	Track Works
RCD	Railcar Depot
WSP	Workshop
DEQ	Depot Equipment
TOP	Train Operation
DES	Design System
RAM	RAMS
SIG	Signage
MNT	Maintenance

Field 4			
Area Code			
Code	Area Designation	Code *(Contd)*	Area Designation *(Contd)*
XXX		XXX	
		SBA	BKC
AAA	All Areas	SVN	Vidyanagari
AAO	Others	SSC	Santacruz
		SC1	CSIA T1
P00	All Packages	SSR	Sahar Road
P01	Package 01	SC2	CSIA T2
P02	Package 02	SMA	Marol Naka
P03	Package 03	SMI	MIDC
P04	Package 04	SSE	SEEPZ
P05	Package 05		
P06	Package 06	T00	Entire Corridor
P07	Package 07	CPV	Beginning of Corridor/Cuffe Parade → Beginning of Vidhan Bhavan
		VBC	Beginning of Vidhan Bhavan → Beginning of Churchgate
D00	All Depots	CGH	Beginning of Churchgate → Beginning of Hutatma Chowk (Flora Fountain)
D01	Depot 01	HCC	Beginning of Hutatma Chowk → Beginning of Mumbai CST
D02	Depot 02	CSK	Beginning of Mumbai CST → Beginning of Kalbadevi
D03	Depot 03	KDG	Beginning of Kalbadevi → Beginning of Girgaon
		GGG	Beginning of Girgaon → Beginning of Grant Road
S00	All Stations	GRM	Beginning of Grant Road → Beginning of Beginning of Mumbai Central
SCP	Cuffe Parade	MCM	Beginning of Mumbai Central → Beginning of Mahalaxmi
SVB	Vidhan Bhavan	MLS	Beginning of Mahalaxmi → Beginning of Science Museum
SCG	Churchgate	SMA	Beginning of Science Museum → Beginning of Acharya Atrey Chowk
SHC	Hutatma Chowk	AAW	Beginning of Acharya Atrey Chowk → Beginning of Worli
SCS	Mumbai CST	WOS	Beginning of Worli → Beginning of Siddhivinayak Temple
SKD	Kalbadevi	STD	Beginning of Siddhivinayak Temple → Beginning of Dadar
SGG	Girgaon	DAS	Beginning of Dadar → Beginning of Shitla Devi Temple
SGR	Grant Road	SDD	Beginning of Shitla Devi Temple → Beginning of Dharavi
SMC	Mumbai Central	DHB	Beginning of Dharavi → Beginning of BKC
SML	Mahalaxmi	BAV	Beginning of BKC → Beginning of Vidyanagari
SSM	Science Museum	VNS	Beginning of Vidyanagari → Beginning of Santacruz
SAA	Acharya Atrey Chowk	SCC	Beginning of Santacruz → Beginning of CSIA (Domestic)
SWO	Worli	C1S	Beginning of CSIA (Domestic) → Beginning of Sahar Road
SST	Siddhivinayak Temple	SRC	Beginning of Sahar Road → Beginning of CSIA (International)
SDA	Dadar	C2M	Beginning of CSIA (International) → Beginning of Marol Naka
SSD	Shitla Devi Temple	MAM	Beginning of Marol Naka → Beginning of MIDC
SDH	Dharavi	MIS	Beginning of MIDC → SEEPZ (1SE)/End of Corridor

Field 5		
MOM Number		
Year	Month	Unique Seq. No.
NN	NN	NNN
15	01 to 12	001 to 999
16	01 to 12	
17	01 to 12	
18	01 to 12	
19	01 to 12	

ANNEXURE C
Field Codes for Document-type C (Drawings)

Field 1 Entity Codes		Field 2 Discipline Code		Field 3 Area Code				Field 4 Drwg No.	Field 5 Sheet No.	Field 6 Revision Index	
Code	Entity	Code	Discipline	Code	Area Designation	Code (Contd)	Area Designation (Contd)	Unique Seq. No of Drawing Set	Drawing Sheet Nos	Release	Unique Seq. No
LLL		LLL		XXX			XXX	NNNN	NNN	L	(N)
						SBA	BKC	0001 to 9999	001 to 999	A & B	1,2,3....
AAA	All Entities	AAA	All Disciplines	AAA	All Areas	SVN	Vidyanagari				
AAO	Others	AAO	Others	AAO	Others	SSC	Santacruz				
						SC1	CSIA T1				
MMR	Mumbai Metro Rail Corp. Ltd	PMG	PM - General	P00	All Packages	SSR	Sahar Road				
GCC	MAPLE Consortium	COD	Contract Admin	P01	Package 01	SC2	CSIA T2				
		PCM	Project Control Management	P02	Package 02	SMA	Marol Naka				
AAB	All Contractor/Supplier	COS	Construction Safety	P03	Package 03	SMI	MIDC				
TBA	Contractor/Supplier 1	QAS	Quality Assurance	P04	Package 04	SSE	SEEPZ				
TBA	Contractor/Supplier 2	ENV	Environmental	P05	Package 05						
TBA	Contractor/Supplier 3	RRL	R&R and Land Acquisition	P06	Package 06	T00	Entire Corridor				
TBA	Contractor/Supplier 4	RIS	Risk	P07	Package 07	CPV	Beginning of Corridor/Cuffe Parade → Beginning of Vidhan Bhavan				
TBA	Contractor/Supplier 5	MAG	Maple Admin - General			VBC	Beginning of Vidhan Bhavan → Beginning of Churchgate				
TBA	Contractor/Supplier 6	HRS	HR	D00	All Depots	CGH	Beginning of Churchgate → Beginning of Hutatma Chowk (Flora Fountain)				
TBA	Contractor/Supplier 7	ITE	IT	D01	Depot 01	HCC	Beginning of Hutatma Chowk → Beginning of Mumbai CST				
TBA	Contractor/Supplier 8	FIN	Finance	D02	Depot 02	CSK	Beginning of Mumbai CST → Beginning of Kalbadevi				
TBA	Contractor/Supplier 9, etc...	PRE	Public Relation	D03	Depot 03	KDG	Beginning of Kalbadevi → Beginning of Girgaon				
		TRG	Training			GGG	Beginning of Girgaon → Beginning of Grant Road				
		STK	Stakeholders	S00	All Stations	GRM	Beginning of Grant Road → Beginning of Beginning of Mumbai Central				
		SEC	Security	SCP	Cuffe Parade	MCM	Beginning of Mumbai Central → Beginning of Mahalaxmi				
				SVB	Vidhan Bhavan	MLS	Beginning of Mahalaxmi → Beginning of Science Museum				
		CVG	Civil – General	SCG	Churchgate	SMA	Beginning of Science Museum → Beginning of Acharya Atrey Chowk				
		ARP	Architecture Station Planning	SHC	Hutatma Chowk	AAW	Beginning of Acharya Atrey Chowk → Beginning of Worli				
		TUN	Tunnelling	SCS	Mumbai CST	WOS	Beginning of Worli → Beginning of Siddhivinayak Temple				
		GEO	Geotechnical	SKD	Kalbadevi	STD	Beginning of Siddhivinayak Temple → Beginning of Dadar				
		STR	Structural	SGG	Girgaon	DAS	Beginning of Dadar → Beginning of Shitla Devi Temple				
		UTL	Utility	SGR	Grant Road	SDD	Beginning of Shitla Devi Temple → Beginning of Dharavi				
		TRP	Transportation Planning	SMC	Mumbai Central	DHB	Beginning of Dharavi → Beginning of BKC				
		DEC	Design Civil	SML	Mahalaxmi	BAV	Beginning of BKC → Beginning of Vidyanagari				
		NAT	NATM	SSM	Science Museum	VNS	Beginning of Vidyanagari → Beginning of Santacruz				
		CAC	Cut and Cover	SAA	Acharya Atrey Chowk	SCC	Beginning of Santacruz → Beginning of CSIA (Domestic)				
		LAS	Launch shaft	SWO	Worli	C1S	Beginning of CSIA (Domestic) → Beginning of Sahar Road				
		MEP	MEP	SST	Siddhivinayak Temple	SRC	Beginning of Sahar Road → Beginning of CSIA (International)				
				SDA	Dadar	C2M	Beginning of CSIA (International) → Beginning of Marol Naka				
		SYG	Systems – General	SSD	Shitla Devi Temple	MAM	Beginning of Marol Naka → Beginning of MIDC				
		SYI	System Integration	SDH	Dharavi	MIS	Beginning of MIDC → SEEPZ (1SE)/End of Corridor				
		AFC	Automatic Fare Collection								
		STPT	Signalling, Train Control & PSD								
		LET	Lifts & Escalators								
		PSS	Power Supply System								
		OCS	Overhead Contact System								
		TVE	TVS & ECS								
		RST	Rolling Stock								
		TRW	Track Works								
		RCD	Railcar Depot								
		WSP	Workshop								
		DEQ	Depot Equipment								
		TOP	Train Operation								
		DES	Design System								
		RAM	RAMS								
		SIG	Signage								
		MNT	Maintenance								

Annexure D: Revision and Version Record (Example)

REVISION AND VERSION RECORD

Project Name	MUMBAI METRO LINE 3		
Document No.	GCC-GCC-QAS-P00-150001-A2	**Date of 1st Issue**	15.10.2015
Document Title	DOCUMENT IDENTIFICATION AND NUMBERING PROCEDURE		

Rev	Date of Issue / Rev	Description	Prepared/ Revised	Checked	Approved
A1	15.10.2015	First Issue	RD	RL	RJM
A2	29.03.2016	Second Issue	RD	PK	RJM

Mumbai Metro Rail Line 3
BIDDING DOCUMENTS

EMPLOYER'S REQUIREMENTS
GENERAL SPECIFICATIONS

Part 2

Section VI (1)
Sub-Division F

Appendix 24
(Version – C)

SYSTEM SAFETY REQUIREMENTS

July 2019

TABLE OF CONTENTS

1. ABBREVIATION & DEFINITION

1.1 Abbreviation

ALARP	As Low As Reasonably Practicable
CMRS	Commissioner Metro Railway Safety
DBR	Design Basis Report
DoT	Department of Telecommunication
EIG	Electrical Inspector of Government
FFA	Functional Failure Analysis
FMECA	Failure Mode Effects and Criticality Analysis
FMEA	Failure Mode Effect Analysis
FTA	Fault Tree Analysis
FRACAS	Failure Reporting, Analysis & Corrective Action System
FRB	Failure Review Board
HAZOP	Hazard Operability Study
MMRC	Mumbai Metro Rail Corporation
IHA	Interface Hazard Analysis
IRA	Independent RAM Assessor
ISA	Independent Safety Assessor
MMRC	Mumbai Metro Rail Corporation
MEP	Mechanical, Electrical & Plumbing
MoR	Ministry of Railway
MRA	Metro Rail Administration
MSS	Manuals of Specification & Standards
O&M	Operation & Maintenance
O&SHA	Operation & Support Hazard Analysis
OCS	Overhead Contact System

OMC	Operation and Maintenance Contractor
PHA	Preliminary Hazard Analysis
PSS	Power Supply & SCADA
QA	Quality Assurance
QRA	Quantitative Risk Assessment
RAM	Reliability, Availability and Maintainability
RAMS	Reliability, Availability, Maintainability and Safety
RDSO	Research Design & Standard Organization
RS	Rolling Stock
RSSB	Rail System Safety Board, UK (United Kingdom)
SAR	System Assurance Requirements
SC	Safety Consultant
SCIL	Safety Critical Item List
SCAL	Safety Critical Activity List
SIL	Safety Integrity Level
SOP	Standard Operating Procedure
SSIL	Software Safety Integrity Level
SSP	Sub-system Safety Plan
SHA	System Hazard Analysis
SSHA	Sub-system Hazard Analysis
S&TC	Signaling & Train Control System
TS	Technical Specification
V&V	Verification & Validation

2. Definitions

Term	Definition
Component	The elements (sub-assemblies or any lower order elements of the sub-assemblies) of the Sub-system are referred in this document as component. Note: "component" with small "c" indicate the general meaning
Commissioning	A collective term for the activities undertaken to prepare a system or product prior to demonstrating that it meets its specified requirements
Compliance	A demonstration that a characteristic or property of a product satisfies the stated requirements.
Contractor	The Sub-system suppliers such as RS, S&TC etc. are referred to as Contractors in this document.
Functional Failure Analysis	The analysis method which analyses the probable failure scenarios of the intended function of the system
Functional Safety	Part of the overall safety related to the system, that depends on the correct functioning of the safety related systems and other risk reduction measures
Lowest level Functional Unit	The smallest Component of a System that has the capability to accomplish specified function(s) independently when the specified sets of inputs and outputs are available to it
Master Hazard Log	A hazard log maintained for the Project which contains all Sub-system hazards (consolidation of Contractor's hazard log), System hazards, operation hazards and any other hazards as identified from time to time.
Hazard	Potential source of harm
Harm	Physical injury or damage to the health of people or damage to property or the environment
Hazardous Event	Event that may result in harm
Project	Project shall mean Mumbai Metro Rail Project. Note: "project", with small "p" is used for its general English meaning
Proven in use	Demonstration, based on an analysis of the operational experience for a specific configuration of a Component that the likelihood of dangerous systematic faults is low enough so that every safety function that uses the element achieves its required SIL.

Qualitative Risk Analysis	A risk assessment that justifies the risk reduction through compliance to codes and standards and through logical arguments.
Quantitative Risk Analysis	A risk assessment that justifies the risk reduction through data collected from various sources of database
Residual risk	Risk remaining after protective measures have been taken
Redundancy	The existence of more than one means of performing a required function
Risk	Combination of the probability of the occurrence of harm and the severity of that harm
Safety related system	Designed system that both - Implements the required safety functions necessary to achieve or maintain a safe state for the equipment under control. - Is intended to achieve, on its own or with other systems and other risk reduction measures, the necessary safety integrity for the required safety function
Safety Integrity	Discrete levels (one out of a possible four) corresponding to a range of safety integrity values where SIL value of 4 represents the highest level of safety and SIL 1 has the lowest
Stake holder	Is used in general sense and shall mean an individual member or organization associated with the Project or the public or the passenger who in some way is related to the Mumbai Metro Rail System or Project.
Stage	The Project has been planned to be operational in six (06) stages where each stage represents a section of line in the rail system. For detail about these sections, please refer condition of contract "COC" of the Sub-system contract document.
System	All the subsystems which, working together, deliver the complete metro rail system. Here System shall mean "Mumbai Metro Rail Transit System". Note: "system", with small "s" is used for their general meaning
Sub-system	A group of components working together within the System to contribute to satisfying specified Project performance requirements. The Sub-systems that form the System are Alignment & Track, Signaling & Train Control (S&TC), Power Supply & SCADA (PSS), Over Head Electrical System (OETS), Automatic Fare Collection

	(AFC), Communication Systems (COM), Rolling Stock (RS) etc. Note: "sub-system", with small "s" is used for their general meaning
Systematic Failure	Failure, related in a deterministic way to a certain cause which can only be eliminated by a modification of the design or of the manufacturing process, operational procedures, documentation or other relevant factors
Sub-Contractor	Supplier of a particular component
Verification	Confirmation by examination and provision of objective evidence that the specified requirements have been fulfilled
Validation	Confirmation by examination and provision of objective evidence that the particular requirements for a specified intended use are fulfilled.

3. Introduction

3.1 Objective of this Document

3.1.1 As part of the overall requirement to implement and demonstrate MMRC's capability in delivering a metro rail system that meets the safety specifications.

3.1.2 MMRC is committed to meeting all internal and regulatory safety requirements in order to create a safe environment for passengers, staff & the public. This document describes the minimum activities and the related process, tools and techniques to be performed by MMRC Project team, its Consultants, Contractors and Sub-contractors, Auditors and Assessors to ensure provision of a safe and reliable metro rail system to all concerned.

3.1.3 While this document shall serve as a guideline document for the Contractors to align their "Sub-system Safety Plans" to this document, at the same time, it also provides the external auditors, assessors and other regulatory and certifying agencies, the strategy of MMRC to design, build, operate and maintain a safe metro rail system.

3.2 Scope of the Document

3.2.1 This document describes the minimum level of safety activities and related process, tools and techniques to be adopted for the System and Sub-systems.

3.2.2 This document identifies the performance requirements for concerned Stakeholders / organisation to perform and supervise the work to ensure that the design and delivery of the System complies with the safety requirements. As specified in the System Assurance requirements.

3.2.3 As stated, the requirements as mentioned in this document are the minimum and it is the responsibility of the Contractors to implement a robust safety process to deliver a safe and reliable system. Should there be any conflict between the content of this document and the Contractor's opinion about safety, the same shall immediately be brought to the notice of MMRC for discussion and resolution. In this regards, the decision of MMRC shall be considered as final.

3.2.4 This document does not cover civil engineering assets such as tunnel, station building etc. because in their case prescriptive approach to safety management is adopted. The design and development of civil engineering assets is as per approved national and international codes and practices.

3.2.5 The safety activities related to performance monitoring, operation & maintenance and modification & retrofit phases [Ref: Figure 4] will be detailed out in a separate document called "Safety Management System (SMS)" to be prepared by OMC in due course.

3.2.6 Activities related to RAM & EMC, whilst integral part of the system assurance activities, are covered separately in appropriate documents such as System RAM Plan, EMC Plan etc.

3.2.7 This document is restricted to the "Functional /operational Safety". The "Construction Safety, Health & Environment" being a broad subject is considered out of the scope of this document. The same shall be appropriately covered in the respective Project document (SHE Manual & SHE Conditions).

3.3 Limitations, Assumptions & Facts

3.3.1 This plan adopts a generic approach which is applicable to a broad spectrum of metro rail systems. Further there are no significant assumptions considered while preparing this document. Hence it is very unlike for this document to experience significant changes to the original content.

3.3.2 However, it is to be noted that, this document is a dynamic document which gets updated as and when new information is available during the Project execution.

3.4 Document References

Following documents and standards are referred while preparing this DOCUMENT.

1. EN 50126-1: Railway Applications – The specification and Demonstration of Reliability, Availability, Maintainability & Safety (RAMS) – Part 1: Basic Requirements & Generic Process
2. EN 50126-2: Railway Applications – The specification and Demonstration of Reliability, Availability, Maintainability & Safety (RAMS) – Part 2: Guide to the application of EN 50126-1 for Safety
3. EN 50126-3: Railway Applications – The specification and Demonstration of Reliability, Availability, Maintainability & Safety (RAMS) – Part 3: Guide to the application of Rolling Stock RAMS
4. International Engineering Safety Management 2013 published by---- (Technical Programme Delivery Limited; issued on April 1,2013.
5. RDSO Procedure for Safety Certification and Technical Clearance (Dec 2015) issued by Ministry of Railways.

4. SYSTEM DESCRIPTION

4.1 System Technical Information

4.1.1 The Mumbai metro rail system will have a length of approximately 33.6 Kms. It will have 26 underground metro Stations and at grade Depot at Aarey Colony, north-south axis from Cuffe Parade to Seepz - Aarey.

4.1.2 The System shall be designed for a minimum ultimate capacity of 50 000 PHPDT (Peak Hour Peak Direction Traffic) for the year 2045. Commercial services are likely to start in the year 2020.

4.1.3 The Trains shall be operated continuously such that the first Train in each direction shall depart no later than 0500 hours and the last Train shall terminate not earlier than 2330 hours at the frequency specified provided that on Sundays the duration of services may be reduced by 4 (four) hours.

4.1.4 The Trains in each direction shall be operated such that the difference between arrival time of two Trains at any Station shall not exceed 5 minutes; provided that such difference may be increased, subject to a maximum of 15 (fifteen) minutes, depending upon the number of Users in the respective hour.

4.1.5 The average speed of train movement from terminal to terminal during any hour of the day, including stops at the Stations, shall be at least34 km per hour. Stops at the Stations shall be at least 20 (twenty) seconds each.

4.1.6 The normal service headway shall be 2 minutes in the peak time in 2045. The trains shall be capable of sustaining a maximum operating speed of 85kmph with a design speed of 95kmph.Trains of 8-car configuration (DT-M-M-M-M-M-M-DT) shall be introduced since beginning.

4.1.7 The S&TC system shall be based on the CBCT technology (Communication Based Train Control) with a minimum design head way of 90 seconds. At present the mainline S&TC will be as per G0A2 standards and depot S&TC will be to G0A4 standard i.e. unattended Train Operation. The mainline S&TC subsystem shall be so designed that in future it should be upgradable to G0A4.

4.1.8 The track system in mainline shall be ballast-less standard gauge (1435 mm). The track system in depot shall be with ballast.

4.1.9 All the 3 Lines shall utilise 25 kV, 1ph, 50 Hz AC overhead traction system.

5. SAFETY POLICY & STRATEGY

Safety policy is framed and issued under MRA signature to demonstrate the commitment of senior management towards safety.

5.1 Safety Policy Statement – Proposed safety policy statement is given below.

Metro Rail Safety Policy

MMRC recognizes that, maintaining a high level of safety whilst delivering operational excellence is paramount to its business success. We are committed to the provision of metro rail transport service which maintain the highest possible levels of safety for our Employees, Passengers, Public and the Environment.

Our ethos of safety is:

- All accidents are preventable
- All risks can be reduced or eliminated
- Safety is the responsibility of each employee
- Development and implementation of safety practices and procedures is the responsibility of MMRC's management.
- Strive for continuous improvement in safety performance

We ensure metro rail safety through:

- Integration of safety into all phases of our business including design, procurement, construction, installation, commissioning & testing, recruitment & training and operation & maintenance.

- Provision of an effective risk management strategy to reduce risks and eliminate potential hazards to as low as reasonably practicable.

- Provision of such information, training, instruction and equipment as necessary to enable our employees, to undertake their work safely.

- Compliance with, and where reasonably practicable to do so, exceeding the requirements of relevant safety acts, legislation, industry standards and good practices.

- Establishment of a positive safety culture, built on mutual trust, open communication, shared values and confidence in the effectiveness of the preventive measures that empower our Employees, Consultants, Contractors and all other Stake holders to provide suggestions and actively contribute towards improving safety practices.

- Safety monitoring and regular safety audits of the metro rail safety policy and our safety management plans.

This policy will be reviewed at least once every year and updated as necessary.

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Issue Date

Chief Executive & Managing Director

Mumbai Metro Rail Corporation

5.2 Safety Strategy

5.2.1 The framework of this DOCUMENT involves a structured process, which conforms to international railway standard EN50126: Railway applications - Specification and Demonstration of RAMS, which is a well proven and recognized standard in the railway industry around the world.

5.2.2 Further the DOCUMENT conforms to appropriate legislations and adopts best practices from other international standards and industry good practices (e.g. International Engineering Safety Management), as appropriate, so that the minimum level of safety thus achieved is at least equal to or better than similar existing international metro rail systems.

5.2.3 The design, installation, testing and commissioning of the metro rail system is planned to be achieved through award of various Sub-system contracts such as civil, stations, depot, rolling stock, S&TC, track works, OCS, PSS, Telecommunications etc. The individual Contractors shall ensure the achievement of the safety performance of their respective Sub-systems and shall ensure compliance to DOCUMENT and relevant standards.

5.2.4 The safety activities shall be considered as an integral part of the design and development process. The Contractors shall ensure participation of their system assurance organization in all engineering reviews.

5.2.5 All engineering submissions by the Contractors at any level shall be considered as incomplete without the completion of the planned safety activities and without the submission of the planned safety documents.

5.3 Safety Standards

5.3.1 In addition to documents / standards referred in 3.4, latest edition of the following mandatory standards shall be implemented for ensuring safety.

- EN 50128: Railway Applications - Communications, Signaling and processing systems - Software for railway control and protection systems

- EN 50129: Railway Applications - Communications, Signaling and processing systems - Safety related electronic systems for Signaling

5.3.2 Relevant sections of, EN 50128 & EN 50129 shall be implemented for all Sub-systems and shall not be limited to telecommunication and Signaling & train control systems.

5.3.3 Apart from the above mentioned mandatory standards, following is a list of standards and best practices, provided for additional guidelines to be implemented appropriately.

- IEC 61025: Fault Tree Analysis

- BS 5760, Part 5: Reliability of systems, equipment and components. Guide to failure modes, effects and criticality analysis (FMEA and FMECA)

- MIL-STD-1629A: Procedure for performing a Failure Mode Effect and Criticality Analysis

- MIL HDBK 764: System Safety Engineering – Design Guide for Army Material
- MIL-STD-882D: Standard practice for system safety
- BS EN 115: Safety of the Escalators and moving walk
- IEC 61882: Hazard and Operability (HAZOP) Studies: Application Guide.
- IEC 61508: Part 1-5: Functional safety of electrical-electronics safety programmable electronic safety related systems.
- NFPA 130: Fire Protection Standard: "Fixed guide way transit and passenger rail systems".
- Engineering Safety Management System, published by –Technical Programme Delivery Limited issued on April 1,2013

5.4 Safety Principles

Implementation of the safety policy shall be achieved through compliance to established international standards and best practices. The safety principles shall include the following.

5.4.1 Compliance with legislations, Acts and Standards

Contractors shall design their systems to comply with current accepted practices, codes, regulations, standards and other design safety principles. Deviations from, or non-compliance with accepted codes, standards and regulations, in particular for new or novel equipment shall be assessed in terms of the impact on system safety. The relevance and application of the design safety principles formulated for the design should be confirmed for normal, degraded and emergency operation of the system. Since safety is a proven integral part of these legislations, acts and technical standards, compliance to these documents, ensures safety of the system.

5.4.2 Proven-in-use

So far as is reasonably practicable, proven-in-use systems / components / services shall be adopted with a known and high degree of safety & reliability.

5.4.3 Fail Safe Design

Fail safe design principle shall be incorporated for safety critical features which would allow the system to transfer from a high loss or risk mode to a lower loss or risk mode upon the occurrence of a critical failure.

5.4.4 Redundancy in design

Specifically, for safety critical functions, reduction of the probability of occurrence of a safety failure can be achieved by increasing the component reliability or by providing supervised redundant mechanism. Single infringement to safety loop shall not jeopardize the safety of operation.

5.4.5 Qualitative Safety Principle

MMRC recognizes the fact that quantitative safety analysis is highly dependent on the integrity of the data and data sources. Unfortunately, there is practical limitation for validation of data

from these data sources. Hence, qualitative (i.e. logical safety) rather than quantitative safety principles shall be the primary objective of the safety implementation in the Project.

5.4.6 **Reviews, Audits & Assessments**

Reviews, audits and assessment by appropriate agencies shall be the primary principle of safety at different phases of the Project. MMRC recognizes the fact that, good industry practices of safety can only be ensured through a proper audit and assessment process.

5.4.7 **Risk Identification & Control**

Hazard identification and mitigation shall be an integral part of the Project at various phases. All hazards shall be minimized to ALARP. While determining the necessity for additional risk control measures, the Contractors shall use good engineering judgement rather than focusing on the quantitative values. So far as is reasonably practicable, elimination of hazards through implementation of appropriate design features shall take priority over that by operational procedures. Operational and maintenance activities identified as measures to mitigate the risks, shall be specific with clear assessment criteria. During consideration of precedence in the control of hazards, the human limitations shall be considered as an engineering constraint.

6. SAFETY TARGETS & REQUIREMENTS

6.1 Safety Targets

6.1.1 The Mumbai metro rail system shall be designed, built, operated and maintained to achieve zero injury vision. However, for statistical purposes the following safety targets are proposed. These targets shall be achieved by the OMC during O&M phase.

- Passenger injury rate shall be 0.4 per million passengers as measured on a monthly average basis.
- All identified hazards shall be mitigated to an acceptable level following ALARP principle as described in EN 50126.

6.2 General Safety Requirements

6.2.1 MMRC, its consultants and Contractors for their respective scope of works shall ensure that, their delivered system is safe to manufacture, install, commission, operate and maintain.

6.2.2 MMRC & its Contractors for their scope of works shall perform the safety tasks as identified in this document. The safety principles, mandatory standards and recommended standards as described in this plan shall be implemented to ensure safety.

6.2.3 The Contractor's safety strategy shall integrate the safety assurance elements in all phases of the works and shall incorporate a disciplined approach to evaluate the Sub-system design. The Sub-system safety strategy shall be approved by MMRC.

6.2.4 The Contractor and consultants shall make recommendations for re-engineering or modifications necessary to ensure compliance with specified requirements including fail safe design, redundancy, utilization of high reliable components, built-in self-diagnostics and self-healing features, utilization of in-service status displays to enhance fault isolation and test etc. to improve the safety of the systems.

6.3 Technical Safety Requirements

6.3.1 Apart from the above mentioned requirements in System assurance requirements there are numerous safety requirements mentioned in the form of functional and technical requirements throughout the technical specifications of the Sub-system contracts. Contractors shall implement these safety requirements as mentioned in SAR, Technical Specifications and this document.

6.3.2 The Contractors shall also comply with the safety requirements as suggested by Project's internal and external reviewers, auditors & assessors such as OMC, statutory agencies including CMRS.

7. SAFETY ORGANIZATION

7.1 Project Safety Organization Chart

7.1.1 The overall Project safety organization along with the internal & external stakeholders associated with the Project safety is shown in Figure: 1. this figure also shows the safety assurance provided by different stakeholders at different levels.

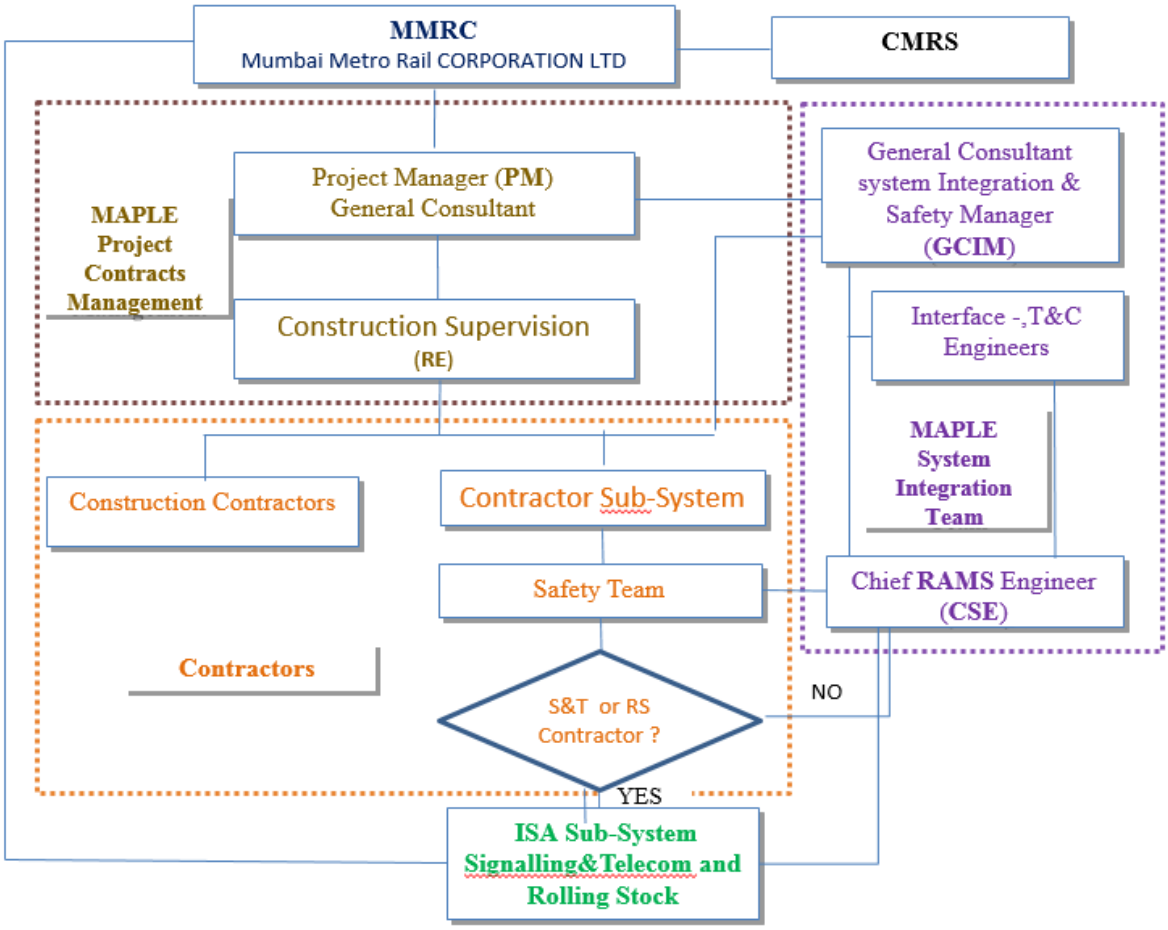


Figure 1: Project Safety Organization

7.1.2 Figure below shows the high level organization of MMRC

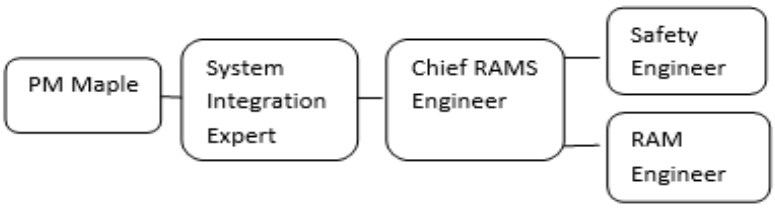


Figure 2: Safety Organization as provided by GC

7.1.3 The organization structures show the hierarchy of different disciplines as far as the efficient safety management is concerned and it does not represent the actual organization structure with respect to all other aspects of the Project execution.

7.2 Roles & Responsibility

7.2.1 The safety of the Project will be ensured through a dedicated system assurance team which comprises of team members from MMRC, GC and Contractors. Further, number of agencies such as MoR (RDSO), ISA, CMRS, etc. are involved in ensuring the safety during various phases of the Project. These roles are empowered appropriately to ensure implementation of the safety activities in the Project.

7.2.2 Figure 1 above shows the safety roles inside the Project organization. Safety activities corresponding to Sub-system shall be performed by the respective Contractors and safety activities corresponding to System shall be performed by MMRC / GC. CMRS is the final approving authority for commencement of the revenue service. The detailed role and responsibility in the organization is described below.

7.2.3 Ensuring safety through implementation of the appropriate safety principles and processes as mentioned in this safety plan, or otherwise, is the responsibility of each technical discipline head of MMRC / GC, in consultation with the designated safety experts / safety engineers / safety coordinators.

7.2.4 Contractor's Safety Organization

Each Subsystem Contractor shall appoint safety personnel who will oversee all the safety activities of their respective Sub-system. Primary responsibilities of the Contractor's safety organization shall be as listed below.

- Perform appropriate safety activities including safety analysis and produce safety documents for their respective Sub-systems complying with the overall DOCUMENT and relevant standards.
- Provide regular updates on safety progress to MMRC.
- Perform safety review of specification, design, manufacturing, testing and commissioning documents prior to submission of the same to MMRC to ensure that the safety aspects of the Sub-systems are implemented.
- A key responsibility of the safety organisation shall be to ensure that there is a feedback from the safety studies at the design stages, in order to eliminate or reduce weak points that could have an adverse effect on the safety of the system.

7.2.5 Safety Organization of GC

The safety organization of General Consultant (GC) shall oversee the management of safety activities for the overall Project with the help of other team members of safety organization. Primary responsibilities of the safety organization of GC shall be as listed below.

- Prepare the document that shall in turn identify the safety processes for all Sub-system Contractors.
- Prepare safety requirements for all Sub-systems to be included in the respective technical specification and other contract documents.
- Prepare design safety study report for the Project through consolidation of the Sub-system design study report from the Contractors.
- Prepare Specific Application System Safety Case (Engineering) for the Project through consolidation of the Sub-system Engineering Safety Case from the Contractors.
- Identify resources to manage System safety activities and monitor of Sub-system safety

submissions.

- Conduct periodic safety audits and assessment on contractor's work.
- Review and approve Sub-system safety submissions.
- Set up System hazard log and ensure all relevant and credible hazards are tracked from identification to verification, to validation, and to close out. Ensure ALARP demonstration is conducted as necessary.
- Review and approve appropriate Sub-system level specification, design, manufacturing, testing and commissioning documents as submitted by the Contractors to ensure that the safety requirements have been adequately implemented.
- Co-ordinate and support the audit and assessment as conducted by the external auditors and regulatory agencies.
- Support the achievement of System safety certification.
- Review the System safety submissions from contractors to make sure that these documents are in line with the specified contractual safety requirements.
- Review appropriate System specifications, design, manufacturing, testing and commissioning document as submitted by contractors to ensure that the System meets the required safety performance level.
- Support the audit and assessment as conducted by the external auditors and regulatory agencies.

7.2.6 **Safety Organization of MMRC**

The safety organization of MMRC shall oversee the safety management to ensure the correct implementation of the laid down safety management processes and principles for the complete System which shall also include the safety activities performed by the consultants appointed by MMRC at various phases of the Project execution. Primary responsibilities of the safety organization of MMRC are as listed below.

- Appointment of appropriate agencies to ensure compliance of safety requirements to ensure safety of the System
- Act as the safety decision making and approving entity in the Project's internal organization.
- Conflict resolution between various agencies as shown in the Project organization chart, in consultation with relevant stakeholders
- Coordination with statutory agencies for safety approvals

7.2.7 **Independent Safety Assessor:**

MMRC may appoint an ISA to continuously monitor and ensure that the safety activities are being properly carried out in various phases of Project life cycle. Primary responsibilities of ISA are as listed below.

- Conduct an independent review of the policies, procedures and the documents developed by MMRC, its consultants & Contractors to implement the Project safety activities and ensure that they are in compliance with the requirements of the SAR and relevant standards and assure that system safety risks are eliminated or reduced to an acceptable level.
- Review the criteria and targets developed by MMRC and safety analysis undertaken by it in accordance to those criteria.
- Review/witness the verifications and validation activities and tests including safety validation, as conducted by MMRC and its Contractors to demonstrate that safety requirements and targets are met.
- Examine, and through certification, verify that the key safety requirements and obligations

of the Project can be met before service trials and before commencing revenue operations.

- Support MMRC in the System safety certification process.

7.2.8 **Regulatory Agencies:**

MMRC has to involve various regulatory agencies for their approval in their respective areas before commissioning of the System. Some of the primary regulatory agencies are as mentioned below.

- **MoR**: MoR, through their technical wing RDSO, issues technical approvals for major safety critical sub-systems of the metro rail system. RDSO issues speed certificates for RST (rolling stock) and carries out oscillation trials. It also issues speed certificates for auxiliary vehicles. RDSO may also be involved in the technical approval of other Sub-systems based on guidelines in force from time to time.
- **EIG**: For all electrical systems (650 volts and above) EIG inspects and certifies that these systems comply with all electrical rules and regulations and are safe for commissioning. EIGs sanction is mandatory before commissioning / energising any electrical systems.
- **Fire Safety Department**: The fire safety department's approval is required for all stations and building of the metro rail system before the same shall be opened for passenger service.
- **DoT:** PTCC clearance is required from DoT to certify that public telephone network in the vicinity of metro rail system is safe from induced voltage considerations.

7.2.9 **CMRS**

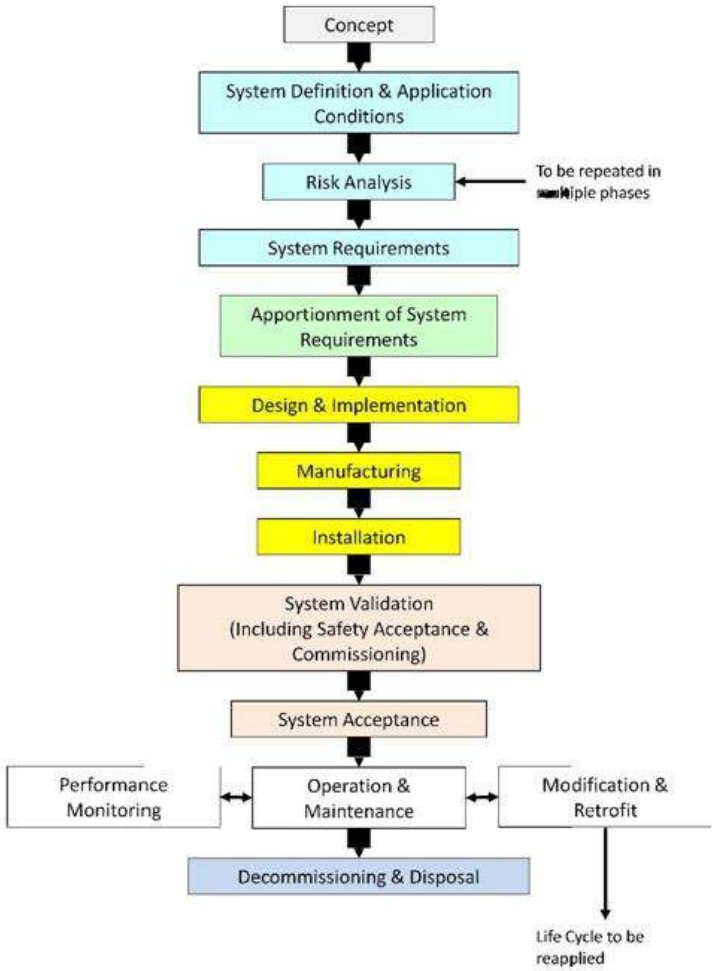
CMRS is empowered by the Central Government of India to inspect the metro rail system before the start of commercial operation and provide his sanction for the opening of the metro rail service.

- CMRS roles and responsibilities are detailed in rules for opening of metro railway for passenger services. i.e. reviewing the documents, scrutiny of safety proof and evidence (Safety Case), witnessing the vital test and trials, inspections etc. to satisfy himself fully about the safety of the system and recommend commissioning of metro rail system to the Central Government.
- During O&M phase CMRS inspects periodically that safety management is being done and improved continually.
- In case of the serious accidents he investigates and gives recommendations for system improvement to avoid recurrence of similar accidents.

8. SYSTEM SAFETY LIFE CYCLE PHASES

The System shall follow the safety management approach as defined in EN 50126: 1999, Part 1. Following figure shows the different phases of the System safety life cycle and the different parties responsible for implementing the safety activities in the Project.

Figure 8.1 – System Safety Life Cycle Phases



9. SAFETY MANAGEMENT ACTIVITIES

9.1 Introduction

9.1.1 RAM and Safety Engineering Process in all the sub-systems excluding civil engineering structures will be as per EN 50126. Independent Safety Assessment by ISA will be done only for Rolling Stock and Signaling and Train Control subsystem. Software safety Assurance will be managed by the contractors as per relevant codes such as EN 50128, EN50129 etc. For other sub-systems such as OCS, PSS, Communication, Track etc. The GC will manage the safety assurance process. The life cycle phases as described in the following sections are the ones as described in the aforesaid standard and in Figure 8.1 of this DOCUMENT.

9.1.2 International Engineering Safety Management published by Technical Programme Delivery Limited is considered here as a guideline, where ever considered appropriate, while designing these safety management activities.

9.1.3 It is not the aim of this document to repeat the content of the above mentioned standards in this DOCUMENT, rather, a brief about the process requirement is mentioned in this section and the Contractors are advised to refer to the aforesaid standard and guidelines for establishing the safety assurance framework and the implementation process.

9.1.4 The reviewers, auditors and assessors including consultants and external regulatory agencies shall be performing their safety responsibilities [Refer: Section 6.2] at various phases of the Project execution. The Project shall support the review, audit and assessment by these entities at any phase of the Project execution as their activities are not limited to a particular phase of the Project rather their scope is to ensure the safety of the System in broader sense.

9.1.5 While all activities as mentioned in this document are mandatory requirements for all safety critical Sub-systems such as RS, S&TC, OCS, PSS, fire protection and control systems, AFC, lifts, escalators etc. it is recognized that some of the activities as mentioned in this DOCUMENT may not justify the effort needed to complete these activities as compared to the safety criticality of those Sub-systems. In those cases, the Contractors are advised to discuss these deviations with MMRC for approval.

9.2 Phase 1: Concept Phase

9.2.1 This phase of the Project is referred to the phase prior to the appointment of GC by MMRC. Hence the activities are out of the scope of this document.

9.2.2 The feasibility study of the Project issues such as physical, social, political, legislative & economical issues are appropriately taken care to a reasonable acceptable level.

9.3 Phase 2: System Definition & Application Condition

9.3.1 This phase is the responsibility of both MMRC and GC. The activities of this are completed by MMRC and the same are incorporated in Detailed Project Report. MMRC has conducted a detailed study of the Project technical requirements including safety requirements and design basis reports (DBR) have been prepared for various subsystems.

9.3.2 DBR incorporates past experience data including safety data and preliminary hazard analysis outcome.

9.3.3 This document is initiated in this phase which encompasses, apart from other contents, safety policy, safety targets and requirements, safety management activities and safety acceptance criteria for the Project. A risk acceptance strategy and risk matrix is created which shall be the basis for the hazard analysis in the subsequent phases of the System life cycle.

9.4 Phase 3: Risk Analysis

9.4.1 This is a common activity performed at different stages of the Project and by different parties.

9.4.2 MMRC/GC will conduct a preliminary hazard analysis (PHA) to identify high level System hazards and high level safety requirements for different operational conditions such as normal, degraded and emergency conditions.

9.4.3 The output of the PHA is an integral part of the DBR which further transforms into the technical specification of the Sub-system contracts.

9.4.4 A hazard log is initiated which contains the hazards identified by PHA. The hazard log template to be followed for the Project, complying with the requirements of EN 50126, is mentioned in Annexure 3. This template shall be the mandatory template to be followed throughout the Project by all the Contractors for ease in Master Hazard Log management.

9.5 Phase 4: System Requirements

9.5.1 System requirements phase is again an activity of MMRC. GC reviews the system requirements.

9.5.2 Deviation to DPR where ever appropriate based on the DBR shall be proposed without compromising the safety of the System.

9.5.3 The Safety Requirements as an output of the PHA study shall be considered as an integral part of the DBR which shall then be transformed into the TS of the Sub-system Contracts.

9.6 Phase 5: Apportionment of the System Requirements

9.6.1 This phase of the Project is the responsibility of MMRC and GC where the System safety requirements as identified in the previous stage shall be assigned to the respective Sub-systems.

9.6.2 No quantitative apportionment of the safety targets of the System to respective Sub-systems is envisaged for the Project. The System wide safety targets as mentioned in section 5.1 shall be achieved through a robust safety management process and risk acceptance criteria as mentioned in this document.

9.6.3 At this stage, a safety process requirements and a set of safety functional & technical requirements including Sub-system safety acceptance criteria shall be recommended for each of the Sub-systems. These requirements shall be passed to the Contractors through GS and TS.

9.6.4 Safety for the individual Sub-systems shall be the responsibility of the respective Contractors. Hence, the Contractors are advised, to review the Sub-system safety requirements and discuss any issues, in their opinion, that may adversely impact the safety of their Sub-systems.

9.7 Phase 6: Design & Implementation

9.7.1 This phase of the Project is the responsibility of the individual Contractors. The Contractors shall review and analyse the high level Sub-system safety requirements as identified in previous stages to establish detailed level safety requirements. Adequacy of the high level safety requirements as mentioned in previous phases shall be analysed and additional safety requirements shall be identified if necessary. A safety requirement specification (SRS) shall be produced by the Contractors for their respective Sub-systems.

9.7.2 Following hazard and failure analysis activities shall be conducted by the Contractors during this phase. Some of the analysis shall be repeated during various phases of the System life cycle.

- Preliminary Hazard Analysis (PHA)
- Sub-system Hazard Analysis (SSHA)
- Interface Hazard Analysis (IHA)
- Failure Mode Effect & Criticality Analysis (FMECA)
- Operation & Support Hazard Analysis (O&SHA)
- Fault Tree Analysis (FTA)
- Quantitative Risk Analysis (QRA)

9.7.3 Functional Failure Analysis (FFA) & Hazard & Operability Study (HAZOP) shall be considered as the primary techniques while performing these analysis activities.

9.7.4 A Safety Critical Item List (SCIL) shall be produced by the Contractors for a focused safety approach to these items.

9.7.5 The SIL assignment and allocation shall be conducted by the Contractors for their respective Sub-systems where ever mentioned in their respective Contract documents. EN 50126: Part 2, EN 50128 & EN 50129 shall be referred for SIL assignment process.

9.7.6 Safety reviews shall be conducted regularly on Sub-system design to identify design features that may adversely affect the safety performance of the Sub-system. The safety review shall also be done during the implementation, commissioning and O&M phases. All safety review outcomes shall be documented as safety hazards in the hazard log and shall be mitigated to ALARP.

9.7.7 Design and implementation including procurement shall consider the followings as the primary principles behind each activity.

- Confirmation to relevant codes, standards, rules, regulations and legislations
- Proven components / sub-systems
- Fail safe design
- Redundant design specifically for SCIL, as reasonable as practical
- Risk control to ALARP

9.7.8 A "Sub-system Design Safety Study Report" shall be produced by each Contractor at the end of the design phase that shall explain the safety activities conducted till the design phase to ensure the safety of their Sub-systems. The report shall be updated with validation results from the testing and commissioning phases. This report is expected to contain the claims of the implementation of the approved "Sub-system Plan" and the deviation to the same if any with justification.

9.7.9 Each Contractor shall produce a "Specific Application Safety Case (Engineering)" for their scope of work. The first draft of application specific safety case shall be produced at the beginning of the detail design phase and the second draft shall be provided at the end of the detail design stage. It is to be noted that though the first draft is to be produced at the beginning of the detail design stage but in practice, the work for preparing the safety case indeed shall start right from the initial stage of Project execution. The Contractor shall have to collect all the evidences right from the beginning of the Project for its respective scope of work, for every safety claim that it will be stating in the safety case.

9.8 Phase 7: Manufacturing

9.8.1 Safety activities of this phase are the responsibility of the individual Contractors. The Contractors shall ensure use of safety validated components for use in the manufacturing process. Quality assurance is the key element in this phase to ensure safety.

9.8.2 Hazard mitigation measures for those hazards that need some action in the manufacturing phase are to be implemented by the Contractors.

9.8.3 Closed loop communication process between design and manufacturing shall be established to mitigate any safety risks arising from design changes due to manufacturing constraints or limitations. All such constraints shall be recorded appropriately including in the hazard log for tracking of the issue to closure.

9.8.4 Factory acceptance test (FAT) shall be carried out during this stage which shall also include appropriate review / analysis of the FAT reports related to the safety requirements.

9.9 Phase 8: Installation

9.9.1 Safety activity of this stage is the responsibility of the Contractors and GC. Contractors shall develop method statements for proper installation which in turn shall ensure that no failure / hazard are injected into the System due to inappropriate installation. One single failure shall not affect the system performance substantially.

9.9.2 The training of the operation and maintenance personnel shall be started at this phase. It will be preferable to associate O&M staff during installation for witnessing.

9.10 Phase 9: System Validation:

(Including Safety Acceptance & Commissioning)

9.10.1 System validation is the responsibility of the Contractors and GC. MMRC shall provide appropriate support as per the provision of the contract. Safety requirements along with other functional and performance requirements shall be verified and validated during the following onsite testing programs.

- Sub-system standalone testing
- Interface testing
- System Integration Testing

9.11 Phase 10: System Acceptance

9.11.1 Sub-system, acceptance, including the interfaces between Sub-systems is the responsibility of the Contractors and GC. MMRC may support appropriately as per the provision of the contract. OMC shall take a bigger role in this phase of the project. This phase comprises of trial run during which the System is to be operated as is intended for. Adequacy of the operational arrangements including manuals, procedures and human factors employed in the System is the primary objective of the trial run apart from validating the System for an integrated operation. Inspection, audits and safety demonstrations such as detrainment and passenger evacuation, station fire & passenger evacuation etc. are conducted to assess the mitigation of hazards through operational arrangements.

9.11.2 Safety certification authority i.e. CMRS and other approving agencies such as ISA shall be involved in these stages to provide their approvals for the metro rail operation for passenger service.

9.12 Phase 11: Operation & Maintenance

9.12.1 This phase is the primary responsibility of the OMC and the respective sub-system maintenance contractors. The designed System is supposed to be operated and maintained as per the operational and maintenance manuals and all safety issues observed are reviewed by the safety organization of the OMC for appropriate mitigation.

9.12.2 Safety activities during this stage shall be further detailed out in the "Safety Management System" document to be prepared by the OMC. Among the various other safety activities, continuous risk management and control shall be one of the primary safety activity of this phase. The SMS is to be submitted to ISA and CMRS before commissioning for approval.

9.13 Phase 12: Performance Monitoring

9.13.1 This phase, a sub-phase of the O&M phase, is a primary responsibility of the OMC. Safety performance of the System shall be monitored during this stage. Hazard log shall be appropriate updated for every safety issue observed during operation and maintenance.

9.14 Phase 13: Modification & Retrofit

9.14.1 This is a sub-phase of the operation and maintenance phase and depending on the nature of the modification activity. MMRC and, OMC will be responsible. However, ensuring safety of the modified or retrofitted System shall be the primary responsibility of the OMC.

9.14.2 The safety activities for this stage shall depend on the nature of the modification and the retrofit to be performed. Some of the life cycle phases may be repeated during this phase to ensure that the safety requirements of the original System are intact. The safety management system of the OMC shall detail out more on the safety activities of this stage.

9.15 Phase 14: Decommissioning & Disposal

9.15.1 This stage shall be the responsibility of MMRC and other agencies involved at that time.

9.15.2 A safe dismantling and disposal process shall be followed to ensure safety to the System interfaces and boundaries. It is premature to talk about this stage in detail at this stage. A detailed plan shall be designed including the safety management activities if the need arises.

9.15.3 The Contractor shall provide the necessary supporting material / information / documents pertaining to decommissioning & disposal stage as per EN 50126 which shall include the identification of list of dangerous material or critical material for health including their location of use and volume during design stage.

9.15.4 Experience management is another key element of this phase. The problems experienced, their resolution, lessons learnt etc. should be documented in this phase to be used for future similar projects.

10. SOFTWARE SAFETY MANAGEMENT

10.1 Software failures are mainly systematic failures which can be controlled through a structured process of software development. Hence Sub-systems that involves software to perform safety related functions need special consideration as explained in following clauses.

10.2 Software safety functions within systems and subsystems shall be implemented using the architecture, methods, tools and technique defined in relevant detailed standards such as EN 50128 or IEC 61508. Further the quality principles as mentioned in software quality assurance plan shall be strictly adhered to.

10.3 SIL assessment shall be carried out for the safety related functions as per appropriate standards (EN50129). As per the SIL rating software safety assurance will be managed.

11. SAFETY DELIVERABLES

The safety deliverables at different stages of the Project as explained in previous section is summarized in the below mentioned table.

SN	SAFETY DELIVERABLES	SYSTEM SAFETY LIFE CYCLE PHASE													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Project Safety Plan	-	P	U	U	U	U	U	U	U	U	U	U	U	U

2	System Preliminary Hazard Log	-	P	U	U	U	U	U	U	U	U	U	U	U	U
3	Sub-system Safety Plan	-	-	-	-	-	P	U	U	U	U	-	-	-	-
4	Sub-system Safety Requirements Specification	-	-	-	-	-	P	U	U	U	-	-	-	-	-
5	Sub-system PHA Report	-	-	-	-	-	P	-	-	-	-	-	-	-	-
6	Sub-system IHA Report	-	-	-	-	-	P	U	U	U	U	-	-	-	-
7	Sub-system SSHA Report	-	-	-	-	-	P	U	U	U	U	-	-	-	-
8	Sub-system FMECA Report	-	-	-	-	-	P	U	U	U	U	-	-	-	-
9	Sub-system O&SHA Report	-	-	-	-	-	P	U	U	U	U	-	-	-	-
10	Sub-system Hazard Log	-	-	-	-	-	P	U	U	U	U	-	-	-	-
11	Sub-system SCIL & SCAL	-	-	-	-	-	P	U	U	U	U	-	-	-	-
12	Sub-system SIL Assessment Report	-	-	-	-	-	P	-	-	-	-	-	-	-	-
13	Sub-system Safety Validation Plan	-	-	-	-	-	-	P	U	U	U	-	-	-	-
14	Sub-system Design Safety Study Report	-	-	-	-	-	P	U	U	U	U	-	-	-	-
15	Sub-system Specific Application Safety Case	-	-	-	-	-	P	U	U	U	U	-	-	-	-
16	Master Hazard Log (System)	-	P	U	U	U	U	U	U	U	U	U	U	U	U

17	System Safety Validation Plan	-	-	-	-	-	-	-	P	U	U	-	-	-	-
18	System Specific Application Safety Case (Engineering)	-	-	-	-	-	-	-	-	-	P	-	-	-	-
19	System Specific Application Safety Case (Operation)	-	-	-	-	-	-	-	-	-	P	U	U	U	U

Note:

1. P = Produce, U = Update (if any), "- "= Document not required / document finalized
2. All System Specific documents except item 19, shall be prepared by MMRC
3. Item 19 shall be prepared by OMC
4. All Sub-system specific documents shall be prepared by the respective Contractors.

12. HAZARD IDENTIFICATION, MANAGEMENT & RISK CONTROL

12.1 Hazard Identification & Analysis

Hazard identification and analysis is the process of identifying the potential hazards inherent in a system, the accidents that could result and the accident triggers that could give rise to these accidents. Following hazard identification & analysis activities shall be conducted by the Contractors at various phases as mentioned in subsequent sections. These activities shall be repeated during various phases of the Project.

12.1.1 Preliminary Hazard Analysis (PHA)

PHA shall be conducted by each Contractor to identify the high level generic hazards. PHA shall result into further safety requirements for the Sub-systems and shall aid as an input to the further hazard identification and analysis studies to be conducted in the latter stages of the Project.

12.1.2 System Hazard Analysis (SHA)

SHA shall be performed by the Contractors to identify and assess hazards associated with a system level design. System in SHA shall mean each Sub-system. This may include identifying hazards related to the subsystem failure modes, critical human inputs, and hazards occurring due to functional connection between subsystems.

12.1.3 Sub-system Hazard Analysis (SSHA)

SSHA shall be performed by each Contractor on the subsystems of the Sub-systems to identify and assess hazards associated with a subsystem level design. Sub-system in SSHA shall mean each Component of the Sub-system i.e. Brake system for RS, automatic train control (ATC) for S&TC etc. This may include identifying hazards related to the equipment failure modes, critical human inputs, and hazards occurring due to functional connection between components and equipment included in each subsystem.

12.1.4 **Interface Hazard Analysis (IHA)**

The purpose of the IHA is to identify and assess existing or potential hazards between Sub-systems and their effect on safety. The IHA shall be conducted on the critical interrelationships of each Subsystem to determine the cause and effect of possible independent or dependent failures that could present a hazardous condition. The IHA shall be a combined exercise between the interfacing parties and the mitigation measures shall be agreed by both the interfacing parties.

12.1.5 **Failure Mode Effect and Criticality Analysis (FMECA)**

FMECA shall be used to identify and analyse hazards in addition to failure modes. All hazards thus identified shall be maintained in the common hazard log. The FEMCA template as in Annexure 4 shall be followed while conducting the FMECA.

12.1.6 **Fault Tree Analysis (FTA)**

As a minimum, FTA shall be conducted for critical hazards as far as reasonable practical.

12.1.7 **Operation & Support Hazard Analysis (O&SHA)**

OSHA shall be carried out by each Contractor & OMC including system maintenance contractors to identify and evaluate hazards associated with operation and maintenance personnel and procedures during installation, testing, operations (normal / degraded / abnormal / emergency), and maintenance. The objective of the O&SHA will be to identify and update the SCIL that identifies items essential to continued safe operation of the railway, and require particular maintenance attention; and SCAL, that require particular attention during staff selection, training and certification to ensure the safety of the railway. For further clarity it is to be noted that O&SHA is not only the responsibility of the OMC and maintenance contractors but the Contractors shall also carry out O&SHA to a reasonable level to identify the relevant hazards since O&SHA is be conducted for all interactions between O&M personnel with the system, subsystem and equipment.

12.1.8 **Quantitative Risk Analysis (QRA)**

QRA shall be conducted for each risk as identified during the various hazard identification and analysis activities. The QRA shall implement the risk acceptance criteria and risk matrix as described in this document.

12.1.9 **Hazard Analysis Techniques (HAZOP & FFA)**

Following hazard analysis techniques shall be followed while carrying out the above mentioned hazard analysis.

- **Hazard & Operability Study (HAZOP)**

HAZOP technique is a structured brain storming technique where guidewords are used to identify potential hazards with the participation of multi-disciplinary team including designers, OMC and all concerned stakeholders. For detail on the HAZOP process, IEC 61882: Hazard & Operability (HAZOP) Studies: Application Guide can be referred.

- **Functional Failure Analysis (FFA)**

FFA technique shall be followed for hazard identification and analysis activities. FFA involves identification of the safety related functions for systems, subsystems, components and

interfaces and then an analysis of the failures of these functions with the help of a multi-disciplinary team

12.2 Hazard Management

12.2.1 Sub-system Hazard Management

Contractors shall carry out the hazard identification and analysis activities for their respective Sub-systems at different stages as stated in this document. They shall be maintaining a Sub-system specific hazard log which shall be exchanged with the safety organization of the MMRC. The frequency and means of communication shall be combining determined with the Contractors.

12.2.2 Interface Hazard Management

Interface hazard management shall be the responsibility of the lead contractor as defined in the Sub-system contract document. The responsibility of the lead contractor with respect to IHA shall include the following:

- Initiation of the IHA process with the interfacing Sub-system
- Transfer of the interface hazards to other parties and getting agreement on the transferred hazards.
- Provide information on all interfacing hazards to MMRC for its record and review

MMRC shall support in resolving any conflict if arises related to transfer of interface hazards and the decision of MMRC shall be final on this regards.

12.2.3 System Hazard Management (Master Hazard Log Management)

- MMRC shall maintain a hazard log, to be called as "Master Hazard Log" for the System which shall contain all the hazards of the Project identified by all parties and by all means.
- Master Hazard Log shall provide a summary view of all the open and closed hazards with various Sub-systems and hazard owners.
- Master hazard log shall be maintained up to date with the inputs received from the Contractors and with any System level hazards identified by MMRC.
- On time hazard closure and monitoring of the proper interface hazards transfer by the Contractors shall be the primary focus of the master hazard log management.

12.2.4 Residual Risk Transfer

- Residual risks are those risk which could not be closed during the Project phase even after considering appropriate design measures and/or devising O&M procedures and hence are transferred to O&M phase for monitoring and mitigation.
- The aim of the Project team shall be to minimize the number of residual risks at every stage and by every party of the Project.
- At the end of the Project stage, the residual risks from the master hazard log shall be transferred to the OMC. The OMC shall clearly review each such hazard and the respective mitigation procedural measure to satisfy him before accepting the residual risk.

12.3 Risk Acceptance & Control

12.3.1 Risk control refers to the process of eliminating or minimizing the identified hazards to an agreed acceptance level.

12.3.2 ALARP shall be used as the basis of Project risk acceptance. The purpose of ALARP assessment shall be to provide the evidence to demonstrate the achievement of ALARP for each risk where the initial assessment indicates that the risks are not acceptable.

12.3.3 Unlike in other countries, where risks in the ALARP or tolerable region are accepted through a cost-benefit analysis, in India there are no such regulations in force till now that recommend for a cost-benefit analysis for acceptance of risk. In the absence of a proper regulation, some of the metro rail projects in India has adopted the method of engineering judgement backed up with relevant data as the basis of risk acceptance.

12.3.4 MMRC has decided to follow a similar approach as followed by other Indian metro projects for risk acceptance. Engineering judgement from a multi-disciplinary engineering team that consists of the engineers from Contractors, consultants, reviewers, auditors & assessors and regulatory agencies shall be the basis of risk acceptance rather than a cost benefit analysis for the tolerable re-join of the ALARP. At any stage of the Project execution, if the acceptability of a particular risk is being questioned by any of the entities, MMRC is committed to provide a proper resolution to the same.

12.3.5 All hazards identified are categorised by their frequency of occurrence and severity. The combination of frequency and severity shall determine the risk category. Table 1 to Table 4 is used to categorise the hazards.

12.3.6 The risk matrix should be applied to the Project at both the System and Sub-system level such that frequencies of hazardous events and severities apply to all equipment on the line and effects are assessed at the System level.

12.3.7 The primary objective of the safety risk matrix as in table 4 is to provide appropriate risk acceptance criteria for the System and Sub-system hazard analysis. This matrix is designed such that implementing the same may exceed the achievement of the safety targets as defined in section 5.1 of this DOCUMENT. Hence this matrix shall not be interpreted to arrive at additional safety targets for the System other than those mentioned in section 5.1 of this document.

12.3.8 When a hazard is identified, an estimate on the likely accident frequency of occurrence shall be made based on the frequency guide given in Table 1 and Table 3.

12.3.9 As a matter of principle, risk matrix should be approved by the system certifying authority i.e. CMRS for the Indian metro rail systems. However, following the general trend in metro rail projects in India, CMRS does not get involved himself in the project technical details until the system acceptance and certification phase of the project.

12.3.10 However, the safety risk matrix is in line with EN 50126 and good industry practices. Further, the same shall be reviewed by ISA, who in turn shall verify that the safety matrix as adopted by the Project is in line with the standard and industry good practices.

12.3.11 **Frequency of Hazardous Events**

Table 1: Frequency of hazardous events

CATEGORY	DESCRIPTION	FREQUENCY GUIDE
A	Likely to occur a few times per week	≥ / 100 Year
B	Likely to occur a few times per month	≥ 10 - < 100 / Year
C	Likely to occur a few times per year	≥ 1 - < 10 / Year
D	Likely to occur a few times in 10 years	≥ 10^{-1} - < 1 / Year
E	Likely to occur once since operation	≥ 10^{-2} - < 10^{-1} / Year
F	Unlikely to occur	≥ 10^{-3} - < 10^{-2} / Year
G	Very unlikely to occur	≥ 10^{-4} - < 10^{-3} / Year
H	Remote	≥ 10^{-5} - < 10^{-4} / Year
I	Improbable	≥ 10^{-6} - < 10^{-1} / Year
J	Incredible	< 10^{-6} / Year

12.3.12 **Hazard Severity Category**

Table 2: Hazard Severity Category

Severity Category		**1**	**2**	**3**	**4**	**5**	**6**	**7**
		Disastrous	**Catastrophic**	**Critical**	**Serious**	**Marginal**	**Negligible**	**Trivial**
Employee (staff / Contractor)	**Fatality**	-	≥ 5	< 5	-	-	-	-
	Major Injury	-	-	≥ 5	< 5	-	-	-
	Minor Injury	-	-	-	-	≥ 5	< 5	-
Passenger / Public	**Fatality**	51-500	5-50	< 5	-	-	-	-
	Major Injury	501-5000	51-500	5-50	< 5	-	-	-
	Minor Injury	>5000	501-5000	51-500	5-50	< 5	-	-
Train Service	**System Disruption**	1 Month	1 Week	1 Day	1 Hour	< 20 Mins	-	-
	Line Disruption	Few Months	1 Month	1 week	1 Day	Few Hours	20-60 Mins	-
	Station Disruption	1 Year	Few Months	1 Month	1 week	1 Day	Few Hours	< 20 Mins

Definition of Major injury:

- Fracture of any bone (but not a bone in the hand or foot)
- Amputation of hand or foot, or complete severance of a finger or more
- Penetrating injury or burn to an eye or loss of sight
- Electric shock requiring immediate medical treatment
- Loss of consciousness resulting from lack of oxygen
- Inhalation or ingestion through the skin of any substance leading to acute illness or requirement for medical treatment
- Medical treatment resulting from exposure to pathogen
- Any other injury requiring admittance to hospital for more than 24 hours

Definition of Minor injury:

- Any personal injury which is not a major injury

12.3.13 **Risk Classification**

Table 3: Risk Classification

NOTATION	RISK CATEGORY	DESCRIPTION
R1	Intolerable	Risk Must be Eliminated
R2	Undesirable	Risk must be reduced if it is reasonably practicable to do so and with the agreement of the safety authority / MMRC as appropriate
R3	Tolerable	Risk can be acceptable with adequate control and with the agreement of MMRC
R4	Negligible	Acceptable with agreement of MMRC

12.3.14 **Safety Risk Matrix:**

Frequency of Hazardous Event			Severity Level of Hazard Consequence						
			1	2	3	4	5	6	7
			Disastrous	Catastrophic	Critical	Serious	Marginal	Negligible	Trivial
A	Likely to occur a few times per week	≥ 100 / Year	R1	R1	R1	R1	R1	R1	R3
B	Likely to occur a few times per month	≥ 10 - <100 /Year	R1	R1	R1	R1	R1	R2	R4
C	Likely to occur a few times per year	≥ 1 - <10 /Year	R1	R1	R1	R1	R2	R2	R4
D	Likely to occur a few times in 10 years	≥ 10^{-1} - <1 /Year	R1	R1	R1	R1	R2	R3	R4
E	Likely to occur once since operation	≥ 10^{-2} - <10^{-1} /Year	R1	R1	R1	R2	R3	R4	R4
F	Unlikely to occur	≥ 10^{-3} - <10^{-2} /Year	R1	R1	R2	R3	R3	R4	R4
G	Very unlikely to occur	≥ 10^{-4} - <10^{-3} /Year	R1	R2	R3	R3	R4	R4	R4
H	Remote	≥ 10^{-5} - < 10^{-4} /Year	R2	R3	R3	R4	R4	R4	R4
I	Improbable	≥ 10^{-6} - < 10^{-1} /Year	R3	R3	R4	R4	R4	R4	R4
J	Incredible	< 10^{-6} / Year	R3	R4	R4	R4	R4	R4	R4

Table 4: Risk Matrix

13. DOCUMENTATION & DATA CONTROL

13.1 MMRC uses an established document & data control management system that is implemented through a computerized database management system known as the EDMS i.e. "Electronics Database Management System".

13.2 The "Document Management System Manual", a controlled document from MMRC will be circulated to all stake holders to manage the document and data control process effectively for the Project. The process explained along with the use of EDMS is applicable for all the stakeholders such as the Contractors, Consultants, ISA, IRA and MMRC.

13.3 The document management system manual includes the following aspects of the document and data control process.

- Roles & responsibility of the document control department
- Basic rules of the document management system
- Document handling & storage process

- Types of communication
- Document flow process
- Document approval process
- Document numbering system
- User's guide to EDMS
- Forms & Templates

13.4 The procedure for document and data control outlines the protocol to be observed for updating and revising existing documents as a result of structured reviews.

13.5 The process of document & data control management undergoes regular reviews from the QA team as per the established quality management system and necessary improvements are implemented as appropriate based on the audit outcome.

14. SAFETY COMMUNICATION

14.1 Background

14.1.1 Safety issues are not restricted to the boundary of a particular system or the scope of work of a particular Contract. In a scenario like the current Project, where multiple stakeholders are responsible for their individual scope of work including that of Contractors and Consultants, an effective communication especially for safety related communications is very essential to establish a safe metro rail system. MMRC recognizes the importance of providing personnel with the necessary information to enable them to discharge their safety responsibilities effectively. A lack in the process of safety communication may lead to un-identification of hazards or improper mitigation of hazards and as a result that will ultimately have effect on the safety aspects of the System.

14.2 Scope of communication

14.2.1 As a general principle anything within the scope of the broader System that has a bearing on the safety of the System, irrespective of the fact that whether the matter is in the purview of a particular stakeholder or not, should be communicated following any or all of the methods as described in the document.

14.2.2 Following is an un-exhaustive list of matters that should be communicated.

- New hazards identified with/without risk and mitigation measures
- Interface hazards that are identified by one stake holder & to be mitigated by others
- Safety requirements identified during course of project execution
- Lesson learned related to safety or matter that may have a bearing on safety
- Safety management processes as evolved/updated from time to time during project execution
- Safety precautions and warnings during project execution

- Accidents during project execution stage due to due to lack of improper functional/engineering safety arrangements

14.3 Communication within Organization:

14.3.1 "Communication within organization" shall mean the safety related communications within the organization of a particular Contractor such as Rolling Stock or within the internal organization of MMRC or within the internal organization of GC and so on.

14.3.2 Both formal as well as informal communication should be encouraged by the management of the organization, however, following any informal communication, a formal documentation and formal communication of the outcome should be communicated with the appropriate stakeholders.

14.3.3 The means of communications shall include the followings.

- Face to face meetings during different formal as well as informal quorums
- Internal training sessions
- Safety shall be included as a primary agenda for all technical reviews and management briefings etc.
- Employees should be encouraged to share their safety experiences through electronic media such as emails.
- Official notice boards dedicated to safety (may be combined with HSE) shall be implemented and management as well as employees should be encouraged to use these boards to share safety related communications.

14.4 Communication External to Organization:

14.4.1 All communication between organizations shall be formal communication with appropriate reference numbers as per the general communication strategy implemented for the Project.

14.4.2 Communication related to safety interface shall be the responsibility of the lead Contractor and the lead Contractor shall be responsible for non-communication or delayed communication of safety related matters such as identification & transfer of interface hazards to appropriate contractors. The Employer will assist in conflict management, if required, for such cases.

14.4.3 The concerned lead Stakeholder/ organisation or The Employer shall identify an authority / point of contact to communicate & take control (when there are many organisations or stake holders are in operation) with level & priority during the emergency/ safety critical incidence to regulate and ensure unified command to mitigate the criticality.

14.5 Resolution of Safety Concerns (Employer's Organization)

14.5.1 MMRC recognizes the fact that "conflict-in-opinion" among various stake holders is an inherent entity in any project management and if not managed properly, the safety of the System may be at risk. Hence the following escalation procedure shall be implemented to give proper justice to every safety concern raised at any level of the Project organization. The identified Authority for safety shall propagate and resolve such concerns.

14.5.2 The escalation / safety review process for safety concerned raised shall be as per Figure: 5.

14.5.3 All issues shall be logged to hazard log whether relevant or non-relevant.

14.5.4 Safety expert shall be the nodal agency for the escalation/review process and the Head-System s (MMRC) shall be ultimate approving authority for safety related concerns raised in consultation with the Safety Expert.

14.5.5 A similar process shall be proposed by the Contractor based on the Contractor's organizational arrangement for Employer's approval.

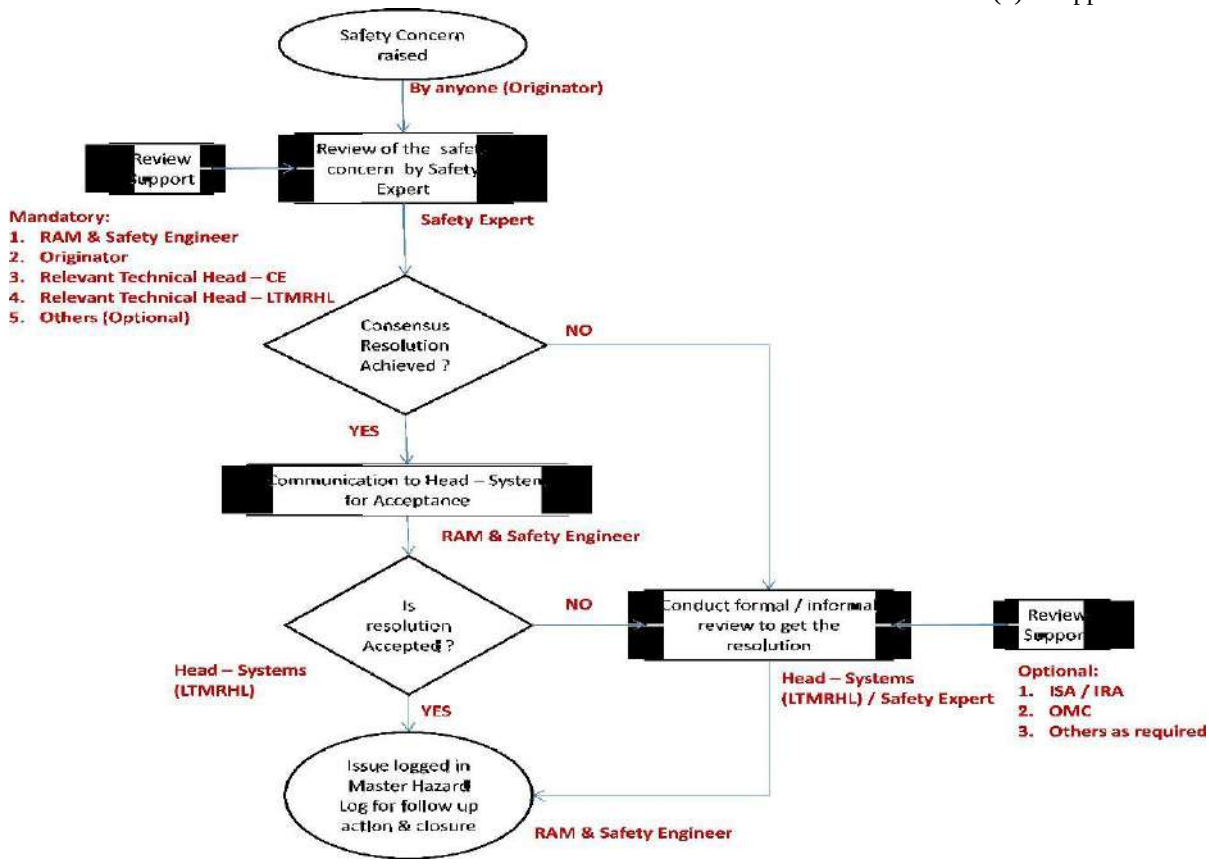


Figure 14.1 – Resolution of Safety Concerns

15. SUB-CONTRACTORS SAFETY MANAGEMENT

15.1 The Contractor shall devise an appropriate Sub-contractor safety management plan in line with this document to ensure the quality and safety deliverable from the work performed by its Sub-contractors. The Sub-contractor safety management shall be a part of the Sub-system safety plan.

15.2 Appropriate safety requirements that are specified in this document for the Sub-system shall also be applicable to the Sub-contractors.

15.3 The Sub-contractor selection shall be made considering the safety principle of "proven system".

15.4 The Contractor shall conduct regular audits and assessment of the sub-Contractor to monitor the safety performance of the supplies.

16. SAFETY AUDITS & ASSESSMENTS

The Contractors shall conduct internal safety management audits to verify that the system safety activities of the Sub-systems are planned and carried out according to the requirements in the respective Sub-system safety Plan.

MMRC and GC shall conduct safety management audits on the Contractors and Sub-contractors scope of work. The Contractor shall provide all necessary supports for the same.

16.1 The safety audit by GC on each Contractors and Sub-contractors will be carried out on a regular interval of 3 months, which is a tentative interval subjected to change from time to time based

on progress of the project. Contractors shall recommend a detailed audit schedule for the review and approval of MMRC.

16.2 Safety audits shall be conducted throughout the Project lifecycle by the Contractors and at least once during each Project phase or in accordance with the quality management requirements.

16.3 All audit reports shall be submitted to GC/MMRC according to the quality management requirements.

16.4 Safety management and system assurance audits can be combined into one audit report. The results of the audit and the adopted corrective actions shall be reported in the safety case.

16.5 The Contractor shall provide necessary supports to GC/ MMRC and its auditors and assessors for conducting audits and assessments at various phases of the Project life cycle.

16.6 A similar auditing process shall be established by the Contractors to audit the safety activities performed by the Sub-contractors.

17. SAFETY ACCEPTANCE CRITERIA

17.1 Sub-system Safety Acceptance Criteria

Following points shall be strictly complied by the Contractors in order to get a safety acceptance of their relevant Sub-systems from MMRCL.

17.1.1 The Contractor shall carry out all safety related activities as mentioned in this document, relevant standards and their individual approved Sub-system safety plan and submits appropriate documents as evidence of these activities to MMRCL on a timely manner for successful implementation of the safety.

17.1.2 Safety shall be integrated into the Sub-system design & development process. Failure to complete safety activities on time shall be considered as non-compliance to the document.

17.1.3 The Contractor shall present a compliance matrix that shall trace the design to the contract documents, to demonstrate that all qualitative and quantitative safety requirements are considered while designing the Sub-system.

17.1.4 The Contractor shall eliminate or minimize all hazards to ALARP following the risk acceptance criteria as mentioned in this document.

17.1.5 The Contractor shall get their Sub-systems approved from the relevant external agencies such as RDSO, EIG, Fire Department, ISA, IRA, CMRS etc. as per the provisions of General Specification.

17.1.6 Safety demonstration shall be carried out by the Contractors following relevant standards and as per this DOCUMENT.

17.2 System Safety Acceptance Criteria

17.2.1 Safety acceptance of all Sub-systems is a pre-condition for System safety acceptance.

17.2.2 MMRC shall eliminate or minimize all hazards as mentioned in the Project hazard log, which also contains the operational hazards, to ALARP following the risk acceptance criteria as mentioned in this document.

17.2.3 All safety requirements as mentioned in SAR shall be complied by MMRC for System safety acceptance.

18. SYSTEM SAFETY APPROVAL & CERTIFICATION

18.1 Background

18.1.1 Mumbai Metro Line 3 shall be build & operate to comply with the following two Acts.

- Metro Railways (Construction of Work) Act – 1978
- Metro Railways (Operation & Maintenance) Act – 2009

18.1.2 The Metro Railway O&M Act empowers the CMRS to audit the new (also modification to existing metro railways) metro rail projects in India for safety of passengers, public and staff and thus sanctions his approval for opening the metro railway for revenue service. Metro Act has identified Ministry of Railways (MoR) for safety planning & technical approvals.

18.1.3 The Metro Railway O&M Act (section V) specifies the role of CMRS. "Opening of Metro railways for carriage of Passenger Rules" have been issued by Central Government.

18.1.4 Various external agencies are involved during different phases of the Project execution to ensure the safety of the System. Annexure 1 shows the chart of agencies and their involvement.

18.2 Safety Approval Process

18.2.1 The Contractors shall be responsible for getting the relevant approvals for their individual Sub-systems from the applicable external agencies. MMRC will support the Contractors in getting these certificates if requested by Contractors.

18.2.2 Specific System Safety Case (engineering & operational) for the System shall be prepared by GC/ MMRC which shall contain claims, arguments and evidence of safety implementation throughout the Project phases. The plan for preparing safety case is presented in the following sections.

18.2.3 With all the safety audits and assessment reports, completion certificate, provisional certificate, engineering safety case, operational safety case along with a pre-determined set of Project documents, MMRC shall approach CMRS for getting the System approved for passenger service. This will take place during the initial phase of the trial running when all the safety related mock drills and operational exigencies are successfully demonstrated to be under controlled by MMRC operation organization.

18.2.4 After a reasonable time, frame for CMRS and his technical staff's review of the submitted documents, CMRS along with his technical staffs, shall conduct onsite audit & assessment of the System and operational arrangements including O&M arrangements as detailed in SMS.

18.2.5 Based on the scrutiny of documents and inspection CMRS will issue an inspection report and recommend opening of new line to the Central Government. The government after examining will issue sanction for commencing operation.

19. SYSTEM SAFETY CASE PLAN

19.1 Background

19.1.1 Safety case is a compelling logical argument with supporting evidence to demonstrate that the as-used system, in an operating environment and given role, is acceptably safe. Safety case shall demonstrate the implementation of the different system level plans, through a set of justified logical arguments backed up by documental evidences.

19.1.2 There are primarily two ways to demonstrate that the system is safe.

- Safety through Prescription
- Safety through Logical Arguments

19.1.3 The "prescriptive approach" is based on compliance conformance to (i) detailed regulations (ii) standards and (iii) acceptable codes of practice where as the "Safety through logical argument" is a top down "go al oriented approach" where the primary goal is system safety and is demonstrated through a set of logical arguments that provides "why the system is safe".

19.1.4 Both the methods have their own advantages and disadvantages. The Project has decided to benefit from both the methods and hence the development of the safety case shall be based on the arguments from both these approaches.

19.2 Principles of Safety Case Development

19.2.1 The primary principle of System safety case development shall be the "principles of logical arguments" as described above.

19.2.2 However, the principle of "prescriptive approach" shall also be used where ever appropriate backed up with a logical argument.

19.2.3 The System is a product (or collection of products) developed & operated by People using a standard set of Process. Hence product, process & people are the three key constituents of the system. Hence the safety case shall involve product assurance, people assurance and process assurance aspects of the system assurance.

19.2.4 Product Assurance: This shall address the adequacy of the system requirements & shall provide the required level of confidence, arguments and supporting evidence that:

- Necessary & sufficient set of requirements has been determined for the system
- The system requirements have been (and eventually will be) fully satisfied.
- All requirements introduced at each level of the design, can be traced to implementation in the Sub-system/ Component and that the functions which are not traceable to the higher level requirements cannot degrade the performance or integrity of the system.

19.2.5 Process Assurance: This shall address the adequacy of the system processes & shall provide the required level of confidence, arguments and supporting evidence that:

- The planed processes as stipulated in various system & Sub-system level plans are implemented for the development of the integrated metro rail system.

19.2.6 People Assurance: This shall provide the required level of confidence, arguments and supporting evidence that:

- A process in whatever forms it is established to identify appropriate and un-ambiguous requirements for acceptable technical competency for all identified roles within the Project team.

19.2.7 All staffs are reviewed against their job description and corrective actions are recorded and monitored where required level of competency is not achieved, with the view to achieve those required level of competency.

19.3 Arguments & Evidences

19.3.1 For the purpose of development of the safety case, a coherent and convincing set of arguments supported by adequate evidence shall be collected throughout the Project life cycle.

19.3.2 These evidences shall be collected by every member of the Project team including MMRC, Contractors, Sub-contractors and external auditors who is responsible for the activity whose safety is being questioned.

19.3.3 An argument in a safety case is a justification that the safety or any other assurance claim made is true or false. It includes context, criteria, assumptions and evidences. Arguments should be clear, consistent, well-reasoned, and complete. Evidence is information that demonstrably justifies the arguments.

19.3.4 To be adequate, the evidence must be sufficient for its use in the safety case arguments, including both its quality and its provenance. The stated context and criteria apply to each piece of evidence. Where inputs, states, or condition can vary, evidence must cover all possibilities or have a sufficient sample to justify the argument. Evidence must be verifiable and auditable.

The following are some of the sample evidences that can be used to demonstrate that the argument made for the safety claim is true.

- Certification of trusted agencies
- Static analysis tool results for design and code
- Conformance to coding standards for software
- Mathematical proofs and results of proof-checkers
- Assurance testing reports
- Modelling and simulation results
- QA audit & assessment results
- Certification of compliance against various specifications from recognized agencies
- Independent evaluation results from recognized agencies
- Personnel clearances (of developers, operational administrators, and users)
- Proof of personnel training/education on developing assured systems
- Proof of personnel training/education for operational administrators/users on how to operate securely and respond to incidents
- Verification/test results showing that the target environment's defences are adequate to protect the system being developed
- Test results demonstrating the adequacy of countermeasures

- Model Integration (CMMI) level, large-scale or in-depth review/evaluation/peer review reports
- Field history
- Minutes of meeting, attendance sheet for brain storming sessions etc. can also be used as evidences provided they are duly signed by the appropriate attendees and these are being circulated using established communication systems that can provide a trail of date history.

19.3.5 Evidence can be used regardless of whether an element is custom-developed, or is a Commercial-of-the-shelf (COTS) element, though the specific kinds of evidence available will vary. Evidence is collected throughout the life cycle and verified at each review.

19.3.6 MMRC or any other related representatives including the GC, ISA, IRA, CMRS reserves the right to question the integrity of the evidence in which case additional evidences may be necessary.

19.4 Safety Case Development Methodology

19.4.1 EN 50126: Part 2 recommends the use of three levels of safety case namely (i) generic product safety case (ii) generic application safety case & (iii) specific application safety case. While the Project shall consider generic product safety case & generic application safety case for selection of safe product and safe Sub-systems / Components, but the ultimate safety of the system / sub-system shall be demonstrated through the production of a "Specific Application Safety Case".

19.4.2 Each Contractor shall provide their safety case specific to the Project which shall be known as the "Sub-system Engineering Safety Case". The safety case shall include the entire scope of work performed by the Contractors and shall be as per the structure provided in this DOCUMENT.

19.4.3 MMRC shall produce two System level safety cases namely:

- Engineering Safety Case (ESC) that shall consolidate the scope of work of all System Contractors. This safety case shall be prepared by GC in line with the structure as mentioned in this DOCUMENT.
- Operational Safety Case (OSC), which shall describe and demonstrate the arrangements made by the OMC to manage metro rail infrastructures and operate trains or stations. The OSC shall be prepared by the OMC.

19.4.4 The internal & external Project teams at their respective level such as Sub-contractor, Contractor, MMRC, ISA, IRA, GC etc. shall be accountable to provide appropriate evidences for building the safety case.

19.5 Structure of Safety Case

19.5.1 The ESC and OSC for the System and Sub-system shall be developed following the structure and guidelines as described in EN 50129 and EN 50126- Part 2. Though, EN 50129 is applicable for Signaling & communication systems, MMRC and all its Contractors shall use the same structure for development of safety case. Appropriate guidance can also be considered from other guiding standards and references such as International Engineering Safety Management.

20. ANNEXURE 1: Safety Assurance Process in MMRL3

S.N.	Basic Guidance	Agency	Deliverable	Safety Certification
1	Relevant Acts, legislation, rules, local byelaws etc.	Statutory Agencies such as Police, fire Dept., Mumbai Municipal corporation, Electrical Inspector of Government, Department of Telecommunication	Approvals	CMRS scrutinises the various approvals by statutory agencies, Technical Approval by Ministry of Railways, documents submitted by Metro Rail Administration, Inspects thoroughly and issues safety certificate.
2	EN50126, EN50128, EN50129, International safety engineering Management.	Independent Safety Assessor	Internal safety Certificate for RST and S&TC	

3	EN50126, EN50128, EN50129, International safety engineering Management. Experience, expertise, Contract documents, National and international codes and best practices.	General Consultant	(1) Internal safety Certificate for Track, OETS, PSS, Communications (2) Submits documents as per Rules of Opening, Metro Act to CMRS through Metro Rail Administration	
4	Documents submitted by all the agencies	Metro railway Administration-(MD MMRC)	Corresponds with CMRS and submits all the documents and approvals to CMRS	
5	**"**Procedure for Safety Certification and technical Approval of Metro-Rail" December 2015 issued by RDSO, Codes, Manuals etc**.**	Ministry of Railways, RDSO approves SOD, DBR, and conducts Oscillation Trials	Technical approval, Speed Certificate after oscillation Trials, and Final Approval to commence revenue operations	

21. ANNEXURE 2: HAZARD INITIATION FORM

<table>
<tr><th colspan="4">HAZARD INITIATION FORM</th></tr>
<tr><td>NAME:</td><td></td><td>DATE:</td><td>Ref No:</td></tr>
<tr><td rowspan="6">HAZARD DETAILS</td><td colspan="3">Sub-system / Component / Activity:</td></tr>
<tr><td colspan="3">Hazard Description:</td></tr>
<tr><td colspan="3">Hazard Cause:</td></tr>
<tr><td colspan="3">Potential Accident:</td></tr>
<tr><td>Likelihood:</td><td>Consequence:</td><td>Risk:</td></tr>
<tr><td colspan="3">Hazard Owners: (To be assigned by Safety Organization)</td></tr>
<tr><td rowspan="3">HAZARD MITIGATION</td><td colspan="3">Response:</td></tr>
<tr><td colspan="3">Document / Drawing Reference:</td></tr>
<tr><td>Likelihood:</td><td>Consequence:</td><td>Risk:</td></tr>
</table>

22. ANNEXURE 3: HAZARD LOG TEMPLATE

HAZARD INFORMATION								EXPOSED GROUP					EXISTING RISK CONTROL						
Sl. No	Hazard ID	Hazard Source Reference	Sub-system / Broad Activity Broad Category	Component / Specific Activity	Hazard Description	Potential Cause	Potential Accident	Passenger	Public	Staff	Contractor	Environment	Causal Control	Owner	Evidence of Existing Causal Risk Control	Consequence Control	Owner	Evidence of Existing Consequence Risk Control	
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			

INITIAL RISK			ADDITIONAL RISK CONTROL						RESIDUAL RISK					
Frequency	Severity	Risk Index	Additional Design Controls	Owner	Evidence of Additional Risk Control through design	Operational & Maintenance Control	Owner	Evidence of Additional Risk Control through Operation & Maintenance	Frequency	Severity	Risk Index	HAZARD STATUS	REMARKS	CHANGE CONTROL (DATE)

23. ANNEXURE 4: FMECA TEMPLATE

FAILURE INFORMATION								Failure Detection			Failure Effects				EXISTING RISK CONTROL				
Sl. No	FMECA ID	System / Sub-system	Item Name / Functional identification	Operating Mode	Function	Failure Mode	Failure Cause	Detectable means to Operator	Detectable means to Maintainer	Built-in Test Function	Sub-system (Local)	Transit System	Safety	Reference Hazard ID	Failure Rate	Data Source	Chargeable Failure	Service Disruption Time	Existing Design Safeguard
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			

INITIAL RISK			ADDITIONAL RISK CONTROL						RESIDUAL RISK			Immediate Action During Traffic Hours	Follow up Action During Non-Traffic Hours	STATUS	REMARKS	CHANGE CONTROL (DATE)
Frequency	Severity	Risk Index	Additional Design Controls	Owner	Evidence of Additional Risk Control through design	Operational & Maintenance Control	Owner	Evidence of Additional Risk Control through Operation & Maintenance	Frequency	Severity	Risk Index					

Note: Refer risk matrix table for determination of initial & residual risk.

Mumbai Metro Rail Line 3
BIDDING DOCUMENTS

EMPLOYER'S REQUIREMENTS
GENERAL SPECIFICATIONS

Part 2

Section VI (1)
Sub-Division F

Appendix 25

SUPPLY OF TOOLS, EQUIPMENTS AND SPARES

July 2019

1. Tools and Spares

1.1 General

1.1.1 The Contractor is required to supply tools and spares necessary to operate and maintain the system efficiently after the commissioning. This specification specifies a minimum list of tools and spares to be supplied by the Contractor. These tools and spares shall be handed over before the commissioning of the system to enable the Employer to maintain the system as per schedule 1& 2 of Part 1 Section IV-B Pricing Documents.

1.1.2 This list has been developed on the basis of past experiences. However, the list is not exhaustive. On the basis of manufacturer recommendations and past experience, the bidder may specify additional tools and spares required for proper handling, operating and maintaining the system for five years.

1.1.3 The Contractor should ensure that the Tools and Equipment supplied by him are compatible with the equipments to be supplied under this Contract.

1.1.4 The Contractor shall provide an exhaustive list of spares required to be maintained during 'Defect Liability Period' ('Defect Liability Spares').This list should be provided sufficiently in advance to the Engineer and ensure physical availability of these spares at least one month prior to the Date of Revenue Operation of respective sections.

1.2 Equipments, Tools and Spares

1.2.1 General

1.2.1.1 The Track work Contractor shall supply, deliver and hand over to the Employer specialized brand new machines, tools and equipment as stated below:

1.2.1.2 The Contractor shall propose detailed specifications of the above machines, tools and spares for approval by the Engineer. Wherever Indian Railways / RDSO specifications are available for above item, these shall be preferably followed, as applicable / customized for standard gauge.

1.3 List of Equipments and Tools

Nil

1.4 List of Spares

Sr. No.	Description	Unit	Quantity
1	**Procurement of Turnout set**		
1.1	1:7 Turnout R190 - (1 set consist of 2 nos thick web switches HH, Stock rail with sliding chairs, 1no weldable CMS crossing with check rail set for ballastless track and Turnout fastening complete from Toe of switch to Back of crossing for ballastless track)	Sets	4
1.2	1:9 Turnout -R300 - (1 set consist of 2nos thick web switches HH, Stock rail with sliding chairs baseplate complete, 1no	Sets	3

	weldable CMS crossing with check rail set for ballastless track and Turnout fastening complete from Toe of switch to Back of crossing for ballastless track)		
1.3	1:9 Turnout -R300 - (1 set consist of 2nos thick web switches HH, Stock rail with sliding chairs baseplate complete, 1 no weldable CMS crossing with check rail set for Mono block PSC sleepers and Turnout fastenings complete from Toe of switch to Back of crossing for ballasted track)	Sets	2
1.4	1:7 Turnout R190 - (1 set consist of 2nos thick web switches HH, Stock rail sliding chairs baseplate complete, 1 no weldable CMS crossing with check rail sets for Mono block PSC sleepers and Turnout fastenings complete from Toe of switch to Back of crossing for ballasted track)	Sets	6
2	**Procurement Diamond- Xing**		
2.1	Diamond Xing HH of 1 in 5.5, Cuffe Parade with Fastening System including check rail set for ballastless track **(Note**: **This 1 set of Diamond crossing are required to be supplied at the store depot of Contractor 10B at Mumbai)**	Set	1
2.2	Diamond Xing HH of 1 in 7 at CST and Acharya Atre and Sahar Road with Fastening System including check rail set for ballastless track **(Note**: **Two sets of Diamond crossing are required to be supplied at the store depot of Contractor 10B at Mumbai)**	Sets	3
3	**Procurement of Buffer Stop**		
3.1	Friction Buffer Stop 25 KMPH	Sets	2
3.2	Procurement of Friction Buffer Stop 10 KMPH	Sets	2
3.3	Procurement of Friction Buffer Stop 5 KMPH (Including Depot)	Sets	4
3.4	Procurement of Retractable Buffer Stop 5 KMPH	Sets	2
4	**Procurement of PSC Sleepers**		
4.1	PSC Sleepers of Turnout of ballasted track system for 1in7 R190	Sets	2
4.2	PSC Sleepers of Turnout of ballasted track system for 1in9 R300	Set	1
4.3	PSC Sleepers of Diamond crossing according to the depot track system for 1in7 R190 for ballasted track	Set	1
5	Rail fasteners system for ballasted track. 1 set of Rail fasteners consists of for one-rail seat, 2-Metal liners, 2-ERC Mark 3, 1-Grooved Rubber sole plate 10mm.	Sets	6000
6	Procurement of PSC Sleepers including Inserts for rail seats only as per design as per design.	Nos	300
7	Booted Twin block sleepers with resilient pad for mainline	Nos.	200
8	Booted Twin block sleepers with Resilient pad for turnouts complete 1 in 9 R300 including CMS crossing.	Sets	1

9	Booted Twin block sleepers with Resilient pad for turnouts complete 1 in 7 R190 including CMS crossing	Sets	1
10	Booted Twin block sleepers with Resilient pad for diamond crossing complete 1in 7 R190 including crossing.	Sets	1

MUMBAI METRO LINE 3 (COLABA-BANDRA-SEEPZ)

CONTRACT MM3-CBS-TWK-03 (Package 10C)

Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of Ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and Ballasted Track in the area of at-grade Aarey Station and in the Depot area of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ).

and

Procurement and Supply of Turnouts, Scissor Crossovers and Buffer Stops for the entire Mainline for Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ) including Package 10 B.

TENDER DOCUMENTS
Part 2

Section VI (2)

EMPLOYER'S REQUIREMENT
OUTLINE DESIGN SPECIFICATIONS

July 2019

Mumbai Metro Rail Corporation Ltd
Line 3 Transit Office, Wing 'A' North Side of City Park 'E'- Block,
Bandra-Kurla Complex,
Bandra (East) Mumbai 400 051, India

TENDER DOCUMENTS
Composition of Documents

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	Section I.	Instructions to Bidders(ITB)
	Section II.	Bid Data Sheet(BDS)
	Section III.	Evaluation and Qualification Criteria
	Section IV- A.	Bidding Forms
	Section IV- B.	Pricing Document
	Section V.	Eligible Source Countries of Japanese ODA Loan
Part2	**Employer's Requirements**	
	Section VI.(1)	General Specifications A. General B. Functional C. Design D. Construction E. Inspection Testing and commissioning F. Appendices
	Section VI (2)	Outline Design Specifications
	Section VI (3).	Outline Construction Specifications
	Section VI (4)	Tender Drawings
Part 3	**Conditions of Contract and Contract Forms**	
	Section VII	General Conditions of Contract (GCC)
	Section VIII	Particular Conditions of Contract (PCC)
	Section IX.	Annex to the Particular Conditions - Contract Forms
Part 4	**Reference Documents**	
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EMPLOYER'S REQUIREMENTS

OUTLINE DESIGN SPECIFICATION

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List of Appendixes:

Appendix No.	Description
1	Alignment Design Criteria

1.0 INTRODUCTION & PURPOSE OF THE DOCUMENT

The purpose of the document is to describe the Trackwork design criteria and rules, the applicable standards and documents in order to carry out the Trackwork designs of the Mumbai Metro Line 3 in compliance with relevant design standards and requirements.

Design Report will be referred as the baseline of Trackwork Detailed Design within the Request for Proposal (RFP).

List of Abbreviations

CWR	Continuous Welded Rail	CMS Crossing	Cast Manganese steel Crossing
LWR	Long Welded Rail	PSC	Pre-stressed Concrete Sleeper
GMT	Gross Million Ton	RDSO	Research Design Standard Organization
MMRC	Mumbai Metro Rail Corporation	SOD	Schedule of Dimension
MOR	Ministry Of Railways	CRS	Commissioner Railway Safety
MOUD	Ministry Of Urban Development		
RCC	Reinforced Cement Concrete		

1.1 Definitions

Ballast	Crushed rock material placed below and around the sleepers on Ballasted Track.
Ballasted Track	Track elements comprising of running rails, sleepers, and rail-fastening. Assemblies, insulators, base plates, concrete sleepers, ballast, and sub- ballast. Also, Track consisting of rails fastened to concrete sleepers that are supported by ballast on a concrete slab or on a layer of sub-ballast that is resting on a Track-bed of compacted sub-grade, may occur at- grade, on a raised or retained embankment, in an open or retained cut, on a deck bridge, or in an underground section, cut and cover or tunnel.
Ballastless Track	Track elements comprising of running rails, rail-fastening assemblies, insulators, rail pads, eventually baseplate, eventually resilient pads, attached to a concrete support laid down on a further concrete support (for example viaduct deck, 1st pouring concrete or a underground invert).
Bonded Joint	A rail joint that uses high-strength adhesives in addition to bolts to join two rail lengths together. The joint may be insulated or non-insulated.
Cant	The design vertical distance that the outside rail of a curve is set higher level than the inner rail on a curve. (Also called super-elevation).
Cross Level	The vertical relationship of the top of one running rail to that of the opposite running rail at any point in the Track.
Crossover	Two turnouts connecting one Track to another. Crossovers may be facing or trailing.
Crossover - Single	Consists of two turnouts positioned in two Tracks that allow the vehicle to go from one Track to another. Two turnouts connecting one Track to another. Crossovers may be facing or trailing and the turnouts are usually identical.
Crossover - Double (scissors)	Consists of two crossovers of opposite hand orientation crossing upon each other. In addition to the four turnouts involved, a Track crossing (diamond) is needed between the two crossovers. A double crossover is used only when it is necessary to be able to switch from one Track to another in either direction and there is insufficient space to install two independent single crossover of opposite hand orientation.

LWR	Long Welded Rail (LWR) is a welded rail, the central part of which does not undergo any longitudinal movement due to temperature variations.
CWR	Continuous Welded Rail (CWR) is a LWR which would continue through station yards including points and crossings.
Direct Fixation Track	When the continuous welded rails (CWR) of the Track system is fastened to reinforced concrete plinths or slab with specially designed clips, pads, and anchors, etc. is called Direct Fixation Track.
Electrical Isolation	The electrical resistance required between the running rail and the ground to prevent harmful levels of stray current especially from the dc traction power circuit.
Friction Buffer	An energy-dissipating device consisting of a steel frame, a cushioned head to engage the vehicle-end sill and friction shoes attached to the Rail head.
Low Vibration Track (LVT)	Special Track arrangement to dampen the vibration and/or reduce the noise is termed as LVT Track construction/system. It's also commonly used intending a particular Track system with bi-blocks sleepers booted on a resilient layer and embedded in a concrete slab.
Shop or Pit Track	Special Track where the rails are embedded in the concrete floor of a shop or supported on columns in a service or inspection pit.
Sub-ballast	An aggregate material that is placed and compacted between the ballast and sub-grade to prevent migration of ballast in to the sub-grade and to prevent the migration of sub-grade into the Track ballast.
Turnout	Switching-and-crossing mechanism that allows rolling stock to divert from one Track to another. Turnouts may be facing (diverting from the line in the direction of normal running) or trailing (converging to the line in the direction of normal running).

1.2 Type of Track Structure (Permanent Way)

1.2.1 Following types of Track structures are envisaged for the Project:

- Ballastless Track to be adopted for Tunnels and at Ramp in Box Tunnel for main line
- Special Ballastless Track, for washing lines in Depot.
- Special Ballastless Track for inspection lines in Depot - this can be on concrete or steel columns, depending of the needed width of the inspection pit.
- Embedded Track for workshops in the Depot.
- Ballasted Track for At-Grade sections for main line and Depot
- Transition Slab from Ballastless Track to Ballasted Track at ramp and Aarey Station
-

1.2.2 The Permanent Way system covers the following components:

- Rails including rail connections.
- Rail to sleeper / rail fastening system including base plates, rail pads, rail clips, bolts, insulators etc.
- Non-Ballasted Track systems (Ballastless Track).
- Sleepers including Ballast in Depot. For ballasted Track.
- Special connections including turnouts with Thick Web Switches for Ballastless and Ballasted Track, Crossovers, Switch Expansion Joints, Buffer Stops and insulated rail joints.
- Derailment guards.
- Permanent Track signage.

2.0 OVERALL DESIGN APPROACH

2.1 General

2.1.1 Track shall be laid to standard gauge of 1435mm, the Track gauge being the distance between the inner sides of the head of both rails measured 14mm below top of rails according to 60E 1 rail profile, to be confirmed by wheel/rail interface study done by Rolling Stock manufacturer. Gauge widening on curves shall be done as per the design and performance requirements in tandem with Rolling Stock designs.

2.1.2 To the extent possible, uniformity of design standards shall be maintained throughout the Rail System.

2.1.3 The Track structure designed for the Project shall:

- Ensure highest levels of safety, reliability and comfort.
- Have noise and vibration emitted by train passing well within the limits laid down in "Guidelines for Noise and Vibrations" from RDSO .
- Require minimum or no maintenance and be of proven design.
- Ensure surface and sub-surface drainage.
- Ensure low resistance traction current return path.
- Integrate with other systems.

2.2 Design Approach

2.2.1 The design shall be developed as per the prevailing environmental conditions at Project Site i.e. in Mumbai. The environmental data are as under:

a) Average Climatic Condition Data

As per India Meteorological Department (Period 1961–2010, record high and low temp shown in figure).

- Maximum Air Temperature42.2 degree centigrade
- Minimum Air Temperature7.4 degree centigrade

[Max and Min Air Temperature: refer to the Indian Meteorological Department]

b) Average Rainfall Data

The highest rain fall ever recorded in Mumbai was 944mm in 24 Hours on 26th July 2005. Peak Intensity of rainfall in Mumbai is 120mm/h

[Highest rain fall ever recorded in Mumbai: refer to the Indian Meteorological Department Rain fall data on 26th July 2005]

Table: No. 1

Climate data for Mumbai

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high °C	37.1	39.6	41.7	42.2	41	37.1	34.8	33.5	36.4	37.9	37.4	39.8	42.2
Average high °C	30.7	31.2	32.5	33	33.3	32.1	30	29.6	30.4	33.2	33.5	32	31.8
Average low °C	16.8	17.8	21	23.9	26.3	26	24.9	24.7	24.3	23.4	20.9	18.6	22.4
Record low °C	7.4	8.5	13.8	16.9	20.2	19.8	21.2	19.4	20.7	16.7	13.3	10.6	7.4
Average rainfall mm	0.6	1.3	0.2	0.7	12.5	523	799.7	529.7	312.3	55.8	16.8	5.3	2,258
Average rainy days	0.1	0.1	0	0.1	0.7	14.5	23.2	21.4	14.4	3	1	0.4	78.9
Average relative humidity(%)	69	67	69	71	70	80	86	86	83	78	71	69	75
	269.5	257.6	274.3	283.7	296.2	149	73.4	75.9	165.1	240.2	245.8	253.2	2,583.50

c) As per Criteria for Earthquake Resistant Design of Structures IS: 1893 (Part 1)-2002 Mumbai Falls under Seismic Zone III with Zone Factor (Z) 0.16.
As per Richter Scale Mumbai Earthquake intensity is ranges between 5 and 6.9 magnitude.
The above data shall be considered for preliminary designs for at grade Track and will be reviewed and revised (based on the records), if required for detailed design.

d) For underground sections the average temperature expected is 27º C with less fluctuations.

e) Ground water level as per Central Ground Water Board (CGWB) ranges between 2.0 to 5.0 m below ground level in Mumbai Region.

2.2.2 The proposed design shall conform to the applicable codes, standards and specifications as detailed in the Design Basis Report.

2.2.3 The proposed design shall be based on proven Track technology and such Track work components selected, shall have been in service in other comparable transit systems. This shall not preclude the use of improved Track technology where this may be regarded as a single incremental advance from a proven base, and shall be applied as appropriate to improve quality and reduce maintenance expenses.

2.2.4 Track shall be laid to high quality of line, level and surface meeting requirements and Good Industry Practice, for similar system and operating speeds.

2.2.5 Track spacing or distance between Track centres shall consider the vehicle Kinematic envelope, Structure Guage, and extra Clearance on curves .The clearance envelope should be developed in relation to the theoretical centre line of Track at top of rail ,as detailed in SOD Appendix 18 of Section VI (1) F.

2.2.6 The Track system and its components shall be compatible with the Rolling Stock proposed for the Project and the operational loads. Track shall be designed to conform to the appropriate

load of 17 T; axle loads of Rolling Stock and extra for dynamic effects for design speed of 95 km/h (acceleration and braking force) and shall enable a level of passenger comfort as per international standards to be achieved throughout the service life of the System.

2.2.7 The Track system shall be so designed as to provide a continuous electrical contact between the train and traction power supply (25 kV OHE system).

2.2.8 The proposed Track structure shall maintain stability, line and level under all conditions of applied load and temperature stresses.

2.2.9 The Track work design shall duly address the drainage requirements.

2.2.10 The proposed design shall be compatible with the electrical and mechanical requirements of signalling and electric traction systems proposed.

2.2.11 The selection of materials and the Track design shall facilitate the routine maintenance of the Track and replacement of components on the assumption that the Project will operate in 04.00hrsto 24.00hrs period per day (except Sundays when services may be reduced), every day of the year.

3.0 CODES AND STANDARDS

3.1 Introduction

3.1.1 The Materials and Workmanship Specification for Track work shall be read in conjunction with all the documents forming part of the Contract.

3.1.2 No Permanent Works shall be carried out until all methods and materials have been properly identified and procured for use by the Contractor with due Notice of No Objection from Employer's Representative.

3.1.3 Unless noted otherwise in the Contract, all components and materials shall be handled, transported and stored, in accordance with the manufacturer's recommendations with prior issue of Notice No Objection of Employer's Representative.

3.1.4 The test results as per specification of each test to be carried out as per Employer's Representative's requirement shall be recorded and submitted in a format decided in consultation with the Employer's Representative and shall include graphical presentation of results as well as numerical base data where ever required.

3.2 Codes

The design and construction of the Permanent Works shall comply with codes of practice and standards prevalent at the time of submission of Tender Documents. Regulations made and requirements issued by the Indian Government and by relevant utility authorities shall be followed and specified.

Alternative or additional codes, standards and specifications proposed by the Contractor shall be internationally recognised codes including Indian Railway Standards (IRS) and Indian Road Congress (IRC) and shall be equivalent to or better than, Indian Standards issued by the Bureau of Indian Standards or any other Indian professional bodies or organisations, subject to being, in the opinion of the Employer's Representative suitable for incorporation into the Specifications.

Subject to the requirement of this specification and other control documents all design work will comply with the appropriate current standards issued by the Bureau of Indian Standards (BIS) & Research Design Standard Organisation (RDSO) or if such a standard does not exist, then the appropriate current standard issued by the British Standard Institute (BSI). If appropriate standard from BIS,RDSO and BSI does not exist, then subject to issue of No Objection Notice by the authority, an appropriate current standard from a reputable institution may be used. All standards shall be that including Amendments and Addendum, current at the date of tender shall be applicable.

3.2.1 **Indian Railway Standards**

IRS T-1	Fish plate
IRS T-10	Switches, crossing and SEJ's
IRS T-12	Rails
IRS T-19	Fusion welding of rails by Alumino-Thermic process
IRS T-23	Fish bolts and nuts
IRS T-28	High Tensile steel fish bolts and nuts
IRS T-29	CMS crossings
IRS T-31	ERC
IRS T-47	GR (Grooved Rubber) sole plate (for 10 mm sole plate pad and any other relevant specification)
IRS T-39	PSC sleepers for Plain Track
IRS T-44	GFN (Glass Filled Nylon) - 66 liners
IRS T-45	PSC sleepers for Turnouts
IRS T-46	SGCI (Spheroidal Graphite Cast Iron) inserts

Indian Railway Manual for Alumino -Thermic Welding

Indian Railway Manual for flash butt Welding

Indian Railway Manual for Ultra Sonic Testing of Rails and Welds

Indian Railway Manual of instructions on Long welded rails

Indian Railway Manual for Glued Insulated Joint

RDSO Manual for Procedure for safety certification and Technical Clearance of Metro System

RDSO guide lines for Noise and Vibration CT-38

3.2.2 **Indian Standards (IS)**

IS 456	Code of Practice for Plain and Reinforced Concrete.
IS 800	Code of Practice for General Construction in Steel

3.2.3 International Union of Railways Standard Codes (UIC)

UIC Code 860 – 0	Technical Specification for the supply of Rails
UIC Code 861 – 3	Standard 60 kg/m Rail Profiles Types: UIC 60. UIC Code 864 – 2 Technical Specifications for Supply of Steel Track Bolts
UIC Code 864 – 3	Technical Specifications for the supply of spring steel washers used in Permanent Way.
UIC Code 864 – 4	Technical Specification for supply of Fishplates or sections for Fishplates made of rolled steel
UIC Code 864 – 5	Technical Specifications for the Supply of Rail Seat Pads
UIC Code 864 – 8	Rolled Profiles for Fishplates for 60 kg/m Rails
UIC Code 866 – 0	Technical Specification for the supply of cast manganese steel crossings for switch and crossing work

3.2.4 International Organisation for Standardisation (ISO)

ISO 1113	Information Processing – Representation of the 7 bit coded character set on punched tape
ISO 1191	Plastics – Polyethylene and Polypropylenes in dilute Solution-Determination of viscosity number and of limiting viscosity number.

3.2.5 European Standards (EN)

EN 1561	Founding – Grey Cast Iron
EN 1562	Founding – Malleable Cast Irons
EN 1563	Founding – Spheroidal Graphite Cast Irons

3.2.6 German Standard (DIN)

DIN 53455	Testing of Plastics – Tensile Test
DIN 53479	Testing of Plastics and Elastomers – Determination of Density
DIN 53508	Testing of rubber - Accelerated ageing

3.2.7 International Electro technical Commission (IEC)

IEC 60093	Method of testing for volume resistivity and surface resistivity of solid electrical insulating materials (Formerly DIN 53482)

The technical specifications and manuals etc. of Indian Railways which are mentioned in Clause 3.2.3, shall be used only as far as they are applicable to a Standard Gauge system. The Contractor shall be responsible for collecting the latest revision of all relevant technical specifications to be used, including any correction slips and alterations, from the issuing body at his own cost and shall submit them to the Employer's Representative for his Notice of No Objection before starting of work.

4.0 TRACK STRUCTURE

MOR/RDSO have issued the "Manual for Procedure for Safety Certification and Technical Clearance of Metro Systems" in Dec 15. Annexure C1 refers to Technical Standard of Track structures for Metro Railways and Annexure C-2 refers to performance criterion of c Systems for Ballastless Track. The Track structure has been designed based on this RDSO manual.

4.1 Operating Environment

Track Structure shall fulfil generally the following conditions:

- Gauge: standard gauge1435 mm.
- Rail Seat inclination (slope) 1 in 20
- Speed potential (Design speed 95 km/h & operating speed 85 km/h)
- Static axle load: 17 tons
- Design rail temperature range: At Mumbai following ambience temperature has been adopted:
  Maximum Air Temperature 42.2 degree centigrade
  Minimum Air Temperature 7.4 degree centigrade.
- Maximum Gradient : 4% (Compensated)
- Maximum Curvature: Minimum Radius in UG Section is 230 meter; on Ramp 250 m. In Depot Minimum Radius is100 meter.

4.2 Requirements of the Track Structure

The Track Structure layout will fulfil the following requirements:

4.2.1 The Track alignment is to be confirmed from the Contractor to satisfy Schedule of Dimensions requirement.

4.2.2 The Contractor shall ensure that no permanent structure is within the Structure Gauge profile and the material & installation of track work shall comply with the provisions of Schedule of Dimensions in Appendix 18.

4.2.3 Ride comfort and running safety of Track vehicle dynamics has to be satisfied.

4.2.4 The horizontal alignment consists of a series of straights joined to circular curves generally with transition curves. Curvature and cant are calculated based on the train speed on the section. Compound and reverse curves, if any, are connected by an adequate transition curve.

4.2.5 The vertical alignment has been designed to achieve a smooth profile line with gradual changes. Changes in the profile are connected by vertical curves, which shall be as generous in length as the location allows. Vertical curves including its transition (if any) shall not be located at stations within the length of platform. A vertical curve within the length of transition curve is prohibited for ballasted track and not desirable for ballastless track. A vertical curve within Turnouts area is also prohibited. Vertical curve radius is constrained by the need to limit the vertical acceleration for passenger ride comfort. Vertical curve restricted to Radii 1500 meter minimum.

4.2.6 The Track structure has been designed with Long Welded / Continuous Welded rail on main line Track in case of Ballasted as well as Ballastless Track.

4.2.7 The technical standards for Track structure deal with the following components:

- Rail and Welding
- Sleeper and fastening for Ballasted Track
- Ballastless Track structure
- Fastening system for Ballastless Track
- Insulated Glued joint
- Turnout, scissors crossover
- Switch Expansion Joint (if required).

4.3 Track Design Parameters and data

Table: No. 2

S. No.	CRITERIA	DIMENSION
1	Gauge	1435 mm SG
2	Electric power collection	Overhead contact system (OCS) – 25kv(AC)
3	Inclination of Rail	1 in 20
4	Wheel profile	IRS type or UIC 510-2 to be interfaced with Rolling Stock Supplier.
5	Rail profile	UIC 60E1

Table: No. 3

S. No.		Ballasted Track	Ballastless Track
1	Rail type main line and Test Track	UIC 60E1, IRS-T-12-2009, 1080 grade head hardened	UIC 60E1, IRS-T-12-2009, 1080 grade head hardened
2	Rail type depot	UIC 60E1, IRS-T-12-2009, 880 grade	UIC 60E1, IRS-T-12-2009, 880 grade
3	Sleeper/ fastener Spacing	Depot 650 ± 20mm (The spacing of 650mm will be measured on average basis for each Rail length 13m) Main Line and Test Track 600 ± 20mm (The spacing of 600mm will be measured on average basis for each Rail length 13m)	Main line (underground) 700 ±10 mm Depot 700 ± 20 mm (except for Track on steel columns & embedded Track where spacing may be 1.2m centre to centre) (The spacing of 700mm will be measured on average basis for each Rail length 13m)
4	Ballast cushion depth	Test Track/Mainline: 300 mm Depot &Other lines: 250 mm RC Slabs : 350mm	N/A
5	Standard	13m	13m

S. No.		Ballasted Track	Ballastless Track
	Rail length		

4.4 Rails and Rail Welding

4.4.1. Rails

For main line in tunnel as well in at-grade section Track the rail used shall be UIC 60E1, 1080 grade Head Hardened for Underground.

For Depot lines: The rail used will be UIC 60E1, 880 grade.

"The rail shall be class 'A' rails as per IRS-T-12-2009 specification with latest amendments. The rail length will be 13 m on consideration of transportation and handling. The rails will be welded into LWR/CWR as per Indian Railway Manual."

Refer Profile UIC 60E1 in accordance with IRS-T12-2009, Class A First Quality Rail.

4.4.1.1. Rail requirements

All Rails to be used as Running Rails on Main Lines and in Depot, and also the Rails to be used in the manufacture of Turnouts and the abutting Rails within 26m of Turnouts shall be class A First Quality Rails fully conforming to the full manufacturing processes, equipment used in the manufacturing process, testing procedures, and frequency of tests as stipulated in the code IRS – T – 12-2009 with the latest amendments.

4.4.2. Welding of rail

- All main lines and depot lines shall be welded into a LWR by flash butt welding process except at location as approved by Engineer. Alumino-thermic welding shall only be permitted in exceptional circumstances when dictated by site conditions/constraints.
- The welding process shall be suitable for UIC60E1 rail sections of rail grades IRS-T-12-2009 880 grade & 1080 grade head hardened.
- All main lines and depot lines shall be USFD tested and welded into a LWR by flash butt welding process except at location not approved by the Employer's Representative.
- Alumino-Thermic welding shall only be permitted in exceptional circumstances when dictated by site conditions/ constraints and as approved by the Employer's Representative.
- Only RDSO (Ministry of Railways, Govt. of India) approved welders and approved & renowned welding firms shall be detailed to do welding.
- The welding process shall be suitable for UIC 60E1, 880 grade & 1080 grade HH rails. 1.21.2 Flash-butt welding

The welding of rails should conform to Indian Railway specifications and technical instructions issued from time to time.

The present instructions are contained in following documents:

- **Alumino-Thermic Welding**
  - Indian Railway Standard specifications for Alumino-Thermic Welding of Rails (IRS/T-19 with latest amendments).
  - Manual for fusion welding of rails by the Alumino-Thermic Process Revised 2012 with

latest amendments.

- The welding portion and equipment required for the Alumino-Thermic rail welding process shall be manufactured and tested in accordance with relevant Technical Specifications for approval of the process and supply of portions for Fusion welding of rails and performance and acceptance of Alumino-Thermic welding of rails of Indian Railways.

- **Flash-Butt Welding**

Manual for Flash Butt Welding of rails - January 2012, with latest amendments.
The flash-butt welding machine shall be mobile type capable of making in situ welds.
The Flash Butt Welding of rail joints shall be undertaken in accordance with the relevant Indian Railways Manual for Flash Butt Welding of rail.
For 1080 grade HH rails, the minimum breaking load and minimum deflection as mentioned in the relevant clause of Indian Railway manual for flash butt weld shall be such that the weld shall not show any sign of cracking up to the specified rail deflection and the load at this deflection shall be more than specified minimum breaking load. The values of specified deflection and specified minimum breaking load shall be as mentioned in the Indian Railway manual for flash butt weld 1996.

4.5 Rail Grinding

Grinding of rails will be carried out at these 2 stages given below:

a) Preventive grinding which is carried out at initial stages of rail installation.

Preventive grinding

Certain rails surface defects, both inherent and of accidental origin, appear in the rail wheel contact area soon after new rails are installed. A squat or black spot is a progressive cracking of the visible running surface of the rail, which in final stages develops into transverse cracking ultimately leading to rail fracture. Limitations exist in the ultra-sonic flaw detection of such faults. Besides squat, Rail fatigue can lead to shelling and head chipping (more common on outer rail of a curve). Although rail grinding may not be effective in removing these defects altogether, it does remove the surface layer of the new railhead whose mechanical qualities are not as high as those of the rails deeper layers. This phenomenon is due to surface Decarburization of the rail head in its active part, as it leaves the rolling mill. Decarburization promotes the squat faults and by removing the surface layer of the rail to a depth of approx. 0.3 mm, the appearance of squats is discouraged. Preventive grinding thus removes a zone of congenital weakness from the rails morphology and thus results in prolonging its life span and improves the geometric quality of the track. Grinding of Rail top also help in reduction of Noise & Vibration attenuation. 1st Rail grinding will be done immediately after laying.

4.6 Track Form in Tunnel

The High attenuation booted twin block sleepers embedded in track slab will be provided with derailment guard on location of curves having radii equal or less than 500m as per drawing

given in section VI (4) Tender Drawings in bored and Box tunnel and covering loactions as per SOD.

4.7 Ballastless Track with Embedded Track

The booted twin blocks track system will consist of reinforced concrete blocks that are separated from the concrete in which they are encased by a rubber boot especially developed for this purpose. The boot contains a resilient block pad below the concrete block.

This elastic support of the concrete block by means of a pad, which is individually designed for each project, allows improved load distribution. An elastic rail pad is used because this is decisive for one of the characteristics of this system – the dual-level elasticity.

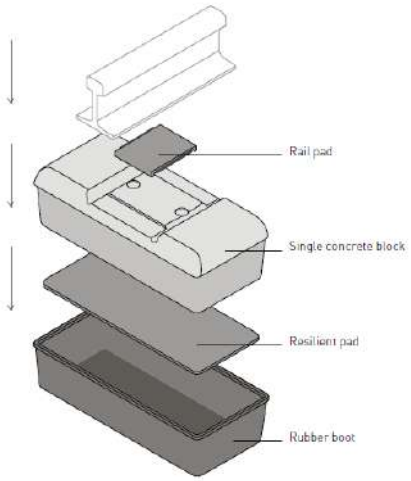

FIG 2. Illustrative expanded view of booted twin blocks track

The booted twin blocks track consists of single supports decoupled from the embedment concrete by rubber boots. The shape of the rubber boots and structure of the rubber boot walls allow a free deflection of the concrete block accommodating a fastening system for Twin block concrete sleepers in ballastless tracks and resting on a resilient block pad.

The rail support has a dual-level elasticity, the first one directly under the base of rail the second one under the concrete block.

The static stiffness of the rail support is adjustable due to the selection of the block pad stiffness. The static stiffness ranges from 7 kN/mm – 30 kN/mm.

The rail support allows a vertical adjustment of the rail position up to 25 mm by shimming of the concrete block. Lateral adjustability of the rail position is provided by the fastening system.

The rail supports is exchangeable without demolishing the embedment concrete in short service breaks and without being influenced by the climatic conditions.

For HA system twin block sleeper has got wide block as well as high quality elastic pad the system shall have a low natural frequency.

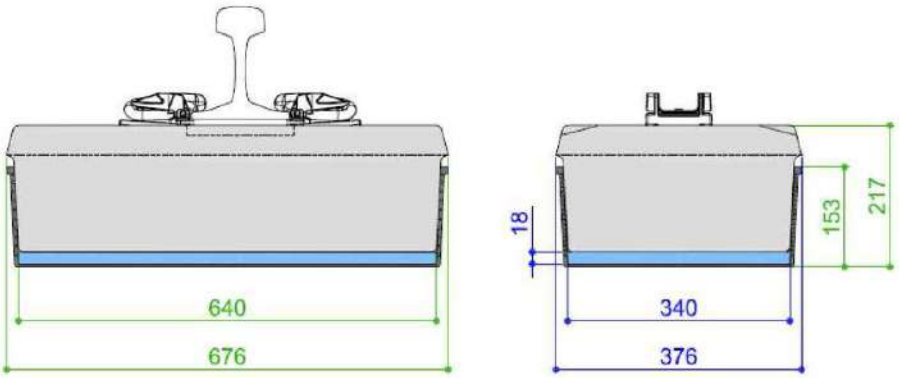

FIG 3. "High Attenuation" block [the dimensions are only indicative and the fastening system shall be different]

- **Elastic Pad Below the Blocks**

Elastic pad below the rails shall be used considering RDSO fastener performance criteria. Elastic pads shall be tested and test report of the reputed independent institute / laboratory will have to be submitted. The testing is to be done for Cat B as specified in EN-13481-Part-I 2012 & EN-13481-5:2012 with rail section to be used in proposed system if other design particulars are meeting the requirement of Cat –B.

The stiffness of the Elastic pad below the block is of 7kN/mm (Minimum) and 25kN/mm (Maximum) shall be used considering RDSO fastener performance criteria.

The purpose of the structural calculations is to utilise maximum possible stresses in structural concrete. Since, the maximum stiffness of the Elastic pad is taken for structural analysis.

The above specifications are for reference only subjected to compliance of provisions of para 4.8 Rail Fastening System , para 4.9 Performance requirement of the Fastening System and "Procedure For Safety Certification And Technical Clearance Of Metro Systems December 2015 by RDSO".

4.8 Rail Fastening System

4.8.1 Purpose of Fastenings

The performance criteria define the performance standard of fastening system for Ballastless Track of Metro Railway System. The norms have been laid down vide Ministry of Railway's letter No.2009/Proj/mas/9/2 dated 21/5/2010. Apart from other characteristics, the fastening system is also required to moderate vibration and noise transmitted through the rail and to reduce the Track stiffness and the impact on the Track structure, so as to obtain the parameters as detailed in the ensuing paragraphs.

In case a new Fastening system which is not approved by MOR is introduced in the country for the first time, the details of the same shall be submitted to MOR, the same shall be kept in observation by MOR for a period of 2 years in association of Metro system.

4.9 Performance requirement of the Fastening System

4.9.1. Principles

a) The fastening system shall be designed to hold the two rails of the Track strongly to the supporting structure in upright position by resisting the vertical, lateral and longitudinal forces (including thermal forces) and vibrations.

b) The fastening shall be with a proven Track record. Fastening System should have satisfactory performance record of minimum three years in service in regular revenue operation on Ballastless Track on any two different established railway systems (except exclusive freight Tracks) for a length of at least 5 km in each metro having speed potential of at least 95 km/h & design axle load of at least 17 t irrespective of wheel profile and rail section. In these regards, supplier should submit certificate of performance from user railways administration including proof of use of the fastening system. The supplier has also to submit a certificate that the components of fastening assembly are having same material and specifications. In case the proven system is having different rail section and wheel profile along with details of test results as per test plan of Table No.6 in Para 4.6.3

c) The fastening shall provide insulation to take care of return current of traction system.

4.9.2. Technical performance requirements

The Fastening shall:

- Have design service life of 30 years in general. However its components such as rail pad, rail clip etc. can be designed for 300 GMT or 15 years whichever is less. Anchor bolts or studs used for fixing base plate to the concrete should not be required to be replaced during service life. Its components must not suffer any degradation during service life to a degree so as to affect the performance.

The fastenings have to be resistant to following conditions and factors:

- Atmospheric ultraviolet radiation.
- Proximity of Track up to 10 m from salt water source.
- Contact with oil, grease or distillate dropped from Track vehicles.

The fastening system shall:

- Permit quick and easy installation and replacement with special tools.
- Be capable of vertical adjustment during service life up to 12 mm using shims.
- Permit the attainment of the following tolerances when installed, and later during service

4.9.3. Fastening System Track Tolerances

Table: No. 4

Sr. No.	Parameter	Installation (mm)	Maintenance (mm)
1	Gauge	+2/-1	+4/-2
2	Cross level on straight Track	±1.5	±5

3	Super-elevation on curved Track	±1.5	±3
4	Vertical alignment over 20m chord	±3	±6
5	Lateral alignment over 20m chord on straight Track	±2	±6
6	On curves-variation over the theoretical versine on 20m chord	±2	±5

- Anchor bolts/studs eventually used for fixing the bearing plate in concrete shall have splayed ends. Detailed calculations of the number of anchor bolts required on tangent and curved Tracks shall be furnished by the supplier, endorsed and approved by DDC/GC.
- For all the fastening components as per approved assembly, the supplier shall furnish detail drawings, specifications and inspection & test plan to GC/DDC.
- The supplier should furnish the 'Installation and Maintenance Manual' which shall be endorsed and approved by DDC/GC.
- Any change in component subsequent to the approval of the fastening system by MOR shall be permitted only for specific requirement of the Metro. MOR's approval of such changes shall be processed with specific recommendations enclosing test report of the component / whole assembly with detailed justification.
- The rail fastening system shall be tested to the specifications given in this document or proposed from the Contractor and endorsed by GC for different technical parameters and should meet the acceptance criteria as mentioned here. Test report of the reputed independent institute / laboratory will have to be submitted. The testing is to be done for dynamic /static test as specified in EN-13481-Part-I 2012 & EN-13481-5:2012 with the rail section to be used in proposed system.
- The Contractor must enclose standards, referring to this tender, in the English language. The Contractor is required to refer, if and when appropriate, to the respective UIC resp. EN Specifications or equivalent.
- Further, the Contractor is required to submit, as part of his tender, drawings of all components of offered track fastening system. The Contractor may enclose to his tender any additional supporting technical descriptions which the Contractor considers to be necessary. The approval of such documentation by the Purchaser shall not relieve the Supplier from any liabilities.
- The system shall also be able to render itself for the facility of complete preassembly.
- The anchoring insert in the concrete support (sleeper or block) shall allow a direct transmission of forces into the concrete. The influence of different thermal expansion coefficient of concrete and plastic has to be minimized by using stronger material as Polyamide, for example. The screw/dowel combination shall be designed with a rounded thread for providing an easy handling in the sleeper plant and avoiding of faulty screwing-in of the screw in the plastic insert.
- The screws shall be anchored in replaceable plastic dowels, which shall be removed without core drilling process.
- The exchange of all fastening components as well as of the anchoring device should be possible.

- The fastening system must be electrically insulated without any additional insulating parts. The fastening system must ensure 2.5 Ohm * km track insulation and not less than 5000 Ohm insulation between the two rail seats.
- The rail fastening system shall have a protection in the tension clamp against tilting/rotation of rails and overstressing of its spring elements.
- The lateral loads from rail have to be transmitted by plastic components into the concrete shoulder, if any.

Table: No. 5

S.NO	Technical Parameter	Test Method	Acceptance Criteria	Remarks
1	Determination of longitudinal rail restraint	EN-13146-1 (latest version)	7kN (min.)	This had to be tested before repeated load test
2	Vertical stiffness of complete fastening	EN-13146-4 (latest version)	35kN/mm (max)	No sliding, yield or cracking is allowed for the fastener parts.
3	Determination of clamping force	EN-13146-7 (latest version)	18kN (min)	This has to be tested before repeated load test.
4	Determination of electrical resistance	EN-13146-5 (latest version)	5 KΩ (min)	The user may specify a higher value for use with certain track circuit.
5	Effect of severe environment conditions	EN-13146-6 (latest version)	The fastening system shall be capable of being dismantled, without failure of any component, using manual tools provided for this purpose after exposure to the salt spray test	
6	Effect of repeated loading	EN-13146-4 (latest version)	No wear or deformation	Test load & fastening position will be taken as per EN-13481-6
6A	On vertical stiffness	EN-13146-4 (latest version)	Variation less than 25% of the initial value.	No sign of bond failure/fracture/slippage

6B	On longitudinal rail restraint	EN-13146-1 (latest version)	Variation less than 20% of the initial value.	Except the rail and fastener, no sliding yield or cracking is allowed for fastener parts. Longitudinal load/ deformation curve shall fall in the envelop of upper and lower limit which is to be submitted along with test report.
6C	On Clamping force	EN-13146-7 (latest version)	Variation less than 20% of the initial value.	

Table No. 6
Test Plan for fastening system (bonded and not bonded for Ballastless Track)
(As per provision of latest EN – 13481 – Part 1: 2012 & EN – 13481 - 5: 2012)

Sr. No	Technical parameter	Test Method	Acceptance criteria	Remarks
1	Longitudinal Rail restraint	EN-13146-1	7 kN (min)	This has to be tested before repeated load test
2	Vertical static stiffness of complete Fastening system	EN-13146-4	35 kN/mm (max)	No sliding, yield or cracking is allowed for the fastener parts. Static stiffness shall be calculated in the secant range 5-80 kN.
3	Dynamic/static stiffness ratio	EN13481-5, Annex B	1.4 (max)	Ratio is calculated by dividing the dynamic stiffness to static vertical stiffness.
4	Clamping force	EN-13146-7	18 kN (min) per rail seat	This has to be tested before repeated load test.
5	Electrical resistance	EN-13146-5	5 kΩ (min)	Higher value may be specified if required by Metros for Track circuit.

6	Effect of severe environmental conditions	EN-13146-6	The fastening system shall be capable of being dismantled without failure of any component, using manual tools provided for this purpose after exposure to the salt spray test.	
7A	Effect of repeated loading	EN-13146-4	No wear or deformation.	Test load and fastening position will be taken as perEN13481-6.
7B	On Longitudinal rail restraint	EN-13146-1	Variation less than 20% of the initial value.	Except the rail and fastener, no sliding, yield or cracking is allowed for fastener parts. Longitudinal load/ deformation curve shall fall in the envelope of upper and lower limit which is to be submitted along with the report.
7C	On Clamping force	EN-13146-7	Variation less than 20% of the initial value.	

4.9.4. **Fastening for Ballastless Track and Turnouts on Twin Block sleepers**

Twin Block High attenuation sleepers may be with rail fastening, Fast clip or W-14 or similar which satisfies the performance and testing criteria of RDSO as given in para 4.9.1, 4.9.2 and 4.9.3 above.

4.10 Pre Stressed Concrete (PSC) Sleepers

i. Pre-stressed mono-block sleepers are proposed to be laid in all ballasted Tracks. The minimum length of the Track sleeper shall be 2.50 m with a minimum thickness below rail seat of 200mm.

ii. Standard Gauge PSC sleeper for standard gauge will be designed by Contractor following in principal guidelines of Indian Railway and the same shall be approved from Employer . With specifications IRS-T-39 (revised from time to time).The testing will also be done as per standards laid down

iii. The sleepers should be compatible to the fastening system adopted. All sleepers for ordinary Track, as well as switches and crossings shall be designed for a static axle load of 17 t.

iv. The maximum longitudinal spacing between the centre lines of adjacent sleepers shall be as follows:

- Depot Tracks: 650 ± 20 mm (Average 1538 Nos /Km)
- Test Track/Mainline (ballasted): 600 ± 20 mm (Average 1667 Nos/Km)

In curved Tracks the distance between the sleepers shall be measured at the outer rail of the Track.

v. Mono block PSC sleepers shall be used on plain line, turnouts, derailing switches (if any) and level crossings for ballasted line Track in the Depot and Mainline.

The PSC sleepers should satisfy the following design requirement:

4.10.1 **Design Parameters**

- Rail sleeper fastening - Elastic resilient type
- Spacing of sleepers – 600mm for mainline & Test Track, 650mm (max) for Depots and other non-running lines, except at few locations such as near point machine locations where it may be varied to meet the design requirements.
- Ballast cushion – As per RDSO GE 1 specification, The Ballast cushion shall be 250mm for Depots and sidings, however Test Track, Inspection Track will be of mainline standard i.e. 300mm of Ballast cushion will be provided.The Ballast cushion on RCC Slab will be Mininum 350mm Subjected to the Drawings for Aarey Station and Depot
- Ballast profile suitable for LWR/CWR.

Note: The Drawing has been prepared to indicate the areas of various Ballast Cushion.

4.10.2 **Specifications and Drawings (with latest amendment)**

- Special Cement - IRS T 401985
- HTS wire plain and strand - BIS -1785 (Pt-1) 1983 and BIS 6006
- Polyethylene dowels - Provisional 1997 Dwg. No. RDSO 3002 Alt-3
- IRS Specification for Turnout Sleeper T- 45 1996
- IRS Bridge code 2015
- Code of Practice for Pre-stressed Concrete IS-1343

4.10.3 **Design's additional requirements**

The connections of the slide chairs and bearing plates/special bearing plates/brackets shall be designed for easy installation and maintenance. All the fittings shall be suitably designed to ensure full compatibility & also to ensure interchange ability of slide chairs between ballasted and Ballastless turnouts.

For attaining suitable cant of the rail, as provided on mainline (excluding crossing and switch portion) suitably designed pads of appropriate material shall be provided between rail pad & PSC sleeper. Also fastening system should be designed to achieve the desired Toe Load.

4.11 Ballasted Track in Depot and Mainline

Ballasted Track shall generally conform to Indian Railway Standards. Ballasted Track shall be laid over compacted formation. The top of formation will be laid with an adequate blanket layer to permit proper drainage.

4.11.1 Ballast

- The Track ballast shall have a thickness as specified between the bottom of sleeper directly under each rail. The ballast section shall be placed in a trapezoidal shape with the top extending 350 mm and 400 mm in the sharp curves R≤300m beyond each edge of sleeper and tapering downward at a "1 vertical in 1.8 horizontal slopes."
- Ballast for ballasted Tracks and turnouts shall be machine crushed, and shall be manufactured, tested, delivered and installed in accordance with Indian Railway Standard IRS-GE-1 "Specification of Track Ballast".
- Ballast should be hard, durable and as far as possible angular along the edges, corners, free from weathered portions of parent rock, organic impurities, and inorganic residues.
- The ballast should satisfy the following size and gradation:
  - Retained on 65 mm sq. mesh sieve – 5% maximum
  - Retained on 40 mm sq. mesh sieve – 40%to 60%.
  - Retained on 20 mm sq. mesh sieve - Not less than 98%.

- Ballast sample shall satisfy the following physical properties when tested in accordance with IS: 2386 Pt. IV-1963
  - Aggregate Abrasion Value: 30 max.
  - Aggregate Impact Value: 20 Max.

4.11.2 Fastening System for Ballasted Track

The elastic fastening system prevalent on Indian Railways shall be used duly ensuring the Inspection protocol for fastening components laid down for IR. The components will be as under:

- Elastic Rail Clip as per specification IRS.T-31- up to latest correction slip .
- Grooved Rubber sole plate 10 mm thick as per specification IRS.T- up to latest correction slip
- Metal Liners: As per IRS Provisional- up to latest correction slip.
- Glass Filled Nylon -66 insulating liner IRS.T-44- up to latest correction slip.
- Spheroidal Graphite Cast Iron Inserts IRS T -46 - up to latest correction slip.

4.12 Transition between Ballasted and Ballast less Track

- Transition zones are zones in which the track stiffness changes abruptly. Transition zones are usually associated with track geometry deterioration that requires frequent maintenance. This change of stiffness causes increased dynamic forces, which depends on the speed, the stiffness ratio, the damping properties and the transition length.
- Transitions shall be designed to keep the impact of discontinuities on Track integrity and ride comfort within specified limits. Smooth transition between the different Track forms and related different Track stiffness's is intended to avoid high load impact due to the sudden change of the

Track stiffness and consequent loss of compaction of the ballasted Track and to ensure sufficient ride comfort too. Appropriate measures must be taken predominantly in course of the design of the supporting structures.

- There will be slab Track to at-grade (ballasted Track) transitions. An appropriately designed transition structure requires stiffness of the Tracks across the transitions to have similar magnitude over an adequate transition. The stiffness of the slab Track will depend on the type of rails, type of fastenings, fastening spacing and fastening vertical stiffness. While the sub-surface and sub-ballast layers will be additional key parameter for Track stiffness for ballasted Track.

4.13 Ballastless Track Structure

Track may be laid on cast in situ 1st pour concrete, herein after referred to as the "Ballastless Track", depending on the Design of the Track structure. The Ballastless Track shall be designed with derailment guards in curved track having radius 500m or less as specified in SOD Para 1.11.The Track slab dimensions and the clearance between rail and derailment guard shall be sufficient to accommodate the fastening system and to facilitate easy and convenient replacement of the fastening system. The clearance between rail and derailment guard shall be within adequate, designed limit.

In general, Track structures on which the fastening and rails are to be fitted shall:

- Resist the Track forces.
- Have adequate edge distance of concrete beyond the anchor bolts (in case of direct fixation fasteners) to provide resistance against edge failure.
- Provide a level base for uniform transmission of rail forces.
- Have geometrical accuracy and enable installation of Track to the laid down tolerances.
- Ensure adequate drainage.
- Resist weathering.
- Be construction friendly, maintainable and quickly repairable in the event of an accident causing damages to the Track structure.
- Ensure provision for electrical continuity between consecutive Track structure's elements by an appropriate design.
- Ensure the possibility for evacuated passengers to walk effortlessly until the next station in case of train stop between two stations.

4.13.1 Load Combinations

The loads to be taken into account in the Track calculation are presented in the following sections. Some of them apply vertically to the structure, other horizontally. In addition to this the lurching force and the radial force due to thermal expansion have to be considered.

Table No. 7

Type of load	Symbol	Description	Application	
			Horizontal	Vertical
Dead load	*DL*	*Self-weight*		*X*
Live load	*LL*	*Train weight*		*X*
	DY	*Dynamic impact*		*X*
	CF	*Centrifugal force*	*X*	*X*
	RF	*Racking force*	*X*	
	LF	*Longitudinal traction/braking force (including gradient)*	*X*	
	LF1	*Lurching force*		*X*
	LR	*Long welded rail load*	*X*	
	EQ	*Earthquake*	*X*	*X*
	RT	*Radial force due to thermal expansion*	*X*	
	BY	*Buoyancy Force*		*X*
	DR	*Derailment Force*	*X*	

4.14 Evacuation path

In case that the train is stopped between stations due to power failure or other reasons, the passenger on train will be evacuated from the ends of train. The passenger will walk on the track bed to the platform of the next station or via Cross Passages. The Evacuation Path will be provided level crossing check rails.

In order to ensure the passenger safe and smooth evacuation to the next station the structure on the track bed shall be considered carefully. Any protuberant object which would hamper the evacuation of the passenger shall be avoided and the drainage on the track shall be covered if designed along the walking surface of the evacuation path.

4.15 Check Rail

Check rails should be provided on curves on main line where radius is 190m or less on Standard gauge. The clearance of check rail shall be suitably decided after adequate studies.
Check rails shall not be mandatory for curves in depots, yards and non-passenger lines where speed is not more than 25 km/h.

4.16 Derailment Guards

The derailment guard will be provided inside of the running rails in tunnel sections where multiple Tracks are present.
The MOR letter no. 2011 / Project / MOU / 31 / 1Vol.1–Tunnel dated 26.11.2015 has specified the following provisions for single Track in tunnel:

Sr. No.	Location of Derailment Guards in single Track in tunnel
1	Tunnel Portal: 200m from tunnel portal outside the tunnel to 50m inside the tunnel.
2	In curved Track having radius 500m or less including transition portion but excluding location where check rail is provided.
3	Covering locations of all important installations e.g. location of any substation or hazardous structures inside the tunnel, damage to which - in assessment of MMRC - can result into serious loss of life or/and infrastructure as a result of derailment in tunnel.

The above is subject to the condition that metro railway shall carry out the risk assessment analysis for derailment in tunnels and ensure that the maintenance practices in the maintenance manual are as per the risk assessment mitigation plan.

The lateral clearance between the running rail and the derailment guard shall be 320 ±10 mm. It shall not be lower than 25 mm below the top of the running rail and should be clear of the rail fastenings to permit installation, replacement and maintenance.

Derailment guard shall be designed such that in case of derailment:

- The wheels of a derailed vehicle under crush load, moving at maximum speed are retained in the tunnel.
- Damage to Track and supporting structures is minimum.

The detailed design calculations of derailment guards along with detailed structural drawings shall be furnished.

4.17 Glued Insulated Rail joint (IRJ) (IF ANY)

The track Circuiting is not being provided on ML3.However Wherever inescapable, G3 (L) type of glued insulated rail joint shall be used as per RDSO drawing no.T-5843. The glued joints shall be manufactured and tested in accordance with RDSO's 'Manual for Glued Insulated Rail Joints-1998' with all amendments.

4.18 Signal and Traction Return Rail Bonds

At locations provided by Power Supply &Traction and Signalling contractors, Track work and/or traction return rail bonds are to be attached to the rail through thermite welding or any other suitable technique.

4.19 Electrical Interface and Stray Current provision

The electrical continuity within the ballastless Track shall be ensured.

While corrosion caused by AC current can occur due to the alternating positive and negative half-cycles, it is normally significantly less than corrosion caused by DC current. Nevertheless it is required to adequately develop an assessment study in order to define the needed measures and provisions for protection against corrosion from stray electrical currents and to interface these with the complementary provision from the Signalling System.

4.20 Turnouts and Diamond Crossings.

On main lines, the turnouts and diamond crossing shall be of the following standards.

Only Thick web switches will be provided and their implementation will be according to the operating speed in straight and curved Tracks:

a) 1 in 9 type or flatter turnout (desirable) with minimum 300meter radius,
b) 1 in 7 type turnout (minimum) with minimum 190 meter radius,
c) Scissors cross-over of 1:9 / 1:7 type consisting of 4 turnouts and 1 diamond crossing.
d) The Slide chairs in the turnouts plates will be cast steel base plate.
e) All the base plates in the turnouts including check rail plates will be one piece cast steel base plate.

4.20.1 **Turnouts and Diamond Crossings in Depot and non-running lines**

On depot and other non-running lines, the turnouts and diamond crossing shall be of the following standards:

a) 1 in 7 type with minimum radius 190 m (but only if indispensable) or flatter turnout desirable.
b) Scissors crossover of 1 in 7 or 1in 9 type consisting of 4 turnouts and 1 diamond crossing.
c) Derailing switches will be 1 in 7/1 in 7 type symmetrical split turnout..

The requirement for turnouts as specified in the following clauses shall include switch devices, crossings and associated check and lead rails as appropriate:

d) Turnouts (switches, lead, crossings and associated closure & check rails) shall be suitable for installation on PSC sleepers for ballasted Track or concrete slab/ embedded sleepers or blocks etc. for Ballastless Track.
e) Turnouts shall be manufactured to allow installation of continuously welded Track.
f) Turnout shall be compatible with proposed rolling stock and its operational characteristics.
g) The slide chairs and all the base plates in the turnouts including check rail plates will be single cast steel base plate
h) The assembly must ensure continuous electrical contact with the train and all the points shall be operated by electric motors.
i) The CMS crossing shall be subjected to explosive hardening.
j) All turnouts and their components shall be designed to minimize electrical leakage from running rails to the ground.
k) Scissor crossover should be designed for Specific Track centres, not infringing SOD.

4.20.2 **Geometrical parameters of Turnouts, scissors, and crossover**

Detailed design of all turnouts, scissors, and crossover should comply the following geometrical parameters.

Standard Gauge:

(a) **1 in 9 turnouts**

The design shall be tangential with a switch angle not exceeding 0°20'00". It is desirable

that the radius of lead rail of turnout is not less than 300m. Lead curve of 190 m radius may be laid as an exception. All clearances shall be in accordance with relevant provisions of SOD.

(b) **1 in 7 turnouts**

The design shall be tangential with a switch angle not exceeding 0°20'00". It is desirable that the radius of lead rail of turnout is not less than 190m. All clearances shall be in accordance with relevant provisions of SOD.

(c) **Scissors Crossover**

The basic geometry of the turnouts of scissors crossover shall be same as that of corresponding ordinary turnouts as mentioned in the clauses above.

4.20.3 **Operating requirement of turnout and scissor crossover**

Track layout design shall permit trains to operate at maximum capability wherever possible. Turnouts and crossover shall be selected such that they do not form a restriction to the operating speed on main line. Switches and crossings shall not be located on transition curves or vertical curves.

Speed:

The turnout shall be designed for the speed on mainline side equal to the speed as on mainline Track.

The minimum speed potential of the various turnouts and scissors crossover on the Turnout side should be as follows:

- 1 in 9 type turnout with 300 m radius (speed potential of 45km/h)
- 1:7 / 1:9 type turnout with 190 m radius (speed potential of 35km/h)
- 1 in 7 type turnout with 140 m radius (speed potential of 25 km/h)
- Scissors crossover 1 in 9 type with 300 m radius (speed potential of 45 km/h)
- Scissors crossover 1:9 / 1:7 type with 190 m radius (speed potential of 35km/h)
- Scissors crossover 1 in 7 type with 140 m radius (speed potential of 25 km/h). Not permitted as per SOD in main line.
- 1 in 7 type symmetrical split turnout (speed potential of 45Km/h).

4.20.4 **Technical Specifications of the Turnouts**

- All the points shall be capable of being operated by electric motors in accordance with the signalling specification.
- The top surfaces of PSC sleeper / ballastless Track supporting rail seat of turnouts and scissors crossover shall be flat without any cant/slope.
- The Track form of the turnout shall have uniform resilience as that of the adjoining Track form.
- The fixation of turnouts, scissor cross-over on Track structure shall be through base plates/bearing plates in case of direct fixation fasteners.
- The slide chairs and all the base plates in the turnout including check rail plates will be cast steel base plate or forged base plate.

4.20.5 **Rails on the Turnouts**

- The rails used in turnouts shall be 1080 grade Head Hardened in mainline section and all Ballastless track Structures.
- Rails used in turnouts on depot and other non-running lines will be of 880 grade.
- The rail seat inclination will be kept 1:20 towards inner side of the Track gauge.

The rails used for manufacturing of turnouts shall satisfy the following conditions:

- The rails shall be manufactured and tested in accordance with IRS/T-12-2009 with latest amendment.
- The section of rails shall be UIC 60E1 for stock, lead and 60E-1A1 (ZUl-60)/60E-1A4 for switch rail. The rails shall be with un-drilled ends.
- The rails shall be of grade 1080HH and be suitable for being welded.
- The rails shall qualify as Class 'A' rails as per IRS/T-12-2009.
- Welded by by flash butt welding technique and AT welding in exceptional locations.

4.20.6 **Switches**

All the switches in Ballastless and ballasted Track should be Thick Web Switches.

Each switch device shall consist of two stock rails, one left hand and one right hand and two switch rails, one left hand and one right hand.

- All switch rails on main lines shall be manufactured from suitable asymmetrical thick web rail section with prior approval of purchaser. The switch rails shall be ZU1-60 or 60E1A1.The switch rail shall be one piece with no joint within the switch rail length.
- All switches (stock rail & switch rail) shall be of 1080 grade Head Hardened (HH) in accordance with IRS-T-12-2009 (with latest amendment) specifications. Further these 1080 HH grade rails shall be suitable of being welded by short pre-heat process of alumino-thermic welding technique as specified in IRS-T-19 (latest version) for fusion welding of rails duly following the provisions of Indian Railway Manual for Alumino – Thermic welding.

  The switch rail shall be one piece with no weld or joint within the switch rail length.

  The end of the asymmetrical switch rail shall be forged to 60E-1 (UIC60) rail profile with minimum length of 500 mm. The forged switch rail heel shall be suitable for welding or installation of insulated rail joint.

  Slide chairs in the switch portion shall be coated with an appropriate special coating, so as to reduce the point operating force and to eliminate the requirement of lubrication of sliding surfaces during service.
- Alternatively the supplier may suggest low maintenance Roller system for switch device.

  Roller type slide chairs (adjustable in height) to ensure that the slide chairs are not required to be lubricated.

  Switches shall provide suitable flange way clearance between the stock rail and the switch rail with the switch rail in open position (minimum 60mm).The and 1 in 9 (with radius of

300m.) and flatter turnouts shall be provided with second drive or other suitable arrangement to ensure minimum gap of 60mm at Joint of Head as well as proper housing of switch rail with stock rail up to Heel Joint. 1 in 9 turnout (with radius of 190m) and 1 in 7 and sharper turnouts may not be provided with second drive arrangement, however minimum gap of 60mm at Joint of Head as well as proper housing of switch rail with stock rail up to heel joint should be ensured. The normal opening of switch at toe of switch shall be kept as 160mm.

The switch manufacturer shall include provision for all holes required to main drive machines, stretcher bars and detection equipment to suit the requirements of the signalling and switch operating system duly chamfered to avoid stress concentration at the edge of the holes.

The switches shall be designed with an anti-creep device at the heel of switch to withstand thermal forces of the CWR Track.

4.20.7 **Crossings**

All crossings shall be cast manganese steel (CMS) crossings with weldable rails of minimum 1.2m length undrilled for welding into the overall turnout.

The CMS crossings shall be manufactured from Austenitic Manganese steel as per UIC 866.

All CMS crossings shall have welded leg extensions of 60E-1 (UIC60) rails. This shall be achieved by flash butt welding of buffer transition rail piece of suitable thickness to CMS crossings and rail leg extension.

All CMS crossings on main line shall have a minimum initial hardness of 340 BHN.

All CMS crossings and their welded leg extensions for all scissor crossovers shall be suitably dimensioned so as to eliminate the necessity of providing small cut rail pieces for the purpose of inter-connection. However, the need for providing insulated glued joints from Interface requirement point of view shall be taken care of in the design, if required.

The provision of rail cant shall be taken care of on the top surface of the CMS crossing and the bottom surface of all CMS crossing shall be flat.

4.20.8 **Check Rails**

The check rail section shall be 33Cl (UIC33) or similar without any direct connection with running rails.

Check rails shall have the facility for the adjustment of check rail clearances up-to 10mm over and above the initial designed clearance.

Each check rail end shall be flared by machining to have minimum clearance of 62mm at end.

The check rail connections in turnouts shall be through specially lasted designed bearing plates / brackets.

All the check rails shall be higher by 25mm above running rails. The lengths and positions of the check rail in diamond crossings shall provide safety and be compatible with the overall Track layout.

4.20.9 **Sleepers for Turnouts(Ballasted Track)**

- Sleeper shall be of pre-stressed concrete, mono-block, suitable for installation in Track both with and without signalling circuits and with and without electrification.

- Sleepers shall be designed to provide a minimum service life of fifty years under nominal axle load as that of main line for the Metro system. Rail seat pads and rail clip etc. shall be designed to provide a minimum service life of 15 years.
- The sleeper base surface shall be rough cast while the top and side surface shall be smooth to prevent retention of moisture and foreign materials.
- Sleepers must be suitable for installation by Track laying machines and sleeper insertion equipment of a type used for isolated sleeper laying.
- The Ballasted Track Turnout Sleepers length will be capable of Supporting the Signalling Point Machine
- The sleeper must be able to transfer all the relevant Track forces generated by train operations and the forces of rail expansion and contraction to the ballast.

4.21 Switch Expansion Joint (SEJ)

The SEJ for ballasted Track shall be laid on PSC sleepers whereas the SEJs for Ballastless Track, if required, shall be laid on reinforced concrete slab (only if outside tunnel environmental conditions).
The rail section for all SEJs shall be UIC 60, 1080 HH grade as per IRS-T-12-2009.
The SEJ for ballasted Track shall be designed for a maximum gap of 80 mm.
Sleepers used for SEJs shall be flat and cant, if any, will be provided through Cast Iron chair.
The SEJ shall be suitable for two way directional traffic.
The ballasted SEJ shall be as per RDSO drawing T-6902 &T-6922.
Sleepers used for SEJs shall be flat and cant will be provided through CI chair.

The Contractor shall realize a specific report (including the turnouts) in order to justify using or not using a Switch Expansion Joint. The objective is minimizing the number of SEJ. If it is necessary to use Switch Expansion Joint, it will respect the specifications.

4.22 De-Stressing of CWR

- The de-stressing of rails shall not be undertaken until it has been demonstrated to the Engineer's satisfaction that the track has been completed to the specified standard & specification and the method of working for de-stressing of the relevant track form has been approved by the Engineer.
- The final welding of joints within turnouts shall be undertaken as per sequence as approved by Engineer and within the stress free temperature range.
- The elementary long welded rail shall be laid on rollers placed on the metal base plates or sleeper rail table, with the rollers at maximum 6.00-m intervals. In any case, rollers shall have suitable diameter to avoid contact between rail and intermediate sleepers/metal base plates.
- After placing the long welded rail on rollers, it shall be stress relieved by hitting the rail on each side of the head with wooden mallets as approved by Engineer.
- For de-stressing of CWR, guidance may be taken from LWR manual of Indian Railways.
- The rails for continuously welded track shall be de-stressed in accordance with temperature conditions

4.23 Buffer Stops

CLAUSE 4.23 : **ATTACHMENT NO. 2**

BUFFER STOPS :

The Buffer stops will be designed for 8 car trains.The weight of empty train will be 336 tonnes and fully loaded car is 544 tonnes.The speed potential for Buffer stop is given below :

NAME OF THE TRACK	NO.OF BUFFER STOPS SPEED 25 KMPH	NO.OF BUFFER STOPS SPEED 10 KMPH	NO.OF BUFFER STOPS SPEED 5 KMPH	OBERALL LENGTH OF BUFFER STOP INCLUDING SLIDING LENGTH OF TRACK	Loaded/Empty
AAREY DEPOT					
TEST TRACK/DP-48	2			14.5	Empty
OPEN STABLING ZONE (1 & 2)			29	7.5	Empty
DELIVERY TRACK			1	7.5	Empty
DP 6 & 7 (Aarey Station & Stabling Line)	2			14.5	Loaded
DP 37 & 50 (DEAD ENDS)			2	7.5	Empty
DP 29/UNDER FLOOR WHEEL LATHE			1	7.5	Empty
RETRACTABLE BUFFER STOP-MAINTAINENCE WORKSHOP			3	7.5	Empty
SHUNTING NECK 1		1		10.5	Empty
SHUNTING NECK 2		1		10.5	Empty
MAINTANANCE WORKSHOP (INSPECTION BAY)			4	7.5	Empty
OCC & INFRASTRUCTURE MAINTAINENCE			4	7.5	Empty
MAIN LINE					
CUFFE PARADE STATION					
UP LINE	1			27.4	Loaded
DOWN LINE	1			27.4	Loaded
BKC STATION					

POCKET TRACK UP LINE			1	8.5	Loaded
POCKET TRACK DOWN LINE			1	8.5	Loaded
SPARES					
As Spares - Friction Buffer Stop 25 KMPH	2				
As Spares - Friction Buffer Stop 10 KMPH		2			
As Spares - Friction Buffer Stop 5 KMPH			4		
As Spares - Retractable Buffer Stop 5 KMPH			2		
TOTAL	**8**	**4**	**52**		
GRAND TOTAL	**64**				

4.24 Level Crossings

The Contractor shall be responsible to provide the precast RCC road Surfacing at level crossings in the depot at the locations shown in the Depot Drawing .

4.25 Permanent Markers

Permanent Markers shall be designed and manufactured according to applicable standards and specifications.

All permanent markers shall be manufactured from aluminium sheet.

Table: No. 8

Sl. No.	Type of Permanent Marker	For use of Maintenance	For use of Driver	For use of others	Remarks
1	Km Marker		**X**		
2	Chainages Marker	**X**		**X**	For Signal & Power
3	Horizontal Curve Marker	**X**			
4	Vertical Curve Marker	**X**			
5	Turnout Number Marker	**X**	**X**	**X**	For Signal & Power
6	Gradient Marker	**X**			
7	Weld Marker	**X**			
8	LWR / CWR Reference Marker	**X**			

	(if needed)				
9	REJ Marker (if needed)	**X**		**X**	For Signal and Power
10	Fouling Point Marker	**X**	**X**	**X**	For Signal and Power
11	Applied Cant Marker	**X**			
12	Speed Restriction Markers		**X**	**X**	For Signal and Power

Exact position, final fixation arrangements, installation procedures, specification of epoxy adhesives/fixing arrangement to be used shall be precised in the Detail Design.

4.25.1 **Environment conditions**

Permanent Markers shall be designed in order to meet the environmental conditions prevailing in the area of Mumbai, such as:

- Atmospheric ultra violet radiation,
- Moisture and humidity in the tunnel,
- Contact with oil, grease or distillate dropped from track vehicles,
- Design rail temperature range,
- Air throughout the Project area can contain considerable moisture content and the atmosphere can be corrosive.

4.25.2 **Service life of Permanent Markers**

The design service life of the Permanent Markers shall be 30 years when maintained as per standard procedures as recommended by the supplier. However, the design service life shall be reconfirmed by the Approved Supplier at Definitive Design Stage.

4.25.3 **Types of permanent markers**

As the track is completed, permanent markers shall be provided and installed as follows:

- Chainages Marker,
- Kilometres Marker,
- Horizontal Curve Marker,
- Vertical Curve Marker,
- Turnout Number Marker,
- Fouling Point Marker,
- Weld Marker,
- Applied Cant Marker,
- Gradient Marker,
- REJ Marker (if any).

4.26 Manufacturers

The Contractor shall submit to the Employer's Representative for each item or component to be manufactured, the proven service record of the components and full details of the previous relevant experience of the proposed manufacturer in the production of that item, and also previous

experience of manufacturing similar products for the Railway industry as well as for MRT Projects. The major items that require particular and specific previous manufacturing expertise and require prior approval from the Employer's Representative are as follows:

(i) Friction buffer stops;
(ii) Track fastening system components
(iii) Turnouts and crossovers, in general and in particular any previous manufacture of turnouts and crossovers of the type specified.

4.27 Design and Serviceability

4.27.1 General

The "design life" of a structure or component is that period for which the item is required to fulfil its intended function when maintained in accordance with agreed procedures to meet a required level of performance. The definition of a "design life" for a structure or component does not necessarily mean that the structure will no longer be fit for its intended purpose at the end of that period. Neither will it be expected to necessarily continue to be serviceable for that length of time without adequate maintenance to mitigate the demands of degradation.

4.27.2 Civil Engineering Structures

The design life of all civil engineering structures above ground shall be a minimum of 120 years unless otherwise specified or agreed upon.

Adequate measures shall be taken to ensure minimum of 120 years serviceability of civil structures, producing durable concrete. Suitable property enhancers/ blending materials confirming to relevant codes may be used as required.

The concrete shall be tested for permeability according to DIN 1048 and ability to resist chloride ion penetration according to ASTM C 1202. Water permeability shall not be more than 10 mm and RCPT value shall not exceed 1000 coulombs.

All sources for property enhancers of concrete shall be approved by the Employer's Representative.

Contractor is expected to submit a report demonstrating, the approach in design, construction & selection of material so as to achieve 120 years design life.

4.27.3 Serviceability of Track

The service life of rails shall be 35 years and that of fastening system as a unit shall be 30 years. However, components of the fastening system such as rubber pad, rail clip etc. shall have service life of 15 years or 300 GMT, whichever is less. Anchor bolts or studs eventually used for fixing the fastener to the concrete should not be required to be replaced during service life. Full service life is to be attained under the following conditions.

a) Atmospheric ultra violet radiation
b) Proximity of track up to 10m from salt water source
c) Contact with oil, grease or distillate dropped from track vehicles.

5.0 NOISE AND VIBRATION MITIGATION

MM3 Line shall be designed to ensure that noise emitted is well within the prescribed limits for the particular area.

Requirements to assessment levels (L) are based on energy-equivalent mean values of sound pressure level for day and night as mentioned in below table.

5.1 Noise

Noise Pollution Standards in India

The ambient air quality standards in respect of noise in different areas/zones have been notified by the ministry of Environment & Forest, Government of India vide The Noise Pollution (Regulations and Control) Rules, 2000.The Schedule of ambient air quality standards in respect of noise notified in the above rules is reproduced below:

Table: No. 9
Ambient Air Quality-standards in respect of Noise

Area Code	Category of Area/Zone	Limits in dB(A) L_{eq}	
		Day Time	Night Time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

Note:

1. Day time shall means 6:00 a.m. to 10:00 p.m.
2. Night time shall means from 10:00 p.m. to 6:00 a.m.
3. Silence zone is defined as an area comprising not less than 100m around hospitals, educational institutions and courts. The silence zones are zones which are declared as such by the competent authority.
4. Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.
5. dB(A) L_{eq} denotes the time weighed average of the level of sound in decibels on scale A, L_{eq} being energy mean of the noise level over a specified period.

5.2 Vibrations

The effects of ground-borne vibrations include feel-able movement of the building floors, rattling of windows, shaking of items on shelves or hanging on walls, and rumbling sounds. Annoyance from vibrations often occurs when the vibrations exceed the threshold of perception by 10 decibels or less. This is an order of magnitude below the damage threshold for normal buildings.

RDSO Guidelines for Noise & Vibrations, Metro Rail Transit system Recommended Criteria for Ground-borne Vibration & Ground-Borne Noise for General assessment is given below:

Table: No. 10

Land use category	**Ground-borne Vibration Impact Levels (VdB ref=25.4μ mm/s)**	**Ground-borne Noise Impact Levels (dB ref 20 μ Pa)**
Category 1: Buildings where vibration would interfere with interior operations	65 VdB	N/A*
Category 2: Residences and buildings where people normally sleep	72 VdB	35 dB(A)
Category 3: Institutional land uses with primarily day time use	75 VdB	40 dB(A)

*Vibration sensitive equipment is not sensitive to ground-borne noise

Vibration generated from train movement is the result of the interaction between vehicle wheels and rails. The train wheels rolling on the rails create vibration energy that is transmitted through the Track support system into the transit structure.

The amount of energy that is transmitted into the transit structure is strongly dependent on factors such as how smooth the wheels and rails are and the resonance frequencies of the vehicle suspension system and the Track support system. These systems, like all mechanical systems, have resonances, which result in increased vibration response at certain frequencies, called natural frequencies.

The vibration of the transit structure excites the adjacent ground, creating vibration waves that propagate through the various soil and rock strata to the foundations of nearby buildings. The vibration propagates from the foundation throughout the remainder of the building structure. A schematic of this phenomenon is presented in the figure below.

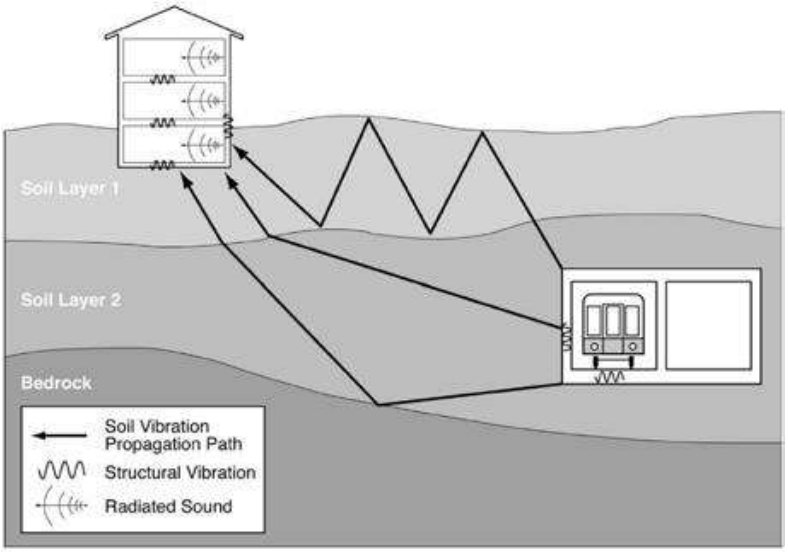

Fig 4 Vibration propagation into buildings for tunnel configuration

5.3 Ground-borne noise impact in underground section

The vibration resulting from Track-train interaction is transmitted through the tunnel structure and the surrounding ground to adjacent buildings. The resulting vibrations of the walls and floors in these buildings cause the secondary radiation of noise called ground-borne noise.

The vibration resulting from Track-train interaction is transmitted through the tunnel structure and the surrounding ground to adjacent buildings. The resulting vibrations of the walls and floors in these buildings cause the secondary radiation of noise called ground-borne noise.

5.4 Estimation of ground-borne vibration

Ground-borne noise is a result of ground-borne vibration. Therefore, the prediction of ground-borne vibration at specific location has to be preceded to assess the ground-borne noise.

The factors how the soil can mitigate the propagation of vibrations is mainly given from its own characteristics and have a different behaviour depending from the frequency of the vibrations generated from the source.

The classification of frequency characteristics for underground are:

• **Low frequency:** < 30Hz: Low-frequency vibration characteristics can be assumed for subways surrounded by non-cohesive sandy soil or whenever a vibration isolation Track support system will be used.

• **Typical:** peak between 30 and 80Hz. This is the typical vibration characteristic that is considered as the default assumption for subways.

• **High frequency:** > 80Hz. High-frequency characteristics should be assumed for subways whenever the transit structure is founded in rock or when there is very stiff clay soil.

The relevant excitation spectra of vibration and ground-borne noise generated by railway traffic are usually between 10Hz and 200Hz, the typical maximum values being measured between 30Hz and 80Hz (relevant frequency band).

Vibrations with frequencies above this range are dissipated rapidly by materials such as soil or concrete, which carry the waves.

Structure/soil interaction significantly affects the radiation of vibration energy into the surrounding soil. Heavy tunnel structures produce lower levels of ground vibration than lightweight tunnels, depending on soil stiffness and frequency of excitation.

5.5 Vibration Management Plan

The process for controlling the vibration impact of a railway system on the surroundings is explained in the Figure below:

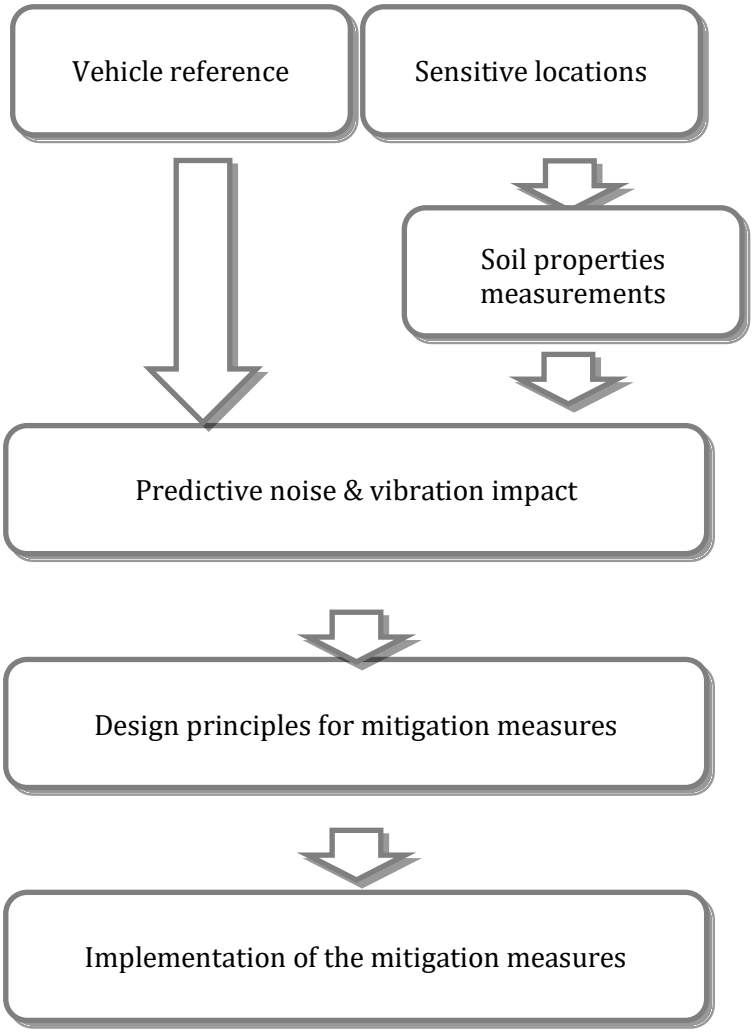

Fig 5 Process for vibration and ground-borne noise control

5.6 Prediction principles

The prediction of ground-borne noise & vibration levels nearby buildings consists of the following steps:

1. Determination of excitation at source : force density level (L_F) ;

2. Propagation of the vibration levels from the Track to nearby buildings through the soil: transfer mobility (TM_{line});
3. Soil-structure coupling at basement levels.

The combination of the force density level and the transfer mobility is used to predict the ground surface vibration.

The following equation is the basis for the prediction procedure, where all quantities are in decibels with consistent reference values:

$$L_v = L_F + TM_{line}$$

Where:

- L_v is the vibration velocity level;
- L_F is the force density for a line vibration source (e.g. : the train);
- TM_{line} is the line source transfer mobility (it is computed from measurements carried out during in-situ measurements).

All the parameters given above are function of frequency.

5.7 Vibration control provisions (Low Vibration Track, LVT)

Numerous methods for controlling ground-borne noise & vibration include continuous floating slab Track, resiliently supported two block or mono-block sleepers, ballast mats, resilient direct fixation fasteners, and alignment modification and low-stiffness vehicle primary suspension systems. Achieving the most practical solution at reasonable cost is of great importance in vibration mitigation design. Factors to consider include as main parameters among many others: maintainability, ease of inspection and cleanliness.

5.8 Resilient direct fixation fastener design for vibration isolation

Resilient direct fixation fasteners used for supporting the rail on ballastless Tracks are very common at heavy rail transit systems where subway are involved. Resilient direct fixation fasteners control ground-borne noise & vibration can be provided with a wide range of stiffness values, allowing to adjust rail support modulus as needed. In general soft fasteners transmit less ground-borne noise &vibration than stiff fasteners do, whereas stiff fasteners reduce rail vibration and rail-radiated noise more than soft fasteners do (however this latter phenomenon is less impacting in tunnel). The selection of a fastener's stiffness will depend on the type of structure and the nature of the vibration or noise that is to be controlled. The static stiffness ranges of fasteners are described as follows:

- The stiffness of the fastener is mainly controlled by the resilience characteristics of the rail pad and of the baseplate pad and by the geometry of the baseplate ("shape factor").
- A low-stiffness fastener will allow the rail to deflect over a larger distance under static load than a high-stiffness fastener. The axle load is distributed over more fasteners with low stiffness than over fasteners with high stiffness, reducing anchor bolt and concrete support stresses.

Low rail support stiffness is advantageous in reducing the vertical resonance frequency of the rail on the fastener stiffness.

5.9 Resiliently supported bi-block or mono-block sleepers

With resiliently supported bi-block or mono-block sleeper designs, each rail resp. both rails are supported on concrete blocks/sleepers set in an elastomer boot encased by a concrete support. A stiff elastomer or plastic rail seat pad protects the concrete block/sleeper at the rail base. The main

advantage of the resilient bi-block or mono-block sleeper system is that anchor bolts are not required thus reducing part count and improving reliability of the rail Fastener system.

Rail pads that are too soft may induce clip fatigue, so clip design must be carefully reviewed and proposed. Also maintenance and durability have to be attentively considered.

5.10 Mitigation Performance

Maximum Vibration with the Mitigation measure to be restricted so as to achieve vibrations at building at surface as per RDSO CT 38 guidelines for noise and vibration .The location wise vibration data as per study at track bed level will be specified for guidance only for assessing the Noise & Vibration required for designing track structure.

5.11 Calculation for the prognosis of the proposed Track system

The following parameters have to be used when calculating the natural frequency and the insertion loss of the system (Prediction):

- Unsprungmass: max 15% of the wheel-set mass.
- Weight of the Track system mass and of the fastening system.
- Total stiffness of theoretical model includes vertical C_{dyn}, calculation (f0,σ1) of bearing underneath the slab (if any) and horizontal C_{dyn}, calculation (f0,σ0) of the side mats (if any).

Output of the calculation should clearly show:

- Natural frequency of the whole Track system.
- Dynamic bedding modulus of material at the operating load levels of running train and at the natural frequency.
- Deflection of rail at operating speed (load level is to be considered: mass of superstructure plus mass of train and considering the effect of elastic rail fastening system).
- Static bedding modulus between load range of minimum load and operating load.
- If systems are calculated as mass spring system, the output shall be natural frequencies and the dynamic interaction ("Transfer function" over the whole frequency range).

Note:

Maximum deflection of rail shall not be greater than 6mm.

5.12 Criteria for Minimum Vibration Attenuation in MML3

i) Vibration attenuation

a) The track structure shall be capable of achieving a minimum vibration attenuation of 22 VdB in the track bed at any one frequency point in the vibration frequency range of 0.5 to 80 Hz, proven via a calculated transfer function chart.

b) Further, the vibration attenuation performance of the proposed booted twin block sleeper system shall be a minimum of 22 VdB more than a direct fixation track with any of the rail fastening used on any of the existing Indian metro network, at any one frequency point between 0.5 to 80 Hz, proven via a calculated insertion loss chart. The static stiffness of the reference direct fixation track system shall be considered as 22.5 kN/mm for this purpose.

c) The proposed track structure shall meet both above criteria independently.

d) The tolerance in vibration attenuation upto -2VdB is acceptable at isolated locations

ii) The track structure shall have a natural frequency of approximately 18 Hz. Variation in natural frequency is acceptable if the attenuation prescribed in Para (i) above is achieved.

iii) The track structure shall be capable of achieving a minimum vibration attenuation of 22 VdB.

iv) TESTING METHOD - The contractor should submit the design report and test/measurement plan to prove that the contractor can meet the specified Noise & Vibration requirement. Those documents need be approved by the employer

APPENDIX 1
ALIGNMENT DESIGN CRITERIA

NUMBER	CRITERIA	VALUE MAIN LINE	VALUE DEPOT TRACKS LINE
Performance criteria			
AL1	Design Speed – Mainline(Straight Section)	95 Km/h	25 km/h shunting Tracks 15 km/h Depot outdoor 5 km/h Workshop
Comfort criteria			
AL2	Non-compensated lateral acceleration at ToR	Desirable < 1.0 m/s^2	NA
AL3	Rate of change of non-compensated lateral acceleration	< 0.65 m/s^3	NA
AL4	Maximum vertical Acceleration	< 0.5 m/s^2	NA
AL5	Abrupt change of cant deficiency	Not Permitted	NA
AL 5.1	Rate Of Change of Cant Deficiency	Desirable :35mm/s Maximum :44mm/s	NA
AL6	Abrupt change of cant deficiency in Turnout zones	100mm (Max. Cant Deficiency)	NA
AL7	Maximum rate of change of cant	Desirable :35mm/s Maximum :55mm/s	NA
Technical criteria			
AL8	Maximum Cant	125 mm	-
AL9	Maximum Cant Excess	100mm	NA
AL10	Maximum cant gradient	Desirable1 in720 Maximum1 in 440	NA
AL11	Minimum transition curve length	0.440*Cant (for cant ≥ 20 mm) For cant < 20 mm L_{min}= 25 m	NA
AL12	Minimum Length of elements (circular curves and straight alignment)	0.3 V	NA
AL13	Minimum straight alignment between reverse curves with cant transition	18 m	-

NUMBER	CRITERIA	VALUE MAIN LINE	VALUE DEPOT TRACKS LINE
AL14	Minimum straight alignment between reverse curves without cant transition excluding turnout zones	20m between two circular curves. 0m between two transition curves. No intermediate values permitted.	20m (no transition curves in Depot)
AL15	Minimum horizontal radius	200m for Underground 120m for At Grade &Elevated.	100m for Depot
AL16	Distance between centrelines (Minimum)	UG-3800mm Elevated -3900mm	Depot and At Grade 3900mm
AL17	Maximum gradient (without considering the effect of horizontal curvature)	4%	4%
AL18	Equivalent gradient of the effect of horizontal curvature	0.04%per degree	0.04%per degree
AL19	Overlapping of vertical curves and horizontal transition curves	No Overlapping is allowed in transition zone.	No Overlapping is allowed in transition zone
AL20	Minimal length of straight alignment in station	20 m before and after station.	NA
AL21	Vertical gradient in station, parking locations	1in 400 & No change in gradient in Platform Area	-
AL22	Compound curve formed by two circular curves in same direction and transition curve in between: Minimal length of the transition curve.	$L=0.008\ (Ca1-Ca2)\cdot V_m$ or $L=0.008\ (Cd1-Cd2)\cdot V_m$ whichever is greater, whereas Ca1, Ca2 are cant, respectively Cd1, Cd2 are cant deficiency of curves no 1 and no 2 in mm.	NA
Turnout location criteria			
AL23	Minimum distance between 2 turnouts excluding the configuration of crossover and scissors crossover	6m	2.5 m
AL24	Distance between 1 turnout and cant transition	15m	30 m
AL25	Distance between 1 turnout and horizontal curve (applicable only if it is not possible to locate a cant transition)	15m (Desirable)/3 m (Minimum) m	30 m
AL26	Distance between 1 turnout and vertical curve	15m (Desirable)/3 m (Minimum) m	30 m

NUMBER	CRITERIA	VALUE MAIN LINE	VALUE DEPOT TRACKS LINE
AL 27	Turnout in Transition Curve	Not Permitted	Not Permitted

MUMBAI METRO LINE 3

(COLABA-BANDRA-SEEPZ)

CONTRACT MM3-CBS-TWK-03
(Package 10C)

Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of Ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and Ballasted Track in the area of at-grade Aarey Station and in the Depot area of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ).

and

Procurement and Supply of Turnouts, Scissor Crossovers and Buffer Stops for the entire Mainline for Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ) including Package 10 B.

TENDER DOCUMENTS

Part 2

Section VI (3)

EMPLOYER'S REQUIREMENT
OUTLINE CONSTRUCTION SPECIFICATIONS

July 2019

Mumbai Metro Rail Corporation Ltd
Line 3 Transit Office, Wing 'A'North Side of City park'E'- Block, ,
Bandra-Kurla Complex,
Bandra (East) Mumbai 400 051, India

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MUMBAI METRO LINE 3
CONTRACT MM3-CBS-TWK-03

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	Section I.	Instructions to Bidders(ITB)
	Section II.	Bid Data Sheet(BDS)
	Section III.	Evaluation and Qualification Criteria
	Section IV- A.	Bidding Forms
	Section IV- B.	Pricing Document
	Section V.	Eligible Source Countries of Japanese ODA Loan
Part2	**Employer's Requirements**	
	Section VI.(1)	General Specifications A. General B. Functional C. Design D. Construction **E.** Inspection Testing and commissioning F. Appendices
	Section VI (2)	Outline Design Specifications
	Section VI (3).	Outline Construction Specifications
	Section VI (4)	Tender Drawings
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	Section IX.	Contract Forms

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MUMBAI METRO LINE3

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Part 2

Section VI (3)

OUTLINECONSTRUCTION SPECIFICATIONS

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MUMBAI METRO LINE 3
CONTRACT MM3-CBS-TWK-03

TENDER DOCUMENTS

Part 2
Section VI (3)
Outline Construction Specifications

TRACK WORKS

Chapter 1: CODES AND STANDARDS

1. CODES AND STANDARDS

1.1. Introduction

The Outline Construction Specifications as will be followed are based on Indian and International Standards as scheduled below. The Contractor shall be responsible for detailing in his specifications submitted to The Engineer, as part of the Definitive Design Submission, the standards on which his materials and workmanship will be based. These shall be of similar or higher standard than those listed below.

The Contractor is required to review in the first instance the Indian Standards and the specifications prepared by the contractor shall be based on Indian Standards to the extent they are applicable.

1.1.1. This Materials and Workmanship Specification for Track work shall be read in conjunction with all the documents forming part of the Contract. The contractor should propose own methodology of construction . The details should be submitted Bid form 5

1.1.2. No Permanent Works shall be carried out until all methods and materials have been subject to issue of notice of no objection by Engineer.

1.1.3. Unless noted otherwise in the Contract, all components and materials shall be handled, transported and stored, in accordance with the manufacturer's recommendations with prior notice of Engineer

1.1.4. The test results of each test to be carried out as per Engineer's requirement shall be recorded and submitted in a format subject to notice by the Engineer and shall include graphical presentation of results as well as numerical base data where ever required.

1.2. Codes

The design and construction of the Permanent Works shall comply with codes of practice and standards prevalent at the time of submission of Tender Documents. Regulations made and requirements issued by the Indian Government and by relevant utility authorities shall be followed and specified.

Alternative or additional codes, standards and specifications proposed by the Contractor shall be internationally recognized codes *including Indian Railway Standards (IRS) and Indian Road Congress (IRC)* and shall be equivalent to or better than Indian Standards issued by the Bureau of Indian Standards or any other Indian professional bodies or organizations subject to being, in the opinion of the Engineer, suitable for incorporation into the Specifications.

Subject to the requirement of this specification and other control documents all design work will comply with the appropriate current standards issued by the Bureau of Indian Standards (BIS), or if such a standard does not exist, then the appropriate current standard issued by the British Standard Institute (BSI) If appropriate standard from BIS and BSI does not exist, then subject to approval by the authority, an appropriate current standard from a reputable institution

may be used. All standards shall be that including Amendments and Addenda, current at the date of tender.

1.2.1 International Union of Railways Standard Codes (UIC)	
UIC Code 860-0	Technical ·Specification for the supply of Rails
UIC Code 861-3	Standard 60 kg/m Rail Profiles Types : UIC 60 and 60 E
UIC Code 864-2	Technical Specifications for Supply of Steer Track Bolts
UIC Code 864-3	Technical Specifications for the supply of spring steel washers for use in Permanent Way.
UIC Code 864-4	Technical Specification for supply of Fish plates or sections for Fishplates made of rolled steel.
UIC Code 864-5	Technical Specification for the Supply of Rail Seat Pads
UIC Code 864-8	Rolled Profiles for Fishplates for 60 kg/m Rails
UIC Code 866-0	Technical Specification for the supply of cast manganese steel crossings for switch and crossing work
1.2.2 International Organization for Standardization (ISO)	
ISO 1113	Information Processing - Representation of the 7 bit coded character set on punched tape
ISO 1191	Plastics - Polyethylene and Polypropylenes in dilute Solution- Determination of viscosity number and of limiting viscosity number.
1.2.3 Indian Standards (IS)	
1.2.3.1 Cement	
IS: 269	Specification for 33 grade ordinary Portland cement.
IS: 650	Specification for standard sand for testing of cement.
IS: 4031	Methods of physical tests for hydraulic cement
IS: 4032	Method of chemical analysis of hydraulic cement
IS: 6925	Methods of test for determination of water soluble chlorides in concrete admixtures
IS: 8112	Specification for 43 grade ordinary Portland cement.
IS: 12269	Specifications for 53 grade ordinary Portland cement.
1.2.3.2 Concrete	
IS: 383	Specification for coarse and fine aggregates from natural sources for concrete.
IS: 456	Code of practice for plain and reinforced concrete.
IS: 516	Methods of test of strength of concrete.

IS: 1199	Methods of sampling and analysis of concrete.
IS: 2386	Parts i to vii. Methods of tests for aggregates for concrete.
IS: 7861	Parts i and ii. Code of practice for extreme weather concreting.
IS: 10262	Recommended guidelines for concrete mix design
IRS	Concrete bridge code
IRC: 21-1987	Standard specifications and code of practice for road bridge section - Ill cement concrete (plain &reinforced(first revision)
IS: 9103	Specifications for admixture for concrete
BS: 14	(Revised)
1.2.3.3 Formwork	
IS: 456	Code of practice for plain and reinforced concrete.
IS: 4990	Plywood for concrete shuttering work.
IRC: 87	Guidelines for design & erection of false work tor road bridge.
IS: 806	Code of practice for use of steel tubes in general building construction.
IS: 1161	Specification of steel tubes for structural purposes.
IS: 1239	Specification of mild steel tubes. Tubular and other wrought steel fittings.
IS: 2750	Specification for steel scaffoldings.
1.2.3.4 Steel	
IS: 280	Mild steel wire for general engineering purposes.
IS: 432	Part I mild steel and medium tensile steel bars. Part II hard drawn steel wire.
IS:456	Code of practice for plain and reinforced concrete.
IS: 814	Parts I & II electrodes for metal arc welding of structural steel.
IS:816	Code .of practice tor use of metal arc welding tor general construction in mild steel
IS: 1566	Hard-drawn steel wire fabric for concrete reinforcement
IS: 1786	Specification for high strength deformed steel bars and wires for Concrete reinforcement.
IS: 2502	Code of practice for bending and fixing of bars tor concrete reinforcement.
IS: 2629	Recommended practice for hot-dip galvanizing of iron &steel
IS: 4759	Hot-dip zinc coating of structural steel and other allied products.

IS: 2751	Code of practice for welding of mild steel plain and deformed bars for reinforced concrete construction.
IS: 9417	Recommendations for welding cold-worked steel bars for reinforced concrete construction.
IS: 800	Code of practice for general construction in steel
1.2.4 European Standards (EN)	
EN 206-1	Concrete-Part 1: Specification, performance, production
EN 1561	Founding - Grey Cast Iron
EN 1562	Founding - Malleable Cast Irons
EN 1563	Founding - Spheroidal Graphite Cast Irons
EN 13230-1	Concrete sleepers and bearers - Part 1 General requirements
EN 13230-2	Concrete sleepers and bearers - Part 2 Pre stressed mono block sleepers
EN 13230-3	Concrete sleepers and bearers - Part 3 concrete bi-block sleepers
EN 13230-4	Concrete sleepers and bearers - Part 4 Pre stressed bearers for switches and crossings
1.2.5 German Standard (DIN)	
DIN 53455	Testing of Plastics - Tensile Test
DIN 53479	Testing of Plastics and Elastomer - Determination of Density
DIN 53508	Testing of rubber - Accelerated ageing
1.2.6 Indian Railway Standards	
IRS T-1	Fish plate
IRS T-10	Switches, crossing and REJ's
IRS T-12	Rails
IRS T-19	Fusion welding of rails by Alumino-Thermic process
IRS T-23	Fish bolts and nuts
IRS T-28	High Tensile steel fish bolts and nuts
IRST-29	CMS crossings
IRS T-31	ERC
IRS T-37	GR sole plate (for 6 mm sole plate pad and any other relevant specification)
IRS T-44	GFN-66 liners
IRS T-46	SGCI inserts

Indian Railway Manual for Alumino-Thermic Welding 1998
Indian Railway Manual for flash butt Welding 1996
Indian Railway Manual for Ultra Sonic Testing of Rails and Welds 1998
Indian Railway Manual of instructions on Long welded rails 1996
Indian Railway Manual for Glued Insulated Joint 1998

The technical specifications and manuals etc. of Indian Railways which are mentioned in clause 1.2.6, shall be used only as far as they are applicable to a Standard Gauge system. The Contractor shall be responsible for collecting the latest revision of all relevant technical specifications to be used, including any correction slips and alterations, from the issuing body at his own cost and shall submit them to the Engineer before starting of work.

1.3. System Interface Activities

1.3.1. System Interfaces exist between the Contractor and the Designated Contractors for systems, where the systems are mutually dependent, or interactive for satisfactory and safe operation. The Contractor shall maintain close coordination/System Interface during design, construction, testing, commissioning, Integrated Testing & Commissioning, trial run and defect liability period with the Designated Contractors and consultants who may be working on the Project, whether or not specifically mentioned in the Contract. The Contractor shall perform all design duties and provide all materials, equipment and labor to ensure the satisfactory accomplishment of System Interface of the systems for which the Contractor is responsible in accordance with Appendix-19 System Interface Management Requirement of Section VI(1)F.

1.3.2. The Contractor shall approach the Engineer for the general System Interface information such as System Interface requirements, contact points of the Designated Contractors, and once information is received, would coordinate with them for System Interface activities including the Engineer in the information loop.

1.3.3. The Contractor shall submit and maintain an agreed System Interface Management Plan. At all stages of the work, all System Interfaces shall be discussed and agreed upon, through the Engineer between the Contractor and the Designated Contractors. System Interfaces should essentially be with Civil Infrastructure, Power Supply & Traction, E & M, Telecommunications, Signaling, Rolling Stock and other Designated Contractors advised by the Engineer. The Engineer's Requirements General Specification outlines the requirements of the System Interface Management Plan.

1.3.4. General System Interface information such as System Interface requirements, draft System Interface sheets etc. have been furnished by the General Consultants while framing the Bid Documents. The responsibility of implementing effective and satisfactory interfacing shall rest with the Designated Contractors involved. The role of General Consultants is to ensure that the whole process goes on smoothly and is implemented with the proper level of quality. General Consultant will specifically intervene when there are disputes and/ or delays.

1.3.5. It will be the responsibility of the Contractor that System Interface requirements will be finalized as early as possible. Contractual delays and consequential implications as a result of delay in such co-ordination on account of reasons attributable to the Contractor, as concluded by Engineer, shall be the sole responsibility of the Contractor.

1.3.6. It would be the responsibility of the Contractor to settle all disagreements with the Designated interfacing Contractors. If such disagreement cannot be resolved by the Contractor, despite all reasonable efforts, then the decision of the Engineer shall be final and binding on both parties.

1.3.7. Broad System Interface requirements between the Contractor and the Designated Contractors detailing the interfacing issues and division of responsibility are summarized in the Engineer's Requirements Appendix-19 of Part 2 Section VI (1) F.

1.3.8. The above System Interface obligations placed on the Contractor shall be read in conjunction with the System Interface obligation mentioned in General Specifications, Conditions of Contract and other Contract documents, in particular, Section A.11 and Appendix – 19 of Part 2 Section VI(1) F.

MUMBAI METRO LINE 3

CONTRACT MM3-CBS-TWK-03

TENDER DOCUMENTS

Part 2
Section VI (3)
Outline Construction Specifications

TRACK WORKS

Chapter 2: SURVEY AND SETTING OUT

2. SURVEY AND SETTING OUT

The setting out of alignment for track construction shall be the responsibility of the Contractor. The following principles shall be adopted for setting out and execution.

2.1. Functional Responsibilities

2.1.1. The planning organization and process of surveys for transferring the alignment for track construction shall be the sole responsibility of the Contractor. He shall at all times maintain common survey System Interface with the Civil Contractors.

2.1.2. Survey and setting out of works shall be carried out by surveyors of appropriate experience and qualification.

2.1.3. The Engineer may carry out random checks to verify the accuracy of the setting out and Contractor compliance of the completed works with given alignment and the specifications. Provisions and arrangement shall be made by the Contractor to facilitate the checks. However, full responsibility lies with the Contractor for the accuracy of line and level of the tracks.

2.2. Survey Controls

The Contractor shall initiate the requested activities over the System Interface with designated Civil Contractors to take over the reference co-ordinates system (x, y, and z) of the project area as defined by the Project. The Secondary Survey Control Markers are additional points to be established by the Contractor along alignment or in the depot from the reference coordinate system including bench mark thus providing survey control for the work areas. The Contractor may also establish additional survey control Markers as local grids or reference system for setting out particular sub-set of work.

2.2.1. Secondary Survey Controls: As each section of track or depot becomes available the Contractor shall submit a schedule of secondary Control Markers and Benchmarks for that area duly interfacing with the Designated Contractors. The Survey Control Markers and Bench Marks shall be used for the control of the Works. The Contractor shall verify the relative accuracy *of* the Survey Control Markers and Benchmarks prior to use.

2.2.2. All the Survey control markers and Benchmarks provided within the project area by the designated Civil Contractors shall be surveyed, with survey computations based on the adopted co-ordinates system. Any changes in values shall be supported by technical evidence and on consultation with all affected parties.

2.2.3. In particular, any changes in co-ordinate values of Secondary Survey Markers shall only be adopted with due notice of no objection of the Engineer. The Contractor shall be responsible to prepare modified drawings/proposals in this regard for Information to all concerned parties and for notice of the Engineer.

2.2.4. It shall be the Contractor's responsibility to protect and preserve the integrity of all the Control Markers during the period of construction of the track works. In the event that any of the Secondary Control Markers or Benchmarks is damaged, the Contractor shall replace and re-establish the points at his own cost to the satisfaction of the Engineer.

2.2.5. In the interfacing area with the other Track Contractor, both Contractors shall agree common Survey control markers and Benchmarks to which both have to refer for survey purposes.

2.3. Setting Out

2.3.1. Setting out points shall be established by transfer from the survey control Markers.

2.3.2. At each site, the position of the site main reference setting out points shall be maintained throughout construction period. Such markers shall be checked against the Survey Control markers by the Contractor at regular intervals to ensure reliability of subsequent works.

2.3.3. The track sitting marks corresponding to both the theoretical center of the track and to the theoretical level of the track running surface, as defined by the relevant topographical data on the documents relating to track layout shall be marked at the beginning and end of each circular curve, transition curve and vertical curve both in the longitudinal and cross directions. The following track sitting marks shall be established:

- In straight sections: every 25 m,
- In curved sections: every 10 m.

The track sitting marks for the center of the tracks shall be shown by plates or nails sealed on the underground section and in the depot, subject to notice by the Engineer. They shall be referenced by the Cartesian co-ordinates of each point identified in this manner, and registered in the topographical logbook. Should there be any discrepancy found by the Contractor with reference to the geometry of civil structure, the same should be System Interfaced with the Civil Contractor. The Contractor shall be responsible to prepare details duly making necessary modifications in layout, if required as a solution to the discrepancy and submit the same to the Engineer for his notice of no objection.

The track sitting marks for the vertical sitting of the track running surface shall be shown by angle plates sealed onto the tunnel sidewalls or on a close, stable basis on the at grade section and in the Depot. They shall be referenced with respect to the theoretical track level. The designed basis for at grade and Depot shall be subject to approval from the Engineer.

Given that the precision of the spatial sitting of track laid directly on concrete is of the utmost Importance, the Contractor shall position the above markings as follows.

2.3.4. Leveling:

The markings showing the track altitude, shall be placed at a constant height in relation to the theoretical level of the track running surface. They shall be placed at every

temporary support frame of track or 5 m, whichever is less.

2.3.5. Layout:

The markings show the centerline of each track, shall be fitted at every temporary support frame of track or 5 m whichever is less in straight sections, in circular curves and in transition curves.

2.3.6. The inner rail for curve and any rail for straight shall first be set out in its absolute position from track sitting marks using co-ordinates computed from the alignment geometry, the elevation or the rail shall be checked using a level, the other rail shall be set correctly relative to cross level and gauge from the first rail.

2.4. Control of Track Works

2.4.1. The Contractor shall ensure that critical dimensions for the Mumbai Metro Rail project are met. Regular checking should be carried out during the construction stages to ensure that the specified permissible deviations are not exceeded.

2.4.2. The Contractor shall establish physically on site such track silting marks that may be grid or offset points to be used as the reference system for the track work. In the event the original structural grid line are destroyed or rendered unusable, the Contractor shall re-establish them at his own cost without delay.

2.4.3. The Contractor shall ensure that all survey and track sitting marks shall be established on Site to required accuracy. He shall also be responsible for each stage of the setting out work and for verifying compliance before construction starts.

2.4.4. The Contractor shall develop a detailed Surveyed Track Analysis spread sheet on Microsoft EXCEL. The detailed format of the Surveyed Track Analysis spreadsheet shall be submitted to the Engineer for information.

2.4.5. The surveyed Track Analysis spread sheet shall tabulate against chainage, the vertical difference (high or low) and horizontal difference (left or right) between the actual surveyed track center line position and the design alignment computed from latest approved alignment geometry. Derived cant, gauge and twist values shall also be compared against design values on the same spreadsheet.

2.4.6. Any out of tolerance condition shall be flagged upon the spreadsheet.

2.5. Survey Instruments

2.5.1. Survey instruments used and the methodology adopted shall be appropriate to the intended measurement task and accuracy specifications. Test measurements and instrument calibration shall be carried under local field conditions.

2.5.2. It is essential that before starting any initial surveys, and at frequent intervals of not more than three months, all measuring equipment should be tested for their accuracy.

2.5.3. All instrument deployed in the Contract shall be in good condition and properly calibrated. Calibration certificates and/or statements of services by local authorized instrument agents of not more than six months shall be the proof that the instruments are in good service conditions.

2.5.4. Notwithstanding the above, instruments shall again be checked to ensure good condition before the Contractor proceeds to carry out a critical survey task.

2.5.5. Horizontal control traverses shall be carried out with modern precise digital survey instruments consisting of co-axial total station with an accuracy not inferior to 2"arc and Accuracy with a prism AP01:± (2+2ppmxD)mm. Precise levelling runs shall be carried out in both directions using digital level with an accuracy not inferior to1.5 mm per km double run. Digital data from the above instrument shall be recorded electronically in the field.

For track surveys non co-axial total station shall not be permitted. Total stations used for track surveys shall have onboard software permitting setting out and checking of points along a calculated alignment in the field. Survey instruments used by the Contractor shall meet such standards.

All setting out is done with reference to the survey control installed before construction works start in an area.

Spigots will be installed in the derailment protection wall at given intervals. The spigots will be used as a reference point for initial setup, and will locate the track to within 5-10 mm, through use of a straight edge with spirit level, and plum bob, or offset gauge.

The survey prism is attached to the spigot in the wall or similarly. The spigot chainage is clearly marked together with cant requirements and height above finished rail level.

Final track alignments will be done by combined survey and track team using a Trolley system or similar precision rail positioning trolley.

This will form part of the survey check and acceptance of the Project Manager/Quality Assurance Manager of the Contractor to certify that the track is within tolerance.

If the track is found to be out of tolerance the concrete will not be poured and the track supervisor will be notified.

2.6. Quality Plan

The Contractor shall submit to the Engineer, for acceptance a separate quality plan related specifically to survey matters. The plan shall address the following:

- Identification of the Contractor key survey staff and the lines of communication.
- Scope of the surveying section including System Interface with designated Contractors
- List of proposed surveying equipment &computer hard/software;
- List of surveying procedures;
- List of detailed method statements for all critical surveying activities;
- Survey test and inspection plan;
- Control of survey data and records

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Part 2
Section VI (3)
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TRACK WORKS

Chapter 3: TRACK INSTALLATION AND CONCRETING OF BALASTLESS TRACK AND SPECIAL TRACK

3. INSTALLATION

3.1. Introduction

Specification Requirements.

The installation and construction work pertaining to this contract shall include, but not be limited to the following:

- Survey onsite and review of the technical requirements shown in this specification and in the Engineer's Requirements.
- Finalization of the construction and installation programme.
- Production of the calculation sheets and installation drawings for site installation.
- Installation in accordance with the finalized installation drawings.
- Co-ordination with the Design Consultants and interfacing Systems.
- Submission of the installation reports and records.
- Testing and commissioning as per finalized protocol and programme.
- Production of as built drawings, documents, calculations sheets and records:

3.2. Track Installation/ Sequence (but not limited to)

General

The following major activities are involved in the construction of ballastless track:

1. Taking over of access from civil contractor including TBM launching location for Track Installation inside Tunnel at related locations.
2. As Built Survey.
3. Stacking of rails and spreading of rails inside Tunnel.
4. Welding & pulling of Rail panels.
5. Levelling of rough surface in the first stage of concrete surface, if required.
6. Cutting, bending and placement of reinforcement, if required.
7. Fixing of shuttering and dummy base plates, if required.
8. Final setting of the track parameters.
9. Concreting.
10. Curing of concrete.
11. Rear works after casting, grouting works.
12. Final track correction and Fixing & tightening of fastening fittings
13. AT welding & De-stressing
14. Final Track Installation with Final Torque & Final Track parameters recording by Track master
15. Cleaning and providing Track connectivity

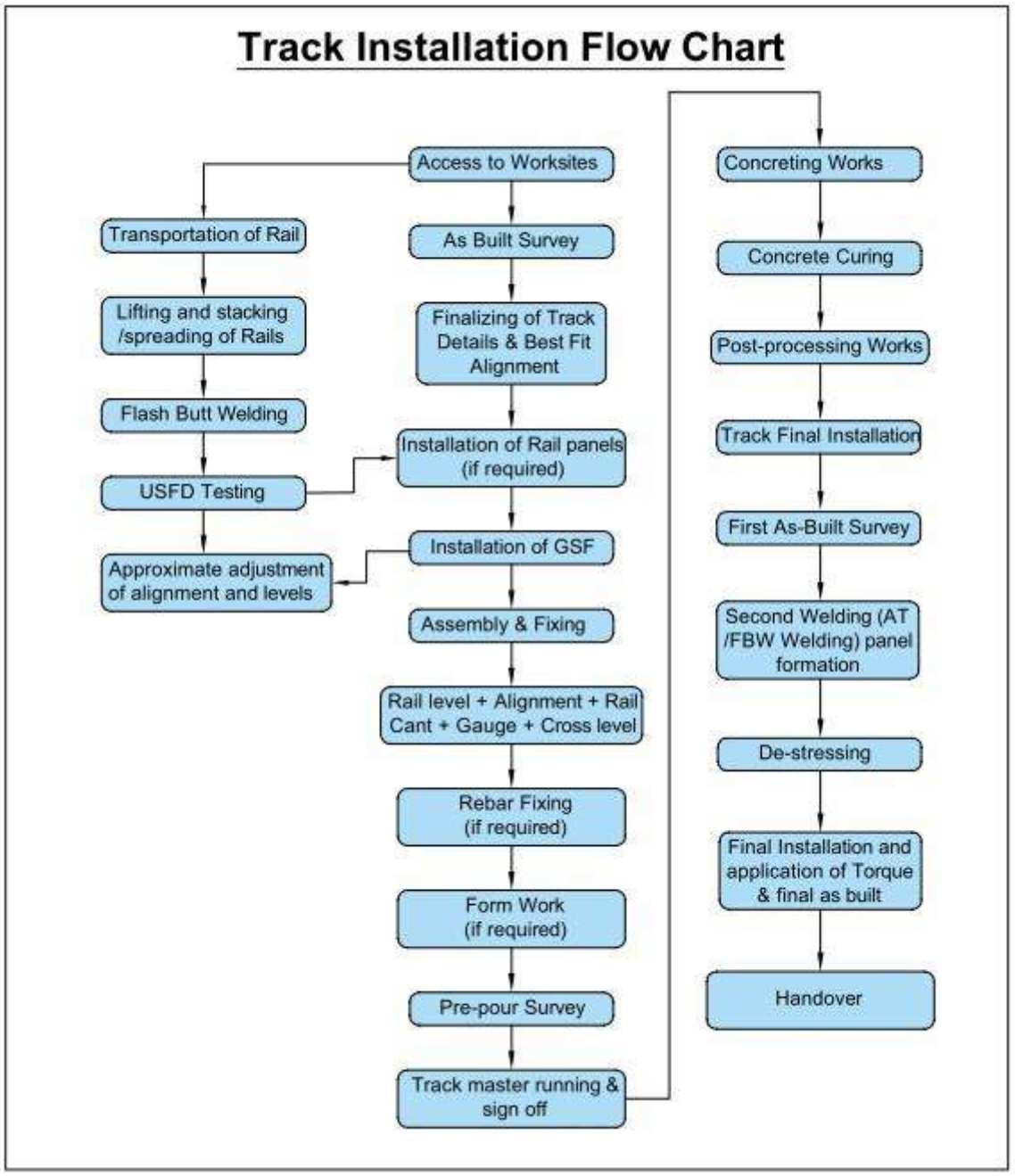

Figure 1: Track Installation Flow Chart

3.2.1. The track gauge throughout shall be 1435 mm on straights and 1435 mm+ gauge widening, if required, on curves measured between the running edge gauge point of each rail and normal to the center line of the track 14 mm below top of Rail.

3.2.2. All main line & depot line track including turnout, x-over and diamond x-ing shall be laid with 1:20 inward rail slope.

3.2.3. The Contractor shall take due cognizance of his proposed rail joining system and the rail fastening assembly spacing in the selection of the appropriate length of long welded rail panels.

3.2.4. The minimum closure rail length in plain line shall be 6 meter except for specific locations as shown on the drawings or as noticed of no objection by the Engineer.

3.2.5. Notwithstanding the nominal track dimensions indicated on the Drawings, the as constructed dimensions may vary subject to the allowable tolerances. In addition may contain ramps, steps, channels, drains, anchor bolts, and the like. The methods of construction shall accommodate these constraints.

All temporary/service tracks, if required for track work on main lines and depot lines, shall be arranged & laid by the Contractor only with prior notice of no objection of the Engineer. The Contractor shall remove these temporary/service tracks after completing the permanent track work

Track forms

3.2.6. The components of slab track system shall be:

(i) Supporting structure will be first stage concreting by civil contractor .
(ii) Track structure will be booted twin block sleepers embedded in track slab including pathway with derailment gaurds
(iii) Longitudinal and cross drains as per the general drainage scheme
(iv) Fastening system
(v) Rail
(vi) other details shown in tender drawings section VI (4)

3.2.7. The special track in depot area shall be of the following types as shown on the Drawings:

(i) Embedded track .
(ii) Track plinth for washable apron (low height plinth without derailment guards).
(iii) Pit tracks with discrete rail supports on each side of the pit.

3.2.8. Track plinth,walkway and drainage shall be laid (as per design), drawing and interfacing requirments.
The components of track plinth system shall be:

(i) Supporting structure on PCC/RCC
(ii) RCC plinth.
(iii) Rail fastening system.
(iv) Reinforced concrete/ precast paving slab for walkway where required along the tracks.
(v) Longitudinal and cross drains as per the general drainage scheme of Aarey depot drawing.
(vi) Any other interfacing requirments

3.2.9. A "Request for Inspection" shall be submitted to the Engineer, complete with all necessary information to allow assessment of the following activities. A Notice of No Objection of the Engineer must be received by the Contractor for the following activities:

(i) Acceptance of support structure including specified surface treatment and shear connectors

(ii) Acceptance of the reinforcement, if any

(iii) Acceptance of the track for jigs, fixtures, supporting form work arrangement and preparation for concreting,

(iv) Acceptance of the track for the movement of construction equipment and machinery,

(v) Acceptance of the track for in situ welding,

(vi) Acceptance of the track for destressing.

3.3. Rail Jointing

3.3.1. Rail Joints

All rail joints throughout the Main lines &Depot lines, including turnouts, except at locations not authorized by the Engineer, shall be welded.

3.3.2. The welding of nominal rail lengths into long welded rail panels for main lines and depot lines shall be by mobile flash butt welding plant. Alumino-Thermic welding shall only be used in exceptional circumstances with prior notice of no objection from the Engineer. Temporary joints between HH rails shall be by means of fish plates & clamps without drilling of holes in rails.

3.3.3. All the welded joints for welding less than 13m rail length shall have prior notice by Engineer.

3.3.4. The Contractor shall obtain Engineer's prior notice of no objection for any rail cutting, which may render generation of unusable small cut pieces. The cut pieces shall remain property of the contractor and shall be removed while clearing the site

3.3.5. Locations of Welds

The spacing of welds and joints shall not be less than 6.0 m between any two welds and for any deviation to this, specific approval of Engineer shall be required in each case. No welds shall be permitted closer than 100 mm to a rail seat as measured between the center *of* the weld and the closest edge of any rail fastener. No welds shall be permitted in the working length of the friction sliding buffer stops.

3.3.6. Long Welded Rails (LWR)

Long welded rail panels (LWR) shall generally be as long as possible. Short panels shall only be permitted when dictated by site conditions/site constraints and covered by a notice of no objection by the Engineer.

3.3.7. Fish-plated Rail Joints

Standard fish-plated joints shall only be used in the depot tracks for locations where welded joints cannot be made.

Standard fish-plated joints shall be installed centrally between two adjacent fastenings and shall

be manufactured and installed to permit the use of standard rail fastening assemblies.

All fish-plated joints shall be fitted with spring washer and nuts.

3.3.8. Glued Insulated Rail Joints (if required)

All glued insulated rail joints, if required, shall be shop manufactured using minimum 6 m long rails. If glued insulated joints have to be manufactured for less than 6 m length due to space constraints, such joints shall have prior notice of No Objection of the Engineer Site fabricated glued insulated joints shall be provided only with prior notice of no objection of the Engineer,

Except in the case of glued insulated joints in the turnout zone the positioning of the glued insulated joint with respect to the approach track (adjoining track) shall be such as to keep a minimum distance of 4.00 m from an existing weld in the rail.

3.3.9. Rail Expansion Joints

Rail expansion joints shall be installed only at locations covered by notice of no objection of the Engineer.

Particular attention shall be given to ensure that rail expansion joints are assembled and installed as per drawing.

Immediately prior to completion of a section, all sliding surfaces of rail expansion joint shall be cleaned and greased.

3.3.10. Rail Temperature

Rail temperatures shall be measured using appropriate embedded type rail thermometers. The minimum number of thermometers required to be used of a segment of track shall be proposed by the Contractor for the prior notice of Engineer.

3.3.11. Cutting of Rails

Rails shall only be cut by using disc type rail cutting machines. The proposed method and equipment for the cutting of rails shall have the prior notice of the Engineer.

Rails required to be cut shall be cold sawn square and vertical across the rail. A deviation from square or vertical of more than 0.5 mm measured about the rail head shall not be permitted. All burrs shall be removed from the rail ends.

Quality of cutting shall be such as to ensure tolerances in flash butt and Alumino-Thermic welding manual.

3.3.12. Drilling of Rails

All fish bolt holes in rails, wherever required, shall be drilled by using proper jigs and drilling machines. All holes in the rails shall be chamfered using chamfering kit & procedure.

3.3.13. Pre-Bending of (UIC 60) Rails

Pre bending of rails for installation in sharp curves is not mandatory. However, if considered necessary or desirable by the Contractor to facilitate the installation, the pre-bending of rails shall only be done using methods and equipment as proposed by the Contractor and approved by Engineer.

3.4. Construction of Reinforced Concrete Slab

3.4.1. The surface of the 1st concrete in tunnel/Station area shall be surveyed to achieve the minimum depth of the Track structure below the rail seats. For such of those locations where minimum depth is not achievable, the Contractor shall, with complete details, seek Engineer's decision.

3.4.2. The Contractor shall prepare and clean the surface of supporting structure for laying of Track Structure by methods as covered by notice of no objection by Engineer.

3.4.3. The slab track shall be constructed by top down method of construction. The laying tolerances for the various track parameters required shall be strictly met. For achieving these tolerances, the Contractor may propose an alternative method/scheme of construction of the Track Structure along with tender submission, if he so desires for Engineer's consideration. However the sole responsibility of achieving the stipulated track laying tolerances lies with the Contractor. The Contractor shall submit the detailed construction methodology including the method of handling and transport of material with the details of temporary works, equipment, plant and machinery, with details of the locations where such method/Scheme has been used for similar project/conditions to demonstrate its success. A notice of no objection by the Engineer is mandatory if any alternative method/scheme is proposed by the contractor for construction of the Track Structure on the Project. If the alternative method/scheme as proposed by the contractor is not covered by notice of no objection by the Engineer, the Contractor shall adopt the top down method for the construction of slab track.

3.4.4. The Contractor shall be responsible to work out the actual height of the Track Structure at each location to maintain the designed rail level and submit the same along with all relevant details for issue of notice of no objection by the Engineer. The Track Structure shall be laid duly making the required provision for cant & vertical curve for all heights worked out above.

3.4.5. During concreting the track fasteners and the running rails shall be protected by adequate covers against possible splattering of concrete.

3.4.6. Side Shuttering may be removed after 24 hrs of pouring of concrete.

3.4.7. The concreted surfaces below the base plates shall be smooth, devoid of any inclusion, roughness and crack, without showing any aggregate at the surface. Further anchor bolts embedded in RCC shall be firm without showing any sign of looseness.

3.4.8. The presence of smooth cavities caused by air bubbles in excess of the value mentioned below shall not be permitted in case of top down construction method.

- Total surface area of the cavities: shall not exceed 3% of base plate area
- Maximum dimensions of the inscribing rectangle of a cavity: 20x30 mm
- Depth of cavity shall not exceed 5 mm in any direction.

Defects within these limits shall be rectified by application of suitable epoxy-based filler material and grinding the surface.

3.4.9 Construction of Embedded Track with Booted High Attenuation Twin Block Sleepers

The Pre-Cast Booted High Attenuation Twin Block Sleepers are to be embedded in the Track Slab; The Booted Twin Block Sleepers with resilient pad shall be fixed with Rail & Fastening system while ensuring the Gauge, spacing & Level of Track and shall be supported on Gauge Supporting Frame (GSF) on removable Jacks resting on Track Bed. Pouring of Concrete will be done along with Track Slab.

3.5. Survey Control

All setting out is done with reference to the survey control installed before construction works start in an area.

Spigots will be installed in the Track Structure at given intervals. The spigots along with the installed survey prism will be used as a reference point for set up. The spigot chainage is clearly marked together with cant requirements and height above finished rail level.

Final track alignment before concreting will be done by a combined survey and track team using a survey system or similar precision rail positioning trolley. This will form part of the survey check to be certified by the Project Manager/Quality Acceptance Manager of the contractor, to certify that the track is within tolerance.
If the track is found to be out of tolerance the concrete will not be poured and Engineer has to be accordingly and urgently notified.

3.6. Final Preparation (before pouring concrete)

Correct track geometry for vertical and horizontal alignment will be set to the approved design by means of adequate installation tools to be approved from the Engineer before commencement of the works and to be described in the Construction Methodology report. The prepared Track must be verified by survey with appropriate geometry checking instruments. This will ensure that the final line and grade of the supported track complies with the specified track tolerances.

Immediately before placing concrete, verification shall also be made that the area to receive concrete is free of standing water and foreign material, and that expansion joint forms and compressible material, if any, have been placed where required.

A stop end shutter will be installed where the proposed concrete pour finishes. This shall be located a minimum of 20 m (straight line) and 10 m (curves) before the end of the already adjusted track in order to permit readjustment of these last 10 m or 20 m together with the next track section.

A similar gap will be left approaching turnout locations, with this section being completed by the turnout crew during their installation work.

The invert will be cleared of all waste and debris prior to concrete placement.

Before any concrete is poured, the QA hold point must be signed off by the Contractor's and Engineer's representative.This will only be done once all the track geometry parameters have been verified. Only after concreting has been authorized to start, the concrete may be transported to the installation site.

3.7. Delivering concrete to the pour

All concrete will be delivered via concreting pump. This pump will deliver directly into the track structure wherever possible.If direct delivery is not possible a secondary concrete delivery system will be used i.e. skip, hopper, mixer truck.

Inside tunnel the concrete will be delivered to site through Mixer trucks mounted on truck and discharged through pump and piping system.

All loads will be rechecked for temperature and slump prior to discharge into the track structure. If concrete is found to be outside specifications it will be rejected.

Samples will be taken by a technician for the manufacture of test cubes. Frequency of testing shall be as per relevant code of Indian Standards.

The entire cycle time from mixing concrete at the offsite plant to discharge into the shutter, is not expected to exceed 80 minutes.

Immediately prior to starting to pump concrete, the pumping line will be lubricated; first with Portland cement and water mixed in the pump hopper, then if necessary a concrete slurry. As an alternative a proprietary product may be used.

The pumping distance will be kept lo a minimum wherever possible.

3.8. Pouring concrete

Concrete pours will generally start from designed construction joints.

The rail fastenings will be protected from concrete by temporary covers, placed over them suitably during initial placing.

On tangent track the concrete will initially be placed in the track center, until it flows completely under the sleeper/block/Base plate and around both ends. The sides of the slab will only then be topped up as necessary

In super-elevated track, the low side will be placed first, and then proceed across the Track structure, then to the center of the Track structure and finally topping up on the high side. This will keep the concrete level stable, until the concrete is above the underside of the concrete sleepers/blocks/Base plates.

The concrete will be placed in one direction and allowed to flow completely under the Base plate, in case of DFF fasteners, in order to avoid the entrapment of air. Care will be taken to monitor the flow of the concrete and ensure no voids remain under the concrete Base plates.

Concrete will be consolidated immediately after placing, with vibrators. The vibrators will be worked in a vertical motion, and the spacing between insertions will not exceed 600mm, this will help horizontal flow and ensure the removal of air.

Care must be taken not to over vibrate the concrete, particularly directly under the Base plates in case of DFF fasteners, and to keep the poker head from touching formwork, temporary supports, cast in pipes, ducts etc.

If during the concrete pour, anything happens that might cause the temporary track support to move or that changes the rail alignment, e.g. a temporary support breaks or the track is hit by heavy equipment, then the concrete pour will be stopped and a survey check carried out. If necessary, a stop-end will be inserted. In the event of a catastrophic failure the concrete will be washed out.

A hold point will be placed and the formal sign off of the track carried out as if it was a new pour. Concrete will not be placed while the track geometry is being corrected.

Notice of No Objection to restart placing concrete will only be given when the formal sign *off* process has been completed.

Standby vibrators shall be kept on site as a precautionary measure until all concrete has been placed.

3.9. Finishing & Curing

The correct concrete level will be indicated by steel angle supported from the formwork, and by correctly levelled cast-in items such as drainage channel or pit forms.

The concrete will initially be levelled off with a screed rail or wood float to a class F1 finish, and then be given a steel trowel finish class F3.

After concrete finishing is complete, the upper surfaces will be sprayed with water or curing agent. This will ensure the concrete does not dry out too quickly during curing, and thus surface shrinkage is minimized.

The Contractor is allowed to submit alternative methodologies seeking for the Engineer's Notice of no Objection.

3.10. Clean Up and Completion

Once the concrete has reached initial set, depending on pour temperature and mix design, the supporting tools will be slightly loosened. In the following shift the supporting tools are to be removed, cleaned and treated with mold oil.

The holes left in the concrete by the track supports will be filled with mortar.

Other temporary supports and formwork will be removed the following day.

At the stop end where a construction joint is required the shutter is removed and the fresh concrete is prepared to remove the retarded concrete to produce a suitable face to cast up against in the next pour.

The formwork will be struck, and moved forward for cleaning and re-oiling while the concrete is still green, any fins or snots can be rubbed off, and minor surface imperfections repaired. Any repairs or defects will be made good.

3.11. Depot Track

3.11.1. Embedded Track

The rail in the embedded track of running lines shall be inclined to the same degree as that of

the adjoining track. The rail in the embedded tracks of the workshop and in the wheel lathe building may be installed vertically. The rails shall be lined, levelled temporarily secured in the slots left by the Depot contractor and cast with a non-shrink grout by the Contractor as per notice of No Objection by Engineer. The required flange way gap shall be provided to the running edges on the inside of the rails and on the outside of the rails the grout shall be stopped 5mm below the top of rail.

3.11.2. Depot rail discretely supported on the concrete pedestal

The Supporting structure constructed by the Depot Contractor shall be surveyed and inspected by the Track Contractor; the Track Contractor shall inform the Engineer's for notice of No Objection before starting the works in conjunction with the track laying. Any misalignment or deficiencies in the supporting structure shall be referred to the Engineer for decision. The rails shall be lined, levelled and fixed using special fastenings in consultation with the Engineer.
For the grouting material the Contractor shall seek for the Engineer's Notice of No Objection.

3.11.3. Drainage

The Contractor shall be responsible for maintaining clear longitudinal & cross drainage paths within plinth /slab track to the main drainage system provided by the designated Civil Contractors. The proposed track drainage arrangement design for Mainline, Crossover and scissors track slabs shall be proposed by the Contractor for each location. The Contractor shall suitably adapt and connect to the drains provided by designated Civil Contractor.

3.12. Turnouts, Crossovers, Diamond Crossings, and Rail Expansion Joints

General

Turnouts on slab track shall be so set out that the line and level of both straight and diverging track are within designed tolerances, as certified by the Project Manager/QA Manager. Check rails shall be set and checked to the correct clearance by using the running edge of the crossing as the datum.

The assembly sequence of turnouts, diamond crossings and derailing switches shall be submitted for issue of Engineer's notice of no objection as part of the overall method statement for preassembly, handling, storage, transportation, unloading and installation.

On completion of a turnout, the Contractor shall immediately scotch the switches with a purpose made hardwood timber scotch and securely clamp the switches for the through route with an appropriate clamp to be arranged by the Contractor. The clamp shall be capable of being padlocked with the switch in the closed position.
No on-track Constructional plant and machinery shall be allowed to operate over a turnout until it has been cleared for use by a notice of no objection by the Engineer.

3.12.1. The Contractor shall approach System Interfacing Contractors and ensure the designed switch opening while fixation of the first stretcher bar by designated signaling contractor.

3.12.2. All stretcher bars for switches shall be installed by the Contractor duly interfacing with designated signaling contractor for provision of suitable insulation.

3.12.3. Switches shall be installed lo provide adequate flange way clearance between the stock rail and the switch rail with the switch rail in open position. The minimum flange way clearance in switch portion shall not be less than 60 mm. The Contractor shall provide arrangements for mounting of point operating mechanism and shall co-ordinate and System Interface with designated signaling contractor to ensure full compatibility with regards to installation requirements and point operate mechanism. The opening of switch at toe of switch shall be kept as 160 mm.

3.12.4. The Contractor shall provide all gauges and measuring equipment and labor necessary to completely check the preassembled turnouts, crossovers, diamond crossings and rail expansion joints.

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Chapter 4: RAIL WELDING AND DESTRESSING

4. RAIL WELDING AND DESTRESSING

4.1. Rail Welding

General

All main lines and depot lines shall be welded into a LWR by flash butt welding process except at location not authorized by the Engineer

Alumino-Thermic welding shall only be permitted in exceptional circumstances when dictated by site conditions/ constraints and as authorized by the Engineer.

Only RDSO/Ministry of Railways, Govt. of India, authorized welders and authorized & renowned welding firms shall be detailed to do welding.

The welding process shall be suitable for UIC60, 880 grade &1080 grade HH rails.

4.1.1. All rail joints throughout the main lines & depot lines, including turnouts except at locations not authorized by the Engineer, shall be welded. All the rail welds shall be USFD tested.

4.1.2. All the welded joints for welding less than 18m rail length on main line and 13 m length on depot lines shall be covered by prior notice of no objection of Engineer

4.1.3. The spacing of welds and joints shall not be less than 6.0 m between any two welds and for any deviation to this, specific notice of Engineer shall be required in each case. No welds shall be permitted closer than 100 mm to a rail seat as measured between the center of the weld and the closest edge of any rail fastener.

4.1.4. No welds shall be permitted in the working length of the friction sliding buffer stops.

4.2. Long Welded Rails (LWR)

Long welded rail panels (LWR) shall generally be as long as possible. Short panels shall only be permitted when dictated by site conditions/site constraints, based on notice of no objection of the Engineer.

Rails shall be welded into the longest strings that can be readily handled, generally 360m long.

Long welded rails shall be prepared under factory conditions for the maximum length possible and site welds reduced to the minimum. All welds produced at site shall be tested.

4.3. Continuous Welded Rail (CWR)

4.3.1. Long welded rail strings shall be joined to form continuous welded rails and finally fastened so that the zero thermal stress rail temperature lies within the range of mean-rail-temperature using a designed mean-rail-temperature.

4.3.2. All tracks shall be continuously welded. Jointed track shall only be proposed in the Depots and Yards where the alignment introduces curves of a radius incompatible with CWR. Where mechanical joints are required for electrical isolation they shall be designed to accept the forces associated with CWR.

4.4. Flash-butt welding

General

The Flash Butt Welding of rail joints shall be undertaken in accordance with the relevant Indian Railways Manual for Flash Butt Welding of rail.

For 1080 grade HH rails, the minimum breaking load and minimum deflection as mentioned in the relevant clause of Indian Railway manual for flash butt weld shall be such that the weld shall not show any sign of cracking up to the specified rail deflection and the load at this deflection shall be more than specified minimum breaking load.

The values of specified deflection and specified minimum breaking load shall be as mentioned in the Indian Railway manual for flash butt weld 1996 (updated).

4.4.1. The flash-butt welding machine (RDSO Approved) shall be mobile type capable of making in-situ welds.

4.4.2. The welding clamps of rail shall provide contact area along the entire web of rail and shall be fitted with spring loaded balls for optimum alignment of rail ends.

4.4.3. The welding head shall be equipped with an integrated shearing device for shearing of the weld seam automatically, immediately after the welding process has been finished suitable for UIC 60, 880 grade & UIC 60, 1080 HH grade rails.

4.4.4. A recorder system shall be provided for the simultaneous recording of butting pressure, upset, and magnitude of current and duration of welding. Any abnormal recordings shall be investigated and the relevant weld shall be closely inspected visually and ultrasonically to ensure the weld is not defective.

4.4.5. The records for all the flash butt welds shall be made available to the Engineer on a daily basis.

Flash-butt welding quality control:

4.4.6. Three (3) samples of flash butt weld shall be made and tested for fatigue test in laboratory in the presence of the QA Manager and the Engineer

4.4.7. The test scheme and arrangements should be covered by prior notice of no objection of the Engineer.

4.4.8. Depending upon the cause of any defective weld it may be necessary to test sample welds from the previous shift production run based on request by the Engineer. The necessary tests as instructed by the Engineer shall be at the Contractors expense. If any of these welds fails in testing, welding shall immediately stop until the cause is Identified and rectified. After rectification it shall be demonstrated by the Contractor to the Engineer that all similarly affected welds have been removed from the track.

4.4.9. Rails outside the required end straightness tolerance shall not be welded. Rail ends that are out of tolerance for straightness after welding may be straightened by the use of a purpose made rail end straightened and cause no damage/indentation to the rails.

4.4.10. Alternatively the rail ends may be cut and re-welded, in which case the payment of such weld shall not be made to the Contractor and the cost of associated rail length shall be recovered from the Contractor.

4.4.11. Qualification of welders

All flash-butt welding machine operators shall be trained and certified either by the manufacturer of the machine or by an independent Institution duly bringing to the notice of the Engineer's Representative.

4.5. Alumino-Thermic Welds

General

An Approved Alumino-Thermic short preheats controlled cooled welding process as per Indian Railway manuals shall be used for the welding of joints.

The weld shall be undertaken in accordance with the relevant technical specification for approval of the process and portions supplied for Thermite welding of rails and relevant technical specification for performance and acceptance of Thermite welding of rails of Indian Railways.

4.5.1. Where rails of dissimilar rail steel grade are welded together the weld portion used shall be that of the higher grade rail and should be welded taking into account the rapid cooling of higher grade (air quenching).

4.5.2. Each weld should be painted according to relevant code.

4.5.3. Qualification of welders:

All Alumino-Thermic welders shall have competency certificate issued by manufacturer of the welding process or by an independent institution duly bringing it to the notice of the Engineer.

4.6. Test Welds and Final Profile of Welds

4.6.1. Arrangements shall be made to have test welds and their testing for proving of the flash butt welding technique, the Alumino-Thermic weld process and competence of welders deployed for welding work.

4.6.2. The welds shall be finished to final profile by controlled profile grinding. The finished weld alignment shall be as per specified tolerances. Rail head profile grinding to produce the finished alignment shall not extend more than 300 mm either side of the weld.

4.7. Weld Records

Records of all welds shall be submitted at intervals not exceeding 1 km of rail welded into long lengths. The Performa for the weld records plan shall be submitted by Contractor for

Engineer's notice and Issue of no objection. This record shall contain, as a minimum, the following information:

(i) Weld chainage to the nearest meter
(ii) Weld number
(iii) Rail grade and section
(iv) Date welded
(v) Weld test record sheet reference (if different to the weld number)
(vi) USFD test results
(vii) Dimensional check results
(viii) Rail weld paint
(ix) Name (code) of welder

4.8. Destressing of CWR

4.8.1. The destressing of rails shall not be undertaken until it has been demonstrated to the Engineer's satisfaction that the track has been completed to the specified standard & specification and the method of working for destressing of the relevant track form has been covered by a notice of no objection by the Engineer.

4.8.2. The final welding of joints within turnouts shall be undertaken as per sequence covered by a notice of no objection by Engineer and within the stress free temperature range.

4.8.3. The elementary long welded rail shall be laid on rollers placed on the metal base plates or sleeper rail table, with the rollers at maximum 6.00 m intervals and appropriate side rollers in curves. The rollers shall have suitable diameter to avoid contact between rail and intermediate sleepers/metal base plates.

4.8.4. After placing the long welded rail on rollers, it shall be stress relieved by hitting the rail on each side of the head with wooden mallets.

4.8.5. Destressing of CWR, will be undertaken from LWR manual of Indian Railways.

4.8.6. The rails for continuously welded track shall be destressed in accordance with temperature conditions.

4.9. Buffer stops

4.9.1. The installation details for friction buffers stops shall be submitted by the Contractor as per manufacturer's guideline for obtaining the Engineer's notice of no objection.

4.9.2. Friction buffer stops shall not be installed until the track is at the design line and level, as approved. The following requirements shall be complied with:

(i) There shall be no Thermite weld within the rail length of the buffer stop or the rail sliding length of the buffer. Any weld that fall within the friction buffer stop rail sliding length shall be ground to produce a smooth and uniform standard rail cross section to ensure that the performance of the buffer stop is unaffected.

(ii) Friction buffer stops shall be assembled and installed with the friction elements properly spaced and the bolts torque strictly in accordance with the manufactures instructions.

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Chapter 5: TRACK TOLERANCES

5. TRACK TOLERANCES

5.1. General

5.1.1. The track parameters of completed track work shall be measured by Contractor in the presence of the Engineer and the measurement recorded shall be in a format covered by a notice of no objection of the Engineer and submitted both in hard and electronic copy.

5.1.2. The variations in horizontal alignment, vertical alignment, versine, cross level/cant, twist and gauge shall not exhibit cyclic patterns.

5.1.3. All the track parameter measurements shall be taken in the floating condition of the track. The base of measurement shall be as below:

- Each sleeper or base plate for the gauge,
- 3 meters for the cant, cross-level and twist,
- 20 meters (half overlapping) for lining and
- 10 meters (half overlapping) for vertical profile

5.1.4. The Contractor shall be solely responsible for complying with the track tolerances stipulated below as per contract.

5.2. Dimensional tolerances

Track tolerances shall comply with the following limits:

(i) Gauge (with reference to 1435 mm)
Maximum rate of variation over the prescribed track gauge

- Track structure: ± 2 mm
- Mean gauge per 200 m for Track structure: (1435 +1.5 mm) to (1435 -1mm)
- Standard deviation within a 200 m Section: less than 1 mm.

(ii) Maximum difference of any point in relation to the designed layout (vertical)

- Track structure: ±4mm

(iii) Difference of any point in relation to the designed layout (horizontal)
Straight:

- Track structure: ±4mm

On straight and curve, deviation of measured versine over its designed value on a 20 m chord (half overlapping):

- Track structure: 2 mm

(iv) On constant grade and vertical curves, maximum deviation of measured versine (vertical) over its designed value on a 20 m chord (half overlapping):

- Track structure: ± 3 mm

(v) Cant/Cross Level (to be measured at every 3m)

Straight track and curved track:

- Track structure ±1.5mm (Deviation from designed value)
- Base plate to base plate (slab track), variation of cant/cross level: ±1mm

(vi) Twist: maximum value on a base of 3 m (slab track), over & above designed value

- Straight and circular portion of curve): 1 mm/m
- On transition portion of curve: 0.5 mm/m

(vii) Turnouts (slab track)

- Stockrail joint (longitudinal location): ±15mm
- Nose to nose of Xing in crossovers (slab track) ±10mm

(viii) Flange way clearance

- At end of the switch planning: +5 mm/-0 mm
- Switch toe opening: +1mm-0 mm
- Switch to squareness: 5mm

Deviation of measured versine over its designed value for switches, lead track (measured on 6 meter half overlapping chord)

(ix) Sleeper/Base plate

- Spacing (from designed spacing) ±2mm
- Sleeper/base plate/ perpendicularity to rail Centerline (out of square): ±5mm

(x) Rail joint squareness across the track: 5mm (only for fish plated rails)

(xi) Tighten-up of fastening components: 10 mm

Design torque ±4mm 5% wherever applicable for bolted fastening system.

5.3. Methods of measuring and recording

5.3.1. The completed track geometry shall be measured for the following track parameters as a minimum:

(i) Gauge

(ii) Horizontal Alignment (Versine) of minimum one rail

(iii) Cross Level/Cant

(iv) Twist

(v) Vertical unevenness (Right hand rail)

(vi) Vertical unevenness (Left hand rail)

5.3.2. The Performa for the measurement of track parameter submitted by the Contractor for Engineer's notice, shall consist of the following as a minimum:

(i) A common base point for recording of location

(i) Cross level/cant

(ii) Gauge

(iii) Horizontal alignment (versine)

(iv) Vertical unevenness both for right &left rail.

5.3.3. The Performa shall show the design figure, actual figure and the difference between design and actual and shall allow columns for marking of twist.

5.3.4. The horizontal versine shall be measured every 10 m (half chord point) using a 20 m chord and moving forward at 10 m Intervals. The versine shall be measured on the inside running edge of the outside rail in curves and either rail of straight tracks at points 14 mm below top of rails. Where a recording changes its measuring rail there shall be a minimum overlap of readings of 60 meters.

5.3.5. The as-built recordings of rail level and horizontal alignment along longitudinal direction with respect to the designed level &alignment shall be obtained by the use of appropriate electronic survey instruments. Horizontal location readings shall be presented as co-ordinates. Deviation from designed co-ordinates shall also be shown.

5.3.6. The vertical and horizontal rail location readings shall be taken with reference to Kilometer location.

5.3.7. The recordings of rail level and horizontal location shall be taken at the intervals as proposed by the Contractor and covered by a notice of no objection by the Engineer.

5.3.8. Longitudinal locations shall additionally include, but not be limited to, switch and crossings locations.

5.3.9. Rail inclination shall be measured using a purposely made digital rail inclinometer and the recordings shall be submitted by Contractor for the Engineer's notice.

5.4. Records

The manual records of rail level, cross-level/cant, gauge, twist, unevenness, versine along longitudinal location and horizontal alignment with reference to the designed locations shall be presented both electronically and in hardcopy in line with the requirements given in the Part 2 Section VI(1), Sub-section-'E' Requirements.

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Chapter 6: METHOD STATEMENTS

6. METHOD STATEMENTS

6.1. General

6.1.1. The proposed method statements, installation procedures and installation plans for the Works shall be summarized and detailed in the Contractor Submission Schedule (CSS). The documents forming the submissions shall use a standard format which shall be submitted by the Contractor.

6.1.2. Method statements detailing the proposed methods of working and incorporating all temporary works required shall be submitted to Engineer for his notice. No Permanent Work shall commence until the method statements are covered by a Notice of No Objection of the Engineer:

6.1.3. Method statements for track laying shall, as a minimum cover the following items, where ever applicable:

(i) Handling & transport (Including for materials to be supplied by Engineer)

(ii) stacking/storage/account I reconciliation of materials (including for the materials to be supplied by the Engineer)

(iii) Pre-assembly

(iv) Delivery

(v) Surveying

(vi) Setting out

(vii) Welding, USFD testing of rails & welds, weld tests up to failure, planning for appropriate length of-rail panels

(viii) Track installation

(ix) Lining & levelling

(x) Concreting

(xi) As constructed records

(xii) Cleaning

(xiii) Destressing

(xiv) Cutting of rails, which may render generation of unusable small cut pieces.

6.1.4. Method statements shall, as a minimum, incorporate hold points, tolerances, finishes required, temporary works, false works, formworks, test and inspection plans and shall include safely and quality control requirements for each activity.

6.1.5. Method statements are also required as a minimum for the following production or installation activities:

(i) Each track form

(ii) Turnouts, crossovers, and scissors crossover

(iii) Rail welding
(iv) Buffer Stops
(v) Surveying
(vi) Recording track parameters, unevenness etc.
(vii) Tests on Completion

6.2. Method Statements

Method Statements shall be prepared and submitted in a standard format as described in Clause 6.1.1 with descriptions under the following minimum headings:

(i) Safety
(ii) Plant, Equipment & Tools
(iii) Construction Method
(iv) Protection to existing drainage facilities, cast-in items, etc.
(v) Tolerances &finishes
(vi) Hold Points
(vii) Performa/check sheets
(viii) False work/Formwork
(i) Temporary Works
(ii) Reference Drawings
(iii) Reference Documents/Clauses

6.2.1. Method Statements shall be itemized and have Document Clause reference column at the right hand side margin.

6.2.2. Each method statement shall be referenced to the relevant clauses of the documents forming the Contract.

6.2.3. Method statements which require the use of any specific/specialized equipment or Constructional Plant shall clearly specify the equipment or Constructional Plant and the operator's experience required.

6.3. Materials and Components

6.3.1. All material such as Rails, Turnouts, fastenings, Reinforcement steel etc. procured by contractor will be stored in storage of contractor and will be brought to the site as required by road and as per availability of access.

6.3.2. **The Contractor shall take necessary approval/permission from concerned authority for transportation of rails in Mumbai by road.**

6.3.3. The Contractor shall be responsible for preparing the firm and level ground for stacking of rails. The Contractor shall also arrange the required wooden battens/spacers for keeping rails in layers.

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Chapter 7: PERMANENT MARKERS

7. PERMANENT MARKERS

7.1. General

7.1.1. As soon as the track is completed, permanent markers shall be provided and installed on both sides as follows:

(i) Kilometer markers
(ii) Change of gradient markers, Vertical & horizontal curve marker
(iii) Curve Reference markers, cant, versine marked on rail web
(iv) LWR/CWR reference markers
(v) Fouling point markers
(vi) Turnout markers
(vii) SEJ

7.1.2. All permanent marker plates/boards made of aluminum and supporting angle to be made of galvanized steel including color scheme comprising reflective paints and fixation arrangement proposed to be used shall have prior notice of no objection of Engineer.

7.1.3. All information to be marked on the markers shall be submitted by the Contractor for Engineer's prior notice.

7.1.4. All markers required to be painted on rail for curves, turnouts and SEJs etc. shall be paint marked by the Contractor. The scheme shall be submitted by the Contractor for Engineer's prior notice.

7.2. Final Condition of Track

7.2.1. Throughout construction generally and immediately after installation of the track: rails, rail fastenings, ducts, track drains and any exposed support structure shall be made clean. This cleaning shall include the use of air/water pressure jetting and vacuum cleaners as necessary.

7.2.2. Once a section has been cleaned, tested and the required track parameters & insulation values (as required by the relevant interfacing parties) have been noticed by the Engineer, that section's accepted level of cleanliness and insulation shall be maintained until the taking over of the section.

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Chapter 8: TESTING AND INSPECTION

TESTING AND INSPECTION

(This is to be read in conjunction with the documents,
"Engineer's Requirements" Section VI (1))

8. TESTING AND INSPECTION

8.1. Laboratory testing and Quality assurance

All materials, components and assemblies shall, unless otherwise noted, be inspected & tested by an Approved independent inspecting agency on case-to-case basis to demonstrate that they satisfy the Engineer's requirements, when tested in accordance with the specified procedures. Where no procedure is specified, the Contractor shall propose suitable standard or particular procedures for obtaining notice of no objection of the Engineer.

8.1.1. The Contractor shall formulate a comprehensive Quality Assurance plan as per the Engineer's requirements, which shall then be followed throughout the duration of the contract.

8.1.2. All materials, components or assemblies shall be tested and inspected at the frequency stated within the latest Specification.

8.1.3. A comprehensive schedule of all material inspection/tests at the required/specified frequency of testing shall be submitted by the Contractor for Engineer's notice.

8.1.4. A sample Performa, with typical examples for the material inspections/tests shall be submitted by the Contractor for Engineer's Representative's notice.

8.1.5. On receiving notice of the material inspection/test schedule, the Contractor shall follow the schedule to prepare the required individual Test and Inspection plans and submits for Engineer's notice.

8.1.6. Such of those tests and inspections, for which Engineer has opined to witness, shall be carried out only in the presence of Engineer. For other tests & inspections test/inspection results and certification thereof shall be done in the presence of QA Manager of the Contractor and submitted to Engineer for his notice. However, Engineer may at his discretion conduct test checks to be organized by Contractor for validation of test/inspection results.

8.1.7. Suitable Performa for the recording and witnessing of all tests and Inspections shall be submitted for Engineer's notice. Confirmation of date of a test or inspection shall be presented on an Approved Performa, not less than 21 Days prior to the date for test/inspection.

8.1.8. No material, component or assembly shall be shipped until the notice of no objection for this has been obtained from the Engineer.

8.1.9. If the items to be tested or inspected fail to meet the requirements of this Specification, necessitating additional visits to the laboratories or works for retesting or inspection the costs of these additional visits shall be at the expense of the Contractor.

Periodically, during the currency of Contract the Engineer's may conduct inspections of construction activities at the premises of the Contractor and those of his suppliers and subcontractors. Such inspections shall include quality procedure checks, witness inspections, both routine and Prototype, and shall also lie for the purpose of monitoring progress. During each inspection suitably qualified staff shall be provided by the Contractor.

8.2. Material and components supplied by the Contractor

All material and components supplied by the Contractor shall be inspected and tested in accordance with the relevant technical specifications.

Welding

8.2.1. All Welds (Flash butt and Alumino-Thermic) shall be tested ultrasonically as per relevant manual for ultrasonic testing of rails and welds.

8.2.2. All the defective welds whether identified as a result of USFD testing or otherwise shall be removed from the track and re-welded by the Contractor. The cost of all the re-welding of the defective/rejected welds and that of associated rail length including cutting of rails, adjustments and all related works shall be borne by the Contractor.

8.2.3. Welding materials

Welding materials for Alumino-Thermic welding shall be tested in accordance with the relevant technical specification for approval of the process and portion supplied for Thermite welding of Rails.

8.2.4. Flash-butt weld tests

Tests for Flash-Butt Welding shall be carried out in accordance with the Indian Railways Manual for Flash Butt Welding of Rails.

8.2.5. Alumino-Thermic weld tests

Tests for Alumino-Thermic Welding shall be carried out in accordance with the Indian Railways Manual for Alumino-Thermic Welding of Rails.

8.3. Switches, Crossings and Rail Expansion Joints

8.3.1. Switch & Crossing Inspection (Installation Tests)

Switches with fixed heel shall be checked as full sets. Running edge offsets and gauge shall be checked at coincidental locations, on both the main and diverging track.

Running edge offsets shall be taken at maximum 1000mm intervals. Running edge offsets shall be within +2mm/ - 1 mm of their design value.

8.3.2. The inspection of switches and derailing switches shall include, but not be limited to, that:

(i) the switch rail evenly butts with the stock rail for specified length of the switch planning with the switch lying naturally,

(ii) the underside of the switches and stock rails bear evenly on all slide base plates,

(iii) the dimensional checks of opening of switch, gauge, alignment, cross level offset, lead, check and wing rail clearances nose to nose and flange ways are within tolerance and

(iv) that switch rails over their free length are not twisted or bent.

8.3.3. The switch toes shall not be out of square/beyond specified tolerances.

8.3.4. Crossings shall bear evenly on all base plates.

8.4. Buffer Stops

8.4.1. The fabricated buffer stops shall be inspected by the Engineer before installation. Necessary assistance shall be provided by Contractor to facilitate the Inspections. A minimum of 21 days' notice in writing of the dates on which the buffer stops will be available for inspection shall be given to the Engineer

8.4.2. The buffer stops shall have the identification plates fixed, prior to the inspection, and these identification plates shall be maintained until the acceptance of the buffer stops in the Works.

8.4.3. Inspection sheets shall be prepared and submitted for notice of Engineer of each assembly clearly showing the design and actual dimensional checks, item number and identification marks.

8.5. Tests on Completion

Tests on Completion are to be undertaken in accordance with the provisions given under 'Inspection, Testing and Commissioning' in Part 2, Section VI(1), Sub Section E, any corrections to the installed Track to ensure that the parameters are within prescribed tolerances shall be carried out promptly. Tests on Completion are deemed to include the submission and notice to Engineer of all of the documentation identified therein and in the specified formal.

8.5.1. **Submissions**

Before any Section of the Works is accepted as completed the following information shall have been submitted for the notice of the Engineer:

- Records and certification for all the tests and inspections.

As-built records/drawings of the following:

- Vertical Alignment
- Horizontal alignment
- Recording unit traces of versine, gauge, twist, cant, cross level and rail top longitudinal profiles
- Weld record plan
- All weld test results as detailed in this section, Destressing records
- Distance in kilometers, co-ordinates, offsets of all permanent track markers
- Rail Inclination records
- The results and reports of all tests and materials, assemblies and items/components.

The results of all Tests shall be submitted in hard copy and electronic format.

8.5.2. **Rail insulation to earth test**

All track work shall be subjected to a rail insulation to earth test. The track shall have a minimum rail-to-earth value to be determined after interfacing with the Designated Contractors for ballast and slab tracks in worst weather conditions.

8.5.3. The rail to earth test shall be undertaken after the track has been completed and cleaned but before it is finally formed into a continuously welded system and before all the bonding is installed. The test shall be undertaken on rail lengths up to maximum length of 1000 m.

8.5.4. The track shall not be finally formed into a continuous length until the rail installation to earth tests have been undertaken and approved.

8.5.5. **Rail to Rail insulation test**

A slab track base test shall be undertaken on all track lengths over 50 meters as a check of the leakage of current through the track from one rail to the other.

8.5.6. The slab track base resistance test shall be undertaken after the track has been completed and cleaned but before it is finally formed into a continuous length and all the bonds are attached.

8.5.7. The testing procedure and the minimum resistance shall comply with the requirements proposed by interfacing with designated signaling contractor.

8.5.8. **Rail inclination inspection**

Both rails of all slab track running line tracks shall be checked, at maximum 1 m intervals, for inclination using a purpose made approved digital inclinometer in the presence of the Engineer's Representative.

8.5.9. If any reading shows the inclination to be outside the specified limits every alternate fastening assembly shall be further checked either side of the non-complaints reading until complaints readings are consistently obtained.

8.5.10. If the length of rail outside the specified inclination exceeds 9 m, the out of tolerance lengths shall be rectified by the Contractor by a method covered by a notice of no objection by the Engineer.

8.5.11. The values and procedures of the above mentioned tests shall be System Interfaced by the Contractor with the Designated Contractors.

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Chapter 9: PLAIN & REINFORCED CONCRETE

9. CONCRETE: PLAIN &REINFORCED

9.1. General

The Contractor will establish a fully-fledged most modern concrete laboratory with trained engineers, Quality Control (QC) Manager and technicians at site/in the casting yard. It will have facilities for testing physical properties of cement, workability of concrete, cube strength, permeability of concrete, sieve analysis, RCPT, aggregate tests, tests required for mix design, chloride tests of water and admixture, concrete temperature, oven, accelerated tests for cement concrete strength, flexural strength of concrete.
One room shall be air-conditioned to control temp and humidity for cement tests.

9.1.1. The durability requirements In terms of environment condition, concrete cover, type and quality of material constituent, cement content and water cement ratio, workmanship to obtain full compaction and efficient curing, shape and size of members shall be taken in to account in the structural design as well as in technical specifications of contract. Design for durability shall be in accordance with the report: "Durability of Concrete Structure", ref. Report No. BS-14 (Revised), published by the Government of India (Ministry of Railways) and as per latest amendments issued by MOR.

9.2. Materials

All the sources of the materials shall be approved in advance before bringing to the Site. All materials for making concrete shall be covered by a notice of no objection by the Engineer. All noticed samples shall be deposited in the office of the Engineer before placing orders for the materials with suppliers. The materials brought on to the works shall conform in every respect to their noticed samples and specifications.

Fresh samples shall be deposited with Engineer whenever type or source of any material changes. The Contractor shall check fresh consignment of materials as brought on to the works to ensure that they conform to the specifications and/or noticed samples.

The Engineer's shall have the option to have any of the materials tested to find whether they are in accordance with specifications at the Contractor expense. All bills vouchers and test certificates which in the opinion of the Engineer are necessary to convince him as to the source and quality of materials or their suitability shall be produced for his inspection when required.

Any materials which have not been found to conform to the specifications and not covered by the notice of no objection by the Engineer shall be rejected forthwith and shall be removed from the site by the Contractor al his own cost within the time stipulated by the Engineer.

Cement:

9.2.1. Cement / blended cement / cementitious material: They all will mean the same thing.

9.2.2. The cement used shall be of the following types:

(i) 43 grade Ordinary Portland Cement conforming to IS: 8112.

(ii) 53 grade Ordinary Portland Cement conforming to IS: 12269.

(iii) IRST-40 Indian Railway standard specifications for special grade cement for use in concrete sleepers.

(iv) PPC as per IS: 1489 (Part-I) (v) PSC as per IS: 455

(v) Fly ash as per I S: 3812 (Part I & II)

9.2.3. Whenever possible all cements of each type shall be obtained from one constant source throughout the contract; cement of different types shall not be mixed together. Different brands of cement, or the same brand of cement from different sources, shall not be used without prior notice of no objection of the Engineer

9.2.4. Packaged cement shall be delivered to the site in original sealed bags which shall be labelled with the weight, name of manufacturer, brand and type. Cement received in torn bags shall not be used. Cement bags will not be handled with hooks which allow ingress of moisture. Contractor may obtain cement in bulk and store it in suitable silos of adequate capacity.

9.2.5. Each type of cement shall be stored in a separate silo and it shall be ensured, that cements of different quality are not mixed up.

9.2.6. All cement shall be fresh when delivered and at ambient atmospheric temperature.

9.2.7. The cement used in the concrete for any complete element shall be from a single consignment. All cement for exposed concrete shall be from the same approved source and uniform in color.

9.2.8. With each and for every delivery of cement the Contractor shall provide manufacturer's certificate that the cement conforms to the relevant Indian standard. The Contractor shall provide complete facilities at site for carrying out the following tests:

9.2.9. Setting time by Vicat's apparatus as per IS: 4031 and IS: 5513.

9.2.10. Compressive strength on cement as per IS: 4031, IS: 650, IS: 10080.

9.2.11. Total chloride content in cement shall in no case exceed 0.05 percent by mass of cement. Also, total Sulphur content calculated as sulphuric anhydride (S03), shall in no case exceed 2.5 percent and 3.0 percent when tri-calcium aluminates per cent by Mass is up to 5 or greater than 5 respectively.

9.2.12. The cement will be blended with processed fly-ash conforming to IS specifications up to a maximum of 35% (depending on the mix design) of cement to

improve the durability of structures. The fly-ash will be transported by the Contractor at his cost and taxes.

Aggregate:

9.2.13. Aggregates from natural sources shall be in accordance with IS: 383. The Contractor shall submit to the Engineer's certificates of grading and compliance for all consignments of aggregate. In addition at site from time to time, the Contractor shall allow for carrying out such tests and for supplying test records to the Engineer

The aggregates shall be procured from approved sources only as directed by the Engineer from time to time.

For fair faced concrete, the Contractor shall ensure that aggregates are free from iron pyrites and impurities, which may cause discoloration. Aggregates shall be stored on paved areas in different compartments according to their nominal size.

Fine Aggregate

The Contractor shall provide complete facilities at site for determining grading of aggregates by sieves as per IS: 383, IS: 460, IS: 1607, and IS: 2386.

The fine aggregate shall be river sand, manufactured sand of approved grading, it sand. It shall be free from clay, loam, earth or vegetable matter, salt or other harmful chemical impurities. It shall be clean, sharp, strong, and angular and composed of hard siliceous material. Sand dredged from sea, creeks will not be used. RMC manufactured with sand dredged from sea/creek will not be used.
The grading of fine aggregate when determined as described in IS: 2386 (part I), shall be within the grading zones I, II, Ill.

The Contractor shall provide complete facilities at site for carrying out the following tests:

(i) Proportion of clay, silt and fine dust by sedimentation method as per IS: 2386 part II
(ii) Moisture content in fine aggregate as per IS: 2386 Part Ill.
(iii) Bulk density Bulkage.
(iv) Specific Gravity

Coarse Aggregate:

The coarse aggregate shall be crushed stone.
Crushed gravel, natural gravel or a suitable combination thereof Coarse aggregate obtained from crushed or broken stone shall be angular, hard, strong, dense, durable, clean and free from soft, friable, thin plate, elongated or flaky pieces and any deleterious material.

The grading of aggregate shall be controlled by obtaining the coarse aggregate in different sizes and blending them in correct proportions as and when required.

All coarse aggregate shall conform to IS: 383 and tests for conformity shall be carried out as per IS: 2386, Parts I to VIII.

The maximum size of coarse aggregate shall be such that the concrete can be placed

without difficulty so as to surround all reinforcement thoroughly and fill the corners of formwork. Unless otherwise permitted by the Engineer the nominal maximum size shall not exceed 40mm.

Water

Water used in the works shall be potable water and free from deleterious materials. Water used for mixing and curing concrete as well as for cooling and/or washing aggregate shall be fresh and clean free from injurious amounts of oil, salts, acids, alkali, other chemicals and organic matter.

Water shall be from the source covered by notice of no objection by the Engineer and shall be in accordance with clause 5.4 of IS: 456. However, chloride content in water shall not exceed 500 mg/liter.

Before starting any concreting work and wherever the source of water changes, the water shall be tested for its chemical and other impurities to ascertain its suitability for use in concrete.

No water shall be used until tested and found satisfactory. Cost of all such Tests shall be borne by the Contractor.

9.3. Blending of Aggregates

In order to obtain optimum workability, individual aggregates of nominal size 40mm, 20mm, 10mm, 4.75mm and 2.36mm will be blended in such a way that the Grading curve for all aggregates will be a smooth curve from size 0.15mm to 40mm falling within the established envelop grading curve. The Contractor shall establish envelop grading curve for each grade of concrete for given maximum size of aggregates and obtain by Engineer before finalizing the mix design.

9.4. Admixtures

9.4.1. Chemical admixtures are not to be used until notice of no objection is issued by the Engineer In case their use is permitted, the type, amount and method of use of any admixtures proposed by the Contractor shall be submitted to the Engineer for his notice. The minimum cement content specified shall not be reduced on account of the use of the Admixtures.

9.4.2. The Contractor shall further provide the following information concerning each admixture to the Engineer:

(i) Normal dosage and detrimental effects if any of under dosage and over dosage.
(ii) The chemical names of the main ingredients in the admixtures.
(iii) The chloride content, if any, expressed as a percentage by weight of admixture.
(iv) Whether or not the admixture leads to the entrapment of air when used in the manufacturer's recommended dosage.
(v) Where two or more admixtures are proposed to be used in any one mix, the manufacturer's written confirmation of their compatibility.

9.4.3. In reinforced concrete, the chloride content of any admixture used shall not exceed 0.1 percent by weight of the admixture as determined in accordance with IS:6925 and the total chloride and sulphate contents in concrete mix shall not exceed 0.10 to and 4.0 percent respectively by weight of cement.

9.4.4. The admixtures when used shall conform to IS: 9103. The suitability of all admixtures shall be verified by trial mixes.

9.4.5. The addition of calcium chloride to concrete containing embedded metal will not be permitted under any circumstances.

9.4.6. Retarding admixtures when used shall be poly hydroxyl compounds.

9.4.7. Each batch I consignment shall be tested for specific gravity & performance in concrete before their use.

9.5. Batching Plants, Mixers and Vibrators

9.5.1. Unless specified in the schedule of items, for all structural concreting work the Contractor shall provide automatic weigh-batching plant of suitable capacity. The plant used shall conform to IS: 4925.

9.5.2. The contractor shall provide Concrete Mixers (IS: 1791 – Batch type concrete Mixers, IS: 2438 – Roller Pan Mixers) and Vibrators (IS: 2505 – Concrete Vibrators Immersion Type, IS: 2506 – Screed board concrete vibrators, IS: 4656 – Form Vibrators form Concrete) supplied by recognized manufacturers.

9.6. Grade of Concrete

The concrete is designated as follows: Concrete M 35/20.
The letter M refers to the mix, the number 35 represents the characteristic compressive strength of 15 cm cubes at 28 days in MPa (Mega Pascal: 1 MPa: 10 kg/cm2 approximately). M35 concrete thus has a characteristic strength of 350 kg/cm2. Other mix design will also be denoted in same way.
The number 20 represents the nominal size of the aggregate in mm.

9.7. Mix Design

It is the complete responsibility of the Contractor to design the concrete mixes by approved standard methods and to produce the required concrete conforming to the specifications and the strength, durability, workability requirements. Mix Design once approved must not be altered without prior notice of Engineer's Engineer. However, If the Contractor anticipates any change in quality of future supply of materials than that used for preliminary mix design, he should inform the Engineer in advance and bring fresh samples sufficiently in advance, to carry out fresh trial mixes. Design mix will indicate by means of graphs and curves etc., the extent of variation in the grading of aggregates which can be

allowed. Cement will mean cement/blended cement/ cementitious material. The S.D. and coefficient of variation shall be established for each grade of concrete. SQC graphs shall be submitted monthly.

Limits of Water and Cementitious material Contents.

Maximum water/cementitious material ratio:

(i) For RCC members including piles: 0.40

(ii) For PSC members: 0.40

9.7.1. Cement/blended cement/cementitious material Content.

Cementitious material in concrete shall not be less than 380 kg/m^3 for RCC work and 400 kg/m^3 for PSC work under severe exposure. However, the quantity of cement (excluding Fly ash) shall be limited to 450kg/m^3 of concrete.

9.8. Permeability test for Concrete

No mix shall be approved without satisfactory permeability by RCPT and DIN 1048 tests. Regular permeability tests shall be carried out as per frequency specified by Engineer.

9.8.1. The Engineer shall select random batches of concrete for examination at his discretion and sampling will generally be done at the point of discharge from the mixer and at placing point.

9.8.2. From the batches thus selected two concrete cylinders shall be made in accordance with DIN 1048.

9.8.3. All cylinders shall be made, cured, stored, transported and tested in accordance with DIN-1048 Specifications. The tests shall be carried out in the site laboratory.

9.8.4. At least two cylinders shall be made on each day's concreting until 60 cylinders have been made for each grade of concrete. The cylinders will be tested as per the procedure, given in Clause 9.8.5 .

9.8.5. Test Procedure:

The permeability of concrete will be verified by the following procedure:

- Prepare a cylindrical test specimen 150 mm diameter and 160mm high.
- After 28 days of curing, test specimen will be fitted in a machine such that the specimen can be placed in water under pressure up to 7 bars.
- At first a pressure of one bar is applied for 48 hours, followed by 3 bars for 24 hours and 7 bars for next 24 hours.
- After the passage of the above period, the specimen is taken out and split in the middle by compression applied on two round bars on opposite sides above and below.
- The water penetration in the broken core is measured with scale and the depth of penetration assessed in mm (max permissible limit 25 mm).

9.8.6. Acceptability Criteria

Rapid Chloride Penetration Test (RCPD as per ASTM-C-1202) shall be carried out under controlled conditions and by trained technicians. The necessary equipment shall be installed at site laboratory. The RCPT values should not be more than 2500 Coulomb's for M-30 and 1500 Coulomb's for M-45 and higher grades.

No extra payment shall be made for this test and cost of the same will be included in his rate for concrete works.

9.9. Batching of Concrete Ingredients

Unless authorized by the Engineer's Representative, all concreting shall be either produced in automatic weigh batching plant installed at site or Ready Mix Concrete manufactured in automatic weigh batching plant.

9.10. Placing temperatures

During extreme hot or cold weather, the concreting shall be done as per procedures set out in IS: 7861, Parts I & II. The concrete temperature shall not be more than 30˚C

In hot weather with temperature exceeding 40˚C, the stock piles of fine and coarse aggregates for concreting shall be kept shaded from direct rays of sun and the concrete aggregates sprinkled with water for a sufficient time before concreting in order to ensure that the temperature of these ingredients is as low as possible prior to batching.

The mixer and batching equipment shall be also shaded and if necessary painted white in order to keep their temperatures as low as possible.

The placing temperature of concrete shall be as low as possible in warm weather and care shall be taken to protect freshly placed concrete from overheating by sunlight in the first few hours of its laying. The time of day selected for concreting shall also be chosen so as to minimize placing temperatures. OPC of 43 and 53 grade conforming to IS: 8112 and IS: 12269 respectively shall be used. For pre-stressed concrete, cement conforming to IRS – T-40 specifications or OPC 53 grade cement with fly ash shall be used.

As regards trial mixes, acceptance criteria, acceptance specification, lot size, sampling and testing and sampling size for piling work, PSC girders (cast-in-situ and pre-cast post-tensioned) and general work, the requirement of the relevant codes, standards and directions of the Engineer's shall be followed.

In case of concreting in exceptionally hot weather the Contractor shall seek Engineer's advice; he may in his discretion specify the use of ice either flaked or used directly in the mix or blocks used for chilling the mixing water.

In either case, the Contractor shall not be paid extra for cost of ice, additional labor involved in weighing and mixing etc. All salt and saw dust shall be removed from ice before use. Quality of water used for making ice shall confirm to IS: 456. A complete record of concrete temperature shall be maintained and submitted. The temperature shall be recorded both at the mixing& placing point.

9.11. Transporting, Placing, Compacting and Curing

Transporting, placing, compacting and curing of concrete shall be In accordance with IS: 456.

Transporting

The mix after discharging from the mixer shall be transported by transit mixers, buckets, pumps etc. without causing segregation and loss of cement slurry and without altering its desired properties with regard to water cement ratio, slump, air content, cohesion and homogeneity. It should be ensured that the concrete is moved to its final destination placed and compacted before initial set. The transportation is to be done by agitating transit mixers, pumps or other approved methods.

Placing

The method of placing shall be such as to prevent formation of cold joints and segregation by providing windows in the formwork for pouring concrete or by termite pipe.

The thickness of horizontal layers shall not exceed 300 mm. High velocity discharge of concrete causing segregation of mix shall be avoided. The concrete shall be placed in the forms gently and not dropped from a height exceeding 1.5 m. Each layer of concrete shall be compacted fully before the succeeding layer is placed and separate batches shall follow each other so closely that the succeeding layer shall be placed and fully compacted before the layer immediately below has taken initial set.

For all heights the rate of placing of concrete by using termite pumps shall not be more than 1.5 m/hr.

Concreting of any portion or section of the work shall be carried out in one continuous operation and no interruption of concreting work will be allowed.

A concrete placing sequence shall be prepared in advance for each concrete pour and notice of it has to be sent to the Engineer.

Compaction:

Internal (needle) and surface (screed board) vibrators of approved type and size shall be used for compaction of concrete.

Internal vibrators shall be used for compaction of concrete in foundations, columns, buttresses arch section, slabs etc., and if required surface vibrators shall also be used. Depending on the thickness of layer to be compacted, 25 mm, 40 mm, 60 mm and 75 mm diameter internal vibrators will be used. The concrete shall be compacted by use of appropriate diameter vibrator by holding the vibrator in position until:

- Air bubbles cease to come to surface.
- Resumption of steady frequency of vibrator after the initial short period of drop in the frequency, when the vibrator is first inserted.
- The tone of the vibrated concrete becomes uniform.
- Flattened, glistening surface, with coarse aggregates particles blended into it appears on the surface.
- To secure even and dense surfaces free from aggregate pockets, vibration shall be supplemented by tamping or tamping by rods in the corners of forms and along the form surfaces while the concrete is plastic.
- A sufficient number of spare vibrators shall be kept readily accessible to the place of deposition of concrete to assure adequate vibration in case of breakdown of those in

use.

- Form vibrators whenever used shall be clamped to the sides of formwork and shall not be fixed more than 450 mm above the base of the new formwork and concrete shall be filled not higher than 230 mm above the vibrator. The formwork must be made specially strong and watertight where this type of vibrator is used.
- Care must be taken to guard against over vibration especially where the workability of the concrete mix is high since this will encourage segregation of the concrete.
- Plain concrete in foundations shall be placed in direct contact with the bottom of the excavation, the concrete being deposited in such a manner as not to be mixed with the earth. Plain concrete also shall be vibrated to achieve full compaction.

Protection of Concrete

Concrete placed below the ground shall be protected from falling earth during and after placing. Concrete placed in ground containing deleterious substances shall be kept free from contact with such ground and with water draining there from during placing and for a period of seven days or as otherwise instructed thereafter. Approved means shall be taken to protect immature concrete from damage by debris, excessive loading, abrasion, vibrations, deleterious ground water, mixing with earth or other materials, and other influences that may impair the strength and durability of the concrete.

Curing

Curing of concrete shall be complete and continuous using potable water free from chlorides and sulphates, water that is free of harmful amounts of deleterious materials that may attack, stain or discolor the concrete as per JS 456. Minimum wet curing will be for ten days by ponding water followed by moist curing by spraying water which shall be maintained up to a total period for at least 21 days from the date of casting.

Immediately after compaction and completion of any surface finishes the concrete shall be protected from the evaporation of moisture by means of polythene sheet, wet Hessian or other material kept soaked by spraying. As soon as the concrete has attained a degree of hardening sufficient to withstand surface damage moist curing shall be implemented and maintained for a period of at least 21 days after casting.

Method of curing and their duration shall be such that the concrete will have satisfactory durability and strength and members will suffer a minimum distortion, be free from excessive efflorescence and will not cause undue cracking in the works by shrinkage.

Curing compounds may be permitted with notice of no objection of Engineer. However, it is required to be proved that using curing compound the concrete shall not have less strength than concrete cured by water curing. It shall not leave any discoloration on the structural concrete.

9.12. Construction Joints

Methodology of providing construction joints and their location shall be submitted in advance for obtaining notice of no objection of Engineer's.

Construction joints in all concrete work shall be made as follows:

The laitance shall be removed by wire brush and aggregate exposed to 1/3rd of its height after the Initial setting of concrete, but without dislodging the aggregate. The mortar around steel and corners shall be removed by air/water pressure jetting. Before placing new

concrete the earlier surface shall be moistened. Cement water slurry will never be sprinkled.
Alternatively, top surface of concrete can be painted with Plasticizer (retarder) before initial setting of concrete. This will not allow cement in the top layer to set, and same if washed before final set of concrete with water will provide a surface free of laitance. This is preferred method of providing construction joint.
Where vertical construction joints are required, these shall be shuttered as directed and not allowed to take the natural slope of the concrete.
Before fresh concrete is placed against a vertical joint, the old concrete shall be chipped by a pneumatic chipping hammer, cleaned and moistened. Alternatively the shutter can be painted with Plasticizer (retarder) before fixing. This will not allow cement in contact with shutter to set. And same if washed with water will provide a surface free of laitance. This is preferred method of providing vertical construction joint. The shutter is required to be removed before the final setting of concrete and concrete surface shall be washed with water jet. Trials shall be made in the site laboratory to decide the method.
No separate payment shall be allowed to the Contractor for forming joints or chipping and cleaning them. Construction joints in concrete walls and slabs for liquid retaining structures shall be prepared in a similar manner to normal construction joints. If use of metal, rubber or plastic water stops is specified, this shall be cast into joints. Measures shall be taken by the Contractor to ensure that no displacement or distortion of water stops takes place during placing of concrete. The construction joints shall ensure proper bond and leak proof joint.

9.13. Cover and Cover blocks

9.13.1. Minimum Clear Cover:

- Bottom reinforcement : 40mm
- Sides, top : 50mm

Clear cover will mean extent of cover from the outermost steel bar including binding wire. All binding wire ends shall be bent towards center of the section.

9.13.2. Cover blocks shall be manufactured on vibrating tables. The grade of mix shall be same as that of main member. All quality control shall be exercised as for the main member the cost of cover blocks shall be deemed to have been included in the rates.

9.14. Cracks

If cracks, which in the opinion of the Engineer may be detrimental to the strength and durability of the construction, develop in concrete construction, the Contractor at his own expense shall test the structure.
If any cracks develop in the concrete construction, which in the opinion of the Engineer's Representative, are not detrimental to the stability of the construction, the Contractor at his own expense shall grout the cracks with epoxy grout or with other composition and also at his own expense and risk shall make good to the satisfaction of the Engineer's all other works such as plaster, molding, surface finish, which in the opinion of the Engineer have

suffered damage either in appearance or stability owing to such cracks. The Engineer's decision as to the extent of the liability of the Contractor in the above matter shall be final and binding.
External crack width shall be restricted to 0.1mm. If cracks width is more than 0.1 mm or in the opinion of Engineer may be detrimental to concrete construction, the Contractor at his own expenses should epoxy grout the cracks.

9.15. Defective Concrete

Badly executed work not conforming to requirements shall be removed and shall not be incorporated in the works. No plastering or repairs will be allowed to concrete.

9.16. Exposed Faces, Holes and Fixtures

On no account shall concrete surfaces be patched or covered up or damaged concrete rectified or replaced until the Engineer's has inspected and photographed the works and issued notice of no objection for rectification. Failure to observe this procedure will render that portion of the works liable for rejection.
Holes for foundation or other bolts or for any other purposes shall be molded and steel angles, holdfasts or other fixtures shall be embedded, according to the drawings.

9.17. Finishes

Unless otherwise instructed the face of exposed concrete placed against formwork shall be rubbed down immediately on removal of the formwork to remove irregularities. The face of concrete for which formwork is not provided other than slabs shall be smoothened with a float to give a finish equal to that of the rubbed down face, where formwork is provided. The top face of a slab which is not intended to be covered with other materials shall be levelled and floated to a smooth finish at the levels or falls shown on the drawings or as directed. The floating shall be done so as not to bring an excess of mortar to the surface of the concrete. The top face of a slab intended to be surfaced with other material shall be left with a spaded finish. Faces of concrete intended to be plastered shall be roughened by approved means to form key.

In the event of finishing not being definitely specified herein or in the drawings, finishes to be adopted shall be covered by notice of no objection of the Engineer
Completed concrete surface shall be tested, where necessary to determine whether surface irregularities are within the limits specified hereinafter.

Surface irregularities are classified as "Abrupt" or "Gradual". Offsets caused by displaced or misplaced form sheathing, or form sections or by loose knots or otherwise defective timber form will be considered as abrupt irregularities, and shall be tested by direct measurements. All other irregularities shall be considered as gradual irregularities and will be tested by use of template, consisting of a straight edge or the equivalent thereof for curved surfaces. The length of the template shall be 150 cm for testing of formed surfaces and 300 cm for testing of unformed surfaces.

The finish for the Track structure shall be manufactured in a skillful, workmanlike manner, accurately to dimensions. There should be no visible offsets, bulges or misalignment of concrete. At construction joints, the forms shall be rightly set and securely anchored close to the joint. Abrupt and gradual irregularities shall not exceed 3mm.

Irregularities exceeding this limit shall be reduced by grinding to a level of 1:20 ratio of height to length. Jute bag subbing or sand blasting shall not be used.
When the floated surface has hardened sufficiently, steel trowel shall be started. Steel trowel on hardened, floated surface shall be performed with firm pressure to produce a dense uniform surface free from blemishes and trowel marks and having slightly glossy appearance. Surface irregularities shall not exceed 5mm.

9.17.1. Exposed Concrete Work

Exposed concrete surfaces shall be smooth and even, originally as stripped without any finishing or rendering. Where directed by the Engineer's Representative, tile surface shall be rubbed with carborundum stone immediately on striking the forms. The Contractor shall exercise special care and supervision of formwork and concreting to ensure that the cast members are made true to their sizes, shapes and positions aiming to produce the surface patterns desired.

No honeycombing shall be allowed. Honeycombed parts of the concrete shall be removed by the Contractor and fresh concrete placed without extra cost, as instructed by the Engineer's Representative. All materials, sizes and layouts of formwork including the locations for their joints shall have prior notice of the Engineer's Representative.

9.18. Concrete for Flooring on Grade

Concrete for flooring on grade shall be placed in alternate bays not exceeding more than 4m x 6m or as specified in the drawings including forming the joints or adjacent bays. The stiff mix shall be thoroughly vibrated and finished to receive the floor finish.

9.19. Grouting

Only branded free flowing, high strength Ferro -grouts shall be used.

9.19.2. Mixing

Dry grout should be mixed in a mechanical mixer: the conventional 200/400 – liter capacity concrete mixer can be used to mix four bags of dry grout; alternatively, paddle type mortar mixers can be used.
The quantity of grout to be mixed at one time should not exceed that amount which can be placed in approximately 10 to 15 minutes.

9.19.3. Batching

Batching of grout by fraction of a bag is not allowed. The quantity of mixing water should be the minimum commensurate with workability, compaction, and filling of the grout in all corners and crevices. Mixing should be done for a minimum of three

minutes to obtain a fluid grout of uniform consistency.

9.19.4. Cleaning and preparation of the surface

The base concrete should be clean and strong, and its surface should be properly hacked; all dust should be removed suction or compressed air. The surface should be thoroughly wetted with water for several hours. Before the grout is poured, all free water should be removed.

9.19.5. Restraint

Heavy back-up blocks of timber or concrete should be fixed on all sides of the base plate to prevent escape of the grout, when poured through the openings provided in the base plate. Adequate restraint must be ensured on all the sides for a period of 7 days to obtain effective expansion and shrinkage compensation.

9.19.6. Curing

The grout should not dry out where external restraint is provided in the formwork, the top opening and all stray openings should be covered with wet sack for at least 14 days.

9.19.7. Placing and Compaction

The grout should be placed quickly and continuously either through the holes in the base plates or from one side only to ensure complete filling without entrapment of air. Grout should be properly spread and compacted by rodding. Excessive vibration should be avoided.

9.19.8. Shrinkage Compensated Grout

Shrinkage compensated grout or non-shrinkable grout of approved manufacturer shall be used. The batching shall be as per the manufacturer's specifications, other procedures being as above.

9.20. Pre-cast Concrete

The clauses in this section shall be considered supplementary to general clauses for reinforced concrete works.

9.20.1. Handling and Storage

The pre-cast units shall be stored as per stipulations in the relevant codes. The area intended for the storage of pre-cast units should be surfaced in such a way that no unequal settlement can occur.

To prevent deformation of slender units, they should be provided with supports at fairly close intervals and should also be safeguarded against tilting. Lifting and handling positions should conform to the Engineer's drawings. In addition, location and orientation marks should be put on the members, as and where necessary. During erection the pre-cast units should be protected against damage caused by local crushing and chafing effects of lifting and transport equipment.

9.20.2. Supports and Connections

Temporary supports provided during erection should take into account all construction loads likely to be encountered during the completion of joints between any combination of pre-cast and in-situ concrete structural elements. The supports should be arranged in a manner that will permit the proper finishing and curing of any in-situ concreting and grouting associated with the pre-cast member being supported when the gaps of joints have to be filled with concrete or mortar. They should first be cleaned and faces of the joints should be wetted. The mixing, placing and compacting of cement and mortar should be done with special care. Mortar of a dry consistency should be in the proportion of 1:1½. (1 part of cement to 1½ parts of sand) and should be placed in stages and packed hard from both sides of the joint.

9.20.3. Tolerances

The following tolerances apply to finished pre-cast products at the time of placement in the structure. The forms must be constructed to give a casting well within these limits:

- Overall dimensions of members should not vary more than + 6 mm per 3 m length with a maximum variation of + 20 mm.

  Cross-sectional dimensions should not vary more than the following:
- ±3 mm for sections less than150 mm thick
- ±4 mm for sections over 150 mm & less than 450 mm
- ±6 mm for sections over 450 mm to 1000 mm
- ±10 mm for sections over 1000 mm
- Deviation from straight line in long sections should not be more than + 6 mm up to 3m, + 10 mm for 3 m to 6 m + 12 mm for 6 m to 12 m.

9.21. Ready Mix Concrete and Pumping

Ready-mixed concrete may be manufactured in a central automatic weigh batching plant and transported to the place of work in agitating transit mixers.

9.21.1. Coarse aggregates

The maximum size of coarse aggregate shall be limited to one-third of the smallest inside diameter of the hose or pipe used for pumping. Provision shall be made for elimination of over-sized particles by screening or by careful selection of aggregates. To obtain proper gradation it may be necessary to combine and blend certain fractional sizes of aggregates. Uniformity of gradation throughout the entire job shall be maintained.

The quantity of coarse aggregate shall be such that the concrete can be pumped, compacted and finished without difficulty.

9.21.2. Fine aggregates

The gradation of fine aggregate shall be such that 15 to 30 percent should pass the 0.30 mm screen and 5 to 10 percent should pass 0.15 mm screen so as to obtain pump able concrete. Sands, which are deficient in either of these two sizes, should be blended with selected finer sands to produce these desired percentages. With this gradation, sands having a fineness modulus between 2.6 and 3.1 are generally

satisfactory. However, for uniformity, the fineness modulus of the sand should not vary more than 0.2 from the average value used in proportioning. Sand from sea bed or creeks shall not be used.

9.21.3. Water, Admixtures and Slump

The amount of water required for proper concrete consistency shall take into account the rate of mixing, length of haul, time of unloading, and ambient 'temperature conditions.

Additions of water to compensate for slump loss should not be resorted to nor should the design maximum water-cement ratio be exceeded. Additional dose of retarder be used to compensate the loss of slump at Contractor cost, when permitted by Engineer Re-tempering water shall not be allowed to be added to mixed batches to obtain desired slump. Slump records at the time and place of concreting shall be maintained and shall conform to the requirements.

9.21.4. Transportation

The method of transportation used should efficiently deliver the concrete to the point of placement without significantly altering its desired properties with regard to water/cement ratio, slump, and homogeneity.

The revolving-drum truck bodies shall be used for transporting the concrete. The numbers of revolutions at mixing speed, during transportation, and prior to discharge shall be specified and agreed upon. Reliable counters shall be used on revolving-drum truck units. Standard mixer uniformity tests, conforming to ASTM standards C 94-69 "Standard Specifications for Ready Mix Concrete", shall be carried out to determine whether mixing is being accomplished satisfactorily.

9.21.5. Pumping of concrete

Only approved pumping equipment, in good working condition, shall be used for pumping of concrete. Concrete shall be pumped through a combination of rigid pipe and heavy-duty flexible hose of approved size and make. The couplings used to connect both rigid and flexible pipe sections shall be adequate in strength to withstand handling loads during erection of pipe system, misalignment, and poor support along the lines. They should be nominally rated for at least 3.5 MPa pressure and greater for rising runs over 30 m. Couplings should be designed to allow replacement of any section without moving other pipe sections, and should provide full cross section with no construction or crevices to disrupt the smooth flow of concrete.

All necessary accessories such as curved sections of rigid pipe, swivel joints and rotary distributors, pin and gate valves to prevent backflow in the pipe line, switch valves to direct the flow into another pipe line, connection devices to fill forms from the bottom up, extra strong couplings for vertical runs, transitions for connecting different sizes of pipe, air vents for downhill pumping, clean-out equipment etc., shall be provided as and where required.

Suitable power controlled booms or specialized crane shall be used for supporting the pipe line.

9.21.6. Field control

Sampling at both truck discharge and point of final placement shall be employed to determine if any changes in the slump and other significant mix characteristics occur. However, for determining strength and durability of concrete, cubes shall be taken from the placement end of line. The temperature of concrete shall be recorded at regular intervals.

9.21.7. Planning

Proper planning of concrete supply, pump locations, line layout, placing sequence, and the entire pumping operation shall be made and got approved. The pump should be as near the placing area as practicable, and the entire surrounding area shall have adequate bearing strength to support concrete delivery pipes. Lines from pump to the placing area should be laid out with a minimum of bends. For large placing areas, alternate lines should be installed for rapid connection when required. Standby power and pumping equipment should be provided to replace Initial equipment, should breakdown occur. The delivery pipes shall be covered with wet hessian cloth.
The placing rate should be estimated so that concrete can be ordered at an appropriate delivery rate.

As a final check, the pump should be started and operated without concrete to be certain that all moving parts are operating properly. A grout mortar should be pumped into the lines to provide lubrication for the concrete, but this mortar shall not be used in the placement. When the form is nearly full, and there is enough concrete in the line to complete the placement, the pump shall be stopped and a go-devil (Blow-out Ball) inserted and shall be forced through the line by water under pressure to clean it out. The go-devil (Blow-out Ball) should be stopped at a safe distance from the end of the line so that the water in the line will not spill into the placement area. At the end of placing operation, the line shall be cleaned in the reverse direction.

9.22. Additional Specifications for Concrete MgO(Magnesium Oxide)

9.22.1. Mineral admixture in the form of micro silica or condensed silica fume if required shall be permitted in the design mix. It shall comply with Indian/International standard Specifications for Silica Fume for use in Hydraulic Cement Concrete and Mortar.

9.22.2. Adequate and complete dispersal of the micro silica during the concrete mixing shall be ensured.

9.22.3. When micro silica is used in powder form the Contractor shall take all precautions against potential health hazards during handling of the material.

9.22.4. Chilled water and/ or ice shall be used in the concrete mix depending on the ambient temperature, dimensions of the concrete element, rate of pouring and design mix constituents.

9.22.5. Special profuse curing arrangements shall be made for dissipation of the heat of hydration. The water curing shall be continued for a period of 21 days.

9.22.6. The concrete design mix and arrangement for mixing, transportation, and curing of concrete shall be subject to the issue of notice of no objection by the Engineer

9.22.7. The concrete temperature shall be recorded for 21 days from the time of placement of concrete.

9.23. Measurement

9.23.1. Measurement shall be made for the finished volume of reinforced cement concrete (excluding lean concrete) only. All linear dimensions shall be measured correct to1 cm & restricted to design dimensions and the volume calculation will be correct to two decimal places in cubic meter.

MUMBAI METRO
LINE3
CONTRACT MM3-CBS-TWK-03

TENDER DOCUMENTS

Part 2 Section VI (3)
Outline Construction Specifications

TRACK WORKS

Chapter 10: REINFORCEMENT

10. REINFORCEMENT

Any steel specified for reinforcement shall conform in every respect to the latest relevant Indian Standard Specifications and shall be of tested quality under the ISI Certification Scheme.
All reinforcement work shall be executed in conformity with the drawings supplied and instructions given by the Engineer and shall generally be carried out in accordance with the relevant Indian Standard Specifications IS: 2502- Bending and Fixing of Bars for Concrete Reinforcement.
The reinforcement steel shall be from primary producers and no re-rolled steel shall be supplied.

10.1. Inspection & Testing

10.1.1. Every bar shall be inspected before assembling on the works and any defective, brittle, rusted or burnt bars shall be removed. Cracked ends of bars shall be cut out.

10.1.2. Reinforcement steel shall lie fresh, free from corrosion. Corroded steel will not be incorporated in work. If there are traces of corrosion, then the Contractor have to give the following treatment to steel for which nothing extra shall be paid.

- Cleaning of steel by wire brush for removal of dust and rust.
- Apply one coat of cement slurry {1kg cement + 600 cc of inhibitor solution (patent No.109784/67)} by dipping or brushing. Allow it to dry for 24 hours in shade. The water is not to be used. The inhibitor solution is prepared in ionized water.
- Apply second coat of cement slurry (same as above). Allow it to dry in shade.

10.1.3. No work shall be commenced without the Engineer notice of no objection to the bar bending schedule proposed by the Contractor.

10.1.4. Manufacturer's Certificate shall be supplied for each lot of supply.

10.1.5. Specimens sufficient for three Tensile Tests for each different size of bar for each consignment delivered shall be sampled and tested by the Contractor. Batches shall be rejected if the average results of each batch are not in accordance with the specifications.

10.2. Bar bending and Bar Bending Schedule

All bars will be carefully and accurately bent by approved means in accordance with IS: 2502, and relevant drawings. It shall be ensured that depth of crank is correct as per the bar cutting and bending schedule and bent bars are not straightened for use in any manner that will injure the material.

Prior to starting bar bending work, the Contractor shall prepare bar bending schedule from

the structural drawings supplied to him and get the prior notice of no objection of Engineer's Representative. Any discrepancies and inaccuracies found by the Contractor in the drawings shall be immediately reported to the Engineer whose interpretation and decision there to, shall be accepted.

10.3. Lapping & Welding

10.3.1. As far as possible bars available of the maximum length shall be used. Laps shown on drawings or otherwise specified by the Engineer will be based on the use by the Contractor of bars of maximum length. Payment for reinforcement shall be made only for reinforcement shown in such drawings and such laps.

10.4. Spacing, Supporting and Cleaning

Bars having butt or lap welds shall be provided as specified in the drawings.

10.4.1. All reinforcement shall be placed and maintained in the positions shown on the drawings.

10.4.2. The Contractor shall provide approved types of supports for maintaining the bars in position and ensuring required spacing and correct cover of concrete to the reinforcement as specified on the drawings. Cover blocks of required shape and size, chairs and spacer bars shall be used to ensure accurate positioning of reinforcement.

10.4.3. Bars must be cleaned, before concreting commences, of all scale, rust or partially set concrete which may have been deposited there during placing of previous lift of concrete.

10.4.4. Only TMT bars shall be provided.

10.4.5. G.I. wire shall be used for binding reinforcement and their ends to be bent towards the center of element.

10.5. Welding

10.5.1. Wherever specified all lap and butt welding of bars shall be carried in accordance with IS: 2571. Only qualified welders shall be permitted to carry out such welding.

10.5.2. For cold twisted reinforcement welding operations must be controlled to prevent a supply of large amounts of heat larger than that can be dissipated. The extreme non twisted end portion shall be cut off before welding. Electrodes with rutile coating should be used.

10.5.3. Bars shall be free from rust at the joints to be welded.

10.5.4. Slag produced in welding after alternative run should be chipped and removed by brush.

10.5.5. Electrode should not be lighted by touching the hot bar.

10.5.6. The welding procedure shall be covered by notice of no objection by the Engineer and tests shall be made to prove the soundness of the welded connection.

MUMBAI METRO
LINE3
CONTRACT MM3-CBS-TWK-03

TENDER DOCUMENTS

Part 2
Section VI (3)
Outline Construction Specifications

TRACK WORKS

Chapter 11: FORM WORK

11. FORM WORK

11.1. General

These specifications shall be read in conjunction with the CPWD specifications1996, MOST Specifications and other relevant specifications described in these specifications.

11.2. Materials

Formwork shall be of steel or any other suitable material. The formwork shall be capable of resisting damage to the contact faces under normal conditions of erecting forms, fixing steel and placing concrete. The selection of materials suitable for formwork shall be made by the Contractor based on the quality consistent with the specified finishes and safety.
All formwork supports (centering, props, scaffolds etc.) shall only be in structural steel and preferably of pipes conforming to IS: 806, IS: 1161, IS: 1239, IS: 2750. Wooden bullies shall not be permitted as props/formwork supports. All props shall be properly braced using x & k bracings.
Steel formwork shall be made of minimum 4 mm thick black sheets stiffened with angle iron frame made out of M.S. angles 40mm x 40mm x 6mm supported at suitable spacing.

11.3. Design & Drawings

The formwork, false work, jigs, fixtures, supports etc. shall be designed by the Contractor and noticed by the Engineer before starting of work. It shall be constructed so that the concrete can be properly placed and thoroughly compacted to obtain the required shape, position and level subject to specified tolerances Approval of the proposed formwork by the Engineer will not diminish the Contractor responsibility for the satisfactory performance of the formwork, nor for the safety and co-ordination of all operations.
Methodology for removal of form should be planned as a part of total form work design.

11.4. Erection of Formwork

The following shall apply to all formwork:

11.4.1. The Contractor shall obtain the approval of the Engineer for the design of forms and the type of material used before fabricating the forms. (Ref. ACI 347 Formwork for Concrete or equivalent L.S. Code).

11.4.2. Provision shall be made for adjustment of supporting struts where necessary. When reinforcement passes through the formwork care should be taken to ensure close fitting joints against the steel bars so as to avoid loss of fines during the compaction of concrete.

11.4.3. Formwork shall be so arranged as to permit removal of forms without jarring the concrete. Wedges, clamps and bolts shall be used wherever practicable instead of nails.

11.4.4. Surfaces of forms in contact with concrete shall be oiled with a mold oil of approved quality or clean diesel oil. If required by the Engineer the Contractor shall execute different parts of the work with different mold oils to enable the Engineer to select the most suitable. The use of oil which results in blemishes of the surface of the concrete shall not be allowed. Oil shall be applied before reinforcement has been placed and care shall be taken that no oil comes in contact with the reinforcement while it is being placed in position.

The formwork shall be kept thoroughly wet during concreting and the whole time that it is left in place. Nothing extra shall be paid to Contractor for oiling.

11.4.5. Immediately before concreting is commenced, the formwork shall be carefully examined to ensure the following:

- Removal of all dirt, shavings, sawdust and other refuse by brushing and washing.
- The tightness of joints between panels of sheathing and between these and any hardened core.
- The correct location of tie bars, bracing and spacers, and especially connections of bracing.
- That all wedges are secured and firm in position.
- That provision is made for traffic on formwork not to bear directly on reinforcing steel.
- Generally the slab will be cast with formwork on both sides.

Each pour will have a stop end shutter fixed the full width of the Track structure. This shutter will be fixed securely.

All other formwork, and temporary box outs will be coated with mold release oil.
The rail will be braced laterally to the formwork, cable trough or adjacent slab using adjustable screw braces (hand tight) that temporarily connect to the rail foot. These braces are fixed where required. They must not be over tightened as this may deflect either the rail or the shutter.

Vertical braces to resist floating will generally not be required as the dead weight of the rail and sleepers will provide sufficient downward load.
Pipes, ducts, and any other cast in items or box-outs will be placed as required. All ducts are to be aligned correctly with no sharp bends or stepped joints. Construction joints will be formed as per approved drawings.

11.5 Age of Concrete at Removal of Formwork

In accordance with CPWD Specifications 96 or IS: 456. The Engineer may vary the periods specified if he considers it necessary. Immediately after the forms are removed, they shall be cleaned with a jet of water and a soft brush.

11.6 Reuse of Forms

The Contractor shall not be permitted reuse of timber facing formwork brought new on the works more than 5 times for exposed concrete formwork and 8 times for ordinary formwork. 5 or 8 uses shall be permitted only if forms are properly cared for, stored and repaired after each use. The Engineer may in his absolute discretion order rejection of any forms he considers unfit for use for a particular item irrespective of number of times the shuttering has been used and order removal from the site of any forms he considers unfit for use in the Works. Used forms brought on the site will be allowed proportionately fewer uses as decided by the Engineer Use of different quality boards or the use of old and new boards in the same formwork shall not be allowed. If any other type of special or proprietary form work is used, the no. of times they can be used will be determined by the Engineer

MUMBAI METRO LINE 3

CONTRACT MM3-CBS-TWK-03

TENDER DOCUMENTS

Part 2
Section VI (3)
Outline Construction Specifications

TRACK WORKS

Chapter 12: CHECKLISTS AND FORMATS FOR TRACK INSTALLATION

12.1. LEVEL FIELD BOOK

PROJECT: Mumbai Metro Rail Project
CLIENT: Mumbai Metro Rail Limited
GENERAL CONSULTANT: Maple Consortium

	Date:
Drawing Number:	
Instrument and its number:	Date of next calibration:
SERIES OF LEVELS FROM..... TO.....	

No. of station	Offset	Back Sight (m)	Intermediate Sight (m)	Fore Sight (m)	Height of collimation (m)	Reduced level (m)	Required Level (m)	Difference	Remarks

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12.2. CHECKLIST FOR SURVEY CONTROL POINT

PROJECT: Mumbai Metro Rail Project
CLIENT: Mumbai Metro Rail Limited
GENERAL CONSULTANT: Maple Consortium

SURVEY CONTROL POINT					
Corridor		Chainage : From.....To.....			
Stage					
Section (Stn-Stn)					
Track (Up-Down)					
Control Point No	Co-ordinates		Elevation	Description	Remarks
	Easting	Northing			

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12.3 CHECKLIST FOR HORIZANTAL ALIGNMENT C.L CO-ORDINATES

Project	**: Mumbai Metro Rail Line-3**		
Client	**: MMRC**		
GC/Engineer	**: MAPLE Consortium**		
Contractor	**:**		
Track	**:**	**Date:**	
Line	**:**	**Location:**	
Turnout No:		**Type of Turnout:**	

S.No	Chainage	As per drawing CL		Actual Values		Difference		Remarks
		Northing	Easting	Northing	Easting	Northing	Easting	

Contractor **MAPLE-GC**

12.4CHECKLIST FOR TRACK SETTING OUT DATA – LIST OF ID POINTS

PROJECT: Mumbai Metro Rail Project

CLIENT: Mumbai Metro Rail Limited

GENERAL CONSULTANT: Maple Consortium

TRACK SETTING OUT DATA - LIST of ID POINTS

STAGE :- **LOCATION:**

ID NO	CHAINAGE IN MTRS	CANT	EASTING	NORTHING	DIST IN MTRS	RAIL LEVELWITH OUTVC	RAIL LEVELWITH VC	GRADIENT
U1								
U10								
TS								
SC								

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12.5CHECKLIST FOR TRAVERSE CONTROL

PROJECT: Mumbai Metro Rail Project

CLIENT: Mumbai Metro Rail Limited

GENERAL CONSULTANT: Maple Consortium

TRAVERSE CONTROL

LOCATION

Control Point No	Bearings			Bearing in degress	Distance	E	N	As pe Site		As per Checking		Difference		Remarks
	DD	MM	SS					Easting	Northing	Easting	Northing	East	North	
				Total distance										
				Accuracy										

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12.6CHECK LIST FOR INITIAL TRACK ALIGNMENT

PROJECT: Mumbai Metro Rail Project
CLIENT: Mumbai Metro Rail Limited
GENERAL CONSULTANT: Maple Consortium

Sl.No.		Yes	No.	NA
1	Center Line has been checked.			
2	GSFs has been placed as per C/L			
3	R.L. has been checked at each GSFs			
4	Rail cant has been checked			
5	Cant of base plate is in right direction.			
6	The rail seat is properly fixed to Rail foot and properly pushed from outside.			
7	Horizontal Alignment			
8	Vertical alignment			
9	Whether Base Plate falling on Flash Butt Welding Joint.			
10	Anchor bolt infringement with Shear Connector checked.			
11	At each base plate, Spacing/Square ness/ Verticality of bolts/Gauge/cross Level checked.			
12	Any other details			

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12.7CHECK LIST FOR REINFORCEMENT

PROJECT: Mumbai Metro Rail Project
CLIENT: Mumbai Metro Rail Limited
GENERAL CONSULTANT: Maple Consortium

Sl.No		Yes	No.	NA
1.	Working drawing checked and approved			
2.	Latest revision being used			
3.	Bar schedules approved			
4.	Reinforcing steel material approved			
5.	Bar bending & cutting satisfactory			
6.	Bar sizes correct			
7.	Bar spacing correct			
8.	Cover to bottom bars correct			
9.	Cover to side bars correct			
10.	Cover to top bars correct			
11.	Cover block approved including fixing			
12	Any other details			

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12.8CHECK LIST FOR SHUTTERING

PROJECT: Mumbai Metro Rail Project
CLIENT: Mumbai Metro Rail Limited
GENERAL CONSULTANT: Maple Consortium

Sl.No.	Description of activity	Yes	No.	NA
1	Form work design/drawing/ sketch approved including de-shuttering arrangement.			
2	Trial pannel approved			
3	Form work alignment correct.			
4	Form work levels correct.			
5	Form work dimensions correct.			
6	Form work members spacing correct.			
7	Form work member material quality acceptable			
8	Form work member size correct.			
9	Joints between panels closed (no gaps)			
10	Joints between panels flush(no steps/lips)			
11	Panel flatness acceptable.			
12	Form work clean.			
13	Form work release oil material approved.			
14	Form work release oil correctly used.			
15	Construction joint preparation satisfactory.			
16	Safe access provided.			
17	Adequate work space provided for labour, equipment.			
18	provision of bond continuity if required			
19	Provision of PVC pipe if required			
20	Anchor bolt infringement with reinforcement.			

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12.9 PROFORMA FOR INTIAL CHECKING OF BALLASTLESS TRACK GEOMETRY

Project	**: Mumbai Metro Rail Line-3**		
Client	**: MMRC**		
GC/Engineer	**: MAPLE Consortium**		
Contractor	**:**		
Line:		**Location :**	**Date :**
Chainage **From:**	**To:**		

Chainage	R.L at every GSF (+/- 2 mm)						Rail Inclination 1:20 (+/- 0.5 mm)	At every GSF location		Versine (+/- 2 mm)		Remarks
	Designed R.L		Achieved R.L		Difference			Cross level (+/- 1.5 mm)	Gauge (+2/-1mm)	Design	Actual	
	RH	LH	RH	LH	RH	LH						

Contractor **MAPLE-GC**

12.10RECORD FOR SOD CLEARANCE

PROJECT: Mumbai Metro Rail Project
CLIENT: Mumbai Metro Rail Limited
GENERAL CONSULTANT: Maple Consortium

Report No:	**Date:**	**Verified by:**
Location/Line no:		

Sl. No.	**Location/Chainage**	**Type of structure**	**Distance from Nearest track centre line**		**Limits as per SOD**
			Vertical	Horizontal	
1.					
2.					
3.					
4.					
5.					

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12.11ABSOLUTE POSITION TRACK ALIGNMENT – TRACK MASTER REPORT

PROJECT: Mumbai Metro Rail Project
CLIENT: Mumbai Metro Rail Limited
GENERAL CONSULTANT: Maple Consortium

w

chainage	HORIZONTAL ALIGNMENT					VERTICAL ALIGNMENT					TRACK GUAGE						
	(GRADE RAIL)		TOLERANCE ± 2mm	± 1mm / 1.000m	± 2mm / 10.000 m	(GRADE RAIL)		TOLERANCE ± 4mm	± 1mm / 1.000m	± 2mm / 10.000m	GUAGE			CANT			
	Actual	Design				ACTUAL	DESIGN				ACTUAL	Diff. -1 +2mm	Guage ± 1mm / base plate	Design cant	Actual cant	Cant ± 1.5/3 m	& Cant ± 1mm / base plate

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12.12CHECK LIST FOR CONCRETE

PROJECT:	Mumbai Metro Rail Project
CLIENT:	Mumbai Metro Rail Limited
GENERAL CONSULTANT:	Maple Consortium

GENERAL

a) Structure	:		
b) Location	:		
c) Part of structure	:		
d) Pouring method	:		
e) Cast level	:	to	RL.
f) Date	:		
g) Drawing no.	:		
h) Estimated pouring time	:		
i) Grade of concrete	:		
j) Quantity of concrete	:		
k) Admixture approved	:Yes/ no		

SURVEY

a) Reference approved	:
b) Lay out	: sketch is drawn in overleaf yes/ no
	Approved : yes/ no
c) Level checked	: yes/ no

REINFORCEMENT

a) Bar bending schedule	: submitted – yes/no
	Approved – yes/ no
b)Tied as per BBS and Drawing -	:yes/ no
c) Anti-corrosive treatment done	:yes/ no
d) Chairs/ spacers provided	: yes/ no
e) Cover blocks provided	: yes/ no

f) Quantity :

FORMWORK

a) Dimensions	:as per drawing – yes/ no
b) Alignment	: OK/ to be corrected
c) Verticality	: OK/ to be corrected
d) Leveling	: OK/ to be corrected
e) Weep holes provided as per drg.	: yes/ no
f) Vibratory equipment	: provided – yes/ no
g) Supports	: OK/ to be corrected
h) Cleanliness & shuttering Oil	: OK/ Not OK

GENERAL ARRANGEMENTS

a) Access	: OK/ to be corrected
b) Lighting provided	: yes/ no
c) Communication system	: provided – yes/ no
d) Safety measures taken	: yes/ no
e) General cleanliness	: OK/ to be improved
f) Stock of material	: sufficient/ not sufficient
g) Staff responsible	:
h) Labour	: sufficient/ to be improved
I) Stand by equipment	: available – yes/ no
j) Name of safety engineer	:

REMARKS :

PERSON IN CHARGE FOR SUPERVISION – Site engineer:

Key person :

CHECKED BY :

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12.13CONCRETE POUR CARD

PROJECT: Mumbai Metro Rail Project
CLIENT: Mumbai Metro Rail Limited
GENERAL CONSULTANT: Maple Consortium

Drawing no. : **Date:**

Structure :

Location :

Segment :

Grade of concrete :

Quantity of concrete :
Cement Required in MT :
Date & time of start :
Expected time of completion :
Method of transportation :
Method of mixing :
Method of pouring :
Rate of pour achieved : cum/hour.
Water- cement ratio :

Admixture : % Retarder/ super plasticizer

Slump observed:

1	2	3	4	5	6
mm	mm	mm	mm	mm	mm

No. Of cubes taken :
ID Marks on cubes :

APPROVED TO POUR : YES/ NO

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12.14 POST CONCRETE CHECKLIST

PROJECT : Mumbai Metro Rail Project
CLIENT : Mumbai Metro Rail Limited
GENERAL CONSULTANT : Maple Consortium

Drawing no. :
Location/Chainage :
Structure :
Plinth no :
Quantity of concrete poured :
Achieved pouring time :
Date of pour :
Date of side shutter stripped :
Date of End shutter stripped :

POSITION/ DIMENSIONS

Alignment : S / NS
Levels : S / NS
Dimensions : S / NS
Non-conformance report no. : dated

CURING

Method :
Starting date :
Finishing date :
Checks :

Date							
Remarks							

References: S-Satisfactory **NS-Not satisfactory.**

SURFACE DEFECTS

No defects/ Minor defects/ Major defects

Non-conformance report no. dated:

CRACKS

No cracks/ cracks date observed:

Nature of cracks: Hairline/ <0.25mm/ >0.25mm

SPALLING

No spalling/ Spalling

Non-conformance report no. dated
for cracking/ spalling

SKETCH(indicate position/ dimensions of crack/spalling)

Inspected by: **Date:** **Signature:**

DEPUTED ENGINEERS EVALUATION (tick as applicable)

Not significant (use as it is) ☐

Structural or indeterminable origin
NCR to be raised ☐

Name: Date: Signature:

QUALITY FOLLOW-UP

Non-conformance report no. Given by Signature

TEST RESULTS SUMMARY

Test	No.	Mean	SD	Max	Min	Compliance
Slump (mm)						Yes/ No
Compressive strength-7days (N/mm^2)						Yes/ No
Compressive strength-28days (N/mm^2))						Yes/ No

Any non-compliance : Yes/No
If yes- action taken :

.....
.....

DATA TRANSFER

Date passed to structure records : Yes/ No

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12.15CONCRETE BATCH SHEET

PROJECT: Mumbai Metro Rail Project
CLIENT: Mumbai Metro Rail Limited
GENERAL CONSULTANT: Maple Consortium

Location of testing lab:
Corridor No: Stage No:

DATE, TIME & Plant location:		Source		Aggregate in the Design mix	
		Portland Cement		20mm (%)	
		Flyash		12.5mm (%)	
		Micro Silica		River Sand (%)	
		Crushed Aggregate		Crusher Sand (%)	
Grade of Concrete:		River Sand		Admixture (%)	
		Admixture			

Ingredients of Mix	Quantity per cum (as per mix design) (Kg)	Water absorption (%)	Water absorption (kg) (col.4 = clo.2 x col.3 / 100)	Free Moisture in ingredients (%)	Free Moisture in ingredients (kg) (col.6 = col.2 x col.5 / 100)	Corrected weight of ingredients per cum after moisture corrections (kg)		for _____ cum (kg)
1	2	3	4	5	6	7		8
Ordinary Portland Cement (kG)						col.2 =		
Flyash (kG)						col.2 =		
Micro Silica (kG)						col.2 =		
Coarse Aggregate Fraction 1 - 20mm (kG)						col.2 + col.6 =		
Coarse Aggregate Fraction 2 - 10mm (kG)						col.2 + col.6 =		
Fine Aggregate Fraction 3 - River Sand						col.2 + col.6 =		

(kG)								
Fine Aggregate Fraction 4 - Cruhser Sand (kG)						col.2 + col.6 =		
Free Water (kG)						col.2 + col.4 - col.6 =		
Admixture (kG)						col.2 =		

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12.16COMPRESSIVE STRENGTH OF CONCRETE CUBES

PROJECT: Mumbai Metro Rail Project
CLIENT: Mumbai Metro Rail Limited
GENERAL CONSULTANT: Maple Consortium

Location of testing lab: Date of testing:
Corridor No: Stage No:

S.No	Date of casting	Location / Identification mark	Grade of concrete	W-C ratio	Age on testing	Cube number	Weight of cube (gm)	Machine load (kN)	Compressive strength (N/mm^2)	
									Individual	Ave

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12.17INSPECTION CHECK LIST FOR REAR WORKS

PROJECT : Mumbai Metro Rail Project
CLIENT : Mumbai Metro Rail Limited
GENERAL CONSULTANT : Maple Consortium

Corridor:				
Stage:				
Chainage: From……..to…….		**Plinth no:**		
Date:				
S.NO.	**Description of activity**	**Remarks/comments**		
		YES	NO	NA
1	Lift rails , remove dummy plates & fastening minimum 10 days			
2	Fastening Assembly Compliance Check			
3	Inspection of concrete defects in plinth under dummy plates.			
4	Checking of looseness of Anchor bolts			
5	Repair works conducted as per approved procedure			
6	Grouting of loose bolts as per approved procedure			
7	Fastening Assembly bearing area is free of foreign materials before installation & all components free of concrete from bearing surfaces			
8	Shims & bushes placed properly to achieve the final track tolerance			

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12.18INSPECTION CHECK LIST FOR DE-STRESSING

PROJECT: Mumbai Metro Rail Project
CLIENT: Mumbai Metro Rail Limited
GENERAL CONSULTANT: Maple Consortium

Report No:	**Date:**	**Verified by:**		
Location/Line no:				
Sl. No.	**DESCRIPTION**	**YES**	**NO**	**N/A**
1.	Whether prevailing rail permits de-stressing?			
2.	Whether all track fastening are in place?			
4.	Sufficient no. of. rollers available or not?			
5.	Sufficient no.of.wooden mallets available or not?			
6.	AT welding batch is ready?			
7.	Cut rail/closure rails are available?			
8.	Whether sufficient no. of. Fastenings kept on hand?			
9.	Whether rail tensor is kept ready in case of low temperature?			

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12.19REQUEST FOR INSPECTION

PROJECT: Mumbai Metro Rail Project
CLIENT: Mumbai Metro Rail Limited
GENERAL CONSULTANT: Maple Consortium

EDMS submission No:	**RFI No :**
Date:	**Date:**

ITEM LOCATION	Discipline: CIVIL / MECHANICAL / ELECTRICAL / RAILWAYS
Corridor No:	Activity:
Stage No:.	
Area name:	Drawing Number:

Quality Hold Point ☐ **Quality Control Point** ☐

Details of item :

Reduced level	**From:** **To:**	**Quantity:**	

Requested by:	**Inspected by:**
Name :	Name :
Date :	Date :
Time :	Time :
Signature:	Signature:

Details of inspection :

1. Inspection completed, the contractor may proceed with the works.	Yes ☐	No ☐
2. Remedial works required as below but further inspection not required.	Yes ☐	No ☐
3. Remedial works required as below and re-inspection is required.	Yes ☐	No ☐

Remarks:

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12.20TOOL BOX TALK REPORT

PROJECT: Mumbai Metro Rail Project
CLIENT: Mumbai Metro Rail Limited
GENERAL CONSULTANT: Maple Consortium

Location : _____
Name of the Section In-charge : _____
Name of the EHSO : _____
Name of the Sub-Contractor/Dept. : _____
Number of workmen present : _____
Date & Time : _____ & _____
Topics discussed : _____
_____
_____
_____
_____

Response of workmen : _____

Remark / Any significant problem : _____
Identified as a result of consultation _____
_____

Signature: ---------- ----------
EHSO Section In-charge

12.21ILLUMINATIONS OBSERVATIONS REPORT

PROJECT : Mumbai Metro Rail Project
CLIENT : Mumbai Metro Rail Limited
GENERAL CONSULTANT : Maple Consortium

Location: **Activity:** **Date of measurement:**

Layout sketch: (show the area of work, source locations and distance from the source where the readings are taken):	Location as per lay out sketch	Time of measurement (am/pm)	Illumination in lux
	1		
	2		
	3		
	4		
	5		
	6		
	7		
	8		

Signature for P&M **Signature for EHSO**

12.22NOISE MONITORING REPORT

PROJECT: Mumbai Metro Rail Project
CLIENT: Mumbai Metro Rail Limited
GENERAL CONSULTANT: Maple Consortium

Sl. No	Date	Time	Monitoring Locations	Activities	Monitoring by Internal / External	Frequency	Noise Limits in dB(A)Leq.	Remarks

EHSO _____

12.23CLEARANCES AND CLEANLINESS REPORT

PROJECT: Mumbai Metro Rail Project
CLIENT: Mumbai Metro Rail Limited
GENERAL CONSULTANT: Maple Consortium

Area / Location Inspected : _____
Inspected By : _____
Date : _____

Sl. No.	Points	Observation	Measures
	STRUCTURAL FABRICATION / ERECTION SITE		
1	Walkways, passages kept clear of materials?		
2	Area & roads kept clear for maneuvering of cranes and material handling equipment?		
3	Scrap, cut-pieces, welding electrode stubs, hand-tools kept tidy in workplace and disposed suitably?		
4	Scrap-bin available in adequate number?		
5	Welding cables, power cables routed properly to avoid run-over by vehicle or tripping hazards?		
6	Compressed gas hoses routed properly?		
7	At least 1 meter on both sides of gantry rails is kept clear of material?		
8	Floor kept clear of water, oil spillage / accumulation?		
	CIVIL WORK AREA		
1	All approach, aisle, ingress / egress to and from work area, excavated pits, ramps, walkways kept clear of debris, tools etc?		
2	Scaffolding materials (H-beam, HD tower frames, bracing, clamps) shuttering boards etc. are stacked properly at site?		
3	Stacking of bricks, hollow blocks are done in safe manner?		
4	Nails removed from wooden planks / timber and not protruding out?		
5	Saw dust, wood chips & scrap wood cleared from carpentry shop and disposed suitably?		
6	Debris from demolition and excavated earth cleared from workplace and access?		
	ELECTRICAL INSTALLATIONS & BOOTHS		
1	Approach to DB, Panels, Switches kept clear?		
2	Fire extinguishers installed at locations where they are easily accessible?		

Sl. No.	Points	Observation	Measures
3	Welding cables and power cables are routed separately?		
4	Routing of cables is done properly to avoid obstruction & tripping hazards?		
5	Floor of electrical booths kept dry?		
6	Rubber mats are in place at electrical panels?		
	STORES		
1	Walkways, entry and exits kept clear?		
2	Materials placed on racks safely accessible?		
3	Compressed gas cylinders are segregated as full or empty and type of gas?		
4	Vertically stored cylinders are secured / chained to avoid toppling and horizontal ones guarded against rolling down?		
5	Flammable storage areas are isolated from store, office and work areas?		
6	Cement bags are stacked in proper gradient safely?		
7	Corrosive material (e.g. acids, alkalis) stored away from other material & kept on collection trays to safeguard against accidental leakage?		
8	Storing area for lifting tools & tackles, ropes, wire ropes & PPE is dry, clean & free of corrosive material?		
9	Easy accessibility to installed fire extinguishers ensured in store?		
	GENERAL		
1	Separate scrap yard allocated for the project?		
2	Approach to workstations, offices, time offices, stores, P&M are well laid and demarcated?		
3	Roads are kept clear of stacked material for free & safe vehicular movement?		
4	Heavy materials stacking are taken care of to prevent slips, collapse and rolling?		

FOR EHSO

12.24WEEKLY ENVIROMENTAL INSPECTION CHECKLIST

PROJECT: Mumbai Metro Rail Project
CLIENT: Mumbai Metro Rail Limited
GENERAL CONSULTANT: Maple Consortium

S. No.	Item	Observation	Remark	Action	
				By Date	By whom
1.0	**AIR POLLUTION**				
1.1	**Dust** (approach roads, adjacent roads, working area, cement handling etc.)	○ Site Satisfactory ○ Site Dusty ○ Sprinkling carried out as required ○ Excavate removal within 2 days			
1.2	**Generators**	○ Satisfactory ○ Maintenance regime followed ○ Black Smoke ○ Leaking oil ○ Drip Pans not available			
1.3	**Vehicles**	○ Satisfactory ○ PUC certificate available ○ Black Smoke ○ Wheel Washed / Cleaned ○ Leaking oil ○ Side of vehicle clear of mud ○ Material transported in closed manner			
1.4	**Air Monitoring**	○ Carried out as per contract ○ Results reported as per contract ○ Remedial measures in place where required			
2.0	**WATER POLLUTION**				
2.1	**Site Drains**	○ Drainage system functional ○ No Contamination			

2.2	**Site Drains**	○ Storage of refuse / excavate muck not near the drains			
2.2	**Adjacent Drains**	○ Not damaged ○ No signs of pouring bentonite ○ No signs of poring chemicals ○ Sign of discharging Silt / debris			
2.3	**Separator Tanks**	○ Tank not full of slit ○ Tank regularly emptied			
3.0	**NOISE POLLUTION**				
3.1	**Noise control measures**	○ All powered mechanical equipments are sound reduced ○ Acoustic / enclosures constructed in areas of excessive noise ○ Equipment located and directed away from noise receptors			
3.2	**Generators provided with acoustic enclosures**	○ Effective ○ Not effective ○ Not provided			
3.3	**Noise Monitoring**	○ Carried out as per contract ○ Not exceeded baseline values ○ Remedial measures in place ○ Results evaluated statistically for inclusion in Monthly report			
4.0	**WASTE MANAGEMENT**				
4.1	**Waste Identified**	○ Chemical Flammable Corrosive Construction related/ oil/ Filters/ Batteries ○ Hazardous ○ Other (Specify)			
4.2	**Storage Containers & Bins**	○ Adequate number and properly place ○ Proper quality ○ Emptied regularly ○ Labeling proper ○ No spillage on container surface noticed ○ Pollutants (e.g. waste chemical), not dumped in bins ○ Recyclable (e.g. metal) not dumped in garbage bins			
4.3	**Oil Waste**	○ Drip pans available ○ No oil stains on ground ○ Spill absorption material available			

		○ Waste oil poured in to designated waste drums ○ Used oil filters not dumped in garbage bins			
4.4	**Excavate/ Muck**	○ Storage satisfactory/ properly secured ○ Dumping in authorized areas ○ No interference with nearby drainage			
5.0	**STORAGE**				
5.1	**Diesel Storage**	○ Extensive diesel spillage on ground not visible ○ Drip pans used when pumping diesel ○ Pipes / connectors/ pumps not leaking ○ Not located close to storm water drains ○ transfer arrangement satisfactory			
6.0	**AESTHETICS & CLEANLINESS**				
6.1	**Housekeeping & Hygiene**	○ Designated storage area for materials ○ Scraps/brickbats/rubbish scattered at site ○ Proper space for handling waste ○ Area Clean and dry ○ Stagnant water treated weekly ○ Proper stacking of drums ○ Barricades are clean, in line, firmly secured and proper earthling ○ Water not allowed to accumulate in work area for any reason			
7.0	**ROADS**				
7.1	Access Roads	○ Satisfactory Maintenance ○ In urgent need of Maintenance			
7.2	Public Roads used by Contractor	○ Satisfactory maintenance ○ Repair not carried out			

FOR EHSO

12.3. EQUIPMENT FITNESS REPORT FOR VEHICLE & EARTH MOVING EQUIPMENT

PROJECT: Mumbai Metro Rail Project
CLIENT: Mumbai Metro Rail Limited
GENERAL CONSULTANT: Maple Consortium

Identification / Reg. No: _____ Make / Model :
_____
Date : _____ Asset code (If applicable):
_____
Inspected Team : _____ Owned by :
_____

Sl. No.	Check Points	Observation	Remarks
1	Engine condition		
2	Clutch / brake		
3	Hydraulic System		
4	Guards / Covers / Doors		
5	Fastener locks pins / Keys.		
6	Horn / Reverse horn / Lights/		
7	Indicators / Wiper Blades		
8	Operators fitness		
9	Tyre pressure		
10	Condition of Battery and Lamps		
11	Operating levers / steering		
12	Gauges & warning devices		
13	Fire extinguisher Provided		
14	First Aid Box		
15	Swing Alarm Provided		
16	Validity of PUC Certificate		
17	Validity of Fitness Certificate		
18	Delay Start Mechanism		

This Vehicle/ Earth Moving Equipment has been checked for the above points and for deployment.

Found fit for deployment Found Unfit for deployment

For P&M Engineer **For EHSO**

12.25VEHICLE & EARTH MOVING EQUIPMENT INSPECTION CHECKLIST

PROJECT: Mumbai Metro Rail Project
CLIENT: Mumbai Metro Rail Limited
GENERAL CONSULTANT: Maple Consortium

Identification / Reg. No: _____ Make / Model :
_____
Date : _____ Asset code (If applicable):
_____
Inspected Team : _____ Owned by :
_____

Sl. No.	Points	Observation	Measures
1	Engine condition		
2	Clutch / brake / Hand brake		
3	Hydraulic System		
4	Guards / Covers / Doors		
5	Fastener lock pins / Keys		
6	Horn / Reverse horn / Lights		
7	Indicators / Wiper Blades		
8	Operator's fitness		
9	Tyre pressure / Tyre Condition		
10	Condition of Battery and Lamps		
11	Operating levers / steering		
12	Gauges & warning devices		
13	Fire extinguisher provided		
14	Rear Side Mirror		
15	Seat Belt		
16	Triangular Retro Reflectors – 4 nos. (Front side – 02, Rear side – 02)		
17	Chock blocks (min 02 nos.)		

Sl. No.	Points	Observation	Measures
18	Delay Start Mechanism		
19	Validity of PUC Certificate		
20	Validity of Fitness Certificate		

For EHSO

12.26HOT WORK PERMIT

PROJECT: Mumbai Metro Rail Project
CLIENT: Mumbai Metro Rail Limited
GENERAL CONSULTANT: Maple Consortium

(**Hot work would mainly comprise -** Welding, Gas-cutting, use of Open Flames or other sources of fire in a fire-prone place containing inflammable substances, explosives & / or other such highly combustible materials susceptible to spontaneous ignition & / or explosion.)
The person taking permit (permittee) to fill up:

Exact location where hot work is being planned _____
Approximate duration of work. From : Date: _____ Time _____
To : Date: _____ Time _____

	Points to be checked	Date:	Date:	Date:	Date:	Date:	Date:	Date:	
I. No	Details	Yes/NO/ Not Required	Yes/NO/ Not Required	Yes/NO/ Not Required	Yes/NO/ Not Required	Yes/NO/ Not Required	Yes/NO/ Not Required	Yes/NO/ Not Required	Remarks
1.	Has the area immediately below the work spot, been cleared / removed of oil, grease & waste cotton etc.?								
2.	Has Gas concentration been tested in case there is gas valve/gas line nearby?								
3.	Have fire extinguishers been kept handy at site?								
4.	Has tin sheet/ wet gunny bag/ fire retardant cloth / sheet been placed to prevent sparks from causing fire?								
5.	Has water hose connection been made for continuous water spray?								
6.	Have all the drain inlets (if any) been closed?								
7.	Any other precautions taken (specify):_____ ___								

The above points have been complied with and conditions rendered safe / hazards innocuous to undertake the hot work.

Name of Permittee (Site Engineer) _____ Signature_____ Designation_____

B) The person giving permit (issuing authority) to fill up:
After checking all the above precautions the hot work can be carried out in the above area.

Name & Signature of issuing authority _____ Section In-charge _____ EHSO

C) Time _____ Date_____ at which the permit closed & filed.

_____

Signature of EHSO

12.27WELDING EQUIPMENT INSPECTION CHECKLIST

PROJECT: Mumbai Metro Rail Project
CLIENT: Mumbai Metro Rail Limited
GENERAL CONSULTANT: Maple Consortium

Identification No. :
Area / Location :

Sl No	Particulars	Observation	Remarks
01	Is Machine placed in isolated place		
02	Is Double grounding has ensured in connections		
03	Condition of the welding machine		
04	Having proper moving parts (tyre mounted)		
05	Condition of the electrode cable & work lead		
06	Is work lead connected properly		
07	Is welder using face shield with 11 / 12 grade black glass		
08	Cable routing properly secured from over lapping		
09	Is any insulation on electrode cable with in 3mtr from electrode holder		
10	Fire extinguisher available in welding shed (check Inspection date)		
11	Is Welding machines secured from direct exposure of rain water		
12	Is Proper illumination available on welding shed		
13	Is work carried out as per IS 3016-1965		
14	Valid Hot Work Permit display at site		
15	Other		

Date: _____ _____

EHS Personal P&M Incharge

12.28CRANE INSPECTION CHECKLIST

PROJECT : Mumbai Metro Rail Project
CLIENT : Mumbai Metro Rail Limited
GENERAL CONSULTANT : Maple Consortium

Identification/Reg. No: _____ Make / Model : _____
Date : _____ Asset code (If applicable): _____
Inspected Team : _____ Owned by : _____

Sl. No.	Points	Observation	Measures
1	Hook and Hook Latch		
2	Over-Hoist Limit Switch		
3	Boom-Limit Switch		
4	Boom Angle indicator		
5	Boom-Limit cut-off switch		
6	Over load limit switch		
7	Condition of boom		
8	Condition of Ropes		
9	No. of load lines		
10	Size and condition of the sling		
11	Stability of crane		
12	Soil Condition		
13	Swing Brake & Lock		
14	Propel Brake & Lock		
15	Hoist Brake & Lock		
16	Boom Brake & Lock		
17	Swing Alarm		
18	Main clutch		
19	Leakage in hydraulic cylinders		
20	Out riggers fully extendible		
21	Tyre pressure		
22	Condition of Battery and Lamps		
23	Guards of moving and rotating parts		
24	Load chart provided		
25	Numbers, position and size of pendant ropes		
26	Reverse horn & Rear view mirror		
27	Validity of Certification by competent authority		
28	Operator's Fitness		

Sl. No.	Points	Observation	Measures
29	Fire Extinguisher in operator's cabin		
30	Caution Boards		
31	Validity of PUC certificate (for tyre mounted)		
32	Validity of Fitness certificate (for tyre mounted)		

For EHSO

12.29TOOL & TACKLES INSPECTION CHECKLIST

PROJECT: Mumbai Metro Rail Project
CLIENT: Mumbai Metro Rail Limited
GENERAL CONSULTANT: Maple Consortium

Area Inspected :
Inspected By :
Date :

Sl No	Particulars	Observation	Measures
Lifting Tool & Tackles			
1	Slings / Wire Ropes		
1.1	Is any defect on slings / wire rope?		
1.2	Condition of "Eye" used in sling / wire rope?		
1.3	Sufficient number of "U" clamps used as per dia.		
1.4	Are any identification code/ marks on the slings / wire rope?		
2	"D" / Bow shackle		
2.1	Is SWL identified on the shackle?		
2.2	Are any identification code/ marks on the Shackles?		
2.3	Opening width of shackles are ok		
2.4	Seating condition of Shackle pin		
2.5	Any defects are observed on the pin?		
3	"U" Bolts & "Eye" Bolts		
3.1	Condition of "U" / Eye bolt used		
3.2	Any cracks / wear were found		
3.3	Tapper of eye bolt is free from rust.		
3.4	Shape of "U" / "Eye" bolt is regular		
4	Hooks & Chain Pulley Block		
4.1	Is any deformation on the eye portion?		
4.2	Is any crack / wear were found?		
4.3	Condition of hook latch		
Electrical / Automotive Tool & Tackles			
1	Spanners & Screw drivers		

1.1	Condition of Spanners / Screw drivers		
1.2	Is any wear / crack on the head / tip of the tackle.		
1.3	Is spanners are free from rust?		
2	Hammer		
2.1	Condition of the hammer		
2.2	Tightness of the handle		
2.3	Materials used for making handle		
3	Crimpers		
3.1	Condition of the crimper used		
3.2	Condition of the insulation		
3.3	Condition of gripers		
3.4	Is any crack on the crimpers		
4	Grinding Machine		
4.1	Condition of Grinding machine		
4.2	Is wheel guard provided properly		
4.3	Wheel having a valid expiry date		
4.4	Is earthing given properly?		
4.5	Condition of the cable connected		
5	Drilling Machine		
5.1	Condition of Drilling machine		
5.2	Is Drill bit fitted properly		
5.3	Use of proper tightening key		
5.4	Is earthing given properly?		
5.5	Condition of the cable connected		
Testers			
1	Earth leakage Circuit Breaker Tester		
1.1	Is polarity showing on the meter is good		
1.2	Accuracy of the meter is acceptable		
1.3	Is calibration required		
2	Surface Resistance Tester		
2.1	Is polarity showing on the meter is good		

2.2	Accuracy of the meter is acceptable		
2.3	Is calibration required		
Any other relevant Information			
1			
2			

_____

Signature of Site EHS Personal

MUMBAI METRO LINE 3
(COLABA-BANDRA-SEEPZ)

CONTRACT MM3-CBS-TWK-03
(Package 10C)

Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of Ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and Ballasted Track in the area of at-grade Aarey Station and in the Depot area of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ).

and

Procurement and Supply of Turnouts, Scissor Crossovers and Buffer Stops for the entire Mainline for Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ) including Package 10 B.

TENDER DOCUMENTS

Part 2

Section VI (4)

EMPLOYER'S REQUIREMENT
Tender Drawings

JULY 2019

JICA LOAN AGREEMENT ID - P 268

Mumbai Metro Rail Corporation Ltd
Line 3 Transit Office, Wing 'A' North Side of City Park 'E'- Block,
Bandra-Kurla Complex,
Bandra (East) Mumbai 400 051, India

TENDER DOCUMENTS

Composition of Documents

Part1	**Bidding Procedures**	
	Section I.	Instructions to Bidders (ITB)
	Section II.	Bid Data Sheet (BDS)
	Section III.	Evaluation and Qualification Criteria
	Section IV- A.	Bidding Forms
	Section IV- B.	Pricing Document
	Section V.	Eligible Source Countries of Japanese ODA Loan
Part2	**Employer's Requirements**	
	Section VI.(1)	General Specifications A. General B. Functional C. Design D. Construction E. Inspection Testing and commissioning F. Appendices
	Section VI (2)	Outline Design Specifications
	Section VI (3).	Outline Construction Specifications
	Section VI (4)	Tender Drawings
Part 3	**Conditions of Contract and Contract Forms**	
	Section VII	General Conditions of Contract (GCC)
	Section VIII	Particular Conditions of Contract (PCC)
	Section IX.	Annex to the Particular Conditions - Contract Forms
Part 4	**Reference Documents**	
	Section X	OHS & E Manual

TABLE OF CONTENTS

Part 2 – EMPLOYER'S REQUIREMENTS

TENDER DOCUMENTS

Part 2

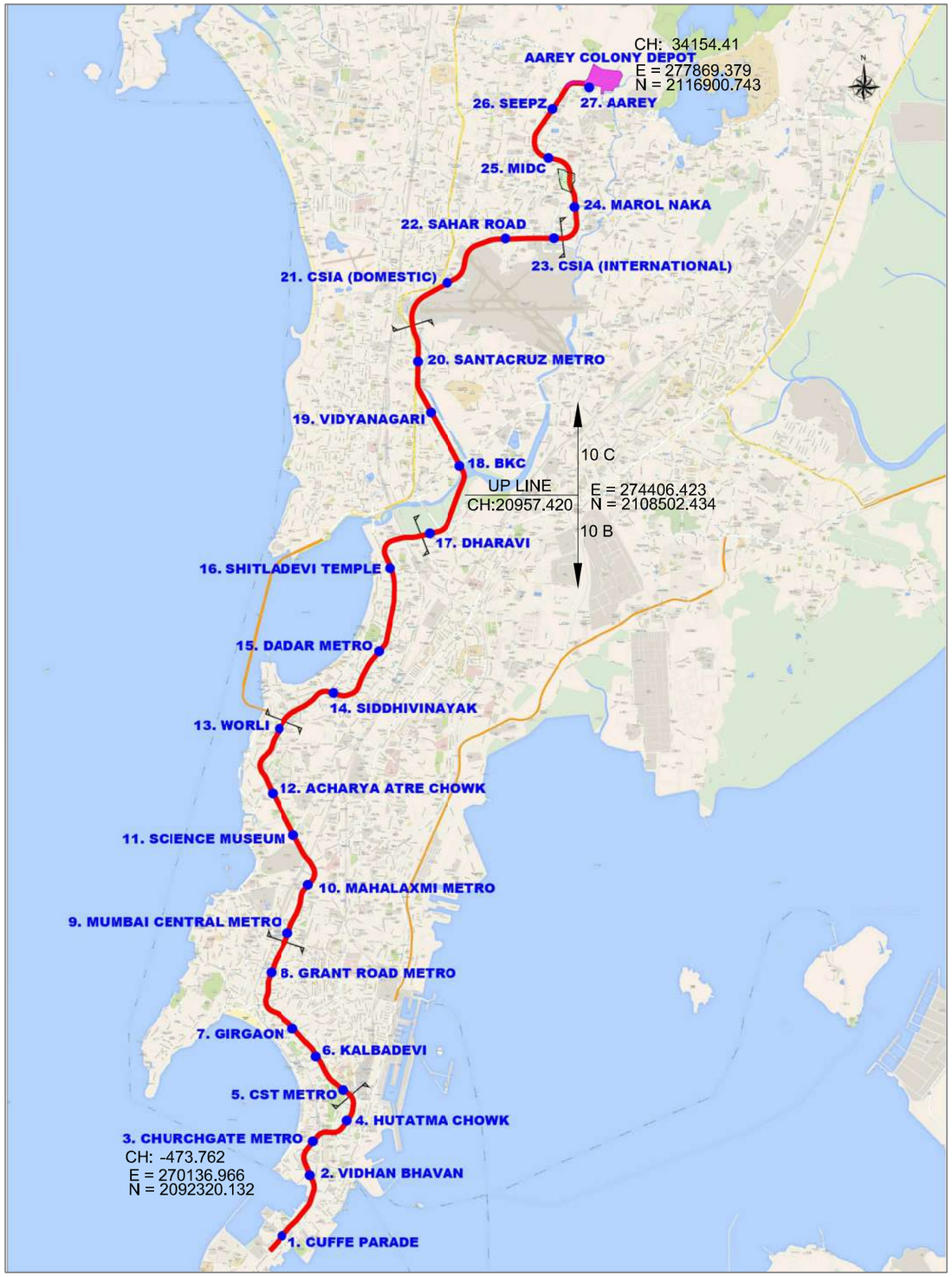
Section–VI (4)

EMPLOYER'S REQUIREMENTS

TENDER DRAWINGS

List of drawings/Index

TRACK WORKS BOUNDARY 10B & 10C
PACKAGES MML3 (TRACK FORM)



NOTE:

1. THE TRACK FORM FOR MAIN LINE ON HIGH ATTENUATION BOOTED TWIN BLOCK SLEEPERS.
2. THE TRACK FORM FOR DEPOT AND AAREY STATION IS SHOWN IN DEPOT TRACK LAYOUT.

LEGEND:

MAIN LINE

VERSIONS	DATE	DESCRIPTION

Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MAH 400098

MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
NaMTTRI Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

DRAWING STAGE			TITLE		
DESCRIPTION	NAME	SIGNATURE	TRACK WORKS BOUNDARY 10B & 10C PACKAGES MML3 (TRACK FORM)		
DRAWN BY	HRM (TI)				
CHECKED BY	VKS (CTE)		DRG No.		
REVIEWED BY	P. LEEMPUT (TRACK EXPERT)		SHEET	-	SCALE -
APPROVED BY	RJM (PM)		DATE	27 September 2018	REV. -

LEGEND:-

TRACK SYSTEM
- BOOTED TWIN BLOCK (HIGH ATTENUATION)
- BOOTED TWIN BLOCK (STANDARD)

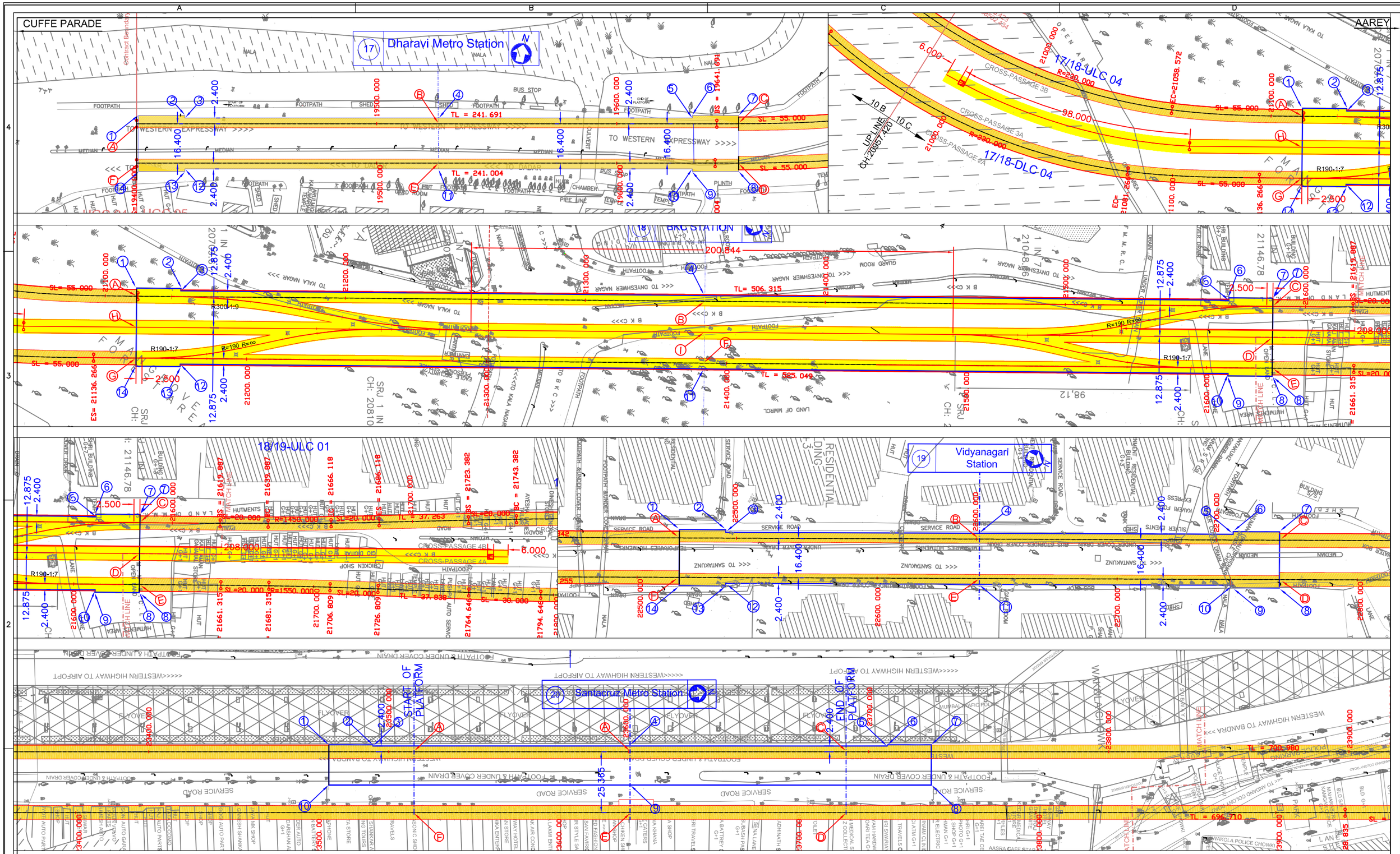
OVERALL TRACK SCHEMATIC LAYOUT

VERSIONS	DATE	DESCRIPTION

Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruiz East, Mumbai. MAH 400098

MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
NaMTTRI Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

DRAWING STAGE			TITLE SCHEMATIC TRACK LAYOUT		
DESCRIPTION	NAME	SIGNATURE	DRAWING NO. :- MM3-GC-TR-GD-0 101 0016		
DRAWN BY	HRM (TI)				
CHECKED BY	VKS (CTE)		DRG No.		
REVIEWED BY	P. LEEMPUT (TRACK EXPERT)		SHEET	-	SCALE -
APPROVED BY	RJM (PM)		DATE	27 September 2018	REV. -



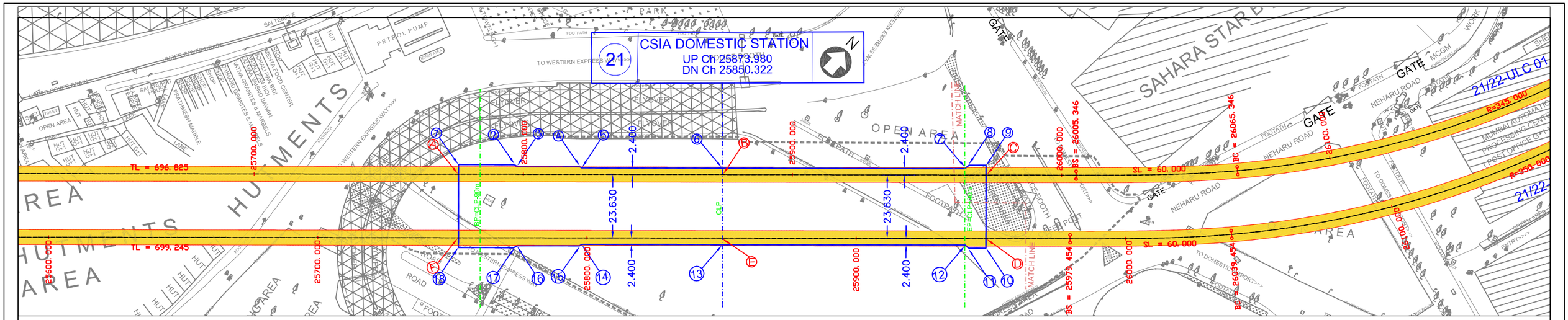
VERSIONS	DATE	DESCRIPTION

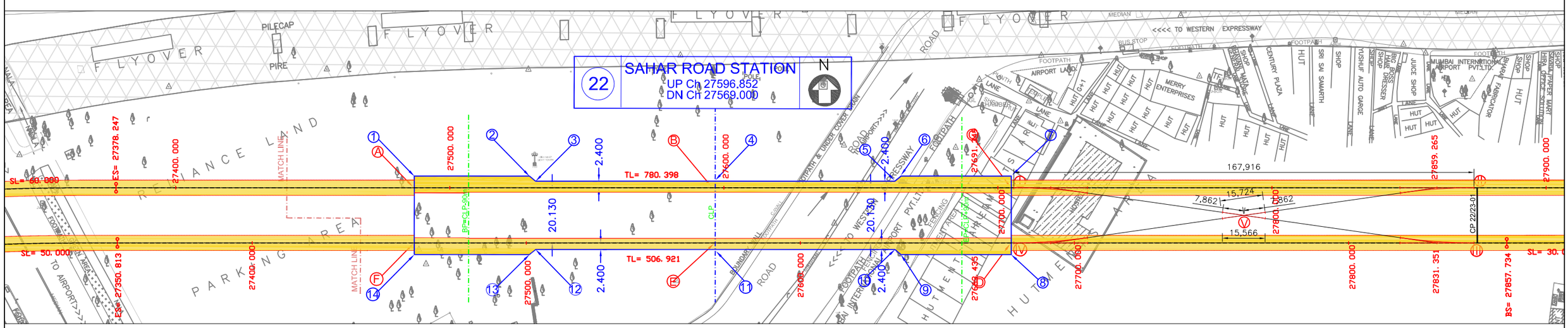
maple
MUMBAI METRO LINE-3
GENERAL CONSULTANT

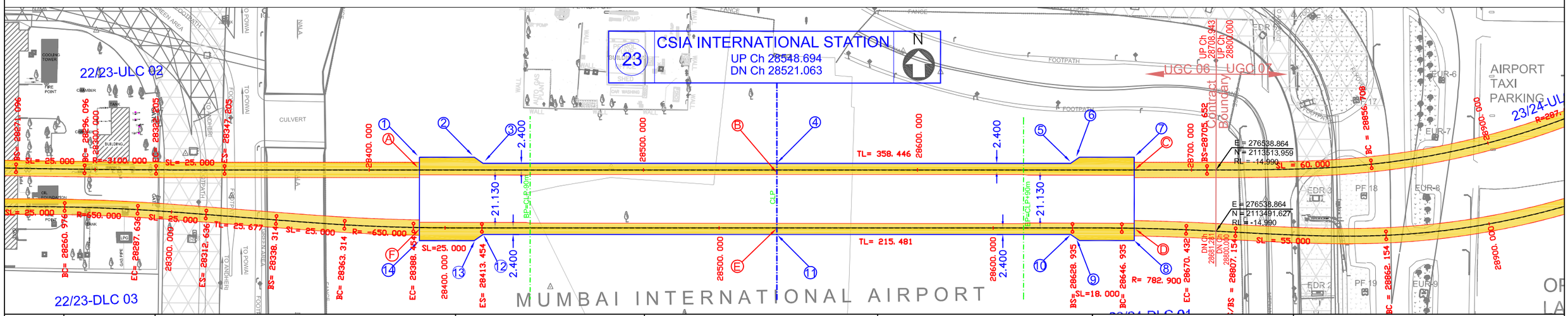
Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MAH 400098

MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
NaMTTRI Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

DRAWING STAGE			TITLE		
DESCRIPTION	NAME	SIGNATURE	WORK AREA FOR TRACK WORK PACKAGE 5 (10B & 10C)		
DRAWN BY	YGP (TI)				
CHECKED BY	VKS (CTE)		DRG No.		
REVIEWED BY	SY CHANG (TRACK EXPERT)		SHEET	1 OF 1	SCALE 1:500
APPROVED BY	RJM (PM)		DATE	27 September 2018	REV. -







VERSIONS	DATE	DESCRIPTION

Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MAH 400098

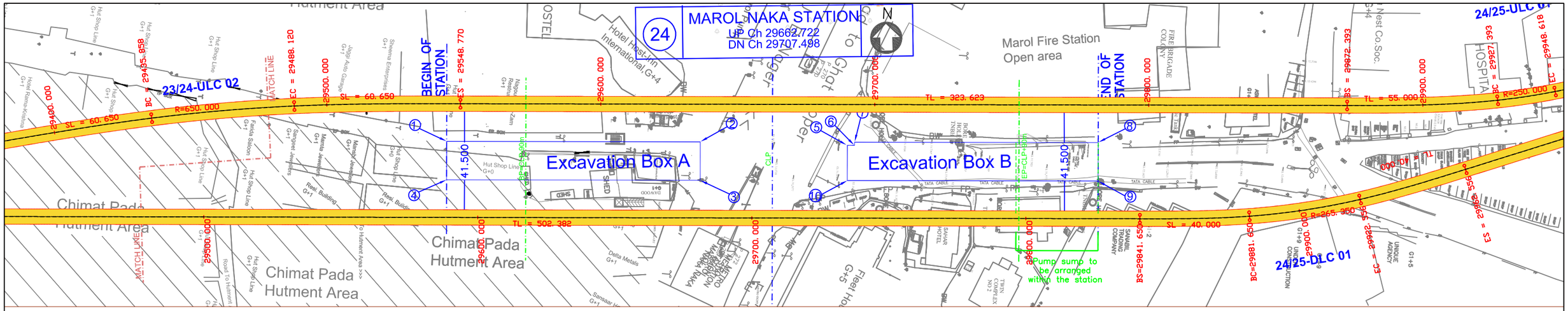
MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
NaMTTRI Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

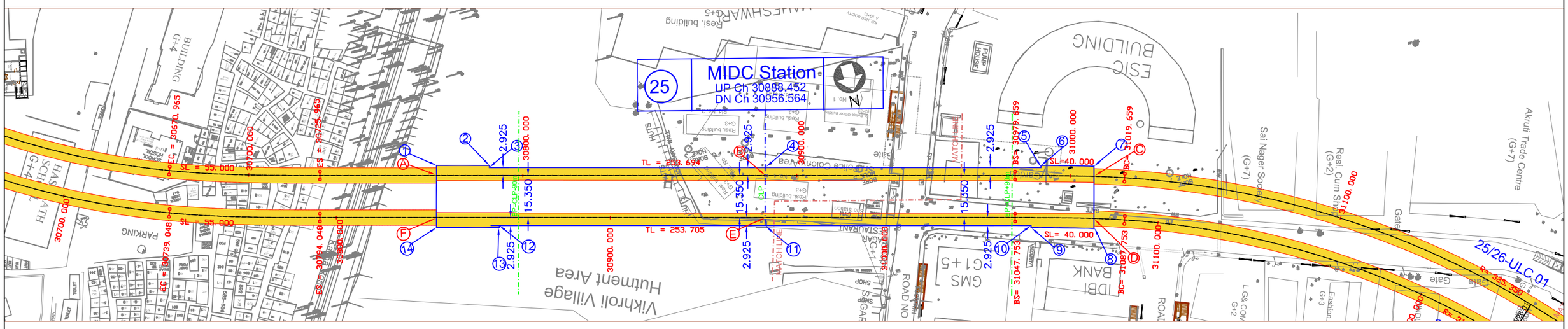
DRAWING STAGE		
DESCRIPTION	NAME	SIGNATURE
DRAWN BY	HRM (TI)	
CHECKED BY	VKS (CTE)	
REVIEWED BY	P. LEEMPUT (TRACK EXPERT)	
APPROVED BY	RJM (PM)	

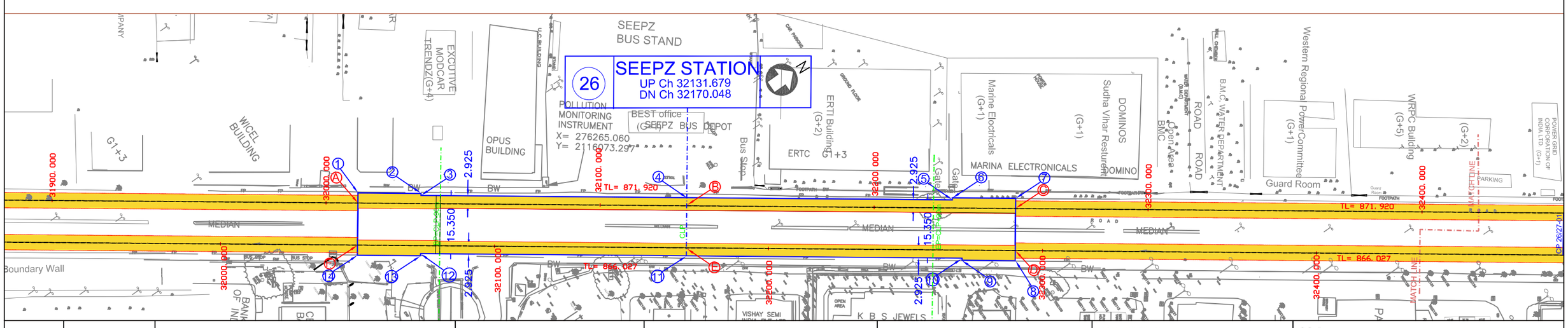
TITLE

WORK AREA FOR TRACK WORK PACKAGE - 6(10C)

DRG No.		
SHEET	1 OF 1	SCALE 1:500
DATE	27 September 2018	REV.







VERSIONS	DATE	DESCRIPTION

maple
MUMBAI METRO LINE-3
GENERAL CONSULTANT

Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MAH 400098

MMRC

MUMBAI METRO RAIL CORPORATION LIMITED,
NaMTTRI Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

DRAWING STAGE		
DESCRIPTION	NAME	SIGNATURE
DRAWN BY	HRM (TI)	
CHECKED BY	VKS (CTE)	
REVIEWED BY	P. LEEMPUT (TRACK EXPERT)	
APPROVED BY	RJM (PM)	

TITLE

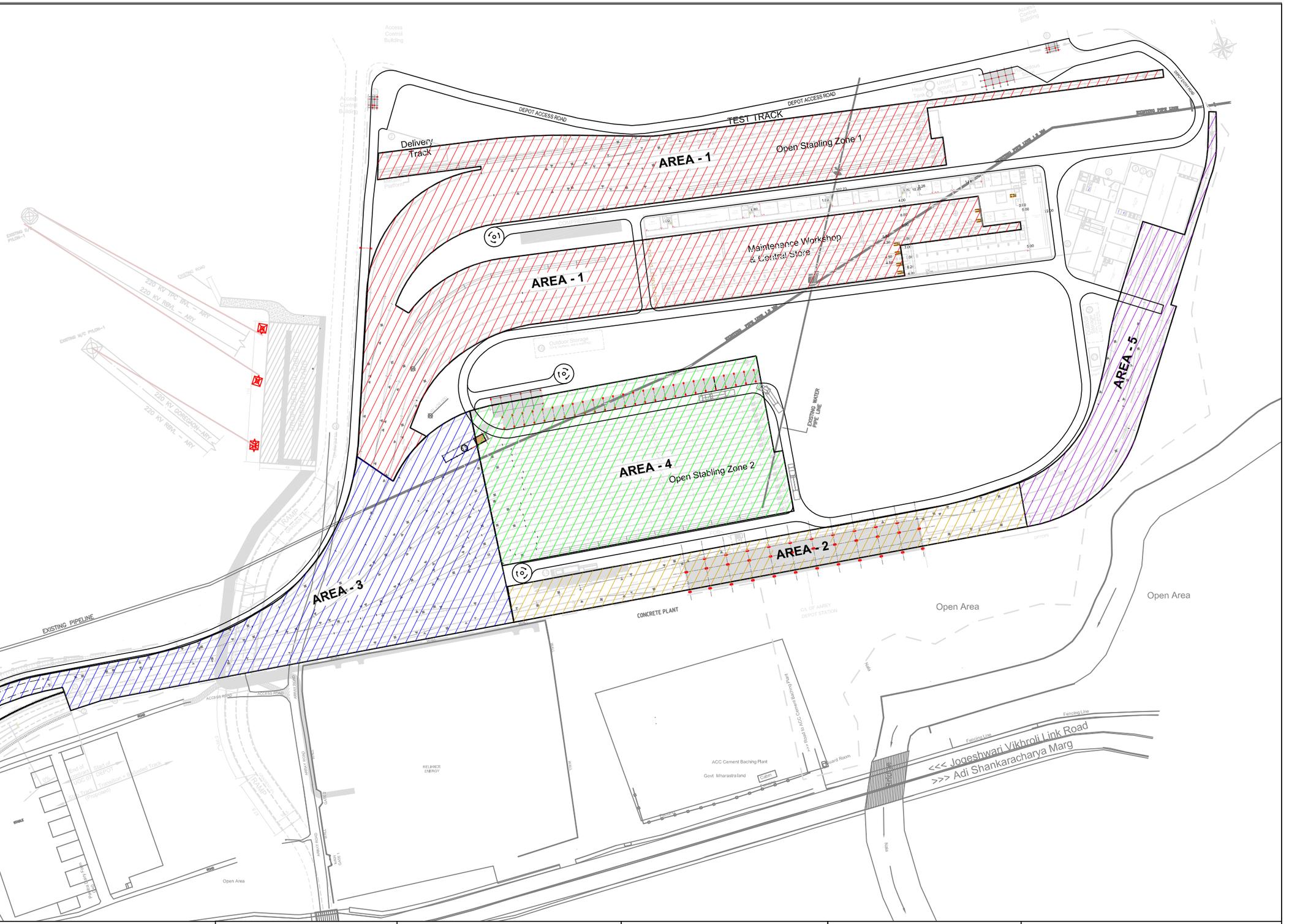
WORK AREA FOR TRACK WORK
PACKAGE 7(10C)

DRG No.		
SHEET	1 OF 1	SCALE 1:500
DATE	27 September 2018	REV.

Sr.No.	Facility Of Aarey Depot
1	OCC, Administration Building
2	Delivery Track
3	Depot Auxiliary Substation ASS 1
4	Test Track
5	Vehicular parking
6	Access Control Building
7	Stabling Line Zone 1
8	Stabling Line Zone 2
9	Stabling Line Zone 3
10	Maintance-Inspection Workshop & Central Store + Shed
11	Under Floor Wheel Lathe Shed
12	Heavy Washing Shed
13	Depot Traction switching station SSP-05
14	Auto Wash Plant
15	Aarey Depot Station & ASS 27
16	Outdoor Storage
17	Infrastructure Maintenance Building + Shed
18	Depot Auxiliary Substation ASS 2
19	Hazardous Store Building
20	Under Ground Tank
21	Over Head Tank
22	Underpass
23	Treatement Plant
24	Receiving Sub Station RSS 3(Under System Contract)
25	Roads Paved

LEGENDS

- AREA 1
- AREA 2
- AREA 3
- AREA 4
- AREA 5



VERSIONS	DATE	DESCRIPTION

maple
MUMBAI METRO LINE-3
GENERAL CONSULTANT

Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MAH 400098

MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
NaMTTRI Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

DRAWING STAGE			TITLE		
DESCRIPTION	NAME	SIGNATURE	AREAS DISTRIBUTION FOR DEPOT WORK PRIORITY		
DRAWN BY	YGP (TI)				
CHECKED BY	VKS (CTE)		DRG No.		
REVIEWED BY	SY CHANG (TRACK EXPERT)		SHEET	1 OF 1	SCALE NTS
APPROVED BY	RJM (PM)		DATE	27 September 2018	REV.

LEGENDS

- (T/O no., Radius,Crossing Angle)
- Tangent Track (Depot)
- Curved Track (Depot)
- Track (Main Line)
- Begin/End of Curve in Turnout
- Fouling Point
- Aarey Station
- New Land Boundary
- Limit Between Mainline & Depot
- Buffer Stop
- Turntable
- Fence
- Track at Level Crossing
- Barrier
- Ballastless track for Main Line
- Transition slab ballasted track
- Ballasted track for main line & Test track
- Ballasted track for DEPOT
- Embedded Track
- Washable Track
- Pedestal Track

Sr.No.	Facility Of Aarey Depot
1	OCC, Administration Building
2	Delivery Track
3	Depot Auxiliary Substation ASS 1
4	Test Track
5	Vehicular parking
6	Access Control Building
7	Stabling Line Zone 1
8	Stabling Line Zone 2
9	Stabling Line Zone 3
10	Maintance-Inspection Workshop & Central Store + Shed
11	Under Floor Wheel Lathe Shed
12	Heavy Washing Shed
13	Depot Traction switching station SSP-05
14	Auto Wash Plant
15	Aarey Depot Station & ASS 27
16	Outdoor Storage (Only Surface,not a building)
17	Infrastructure Maintenance Building + Shed
18	Depot Auxiliary Substation ASS 2
19	Hazardous Store Building
20	Under Ground Tank
21	Over Head Tank
22	Underpass
23	Treatement Plant
24	Receiving Sub Station RSS 3(Under System Contract)
25	Roads Paved
26	total

Type of Track Adopted in Mumbai Metro Line 3

Sr. No.	Description	Package 10A Chainage From	Package 10A Chainage To	Easting	Northing	Total Length For Single Line Track (m)	Package 10B Chainage From	Package 10B Chainage To	Total Length For Single Line Track (m)
1	Ballastless Track	20957.420	33027.253	E = 276876.981	N = 2116753.711	12069.833	-473.672	20957.420	21431.092
2	Transition Slab	33027.253	33034.953	E = 276884.811	N = 2116753.443	7.700	NA		
3	Ballasted Track Mainline	33034.953	33789.411	E = 277632.029	N = 2116650.376	754.458			
4	Ballasted Track Depot	-	-	E = 277869.379	N = 2116900.743	14738.728			
5	Special Track								
	i Washable Apron Track	-	-			275.550			
	ii Embeded Track	-	-			1040.009			
	iii Pedestal Track	-	-			766.836			

VERSIONS	DATE	DESCRIPTION

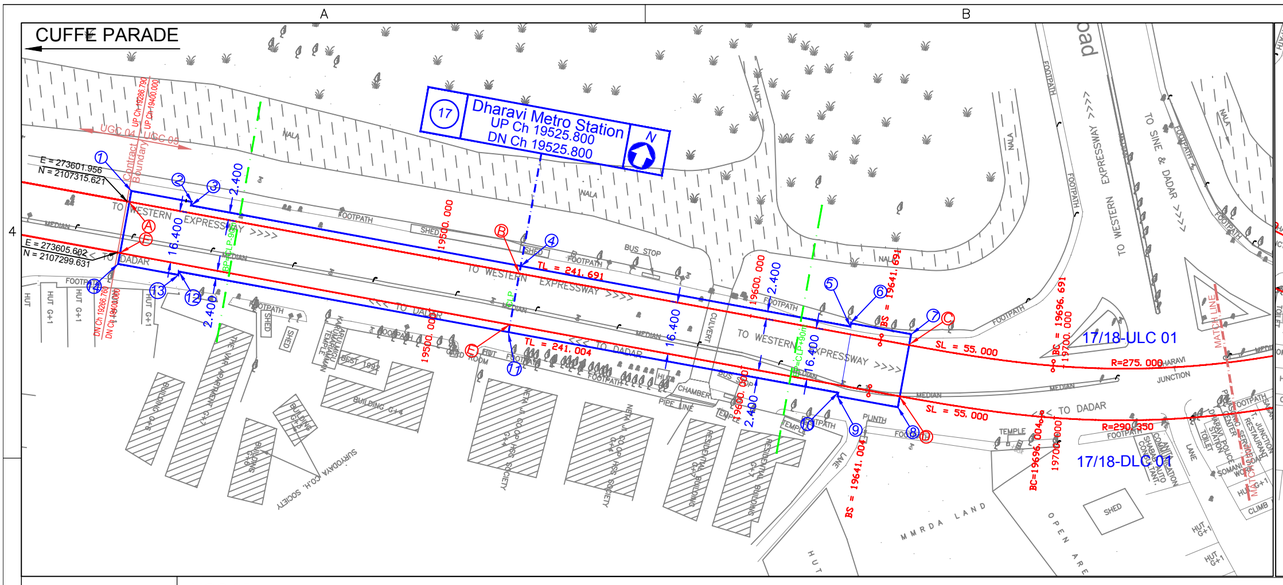
Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruiz East, Mumbai. MAH 400098

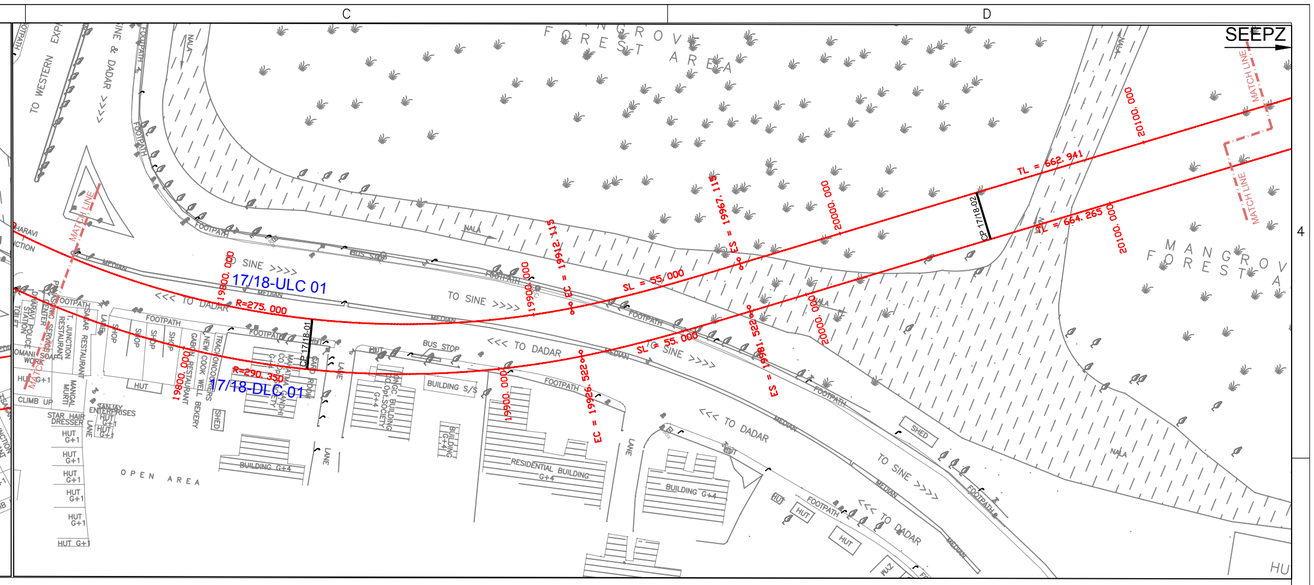
MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
NaMTTRI Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

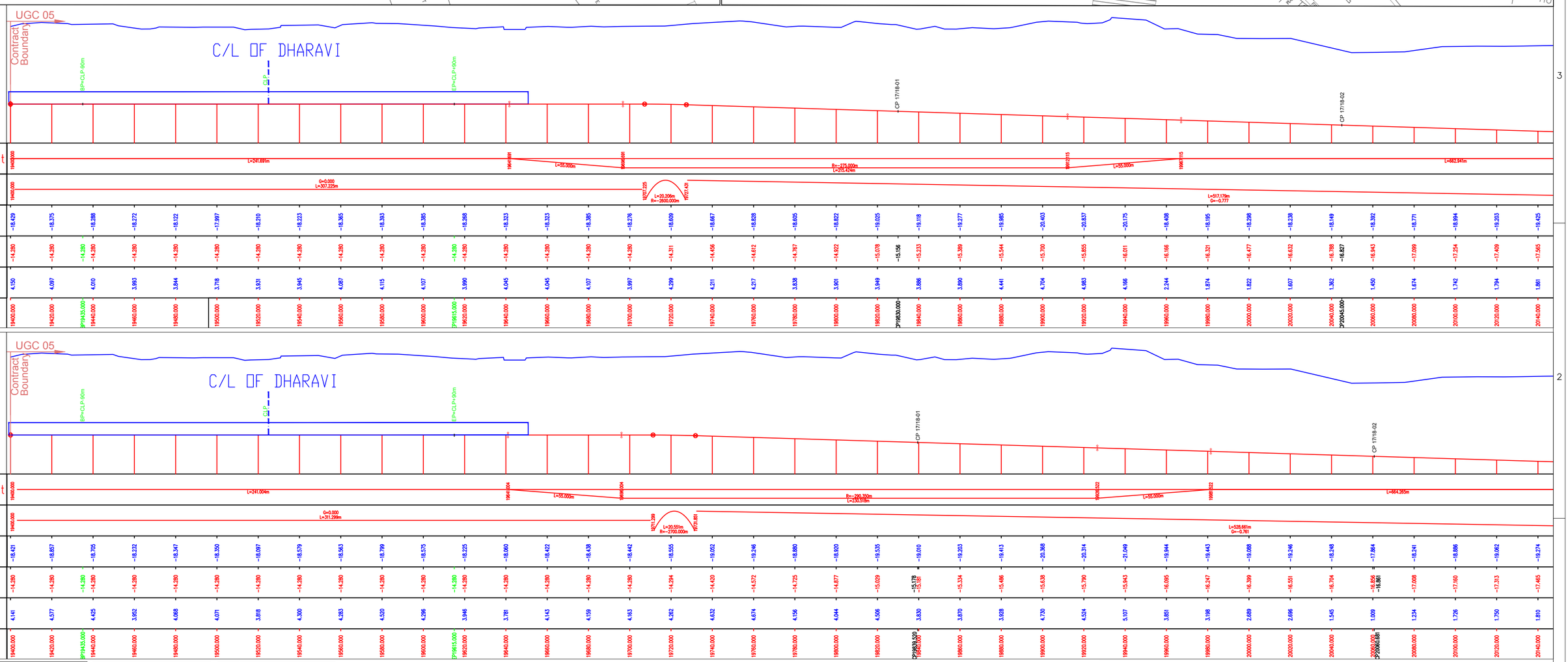
DRAWING STAGE		
DESCRIPTION	NAME	SIGNATURE
DRAWN BY	HRM (TI)	
CHECKED BY	VKS (CTE)	
REVIEWED BY	P. LEEMPUT (TRACK EXPERT)	
APPROVED BY	RJM (PM)	

TITLE
TRACK FORM ADOPTED IN MUMBAI METRO LINE 3 AAREY MAINLINE & DEPOT

DRG No.		
SHEET	1 OF 1	SCALE NTS
DATE	27 September 2018	REV.







Legends:
TL= Tangent length
SL= Spiral length
BC= Begin of Curve
EC= End of Curve
BS= Begin of Spiral
ES= End of Spiral

Legends:
CP= Cross Passage
CP= Cross Passage in low point
BP= Begin of Platform
CLP=Centre Line of Platform
EP= End of Platform

POINTS	COORDINATES	
1	E = 273601.958	N = 2107319.211
2	E = 273620.775	N = 2107323.501
3	E = 273621.020	N = 2107322.429
4	E = 273724.075	N = 2107345.927
5	E = 273827.130	N = 2107369.425
6	E = 273826.885	N = 2107370.497
7	E = 273845.702	N = 2107374.788

POINTS	COORDINATES	
8	E = 273850.905	N = 2107351.973
9	E = 273832.087	N = 2107347.683
10	E = 273831.841	N = 2107348.755
11	E = 273728.788	N = 2107325.257
12	E = 273625.733	N = 2107301.759
13	E = 273625.977	N = 2107300.687
14	E = 273607.160	N = 2107296.396

POINTS	COORDINATES	
A	E = 273602.736	N = 2107315.799
B	E = 273724.608	N = 2107343.587
C	E = 273846.479	N = 2107371.384
D	E = 273850.125	N = 2107355.393
E	E = 273728.254	N = 2107327.597
F	E = 273606.382	N = 2107299.809

CURVE NO.		17/18-ULC 01	17/18-DLC 01
COORDINATE OF APEX	EASTING	274008.232	274019.211
	NORTHING	2107408.257	2107393.939
DEFLECTION ANGLE		56°20'33"	56°20'32"
RADIUS		275	290.350
TRANSITION LENGTH		55	55
CURVE LENGTH		215.424	230.518
CANT		115	110
CANT DEFFICIENCY		96	90
OPERATING SPEED		70	70
EQUILIBRIUM		211	200
CANT GRADIENT		1:478 / 1:478	1:500 / 1:500

NOTE: This drawing supersedes Tender drawings and all previous revisions

REV.	DATE	DESCRIPTION
R4	26.12.2017	Cross Passages incorporated.
R3	13.09.2017	Revised according to new survey.

GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT,LINE No. 3 COLABA- BANDRA-SEEPZ

Coordinates of Station's footprint at Track level duly confirmed in R3 by Contractor's Representative

	NAME	SIGN
DRAWN BY	HRM	
DESIGN BY	JK	On behalf
CHECKED BY	MVD	
APPROVED BY	RJM	

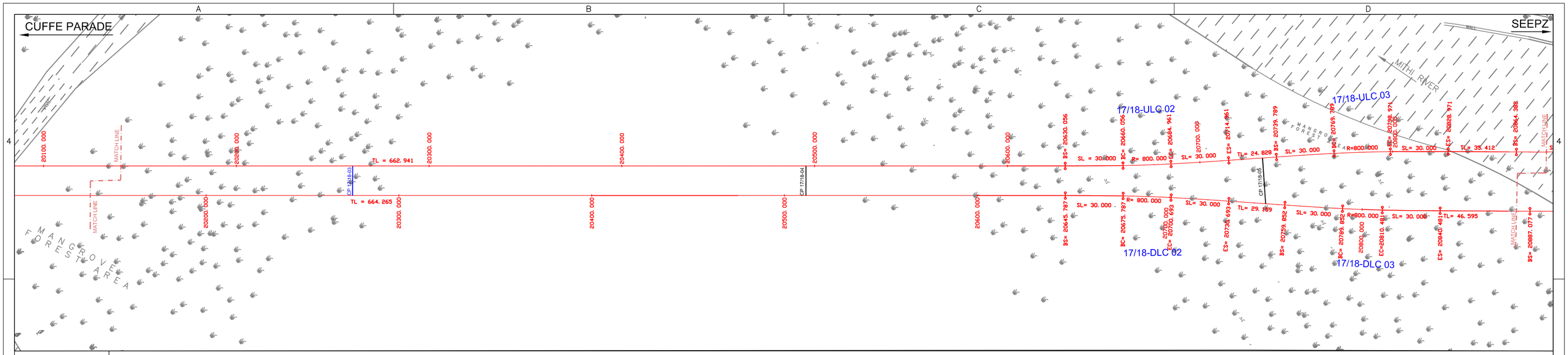
PROJECT: MUMBAI METRO LINE 3
COLABA-BANDRA-SEEPZ

TITLE: HORIZONTAL & VERTICAL ALIGNMENT
From km 19+400 to km 20+140
17 Dharavi Metro Station

DRAWING NO.: MM3-GC-AL-GD-5020001 (SHEET: 1 of 7) REV: R4

SCALE: 1:2000 (A3) DATE: 26 DECEMBER, 2017

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT



Legends:
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CP= Cross Passage in low point
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EP= End of Platform

NOTE: This drawing supersedes Tender drawings and all previous revisions

REV.	DATE	DESCRIPTION
R4	26.12.2017	Cross Passages incorporated.
R3	11.10.2017	Revised according to new survey.

MMRC

GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT,LINE No. 3 COLABA- BANDRA-SEEPZ

CURVE NO.		17/18-ULC 02	17/18-ULC 03	17/18-DLC 02	17/18-DLC 03
COORDINATE OF APEX	EASTING	274321.052	274353.555	274335.428	274382.288
	NORTHING	2108231.223	2108338.300	2108225.816	2108327.485
DEFLECTION ANGLE		3°55'56"	4°14'19"	3°55'56"	3°37'34"
RADIUS		800	800	800	800
TRANSITION LENGTH		30	30	30	30
CURVE LENGTH		24.905	29.181	24.905	20.630
CANT		60	60	60	60
CANT DEFFICIENCY		47	47	47	47
OPERATING SPEED		85	85	85	85
EQUILIBRIUM		107	107	107	107
CANT GRADIENT		1:500/1:500	1:500/1:500	1:500/1:500	1:500/1:500

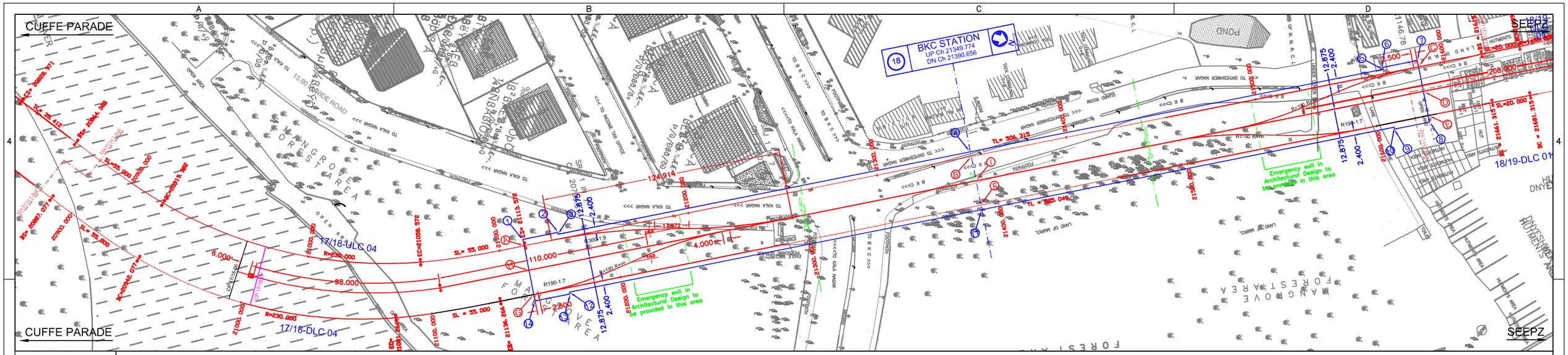
	NAME	SIGN
DRAWN BY	HRM	
DESIGN BY		
CHECKED BY	JK	On behalf
REVIEWED BY	MVD	
APPROVED BY	RJM	

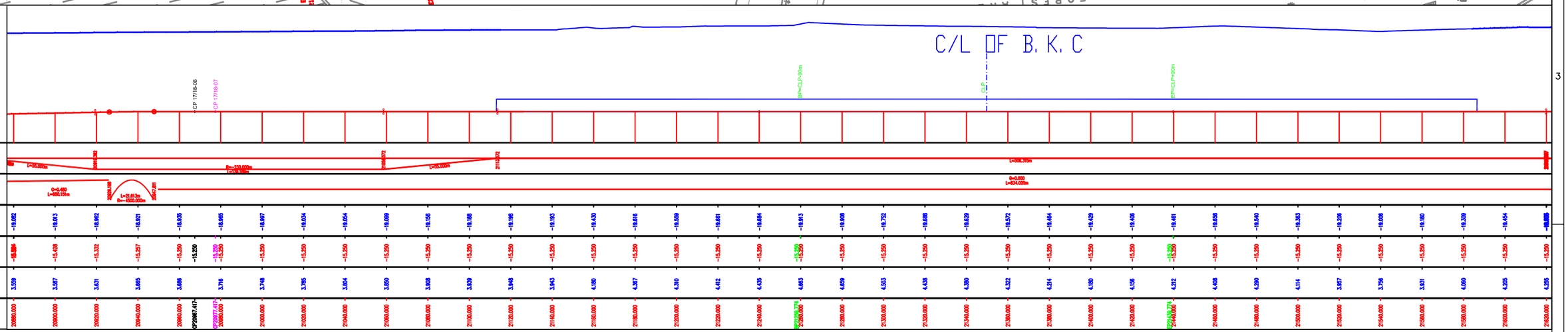
PROJECT: MUMBAI METRO LINE 3
COLABA-BANDRA-SEEPZ

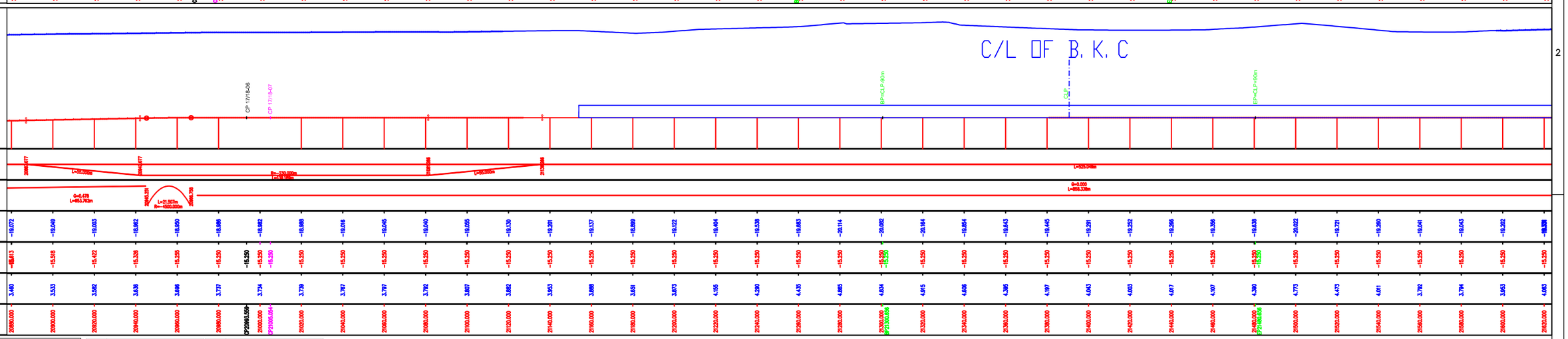
TITLE: HORIZONTAL & VERTICAL ALIGNMENT
From km 20+140 to km 20+880

maple
MUMBAI METRO LINE-3
GENERAL CONSULTANT

DRAWING NO.: MM3-GC-AL-GD-5020002 (SHEET: 2 of 7) | REV: R4 | SCALE: 1:2000 (A3) | DATE:26 DECEMBER, 2017







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Legends:
CP = Cross Passage
CP = Cross Passage in low point
CP = Ventilation Cross Passage
BP = Begin of Platform
CLP = Centre Line of Platform
EP = End of Platform

POINT	COORDINATES		POINT	COORDINATES		POINT	TRACK COORDINATES		POINT	TRACK COORDINATES	
1	E = 274366.818	N = 2108649.681	8	E = 274178.911	N = 2109085.404	A	E = 274369.852	N = 2108651.161	F	E = 274284.3101	N = 2108873.438
2	E = 274358.392	N = 2108666.038	9	E = 274187.337	N = 2109069.047	B	E = 274261.419	N = 2108861.646	G	E = 274392.709	N = 2108663.019
3	E = 274359.258	N = 2108666.484	10	E = 274186.471	N = 2109068.600	C	E = 274153.020	N = 2109073.066	H	E = 274381.264	N = 2108657.122
4	E = 274259.286	N = 2108860.547	11	E = 274286.444	N = 2108874.538	D	E = 274164.465	N = 2109077.962	I	E = 274272.864	N = 2108867.542
5	E = 274159.313	N = 2109054.609	12	E = 274386.417	N = 2108680.475	E	E = 274175.910	N = 2109083.858			
6	E = 274158.446	N = 2109054.163	13	E = 274387.283	N = 2108680.921						
7	E = 274150.019	N = 2109070.520	14	E = 274395.710	N = 2108664.564						

NOTE: This drawing supersedes Tender drawings and all previous revisions

REV.	DATE	DESCRIPTION
R4	26.12.2017	Cross Passages incorporated.
R3	26.10.2017	Revised according to new survey.

MMRC

GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT,LINE No. 3 COLABA- BANDRA-SEEPZ

CURVE NO.		17/18-ULC 04	18/19-ULC 01	17/18-DLC 04	18/19-DLC 01
COORDINATE OF APEX	EASTING	274429.601	274122.551	274460.821	274149.361
	NORTHING	2108535.179	2109131.210	2108530.803	2109143.159
DEFLECTION ANGLE		48°22'30"	1°49'37"	48°22'30"	1°40'54"
RADIUS		230	1450	230	1550
TRANSITION LENGTH		55	20	55	20
CURVE LENGTH		139.189	26.232	139.189	25.494
CANT		120	30	120	30
CANT DEFFICIENCY		98	29	98	25
OPERATING SPEED		65	85	65	85
EQUILIBRIUM		217	59	217	55
CANT GRADIENT		1:460/1:460	1:667/1:667	1:460/1:460	1:659/1:659

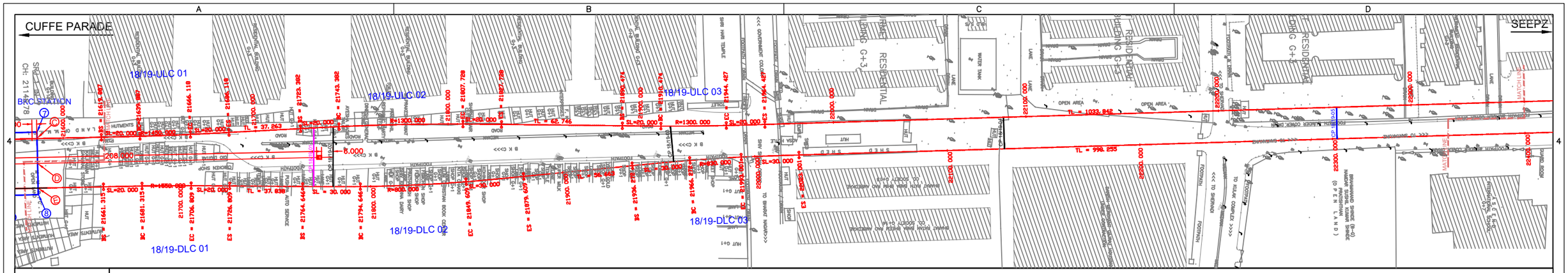
	NAME	SIGN
DRAWN BY	HRM	
DESIGN BY	JK	
CHECKED BY		On behalf
REVIEWED BY	MVD	
APPROVED BY	RJM	

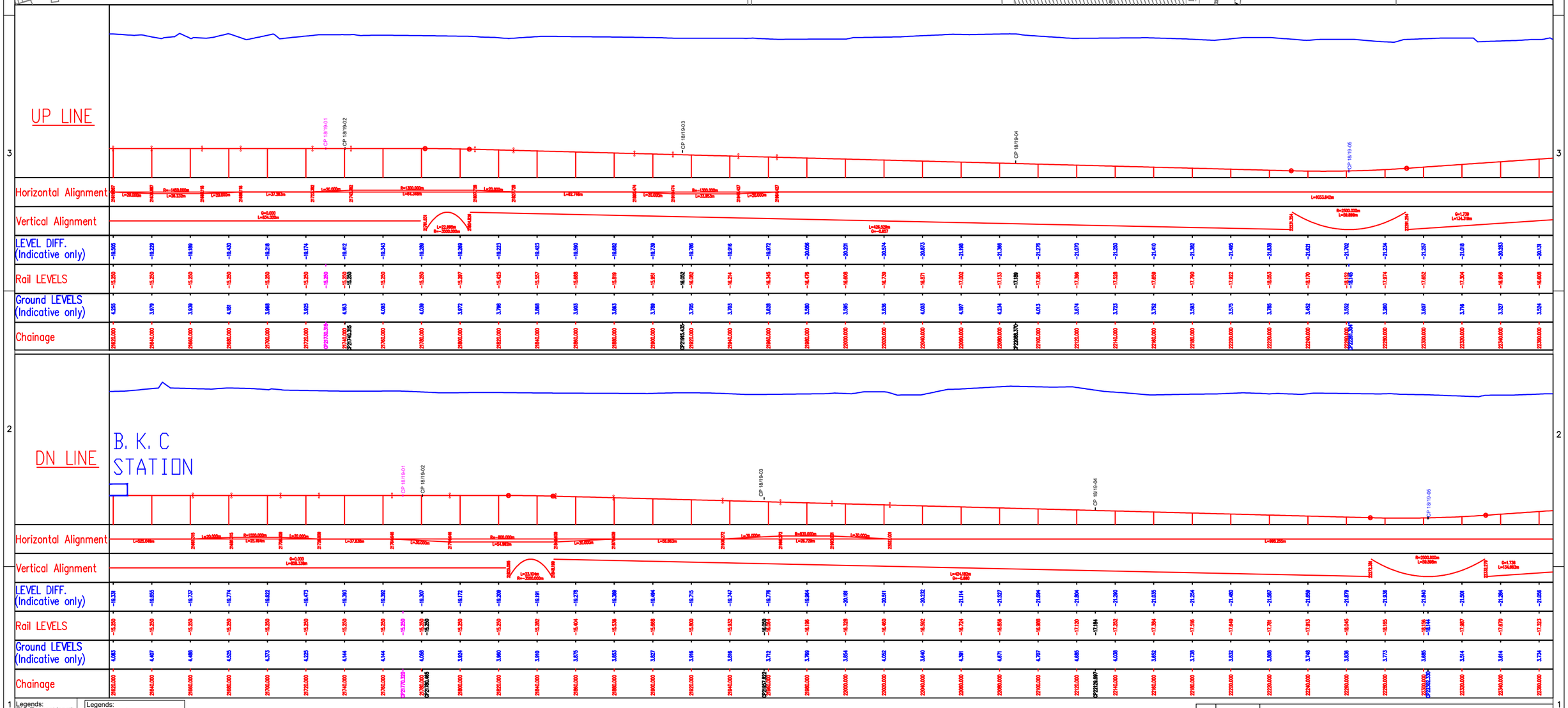
PROJECT: MUMBAI METRO LINE 3
COLABA-BANDRA-SEEPZ

TITLE: HORIZONTAL & VERTICAL ALIGNMENT
From km 20+880 to km 21+620
18 BKC Station

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

DRAWING NO.: MM3-GC-AL-GD-5020003 (SHEET: 3 of 7) | REV: R4 | SCALE: 1:2000 (A3) | DATE: 26 DECEMBER, 2017





Legends:
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Legends:
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CP = Cross Passage in low point
CP = Ventilation Cross Passage
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CLP = Centre Line of Platform
EP = End of Platform

CURVE NO.		18/19-ULC 01	18/19-ULC 02	18/19-ULC 03	18/19-DLC 01	18/19-DLC 02	18/19-DLC 03
COORDINATE OF APEX	EASTING	274122.551	274062.974	273997.896	274145.361	274090.059	274007.360
	NORTHING	2109131.210	2109238.326	2109375.596	2109143.159	2109258.718	2109392.834
DEFLECTION ANGLE		1°49'37"	3°43'03"	2°23'60"	1°40'54"	6°05'06"	3°54'58"
RADIUS		1450	1300	1300	1550	800	830
TRANSITION LENGTH		20	20	20	20	30	30
CURVE LENGTH		26.232	64.346	33.953	25.494	54.962	26.729
CANT		30	35	35	30.354323	60	55
CANT DEFFICIENCY		29	31	31	24.835355	47	48
OPERATING SPEED		85	85	85	85	85	85
EQUILIBRIUM		59	66	66	55	107	103
CANT GRADIENT		1:667 / 1:667	1:571 / 1:571	1:571 / 1:571	1:659 / 1:659	1:500 / 1:500	1:545 / 1:545

NOTE: This drawing supersedes Tender drawings and all previous revisions

REV.	DATE	DESCRIPTION
R4	26.12.2017	Cross Passages incorporated.
R3	10.10.2017	Revised according to new survey.

GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT,LINE No. 3 COLABA- BANDRA-SEEPZ

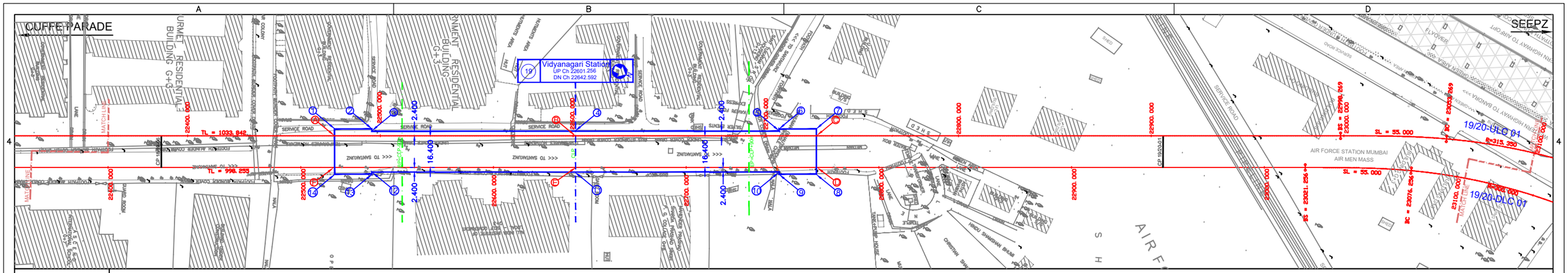
	NAME	SIGN
DRAWN BY	HRM	
DESIGN BY		
CHECKED BY	JK	On behalf
REVIEWED BY	MVD	
APPROVED BY	RJM	

PROJECT: MUMBAI METRO LINE 3
COLABA-BANDRA-SEEPZ

TITLE: HORIZONTAL & VERTICAL ALIGNMENT
From km 21+620 to km 22+360

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

DRAWING NO.: MM3-GC-AL-GD-5020004 (SHEET: 4 of 7) | REV: R4 | SCALE: 1:2000 (A3) | DATE: 26 DECEMBER, 2017



C/L OF VIDYANAGARI STATION

UP LINE

Horizontal Alignment

Vertical Alignment

LEVEL DIFF. (Indicative only)	-20.135 -19.931 -19.644 -16.482 -16.809 -16.879 -16.793 -16.875 -16.833 -16.739 -16.711 -16.503 -16.489 -16.537 -16.522 -16.516 -16.610 -16.888 -16.897 -16.822 -16.095 -16.872 -20.646 -20.891 -21.346 -22.020 -22.124 -21.977 -21.928 -21.936 -22.339 -22.519 -22.823 -22.434 -22.586 -23.005 -23.396 -23.549
Rail LEVELS	-16.608 -16.281 -16.151 -15.963 -15.585 -15.259 -15.106 -15.000 -15.000 -15.000 -15.000 -15.000 -15.000 -15.000 -15.000 -15.000 -15.000 -15.000 -15.000 -15.000 -15.000 -15.000 -15.000 -15.085 -15.199 -15.402 -15.610 -15.818 -16.026 -16.234 -16.442 -16.651 -16.776 -16.859 -17.067 -17.275 -17.483 -17.691 -17.899 -18.107 -18.315 -18.523 -18.731
Ground LEVELS (Indicative only)	3.524 3.672 3.732 3.419 3.305 3.774 3.703 3.598 3.742 3.640 3.621 3.413 3.389 3.448 3.433 3.429 3.721 3.792 3.805 3.835 3.857 4.471 5.038 5.073 5.320 5.795 5.682 5.368 5.068 5.021 5.006 5.026 4.835 4.536 4.480 4.691 4.864 4.855
Chainage	22300.000 22330.000 22338.304 22400.000 22420.000 22440.000 22460.000 22480.000 22500.000 22511.255 22520.000 22540.000 22560.000 22580.000 22600.000 22642.592 22700.000 22720.000 22740.000 22760.000 22780.000 22800.000 22820.000 22840.000 22860.000 22880.000 22900.000 22900.000 22920.000 22940.000 22960.000 22980.000 23000.000 23020.000 23040.000 23060.000 23080.000 23100.000

C/L OF VIDYANAGARI STATION

DN LINE

Horizontal Alignment

Vertical Alignment

LEVEL DIFF. (Indicative only)	-21.006 -20.726 -20.210 -20.013 -19.814 -19.079 -18.700 -18.651 -18.625 -18.641 -18.663 -18.663 -18.540 -18.899 -18.728 -18.780 -18.771 -18.662 -18.756 -18.737 -18.816 -18.833 -19.124 -19.809 -20.335 -20.734 -21.339 -21.970 -22.353 -22.471 -22.156 -22.332 -22.405 -22.478 -22.504 -22.559 -22.728 -23.004
Rail LEVELS	-17.353 -16.878 -16.629 -16.281 -16.151 -15.934 -15.587 -15.274 -15.111 -15.000 -15.000 -15.000 -15.000 -15.000 -15.000 -15.000 -15.000 -15.000 -15.000 -15.000 -15.000 -15.000 -15.086 -15.322 -15.609 -15.814 -15.822 -16.031 -16.239 -16.447 -16.655 -16.733 -16.864 -17.072 -17.280 -17.488 -17.696 -17.905 -18.113 -18.321
Ground LEVELS (Indicative only)	3.724 3.750 3.592 3.733 3.680 3.493 3.494 3.540 3.535 3.521 3.604 3.603 3.457 3.610 3.648 3.695 3.681 3.583 3.670 3.648 3.729 3.729 3.922 4.404 4.822 4.912 5.310 5.732 5.897 5.877 5.293 5.381 5.127 4.890 4.806 4.652 4.615 4.764
Chainage	22300.000 22330.000 22400.000 22420.000 22427.631 22440.000 22460.000 22480.000 22500.000 22520.000 22540.000 22551.592 22560.000 22580.000 22600.000 22620.000 22640.000 22660.000 22680.000 22700.000 22727.592 22740.000 22760.000 22780.000 22800.000 22820.000 22840.000 22860.000 22880.000 22900.000 22920.000 22940.000 22947.127 22960.000 22980.000 23000.000 23020.000 23040.000 23060.000 23080.000 23100.000

Legends:
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EC= End of Curve
BS= Begin of Spiral
ES= End of Spiral

Legends:
CP= Cross Passage
CP= Cross Passage in low point
BP= Begin of Platform
CLP=Centre Line of Platform
EP= End of Platform

POINTS	COORDINATES	
1	E = 273739.333	N = 2109859.674
2	E = 273730.349	N = 2109876.756
3	E = 273731.322	N = 2109877.308
4	E = 273682.118	N = 2109970.817
5	E = 273632.914	N = 2110064.366
6	E = 273631.941	N = 2110063.854
7	E = 273627.956	N = 2110080.936

POINTS	COORDINATES	
8	E = 273643.667	N = 2110091.828
9	E = 273654.653	N = 2110074.747
10	E = 273651.677	N = 2110074.235
11	E = 273700.881	N = 2109980.686
12	E = 273750.085	N = 2109887.136
13	E = 273751.059	N = 2109887.649
14	E = 273760.043	N = 2109870.567

POINTS	COORDINATES	
A	E = 277747.430	N = 2109861.301
B	E = 273684.242	N = 2109971.934
C	E = 273626.054	N = 2110082.565
D	E = 273640.569	N = 2110090.195
E	E = 273698.757	N = 2109979.569
F	E = 273756.945	N = 2109868.938

CURVE NO.		19/20-ULC 01	19/20-DLC 01
COORDINATES OF APEX	EASTING	273447.559	273472.508
	NORTHING	2110421.930	2110409.727
DEFLECTION ANGLE		29°46'3"	29°46'7"
RADIUS		315.350	300.000
TRANSITION LENGTH		55	55
CURVE LENGTH		108.844	100.869
CANT		115	105
CANT DEFFICIENCY		96	88
OPERATING SPEED		75	70
EQUILIBRIUM		211	193
CANT GRADIENT		1:478 / 1:478	1:524 / 1:524

NOTE: This drawing supersedes Tender drawings and all previous revisions

REV.	DATE	DESCRIPTION
R4	26.12.2017	Cross Passages incorporated.
R3	10.10.2017	Revised according to new survey.

	NAME	SIGN
DRAWN BY	HRM	
DESIGN BY	JK	On behalf
CHECKED BY	MVD	
REVIEWED BY	RJM	
APPROVED BY		

GENERAL CONSULTANCY SERVICES
FOR MUMBAI METRO RAIL PROJECT,LINE No. 3
COLABA- BANDRA-SEEPZ

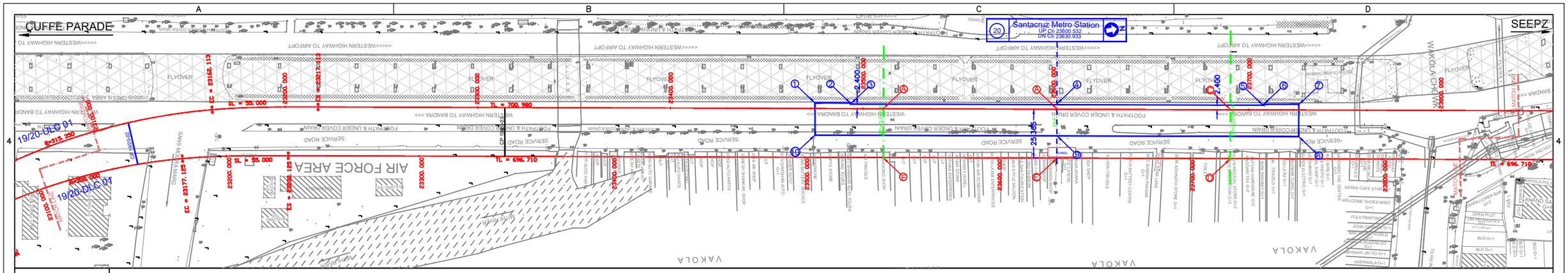
PROJECT: MUMBAI METRO LINE 3
COLABA-BANDRA-SEEPZ

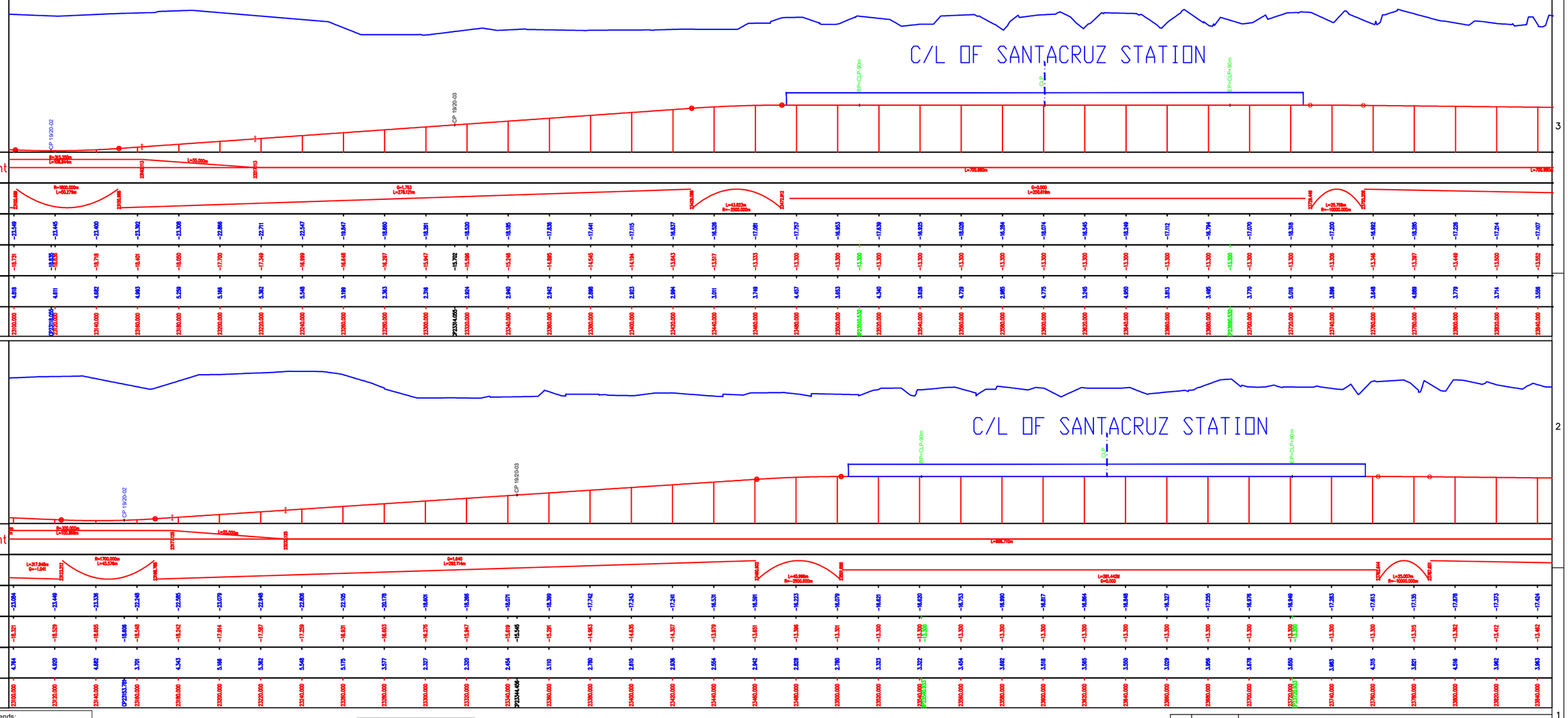
TITLE: HORIZONTAL & VERTICAL ALIGNMENT
From km 22+360 to km 23+100
19 Vidyanagari Station

DRAWING NO.: MM3-GC-AL-GD-5020005 (SHEET: 5 of 7) REV: R4

SCALE: 1:2000 (A3) DATE: 26 DECEMBER, 2017

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT





Legends:
TL= Tangent length
SL= Spiral length
BC= Begin of Curve
EC= End of Curve
BS= Begin of Spiral
ES= End of Spiral

Legends:
CP= Cross Passage
CP= Cross Passage in low point
BP= Begin of Platform
CLP=Centre Line of Platform
EP= End of Platform

POINT	COORDINATES	
1	E = 273457.717	N = 2110791.136
2	E = 273458.368	N = 2110809.525
3	E = 273458.867	N = 2110809.507
4	E = 273462.653	N = 2110916.540
5	E = 273466.439	N = 2111023.573

POINT	COORDINATES	
6	E = 273465.940	N = 2111023.591
7	E = 273466.590	N = 2111041.979
8	E = 273483.330	N = 2111041.397
9	E = 273478.893	N = 2110915.966
10	E = 273474.457	N = 2110790.544

POINT	COORDINATES	
A	E = 273461.870	N = 2110826.516
B	E = 273465.052	N = 2110916.455
C	E = 273468.233	N = 2111006.399
D	E = 273493.582	N = 2111005.502
E	E = 273490.401	N = 2110915.559
F	E = 273487.219	N = 2110825.615

NOTE: This drawing supersedes Tender drawings and all previous revisions

REV.	DATE	DESCRIPTION
R4	26.12.2017	Cross Passages incorporated.
R3	10.10.2017	Revised according to new survey.

GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT,LINE No. 3 COLABA- BANDRA-SEEPZ

CURVE NO.		19/20-ULC 01	19/20-DLC 01
COORDINATE OF APEX	EASTING	273447.559	273472.508
	NORTHING	2110421.930	2110409.727
DEFLECTION ANGLE		29°46'3"	29°46'7"
RADIUS		315.350	300.000
TRANSITION LENGTH		55	55
CURVE LENGTH		108.844	100.869
CANT		115	105
CANT DEFFICIENCY		96	88
OPERATING SPEED		75	70
EQUILIBRIUM		211	193
CANT GRADIENT		1:478 / 1:478	1:524 / 1:524

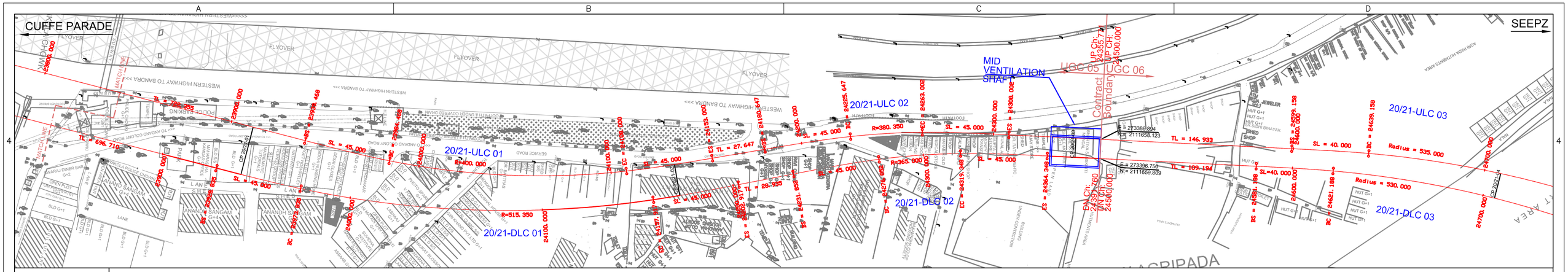
	NAME	SIGN
DRAWN BY	HRM	
DESIGN BY	JK	On behalf
CHECKED BY	MVD	
REVIEWED BY	RJM	
APPROVED BY		

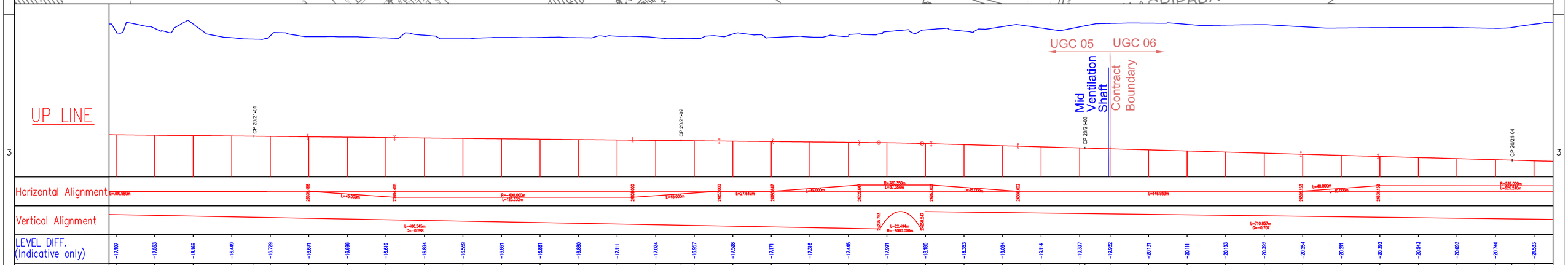
PROJECT: MUMBAI METRO LINE 3
COLABA-BANDRA-SEEPZ

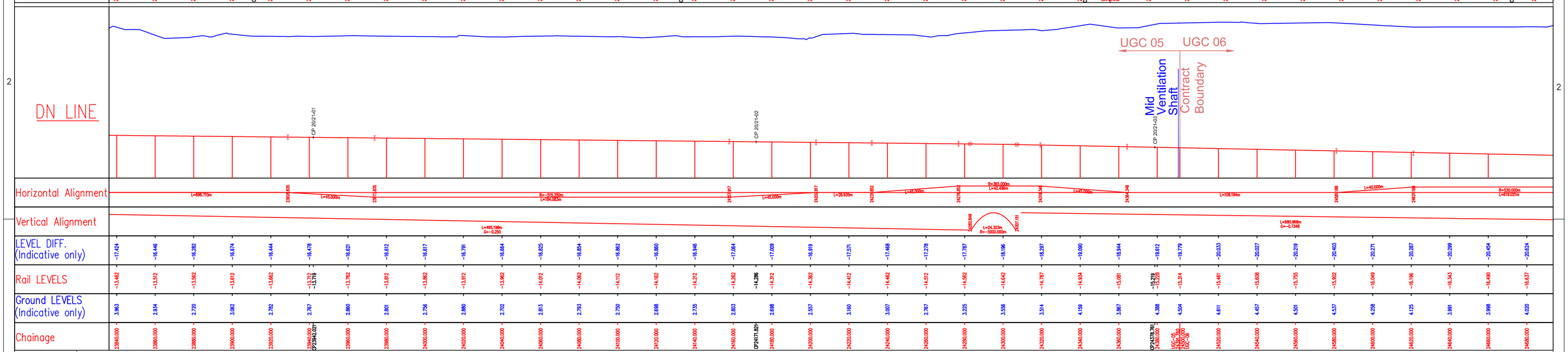
TITLE: HORIZONTAL & VERTICAL ALIGNMENT
From km 23+100 to km 23+840
20 Santacruz Station

DRAWING NO.: MM3-GC-AL-GD-5020006 (SHEET: 6 of 7) | REV: R4 | SCALE: 1:2000 (A3) | DATE: 26 DECEMBER, 2017

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT







Legends:
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SL= Spiral length
BC= Begin of Curve
EC= End of Curve
BS= Begin of Spiral
ES= End of Spiral

Legends:
CP= Cross Passage
CP= Cross Passage in low point
BP= Begin of Platform
CLP=Centre Line of Platform
EP= End of Platform

CURVE NO.		20/21-ULC 01	20/21-ULC 02	20/21-ULC 03	20/21-DLC 01	20/21-DLC 02	20/21-DLC 03
COORDINATE OF APPEX	EASTING	273480.854	273405.718	273302.140	273505.846	273412.585	273315.632
	NORTHING	2111363.190	2111548.092	2112153.510	2111352.188	2111567.258	2112133.946
DEFLECTION ANGLE		24°08'26"	12°24'23"	71°14'38"	25°28'8"	13°44'05"	71°14'38"
RADIUS		400.000	380.350	535.000	515.350	365.000	530.000
TRANSITION LENGTH		45	45	40	45	45	40
CURVE LENGTH		123.532	37.356	625.240	184.083	42.496	619.023
CANT		100	95	85	90	100	85
CANT DEFFICIENCY		67	80	57	71	82	58
OPERATING SPEED		75	75	80	85	75	80

NOTE: This drawing supersedes Tender drawings and all previous revisions

REV.	DATE	DESCRIPTION
R5.1	06.05.2019	Revision to correct minor mismatch of Rail level at the interface of UGC 06
R5	12.07.2018	UP Line Alignment Revised after Ch:23900 due to change in Mid Ventilation Shaft Layout
R4	26.12.2017	Cross Passages incorporated.
R3	11.10.2017	Revised according to new survey.

GENERAL CONSULTANCY SERVICES
FOR MUMBAI METRO RAIL PROJECT,LINE No. 3
COLABA- BANDRA-SEEPZ

	NAME	SIGN
DRAWN BY	YGP	
DESIGN BY	JK	On behalf
CHECKED BY	VKS	
REVIEWED BY	SY Chang	
APPROVED BY	GTP	

PROJECT: MUMBAI METRO LINE 3
COLABA-BANDRA-SEEPZ

TITLE: HORIZONTAL & VERTICAL ALIGNMENT
From km 23+840 to km 24+392
Mid Ventilation Shaft

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

DRAWING NO.: MM3-GC-AL-GD-5020007 (SHEET: 7 of 7) | REV: R5.1 | SCALE: 1:2000 (A3) | DATE: 06 MAY, 2019

CUFFE PARADE

SEEPZ

AIRPORT(RUNWAY) PERMISSION AWAITED

AIRPORT AREA

AIRPORT

OPEN LAND

MUMBAI AVIATION FUEL FARM FACILITY PVT. LTD.

20/21-ULC 03

20/21-DLC 03

Radius = 535.000

R=530.000

UGC 05 UGC 06

Contract Boundary

MID VENTILATION SHAFT

20/21-ULC 02

UP LINE

DN LINE

Mid Ventilation Shaft

Contract Boundary

Horizontal Alignment

Vertical Alignment

LEVEL DIFF. (Indicative only)

Rail LEVELS

Ground LEVELS (Indicative only)

Chainage

Legends:
TL= Tangent length
SL= Spiral length
BC= Begin of Curve
EC= End of Curve
BS= Begin of Spiral
ES= End of Spiral

Legends:
CP= Cross Passage
CP= Cross Passage in low point
BP= Begin of Platform
CLP=Centre Line of Platform
EP= End of Platform

CURVE NO.		20/21-ULC 02	20/21-ULC 03	20/21-DLC 03
COORDINATE OF APPEX	EASTING	273405.718	273302.140	273315.632
	NORTHING	2111548.092	2112153.510	2112133.946
DEFLECTION ANGLE		12°24'23"	71°14'38"	71°14'38"
RADIUS		380.350	535.000	530.000
TRANSITION LENGTH		45	40	40
CURVE LENGTH		37.356	625.240	619.023
CANT		95	85	85
CANT DEFFICIENCY		80	54	58
OPERATING SPEED		75	80	80

Coordinates of Station's footprint at Track level duly confirmed in R3 by Contractor's Representative

NOTE: This drawing supersedes Tender drawings and all previous revisions

R5.2	07.05.2019	Minor Adjustment of Rail level as per the gradient 0.7348% at the interface of UGC05 & 06 to -15.314 m
R5.1	10.10.2018	Typo error of Interface boundary Rail Level between UGC 05 - UGC 06
R5	20.07.2018	UGC 05 Interface & CSIA Alignment
R4.1	09.04.2018	Raising of Rail Level.
R4	15.12.2017	Cross Passages incorporated.
R3	02.11.2017	Revised according to new survey.

	NAME	SIGN
DRAWN BY	HRM	
DESIGN BY	JK	On behalf
CHECKED BY	SB	
REVIEWED BY	VKS	
APPROVED BY	GTP	

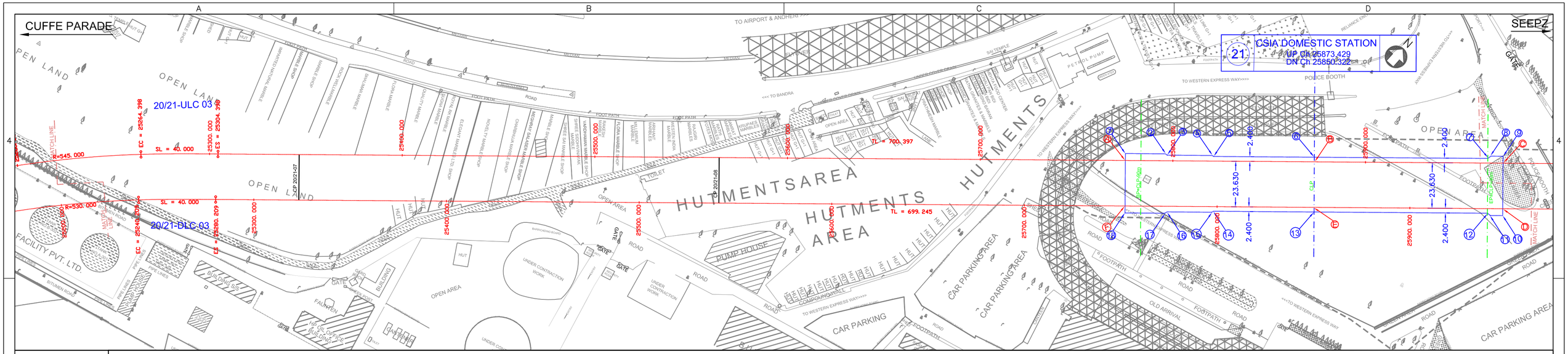
GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT,LINE No. 3 COLABA- BANDRA-SEEPZ

PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ

TITLE: HORIZONTAL & VERTICAL ALIGNMENT From km 24+500 to km 25+220

DRAWING NO.: MM3-GC-AL-GD-6020001 (SHEET: 1 of 6) | REV: R5.2 | SCALE: 1:2000 (A3) | DATE: 07 MAY, 2019

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT



Legends:
TL= Tangent length
SL= Spiral length
BC= Begin of Curve
EC= End of Curve
BS= Begin of Spiral
ES= End of Spiral

Legends:
CP= Cross Passage
CP= Cross Passage in low point
BP= Begin of Platform
CLP=Centre Line of Platform
EP= End of Platform

POINT	COORDINATES		POINT	COORDINATES		POINT	COORDINATES		POINT	TRACK COORDINATES	
1	E = 274069.108	N = 2112573.423	7	E = 274235.095	N = 2112662.049	13	E = 274169.383	N = 2112594.083	A	E = 274070.824	N = 2112570.258
2	E = 274087.317	N = 2112583.295	8	E = 274235.801	N = 2112663.797	14	E = 274123.550	N = 2112569.235	B	E = 274156.977	N = 2112616.967
3	E = 274088.571	N = 2112583.179	9	E = 274241.414	N = 2112666.840	15	E = 274123.027	N = 2112568.382	C	E = 274243.130	N = 2112663.675
4	E = 274109.000	N = 2112594.255	10	E = 274256.108	N = 2112639.737	16	E = 274102.598	N = 2112557.307	D	E = 274254.392	N = 2112642.902
5	E = 274110.000	N = 2112594.228	11	E = 274250.495	N = 2112636.694	17	E = 274102.011	N = 2112556.192	E	E = 274168.239	N = 2112596.193
6	E = 274155.833	N = 2112619.077	12	E = 274248.645	N = 2112637.056	18	E = 274083.802	N = 2112546.320	F	E = 274082.086	N = 2112549.485

R5	20.07.2018	UGC 05 Interface & CSIA Alignment
R4.1	09.04.2018	Raising of Rail Level.
R4	15.12.2017	Cross Passages incorporated.
	03.11.2017	Revised according to new survey.

NOTE: This drawing supersedes Tender drawings and all previous revisions

MMRC

GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT,LINE No. 3 COLABA- BANDRA-SEEPZ

CURVE NO.		20/21-ULC 03	20/21-DLC 03
COORDINATE OF APPEX	EASTING	273302.140	273315.632
	NORTHING	2112153.510	2112133.946
DEFLECTION ANGLE		71°14'38"	71°14'38"
RADIUS		535.000	530.000
TRANSITION LENGTH		40	40
CURVE LENGTH		625.240	619.023
CANT		85	85
CANT DEFFICIENCY		54	58
OPERATING SPEED		80	80

Coordinates of Station's footprint at Track level duly confirmed in R3 by Contractor's Representative

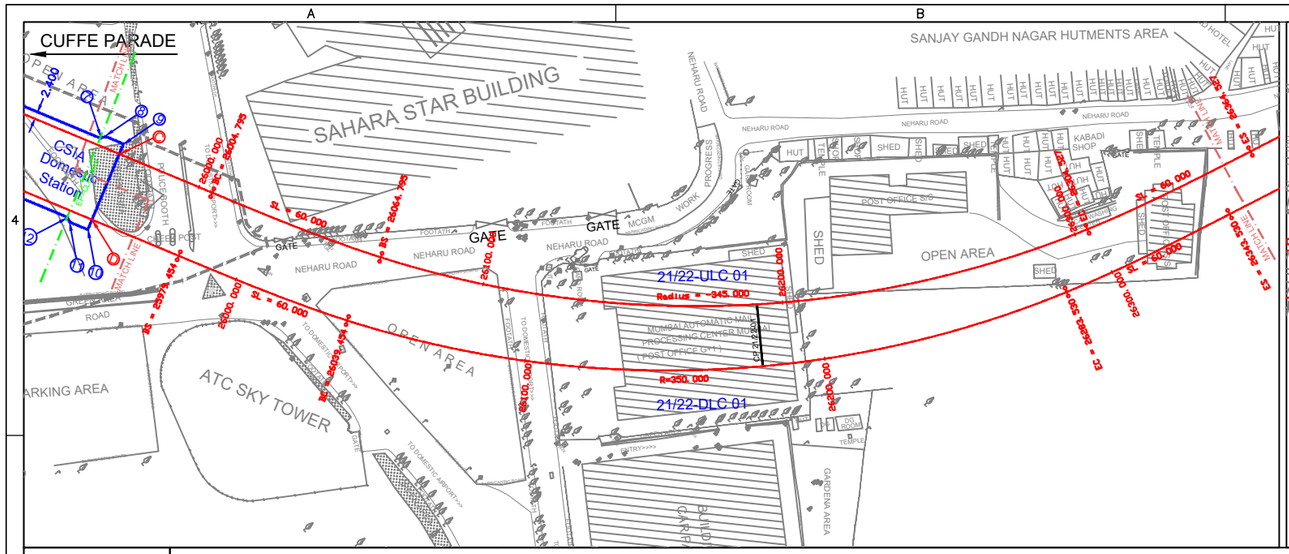
	NAME	SIGN
DRAWN BY	HRM	
DESIGN BY	JK	On behalf
CHECKED BY	SB	
REVIEWED BY	VKS	
APPROVED BY	GTP	

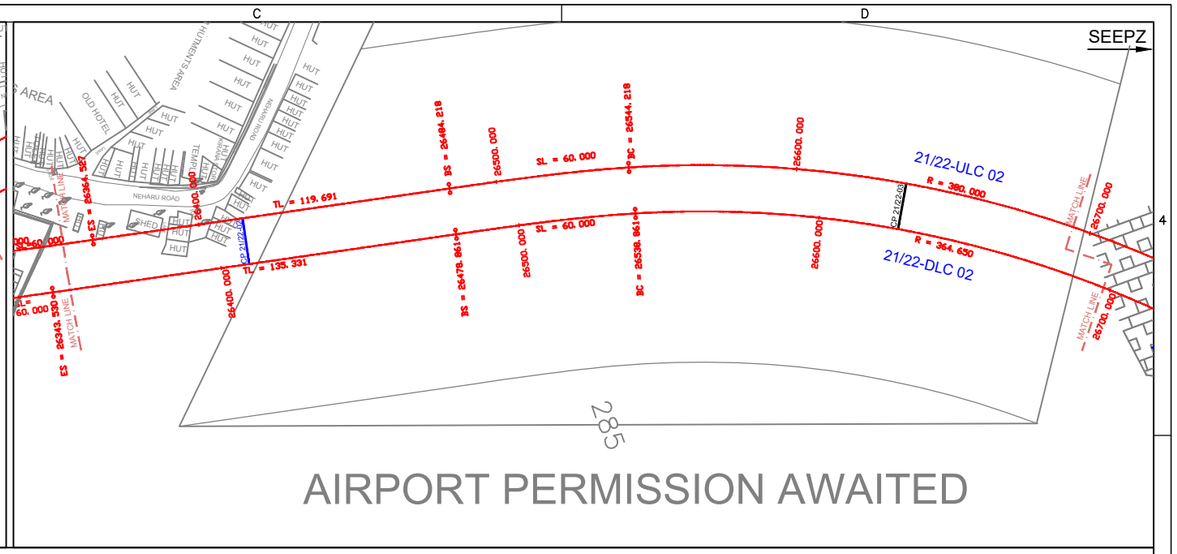
PROJECT: MUMBAI METRO LINE 3
COLABA-BANDRA-SEEPZ

TITLE: HORIZONTAL & VERTICAL ALIGNMENT
From km 25+220 to km 25+960
21 CSIA Domestic Station

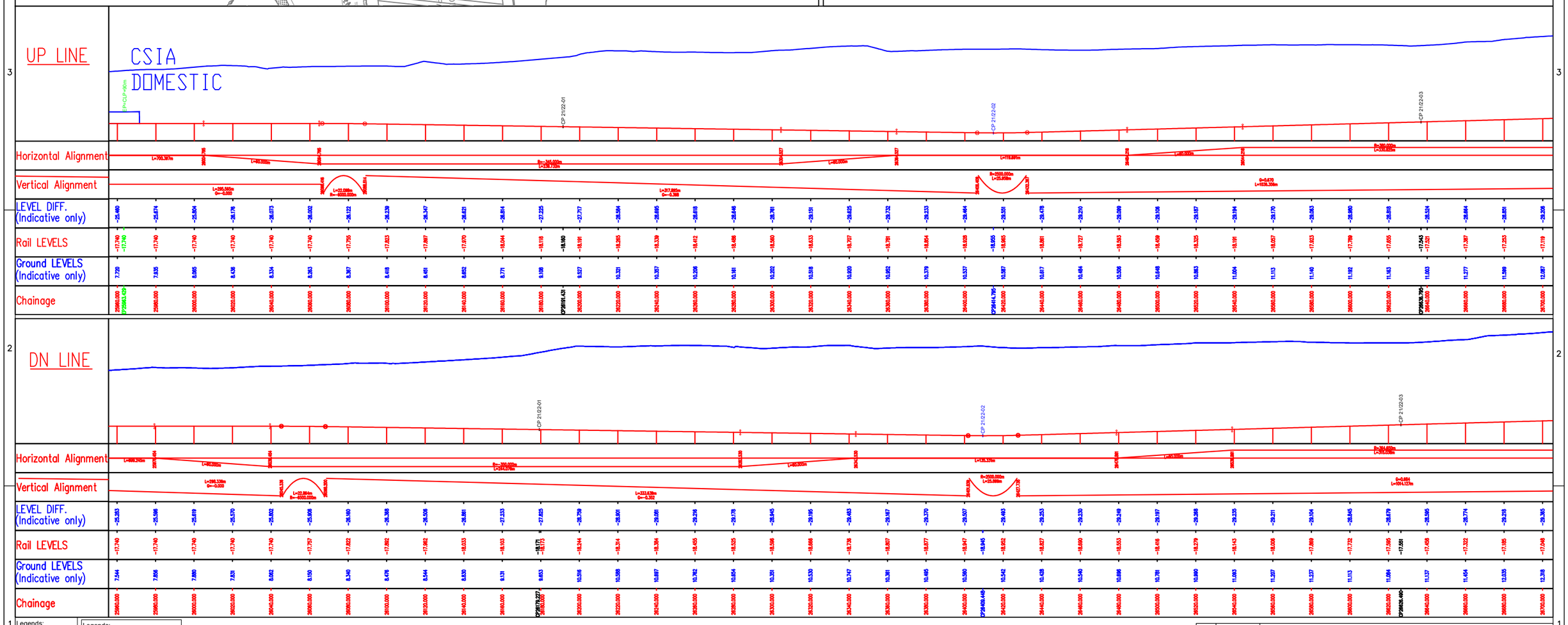
maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

DRAWING NO.: MM3-GC-AL-GD-6020002 (SHEET: 2 of 6) | REV: R5 | SCALE: 1:2000 (A3) | DATE: 20 JULY, 2018





AIRPORT PERMISSION AWAITED



Legends:
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SL= Spiral length
BC= Begin of Curve
EC= End of Curve
BS= Begin of Spiral
ES= End of Spiral

Legends:
CP= Cross Passage
CP= Cross Passage in low point
BP= Begin of Platform
CLP=Centre Line of Platform
EP= End of Platform

NOTE: This drawing supersedes Tender drawings and all previous revisions

R5	20.07.2018	UGC 05 Interface & CSIA Alignment
R4.1	09.04.2018	Raising of Rail Level.
R4	15.12.2017	Cross Passages incorporated.
	03.11.2017	Revised according to new survey.

MMRC

GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT,LINE No. 3 COLABA- BANDRA-SEEPZ

CURVE NO.		21/22-ULC 01	21/22-ULC 02	21/22-DLC 01	21/22-DLC 02
COORDINATE OF APEX	EASTING	274439.775	274552.834	274451.142	274566.095
	NORTHING	2112770.288	2113313.490	2112749.571	2113301.872
DEFLECTION ANGLE		49°48'41"	58°55'41"	49°40'41"	58°55'41"
RADIUS		345.000	380.000	350.000	364.650
TRANSITION LENGTH		60	60	60	60
CURVE LENGTH		239.732	330.825	244.076	315.038
CANT		105	110	120	115
CANT DEFFICIENCY		88	90	97	93
OPERATING SPEED		75	80	80	80

Coordinates of Station's footprint at Track level duly confirmed in R3 by Contractor's Representative

	NAME	SIGN
DRAWN BY	HRM	
DESIGN BY	JK	On behalf
CHECKED BY	SB	
REVIEWED BY	VKS	
APPROVED BY	GTP	

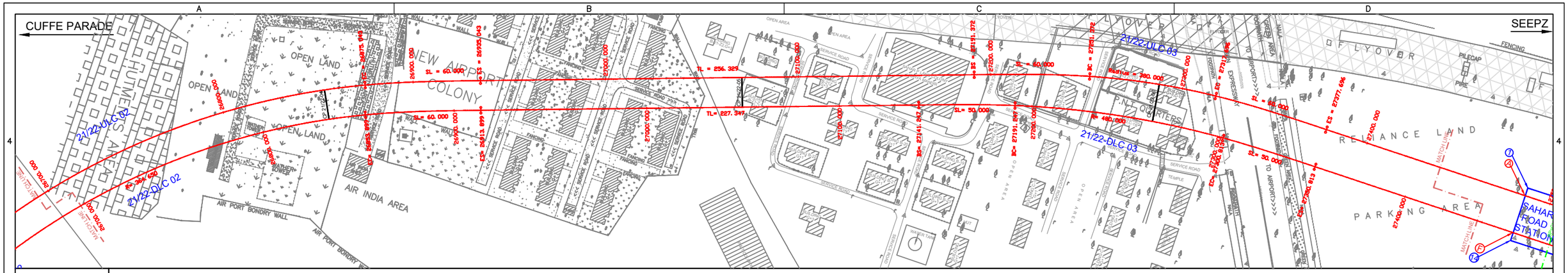
PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ

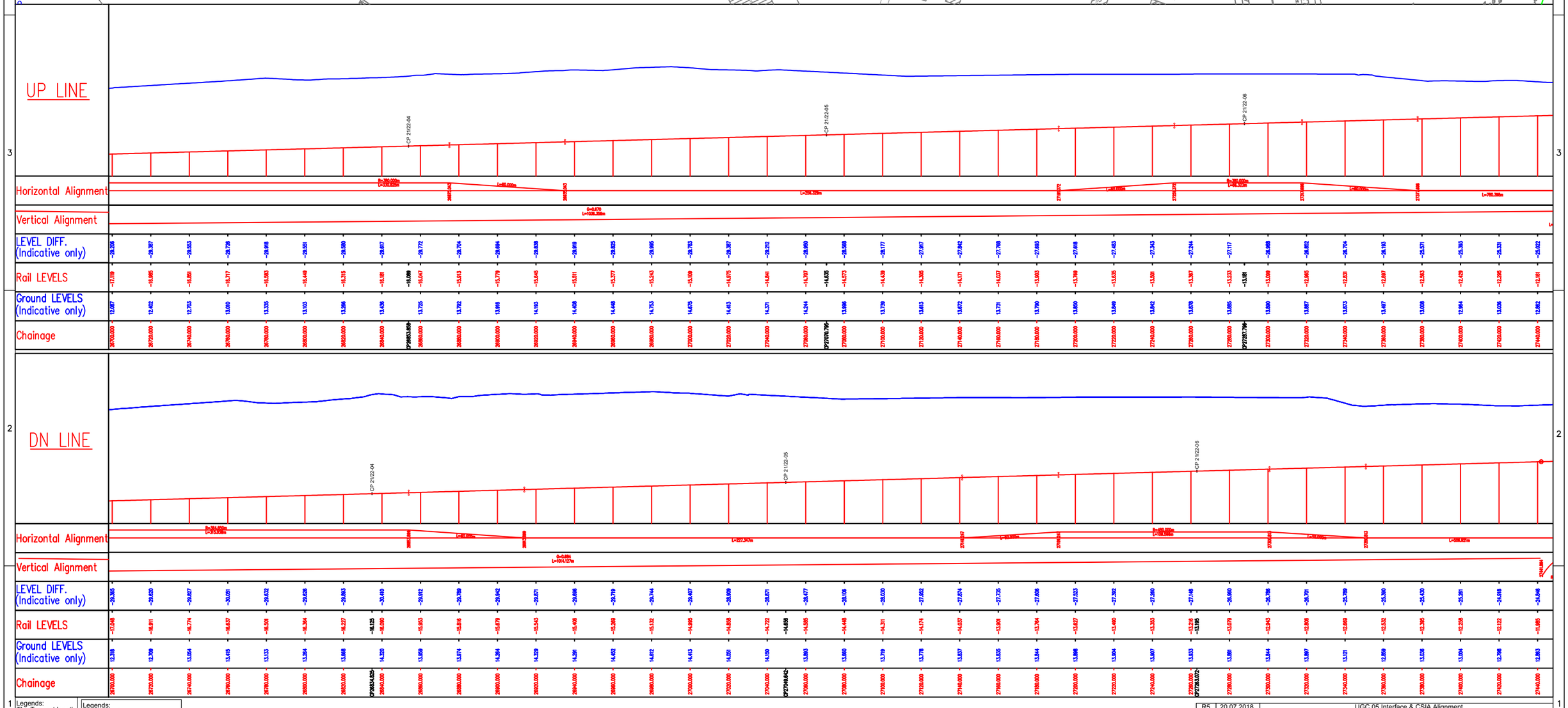
TITLE: HORIZONTAL & VERTICAL ALIGNMENT From km 25+960 to km 26+700

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

DRAWING NO.: MM3-GC-AL-GD-6020003 (SHEET: 3 of 6) REV: R5

SCALE: 1:2000 (A3) DATE: 20 JULY, 2018





Legends:
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ES= End of Spiral

Legends:
CP= Cross Passage
CP= Cross Passage in low point
BP= Begin of Platform
CLP=Centre Line of Platform
EP= End of Platform

R5	20.07.2018	UGC 05 Interface & CSIA Alignment
R4.2	09.04.2018	Raising of Rail Level.
R4.1	15.01.2018	Text amended in curves 21/22-03
R4	15.12.2017	Cross Passages incorporated.
	03.11.2017	Revised according to new survey.

NOTE: This drawing supersedes Tender drawings and all previous revisions

GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT,LINE No. 3 COLABA- BANDRA-SEEPZ

CURVE NO.		21/22-ULC 02	21/22-ULC 03	21/22-DLC 02	21/22-DLC 03
COORDINATES OF APPEX	EASTING	274552.834	275114.377	274566.095	275103.201
	NORTHING	2113313.490	2113510.301	2113301.872	2113490.119
DEFLECTION ANGLE		58°55'41"	19°02'49"	58°55'41"	19°02'49"
RADIUS		380.000	380.000	364.650	480.000
TRANSITION LENGTH		60	60	60	50
CURVE LENGTH		330.825	66.323	315.038	109.566
CANT		110	110	115	100
CANT DEFFICIENCY		90	90	93	78
OPERATING SPEED		80	80	80	85

Coordinates of Station's footprint at Track level duly confirmed in R3 by Contractor's Representative

	NAME	SIGN
DRAWN BY	HRM	
DESIGN BY	JK	On behalf
CHECKED BY	SB	
REVIEWED BY	VKS	
APPROVED BY	GTP	

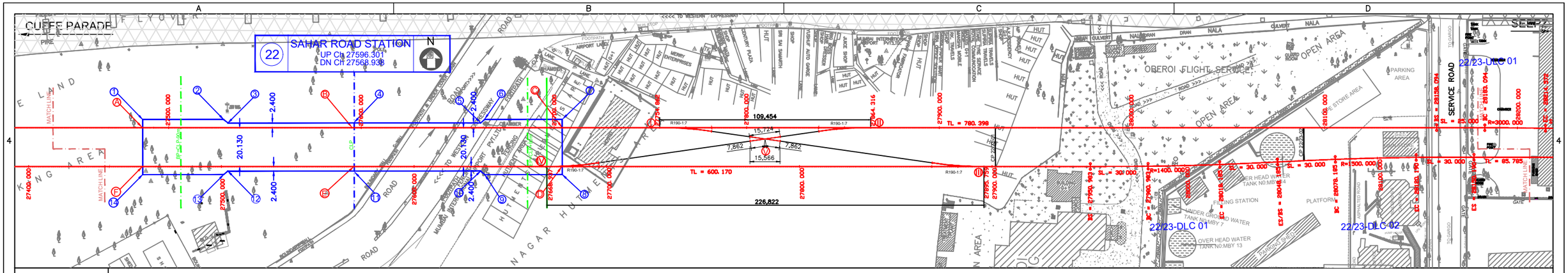
PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ

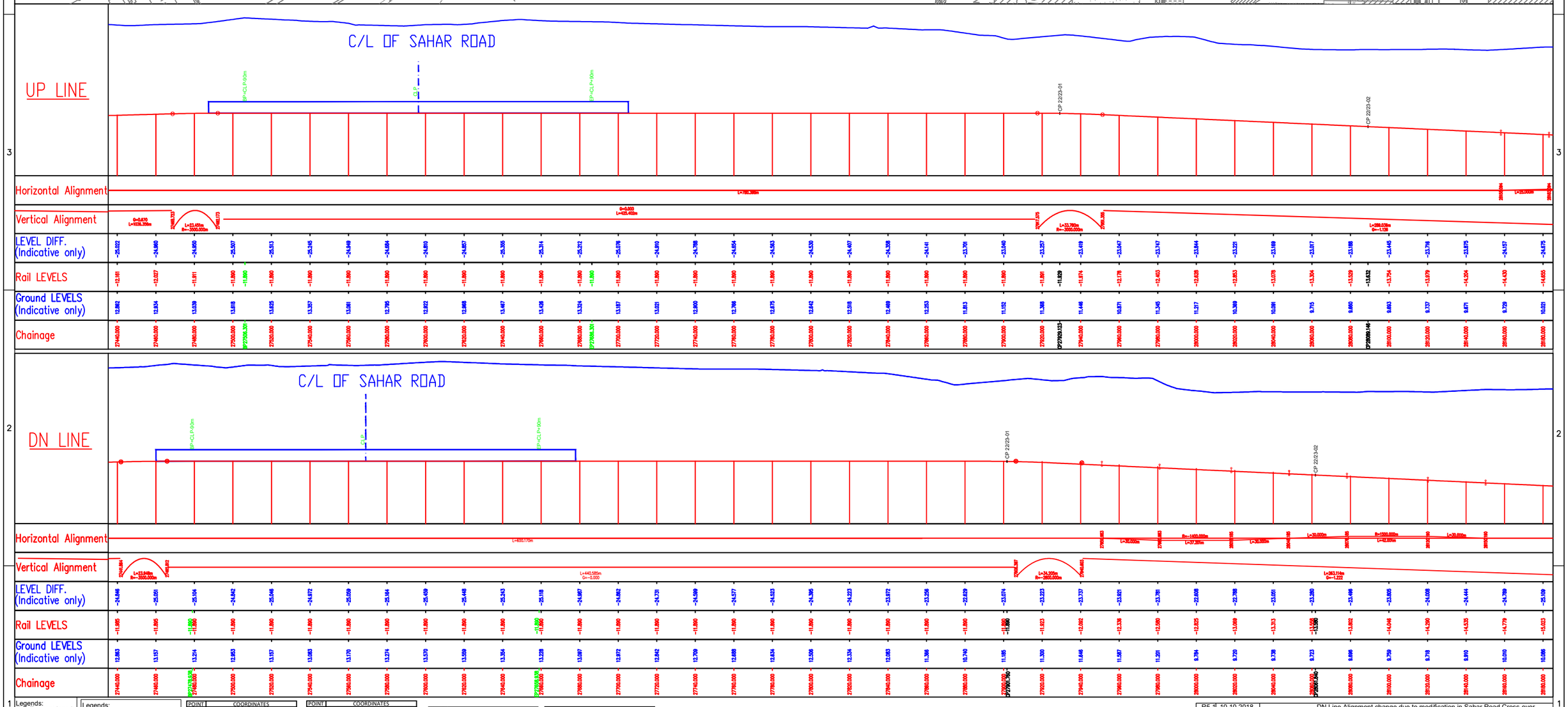
TITLE: HORIZONTAL & VERTICAL ALIGNMENT From km 26+700 to km 27+440

DRAWING NO.: MM3-GC-AL-GD-6020004 (SHEET: 4 of 6) REV: R5

SCALE: 1:2000 (A3) DATE: 20 JULY, 2018

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT





Legends:
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SL= Spiral length
BC= Begin of Curve
EC= End of Curve
BS= Begin of Spiral
ES= End of Spiral

Legends:
CP= Cross Passage
CP= Cross Passage in low point
BP= Begin of Platform
CLP=Centre Line of Platform
EP= End of Platform

POINT	COORDINATES	
1	E = 275316.970	N = 2113515.498
2	E = 275358.987	N = 2113515.695
3	E = 275361.246	N = 2113513.855
4	E = 275426.778	N = 2113514.162
5	E = 275492.347	N = 2113514.468
6	E = 275494.551	N = 2113516.328
7	E = 275534.768	N = 2113516.516

POINT	COORDINATES	
8	E = 275534.902	N = 2113487.887
9	E = 275494.685	N = 2113487.699
10	E = 275492.464	N = 2113489.538
11	E = 275426.894	N = 2113489.232
12	E = 275361.362	N = 2113488.925
13	E = 275359.121	N = 2113487.065
14	E = 275317.104	N = 2113486.869

Point	Coordinates
A	E = 275316.990 | N = 2113511.248
B	E = 275425.789 | N = 2113511.762
C	E = 275534.788 | N = 2113512.266
D	E = 275534.882 | N = 2113492.137
E	E = 275425.883 | N = 2113491.632
F	E = 275317.084 | N = 2113491.119

Scissor Crossover	
Point	Coordinates
I	E = 275585.349 | N = 2113512.503
II	E = 275694.700 | N = 2113513.014
III	E = 275753.358 | N = 2113493.158
IV	E = 275526.881 | N = 2113492.099
V	E = 275640.052 | N = 2113506.877

NOTE: This drawing supersedes Tender drawings and all previous revisions

R5.1	10.10.2018	DN Line Alignment change due to modification in Sahar Road Cross-over
R5	20.07.2018	UGC 05 Interface & CSIA Alignment
R4.2	13.06.2018	The Cross-over adjacent Sahar Road Station
R4.1	09.04.2018	Raising of Rail Level.
R4	15.12.2017	Cross Passages incorporated.

MMRC

GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT,LINE No. 3 COLABA- BANDRA-SEEPZ

CURVE NO.		22/23-ULC 01	22/23-DLC 01	22/23-DLC 02
COORDINATE OF APPEX	EASTING	276029.315	275857.531	275957.013
	NORTHING	2113514.578	2113493.645	2113498.890
DEFLECTION ANGLE		1°04'43"	2°45'01"	2°45'01"
RADIUS		3000.000	1400.000	1500.000
TRANSITION LENGTH		25	30	30
CURVE LENGTH		31.478	37.201	42.001
CANT		0	45	45
CANT DEFFICIENCY		29	16	12
OPERATING SPEED		85	85	85

Coordinates of Station's footprint at Track level duly confirmed in R3 by Contractor's Representative

	NAME	SIGN
DRAWN BY	HRM	
DESIGN BY	JK	On behalf
CHECKED BY	SB	
REVIEWED BY	VKS	
APPROVED BY	GTP	

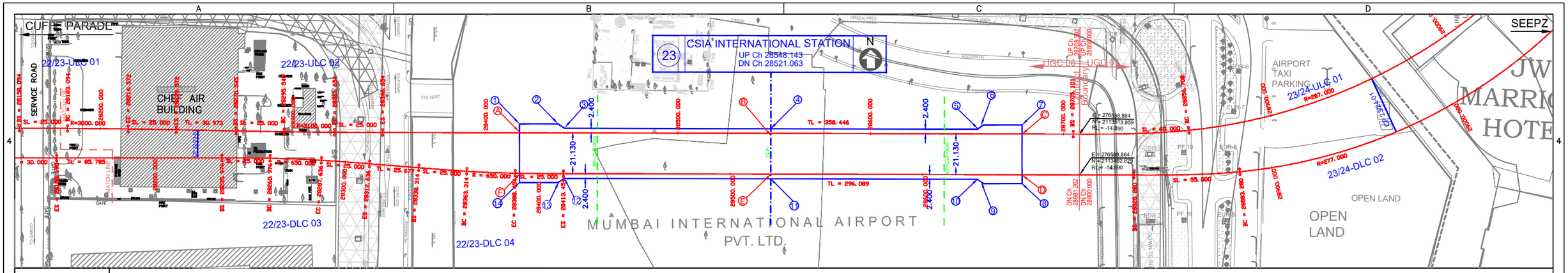
PROJECT: MUMBAI METRO LINE 3
COLABA-BANDRA-SEEPZ

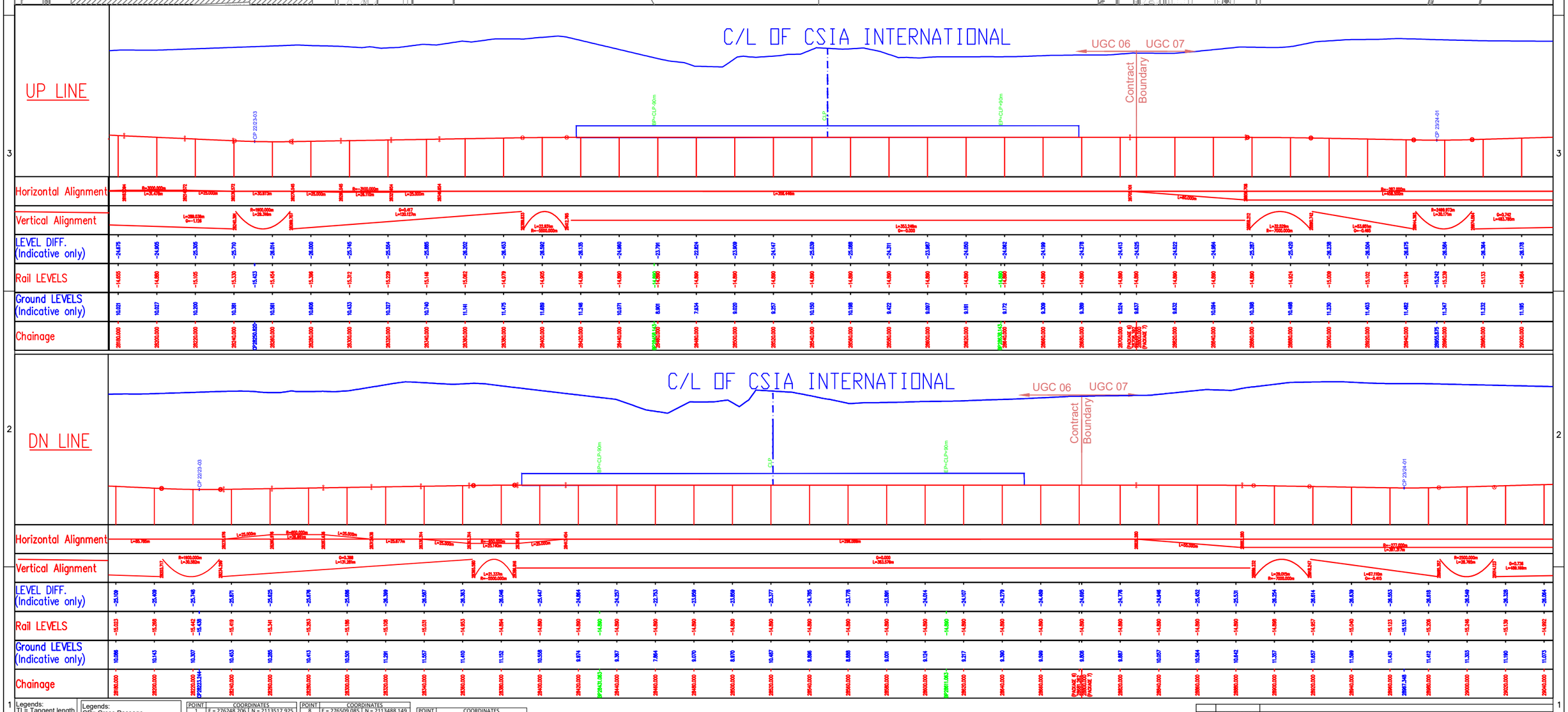
TITLE: HORIZONTAL & VERTICAL ALIGNMENT
From km 27+440 to km 28+180
22 SAHAR ROAD STATION

DRAWING NO.: MM3-GC-AL-GD-6020005 (SHEET: 5 of 6) REV: R5.1

SCALE: 1:2000 (A3) DATE: 10 OCTOBER, 2018

maple
MUMBAI METRO LINE-3
GENERAL CONSULTANT





Legends:
TL= Tangent length
SL= Spiral length
BC= Begin of Curve
EC= End of Curve
BS= Begin of Spiral
ES= End of Spiral

Legends:
CP= Cross Passage
CP= Cross Passage in low point
BP= Begin of Platform
CLP=Centre Line of Platform
EP= End of Platform

POINT	COORDINATES	
1	E = 276248.206	N = 2113517.925
2	E = 276268.205	N = 2113517.977
3	E = 276271.419	N = 2113515.734
4	E = 276378.611	N = 2113515.984
5	E = 276485.801	N = 2113516.235
6	E = 276489.008	N = 2113518.493
7	E = 276509.005	N = 2113518.546

POINT	COORDINATES	
8	E = 276509.085	N = 2113488.149
9	E = 276489.08	N = 2113488.096
10	E = 276485.87	N = 2113490.305
11	E = 276378.671	N = 2113490.055
12	E = 276271.471	N = 2113489.804
13	E = 276268.272	N = 2113487.548
14	E = 276248.286	N = 2113487.495

POINT	COORDINATES	
A	E = 276248.218	N = 2113513.280
B	E = 276378.616	N = 2113513.584
C	E = 276509.017	N = 2113513.889
D	E = 276509.073	N = 2113492.625
E	E = 276378.666	N = 2113492.455
F	E = 276248.266	N = 2113492.272

NOTE: This drawing supersedes Tender drawings and all previous revisions

R5.1	10.10.2018	Typo error of Interface boundary Chainage between UGC 06 - UGC 07
R5	20.07.2018	UGC 05 Interface & CSIA Alignment
R4.2	23.04.2018	Change due to interface
R4.1	09.04.2018	Raising of Rail Level.
R4	15.12.2017	Cross Passages incorporated.

MMRC

GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT,LINE No. 3 COLABA- BANDRA-SEEPZ

CURVE NO.		22/23-ULC 01	22/23-ULC 02	23/24-ULC 01	22/23-DLC 03	22/23-DLC 04	23/24-DLC 02
COORDINATES OF APPEX	EASTING	276029.315	276139.072	276930.361	276132.150	276233.473	276889.883
	NORTHING	2113514.578	2113513.025	2113514.861	2113499.709	2113492.115	2113493.649
DEFLECTION ANGLE		1°04'43"	0°56.41"	103°30'42"	4°33'14"	4°25'11"	93°33'33"
RADIUS		3000.000	3100.000	287.000	650.000	650.000	277.000
TRANSITION LENGTH		25	25	60	25	25	55
CURVE LENGTH		31.478	26.110	458.500	26.661	25.140	397.317
CANT		0	0	110	55	55	115
CANT DEFFICIENCY		29	28	92	34	34	94
OPERATING SPEED		85	85	70	70	70	70

Coordinates of Station's footprint at Track level duly confirmed in R3 by Contractor's Representative

	NAME	SIGN
DRAWN BY	HRM	
DESIGN BY	JK	On behalf
CHECKED BY	SB	
REVIEWED BY	VKS	
APPROVED BY	GTP	

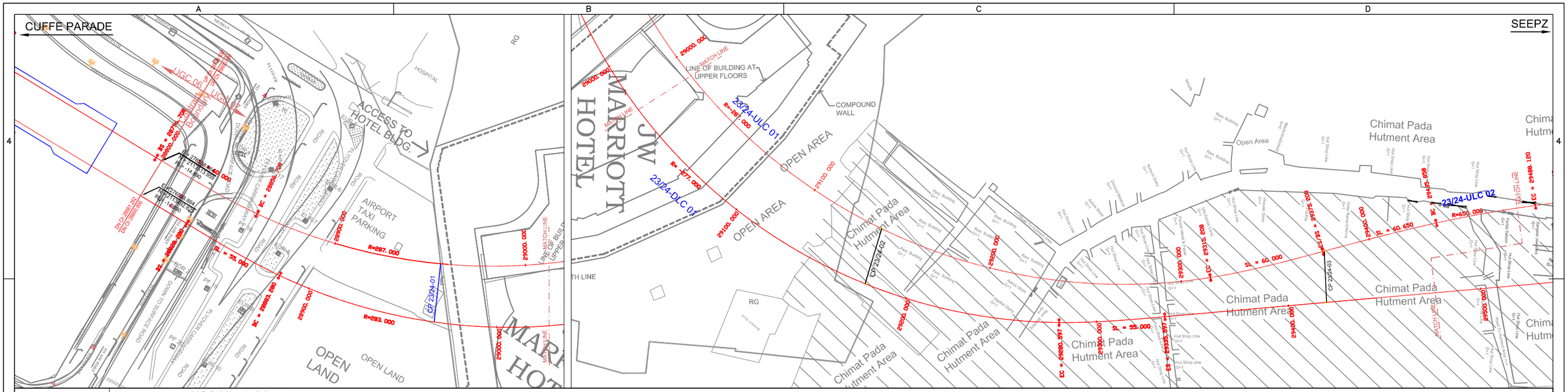
PROJECT: MUMBAI METRO LINE 3
COLABA-BANDRA-SEEPZ

TITLE: HORIZONTAL & VERTICAL ALIGNMENT
From km 28+180 to km 28+700
23 CSIA INTERNATIONAL STATION

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

DRAWING NO.: MM3-GC-AL-GD-6020006 (SHEET: 6 of 6) REV: R5.1

SCALE: 1:2000 (A3) DATE: 10 OCTOBER, 2019



3 UP LINE

CSIA INTERNATIONAL

Horizontal Alignment

Vertical Alignment

LEVEL DIFF.

Rail LEVELS

Ground LEVELS

Chainage

2 DN LINE

CSIA INTERNATIONAL

Horizontal Alignment

Vertical Alignment

LEVEL DIFF. (Indicative only)

Rail LEVELS

Ground LEVELS (Indicative only)

Chainage

Legends:
TL= Tangent length
SL= Spiral length
BC= Begin of Curve
EC= End of Curve
BS= Begin of Spiral
ES= End of Spiral

Legends:
CP= Cross Passage
CP= Cross Passage in low point
BP= Begin of Platform
CLP=Centre Line of Platform
EP= End of Platform

NOTE: This drawing supersedes Tender drawings and all previous revisions

R5.2	17.01.2019	Revised Cross Passages CP-23/24 02 & 03 as per proposal
R5	20.07.2018	UGC 06 Interface & Gradient change between Seepz & Ramp
R4.2	23.04.2018	Change due to interface
R4.1	09.04.2018	Adjustment of Rail Level & Cross Passage.
R4	13.01.2018	Cross Passages incorporated.
R3	10.01.2018	Revised according to new Survey.

MMRC

GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT,LINE No. 3 COLABA- BANDRA-SEEPZ

CURVE NO.		23/24-ULC 01	23/24-ULC 02	23/24-DLC 01
COORDINATE OF APEX	EASTING	276930.358	276816.712	276889.883
	NORTHING	2113514.873	2113983.005	2113493.649
DEFLECTION ANGLE		103°30'42"	9°57'10"	93°33'33"
RADIUS		287.000	650.000	277.000
TRANSITION LENGTH		60.000	60.650	55.000
CURVE LENGTH		458.500	52.912	397.317
CANT		110	70	115
CANT DEFFICIENCY		92	62	94
OPERATING SPEED		70	85	70

Coordinates of Station's footprint at Track level duly confirmed in R3 by Contractor's Representative

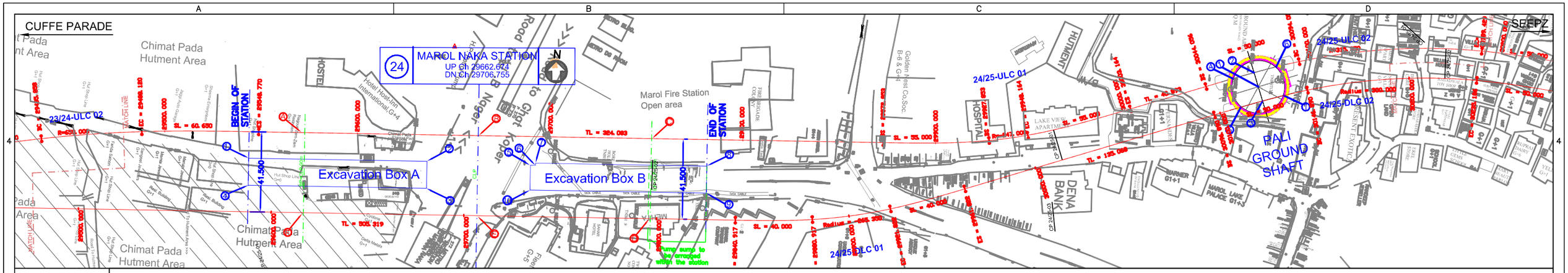
	NAME	SIGN
DRAWN BY	YGP	
DESIGN BY	SB	
CHECKED BY	VKS	
REVIEWED BY	SY CHANG	
APPROVED BY	GTP	

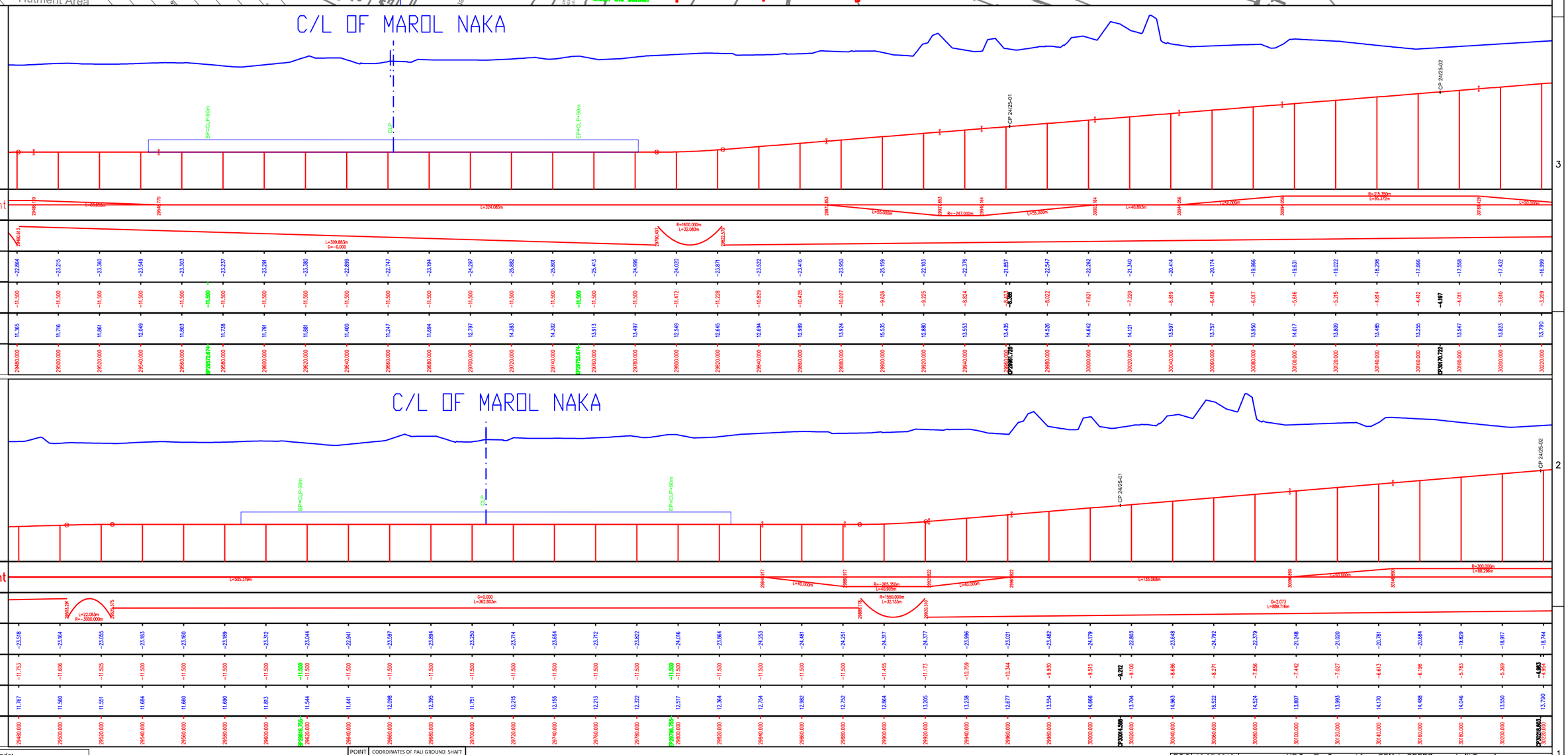
PROJECT: MUMBAI METRO LINE 3
COLABA-BANDRA-SEEPZ

TITLE: HORIZONTAL & VERTICAL ALIGNMENT
From km 28+800 to km 29+480

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

DRAWING NO.: MM3-GC-AL-GD-7020001 (SHEET: 1 of 6) | REV: R5.2 | SCALE: 1:2000 (A3) | DATE: 18 JANUARY, 2019





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BS= Begin of Spiral
ES= End of Spiral

Legends:
CP= Cross Passage
CP= Cross Passage in low point
BP= Begin of Platform
CLP=Centre Line of Platform
EP= End of Platform

POINTS	Coordinates Excavation Box A
1	E = 276825.155 | N = 2114065.664
2	E = 276819.194 | N = 2114158.022
3	E = 276833.165 | N = 2114158.924
4	E = 276839.126 | N = 2114066.566

POINTS	Coordinates Excavation Box B
5	E = 276816.883 | N = 2114211.685
6	E = 276816.716 | N = 2114214.279
7	E = 276815.568 | N = 2114214.205
8	E = 276809.839 | N = 2114307.970
9	E = 276823.810 | N = 2114303.872
10	E = 276829.707 | N = 2114777.512

POINT	COORDINATES OF PALI GROUND SHAFT
1	E = 276745.561 | N = 2114584.829
2	E = 276738.412 | N = 2114582.022
3	E = 276752.710 | N = 2114587.636
4	E = 276742.411 | N = 2114571.291
5	E = 276756.798 | N = 2114576.647
6	E = 276734.473 | N = 2114593.211
7	E = 276748.369 | N = 2114598.305

NOTE: This drawing supersedes Tender drawings and all previous revisions

R5.2	10.07.2019	UP line Realignment from CSIA to SEEPZ on as built Tunnel
R5.1	31.08.2018	Cross Passages Incorporated.
R5	20.07.2018	UGC 06 Interface & Gradient change between Seepz & Ramp
R4.1	09.04.2018	Adjustment of Rail Level & Cross Passage.
R4	13.01.2018	Cross Passages Incorporated.
R3	10.01.2018	Revised according to new Survey.

MMRC

GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT,LINE No. 3 COLABA- BANDRA-SEEPZ

CURVE NO.		23/24-ULC 02	24/25-ULC 01	24/25-ULC 02	24/25-DLC 01	24/25-DLC 02
COORDINATE OF APEX	EASTING	276816.712	276786.019	276711.837	276832.632	276727.452
	NORTHING	2113983.005	2114458.556	2114650.181	2114380.665	2114652.364
DEFLECTION ANGLE		9°57'10"	17°28'10"	26°24'45"	17°28'10"	26°24'45"
RADIUS		650.000	247.000	315.350	265.350	300.000
TRANSITION LENGTH		60.650	55	50	40	50
CURVE LENGTH		52.912	20.311	90.372	40.905	88.296
CANT		70	110	105	90	110
CANT DEFFICIENCY		62	93	79	71	83
OPERATING SPEED		85	65	70	60	70

Coordinates of Station's footprint at Track level duly confirmed in R3 by Contractor's Representative

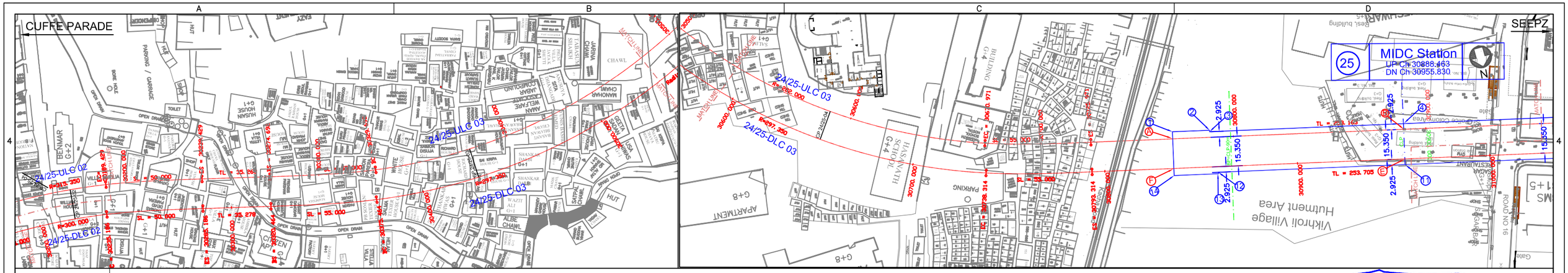
	NAME	SIGN
DRAWN BY	SVM (TI)	
DESIGN BY	JK (STAE.)	On behalf
CHECKED BY	VKS (Ch. T E)	
REVIEWED BY	SY CHANG (Track Expert)	
APPROVED BY	GTP (DPM Civil)	

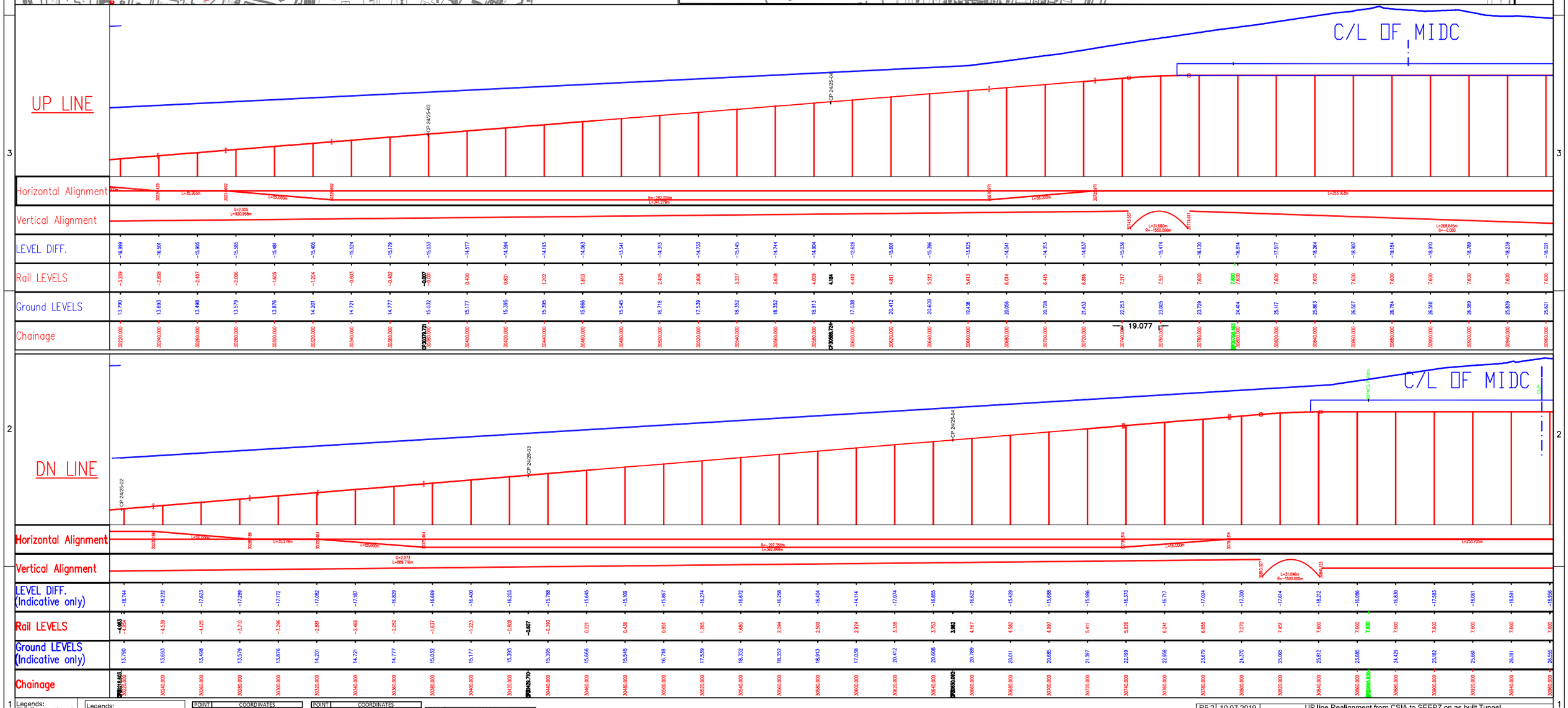
PROJECT: MUMBAI METRO LINE 3
COLABA-BANDRA-SEEPZ

TITLE: HORIZONTAL & VERTICAL ALIGNMENT
From km 29+480 to km 30+220
24 Marol Naka Station

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

DRAWING NO.: MM3-GC-AL-GD-7020002 (SHEET: 2 of 6) | REV: R5.2 | SCALE: 1:2000 (A3) | DATE: 10 JULY, 2019





Legends:
TL= Tangent length
SL= Spiral length
BC= Begin of Curve
EC= End of Curve
BS= Begin of Spiral
ES= End of Spiral

Legends:
CP= Cross Passage
CP= Cross Passage in low point
BP= Begin of Platform
CLP=Centre Line of Platform
EP= End of Platform

POINT	COORDINATES
1	E = 276448.605 | N = 2115124.581
2	E = 276429.939 | N = 2115129.490
3	E = 276430.130 | N = 2115130.216
4	E = 276332.742 | N = 2115157.830
5	E = 276235.359 | N = 2115181.460
6	E = 276235.168 | N = 2115180.735
7	E = 276216.572 | N = 2115185.906

POINT	COORDINATES
8	E = 276222.360 | N = 2115207.877
9	E = 276244.517 | N = 2115201.736
10	E = 276244.327 | N = 2115201.011
11	E = 276338.135 | N = 2115176.332
12	E = 276431.944 | N = 2115151.669
13	E = 276432.135 | N = 2115152.385
14	E = 276454.379 | N = 2115146.535

POINT	COORDINATES
A	E = 276449.539 | N = 2115128.135
B	E = 276333.486 | N = 2115158.658
C	E = 276217.511 | N = 2115189.478
D	E = 276221.419 | N = 2115204.338
E	E = 276337.391 | N = 2115173.504
F	E = 276453.444 | N = 2115142.980

NOTE: This drawing supersedes Tender drawings and all previous revisions

R5.2	10.07.2019	UP line Realignment from CSIA to SEEPZ on as built Tunnel
R5.1	31.08.2018	Cross Passages Incorporated.
R5	20.07.2018	UGC 06 Interface & Gradient change between Seepz & Ramp
R4.1	09.04.2018	Adjustment of Rail Level & Cross Passage.
R4	13.01.2018	Cross Passages Incorporated.
R3	10.01.2018	Revised according to new Survey.

GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT,LINE No. 3 COLABA- BANDRA-SEEPZ

CURVE NO.		24/25-ULC 02	24/25-ULC 03	24/25-DLC 02	24/25-DLC 03
COORDINATE OF APPEX	EASTING	276711.837	276748.531	276727.452	276765.006
	NORTHING	2114650.181	2115049.497	2114652.364	2115061.036
DEFLECTION ANGLE		26°24'45"	80°30'53"	26°24'45"	80°30'53"
RADIUS		315.350	282.000	300.000	297.350
TRANSITION LENGTH		50	55	50	55
CURVE LENGTH		90.372	341.279	88.796	362.849
CANT		105	115	110	110
CANT DEFFICIENCY		79	91	83	85
OPERATING SPEED		70	70	70	70

Coordinates of Station's footprint at Track level duly confirmed in R3 by Contractor's Representative

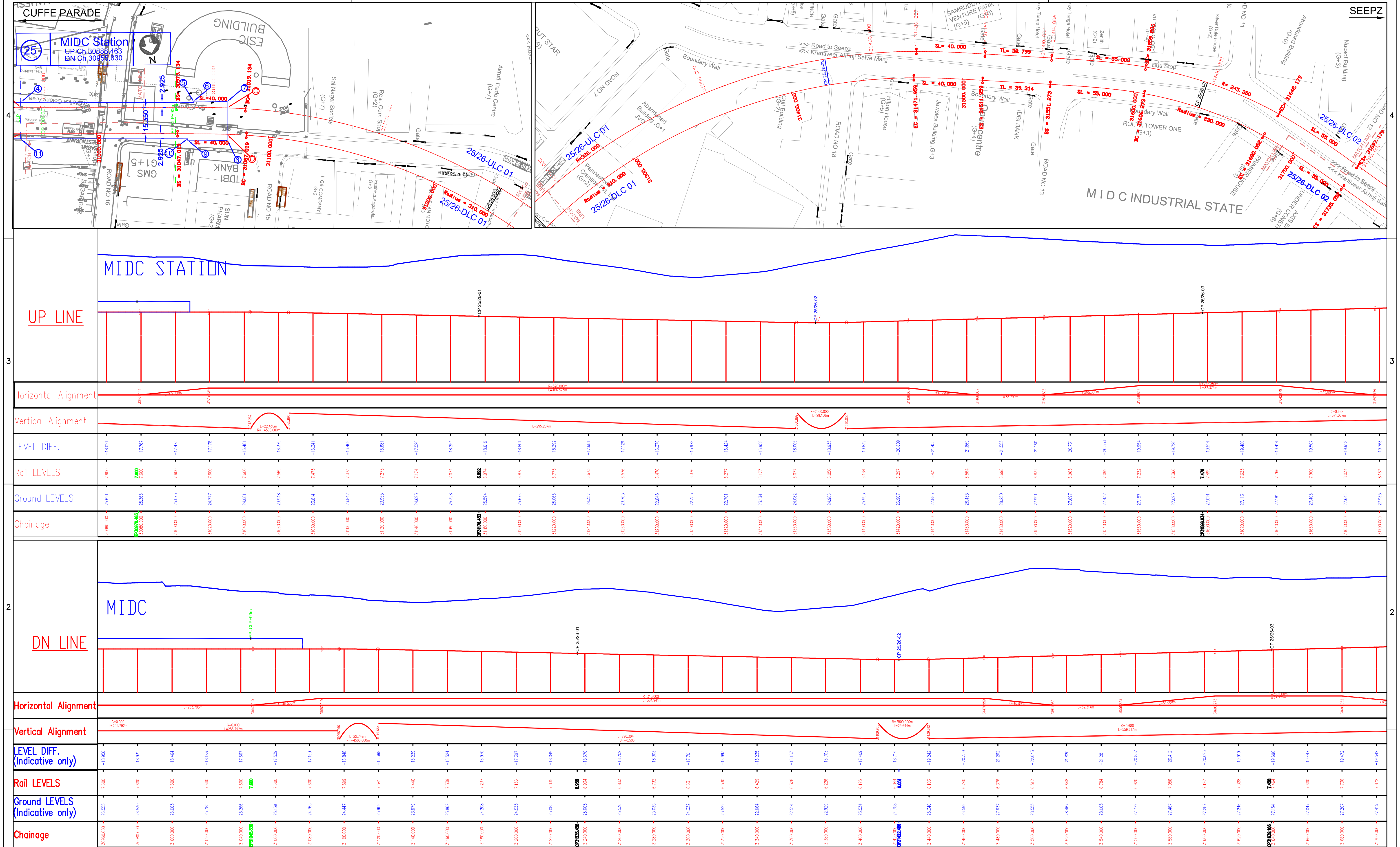
	NAME	SIGN
DRAWN BY	SVM (TI)	
DESIGN BY	JK (STAE.)	On behalf
CHECKED BY	VKS (Ch. T E)	
REVIEWED BY	SY CHANG (Track Expert)	
APPROVED BY	GTP (DPM Civil)	

PROJECT: MUMBAI METRO LINE 3
COLABA-BANDRA-SEEPZ

TITLE: HORIZONTAL & VERTICAL ALIGNMENT
From km 30+220 to km 30+960
25 MIDC STATION

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

DRAWING NO.:MM3-GC-AL-GD-7020003 (SHEET: 3 of 6) | REV: R5.2 | SCALE: 1:2000 (A3) | DATE: 10 JULY, 2019



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SL= Spiral length
BC= Begin of Curve
EC= End of Curve
BS= Begin of Spiral
ES= End of Spiral

Legends:
CP= Cross Passage
CP= Cross Passage in low point
BP= Begin of Platform
CLP=Centre Line of Platform
EP= End of Platform

POINT	COORDINATES	
1	E = 276448.605	N = 2115124.581
2	E = 276429.939	N = 2115129.490
3	E = 276430.130	N = 2115130.216
4	E = 276332.742	N = 2115155.830
5	E = 276235.359	N = 2115181.460
6	E = 276235.168	N = 2115180.735
7	E = 276216.572	N = 2115185.906

POINT	COORDINATES	
8	E = 276222.350	N = 2115207.877
9	E = 276244.517	N = 2115201.736
10	E = 276244.327	N = 2115201.011
11	E = 276338.135	N = 2115176.332
12	E = 276431.944	N = 2115151.659
13	E = 276432.135	N = 2115152.385
14	E = 276454.379	N = 2115146.535

POINT	COORDINATES	
A	E = 276449.539	N = 2115128.135
B	E = 276333.486	N = 2115158.658
C	E = 276217.511	N = 2115189.478
D	E = 276221.419	N = 2115204.338
E	E = 276337.391	N = 2115173.504
F	E = 276453.444	N = 2115142.980

NOTE: This drawing supersedes Tender drawings and all previous revisions

R5.2	10.07.2019	UP line Realignment from CSIA to SEEPZ on as built Tunnel
R5.1	31.08.2018	Cross Passages incorporated.
R5	20.07.2018	UGC 06 Interface & Gradient change between Seepz & Ramp
R4.1	09.04.2018	Adjustment of Rail Level & Cross Passage.
R4	13.01.2018	Cross Passages incorporated.
R3	10.01.2018	Revised according to new Survey.

MMRC

GENERAL CONSULTANCY SERVICES
FOR MUMBAI METRO RAIL PROJECT,LINE No. 3
COLABA- BANDRA-SEEPZ

CURVE NO.		25/26-ULC 01	25/26-ULC 02	25/26-DLC 01	25/26-DLC 02
COORDINATE OF APPEX	EASTING	275968.527	275992.734	275984.569	276007.806
	NORTHING	2115254.647	2115677.635	2115266.299	2115672.352
DEFLECTION ANGLE		78°32'23"	32°04'49"	78°32'23"	32°04'49"
RADIUS		326.000	245.350	310.000	230.000
TRANSITION LENGTH		40	55	40	55
CURVE LENGTH		406.873	82.373	369.941	73.779
CANT		85	110	90	120
CANT DEFFICIENCY		68	94	71	98
OPERATING SPEED		65	65	65	65

Coordinates of Station's footprint at Track level duly confirmed in R3 by Contractor's Representative

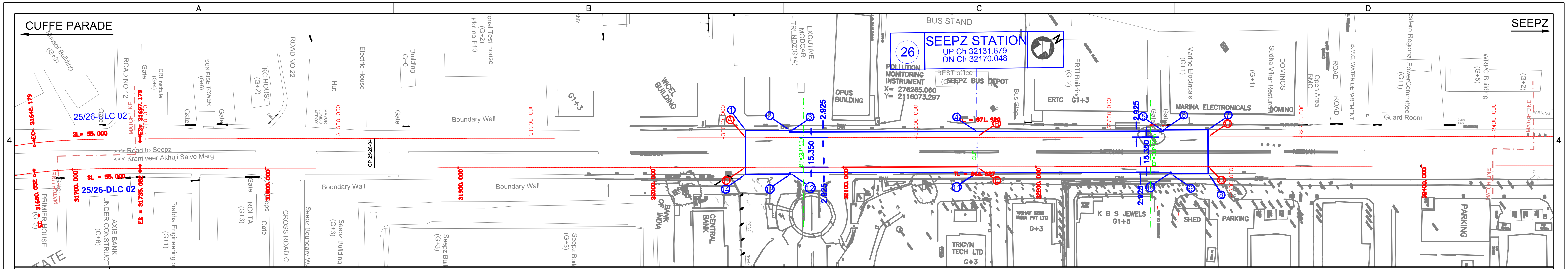
	NAME	SIGN
DRAWN BY	SVM (TI)	
DESIGN BY	JK (STAE.)	On behalf
CHECKED BY	VKS (Ch. T E)	
REVIEWED BY	SY CHANG (Track Expert)	
APPROVED BY	GTP (DPM Civil)	

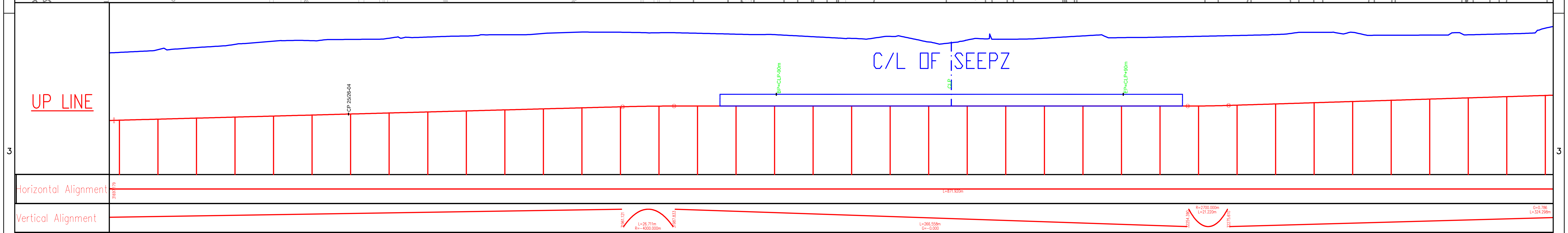
PROJECT: MUMBAI METRO LINE 3
COLABA-BANDRA-SEEPZ

TITLE: HORIZONTAL & VERTICAL ALIGNMENT
From km 30+960 to km 31+700
25 MIDC STATION

maple
MUMBAI METRO LINE-3
GENERAL CONSULTANT

DRAWING NO.: MM3-GC-AL-GD-7020004 (SHEET: 4 of 6) REV: R5.2 SCALE: 1:2000 (A3) DATE: 10 JULY, 2019





UP LINE

Chainage	LEVEL DIFF.	Rail LEVELS	Ground LEVELS
31700.000	-19.768	8.167	27.935
31720.000	-20.000	8.301	28.301
31740.000	-20.135	8.434	28.569
31760.000	-20.407	8.568	28.974
31780.000	-20.696	8.701	29.397
31800.000	-20.620	8.835	29.454
CP31818.913 / 31820.000	-20.650	8.961 / 8.968	29.619
31840.000	-20.681	9.102	29.782
31860.000	-20.691	9.236	29.926
31880.000	-20.686	9.369	30.056
31900.000	-20.720	9.503	30.223
31920.000	-20.753	9.636	30.389
31940.000	-20.698	9.770	30.468
31960.000	-20.644	9.903	30.547
31980.000	-20.491	9.992	30.483
32000.000	-20.416	10.000	30.416
32020.000	-20.295	10.000	30.296
32040.000 / BP32041.679	-20.234	10.000 / 10.000	30.234
32060.000	-19.967	10.000	29.967
32080.000	-19.751	10.000	29.751
32100.000	-20.007	10.000	30.008
32120.000	-19.287	10.000	29.288
32140.000	-19.546	10.000	29.547
32160.000	-19.634	10.000	29.635
32180.000	-19.783	10.000	29.784
32200.000	-20.076	10.000	30.077
32220.000 / EP32221.679	-19.850	10.000 / 10.000	29.851
32240.000	-19.915	10.000	29.916
32260.000	-20.015	10.006	30.021
32280.000	-20.008	10.118	30.126
32300.000	-19.978	10.275	30.254
32320.000	-20.109	10.432	30.541
32340.000	-19.938	10.589	30.528
32360.000	-19.408	10.747	30.155
32380.000	-19.276	10.904	30.179
32400.000	-19.156	11.061	30.217
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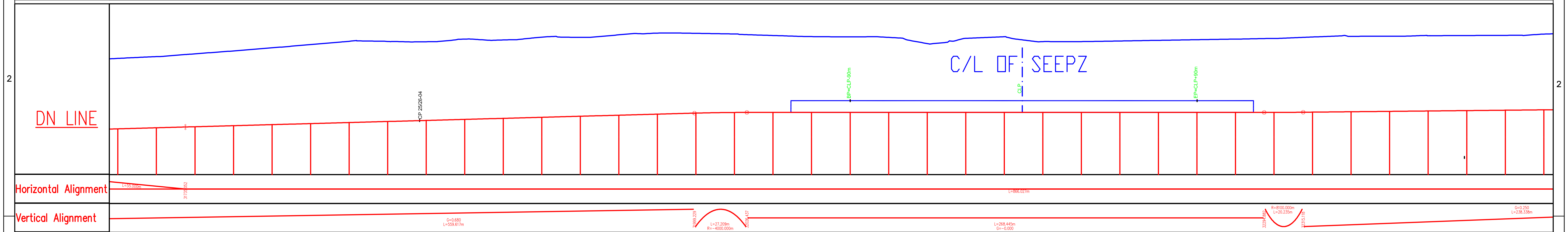
32440.000	-19.710	11.375	31.086



DN LINE

Chainage	LEVEL DIFF. (Indicative only)	Rail LEVELS	Ground LEVELS (Indicative only)
31700.000	-19.542	7.872	27.415
31720.000	-19.631	8.008	27.639
31740.000	-19.869	8.144	28.013
31760.000	-20.106	8.280	28.387
31780.000	-20.375	8.416	28.791
31800.000	-20.658	8.552	29.211
31820.000	-20.953	8.688	29.642
31840.000	-20.767	8.824	29.591
CP31856.612 / 31860.000	-20.603	8.937 / 8.960	29.564
31880.000	-20.817	9.096	29.913
31900.000	-20.575	9.232	29.807
31920.000	-20.794	9.369	30.163
31940.000	-20.631	9.505	30.136
31960.000	-20.839	9.641	30.479
31980.000	-20.909	9.777	30.686
32000.000	-20.739	9.913	30.651
32020.000	-20.574	9.995	30.568
32040.000	-20.366	10.000	30.366
32060.000	-20.228	10.000	30.229
BP32079.314 / 32080.000	-20.191	10.000 / 10.000	30.191
32100.000	-20.118	10.000	30.118
32120.000	-19.293	10.000	29.293
32140.000	-20.011	10.000	30.012
32160.000	-20.216	10.000	30.217
32180.000	-19.585	10.000	29.586
32200.000	-19.583	10.000	29.583
32220.000	-19.663	10.000	29.664
32240.000	-19.749	10.000	29.750
EP32259.314 / 32260.000	-19.829	10.000 / 10.000	29.830
32280.000	-19.903	10.000	29.903
32300.000	-19.988	10.002	29.990
32320.000	-20.147	10.037	30.185
32340.000	-20.179	10.087	30.267
32360.000	-20.145	10.137	30.283
32380.000	-20.158	10.187	30.345
32400.000	-20.132	10.237	30.370
32420.000	-20.107	10.287	30.394
32440.000	-20.224	10.337	30.561

Legends:
TL= Tangent length
SL= Spiral length
BC= Begin of Curve
EC= End of Curve
BS= Begin of Spiral
ES= End of Spiral

Legends:
CP= Cross Passage
CP= Cross Passage in low point
BP= Begin of Platform
CLP=Centre Line of Platform
EP= End of Platform

POINTS	STATION BOX COORDINATES	
1	E = 276228.398	N = 2116016.142
2	E = 276241.707	N = 2116034.900
3	E = 276242.319	N = 2116034.466
4	E = 276298.448	N = 2116113.577
5	E = 276354.577	N = 2116192.688
6	E = 276353.965	N = 2116193.122
7	E = 276367.274	N = 2116211.880

POINTS	STATION BOX COORDINATES	
8	E = 276385.788	N = 2116198.745
9	E = 276374.620	N = 2116183.004
10	E = 276374.008	N = 2116183.438
11	E = 276315.738	N = 2116101.310
12	E = 276257.468	N = 2116019.181
13	E = 276258.080	N = 2116018.747
14	E = 276246.912	N = 2116003.007

POINT	TRACK COORDINATES	
A	E = 276231.395	N = 2116014.015
B	E = 276300.833	N = 2116111.885
C	E = 276370.271	N = 2116209.754
D	E = 276382.791	N = 2116200.871
E	E = 276313.352	N = 2116103.002
F	E = 276243.914	N = 2116005.133

NOTE: This drawing supersedes Tender drawings and all previous revisions

R5.2	10.07.2019	UP line Realignment from CSIA to SEEPZ on as built Tunnel
R5.1	31.08.2018	Cross Passages incorporated.
R5	20.07.2018	UGC 06 Interface & Gradient change between Seepz & Ramp
R4.1	09.04.2018	Adjustment of Rail Level & Cross Passage.
R4	13.01.2018	Cross Passages incorporated.
R3	10.01.2018	Revised according to new Survey.

MMRC

GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT,LINE No. 3 COLABA- BANDRA-SEEPZ

CURVE NO.		25/26-ULC 02	25/26-DLC 02
COORDINATE OF APPEX	EASTING	275992.734	276007.806
	NORTHING	2115677.635	2115672.352
DEFLECTION ANGLE		32°04'49"	32°04'49"
RADIUS		245.350	230.000
TRANSITION LENGTH		55	55
CURVE LENGTH		82.373	73.779
CANT		110	120
CANT DEFFICIENCY		94	98
OPERATING SPEED		65	65

Coordinates of Station's footprint at Track level duly confirmed in R3 by Contractor's Representative

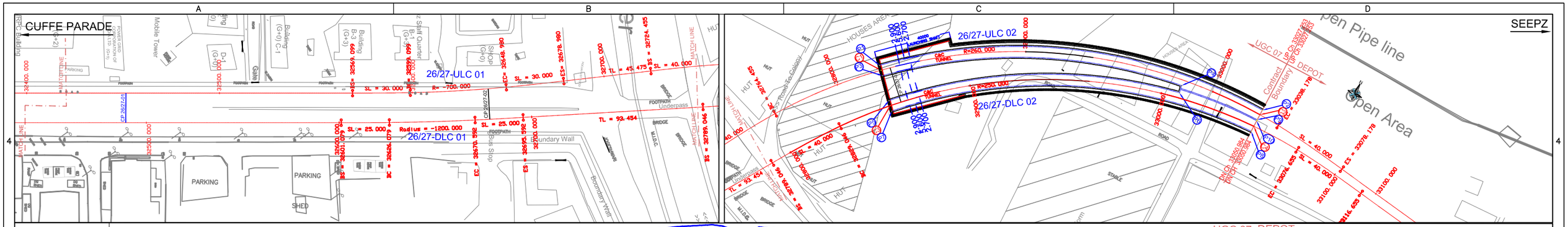
	NAME	SIGN
DRAWN BY	SVM (TI)	
DESIGN BY	JK (STAE.)	On behalf
CHECKED BY	VKS (Ch. T E)	
REVIEWED BY	SY CHANG (Track Expert)	
APPROVED BY	GTP (DPM Civil)	

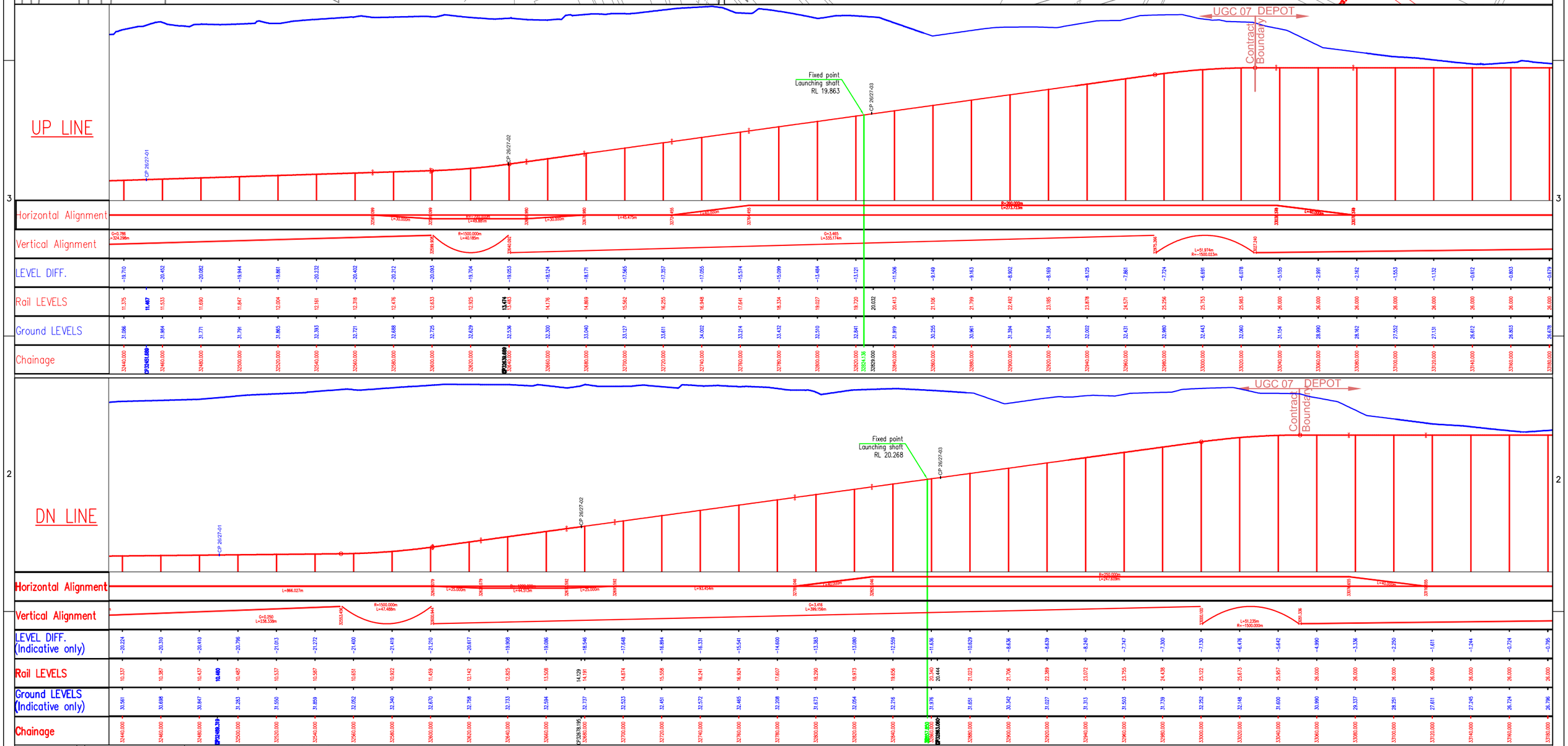
PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ

TITLE: HORIZONTAL & VERTICAL ALIGNMENT From km 31+700 to km 32+440 26 SEEPZ STATION

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

DRAWING NO.: MM3-GC-AL-GD-7020005 (SHEET: 5 of 6) | REV: R5.2 | SCALE: 1:2000 (A3) | DATE: 10 JULY, 2019





Legends:
TL= Tangent length
SL= Spiral length
BC= Begin of Curve
EC= End of Curve
BS= Begin of Spiral
ES= End of Spiral

Legends:
CP= Cross Passage
CP= Cross Passage In low point
BP= Begin of Platform
CLP=Centre Line of Platform
EP= End of Platform

POINTS	COORDINATES OF RAMP	
P1	E = 276690.655	N = 2116683.838
P2	E = 276876.981	N = 2116756.411
P3	E = 276694.459	N = 2116679.727
P4	E = 276833.995	N = 2116748.036
P5	E = 276703.525	N = 2116669.927
P6	E = 276834.815	N = 2116744.223
P7	E = 276707.338	N = 2116665.805

POINTS	COORDINATES OF RAMP	
P8	E = 276876.981	N = 2116744.029
P9	E = 276876.981	N = 2116750.782
P10	E = 276876.981	N = 2116750.188
C1	E = 276692.487	N = 2116681.856
C2	E = 276876.981	N = 2116753.711
C3	E = 276705.363	N = 2116667.940
C4	E = 276876.981	N = 2116746.932

NOTE: This drawing supersedes Tender drawings and all previous revisions

R5.2	10.07.2019	UP line Realignment from CSIA to SEEPZ on as built Tunnel
R5.1	31.08.2018	Cross Passages incorporated.
R5	20.07.2018	UGC 06 Interface & Gradient change between Seepz & Ramp
R4.1	09.04.2018	Adjustment of Rail Level & Cross Passage.
R4	13.01.2018	Cross Passages incorporated.
R3	10.01.2018	Revised according to new Survey.

MMRC

GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT,LINE No. 3 COLABA- BANDRA-SEEPZ

CURVE NO.		26/27-ULC 01	26/27-ULC 02	26/27-DLC 01	26/27-DLC 02
COORDINATE OF APPEX	EASTING	276585.898	276730.396	276590.544	276761.872
	NORTHING	2116513.667	2116776.320	2116493.689	2116767.481
DEFLECTION ANGLE		6°32'18"	69°08'04"	3°19'8"	65°54'55"
RADIUS		700.000	260.000	1200.000	250.000
TRANSITION LENGTH		30.000	40.000	25.000	40.000
CURVE LENGTH		49.881	273.723	44.513	247.609
CANT		65	80	40	90
CANT DEFICIENCY		41	64	31	80
OPERATING SPEED		80.000	60.000	85.000	60.000

Coordinates of Station's footprint at Track level duly confirmed in R3 by Contractor's Representative

	NAME	SIGN
DRAWN BY	SVM (TI)	
DESIGN BY	JK (STAE.)	On behalf
CHECKED BY	VKS (Ch. T E)	
REVIEWED BY	SY CHANG (Track Expert)	
APPROVED BY	GTP (DPM Civil)	

PROJECT: MUMBAI METRO LINE 3
COLABA-BANDRA-SEEPZ

TITLE: HORIZONTAL & VERTICAL ALIGNMENT
From km 32+440 to km 33+051

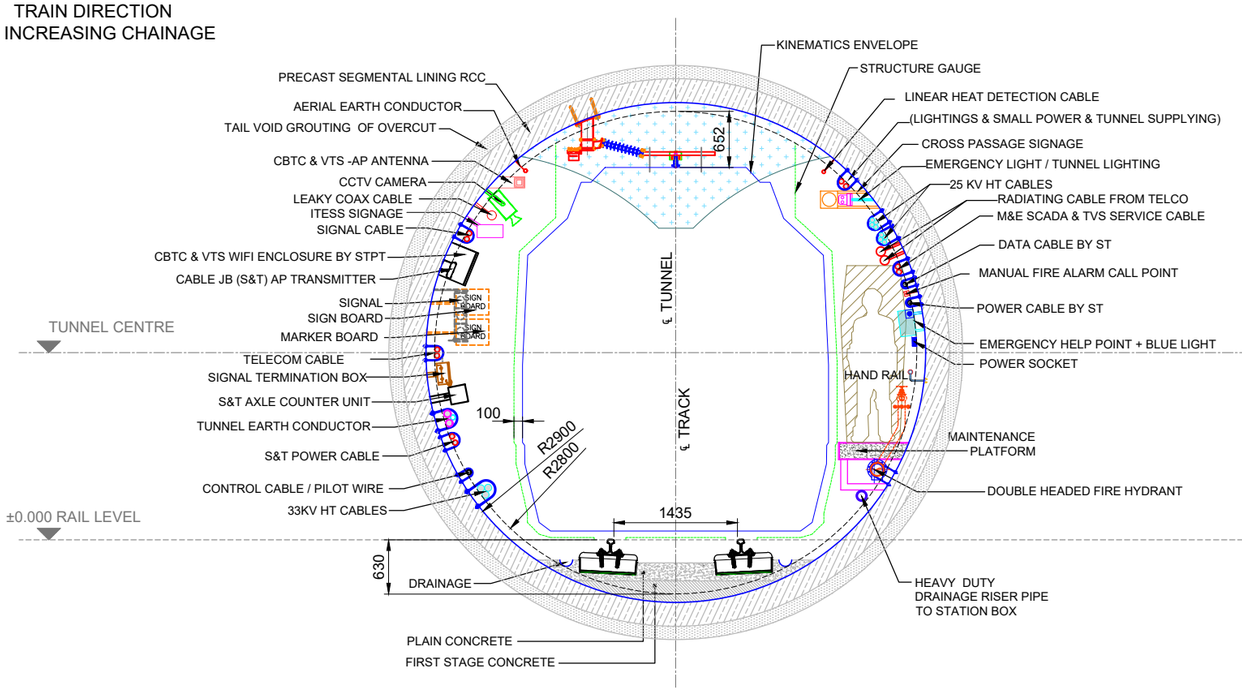
maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

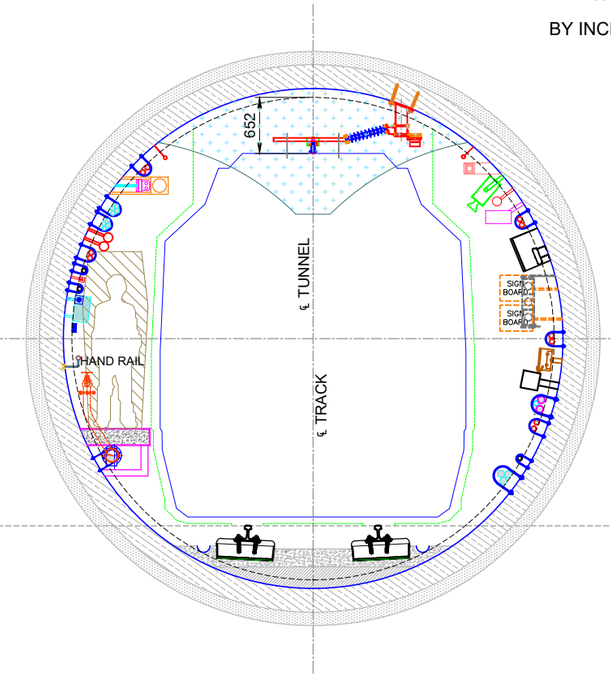
DRAWING NO.: MM3-GC-AL-GD-7020006 (SHEET: 6 of 6) | REV: R5.2 | SCALE: 1:2000 (A3) | DATE: 10 JULY, 2019

PROPOSED TANGENT TRACK TUNNEL INDICATIVE CSD WITHOUT CROSS PASSAGE

TRAIN DIRECTION
BY INCREASING CHAINAGE

TRAIN DIRECTION
BY INCREASING CHAINAGE





NOTES :

1. Red Structure Gauge Line is showing Additional clearance of Curve (Structure Gauge on Curve) and is not applicable on Straight (tangent) Track.
2. Indicative systems & In principle drawings. Physical positions are typical.the UGC M&E contractors shall coordinate with STPT,PSS and TVS contractors to determine optimum physical positions.
3. All Equipments must be Compliant with SALT MIST SPRAY TESTS as per Official Standards and Regulations such as ASTM B1, ASTM B895, EN ISO 9227, EN ISO 60068-2-11, EN ISO 12944-6, ISO 1461.
4. Must be Compliant with Chapter Cross Passages way, NFPA-130, 2017 - 6.3.1.4, 6.3.1.5 & 6.3.1.6
5. All Dimensions for Embedded Track are in mm unless otherwise mentioned.
6. All Dimensions for Track have to be checked, confirmed or redesigned from DDC.
7. Fastening System for Embedded Track representation is only indicative.
8. The Embedded Track design detail need to be cross verify with The Track Engineer.

DEPARTMENT	DATE	NAME INITIAL	SIGN	DESCRIPTION
PM				
DPM CIVIL				
DPM SYSTEM				
TUNNELING				
TVS				
SAFETY				
RST				
TRACK				
INTERFACE				
OCS				
MEP				
TELECOM				
SIGNALING				

INTERFACE DRAWING

GENERAL CONSULTANCY SERVICES
FOR MUMBAI METRO RAIL PROJECT,LINE No. 3
COLABA- BANDRA-SEEPZ

PROPOSED TANGENT TRACK TUNNEL INDICATIVE CSD WITHOUT CROSS PASSAGE

	NAME	SIGN
DRAWN BY		
DESIGN BY		
CHECKED BY		
APPROVED BY		

PROJECT:- MUMBAI METRO LINE 3
COLABA-BANDRA-SEEPZ

TITLE:- SPACE PROOFING DRAWING

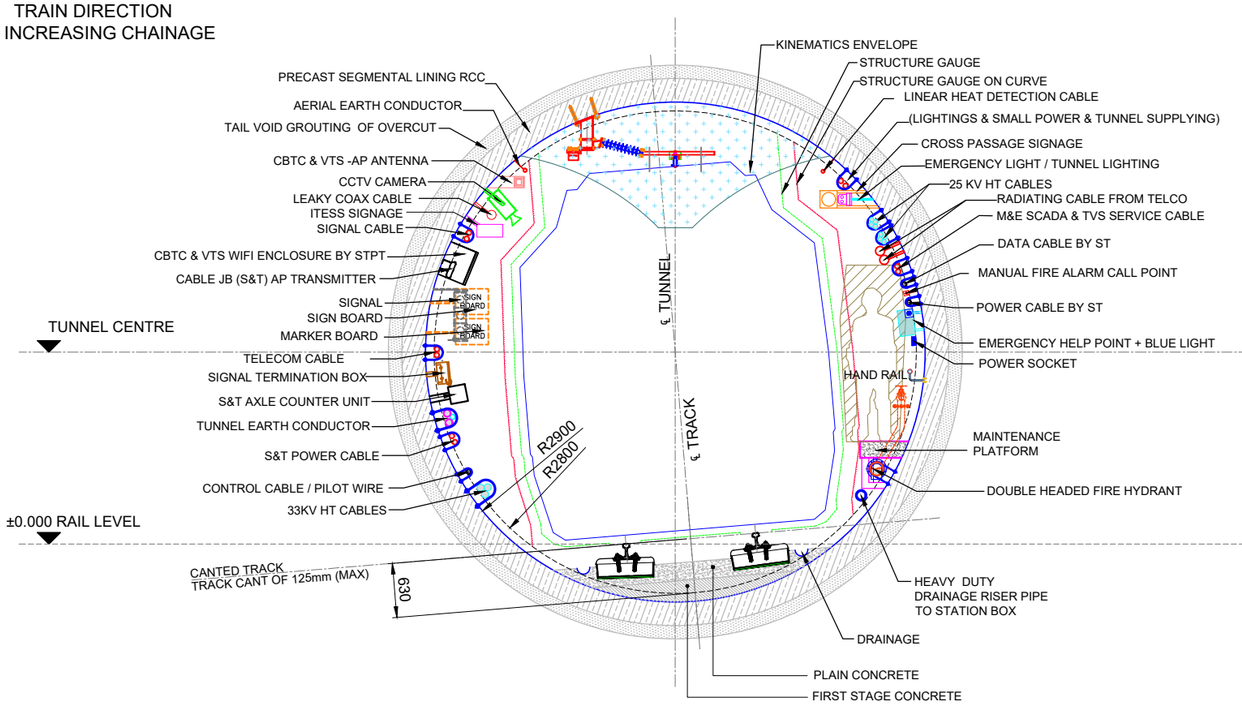
DRAWING NO. :- MM3-GC-SP-GD-0222001 | REV: 00 | SCALE:- 1:50 | DATE:- FEBRUARY, 2018

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

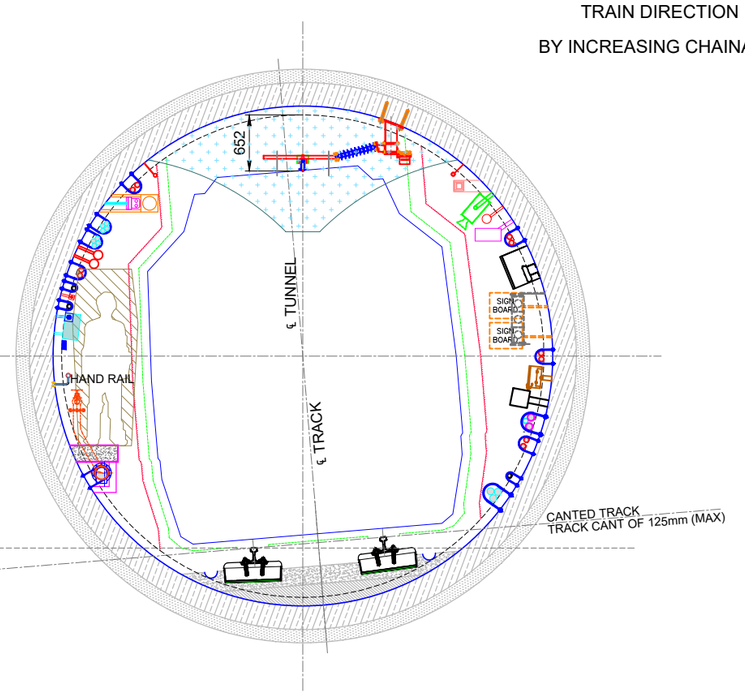
17-Apr-18

PROPOSED CURVE TRACK TUNNEL INDICATIVE CSD WITHOUT CROSS PASSAGE

TRAIN DIRECTION
BY INCREASING CHAINAGE



TRAIN DIRECTION
BY INCREASING CHAINAGE



NOTES :

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2. Indicative systems & In principle drawings. Physical positions are typical.the UGC M&E contractors shall coordinate with STPT,PSS and TVS contractors to determine optimum physical positions.
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4. Must be Compliant with Chapter Cross Passages way, NFPA-130, 2017 - 6.3.1.4, 6.3.1.5 & 6.3.1.6
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DEPARTMENT	DATE	NAME INITIAL	SIGN	DESCRIPTION
PM				
DPM CIVIL				
DPM SYSTEM				
TUNNELING				
TVS				
SAFETY				
RST				
TRACK				
INTERFACE				
OCS				
MEP				
TELECOM				
SIGNALING				

INTERFACE DRAWING

GENERAL CONSULTANCY SERVICES
FOR MUMBAI METRO RAIL PROJECT,LINE No. 3
COLABA- BANDRA-SEEPZ

PROPOSED CURVE TRACK TUNNEL INDICATIVE CSD WITHOUT CROSS PASSAGE

	NAME	SIGN
DRAWN BY		
DESIGN BY		
CHECKED BY		
APPROVED BY		

PROJECT:- MUMBAI METRO LINE 3
COLABA-BANDRA-SEEPZ

TITLE:- SPACE PROOFING DRAWING

DRAWING NO. :- MM3-GC-SP-GD-0222002 | REV: 00 | SCALE:- 1:50 | DATE:- FEBRUARY, 2018

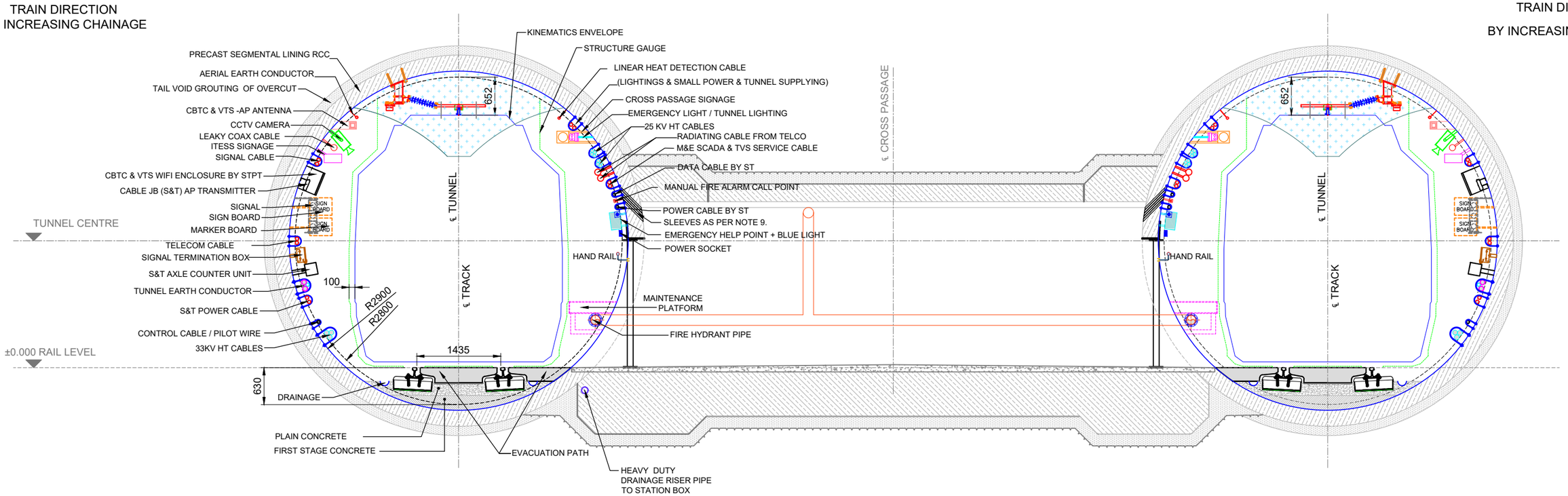
maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

2-Jun-18

PROPOSED TANGENT TRACK TUNNEL INDICATIVE CSD WITH INTERMEDIATE CROSS PASSAGE

TRAIN DIRECTION
BY INCREASING CHAINAGE

TRAIN DIRECTION
BY INCREASING CHAINAGE



NOTES :

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2. Indicative systems & In principle drawings. Physical positions are typical.the UGC M&E contractors shall coordinate with STPT,PSS and TVS contractors to determine optimum physical positions.
3. All Equipments must be Compliant with SALT MIST SPRAY TESTS as per Official Standards and Regulations such as ASTM B1, ASTM B895, EN ISO 9227, EN ISO 60068-2-11, EN ISO 12944-6, ISO 1461.
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6. All Dimensions for Track have to be checked, confirmed or redesigned from DDC.
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8. The Embedded Track design detail need to be cross verify with The Track Engineer.
9. Add five 45-degree angled 25mm sleeves, vertically stacked from cable tray area on tunnel wall to inside of cross passage on both side of cross passages and both ends of cross passages so that each cross passage-end has ten sleeves.

DEPARTMENT	DATE	NAME INITIAL	SIGN	DESCRIPTION
PM				
DPM CIVIL				
DPM SYSTEM				
TUNNELING				
TVS				
SAFETY				
RST				
TRACK				
INTERFACE				
OCS				
MEP				
TELECOM				
SIGNALING				

INTERFACE DRAWING

GENERAL CONSULTANCY SERVICES
FOR MUMBAI METRO RAIL PROJECT,LINE No. 3
COLABA- BANDRA-SEEPZ

PROPOSED TANGENT TRACK TUNNEL INDICATIVE CSD WITH INTERMEDIATE CROSS PASSAGE

	NAME	SIGN
DRAWN BY		
DESIGN BY		
CHECKED BY		
APPROVED BY		

PROJECT:- MUMBAI METRO LINE 3
COLABA-BANDRA-SEEPZ

TITLE:- SPACE PROOFING DRAWING

DRAWING NO. :- MM3-GC-SP-GD-0222003 | REV: 00 | SCALE:- 1:50 | DATE:- FEBRUARY, 2018

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

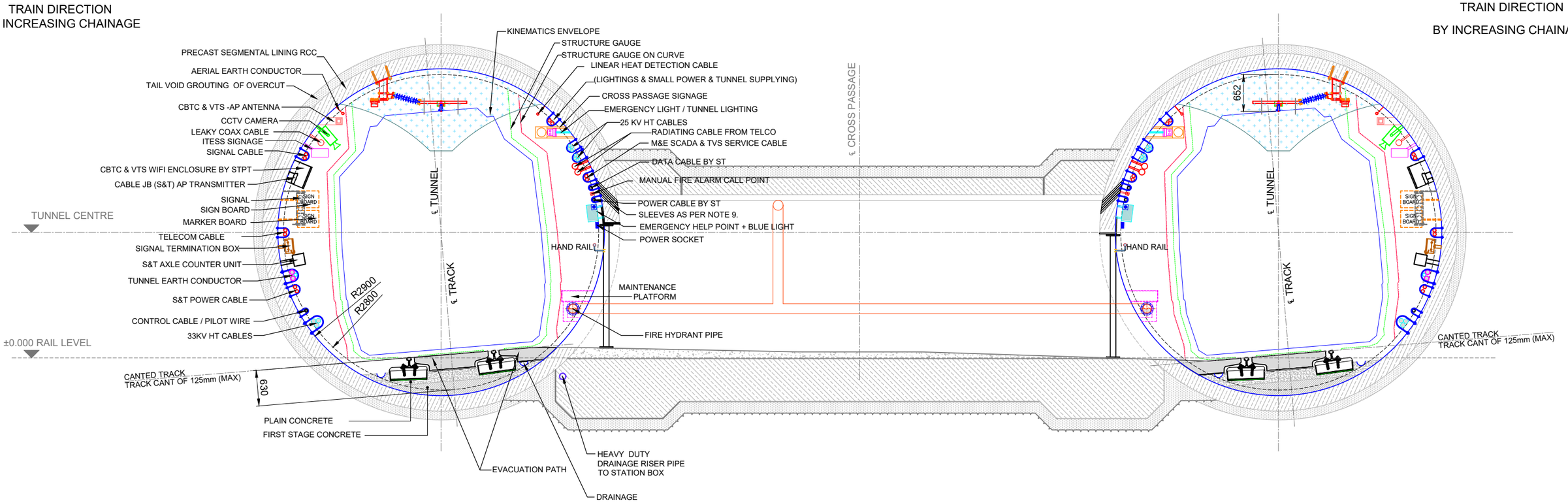
17-Apr-18

6/3/2019 9:59 AM VENUGOPAL NARESHKUMAR D:\WORK\10C DRAWINGS\10 C\03 SPACE PROOFING\MM3-GC-SP-GD-0222003.DWG

PROPOSED CURVE TRACK TUNNEL INDICATIVE CSD WITH INTERMEDIATE CROSS PASSAGE

TRAIN DIRECTION
BY INCREASING CHAINAGE

TRAIN DIRECTION
BY INCREASING CHAINAGE



NOTES :

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2. Indicative systems & In principle drawings. Physical positions are typical.the UGC M&E contractors shall coordinate with STPT,PSS and TVS contractors to determine optimum physical positions.
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4. Must be Compliant with Chapter Cross Passages way, NFPA-130, 2017 - 6.3.1.4, 6.3.1.5 & 6.3.1.6
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DEPARTMENT	DATE	NAME INITIAL	SIGN	DESCRIPTION
PM				
DPM CIVIL				
DPM SYSTEM				
TUNNELING				
TVS				
SAFETY				
RST				
TRACK				
INTERFACE				
OCS				
MEP				
TELECOM				
SIGNALING				

INTERFACE DRAWING

GENERAL CONSULTANCY SERVICES
FOR MUMBAI METRO RAIL PROJECT,LINE No. 3
COLABA- BANDRA-SEEPZ

PROPOSED CURVE TRACK TUNNEL INDICATIVE CSD WITH INTERMEDIATE CROSS PASSAGE

	NAME	SIGN
DRAWN BY		
DESIGN BY		
CHECKED BY		
APPROVED BY		

PROJECT:- MUMBAI METRO LINE 3
COLABA-BANDRA-SEEPZ

TITLE:- SPACE PROOFING DRAWING

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

DRAWING NO. :- MM3-GC-SP-GD-0222004 | REV: 00 | SCALE:- 1:50 | DATE:- FEBRUARY, 2018

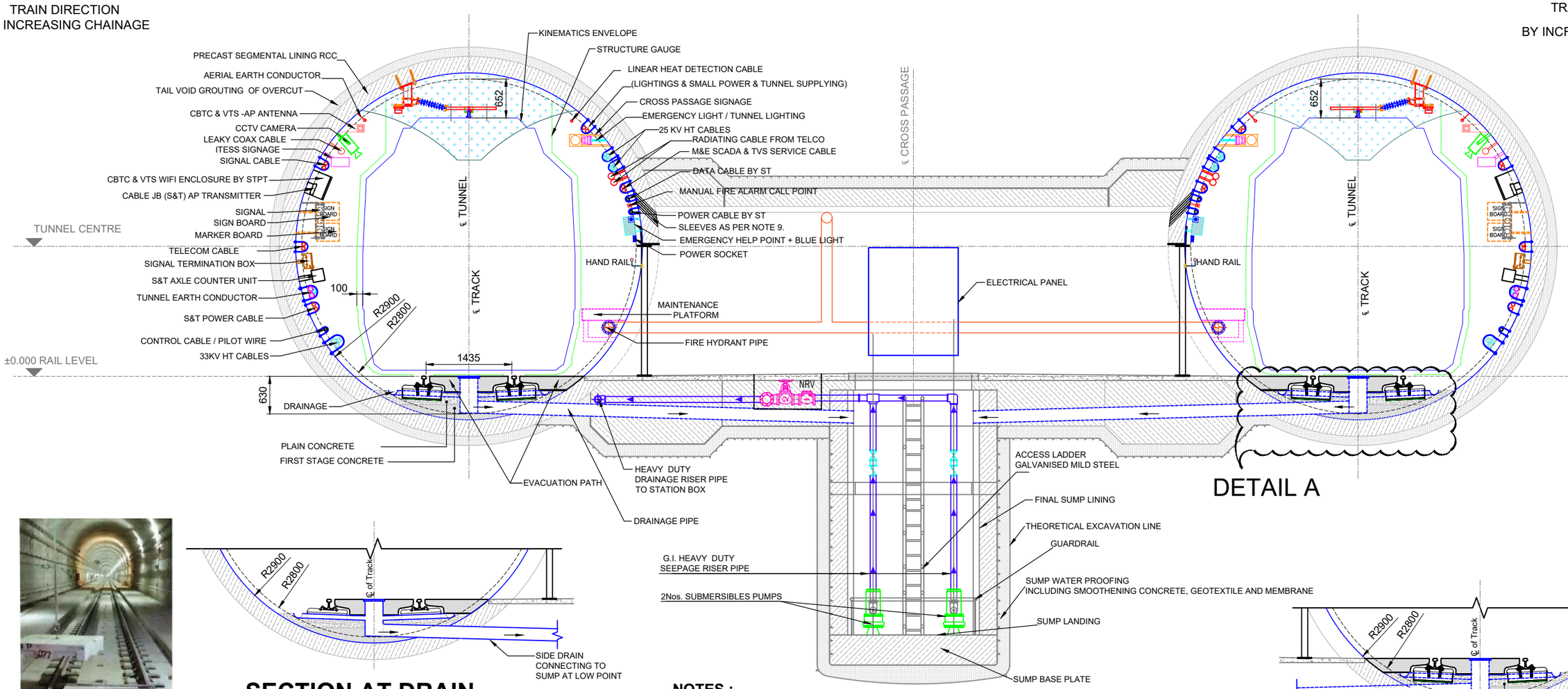
17-Apr-18

6/3/2019 10:00 AM VENUGOPAL.NARESHKUMAR D:\WORK\10C DRAWINGS\10 C\D\3.SPACE PROOFING\MM3-GC-SP-GD-0222004.DWG

PROPOSED TANGENT TRACK TUNNEL INDICATIVE CSD WITH CROSS PASSAGE & SUMP

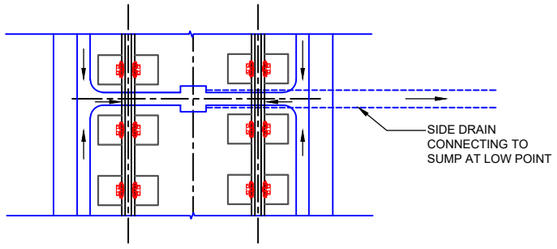
TRAIN DIRECTION
BY INCREASING CHAINAGE

TRAIN DIRECTION
BY INCREASING CHAINAGE

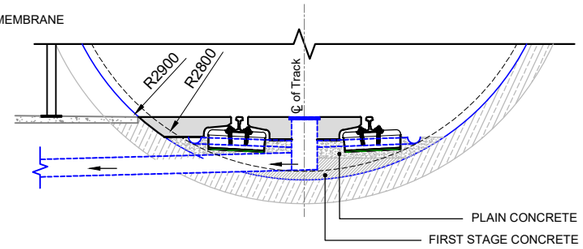


DETAIL A

SECTION AT DRAIN



PLAN AT DRAIN



DETAIL A

NOTES :

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9. Add five 45-degree angled 25mm sleeves, vertically stacked from cable tray area on tunnel wall to inside of cross passage on both side of cross passages and both ends of cross passages so that each cross passage-end has ten sleeves.
10. Cross Passage with Submersible Pumps at only lower points of the main line.

DEPARTMENT	DATE	NAME INITIAL	SIGN	DESCRIPTION
PM				
DPM CIVIL				
DPM SYSTEM				
TUNNELING				
TVS				
SAFETY				
RST				
TRACK				
INTERFACE				
OCS				
MEP				
TELECOM				
SIGNALING				

INTERFACE DRAWING

GENERAL CONSULTANCY SERVICES
FOR MUMBAI METRO RAIL PROJECT,LINE No. 3
COLABA- BANDRA-SEEPZ

PROPOSED TANGENT TRACK TUNNEL INDICATIVE CSD WITH CROSS PASSAGE & SUMP

	NAME	SIGN
DRAWN BY		
DESIGN BY		
CHECKED BY		
APPROVED BY		

PROJECT:- MUMBAI METRO LINE 3
COLABA-BANDRA-SEEPZ

TITLE:- SPACE PROOFING DRAWING

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

DRAWING NO. :- MM3-GC-SP-GD-0222005 | REV: 00 | SCALE:- 1:50 | DATE:- FEBRUARY, 2018

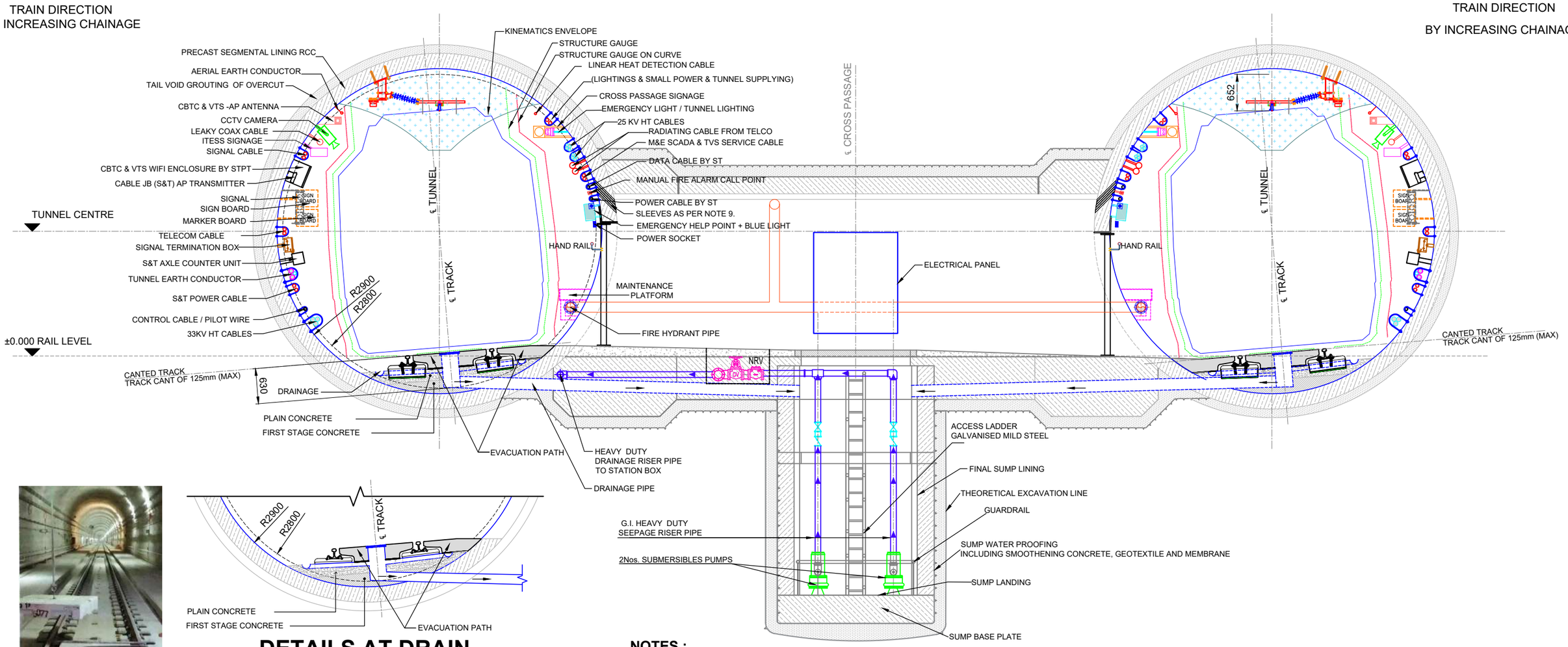
17-Apr-18

D:\WORK\10C DRAWINGS\10 CONDS.SPACE PROOFING\MM3-GC-SP-GD-0222005.DWG
6/3/2019 10:01 AM VENUGOPAL NARESHKUMAR

PROPOSED CURVE TRACK TUNNEL INDICATIVE CSD WITH CROSS PASSAGE & SUMP

TRAIN DIRECTION
BY INCREASING CHAINAGE

TRAIN DIRECTION
BY INCREASING CHAINAGE



DETAILS AT DRAIN

NOTES :

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PM				
DPM CIVIL				
DPM SYSTEM				
TUNNELING				
TVS				
SAFETY				
RST				
TRACK				
INTERFACE				
OCS				
MEP				
TELECOM				
SIGNALING				
DEPARTMENT	DATE	NAME INITIAL	SIGN	DESCRIPTION

INTERFACE DRAWING

MMRC

GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT,LINE No. 3 COLABA- BANDRA-SEEPZ

PROPOSED CURVE TRACK TUNNEL INDICATIVE CSD WITH CROSS PASSAGE & SUMP

	NAME	SIGN
DRAWN BY		
DESIGN BY		
CHECKED BY		
APPROVED BY		

PROJECT:- MUMBAI METRO LINE 3
COLABA-BANDRA-SEEPZ

TITLE:- SPACE PROOFING DRAWING

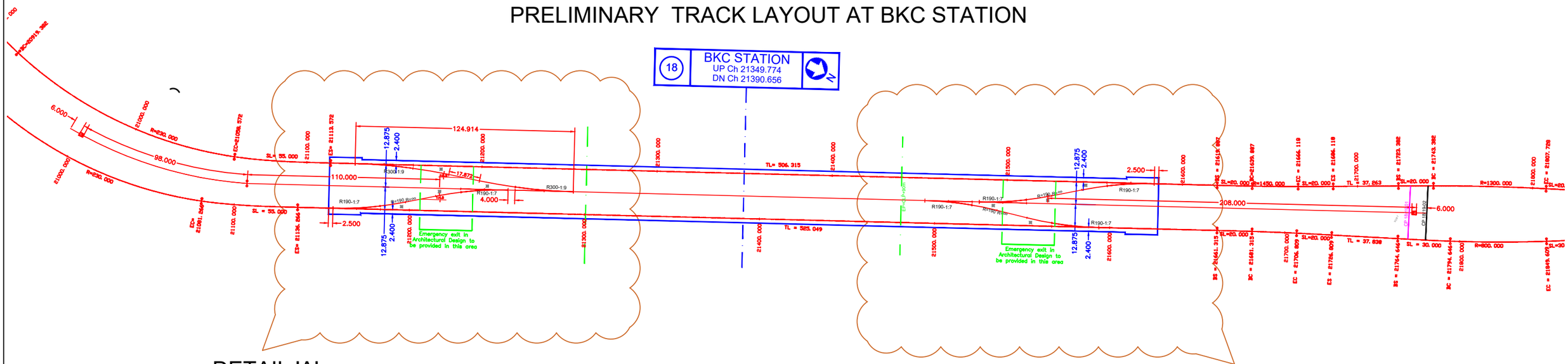
maple
MUMBAI METRO LINE-3
GENERAL CONSULTANT

DRAWING NO. :- MM3-GC-SP-GD-0222006 | REV: 00 | SCALE:- 1:50 | DATE:- FEBRUARY, 2018

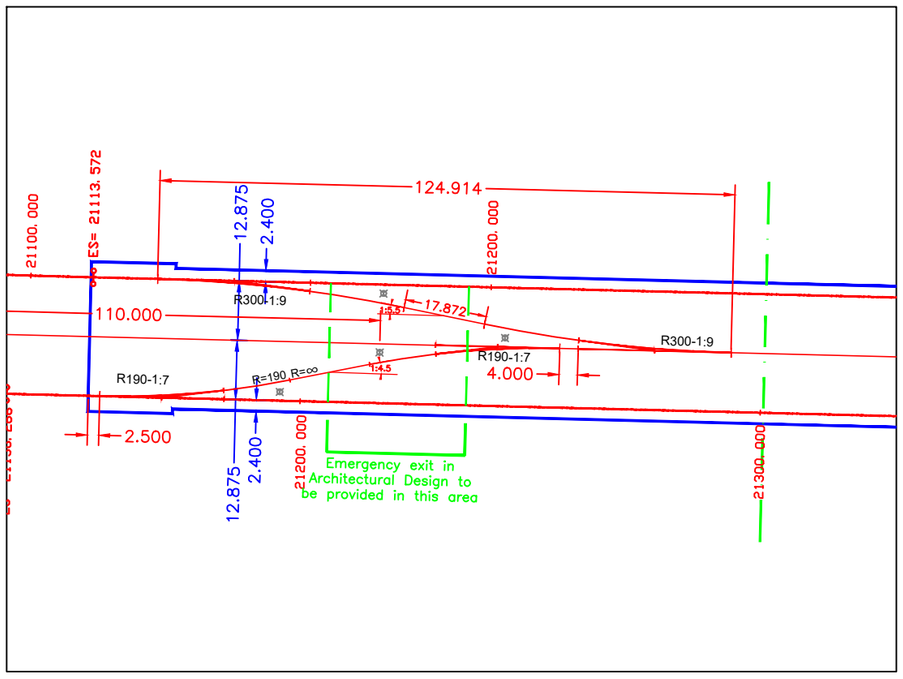
17-Apr-18

D:\WORK\10C DRAWINGS\10 CONDS SPACE PROOFINGS\MM3-GC-SP-GD-0222006.DWG
6/3/2019 10:02 AM VENUGOPAL NARESHKUMAR

PRELIMINARY TRACK LAYOUT AT BKC STATION



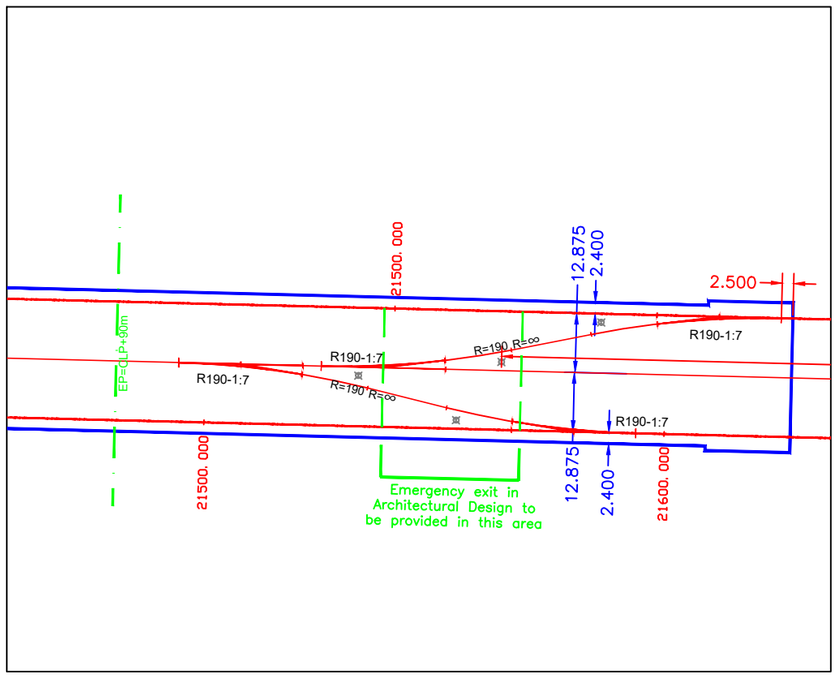
CROSS-OVER 1:9-300, 1:7 - 190 (TRACK CENTERS =12.875m)



DETAIL 'A'

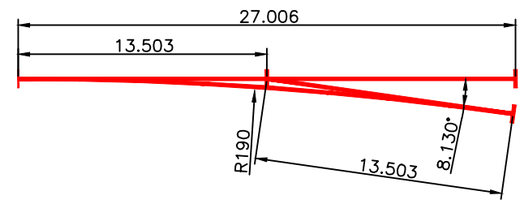
CROSS-OVER 1:9 - 300 (TRACK CENTERS =12.875m)

CROSS-OVER 1:7 - 190 (TRACK CENTERS =12.875m)

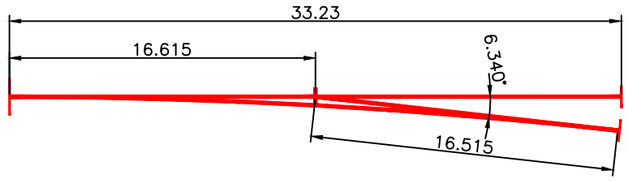


DETAIL 'B'

CROSS-OVER 1:7 - 190 (TRACK CENTERS =12.875m)



Turnout 1:7 - 190



TURNOUT 1:9 - 300

NOTE:

- PLAN LAYOUTS OF STATION OPTIMIZATION,SUBWAY, ENTRY & EXIT STRUCTURES ARE STILL TO BE REVISED.
- REFER TO THE ARCHITECTURAL DRAWINGS FOR THE PLAN LAYOUT OF RESPECTIVE STATION.

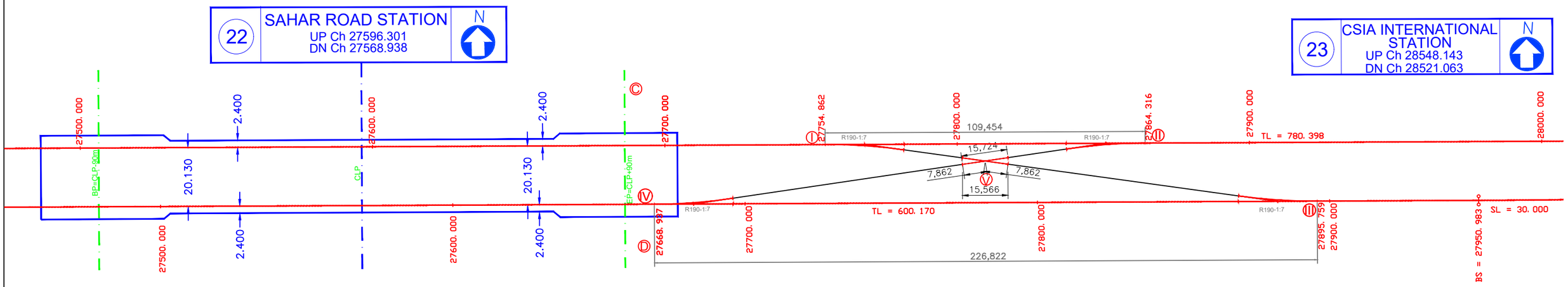
VERSIONS	DATE	DESCRIPTION
-	27 September 2018	FOR APPROVAL

Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruiz East, Mumbai. MAH 400098

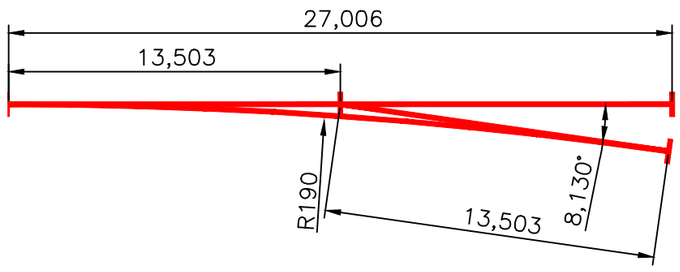
MUMBAI METRO RAIL CORPORATION LIMITED,
NaMTTRI Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

DRAWING STAGE	DETAILED DRAWING		TITLE	PRELIMINARY TRACK LAYOUT AT BKC STATION
DESCRIPTION	NAME	SIGNATURE		
DRAWN BY	HRM (TI)			
CHECKED BY	VKS (CTE)		DRG No.	DRAWING NO. :- MM3-GC-TR-GD-0 101 0020
REVIEWED BY	SY CHANG (TRACK EXPERT)		SHEET	01 OF 01
APPROVED BY	RJM (PM)		DATE	24 October 2018
			SCALE	1:1
			REV.	A

PRELIMINARY TRACK LAYOUT AT SAHAR ROAD



CROSS-OVER 1:7 - 190 (TRACK CENTERS = 20.130m)



Turnout 1:7 - 190

NOTE:

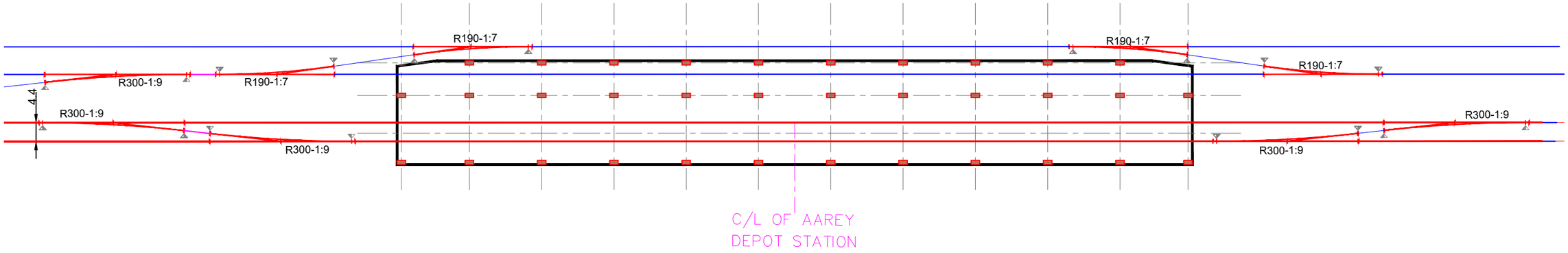
- PLAN LAYOUTS OF STATION OPTIMIZATION,SUBWAY, ENTRY & EXIT STRUCTURES ARE STILL TO BE REVISED.
- REFER TO THE ARCHITECTURAL DRAWINGS FOR THE PLAN LAYOUT OF RESPECTIVE STATION.

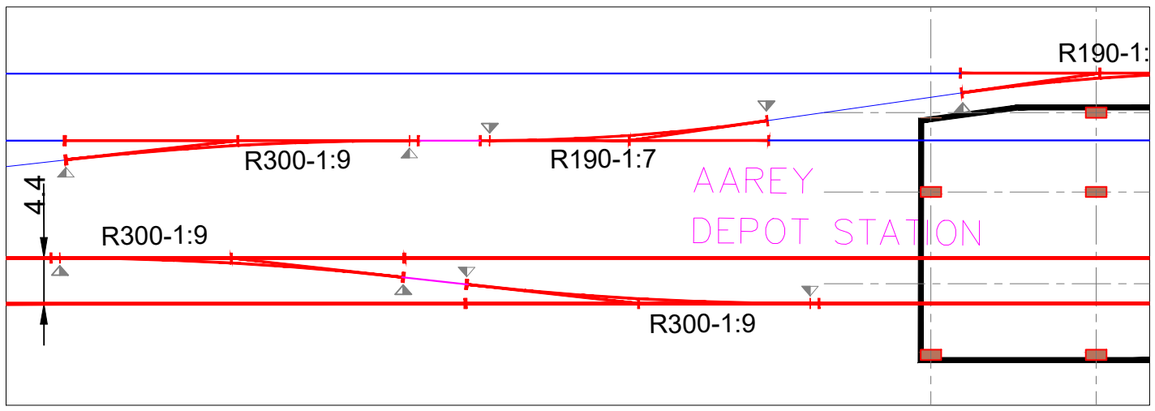
VERSIONS	DATE	DESCRIPTION
-	27 September 2018	FOR APPROVAL

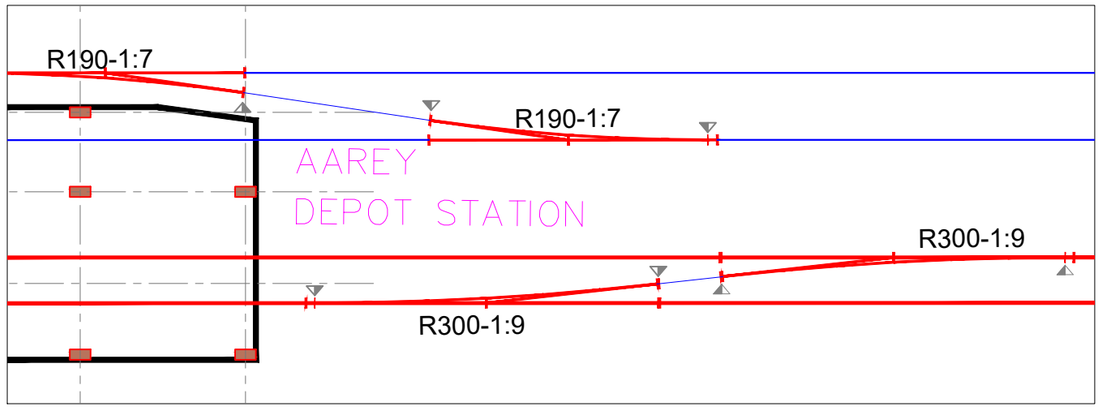
Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruiz East, Mumbai. MAH 400098

MUMBAI METRO RAIL CORPORATION LIMITED,
NaMTTRI Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

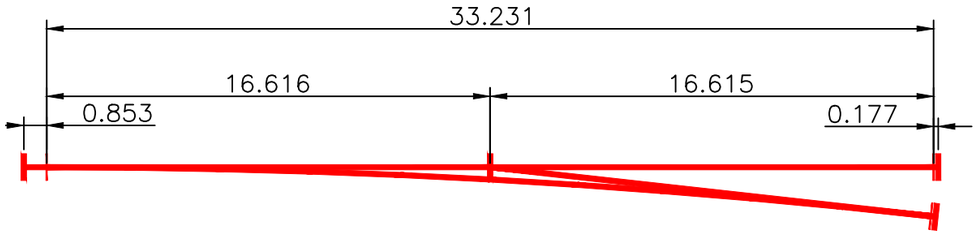
DRAWING STAGE	DETAILED DRAWING		TITLE	PRELIMINARY TRACK LAYOUT AT SAHAR ROAD STATION	
DESCRIPTION	NAME	SIGNATURE			
DRAWN BY	HRM (TI)				
CHECKED BY	VKS (CTE)		DRG No.	MM3-GC-TR-GD-0 101 0021	
REVIEWED BY	SY CHANG (TRACK EXPERT)		SHEET	01 OF 01	SCALE 1 : 1
APPROVED BY	RJM (PM)		DATE	24 October 2018	REV. A



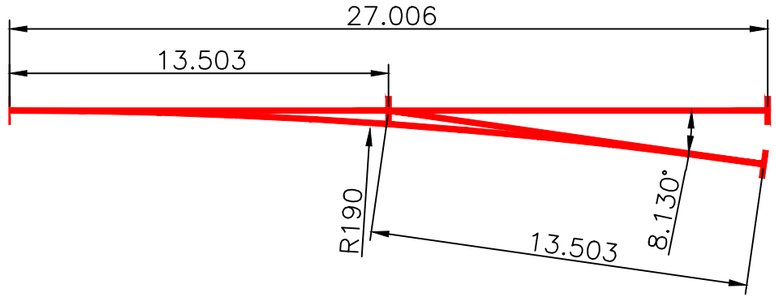




CROSS-OVER 1:9 - 300 (TRACK CENTERS =4.4m)



TURNOUT 1:9 - 300



Turnout 1:7 - 190

NOTE:

- PLAN LAYOUTS OF STATION OPTIMIZATION,SUBWAY, ENTRY & EXIT STRUCTURES ARE STILL TO BE REVISED.
- REFER TO THE ARCHITECTURAL DRAWINGS FOR THE PLAN LAYOUT OF RESPECTIVE STATION.

VERSIONS	DATE	DESCRIPTION

Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruiz East, Mumbai. MAH 400098

MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
NaMTTRI Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

DRAWING STAGE	DETAILED DRAWING	
DESCRIPTION	NAME	SIGNATURE
DRAWN BY	HRM (TI)	
CHECKED BY	VKS (CTE)	
REVIEWED BY	P. LEEMPUT (TRACK EXPERT)	
APPROVED BY	RJM (PM)	

TITLE: PRELIMINARY TRACK LAYOUT AT AAREY STATION

DRG No.	MM3-GC-TR-GD-0 101 0022	
SHEET	01 OF 01	SCALE NTS
DATE	27 September 2018	REV. -

ABBREVIATIONS:-

FOLLOWING NOTATIONS HAVE BEEN FOLLOWED

℄	=	CENTER LINE
R	=	RADIUS OF CURVE
CH	=	CHAINAGE
SRJ	=	STOCK RAIL JOINT
PSC	=	PRE-STRESSED CONCRETE
N.T.S	=	NOT TO SCALE
N/A	=	NOT APPLICABLE
m	=	METER
mm	=	MILLIMETRE
LVL	=	LEVEL
FFL	=	FINISHED FLOOR LEVEL
GL	=	GROUND LEVEL
EJ	=	EXPANSION JOINT
CJ	=	CONSTRUCTION JOINT
UIC	=	(French: Union Internationale des Chemins de fer) OR INTERNATIONAL UNION OF RAILWAYS

LEGENDS:

CONTROL POINT

TURNOUT

STATION / PLATFORM

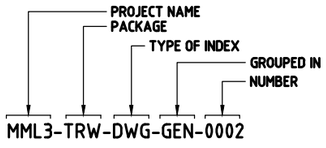
BUFFER STOP

WELDED JOINT

CONCRETE

BALLAST

DRAWING NUMBERING



SYMBOLS

DRAWING TITLE

DRAWING DESIGNATION → MAIN TITLE
DRAWING SCALE → SCALE 1:1000
DRAWING DESCRIPTION → (SUB TITLE)

DRAWING DESIGNATION → SUB TITLE
DRAWING SCALE → SCALE 1:1000
DRAWING DESCRIPTION → (SUB TITLE)
01 / - ← SECTION INDICATION, DRAWING REFERENCE NUMBER

AREA DETAIL SYMBOL

AREA →
DETAIL DESIGNATION → A
DRAWING REFERENCE NUMBER → 0010

ELEVATION SYMBOL

ELEVATION INDICATION →
DRAWING REFERENCE NUMBER → 01 / -

SECTION LINE SYMBOL

SECTION INDICATION →
DRAWING REFERENCE NUMBER → 01 / -
[SECTION LINE]

RAIL TOP LEVEL SYMBOL

PLAN / ELEVATIONS & SECTIONS

TOP OF RAIL [PLAN]

TOP OF RAIL [ELEVATION & SECTION]

MATERIALS & NOTE ON DRAWING

X X — DOT END : SURFACE OR MATERIAL
X X — ARROW END : POINT OR EDGE

REVISION MARK

X: REVISION NUMBER — X

VERSIONS	DATE	DESCRIPTION
A	05 March 2018	FOR APPROVAL
.	.	.
.	.	.
.	.	.
.	.	.

DESIGNED BY
SMEC
Member of the Surbana Jurong Group
SMEC India Pvt. Ltd
41/7, Above Maruti Showroom
Varun Motors Pvt Ltd, 15th cross,
MES College Road, Malleshwaram,
Bengaluru, Karnataka 560003, India

DRAWING STAGE
DETAILED DRAWING

DESCRIPTION	NAME	SIGNATURE
DESIGNED	Gururaja N. (Sr. DE)	
DRAWN	Musaib A. (Sr. TO)	
APPROVED	Shivakumar GC. (GM)	

GENERAL CONSULTANT
maple
MUMBAI METRO LINE-3
GENERAL CONSULTANT
Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MH 400098

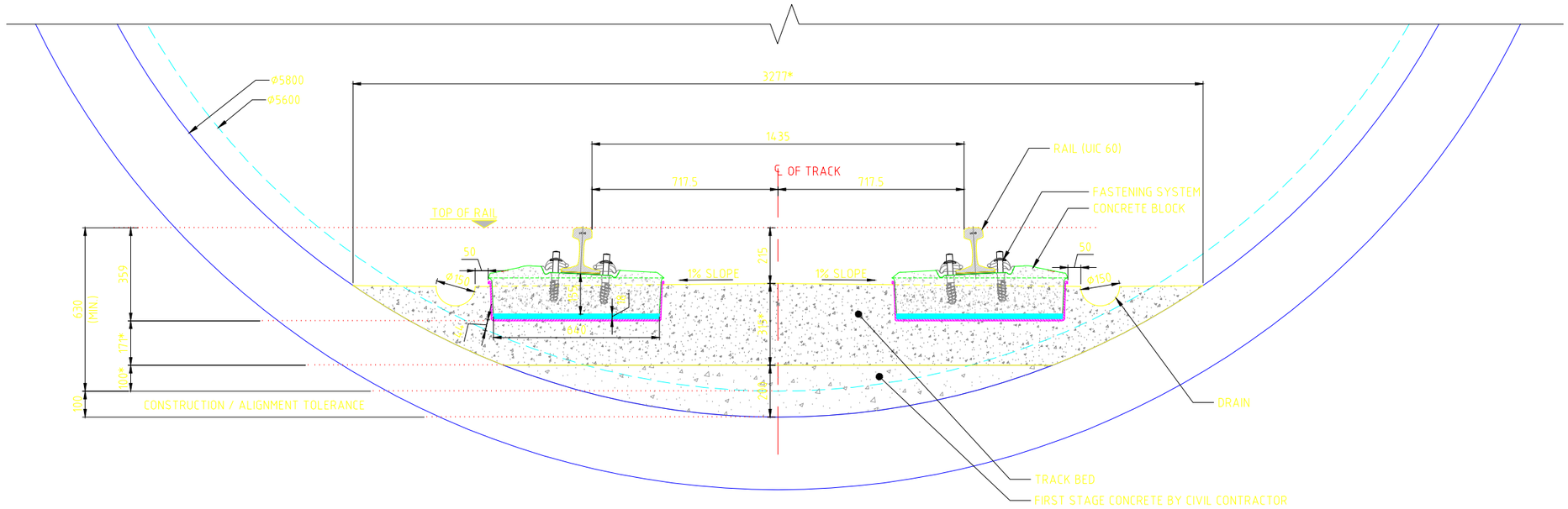
STAMP

DESCRIPTION	NAME	SIGNATURE
DRAWN	HRM (TI)	
CHECKED	VKS (CTE)	
REVIEWED	P. LEEMPUT (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER
MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

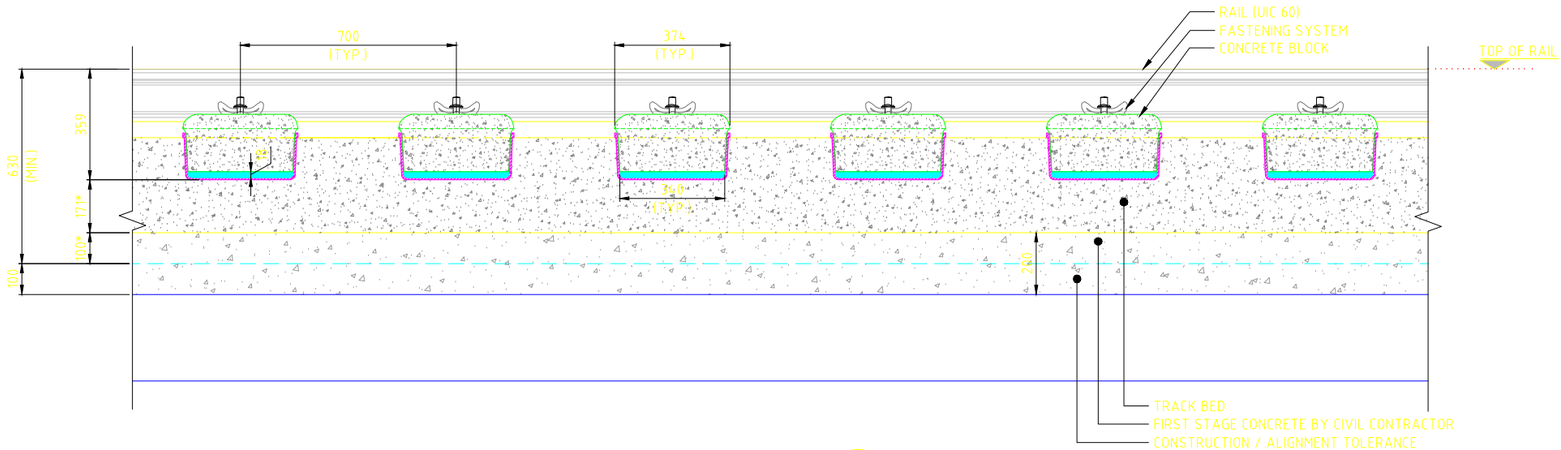
TITLE
ABBREVIATION AND LEGENDS

DRG No.	MML3-TRW-DWG-GEN-0002		
SHEET	01 OF01	SCALE	N/A
DATE	05 March 2018	REV.	A



SECTION 01
SCALE 1: 10 0041

TYPICAL CROSS SECTION OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM IN TUNNEL (STRAIGHT)



SECTION 02
SCALE 1:10 0041

TYPICAL LONGITUDINAL SECTION OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM IN TUNNEL (STRAIGHT)

*VALUES SHOWN ARE INDICATIVE. THESE DIMENSIONS SHOULD BE WORKED OUT AS PER SITE CONDITION.

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE MENTIONED.
2. FOR FASTENING SYSTEM AND BOOTED CONCRETE BLOCK REFER TO DRAWING NO. MML3-TRW-DWG-GEN-0081
3. RAIL INCLINATION SHALL BE 1 IN 20.
4. AN EXPANSION GAP OF 20mm SHALL BE MAINTAINED BETWEEN CONSECUTIVE SLABS AND FILLED WITH SUITABLE COMPRESSIVE MATERIAL.
5. DIMENSIONS OF BOOT AND BLOCKS ARE INDICATIVE ONLY.
6. MINIMUM SLAB THICKNESS OF CONCRETE ADJACENT TO THE BOOTED TWIN BLOCK AND TUNNEL FACE SHALL BE MAINTAINED AS 50mm.
7. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT INTERFACE DRAWINGS.
8. THE CROSS SLOPE SHALL BE 1%.
9. AS PER SOD THE DERAILMENT GUARD SHOULD NOT BE PROVIDED IN STRAIGHT & CURVES HAVING R ≥500m IN TUNNEL.

SCALE 1:10 0.1 0 0.1 0.2 0.3 0.4 0.5

VERSIONS	DATE	DESCRIPTION
A	29 Mar 2018	FOR APPROVAL
B	18 Sep 2018	FOR APPROVAL
.	.	.
.	.	.

DESIGNED BY
SMEC
Member of the Surbana Jurong Group
SMEC India Pvt. Ltd
41/7, Above Maruti Showroom
Varun Motors Pvt Ltd, 15th cross,
MES College Road, Malleshwaram,
Bengaluru, Karnataka 560003, India

DRAWING STAGE
DETAILED DRAWING

DESCRIPTION	NAME	SIGNATURE
DESIGNED	Gururaja N. (Sr. DE)	
DRAWN	Musaib A. (Sr. TO)	
APPROVED	Shivakumar GC. (GM)	

GENERAL CONSULTANT
maple MUMBAI METRO LINE-3 GENERAL CONSULTANT
Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai, MH 400098

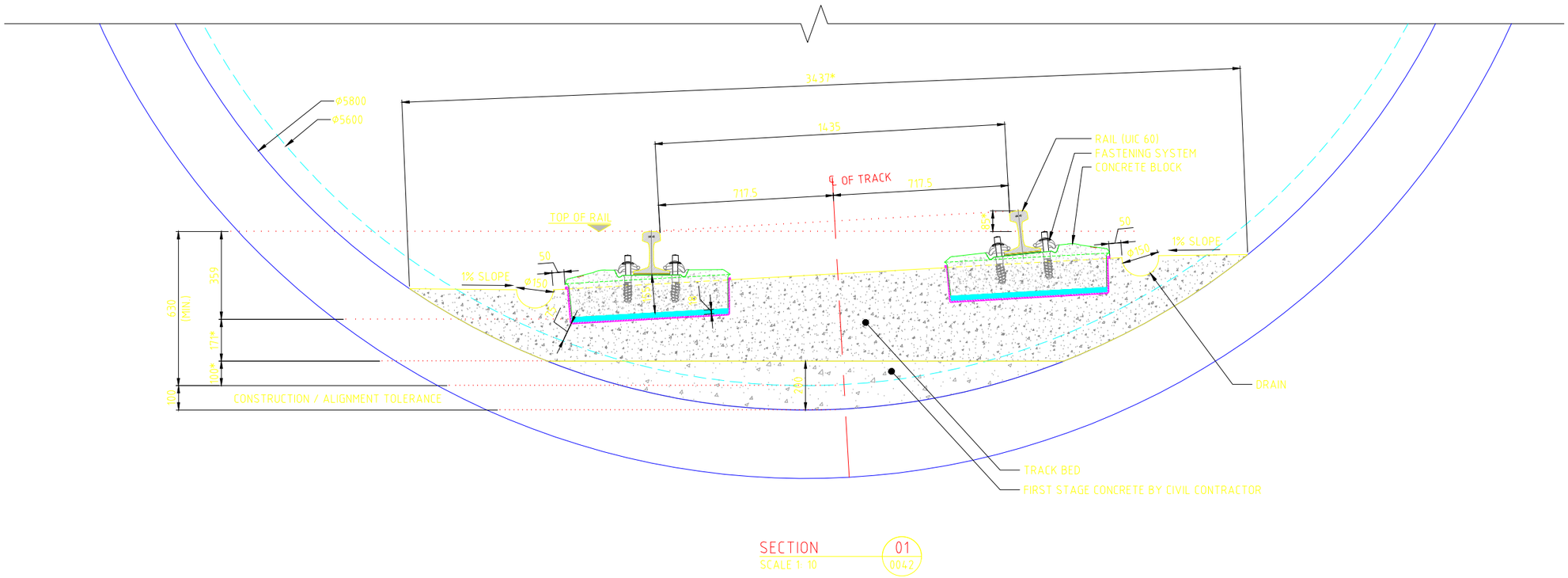
STAMP

DESCRIPTION	NAME	SIGNATURE
DRAWN	HRM (TI)	
CHECKED	VKS (CTE)	
REVIEWED	P. LEEMPUT (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER
MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

TITLE
TYPICAL CROSS SECTION OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM IN TUNNEL (STRAIGHT)

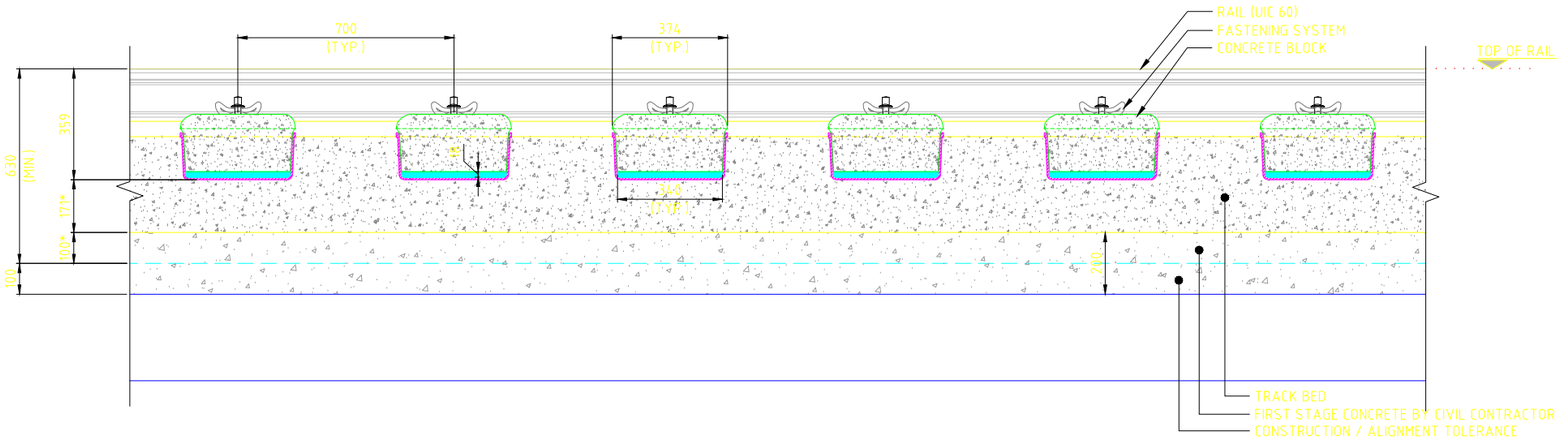
DRG No.	MML3-TRW-DWG-GEN-0031		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	18 September 2018	REV.	B



SECTION 01
SCALE 1: 10 0042

TYPICAL CROSS SECTION OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM IN TUNNEL (CURVE R >500m)

*VALUES SHOWN ARE INDICATIVE. THESE DIMENSIONS SHOULD BE WORKED OUT BASED ON ACTUAL CANT APPLIED AND AS PER SITE CONDITION.



SECTION 02
SCALE 1: 10 0042

TYPICAL LONGITUDINAL SECTION OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM IN TUNNEL (CURVE R >500m)

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE MENTIONED.
2. FOR FASTENING SYSTEM AND BOOTED CONCRETE BLOCK REFER TO DRAWING NO. MML3-TRW-DWG-GEN-0081.
3. RAIL INCLINATION SHALL BE 1 IN 20.
4. AN EXPANSION GAP OF 20mm SHALL BE MAINTAINED BETWEEN CONSECUTIVE SLABS AND FILLED WITH SUITABLE COMPRESSIVE MATERIAL.
5. DIMENSIONS OF BOOT AND BLOCKS ARE INDICATIVE ONLY.
6. MINIMUM SLAB THICKNESS OF CONCRETE ADJACENT TO THE BOOTED TWIN BLOCK AND TUNNEL FACE SHALL BE MAINTAINED AS 50mm.
7. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT INTERFACE DRAWINGS.
8. THE CROSS SLOPE SHALL BE 1%.
9. AS PER SOD THE DERAILMENT GUARD SHOULD NOT BE PROVIDED IN STRAIGHT & CURVES HAVING R ≥500m IN TUNNEL.

SCALE 1:10 0.1 0 0.1 0.2 0.3 0.4 0.5

VERSIONS	DATE	DESCRIPTION
A	29 Mar 2018	FOR APPROVAL
B	18 Sep 2018	FOR APPROVAL
.	.	.
.	.	.

DESIGNED BY
SMEC
Member of the Surbana Jurong Group
SMEC India Pvt. Ltd
417, Above Maruti Showroom
Varun Motors Pvt Ltd, 15th cross,
MES College Road, Malleshwaram,
Bengaluru, Karnataka 560003, India

DRAWING STAGE
DETAILED DRAWING

DESCRIPTION	NAME	SIGNATURE
DESIGNED	Gururaja N. (Sr. DE)	
DRAWN	Musaib A. (Sr. TO)	
APPROVED	Shivakumar GC. (GM)	

GENERAL CONSULTANT
maple
MUMBAI METRO LINE-3
GENERAL CONSULTANT
Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai MH 400098

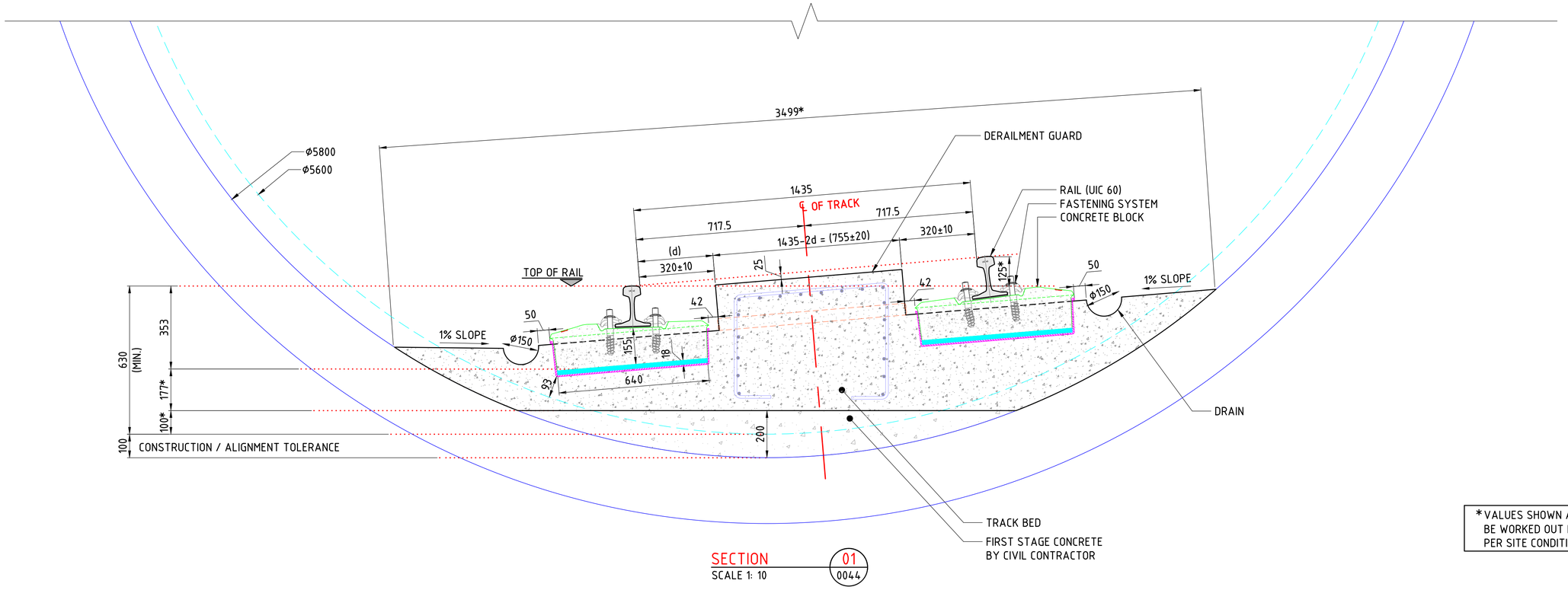
STAMP

DESCRIPTION	NAME	SIGNATURE
DRAWN	HRM (TI)	
CHECKED	VKS (CTE)	
REVIEWED	P. LEEMPUT (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER
MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
Namtrri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

TITLE
TYPICAL CROSS SECTION
OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM
IN TUNNEL (CURVE R >500m)

DRG No.	MML3-TRW-DWG-GEN-0032		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	18 September 2018	REV.	B



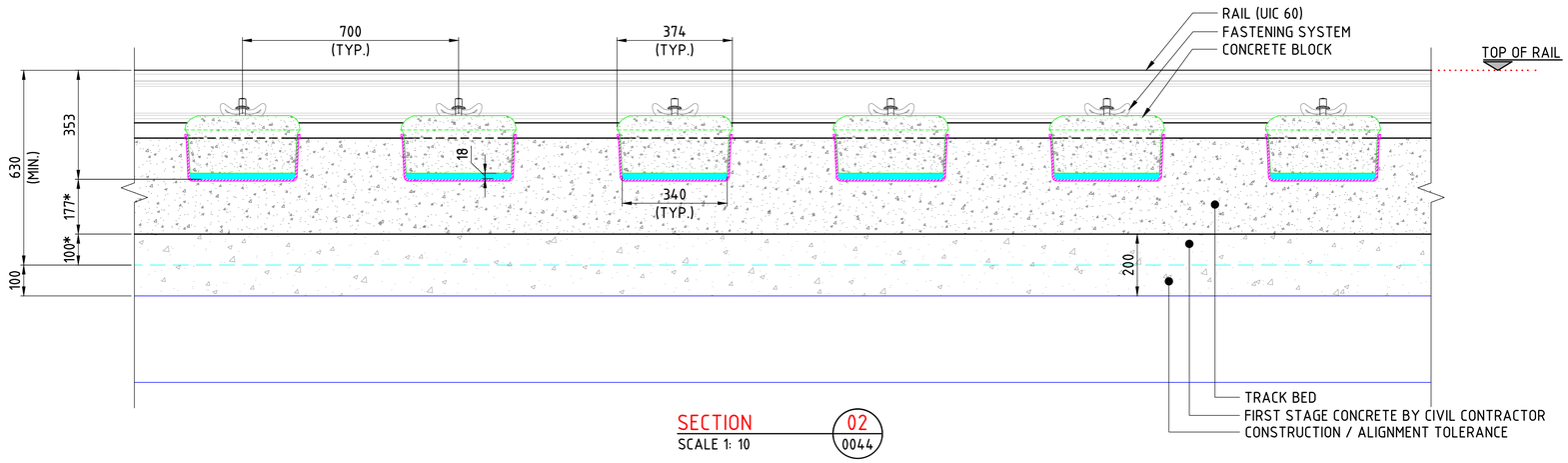
SECTION 01
SCALE 1: 10 0044

TYPICAL CROSS SECTION OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM IN TUNNEL (CURVE R ≤500m)
(WITH DERAILMENT GUARD)

*VALUES SHOWN ARE INDICATIVE. THESE DIMENSIONS SHOULD BE WORKED OUT BASED ON ACTUAL CANT APPLIED AND AS PER SITE CONDITION.

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE MENTIONED.
2. FOR FASTENING SYSTEM AND BOOTED CONCRETE BLOCK REFER TO DRAWING NO. MML3-TRW-DWG-GEN-0081
3. RAIL INCLINATION SHALL BE 1 IN 20.
4. AN EXPANSION GAP OF 20mm SHALL BE MAINTAINED BETWEEN CONSECUTIVE SLABS AND FILLED WITH SUITABLE COMPRESSIVE MATERIAL.
5. DIMENSIONS OF BOOT AND BLOCKS ARE INDICATIVE ONLY.
6. MINIMUM SLAB THICKNESS OF CONCRETE ADJACENT TO THE BOOTED TWIN BLOCK AND TUNNEL FACE SHALL BE MAINTAINED AS 50mm.
7. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT INTERFACE DRAWINGS.
8. THE CROSS SLOPE SHALL BE 1%.



SECTION 02
SCALE 1: 10 0044

TYPICAL LONGITUDINAL SECTION OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM IN TUNNEL (CURVE R ≤500m)
(WITH DERAILMENT GUARD)

SCALE 1:10 0.1 0 0.1 0.2 0.3 0.4 0.5

VERSIONS	DATE	DESCRIPTION
A	29 Mar 2018	FOR APPROVAL
B	18 Sep 2018	FOR APPROVAL
C	26 Apr 2019	'd' revised to 320 ± 10mm
.	.	.
.	.	.

DESIGNED BY
SMEC
Member of the Surbana Jurong Group
SMEC India Pvt. Ltd
41/7, Above Maruti Showroom
Varun Motors Pvt Ltd, 15th cross,
MES College Road, Malleshwaram,
Bengaluru, Karnataka 560003, India

DRAWING STAGE
DETAILED DRAWING

DESCRIPTION	NAME	SIGNATURE
DESIGNED	Gururaja N. (Sr. DE)	
DRAWN	Musaib A. (Sr. TO)	
APPROVED	Shivakumar GC. (GM)	

GENERAL CONSULTANT
maple
MUMBAI METRO LINE-3
GENERAL CONSULTANT
Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MH 400098

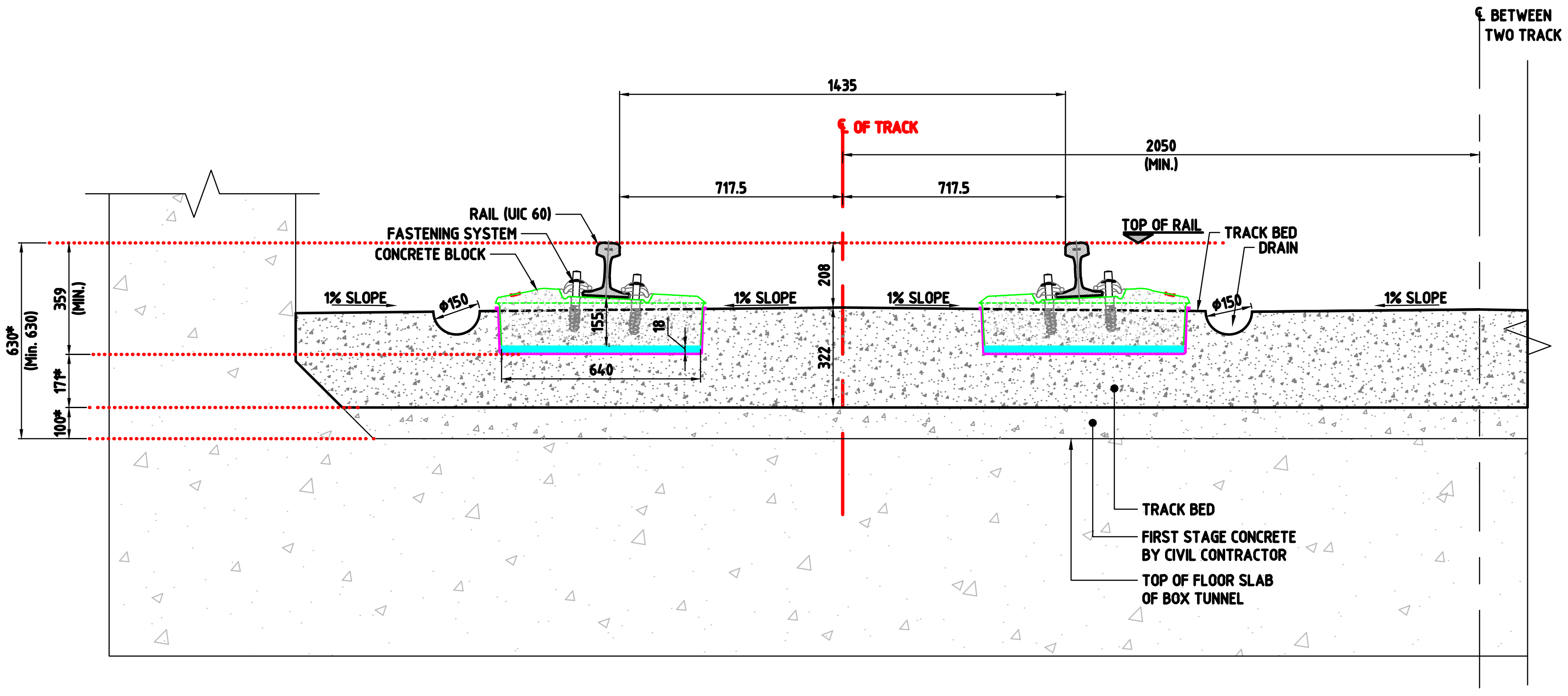
STAMP

DESCRIPTION	NAME	SIGNATURE
DRAWN	HRM (TI)	
CHECKED	VKS (CTE)	
REVIEWED	P. LEEMPUT (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER
MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

TITLE
TYPICAL CROSS SECTION
OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM
IN TUNNEL (CURVE R ≤500m)
(WITH DERAILMENT GUARD)

DRG No.	MML3-TRW-DWG-GEN-0034		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	18 September 2018	REV.	C



SECTION 01 / 0046
SCALE 1: 10

TYPICAL CROSS SECTION OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM IN BOX TUNNEL (STRAIGHT)

*VALUES SHOWN ARE INDICATIVE. THESE DIMENSIONS SHOULD BE WORKED OUT AS PER SITE CONDITION.

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE MENTIONED.
2. FOR FASTENING SYSTEM AND BOOTED CONCRETE BLOCK REFER TO DRAWING NO. MML3-TRW-DWG-GEN-0081
3. RAIL INCLINATION SHALL BE 1 IN 20.
4. AN EXPANSION GAP OF 20mm SHALL BE MAINTAINED BETWEEN CONSECUTIVE SLABS AND FILLED WITH SUITABLE COMPRESSIVE MATERIAL.
5. DIMENSIONS OF BOOT AND BLOCKS ARE INDICATIVE ONLY.
6. MINIMUM SLAB THICKNESS OF CONCRETE ADJACENT TO THE BOOTED TWIN BLOCK AND TUNNEL FACE SHALL BE MAINTAINED AS 50mm.
7. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT INTERFACE DRAWINGS.
8. THE CROSS SLOPE SHALL BE 1%.
9. AS PER SOD THE DERAILMENT GUARD SHOULD NOT BE PROVIDED IN STRAIGHT & CURVES HAVING R ≥500m IN TUNNEL.

SCALE 1:10 0.1 0 0.1 0.2 0.3 0.4 0.5

VERSIONS	DATE	DESCRIPTION
A	29 Mar 2018	FOR APPROVAL
B	18 Sep 2018	FOR APPROVAL
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DESIGNED BY
SMEC
Member of the Surbana Jurong Group
SMEC India Pvt. Ltd
41/7, Above Maruti Showroom Varun Motors Pvt Ltd, 15th cross, MES College Road, Malleshwaram, Bengaluru, Karnataka 560003, India

DRAWING STAGE
DETAILED DRAWING

DESCRIPTION	NAME	SIGNATURE
DESIGNED	Gururaja N. (Sr. DE)	
DRAWN	Musaib A. (Sr. TO)	
APPROVED	Shivakumar GC. (GM)	

GENERAL CONSULTANT
maple
Maple Mumbai Metro 3 General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village, Santacruz East, Mumbai. MH 400098

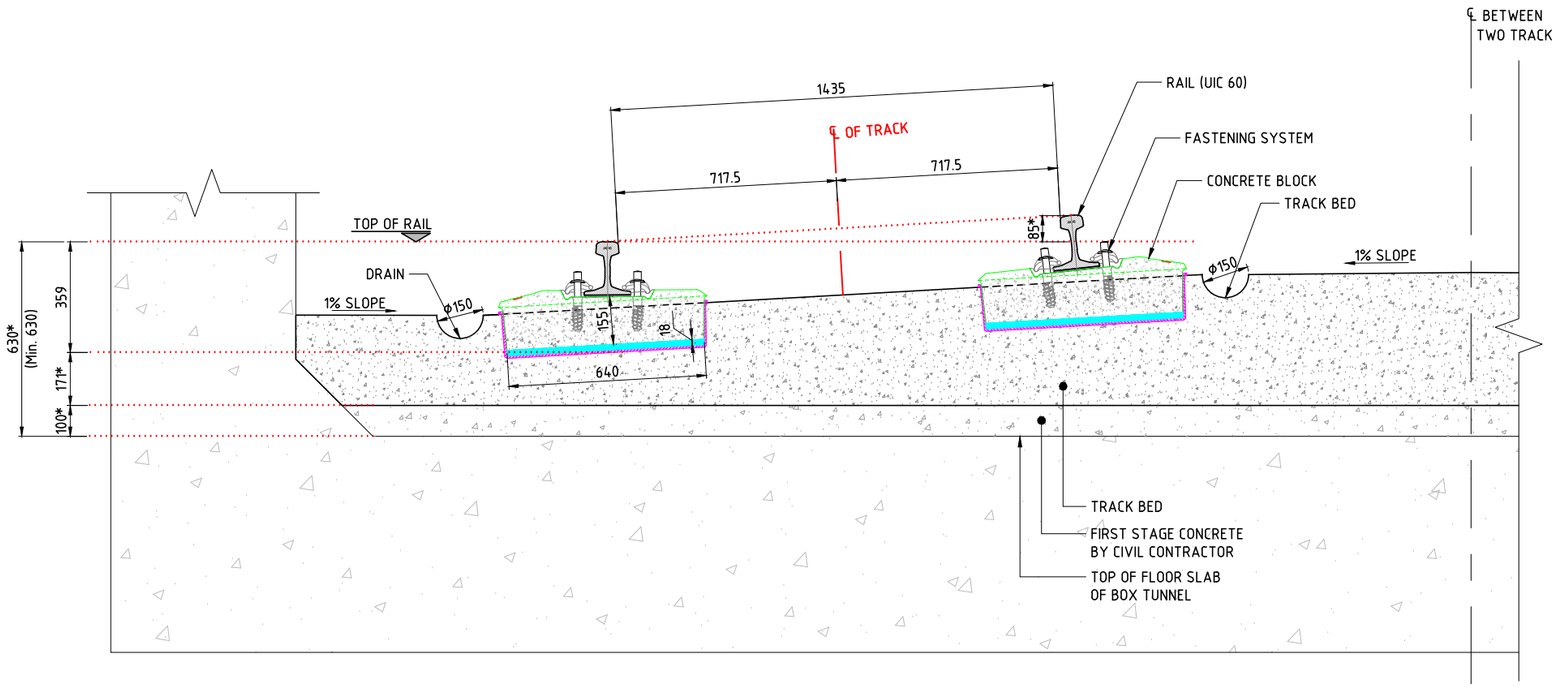
STAMP

DESCRIPTION	NAME	SIGNATURE
DRAWN	HRM (TI)	
CHECKED	VKS (CTE)	
REVIEWED	P. LEEMPUT (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER
MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block, Bandra Kurla Complex, Bandra (East), Mumbai 400051

TITLE
TYPICAL CROSS SECTION OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM IN CUT & COVER (STRAIGHT)

DRG No.	MML3-TRW-DWG-GEN-0036		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	18 September 2018	REV.	B



SECTION 01
SCALE 1: 10 0047

*VALUES SHOWN ARE INDICATIVE. THESE DIMENSIONS SHOULD BE WORKED OUT BASED ON ACTUAL CANT APPLIED AND AS PER SITE CONDITION.

TYPICAL CROSS SECTION OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM IN BOX TUNNEL (CURVE R >500m)

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE MENTIONED.
2. FOR FASTENING SYSTEM AND BOOTED CONCRETE BLOCK REFER TO DRAWING NO. MML3-TRW-DWG-GEN-0081
3. RAIL INCLINATION SHALL BE 1 IN 20.
4. AN EXPANSION GAP OF 20mm SHALL BE MAINTAINED BETWEEN CONSECUTIVE SLABS AND FILLED WITH SUITABLE COMPRESSIVE MATERIAL.
5. DIMENSIONS OF BOOT AND BLOCKS ARE INDICATIVE ONLY.
6. MINIMUM SLAB THICKNESS OF CONCRETE ADJACENT TO THE BOOTED TWIN BLOCK AND TUNNEL FACE SHALL BE MAINTAINED AS 50mm.
7. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT INTERFACE DRAWINGS.
8. THE CROSS SLOPE SHALL BE 1%.
9. AS PER SOD THE DERAILMENT GUARD SHOULD NOT BE PROVIDED IN STRAIGHT & CURVES HAVING R ≥500m IN TUNNEL.

SCALE 1:10 0.1 0 0.1 0.2 0.3 0.4 0.5

VERSIONS	DATE	DESCRIPTION
A	29 Mar 2018	FOR APPROVAL
B	18 Sep 2018	FOR APPROVAL
.	.	.
.	.	.

DESIGNED BY
SMEC
Member of the Surbana Jurong Group
SMEC India Pvt. Ltd
41/7, Above Maruti Showroom
Varun Motors Pvt Ltd, 15th cross,
MES College Road, Malleshwaram,
Bengaluru, Karnataka 560003, India

DRAWING STAGE
DETAILED DRAWING

DESCRIPTION	NAME	SIGNATURE
DESIGNED	Gururaja N. (Sr. DE)	
DRAWN	Musaib A. (Sr. TO)	
APPROVED	Shivakumar GC. (GM)	

GENERAL CONSULTANT
maple MUMBAI METRO LINE-3 GENERAL CONSULTANT
Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MH 400098

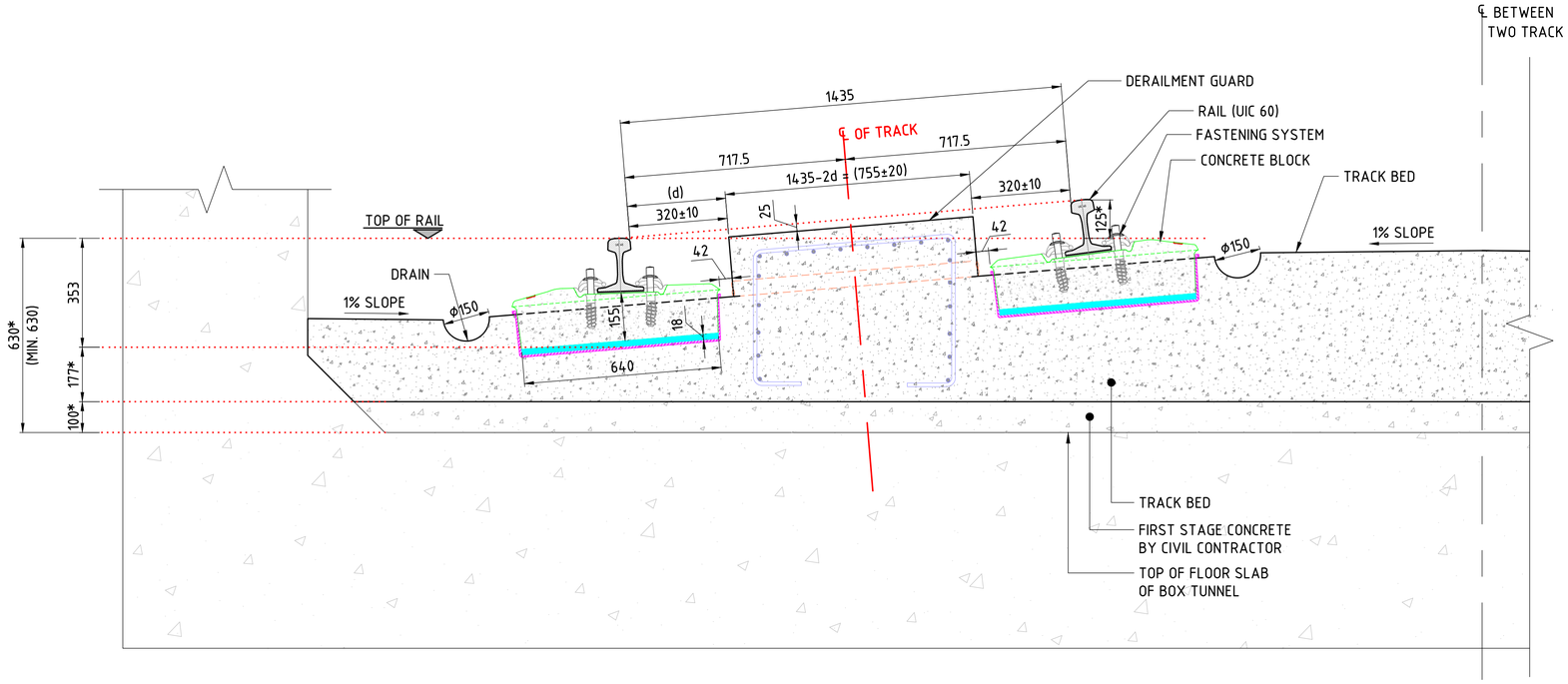
STAMP

DESCRIPTION	NAME	SIGNATURE
DRAWN	HRM (TI)	
CHECKED	VKS (CTE)	
REVIEWED	P. LEEMPUT (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER
MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

TITLE
TYPICAL CROSS SECTION OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM IN CUT & COVER (CURVE R >500m)

DRG No.	MML3-TRW-DWG-GEN-0037		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	18 September 2018	REV.	B



*VALUES SHOWN ARE INDICATIVE. THESE DIMENSIONS SHOULD BE WORKED OUT BASED ON ACTUAL CANT APPLIED AND AS PER SITE CONDITION.

SECTION 01
SCALE 1: 10 0049

TYPICAL CROSS SECTION OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM IN BOX TUNNEL (CURVE R ≤500m) (WITH DERAILMENT GUARD)

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE MENTIONED.
2. FOR FASTENING SYSTEM AND BOOTED CONCRETE BLOCK REFER TO DRAWING NO. MML3-TRW-DWG-GEN-0081
3. RAIL INCLINATION SHALL BE 1 IN 20.
4. AN EXPANSION GAP OF 20mm SHALL BE MAINTAINED BETWEEN CONSECUTIVE SLABS AND FILLED WITH SUITABLE COMPRESSIVE MATERIAL.
5. DIMENSIONS OF BOOT AND BLOCKS ARE INDICATIVE ONLY.
6. MINIMUM SLAB THICKNESS OF CONCRETE ADJACENT TO THE BOOTED TWIN BLOCK AND TUNNEL FACE SHALL BE MAINTAINED AS 50mm.
7. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT INTERFACE DRAWINGS.
8. THE CROSS SLOPE SHALL BE 1%.

SCALE 1:10 0.1 0 0.1 0.2 0.3 0.4 0.5

VERSIONS	DATE	DESCRIPTION
A	29 Mar 2018	FOR APPROVAL
B	18 Sep 2018	FOR APPROVAL
C	26 April 2019	'd' revised 320 ± 10
.	.	.
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DESIGNED BY
SMEC
Member of the Surbana Jurong Group
SMEC India Pvt. Ltd
41/7, Above Maruti Showroom
Varun Motors Pvt Ltd, 15th cross,
MES College Road, Malleshwaram,
Bengaluru, Karnataka 560003, India

DRAWING STAGE
DETAILED DRAWING

DESCRIPTION	NAME	SIGNATURE
DESIGNED	Gururaja N. (Sr. DE)	
DRAWN	Musaib A. (Sr. TO)	
APPROVED	Shivakumar GC. (GM)	

GENERAL CONSULTANT
maple
MUMBAI METRO LINE-3
GENERAL CONSULTANT
Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MH 400098

STAMP

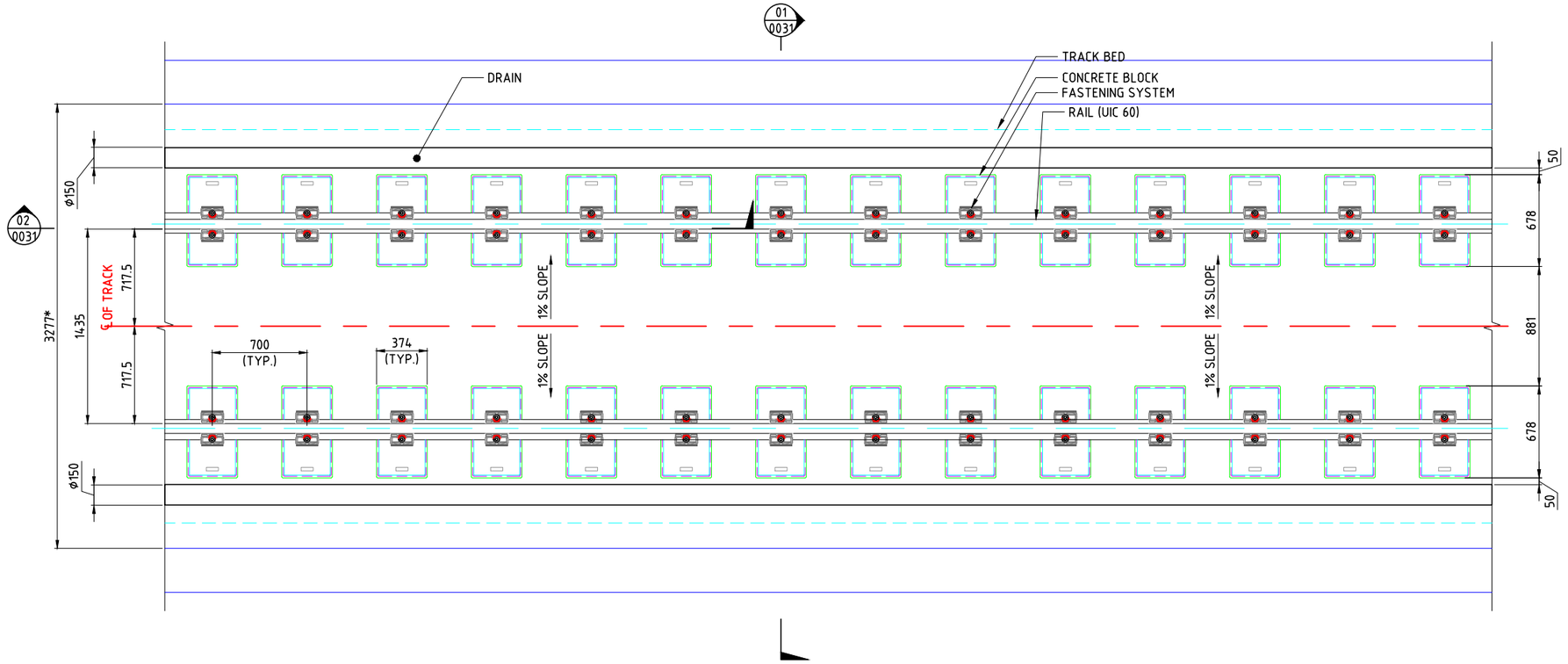
DESCRIPTION	NAME	SIGNATURE
DRAWN	HRM (TI)	
CHECKED	VKS (CTE)	
REVIEWED	P. LEEMPUT (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER
MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

TITLE
TYPICAL CROSS SECTION
OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM IN CUT & COVER (CURVE R ≤500m) - (WITH DERAILMENT GUARD)

DRG No.	MML3-TRW-DWG-GEN-0039		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	18 September 2018	REV.	C

Last Saved by: EGIS On 21 June 2019 09:38:56



PLAN

SCALE 1:20

TYPICAL PLAN OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM IN TUNNEL (STRAIGHT)

*VALUES SHOWN ARE INDICATIVE. THESE DIMENSIONS SHOULD BE WORKED OUT BASED ON ACTUAL CANT APPLIED AND AS PER SITE CONDITION.

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE MENTIONED.
2. FOR FASTENING SYSTEM AND BOOTED CONCRETE BLOCK REFER TO DRAWING NO. MML3-TRW-DWG-GEN-0081
3. RAIL INCLINATION SHALL BE 1 IN 20.
4. AN EXPANSION GAP OF 20mm SHALL BE MAINTAINED BETWEEN CONSECUTIVE SLABS AND FILLED WITH SUITABLE COMPRESSIVE MATERIAL.
5. DIMENSIONS OF BOOT AND BLOCKS ARE INDICATIVE ONLY.
6. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT INTERFACE DRAWINGS.
7. THE CROSS SLOPE SHALL BE 1%.
8. AS PER SOD THE DERAILMENT GUARD SHOULD NOT BE PROVIDED IN STRAIGHT & CURVES HAVING R ≥500m IN TUNNEL.

SCALE 1:20 0.2 0 0.2 0.4 0.6 0.8 1.0

VERSIONS	DATE	DESCRIPTION
A	29 Mar 2018	FOR APPROVAL
B	18 Sep 2018	FOR APPROVAL
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DESIGNED BY

SMEC
Member of the Surbana Jurong Group

SMEC India Pvt. Ltd
41/7, Above Maruti Showroom
Varun Motors Pvt Ltd, 15th cross,
MES College Road, Malleshwaram,
Bengaluru, Karnataka 560003, India

DRAWING STAGE

DETAILED DRAWING

DESCRIPTION	NAME	SIGNATURE
DESIGNED	Gururaja N. (Sr. DE)	
DRAWN	Musaib A. (Sr. TO)	
APPROVED	Shivakumar GC. (GM)	

GENERAL CONSULTANT

maple
MUMBAI METRO LINE-3
GENERAL CONSULTANT

Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MH 400098

STAMP

DESCRIPTION	NAME	SIGNATURE
DRAWN	HRM (TI)	
CHECKED	VKS (CTE)	
REVIEWED	P. LEEMPUT (Track Expert)	
APPROVED	RJM (PM)	

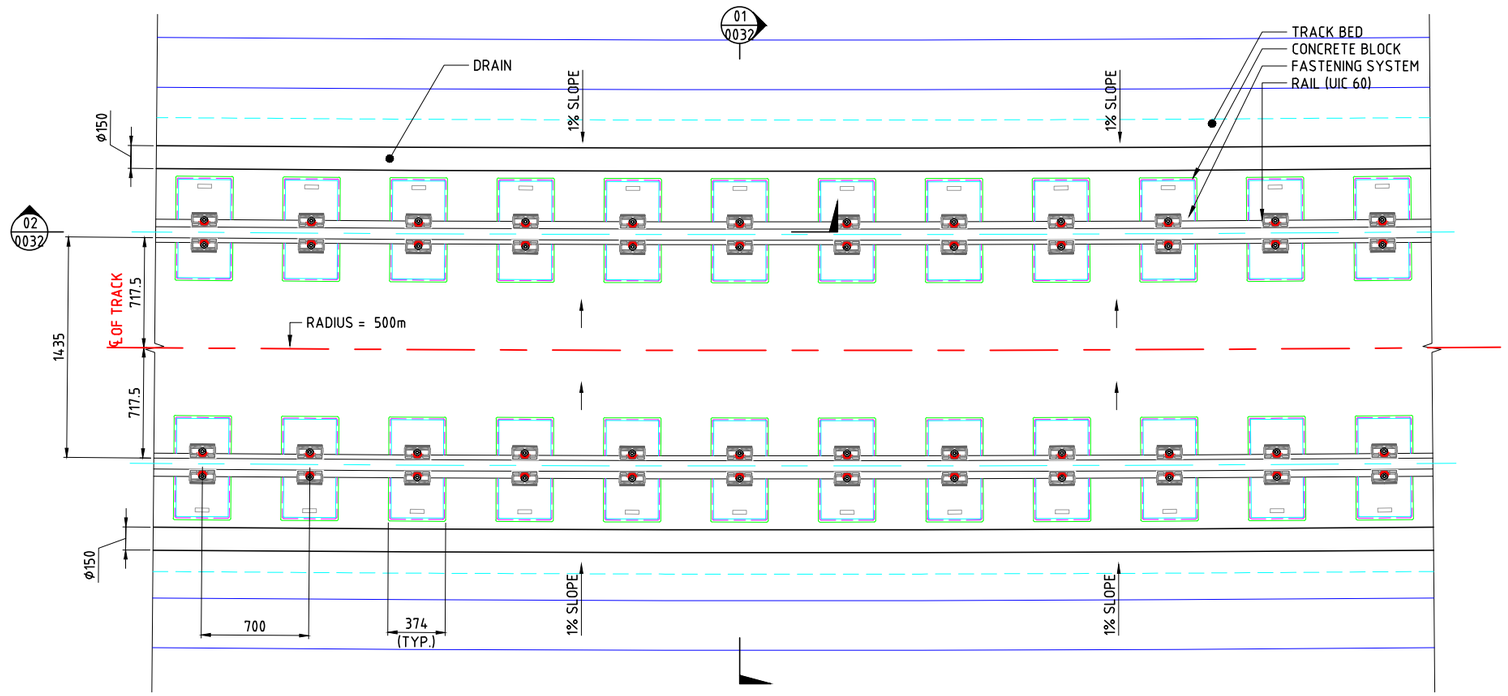
EMPLOYER

MMRC

MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

TITLE: TYPICAL PLAN OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM IN TUNNEL (STRAIGHT)

DRG No.	MML3-TRW-DWG-GEN-0041		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	18 September 2018	REV.	B



PLAN

SCALE 1:20

TYPICAL PLAN OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM IN TUNNEL (CURVE R >500m)

*VALUES SHOWN ARE INDICATIVE. THESE DIMENSIONS SHOULD BE WORKED OUT BASED ON ACTUAL CANT APPLIED AND AS PER SITE CONDITION.

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE MENTIONED.
2. FOR FASTENING SYSTEM AND BOOTED CONCRETE BLOCK REFER TO DRAWING NO. MML3-TRW-DWG-GEN-0081
3. RAIL INCLINATION SHALL BE 1 IN 20.
4. AN EXPANSION GAP OF 20mm SHALL BE MAINTAINED BETWEEN CONSECUTIVE SLABS AND FILLED WITH SUITABLE COMPRESSIVE MATERIAL.
5. DIMENSIONS OF BOOT AND BLOCKS ARE INDICATIVE ONLY.
6. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT INTERFACE DRAWINGS.
7. THE CROSS SLOPE SHALL BE 1%.
8. AS PER SOD THE DERAILMENT GUARD SHOULD NOT BE PROVIDED IN STRAIGHT & CURVES HAVING R ≥500m IN TUNNEL.

SCALE 1:20 0.2 0 0.2 0.4 0.6 0.8 1.0

VERSIONS	DATE	DESCRIPTION
A	29 Mar 2018	FOR APPROVAL
B	18 Sep 2018	FOR APPROVAL
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DESIGNED BY

SMEC
Member of the Surbana Jurong Group

SMEC India Pvt. Ltd
41/7, Above Maruti Showroom
Varun Motors Pvt Ltd, 15th cross,
MES College Road, Malleshwaram,
Bengaluru, Karnataka 560003, India

DRAWING STAGE

DETAILED DRAWING

DESCRIPTION	NAME	SIGNATURE
DESIGNED	Gururaja N. (Sr. DE)	
DRAWN	Musaib A. (Sr. TO)	
APPROVED	Shivakumar GC. (GM)	

GENERAL CONSULTANT

maple
MUMBAI METRO LINE-3
GENERAL CONSULTANT

Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MH 400098

STAMP

DESCRIPTION	NAME	SIGNATURE
DRAWN	HRM (TI)	
CHECKED	VKS (CTE)	
REVIEWED	P. LEEMPUT (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER

MMRC

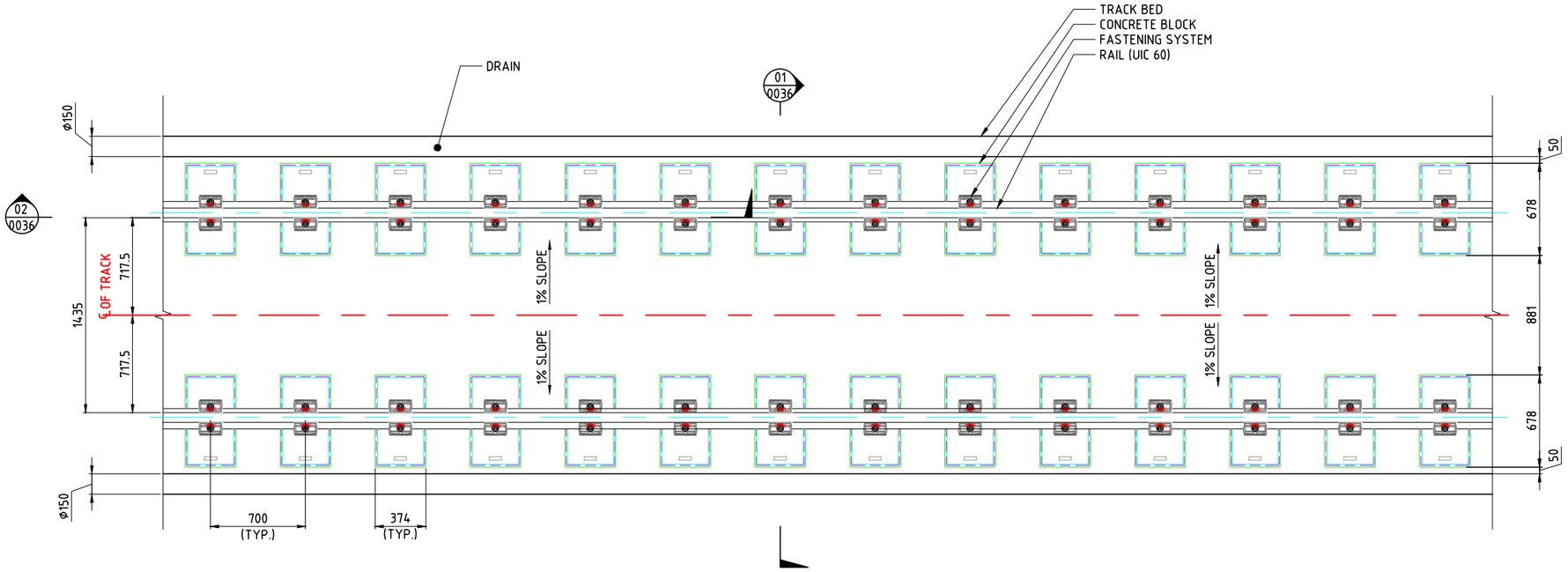
MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

TITLE

TYPICAL PLAN
OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM
IN TUNNEL (CURVE R >500m)

DRG No.	MML3-TRW-DWG-GEN-0042		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	18 September 2018	REV.	B

File Location - D:\WORK\10C Drawings\10 CVCAD\5 Track Structure Drawings\MML3-TRW-DWG-GEN-0042.dwg



PLAN

SCALE 1:20

TYPICAL PLAN OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM IN BOX TUNNEL (STRAIGHT)

*VALUES SHOWN ARE INDICATIVE. THESE DIMENSIONS SHOULD BE WORKED OUT BASED ON ACTUAL CANT APPLIED AND AS PER SITE CONDITION.

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE MENTIONED.
2. FOR FASTENING SYSTEM AND BOOTED CONCRETE BLOCK REFER TO DRAWING NO. MML3-TRW-DWG-GEN-0081
3. RAIL INCLINATION SHALL BE 1 IN 20.
4. AN EXPANSION GAP OF 20mm SHALL BE MAINTAINED BETWEEN CONSECUTIVE SLABS AND FILLED WITH SUITABLE COMPRESSIVE MATERIAL.
5. DIMENSIONS OF BOOT AND BLOCKS ARE INDICATIVE ONLY.
6. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT INTERFACE DRAWINGS.
7. THE CROSS SLOPE SHALL BE 1%.
8. AS PER SOD THE DERAILMENT GUARD SHOULD NOT BE PROVIDED IN STRAIGHT & CURVES HAVING R ≥500m IN TUNNEL.

SCALE 1:20 0.2 0 0.2 0.4 0.6 0.8 1.0

VERSIONS	DATE	DESCRIPTION
A	29 Mar 2018	FOR APPROVAL
B	18 Sep 2018	FOR APPROVAL
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DESIGNED BY

SMEC

Member of the Surbana Jurong Group

SMEC India Pvt. Ltd

41/7, Above Maruti Showroom Varun Motors Pvt Ltd, 15th cross, MES College Road, Malleshwaram, Bengaluru, Karnataka 560003, India

DRAWING STAGE

DETAILED DRAWING

DESCRIPTION	NAME	SIGNATURE
DESIGNED	Gururaja N. (Sr. DE)	
DRAWN	Musaib A. (Sr. TO)	
APPROVED	Shivakumar GC. (GM)	

GENERAL CONSULTANT

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

Maple Mumbai Metro 3 General Consultant

Kumar Plaza Unit no 201 2nd Floor Air India Road Jamilpada, Kalina village, Santacruz East, Mumbai. MH 400098

STAMP

DESCRIPTION	NAME	SIGNATURE
DRAWN	HRM (TI)	
CHECKED	VKS (CTE)	
REVIEWED	P. LEEMPUT (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER

MMRC

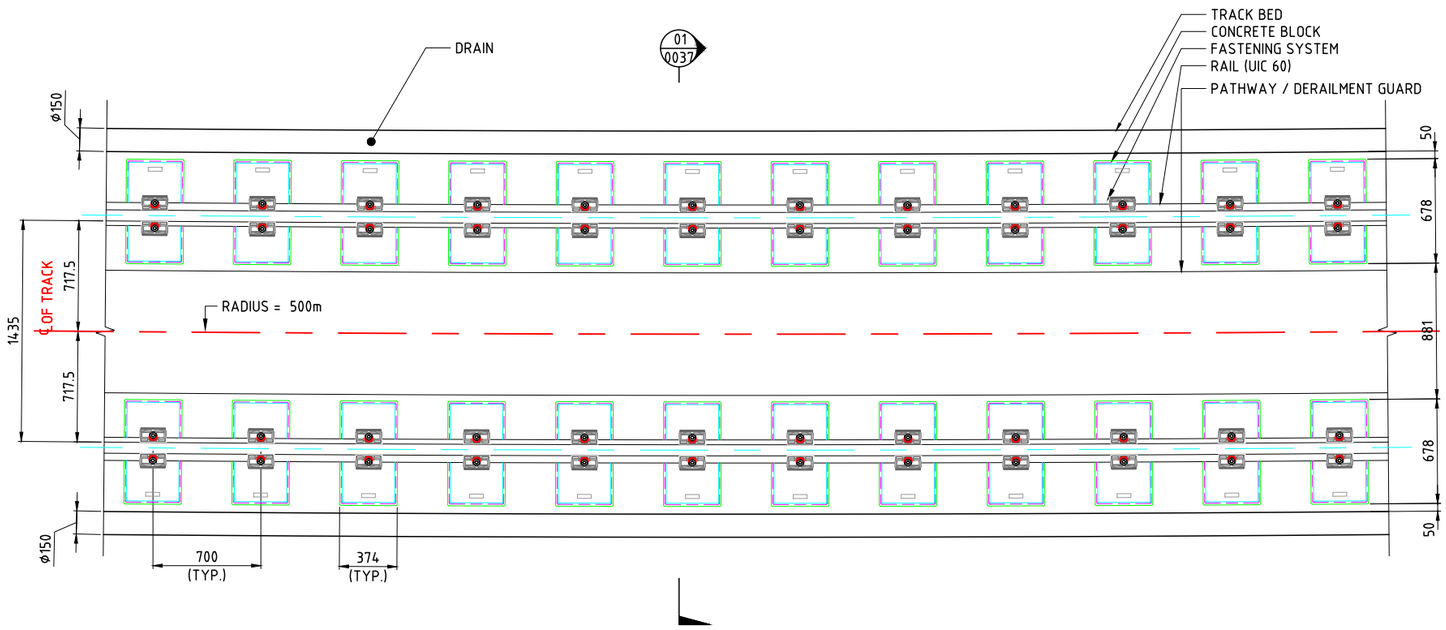
MUMBAI METRO RAIL CORPORATION LIMITED,

Namttri Building, Plot No. R-13, 'E'- Block, Bandra Kurla Complex, Bandra (East), Mumbai 400051

TITLE

TYPICAL PLAN OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM IN CUT & COVER (STRAIGHT)

DRG No.	MML3-TRW-DWG-GEN-0046		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	18 September 2018	REV.	B



PLAN

SCALE 1:20

TYPICAL PLAN OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM IN BOX TUNNEL (CURVE R >500m)

*VALUES SHOWN ARE INDICATIVE. THESE DIMENSIONS SHOULD BE WORKED OUT BASED ON ACTUAL CANT APPLIED AND AS PER SITE CONDITION.

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE MENTIONED.
2. FOR FASTENING SYSTEM AND BOOTED CONCRETE BLOCK REFER TO DRAWING NO. MML3-TRW-DWG-GEN-0081
3. RAIL INCLINATION SHALL BE 1 IN 20.
4. AN EXPANSION GAP OF 20mm SHALL BE MAINTAINED BETWEEN CONSECUTIVE SLABS AND FILLED WITH SUITABLE COMPRESSIVE MATERIAL.
5. DIMENSIONS OF BOOT AND BLOCKS ARE INDICATIVE ONLY.
6. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT INTERFACE DRAWINGS.
7. THE CROSS SLOPE SHALL BE 1%.

SCALE 1:20 0.2 0 0.2 0.4 0.6 0.8 1.0

VERSIONS	DATE	DESCRIPTION
A	29 Mar 2018	FOR APPROVAL
B	18 Sep 2018	FOR APPROVAL
C	24 April 2019	'd' revised 320 ± 10 mm
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DESIGNED BY

SMEC

Member of the Surbana Jurong Group

SMEC India Pvt. Ltd

41/7, Above Maruti Showroom
Varun Motors Pvt Ltd, 15th cross,
MES College Road, Malleshwaram,
Bengaluru, Karnataka 560003, India

DRAWING STAGE

DETAILED DRAWING

DESCRIPTION	NAME	SIGNATURE
DESIGNED	Gururaja N. (Sr. DE)	
DRAWN	Musaib A. (Sr. TO)	
APPROVED	Shivakumar GC. (GM)	

GENERAL CONSULTANT

maple
MUMBAI METRO LINE-3
GENERAL CONSULTANT

Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MH 400098

STAMP

DESCRIPTION	NAME	SIGNATURE
DRAWN	HRM (TI)	
CHECKED	VKS (CTE)	
REVIEWED	P. LEEMPUT (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER

MMRC

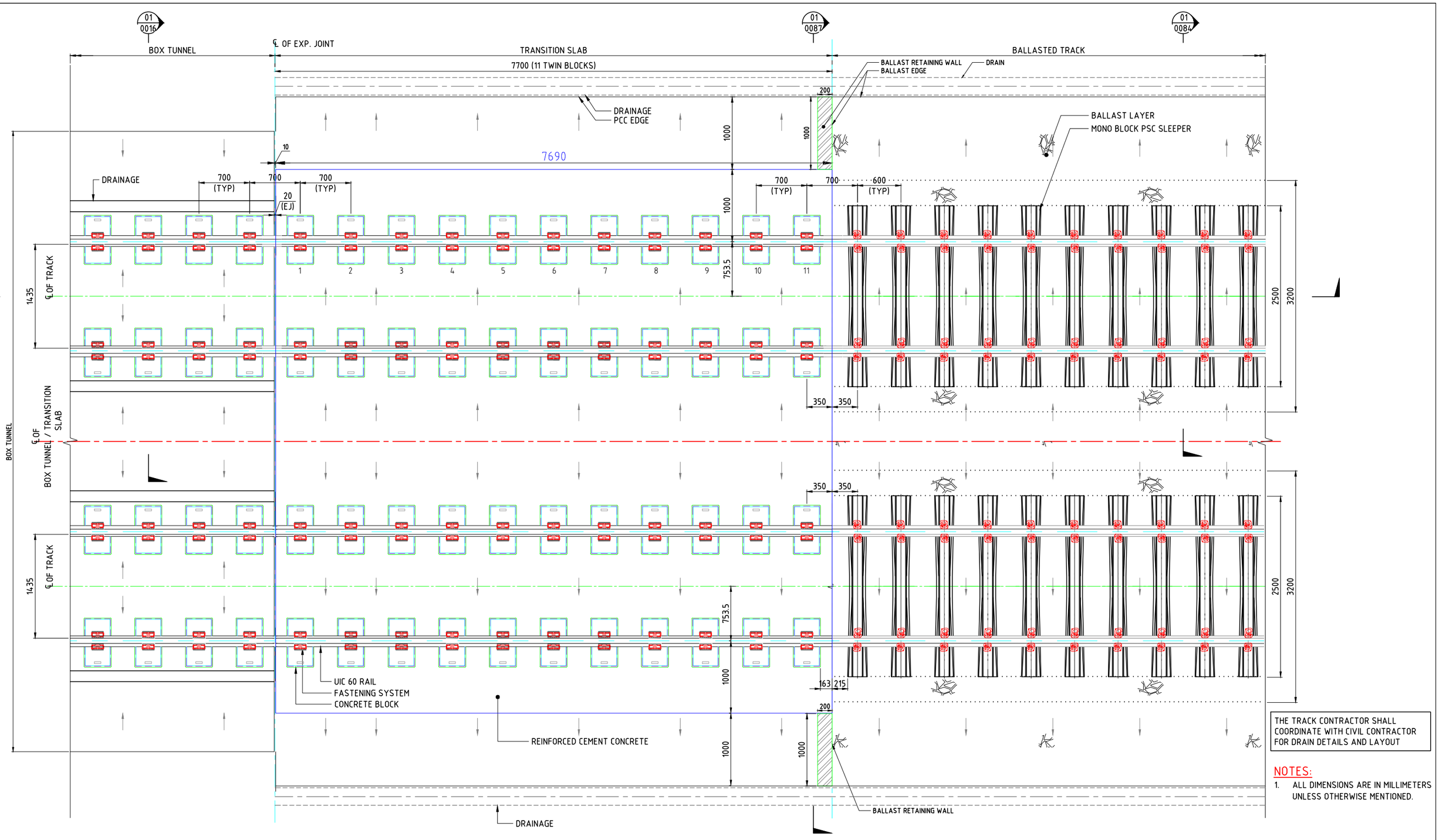
MUMBAI METRO RAIL CORPORATION LIMITED,

Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

TITLE

TYPICAL PLAN
OF BOOTED TWIN BLOCK (HA) TRACK SYSTEM
IN CUT & COVER (CURVE R >500m)

DRG No.	MML3-TRW-DWG-GEN-0047		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	18 September 2018	REV.	C



THE TRACK CONTRACTOR SHALL COORDINATE WITH CIVIL CONTRACTOR FOR DRAIN DETAILS AND LAYOUT

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE MENTIONED.

PLAN VIEW

SCALE 1:25

SCALE 1:25 0.25 0 0.50 1.00

TRANSITION SLAB (BALLAST-LESS TO BALLASTED TRACK) AT DEPOT APPROACH

VERSIONS	DATE	DESCRIPTION
A	29 Mar 2018	FOR APPROVAL
B	18 Sep 2018	FOR APPROVAL
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DESIGNED BY

SMEC

Member of the Surbana Jurong Group

SMEC India Pvt. Ltd

41/7, Above Maruti Showroom Varun Motors Pvt Ltd, 15th cross, MES College Road, Malleshwaram, Bengaluru, Karnataka 560003, India

DRAWING STAGE

DETAILED DRAWING

DESCRIPTION	NAME	SIGNATURE
DESIGNED	Gururaja N. (Sr. DE)	
DRAWN	Musaib A. (Sr. TO)	
APPROVED	Shivakumar GC. (GM)	

GENERAL CONSULTANT

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

Maple Mumbai Metro 3 General Consultant

Kumar Plaza Unit no 201 2nd Floor Air India Road Jamilpada, Kalina village, Santacruz East, Mumbai. MH 400098

STAMP

DESCRIPTION	NAME	SIGNATURE
DRAWN	HRM (TI)	
CHECKED	VKS (CTE)	
REVIEWED	P. LEEMPUT (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER

MMRC

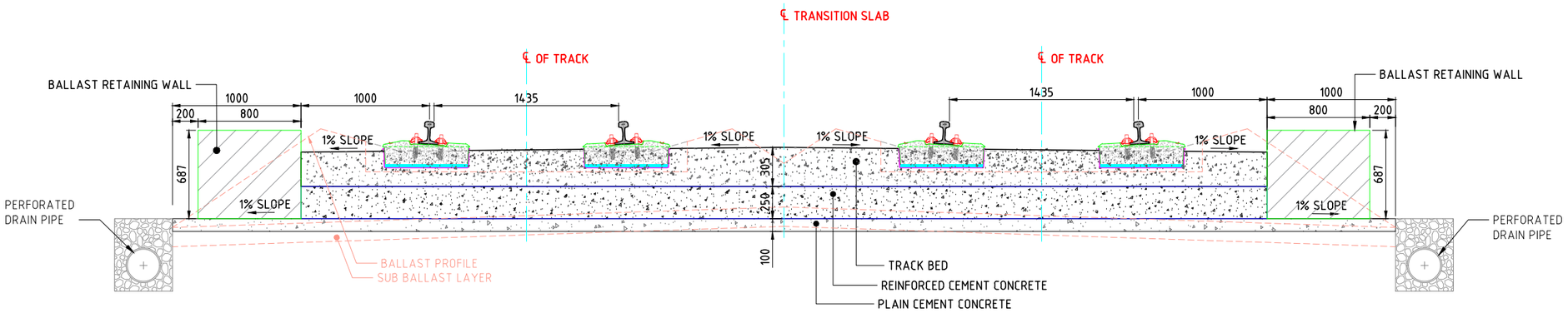
MUMBAI METRO RAIL CORPORATION LIMITED,

Namttri Building, Plot No. R-13, 'E'- Block, Bandra Kurla Complex, Bandra (East), Mumbai 400051

TITLE

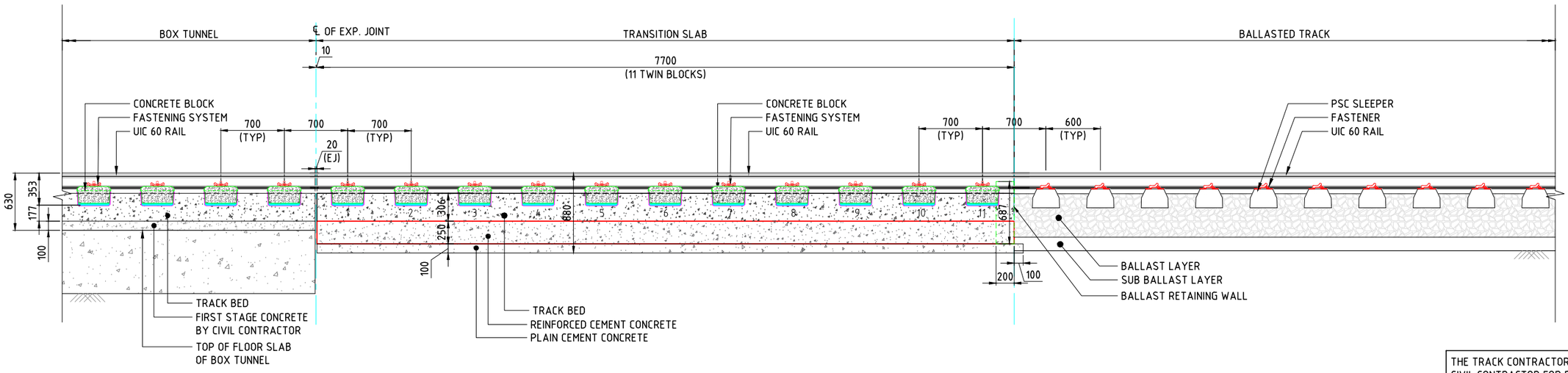
PLAN OF TRANSITION SLAB (BALLAST-LESS TO BALLASTED TRACK) AT DEPOT APPROACH

DRG No.	MML3-TRW-DWG-GEN-0086		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	29 March 2018	REV.	B



SECTION 01
SCALE 1: 20 0086

CROSS SECTION OF TRANSITION SLAB (BALLAST-LESS TO BALLASTED TRACK) AT DEPOT APPROACH



SECTION 02
SCALE 1: 25 0086

LONGITUDINAL SECTION OF TRANSITION SLAB (BALLAST-LESS TO BALLASTED TRACK) AT DEPOT APPROACH

THE TRACK CONTRACTOR SHALL COORDINATE WITH CIVIL CONTRACTOR FOR DRAIN DETAILS AND LAYOUT

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE MENTIONED.
2. CABLE TRENCH AND DRAINAGE SYSTEM WILL BE DESIGNED AND BUILT BY THE CIVIL CONTRACTOR.
3. THE THICKNESS OF BALLAST BED BELOW SLEEPER SHALL BE AS PER TECHNICAL SPECIFICATIONS.

SCALE 1:25 0.25 0 0.50 1.00
SCALE 1:20 0.2 0 0.2 0.4 0.6 0.8 1.0

VERSIONS	DATE	DESCRIPTION
A	29 Mar 2018	FOR APPROVAL
B	18 Sep 2018	FOR APPROVAL
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DESIGNED BY
SMEC
Member of the Surbana Jurong Group
SMEC India Pvt. Ltd
41/7, Above Maruti Showroom
Varun Motors Pvt Ltd, 15th cross,
MES College Road, Malleshwaram,
Bengaluru, Karnataka 560003, India

DRAWING STAGE
DETAILED DRAWING

DESCRIPTION	NAME	SIGNATURE
DESIGNED	Gururaja N. (Sr. DE)	
DRAWN	Musaib A. (Sr. TO)	
APPROVED	Shivakumar GC. (GM)	

GENERAL CONSULTANT
maple
MUMBAI METRO LINE-3
GENERAL CONSULTANT
Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MH 400098

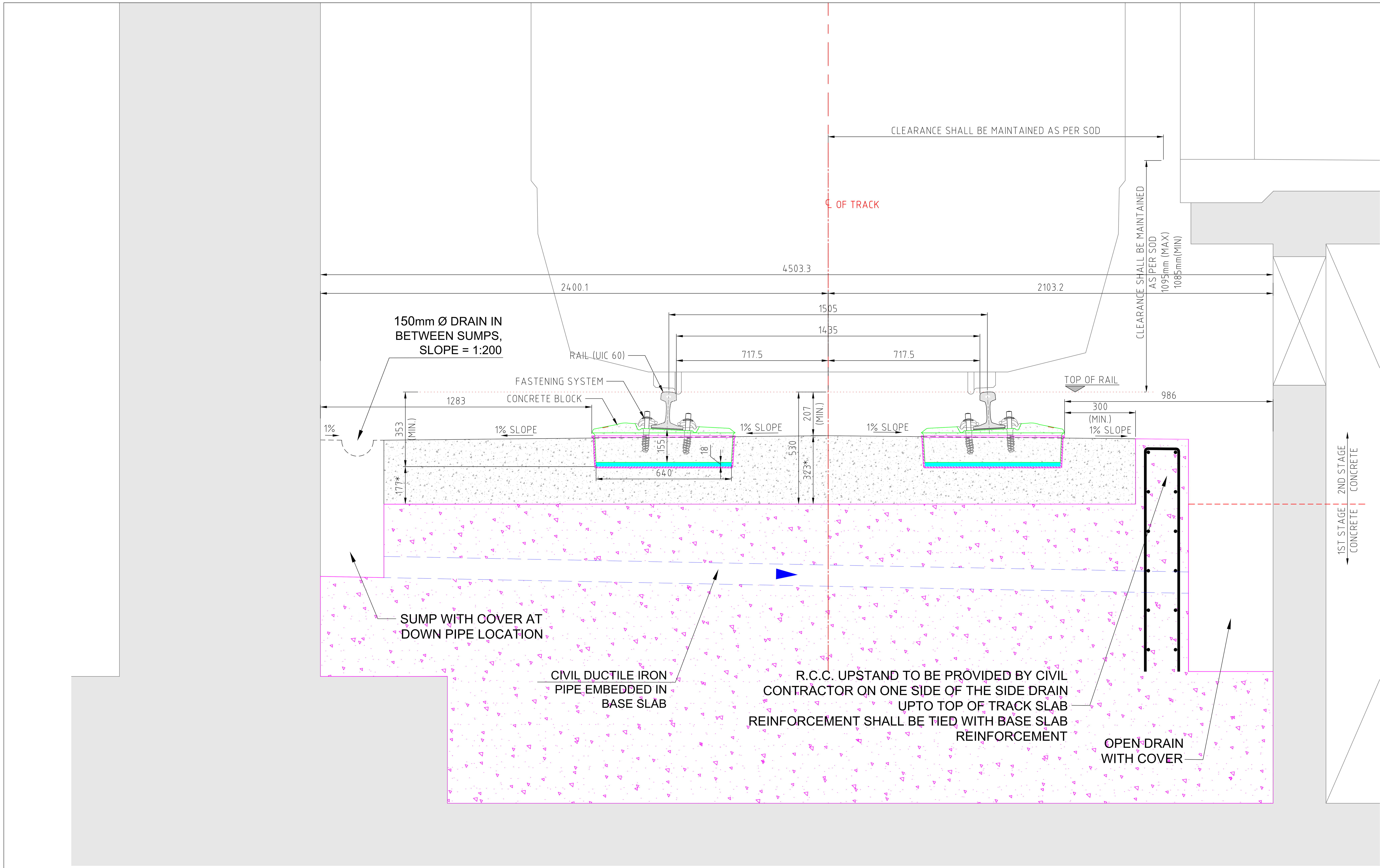
STAMP

DESCRIPTION	NAME	SIGNATURE
DRAWN	HRM (TI)	
CHECKED	VKS (CTE)	
REVIEWED	P. LEEMPUT (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER
MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

TITLE
CROSS SECTION OF TRANSITION SLAB (BALLAST-LESS TO BALLASTED TRACK) AT DEPOT APPROACH

DRG No.	MML3-TRW-DWG-GEN-0087		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	29 March 2018	REV.	B



LEGENDS:

- BY TRACK CONTRACTOR
- BY CIVIL CONTRACTOR

*VALUES SHOWN ARE INDICATIVE. THESE DIMENSIONS SHOULD BE WORKED OUT AS PER SITE CONDITION.

NOTES:

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6. THE CROSS SLOPE SHALL BE 1% ON BOTH SIDE.
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8. THE SIZE OF OPEN DRAIN AND DRAIN COVER WILL BE DESIGNED BY CIVIL CONTRACTOR.
9. R.C.C. UPSTAND WILL BE DESIGNED BY CIVIL CONTRACTOR BASED ON THE FORCES GIVEN BELOW.

S.NO	DESCRIPTION	FORCE
1.	TOTAL LONGITUDINAL FORCE	118.000 KN/M
2.	TOTAL LATERAL FORCE	121.162 KN/M

SCALE 1:10 0.1 0 0.1 0.2 0.3 0.4 0.5

VERSIONS	DATE	DESCRIPTION
-	-	-
-	-	-
B	14.02.2019	INCLUSION OF R.C.C. UPSTAND

GENERAL CONSULTANT

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

Maple Mumbai Metro 3 General Consultant

Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MH 400098

DESCRIPTION	NAME	SIGNATURE
DRAWN	ABK (CAD)	
CHECKED	SB (TE)	
REVIEWED	VKS (CTE)	
REVIEWED	Sy CHANG (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER

MMRC

MUMBAI METRO RAIL CORPORATION LIMITED,

Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

TITLE	TYPICAL CROSS SECTION OF TRACK STRUCTURE INCLUDING DRAINAGE IN UNDERGROUND STATIONS WITH R.C.C. UPSTAND AT SUMP ON ONE SIDE OF OPEN DRAIN		
DRG No.	MML3-TRW-DWG-GEN-0051A		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	19 November 2018	REV.	B

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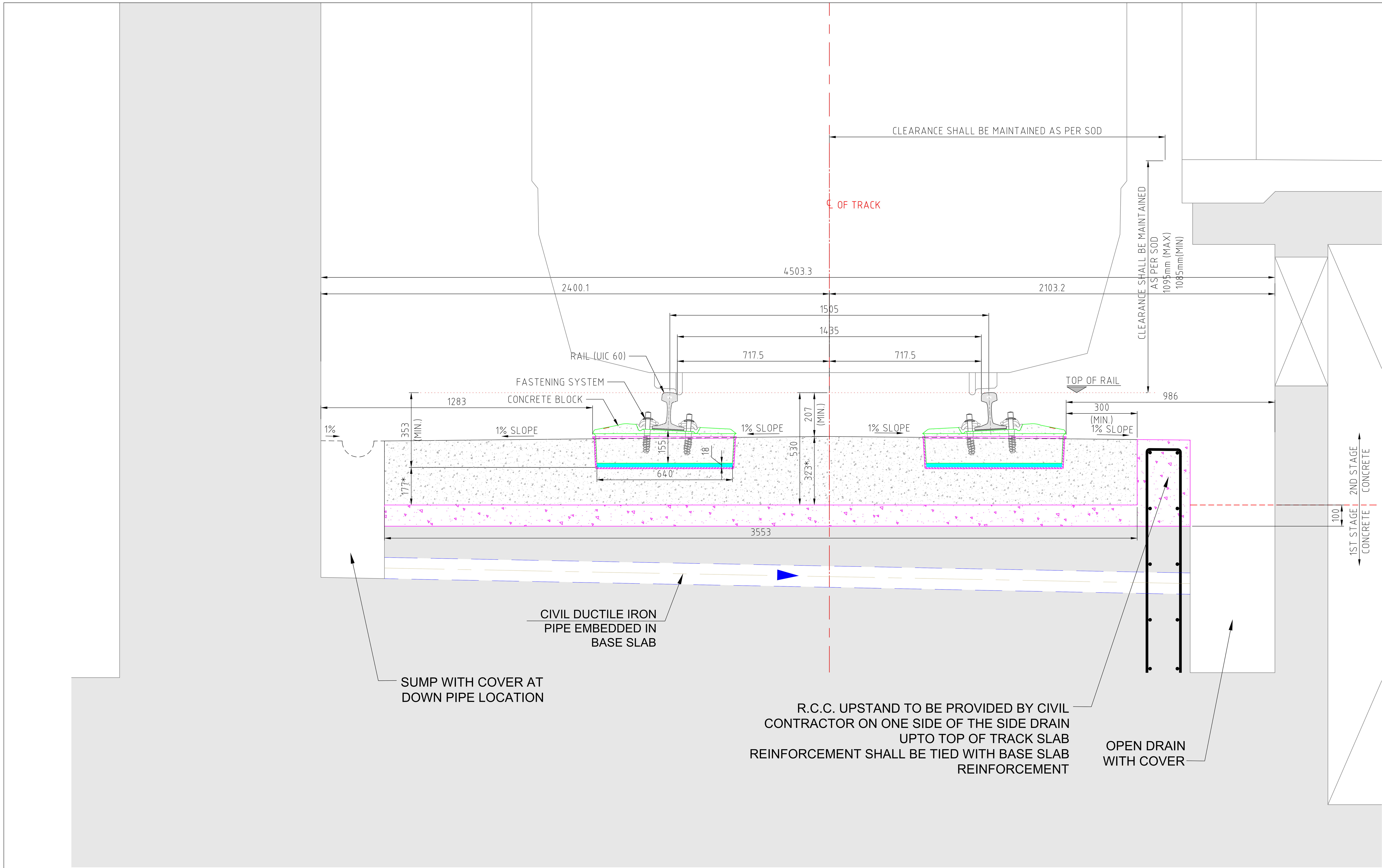

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SCALE 1:10 0.1 0 0.1 0.2 0.3 0.4 0.5

VERSIONS	DATE	DESCRIPTION
-	-	-
-	-	-
B	14.02.2019	INCLUSION OF R.C.C. UPSTAND

GENERAL CONSULTANT

Maple Mumbai Metro 3 General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MH 400098

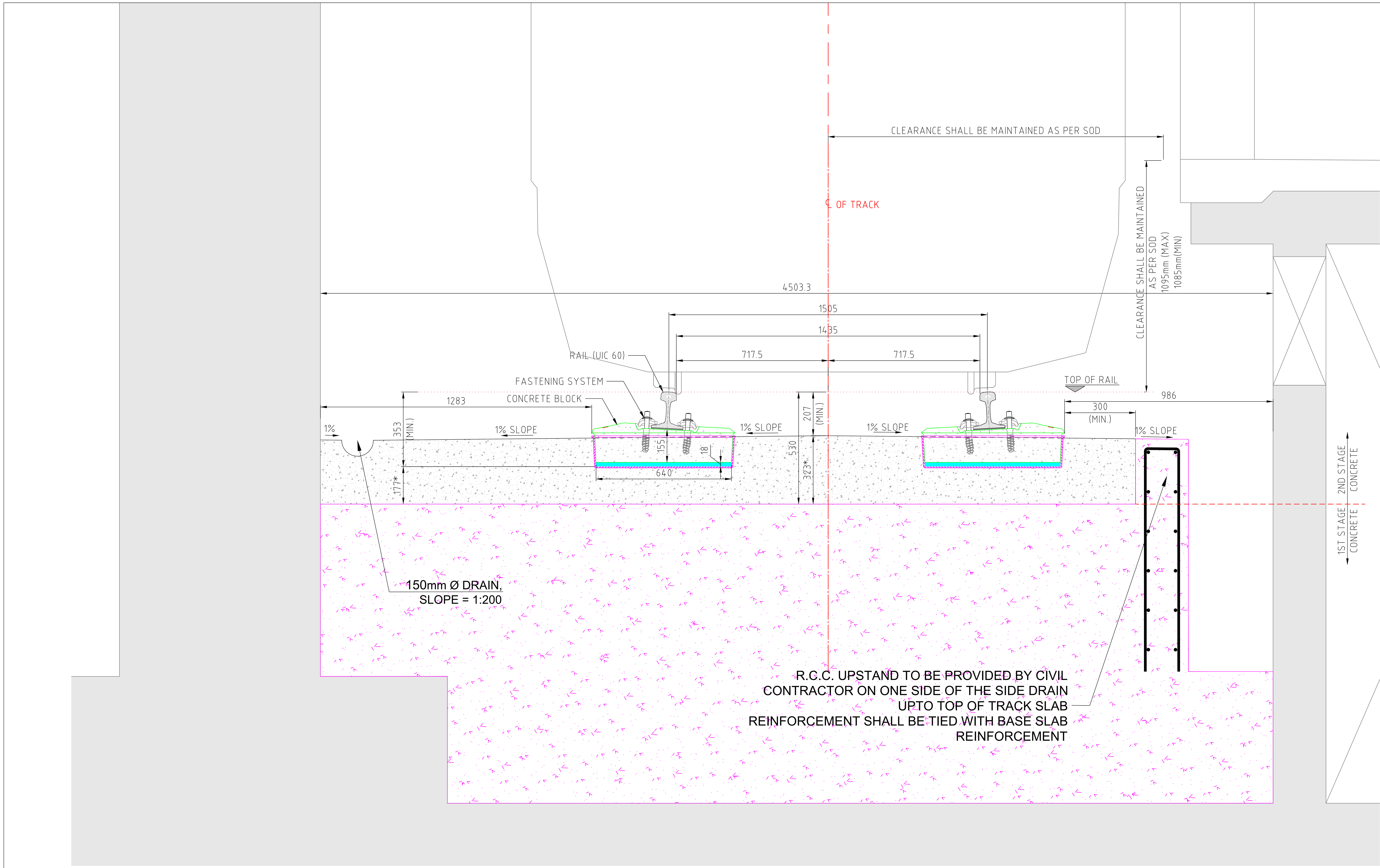
DESCRIPTION	NAME	SIGNATURE
DRAWN	ABK (CAD)	
CHECKED	SB (TE)	
REVIEWED	VKS (CTE)	
REVIEWED	Sy CHANG (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER

MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

TITLE	TYPICAL CROSS SECTION OF TRACK STRUCTURE INCLUDING DRAINAGE IN UNDERGROUND STATIONS WITH R.C.C. UPSTAND AT SUMP ON ONE SIDE OF OPEN DRAIN
DRG No.	MML3-TRW-DWG-GEN-0051B
SHEET	01 OF 01
SCALE	AS SHOWN
DATE	19 November 2018
REV.	B

Last Saved by:-AKHANDARE On 15 February 2019 12:29:31



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SCALE 1:10

VERSIONS	DATE	DESCRIPTION
-	-	-
-	-	-
B	14.02.2019	INCLUSION OF R.C.C. UPSTAND

GENERAL CONSULTANT

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
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REVIEWED	Sy CHANG (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER

MMRC

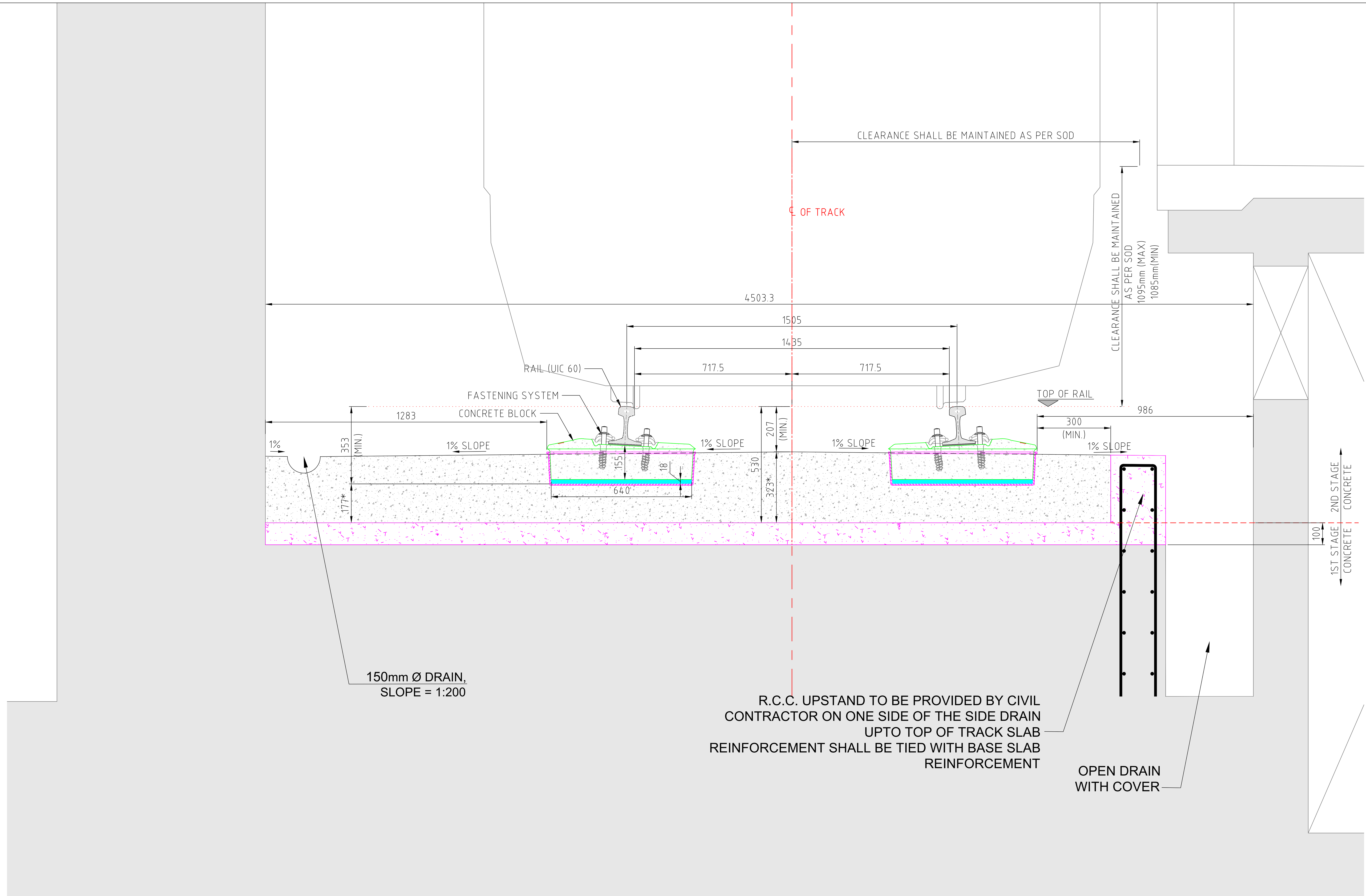
MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

TITLE

TYPICAL CROSS SECTION OF TRACK STRUCTURE INCLUDING DRAINAGE IN UNDERGROUND STATIONS WITH R.C.C. UPSTAND IN BETWEEN SUMPS ON ONE SIDE OF OPEN DRAIN

DRG No.	MML3-TRW-DWG-GEN-0051C		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	19 November 2018	REV.	B

Last Saved by:-AKHANDARE On 15 February 2019 12:30:04



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SCALE 1:10

VERSIONS	DATE	DESCRIPTION
-	-	-
-	-	-
B	14.02.2019	INCLUSION OF R.C.C. UPSTAND

GENERAL CONSULTANT

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MH 400098

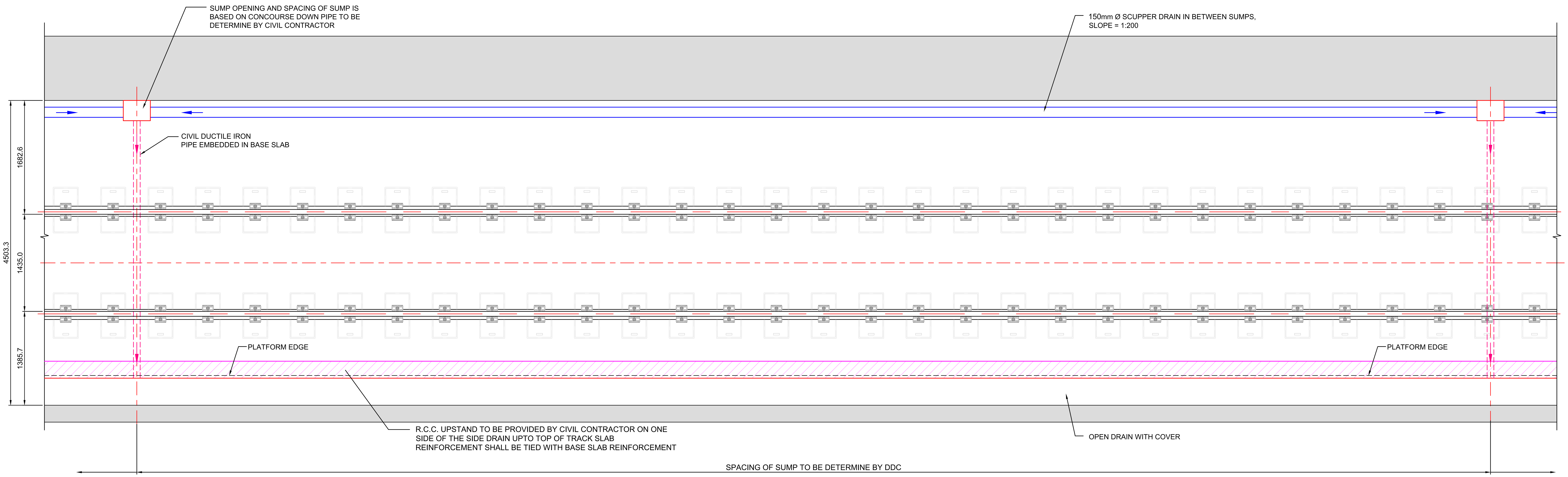
DESCRIPTION	NAME	SIGNATURE
DRAWN	ABK (CAD)	
CHECKED	SB (TE)	
REVIEWED	VKS (CTE)	
REVIEWED	Sy CHANG (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER

MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

TITLE	TYPICAL CROSS SECTION OF TRACK STRUCTURE INCLUDING DRAINAGE IN UNDERGROUND STATIONS WITH R.C.C. UPSTAND IN BETWEEN SUMPS ON ONE SIDE OF OPEN DRAIN
DRG No.	MML3-TRW-DWG-GEN-0051D
SHEET	01 OF 01
SCALE	AS SHOWN
DATE	19 November 2018
REV.	B

Last Saved by:-AKHANDARE On 15 February 2019 12:29:38



TYPICAL PLAN

SCALE 1:30

LEGENDS :

- 150mm Ø DRAIN
- CIVIL DUCTILE IRON PIPE EMBEDDED IN BASE SLAB

0 0.3 0.6 0.9 1.2 1.5m
SCALE 1:30

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VERSIONS	DATE	DESCRIPTION
.	.	.
.	.	.
B	14.02.2019	INCLUSION OF R.C.C. UPSTAND

GENERAL CONSULTANT

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MH 400098

DESCRIPTION	NAME	SIGNATURE
DRAWN	ABK (CAD)	
CHECKED	SB (TE)	
REVIEWED	VKS (CTE)	
REVIEWED	Sy CHANG (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER

MMRC

MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

TITLE	TYPICAL PLAN OF TRACK STRUCTURE INCLUDING DRAINAGE WITH R.C.C. UPSTAND		
DRG No.	MML3-TRW-DWG-GEN-0051E		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	28 November 2018	REV.	B

MML3-TRW-DWG-GEN-0051E_Rev B.dwg

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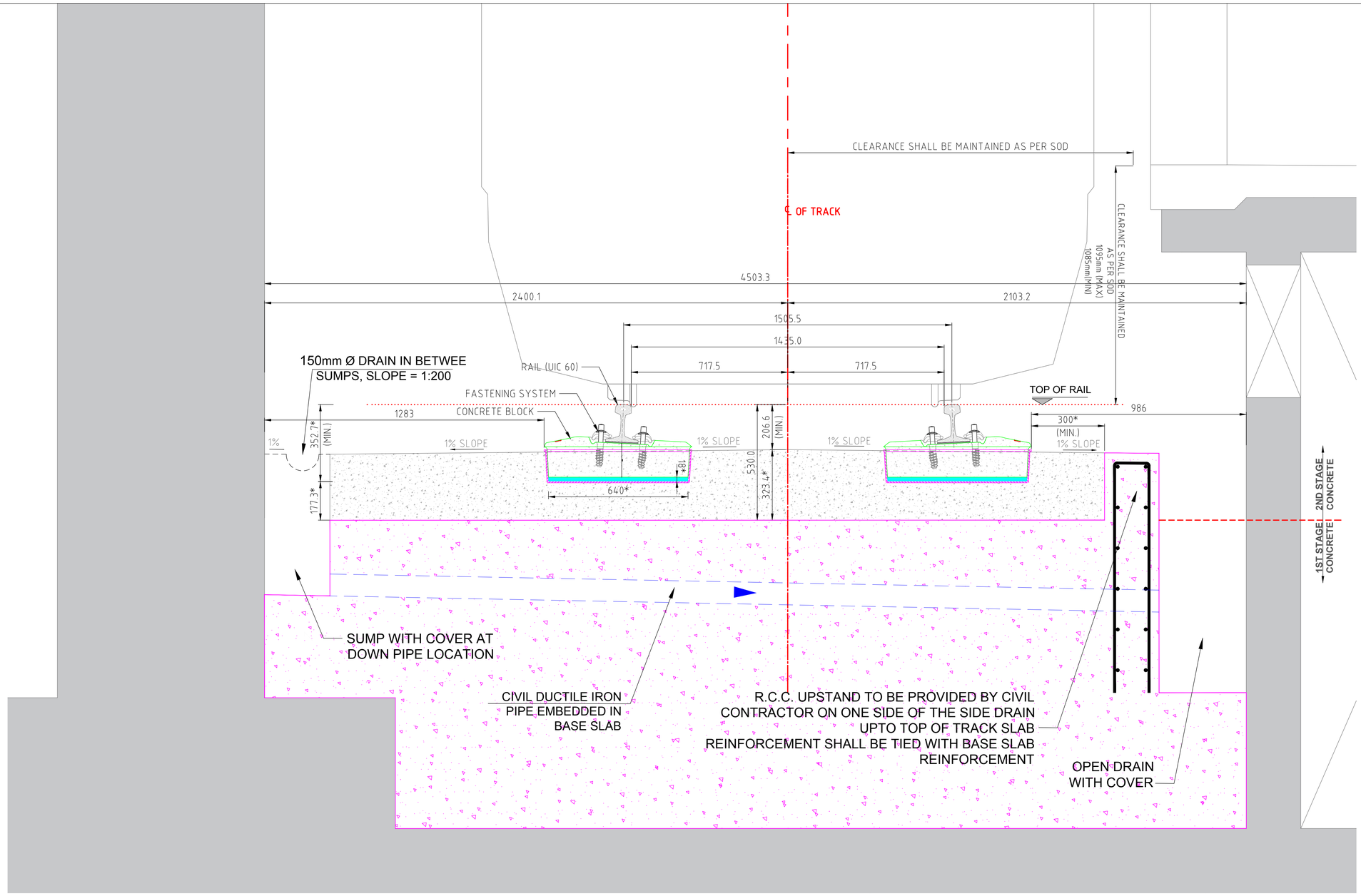

LEGENDS:

BY TRACK CONTRACTOR

BY CIVIL CONTRACTOR

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2.	TOTAL LATERAL FORCE	121.162 KN/M

THE TOP OF FIRST STAGE CONCRETE WILL BE 530 MM BELOW THE TOP OF RAIL

SCALE 1:10 0.1 0 0.1 0.2 0.3 0.4 0.5

VERSIONS	DATE	DESCRIPTION
.	.	.
C	17.09.2019	INCLUSION OF NOTES
B	14.02.2019	INCLUSION OF R.C.C. UPSTAND

GENERAL CONSULTANT

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

Maple Mumbai Metro 3 General Consultant

LINE 3 TRANSIT OFFICE, WING 'B' NORTH SIDE OF CITY PARK 'E'- BLOCK, BANDRA-KURLA COMPLEX, BANDRA (EAST) MUMBAI 400 051, INDIA

DESCRIPTION	NAME	SIGNATURE
DRAWN	SVM (TI)	
CHECKED	NKV (TE)	
REVIEWED	VKS (CTE)	
REVIEWED	Sy CHANG (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER

MMRC

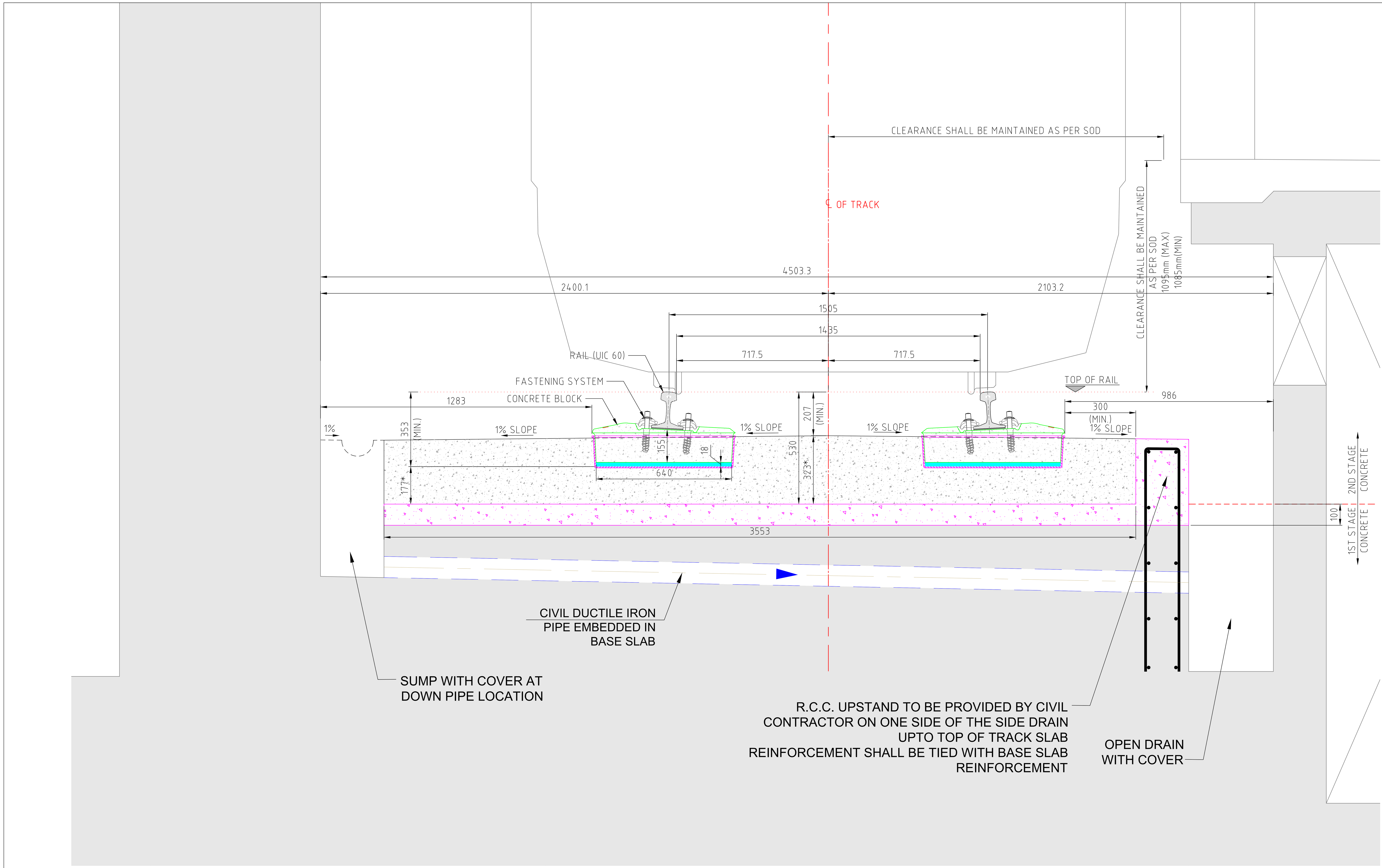
MUMBAI METRO RAIL CORPORATION LIMITED,

LINE 3 TRANSIT OFFICE, WING 'A' NORTH SIDE OF CITY PARK 'E'- BLOCK, BANDRA-KURLA COMPLEX, BANDRA (EAST) MUMBAI 400 051, INDIA

TITLE

TYPICAL CROSS SECTION OF TRACK STRUCTURE INCLUDING DRAINAGE IN UNDERGROUND STATIONS WITH R.C.C. UPSTAND AT SUMP ON ONE SIDE OF OPEN DRAIN

DRG No.	MML3-TRW-DWG-GEN-0051A		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	17 July 2019	REV.	C



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BY CIVIL CONTRACTOR

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VERSIONS	DATE	DESCRIPTION
-	-	-
-	-	-
B	14.02.2019	INCLUSION OF R.C.C. UPSTAND

GENERAL CONSULTANT

Maple Mumbai Metro 3 General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MH 400098

DESCRIPTION	NAME	SIGNATURE
DRAWN	ABK (CAD)	
CHECKED	SB (TE)	
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EMPLOYER

MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block,
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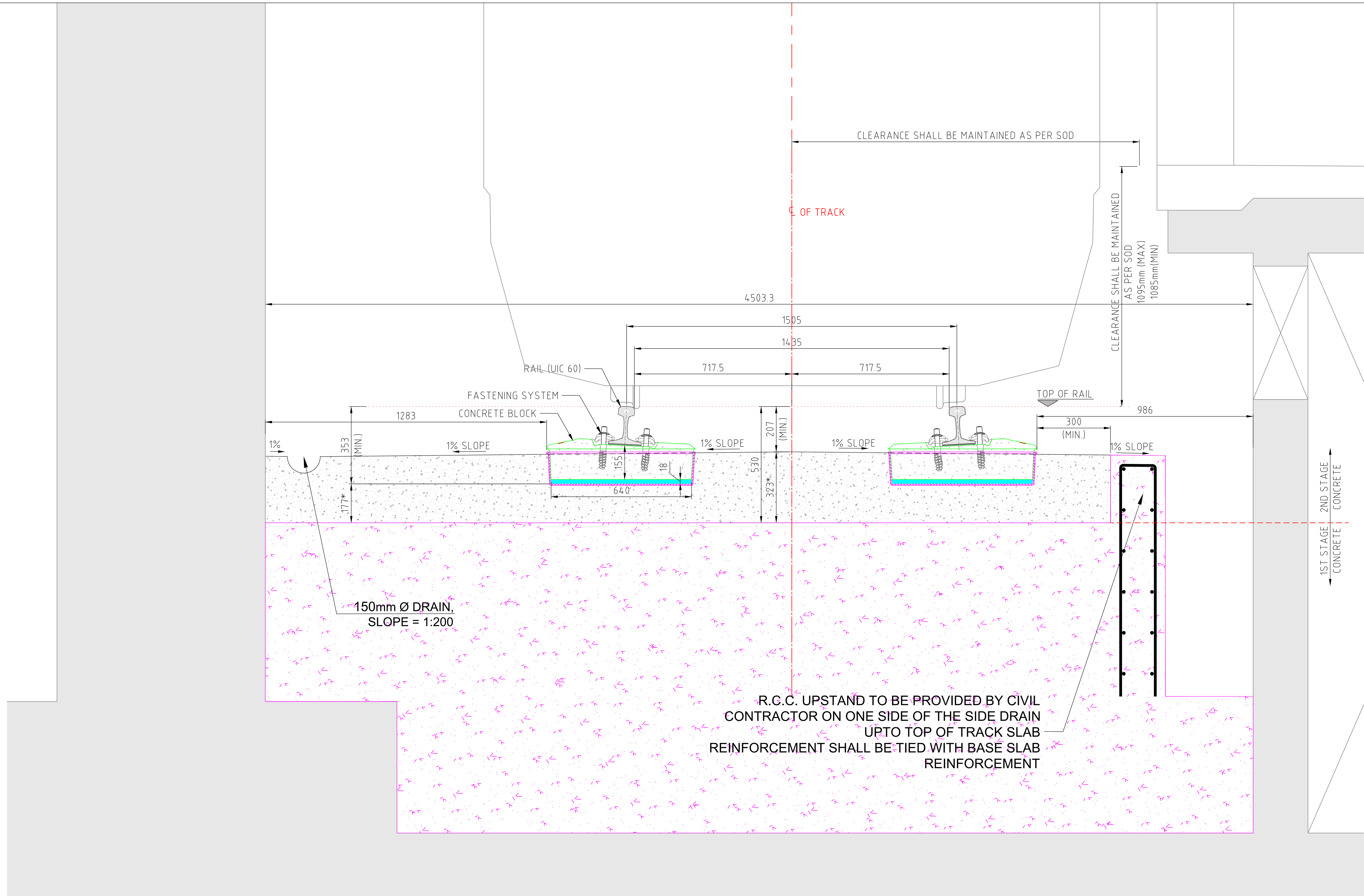
Mumbai 400051

TITLE: TYPICAL CROSS SECTION OF TRACK STRUCTURE INCLUDING DRAINAGE IN UNDERGROUND STATIONS WITH R.C.C. UPSTAND AT SUMP ON ONE SIDE OF OPEN DRAIN

DRG No.	MML3-TRW-DWG-GEN-0051B		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	19 November 2018	REV.	B

Last Saved by:-AKHANDARE On 15 February 2019 12:29:31



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DRG No.	MML3-TRW-DWG-GEN-0051C
SHEET	01 OF 01
SCALE	AS SHOWN
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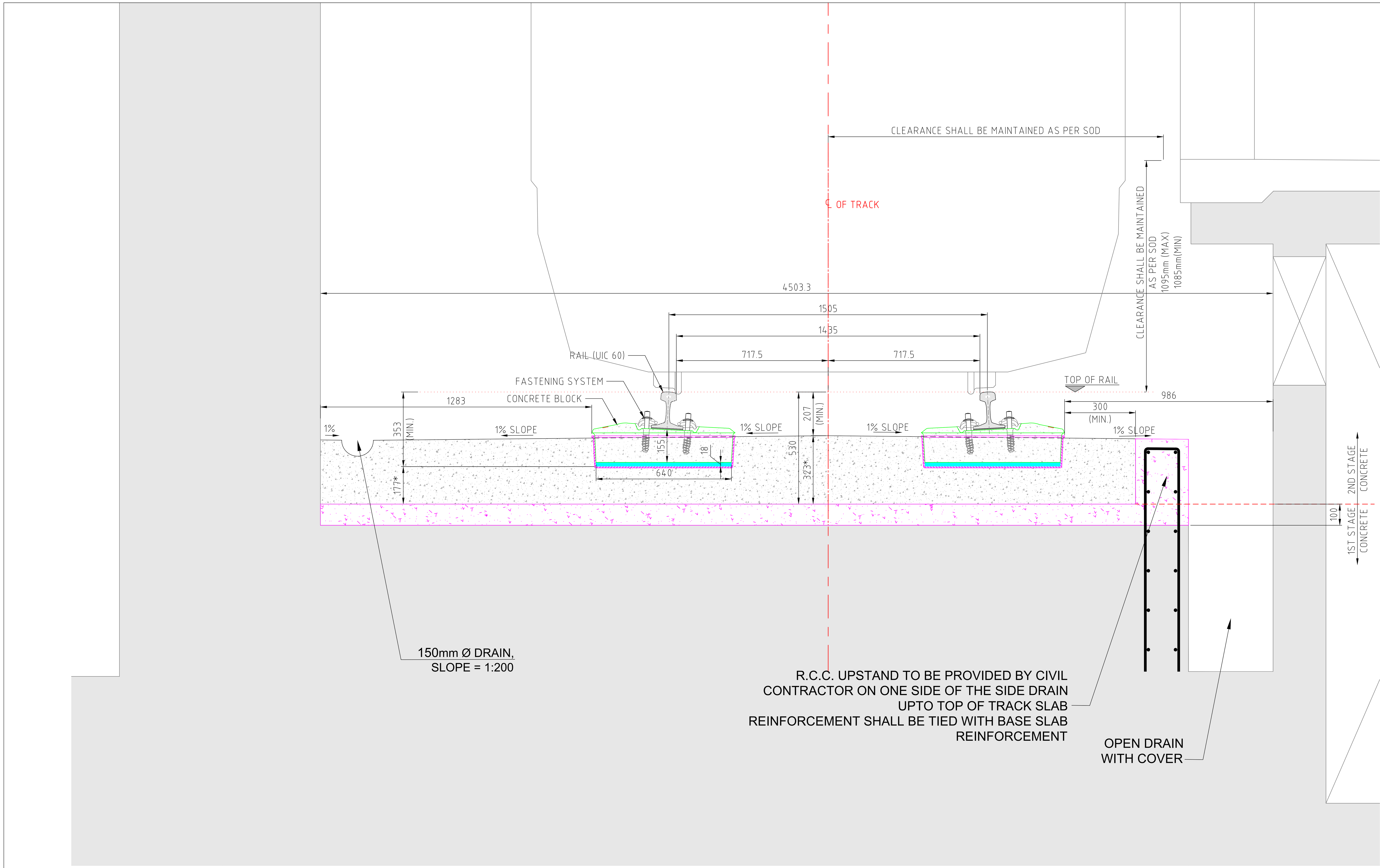

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maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

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Namttri Building, Plot No. R-13, 'E'- Block,
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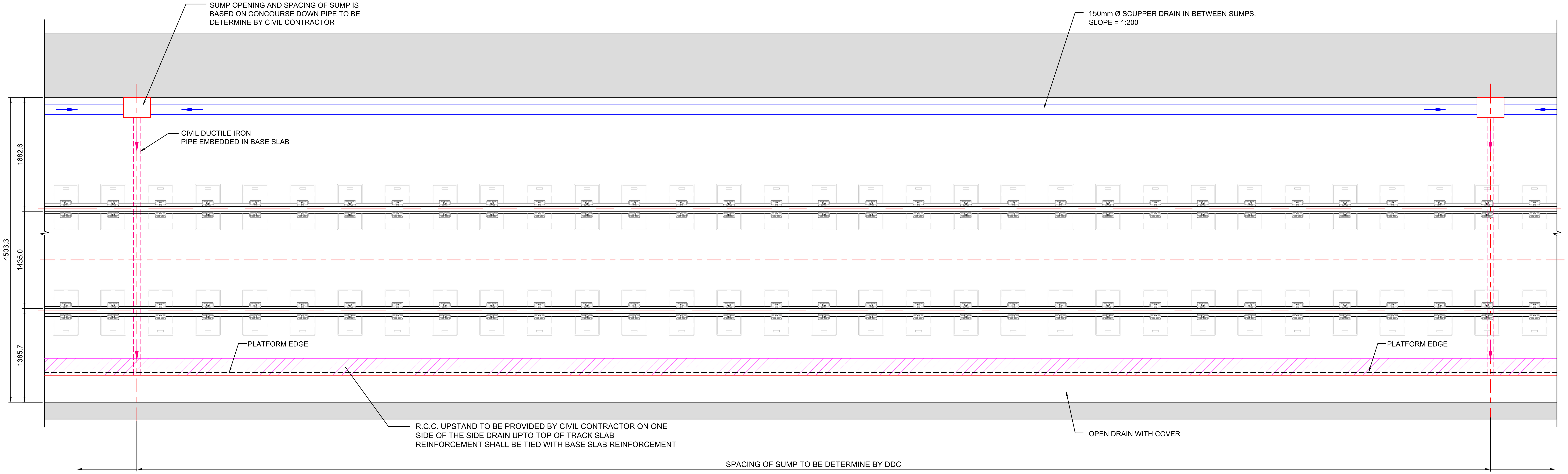
TITLE	TYPICAL CROSS SECTION OF TRACK STRUCTURE INCLUDING DRAINAGE IN UNDERGROUND STATIONS WITH R.C.C. UPSTAND IN BETWEEN SUMPS ON ONE SIDE OF OPEN DRAIN		
DRG No.	MML3-TRW-DWG-GEN-0051D		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	19 November 2018	REV.	B

Last Saved by:-AKHANDARE On 15 February 2019 12:29:38



TYPICAL PLAN

SCALE 1:30

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE MENTIONED.
2. RAIL INCLINATION SHALL BE 1 IN 20.
3. AN EXPANSION GAP OF 20mm SHALL BE MAINTAINED AT 20m INTERVAL BY TRACK CONTRACTOR BETWEEN CONSECUTIVE SLABS AND FILLED WITH SUITABLE COMPRESSIVE MATERIAL.
4. DIMENSIONS OF BOOT AND BLOCKS ARE INDICATIVE ONLY.
5. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT TRACK & CIVIL DRAWINGS.
6. THE CROSS SLOPE SHALL BE 1% ON BOTH SIDE.
7. THE CONCRETING TOLERANCE ±5mm IN HEIGHT AFTER COMPLETION OF FIRST STAGE CONCRETE.

LEGENDS :

- 150mm Ø DRAIN
- CIVIL DUCTILE IRON PIPE EMBEDDED IN BASE SLAB

0 0.3 0.6 0.9 1.2 1.5m
SCALE 1:30

VERSIONS	DATE	DESCRIPTION
.	.	.
.	.	.
B	14.02.2019	INCLUSION OF R.C.C. UPSTAND

GENERAL CONSULTANT

maple
MUMBAI METRO LINE-3
GENERAL CONSULTANT

Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MH 400098

DESCRIPTION	NAME	SIGNATURE
DRAWN	ABK (CAD)	
CHECKED	SB (TE)	
REVIEWED	VKS (CTE)	
REVIEWED	Sy CHANG (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER

MMRC

MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

TITLE	TYPICAL PLAN OF TRACK STRUCTURE INCLUDING DRAINAGE WITH R.C.C. UPSTAND		
DRG No.	MML3-TRW-DWG-GEN-0051E		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	28 November 2018	REV.	B

Last Saved by:-AKHANDARE On 15 February 2019 12:29:34

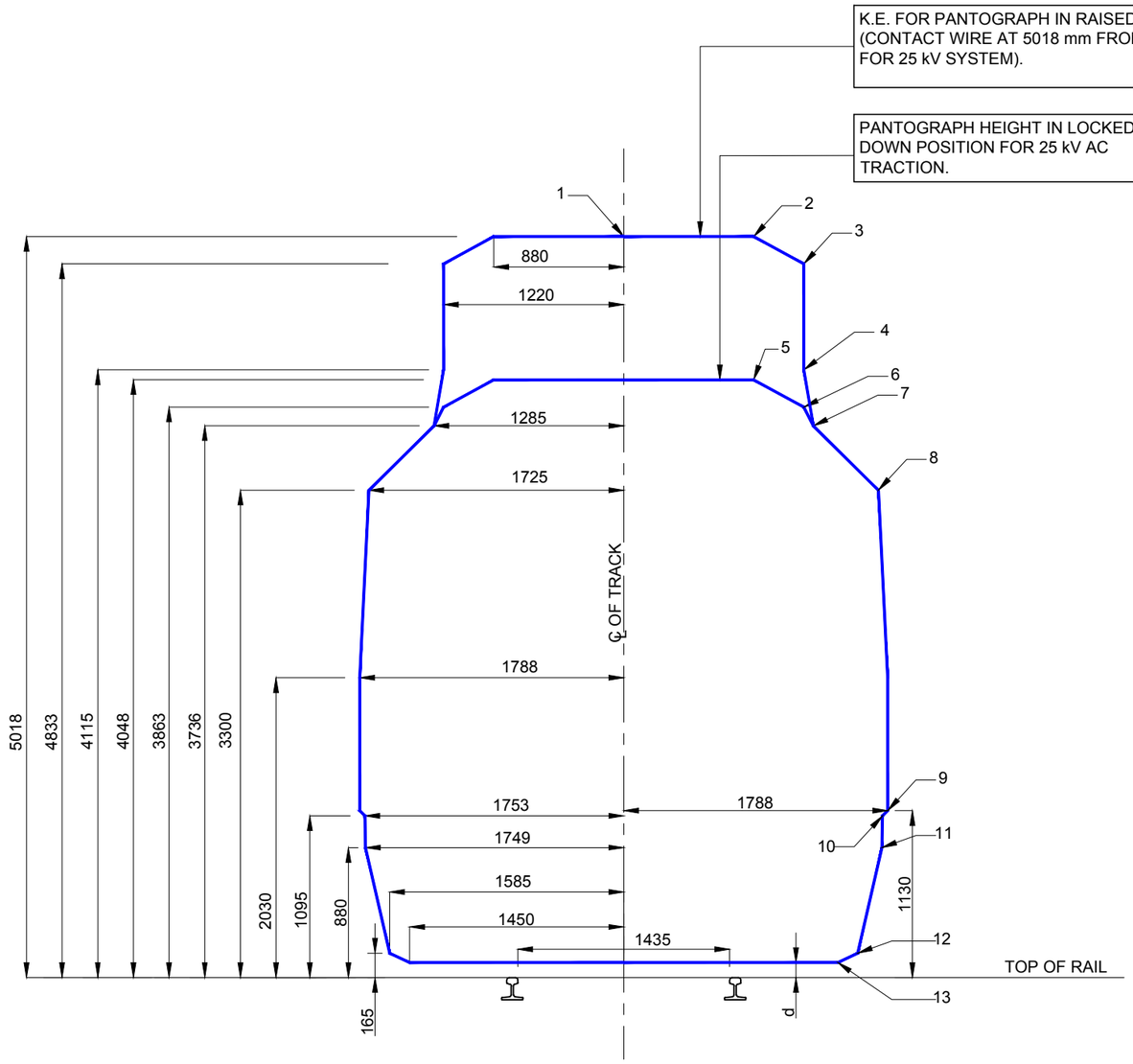


FIG. MMRC-1
Ref. SOD Para 1.5 (a) & 3.1.3 (ii)

CO-ORDINATES OF K.E		
	X	Y
1	0	5018
2	880	5018
3	1220	4833
4	1220	4115
5	880	4048
6	1220	3863
7	1285	3736
8	1725	3300
9	1788	1130
10	1753	1095
11	1749	880
12	1585	165
13	1450	d

NOTES :

1. ALL DIMENSION ARE IN mm UNLESS OTHERWISE STATED.
2. HORIZONTAL CLEARANCE DUE TO CURVES SHALL BE ADDED IF PLATFORM IN CURVE.
3. THE KINEMATIC ENVELOPE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION.
4. CONDUCTOR HEIGHT ABOVE RAIL LEVEL SHALL ALSO TAKE INTO CONSIDERATION PRESCRIBED ELECTRICAL CLEARANCES BETWEEN ALL LIVE OVERHEAD EQUIPMENT AND PANTOGRAPH / VEHICLE AND PARTS THEREOF.
5. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT IS OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUT SIDE THE WHEEL GAUGE FACE.
6. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 6 ABOVE,AND 50mm UNDER DYNAMIC CONDITION. REFERENCE : SOD PARA 1.5 AND SOD PARA 3.1.3(ii)
7. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 95KMPH DESIGN SPEED AND UPTO 85KMPH OPERATING SPEED MAXIMUM

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GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

REV.	DATE	PREP.	APPR.	DESCRIPTION
C	16.01.2018	NKV	RJM	COMMENT RDSO 08.12.17 INCORPORATED
B	02.06.2017	HRM	RJM	COMMENT RDSO 23.05.17 INCORPORATED
A	11-01-2017	KCS	RJM	FIRST ISSUE

PRINTED ON 02-JUN-17

	NAME	SIGN
DRAWN BY	NKV	
FOR RS	ISAO	
APPROVED BY	RJM	

DATE 16-01-2018
SCALE 1:40 (A3 SIZE)

PROJECT: **MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ**
DRAWING TITLE: **KINEMATIC ENVELOPE:AT - GRADE AND ELEVATEDSECTION ON LEVEL OR CONSTANT GRADE TANGENT TRACK**
DRAWING NO: **MM3-GC-SOD-GD-0161001**

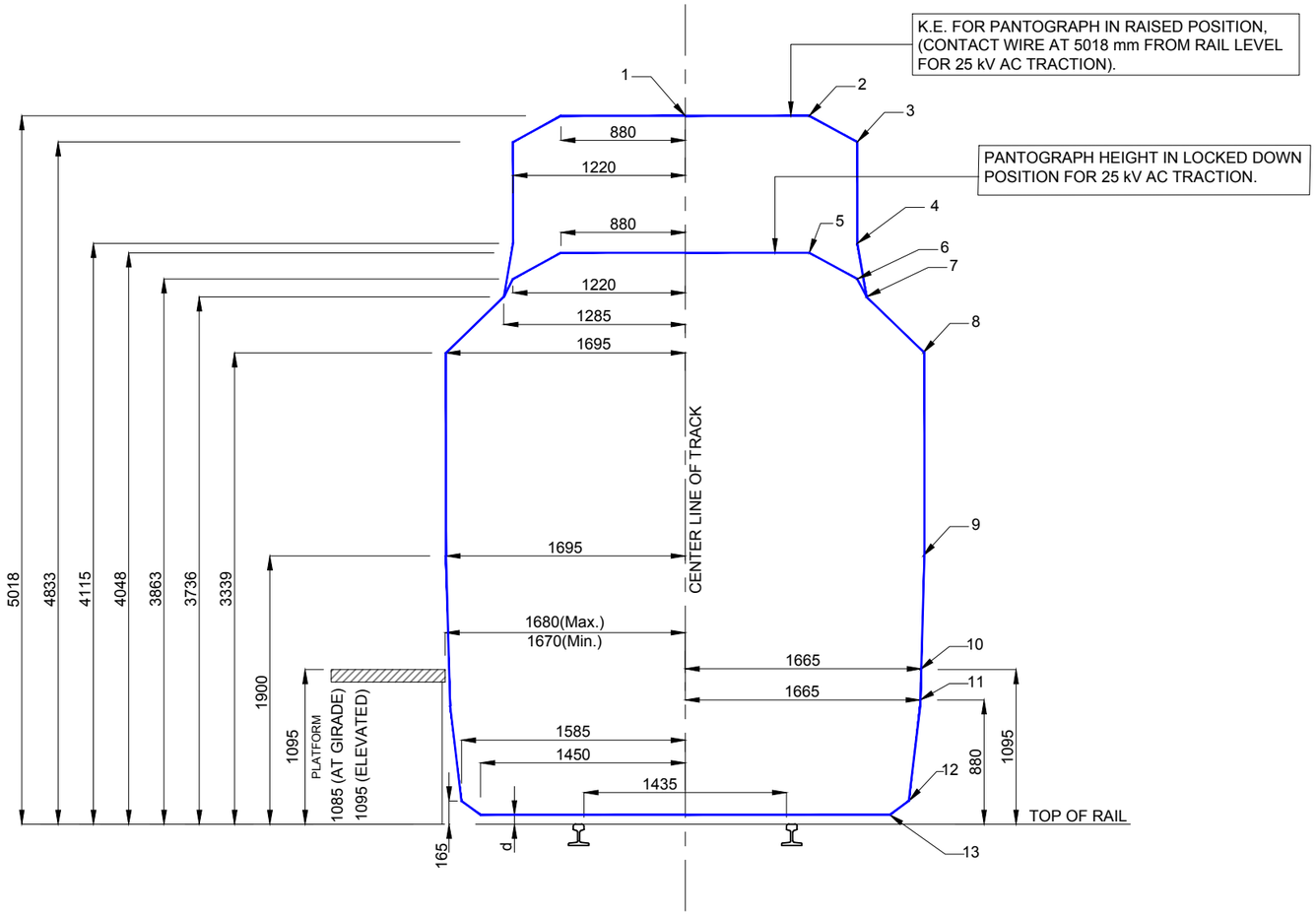

FIG. MMRC-1A
Ref. SOD Para 3.1.3 (iv)

CO-ORDINATES OF K.E		
	X	Y
1	0	5018
2	880	5018
3	1220	4833
4	1220	4115
5	880	4048
6	1220	3863
7	1285	3736
8	1695	3329
9	1695	1900
10	1665	1095
11	1665	880
12	1585	165
13	1450	d

NOTES :

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
2. HORIZONTAL CLEARANCE DUE TO CURVES SHALL BE ADDED IF PLATFORM IN CURVE.
3. THE KINEMATICS ENVELOPE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE MOTION.
4. KINEMATICS ENVELOPE IS VALID FOR SPEED UPTO 70 KMPH OPERATING SPEED AND WIND SPEED OF 70 KMPH MAXIMUM.
5. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
6. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 5 ABOVE, AND 50mm UNDER DYNAMIC CONDITION.
7. THE MAXIMUM AND MINIMUM DISTANCE OF PLATFORM EDGE FROM CENTER LINE OF TRACK SHALL BE AS PER SOD PARA 2.2.1 AND SOD PARA 2.2.2 RESPECTIVELY.
8. THE MAXIMUM AND MINIMUM HEIGHT OF PLATFORM RAIL LEVEL SHALL BE AS PER SOD PARA 2.2.3 .

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GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

REV.	DATE	PREP.	APPR.	DESCRIPTION
B	02.06.2017	HRM	RJM	COMMENT RDSO 23.05.17 INCORPORATED
A	11.01.2017	KCS	RJM	FIRST ISSUE

	NAME	SIGN
DRAWN BY	HRM	
FOR RS	ITS	
CHECKED BY	MVD	
APPROVED BY	RJM	

DATE 02-06-2017

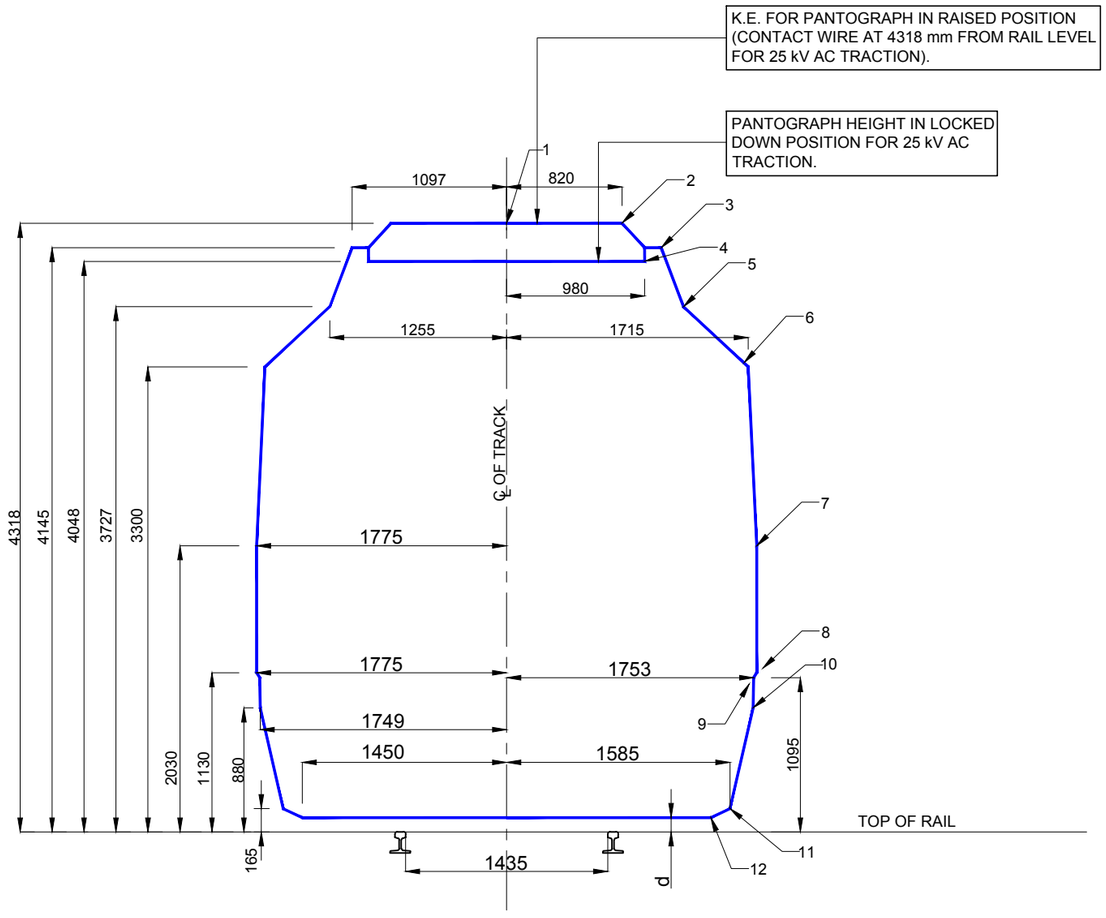
SCALE 1:40 (A3 SIZE)

PROJECT: **MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ**

DRAWING TITLE: **KINEMATIC ENVELOPE:3.2m WIDE CAR, STANDARD GAUGE, AT GRADE AND ELEVATED SECTIONS ON LEVEL OR CONSTANT GRADE TANGENT TRACK AT PLATFORM**

DRAWING NO: **MM3-GC-SOD-GD-0163001**

PRINTED ON 02-JUN-17



CO-ORDINATES OF K.E		
	X	Y
1	0	4318
2	820	4318
3	1097	4145
4	980	4048
5	1255	3727
6	1715	3300
7	1775	2030
8	1775	1130
9	1753	1095
10	1749	880
11	1585	165
12	1450	d

FIG. MMRC-1 (TNL)
Ref. SOD Para 1.5 (b) & 3.1.3 (i)

NOTES :

1. ALL DIMENSION ARE IN mm UNLESS OTHERWISE STATED.
2. HORIZONTAL CLERANCE DUE TO CURVES SHALL BE ADDED IF PLATFORM IN CURVE.
3. THE KINEMATICS ENVELOPE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE MOTION.
4. KINEMATICS ENVELOPE IS VALID FOR SPEED UPTO 70 KMPH OPERATING SPEED.
5. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
6. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 5 ABOVE, AND 50mm UNDER DYNAMIC CONDITION.
7. THE MAXIMUM AND MINIMUM DISTANCE OF PLATFORM EDGE FROM CENTER LINE OF TRACK SHALL BE AS PER SOD PARA 2.2.1 AND SOD PARA 2.2.2 RESPECTIVELY.
8. THE MAXIMUM AND MINIMUM HEIGHT OF PLATFORM RAIL LEVEL SHALL BE AS PER SOD PARA 3.1.3 (i)
7. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 95KMPH DESIGN SPEED AND UPTO 85KMPH OPERATING SPEED MAXIMUM

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GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

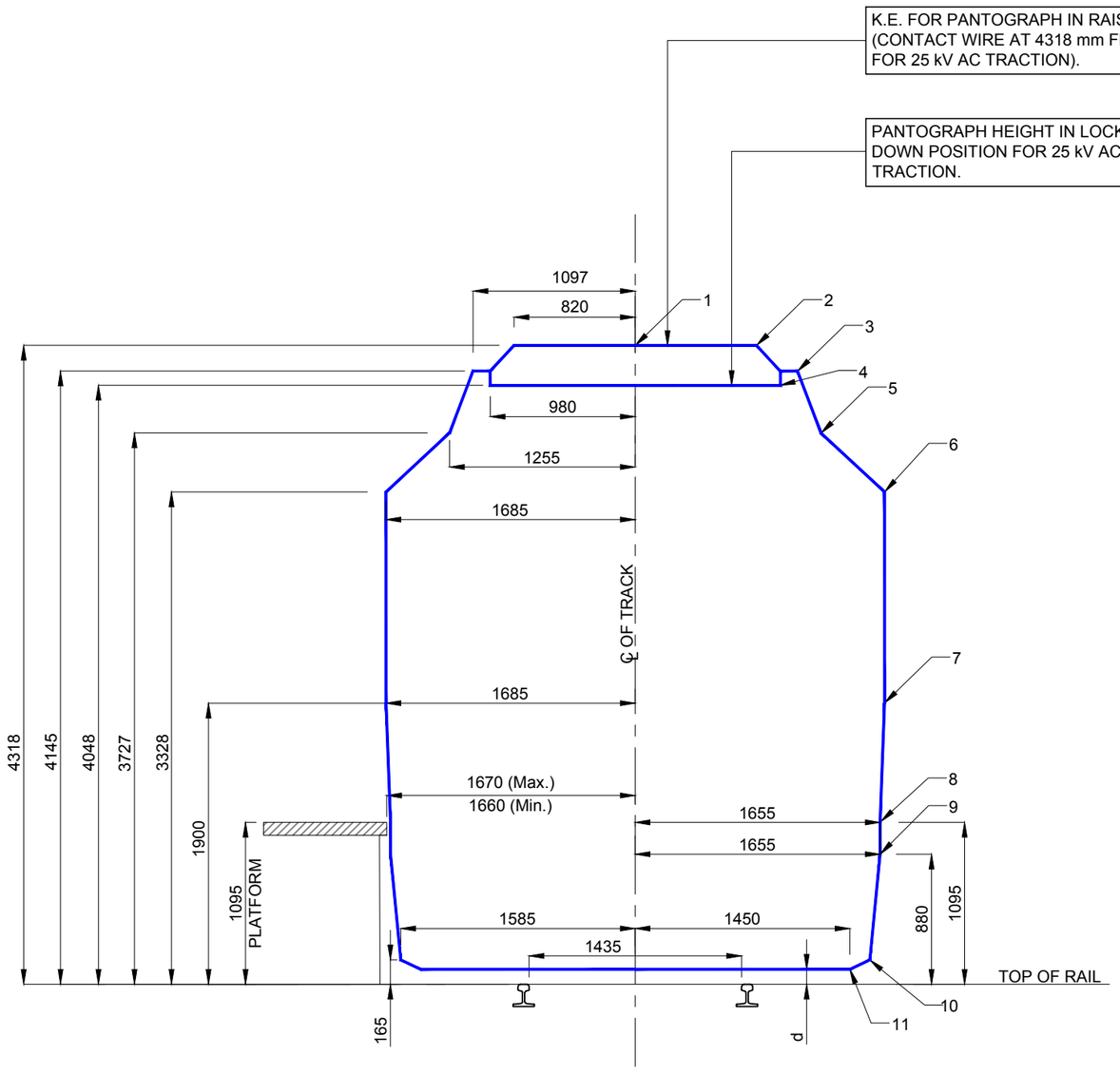
REV.	DATE	PREP.	APPR.	DESCRIPTION
C	16.01.2018	NKV	RJM	COMMENT RDSO 08.12.17 INCORPORATED
B	02.06.2017	HRM	RJM	COMMENT RDSO 23.05.17 INCORPORATED
A	11.01.2017	KCS	RJM	FIRST ISSUE

	NAME	SIGN
DRAWN BY	NKV	
FOR RS	ISAO	
APPROVED BY	RJM	

DATE 16-01-2018
SCALE 1:40 (A3 SIZE)

PROJECT: **MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ**
DRAWING TITLE: **KINEMATIC ENVELOPE : UNDERGROUND SECTIONS (TUNNELS) ON LEVEL OR CONSTANT GRADE TANGENT TRACK**
DRAWING NO: **MM3-GC-SOD-GD-0161002**

PRINTED ON 02-JUN-17



CO-ORDINATES OF K.E		
	X	Y
1	0	4318
2	820	4318
3	1097	4145
4	980	4048
5	1255	3727
6	1685	3328
7	1685	1900
8	1655	1095
9	1655	880
10	1585	165
11	1450	d

FIG. MMRC-1A (TNL)
Ref. SOD Para 3.1.3(v)

NOTES :

1. ALL DIMENSION ARE IN mm UNLESS OTHERWISE STATED.
2. HORIZONTAL CLEARANCE DUE TO CURVES SHALL BE ADDED IF PLATFORM IN CURVE.
3. THE KINEMATICS ENVELOPE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE MOTION.
4. KINEMATICS ENVELOPE IS VALID FOR SPEED UPTO 70 KMPH OPERATING SPEED.
5. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
6. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 5 ABOVE, AND 50mm UNDER DYNAMIC CONDITION.
7. THE MAXIMUM AND MINIMUM DISTANCE OF PLATFORM EDGE FROM CENTER LINE OF TRACK SHALL BE AS PER SOD PARA 2.2.1 AND SOD PARA 2.2.2 RESPECTIVELY.
8. THE MAXIMUM AND MINIMUM HEIGHT OF PLATFORM RAIL LEVEL SHALL BE AS PER SOD PARA 2.2.3

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GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

REV.	DATE	PREP.	APPR.	DESCRIPTION
B	02.06.2017	HRM	RJM	COMMENT RDSO 23.05.17 INCORPORATED
A	11.01.2017	KCS	RJM	FIRST ISSUE

	NAME	SIGN
DRAWN BY	HRM	
FOR RS	ITS	
CHECKED BY	MVD	
APPROVED BY	RJM	

DATE 02-06-2017

SCALE 1:40 (A3 SIZE)

PROJECT **MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ**

DRAWING TITLE **KINEMATIC ENVELOPE:3.2m WIDE CAR, STANDARD GAUGE UNDERGROUND SECTIONS ON LEVEL OR CONSTANT GRADE TANGENT TRACK AT PLATFORM**

DRAWING NO **MM3-GC-SOD-GD-0161002**

PRINTED ON 02-JUN-17

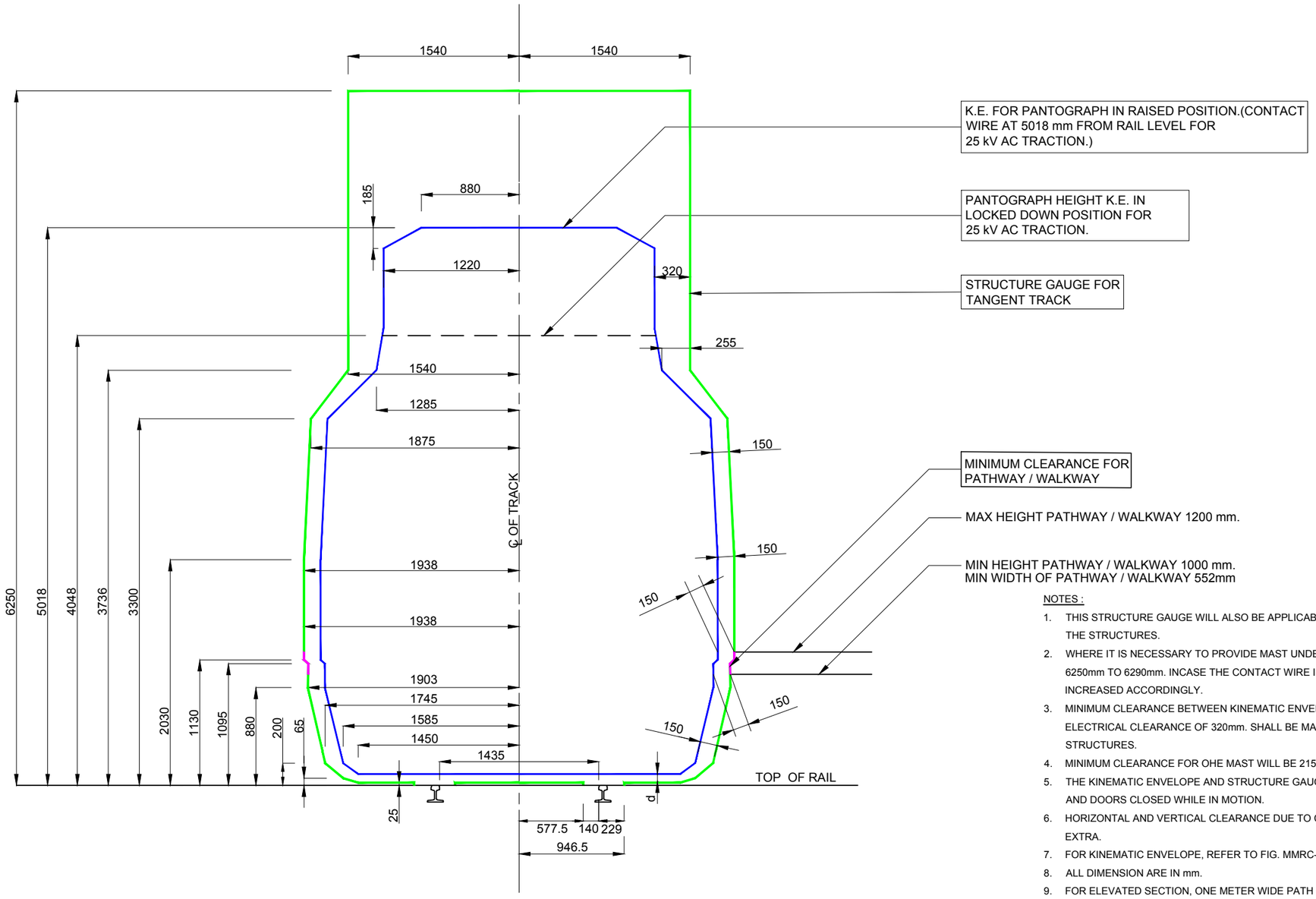

FIG. MMRC-2
Ref. SOD Para 1.4.1(a) & Para 1.10

NOTES :

1. THIS STRUCTURE GAUGE WILL ALSO BE APPLICABLE FOR ROBs /FOBs AT STATIONS WITHOUT THE MAST UNDER THE STRUCTURES.
2. WHERE IT IS NECESSARY TO PROVIDE MAST UNDER THE ROB/FOB, THE HEIGHT SHALL BE INCREASED FROM 6250mm TO 6290mm. INCASE THE CONTACT WIRE IS HIGHER, THE HEIGHT OF THE ROB/FOB SHALL BE INCREASED ACCORDINGLY.
3. MINIMUM CLEARANCE BETWEEN KINEMATIC ENVELOPE AND STRUCTURE GAUGE WILL BE 150mm. MINIMUM ELECTRICAL CLEARANCE OF 320mm. SHALL BE MAINTA INED BETWEEN 25 KV LIVE PARTS AND THE EARTHED STRUCTURES.
4. MINIMUM CLEARANCE FOR OHE MAST WILL BE 2150 mm FROM THE CENTRE OF TRACK.
5. THE KINEMATIC ENVELOPE AND STRUCTURE GAUGE ARE VALID FOR ROLLING STOCK WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION.
6. HORIZONTAL AND VERTICAL CLEARANCE DUE TO CURVES INCLUDING VERTICAL CURVE AND CANT SHALL BE EXTRA.
7. FOR KINEMATIC ENVELOPE, REFER TO FIG. MMRC-1
8. ALL DIMENSION ARE IN mm.
9. FOR ELEVATED SECTION, ONE METER WIDE PATH WAY / WALK WAY WITH PARAPETS IS TO BE PROVIDE AT COACH FLOOR HEIGHT.
10. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
11. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 10 ABOVE,AND 50mm UNDER DYNAMIC CONDITION.
7. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 95KMPH DESIGN SPEED AND UPTO 85KMPH OPERATING SPEED MAXIMUM
8.

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GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

REV.	DATE	PREP.	APPR.	DESCRIPTION
D	16.01.2018	NKV	RJM	COMMENT RDSO 08.12.17 INCORPORATED
C	23.10.2017	HRM	RJM	COMMENT RDSO 05.09.17 INCORPORATED
B	02.06.2017	HRM	RJM	COMMENT RDSO 23.05.17 INCORPORATED
A	11.01.2017	KCS	RJM	FIRST ISSUE

	NAME	SIGN
DRAWN BY	NKV	
FOR RS	ISAO	
APPROVED BY	RJM	

DATE: 16-01-2018
SCALE: 1:40 (A3 SIZE)

PROJECT: **MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ**
DRAWING TITLE: **STRUCTURE GAUGE : AT - GRADE AND ELEVATED SECTIONS ON LEVEL OR CONSTANT GRADE TANGENT TRACK**
DRAWING NO: **MM3-GC-SOD-GD-0163001**

PRINTED ON 23-OCT-17

MMRC-2 (BOX TNL)

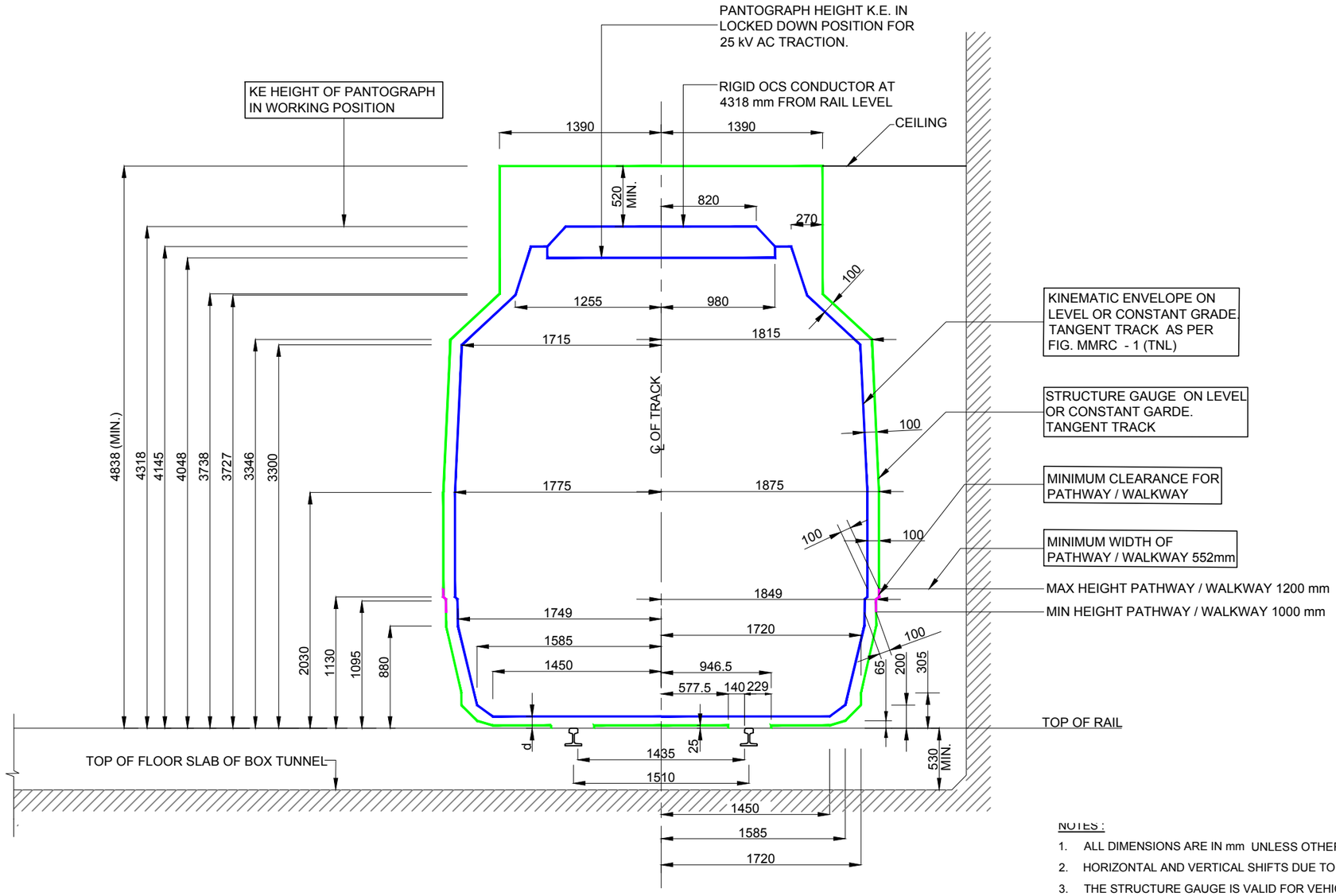

FIG. MMRC-2 (BOX TNL)
Ref. SOD Para 1.4.1(b) (ii) & Para 1.10

NOTES :

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
2. HORIZONTAL AND VERTICAL SHIFTS DUE TO CURVES, INCLUDING VERTICAL CURVES AND CANT SHALL BE ADDED.
3. THE STRUCTURE GAUGE IS VALID FOR VEHICALS WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION.
4. STRUCTURE GAUGE FOR CURVE DOES NOT INCLUDE LATERAL SHIFT (Lean) DUE TO CANT.
5. MINIMUM CLEARANCE BETWEEN KINEMATIC ENVELOPE AND STRUCTURE GAUGE = 100 mm. THE ELECTRICAL CLEARANCE FROM 25 KV LIVE PARTS AND EARTHED STRUCTURE SHALL BE 270 mm.
6. VERTICAL THROW DUE TO VERTICAL CURVE HAS NOT BEEN SHOWN IN THE FIGURE AND SHALL BE EXTRA.
7. FOR DETAILS OF KINEMATIC ENVELOPE REFER TO FIG. MMRC - 1 (TNL)
8. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
9. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 9 ABOVE,AND 50mm UNDER DYNAMIC CONDITION.
7. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 95KMPH DESIGN SPEED AND UPTO 85KMPH OPERATING SPEED MAXIMUM

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GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

REV.	DATE	PREP.	APPR.	DESCRIPTION
D	16.01.2018	NKV	RJM	COMMENT RDSO 08.12.17 INCORPORATED
C	23.10.2017	HRM	RJM	COMMENT RDSO 05.09.17 INCORPORATED
B	02.06.2017	HRM	RJM	COMMENT RDSO 23.05.17 INCORPORATED
A	11.01.2017	KCS	RJM	FIRST ISSUE

	NAME	SIGN
DRAWN BY	NKV	
FOR RS	ISAO	
APPROVED BY	RJM	

DATE: 16-01-2018
SCALE: 1:40 (A3 SIZE)

PROJECT: **MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ**

DRAWING TITLE: **STRUCTURE GAUGE: UNDERGROUND SECTIONS (RECTANGULAR BOX STRUCTURE) ON LEVEL OR CONSTANT GRADE TANGENT TRACK**

DRAWING NO: **MM3-GC-SOD-GD-0163002**

PRINTED ON 23-OCT-17

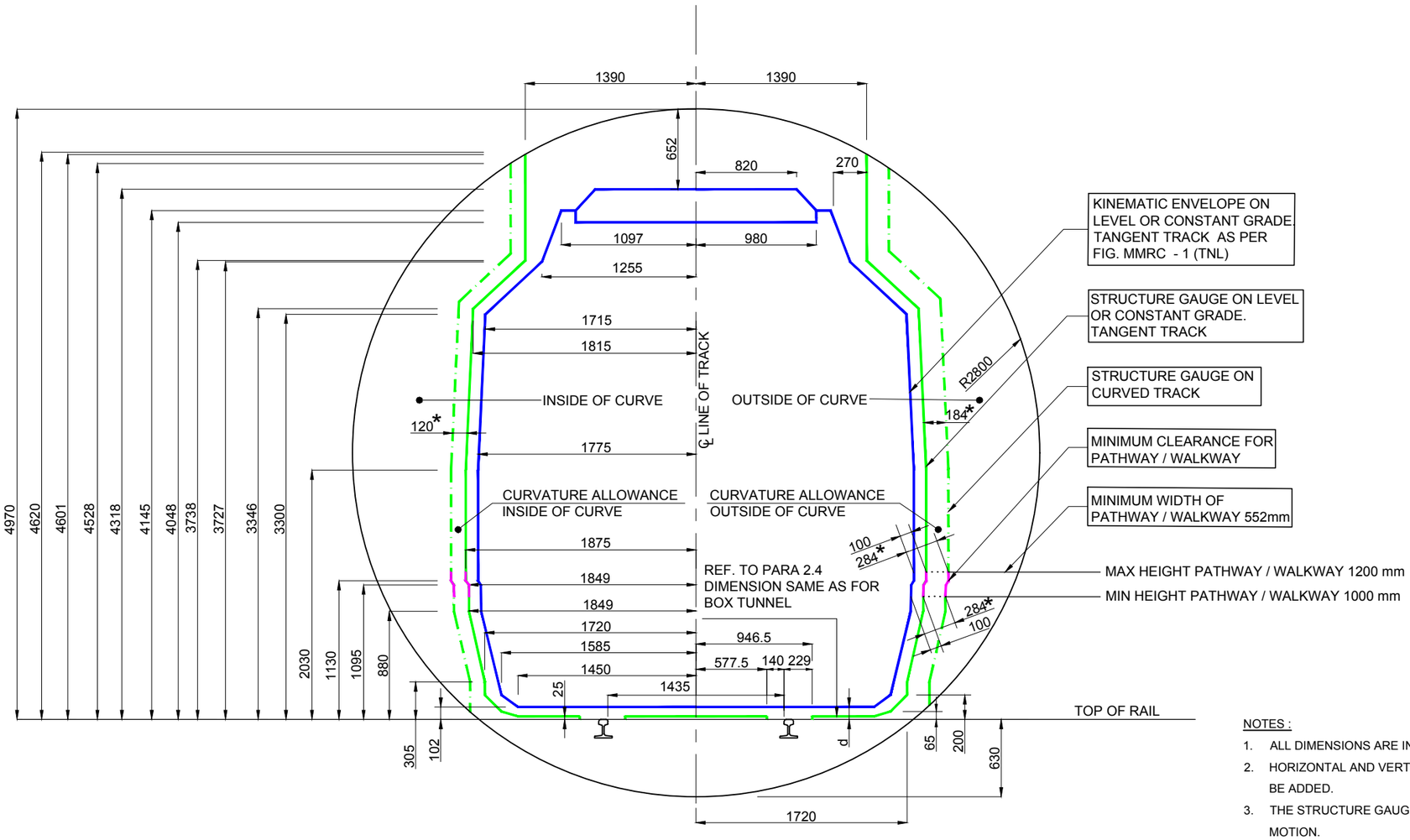

FIG. MMRC-2 (CIRCULAR TNL)
Ref. SOD Para 1.4.1(b) (i) & Para 1.10

*Structure gauge / KE on inside or outside of curve, here as an example R = 200 m (outside)

NOTES :

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
2. HORIZONTAL AND VERTICAL SHIFTS DUE TO CURVES, INCLUDING VERTICAL CURVES AND CANT SHALL BE ADDED.
3. THE STRUCTURE GAUGE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION.
4. STRUCTURE GAUGE FOR CURVE DOES NOT INCLUDE LATERAL SHIFT (Lean) DUE TO CANT.
5. CANT SHALL BE PROVIDED BY RISING OUTER RAIL ONLY AND SHIFTING OF THE CIRCULAR TUNNEL TOWARDS INSIDE OF THE CURVE AND UPWARDS. THIS WILL BE SAME AS ROTATING THE CIRCULAR TUNNEL ABOUT THE MID POINT OF TOP OF INNER RAIL.
6. MINIMUM CLEARANCE BETWEEN KINEMATIC ENVELOPE AND STRUCTURE GAUGE = 100 mm. THE ELECTRICAL CLEARANCE FROM 25 KV LIVE PARTS AND EARTHED STRUCTURE SHALL BE 270 mm.
7. VERTICAL THROW DUE TO VERTICAL CURVE HAS NOT BEEN SHOWN IN THE FIGURE AND SHALL BE EXTRA.
8. FOR DETAILS OF KINEMATIC ENVELOPE REFER TO FIG No. MMRC - 1 (TNL)
9. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
10. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 10 ABOVE,AND 50 mm UNDER DYNAMIC CONDITION.
11. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 95KMPH DESIGN SPEED AND UPTO 85KMPH OPERATING SPEED MAXIMUM

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GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

REV.	DATE	PREP.	APPR.	DESCRIPTION
D	16.01.2018	NKV	RJM	COMMENT RDSO 08.12.17 INCORPORATED
C	23.10.2017	HRM	RJM	COMMENT RDSO 05.09.17 INCORPORATED
B	02.06.2017	HRM	RJM	COMMENT RDSO 23.05.17 INCORPORATED
A	11.01.2017	KCS	RJM	FIRST ISSUE

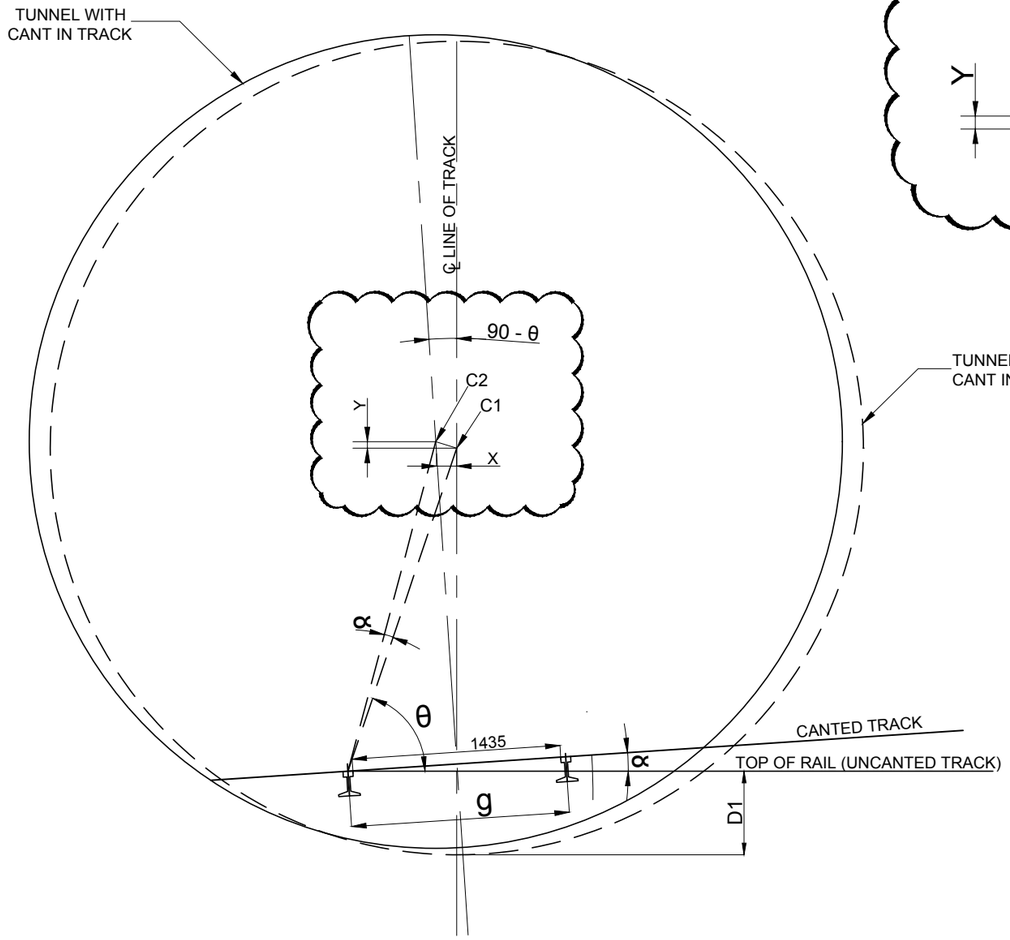
	NAME	SIGN
DRAWN BY	NKV	
FOR RS	ISAO	
APPROVED BY	RJM	

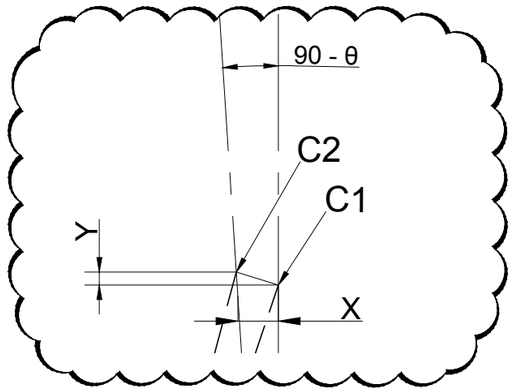
DATE 16-01-2018
SCALE 1:40 (A3 SIZE)

PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ
DRAWING TITLE: STRUCTURE GAUGE: UNDERGROUND SECTIONS (CIRCULAR TUNNEL) ON LEVEL OR CONSTANT GRADE TANGENT TRACK
DRAWING NO: MM3-GC-SOD-GD-0163003

PRINTED ON 23-OCT-17

MMRC-3
LATERAL AND VERTICAL SHIFT CENTRE OF CIRCULAR TUNNEL
(WITH D1 = 630mm, refer to APPENDIX 3)





C1 = CENTRE OF TUNNEL FOR UNCANTED TRACK

C2 = CENTRE OF TUNNEL FOR CANTED TRACK

FIG. MMRC-3
Ref. SOD Para 1.7.1(B)(b)

Remarks:

1) The cant is provided by rotating the outer rail, i.e. rotating the track around the mid point of the top of inner rail.
2) X = Lateral shift of the centre of tunnel towards the inside of curvature.

$$X = [\, 2 * (r - D1) / (\sin \theta) * \sin \alpha/2 \,] * \cos (90 - \theta - \alpha/2)$$

3) Y = Vertical shift of the centre of the tunnel upwards.

$$Y = [\, 2 * (r - D1) / (\sin \theta) * \sin \alpha/2 \,] * \sin (90 - \theta \alpha /2)$$

$\tan \theta = (r - D1)/(g/2)$
$\theta = \tan^{-1}[(r - D1)/(g/2)]$
$\sin \alpha = \text{cant}/g$
$\alpha = \sin^{-1}(\text{cant}/g)$
g= distance center to center of the rails

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GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

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APPROVED BY	RJM	

DATE 02-06-2017

SCALE 1:40 (A3 SIZE)

PROJECT: **MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ**

DRAWING TITLE: **SHIFT OF THE CENTRE OF CIRCULAR TUNNEL DUE TO ROTATION OF TUNNEL FOR CANT**

DRAWING NO: **MM3-GC-SOD-GD-0165001**

PRINTED ON 02-JUN-17

CANT EFFECT ON STRUCTURE GAUGE
AT - GRADE OR ELEVATED SECTIONS
(REFER TO APPENDIX 4)

FIG. MMRC-4
Ref. SOD Para 1.7.1(B) & 1.8.2 (b)

Where:

g = 1510 mm

h = Height above rail level measured perpendicular to plane of track.

E1 = [ab + (h x tan α)] x cos α

F1 = [Ab - (h x tan α)] x cos α

H1 = (Ca / 2) + (h / cos α) + (Ab - h x tan α) x sin α

H2 = (Ca / 2) + (h / cos α) - (ab + h x tan α) x sin α

ab = Ab = Distance from center line of vehicle to Kinematic Envelope for Tangent track at height "h" from rail level.

GENERAL CONSULTANCY SERVICES
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COLABA- BANDRA-SEEPZ

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APPROVED BY	RJM	

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SCALE 1:40 (A3 SIZE)

PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ
DRAWING TITLE: CANT EFFECT ON STRUCTURE GAUGE: AT- GRADE OR ELEVATED SECTIONS
DRAWING NO: MM3-GC-SOD-GD-0164001

PRINTED ON 02-JUN-17

MMRC - 4 (BOX TNL)
CANT EFFECT ON STRUCTURE GAUGE
UNDERGROUND SECTIONS (RECTANGULAR BOX TUNNEL)
REFER TO APPENDIX 4 (BOX TNL)

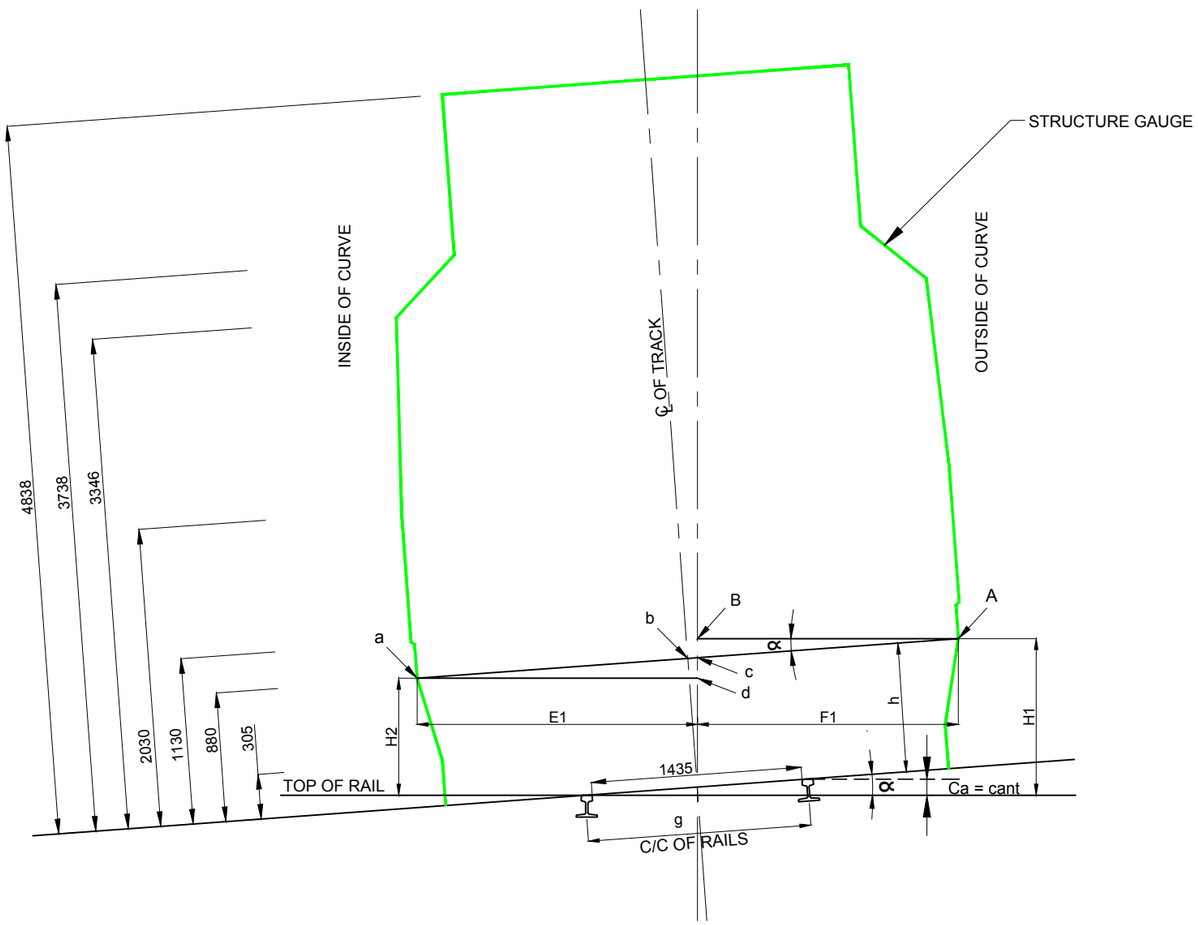

FIG. MMRC-4 (BOX TNL)
Ref. SOD Para 1.7.1(B) (a) & 1.8.2 (b)

Where:

g = 1510 mm Rail centre to centre distance

h = Height above rail level measured perpendicular to plane of track.

E1 = [ab + (h x tan α)] x cos α

F1 = [Ab - (h x tan α)] x cos α

H1 = (Ca / 2) + (h / cos α) + (Ab - h x tan α) x sin α

H2 = (Ca / 2) + (h / cos α) - (ab + h x tan α) x sin α

ab=Ab = Distance from center line of vehicle to Structure Gauge for Tangent track at height "h" from rail level.

NOTE:

ALL DIMENSION ARE IN mm UNLESS OTHERWISE STATED.

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GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

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APPROVED BY	RJM	

DATE: 02-06-2017
SCALE: 1:40 (A3 SIZE)

PROJECT: **MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ**

DRAWING TITLE: **CANT EFFECT ON STRUCTURE GAUGE: UNDERGROUND SECTIONS (RECTANGULAR BOX TUNNEL)**

DRAWING NO: **MM3-GC-SOD-GD-0164002**

PRINTED ON 02-JUN-17

MMRC - 5
CANT EFFECT ON KINEMATIC ENVELOPE
AT-GRADE OR ELEVATED SECTIONS
(REFER TO APPENDIX 5)

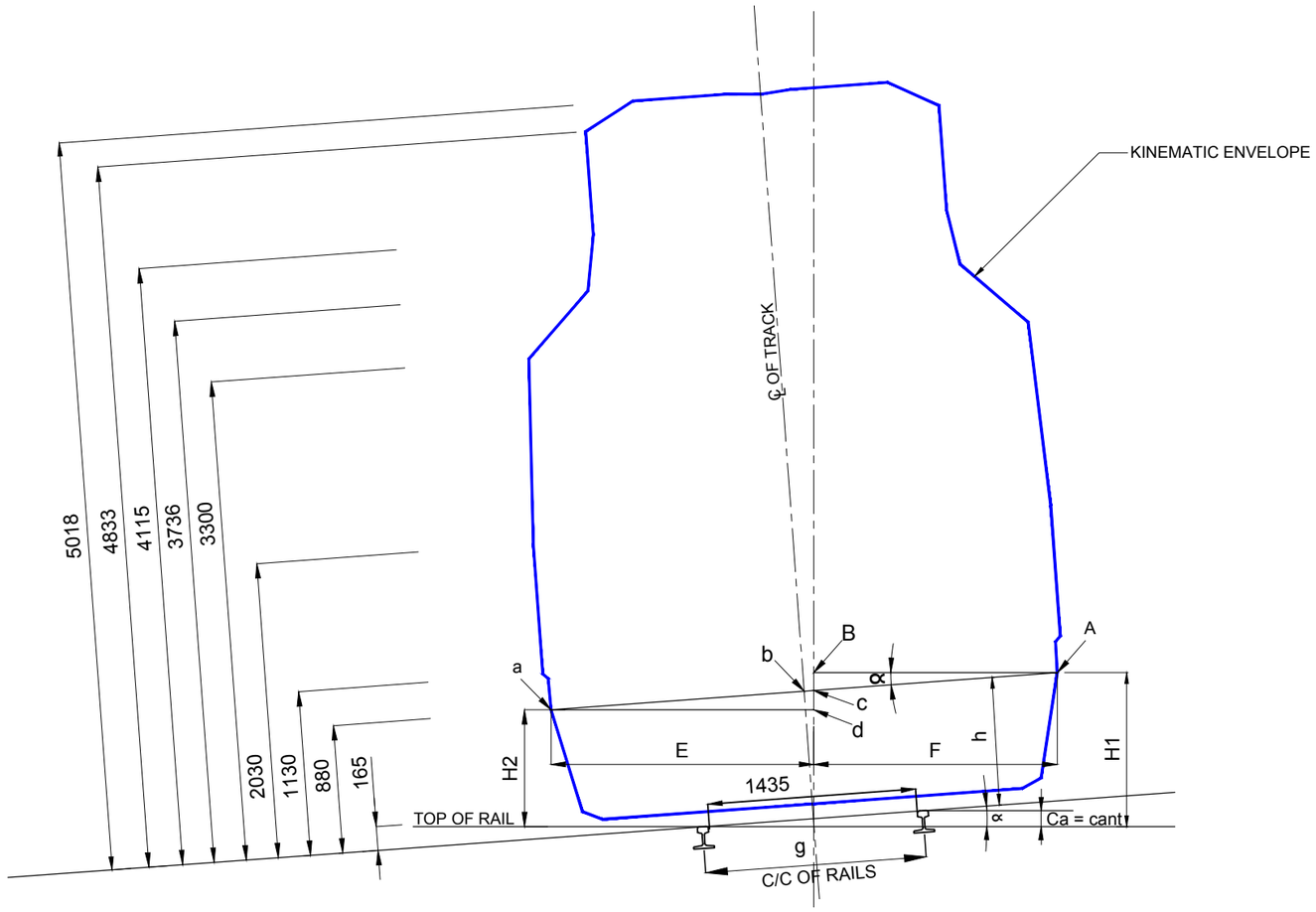

FIG. MMRC-5
Ref.SOD Para 1.8.1

Where:
g =1510 mm Rail centre to centre distance
h = Height above rail level measured perpendicular to plane of track.
E = [ab + (h x tan α)] x cos α

F = [Ab - (h x tan α)] x cos α

H1 = (Ca / 2) + (h / cos α) + (Ab - h x tan α) x sin α

H2 = (Ca / 2) + (h / cos α) - (ab + h x tan α) x sin α
ab=Ab = Distance from center line of vehicle to Kinematic Envelope for Tangent track at height "h" from rail level.

NOTE:

1. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 95KMPH DESIGN SPEED AND UPTO 85KMPH OPERATING SPEED MAXIMUM

GENERAL CONSULTANCY SERVICES
FOR MUMBAI METRO RAIL PROJECT, LINE 3
COLABA- BANDRA-SEEPZ

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FOR RS	ISAO	
APPROVED BY	RJM	

DATE 16-01-2018
SCALE 1:40 (A3 SIZE)
PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ
DRAWING TITLE: CANT EFFECT ON KINEMATIC ENVELOPE: AT-GRADE OR ELEVATED SECTIONS
DRAWING NO: MM3-GC-SOD-GD-0162001

PRINTED ON 02-JUN-17

MMRC-5 (TNL)
CANT EFFECT ON KINEMATIC ENVELOPE
UNDERGROUND SECTIONS
REFER TO APPENDIX 5 (TNL)

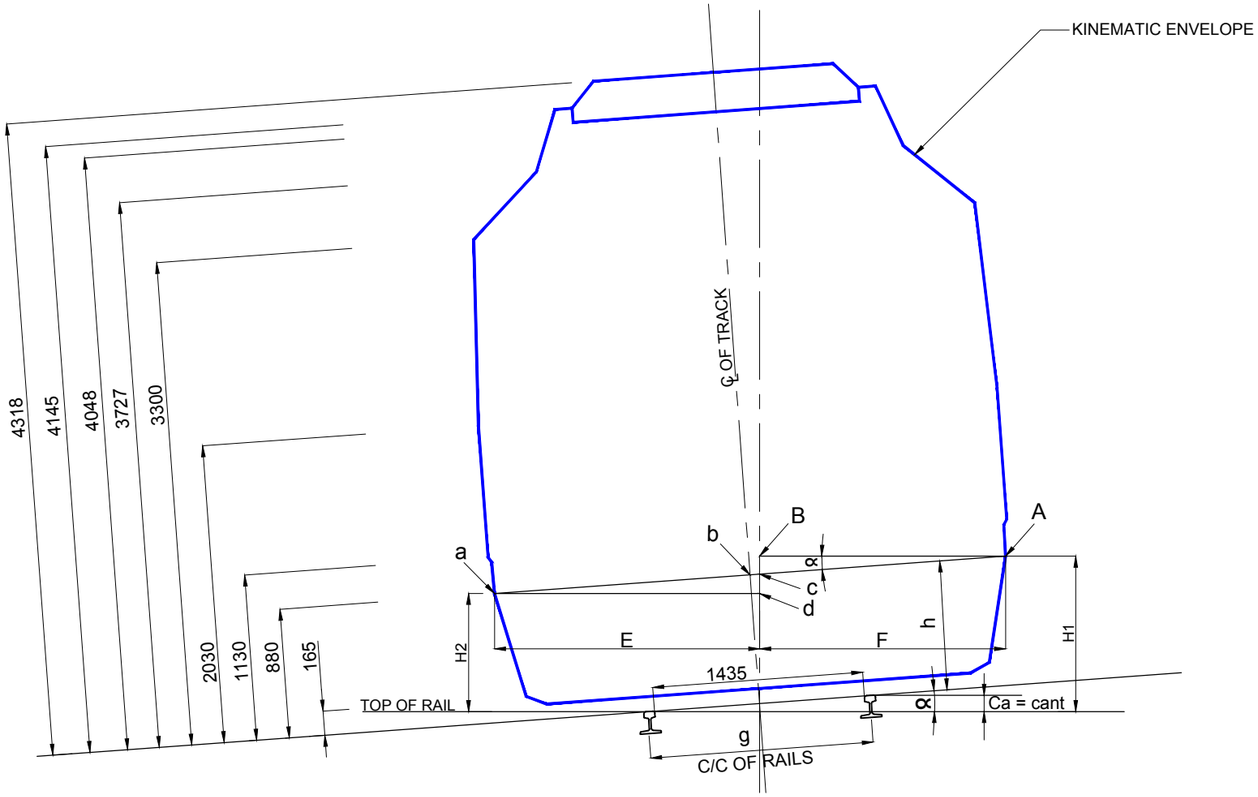

FIG. MMRC-5(TNL)
Ref. SOD Para 1.8.1

Where:

g = 1510 mm Rail centre to centre distance

h = Height above rail level measured perpendicular to plane of track.

E = [ab + (h x tan α)] x cos α

F = [Ab - (h x tan α)] x cos α

H1 = (Ca / 2) + (h / cos α) + (Ab - h x tan α) x sin α

H2 = (Ca / 2) + (h / cos α) - (ab + h x tan α) x sin α

ab = Ab = Distance from center line of vehicle to Kinematic Envelope for Tangent track at height "h" from rail level.

NOTE:

1. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 95KMPH DESIGN SPEED AND UPTO 85KMPH OPERATING SPEED MAXIMUM

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GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

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DATE 16-01-2018
SCALE 1:40 (A3 SIZE)

PROJECT: **MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ**
DRAWING TITLE: **CANT EFFECT ON KINEMATIC ENVELOPE: UNDERGROUND SECTIONS**
DRAWING NO: **MM3-GC-SOD-GD-0162002**

PRINTED ON 02-JUN-17

MMRC - 6
EFFECT OF VERTICAL CURVES ON STRUCTURAL GAUGE
REFER TO APPENDIX 6

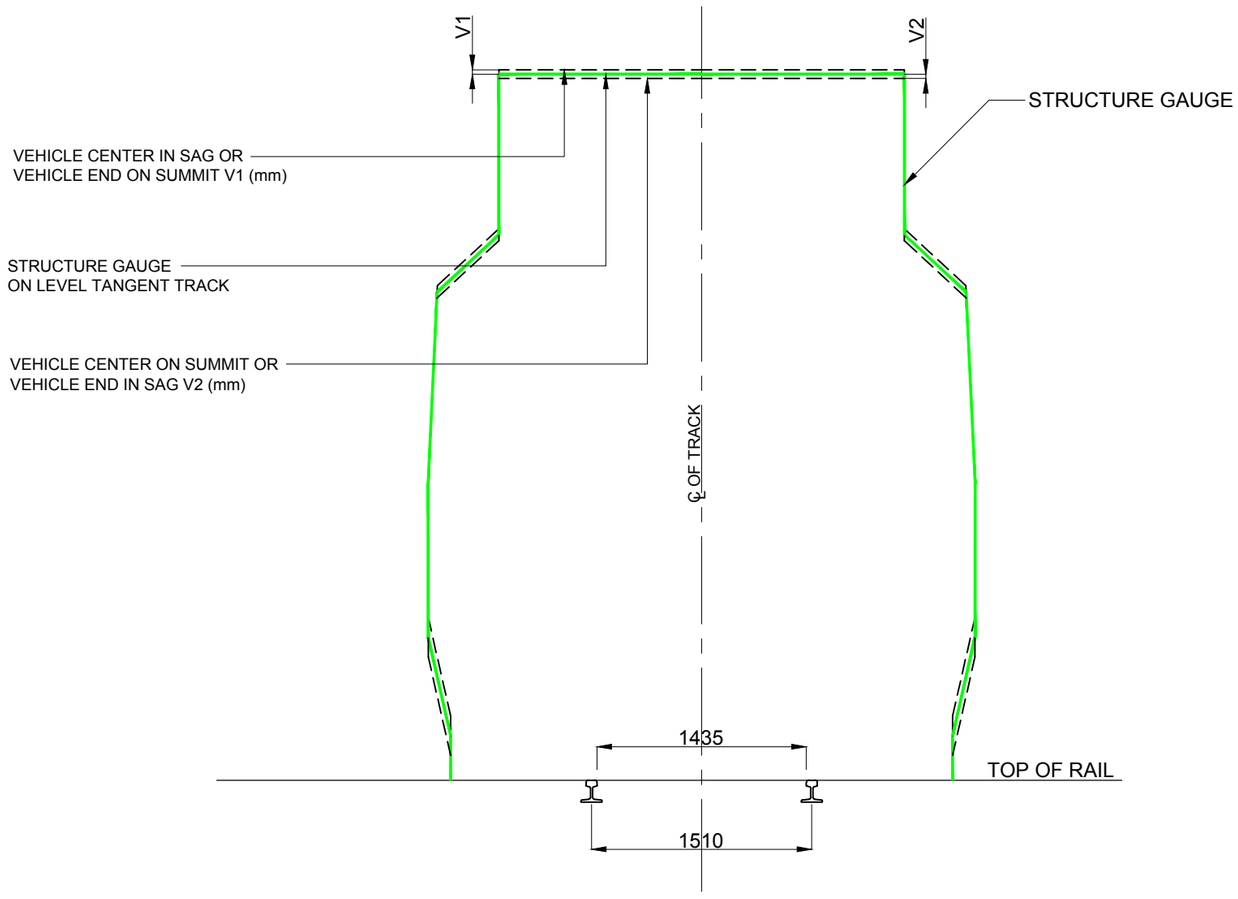

FIG. MMRC-6
Ref. SOD Para 1.7.1 (B) (c)

Mid throw (in mm) V1 = (125 x C²) /R= 28500/R

Where 'C' is the distance between bogie centers = 14.750+0.350=15.100m OR 14.750 - 0.350=14.400 m. .

The worst case will be with C=15.100 m

R is the radius of curve in metres.

End Throw (in mm) V2 = (125 x C1²) /R - (125xC²)/R = 34635/R

Where 'C' is the distance between bogie centers = 14.750+0.350=15.100m OR 14.750-0.350=14.400m .

Worst case will be with C=14.400

'C1' is length of coach in meters = 22.010 m and 'R' is radius of curve in meters.

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APPROVED BY	RJM	

DATE 02-06-2017
SCALE 1:40 (A3 SIZE)

PROJECT: **MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ**
DRAWING TITLE: **EFFECT OF VERTICAL CURVES ON STRUCTURAL GAUGE**
DRAWING NO: **MM3-GC-SOD-GD-0166001**

PRINTED ON 02-JUN-17

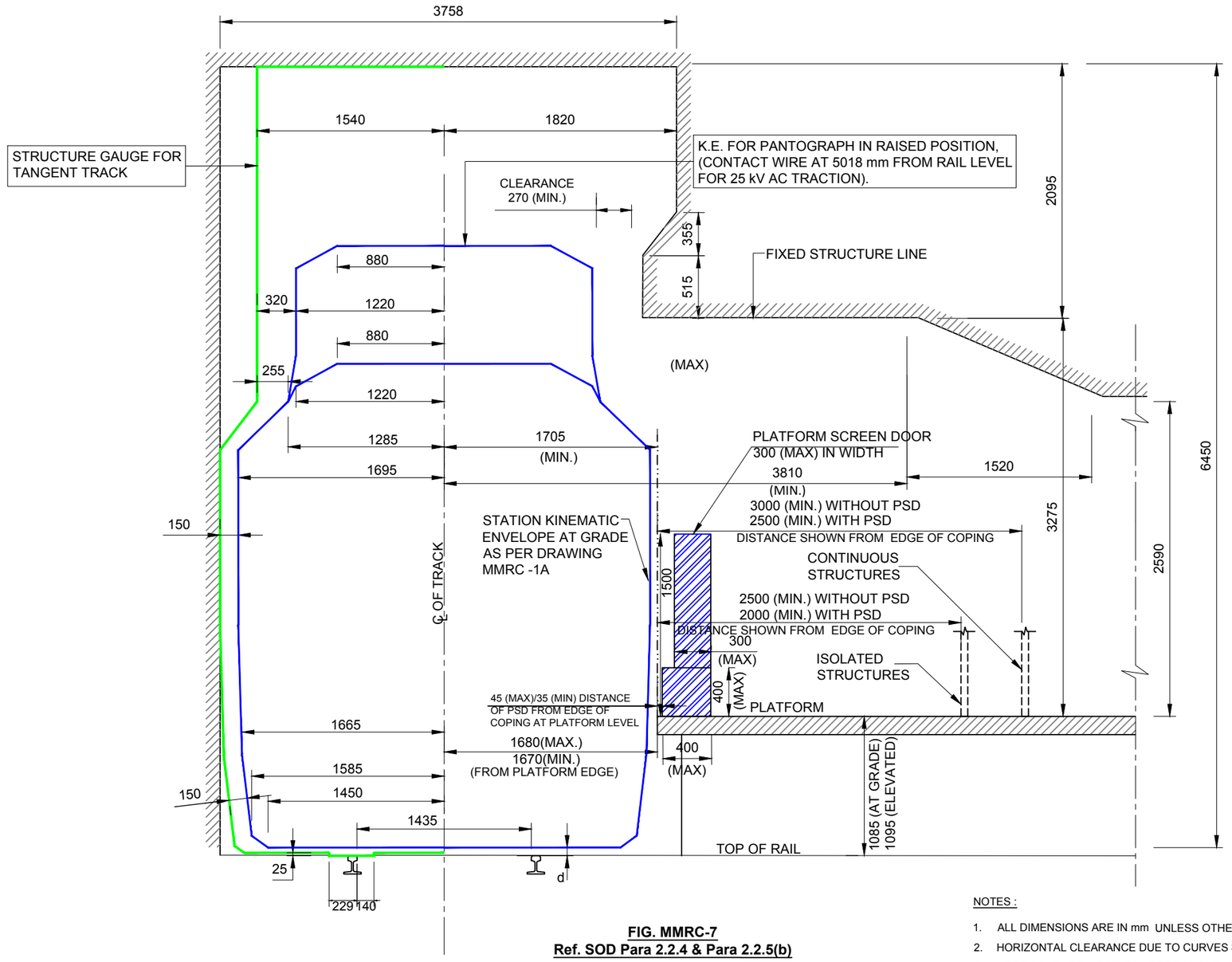

FIG. MMRC-7
Ref. SOD Para 2.2.4 & Para 2.2.5(b)

NOTES :

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
2. HORIZONTAL CLEARANCE DUE TO CURVES SHALL BE ADDED IF PLATFORM IN CURVE.
3. VERTICAL THROW DUE TO VERTICAL CURVE, IF ANY, SHALL BE ADDED.
4. THE STRUCTURE GAUGE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION.
5. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
6. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 5 ABOVE,AND 50mm UNDER DYNAMIC CONDITION.
7. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 70 KMPH OPERATING SPEED MAXIMUM

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A	11.01.2017	KCS	RJM	FIRST ISSUE

	NAME	SIGN	DATE
DRAWN BY	NKV (TE)		20-11-2018
CHECKED BY	VKS (CTE)		
REVIEWED BY	KS CHOI (SIGNALING EXPERT)		SCALE
REVIEWED BY	Sy CHANG (TRACK EXPERT)		1:40
APPROVED BY	RJM (PM)		(A3 SIZE)

PROJECT: **MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ**

DRAWING TITLE: **STRUCTURE GAUGE:AT-GRADE STATION WITH ONE SIDE PLATFORM ON LEVEL OR CONSTANT GRADE TANGENT TRACK**

DRAWING NO: **MM3-GC-SOD-GD-0169001**

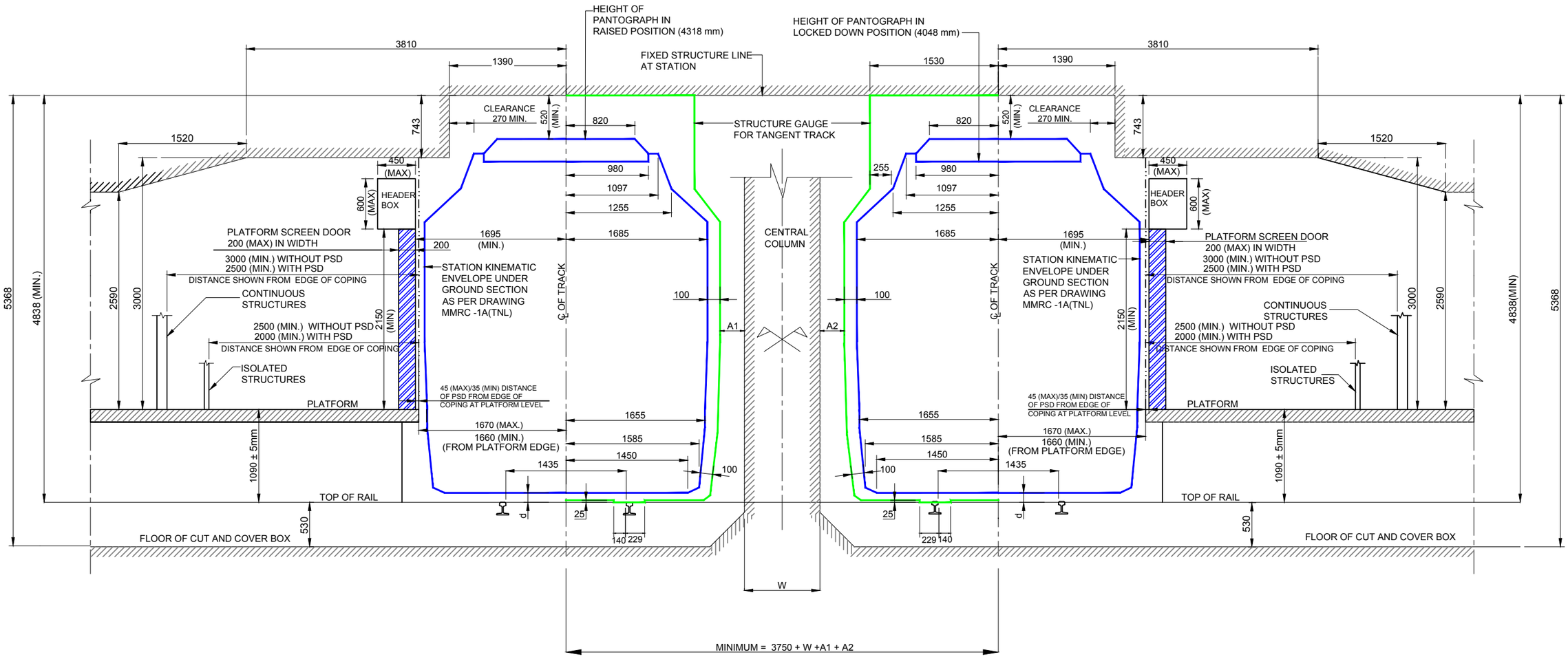

FIG. MMRC-8
Ref. SOD Para 2.2.4 & Para 2.2.5(a)

NOTES :

1. ALL DIMENSION ARE IN mm UNLESS OTHERWISE STATED.
2. HORIZONTAL CLEARANCE DUE TO CURVES SHALL BE ADDED IF PLATFORM IN CURVE.
3. VERTICAL THROW DUE TO VERTICAL CURVE, IF ANY, SHALL BE ADDED.
4. THE STRUCTURE GAUGE IS VALID FOR VEHICLES WITH SEALED WINDOW S AND DOORS CLOSED WHILE IN MOTION.
5. CLEARANCES 'A1' AND 'A2' ARE MEANT FOR SERVICE PURPOSES AND SHALL BE DIMENSIONED AS PER REQUIREMENT.
6. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
7. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 6 ABOVE,AND 50 mm UNDER DYNAMIC CONDITION
8. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 70 KMPH OPERATING SPEED MAXIMUM

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GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

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REVIEWED BY	Sy CHANG (TRACK EXPERT)	
APPROVED BY	RJM (PM)	

DATE: 20-11-2018
SCALE: 1:50 (A3 SIZE)

PROJECT: **MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ**

DRAWING TITLE: **STRUCTURE GAUGE:UNDERGROUND STATION (TUNNEL) WITH SIDE PLATFORMS ON LEVEL OR CONSTANT GRADE TANGENT TRACK**

DRAWING NO: **MM3-GC-SOD-GD-0167001**

TYPICAL FOR 8.0 m WIDE ISLAND PLATFORM.

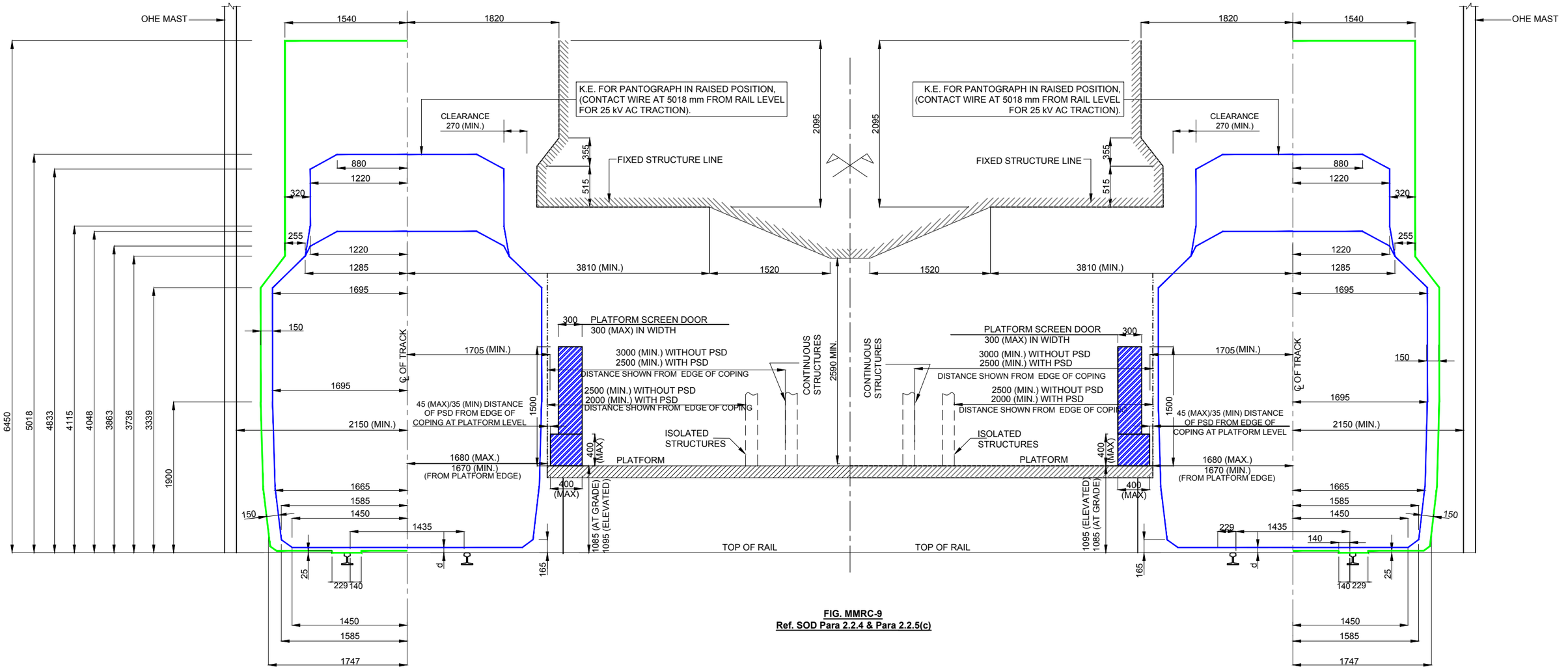

FIG. MMRC-9
Ref. SOD Para 2.2.4 & Para 2.2.5(c)

NOTES :

1. ALL DIMENSION ARE IN mm UNLESS OTHERWISE STATED.
2. HORIZONTAL CLEARANCE DUE TO CURVES SHALL BE ADDED IF PLATFORM IN CURVE.
3. THE STRUCTURE GAUGE IS VALID FOR VEHICLE WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION.
4. MINIMUM CLEARANCE FOR OHE MAST WILL BE 2150 mm FROM THE CENTRE OF TRACK.
5. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
6. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 5 ABOVE,AND 50mm UNDER DYNAMIC CONDITION.
7. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 70 KMPH OPERATING SPEED MAXIMUM

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GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

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REVIEWED BY	KS CHOI (SIGNALING EXPERT)	
REVIEWED BY	Sy CHANG (TRACK EXPERT)	
APPROVED BY	RJM (PM)	

DATE: 20-11-2018
SCALE: 1:50 (A3 SIZE)

PROJECT: **MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ**

DRAWING TITLE: **STRUCTURE GAUGE ELEVATED STATION WITH ISLAND PLATFORM ON LEVEL OR CONSTANT GRADE TANGENT TRACK**

DRAWING NO: **MM3-GC-SOD-GD-01610001**

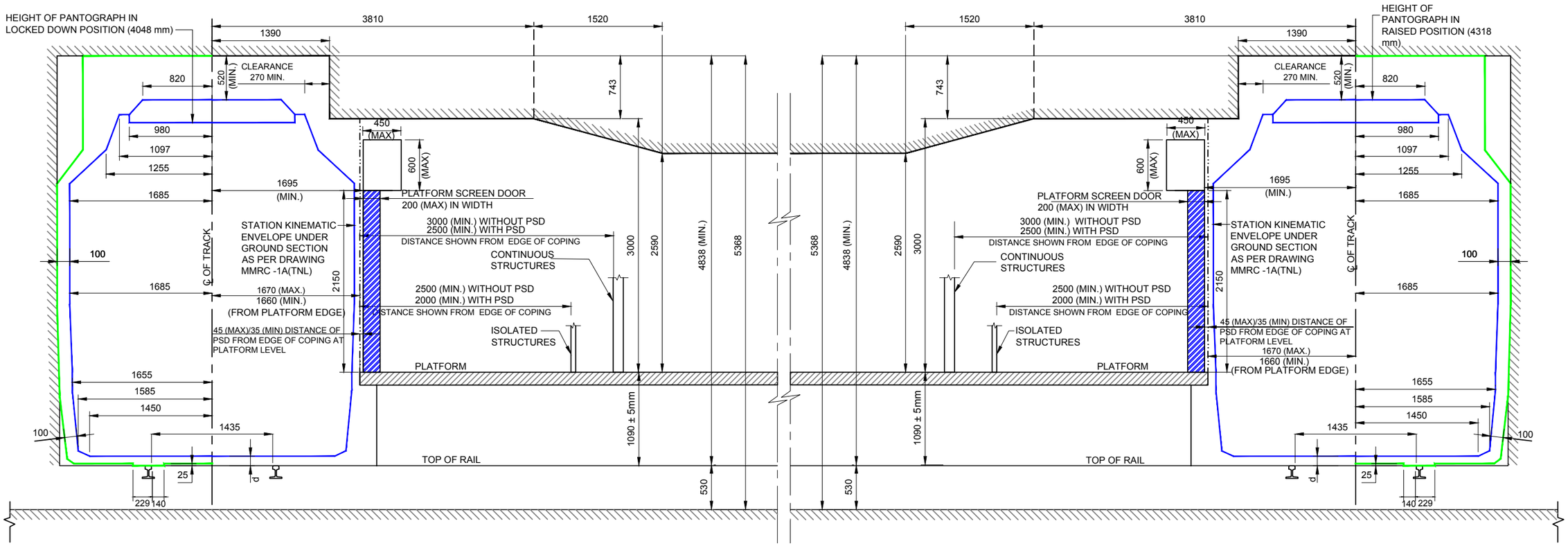

FIG. MMRC-10
Ref. SOD Para 2.2.4 & Para 2.2.5(a)

NOTES :

1. ALL DIMENSIONS ARE IN MM.
2. HORIZONTAL CLEARANCE DUE TO CURVES SHALL BE ADDED IF PLATFORM IN CURVE.
3. VERTICAL THROW DUE TO VERTICAL CURVE IF ANY SHALL BE EXTRA.
4. THE STRUCTURE GAUGE IS VALID FOR VEHICLES WITH SEALED WINDOW AND DOORS CLOSED WHILE IN MOTION.
5. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
6. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 5 ABOVE,AND 50 mm UNDER DYNAMIC CONDITION.
7. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 70 KMPH OPERATING SPEED MAXIMUM

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GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

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REVIEWED BY	KS CHOI (SIGNALING EXPERT)	
REVIEWED BY	Sy CHANG (TRACK EXPERT)	
APPROVED BY	RJM (PM)	

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PRINTED ON 15-FEB-18

PROJECT: **MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ**
DRAWING TITLE: **STRUCTURE GAUGE : UNDERGROUND STATION (TUNNEL) WITH ISLAND PLATFORMS ON LEVEL ORCONSTANT GRADE TANGENT TRACK**
DRAWING NO: **MM3-GC-SOD-GD-0168001**

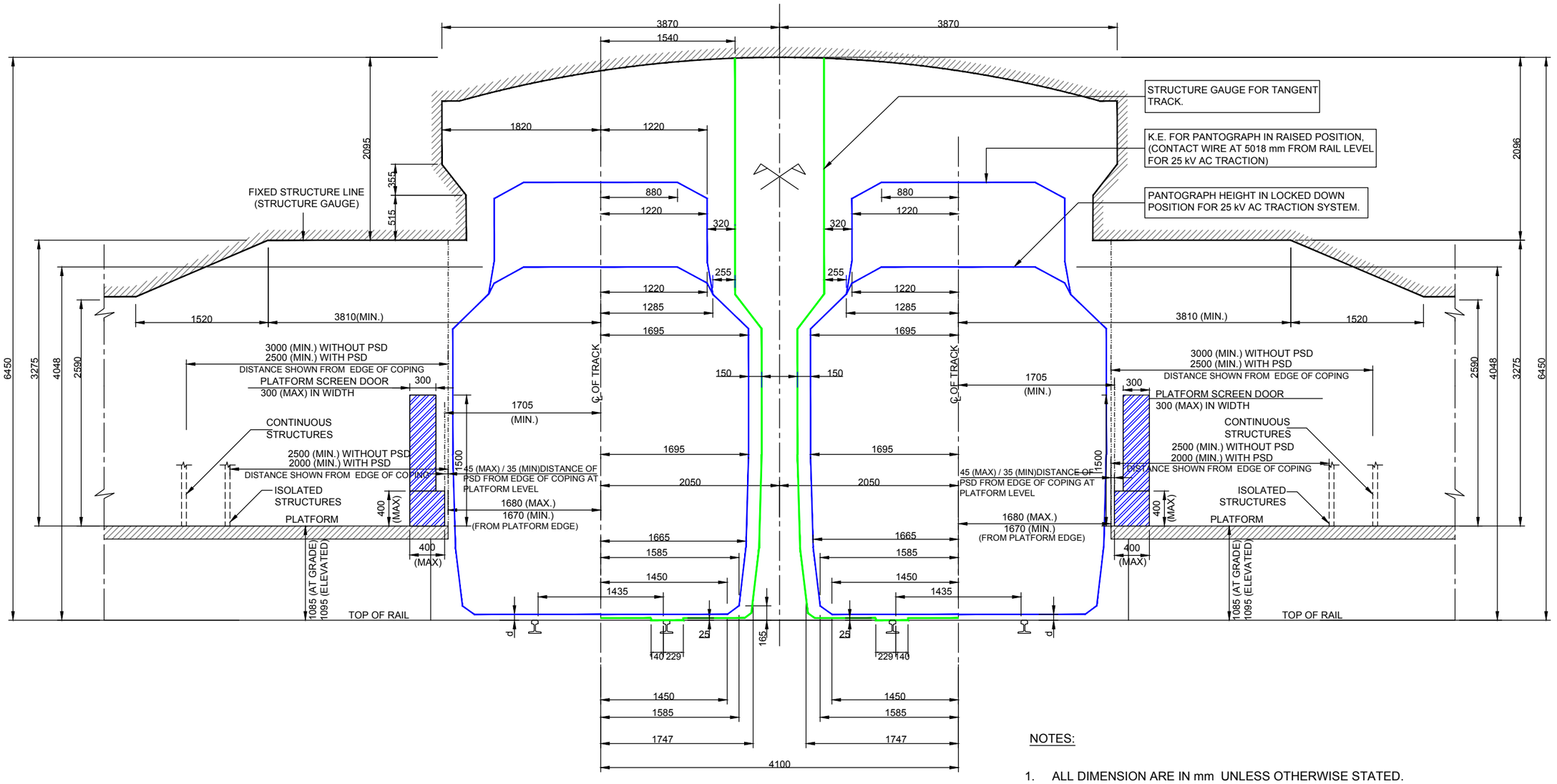

FIG. MMRC-11
Ref. SOD Para 2.2.4 & Para 2.2.5(d)

NOTES:

1. ALL DIMENSION ARE IN mm UNLESS OTHERWISE STATED.
2. HORIZONTAL CLEARANCE DUE TO CURVES SHALL BE ADDED IF PLATFORM IN CURVE.
3. VERTICAL THROW DUE TO VERTICAL CURVES SHALL BE ADDED.
4. STRUCTURE GAUGE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION.
5. OHE IS SUSPENDED FROM CEILING BY DROP ARM.
6. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
7. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 6 ABOVE,AND 50 mm UNDER DYNAMIC CONDITION.
8. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 70 KMPH OPERATING SPEED MAXIMUM

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D	16.11.2018	HRM	RJM	CLEARANCE OF STRUCTURES WITH PSD INCORPORATED
C	16.01.2018	NKV	RJM	COMMENT RDSO 08.12.17 INCORPORATED
B	02.06.2017	HRM	RJM	COMMENT RDSO 23.05.17 INCORPORATED
A	11.01.2017	KCS	RJM	FIRST ISSUE

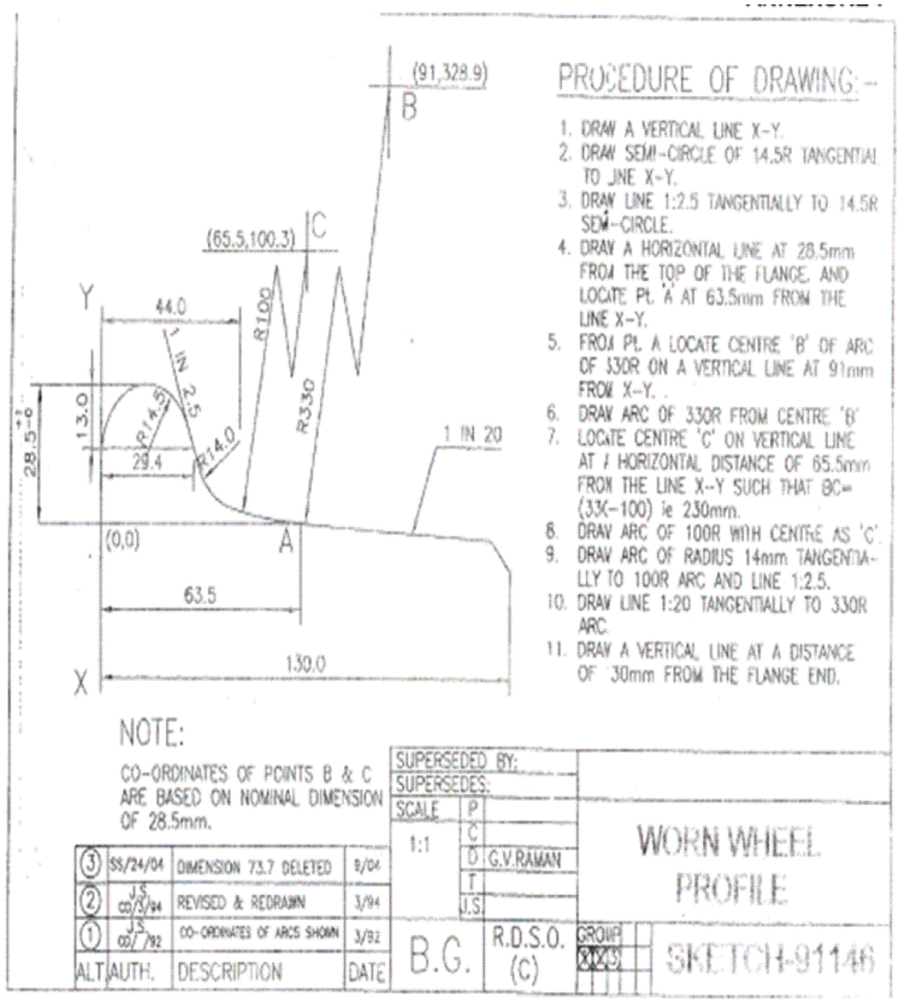
	NAME	SIGN
DRAWN BY	NKV (TE)	
CHECKED BY	VKS (CTE)	
REVIEWED BY	KS CHOI (SIGNALING EXPERT)	
REVIEWED BY	Sy CHANG (TRACK EXPERT)	
APPROVED BY	RJM (PM)	

DATE: 20-11-2018
SCALE: 1:50 (A3 SIZE)

PROJECT: **MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ**

DRAWING TITLE: **STRUCTURE GAUGE : AT - GRADE AND ELEVATEDSTATION ON LEVEL OR CONSTANT GRADE TANGENT TRACK**

DRAWING NO: **MM3-GC-SOD-GD-01611001**



PROCEDURE OF DRAWING:-

1. DRAW A VERTICAL LINE X-Y.
2. DRAW SEMI-CIRCLE OF 14.5R TANGENTIAL TO JNE X-Y.
3. DRAW LINE 1:2.5 TANGENTIALLY TO 14.5R SEMI-CIRCLE.
4. DRAW A HORIZONTAL LINE AT 28.5mm FROM THE TOP OF THE FLANGE, AND LOCATE Pt. 'A' AT 63.5mm FROM THE LINE X-Y.
5. FROM Pt. A LOCATE CENTRE 'B' OF ARC OF 330R ON A VERTICAL LINE AT 91mm FROM X-Y. .
6. DRAW ARC OF 330R FROM CENTRE 'B'
7. LOCATE CENTRE 'C' ON VERTICAL LINE AT / HORIZONTAL DISTANCE OF 65.5mm FROM THE LINE X-Y SUCH THAT BC= (33-100) ie 230mm.
8. DRAW ARC OF 100R WITH CENTRE AS 'C'.
9. DRAW ARC OF RADIUS 14mm TANGENTIALLY TO 100R ARC AND LINE 1:2.5.
10. DRAW LINE 1:20 TANGENTIALLY TO 330R ARC.
11. DRAW A VERTICAL LINE AT A DISTANCE OF 30mm FROM THE FLANGE END.

NOTE:

CO-ORDINATES OF POINTS B & C ARE BASED ON NOMINAL DIMENSION OF 28.5mm.

ALT	AUTH.	DESCRIPTION	DATE
3	SS/24/04	DIMENSION 73.7 DELETED	9/04
2	J.S. CO/S/94	REVISED & REDRAWN	3/94
1	J.S. CO/ /92	CO-ORDINATES OF ARCS SHOWN	3/92

SUPERSEDED BY:
SUPERSEDES:
SCALE 1:1
P C D G.V.RAMAN T U.S.
B.G. R.D.S.O. (C)
GROUP 2020
WORN WHEEL PROFILE
SKETCH-91146

FIG. MMRC-12
Ref. SOD Para 3.1 (5)

MMRC
maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

REV.	DATE	PREP.	APPR.	DESCRIPTION
B	02.06.2017	HRM	RJM	COMMENT RDSO 23.05.17 INCORPORATED
A	11.01.2017	KCS	RJM	FIRST ISSUE

	NAME	SIGN
DRAWN BY	HRM	
CHECKED BY	MVD	
APPROVED BY	RJM	

DATE 02-06-2017
SCALE NOT TO SCALE

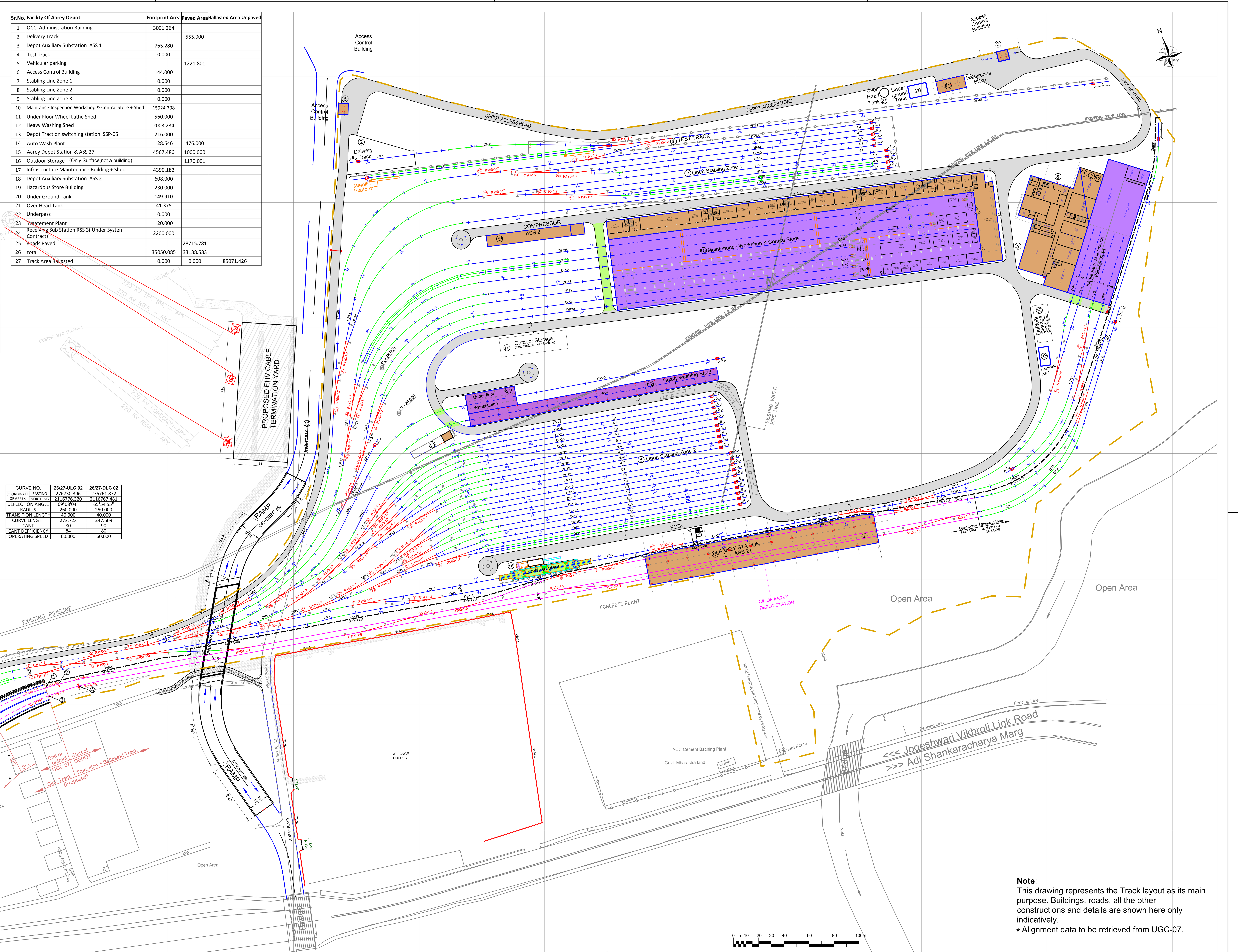
PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ
DRAWING TITLE: RDSO SK - 91146 WORN WHEEL PROFILE
DRAWING NO: MM3-GC-SOD-GD-01612001

PRINTED ON 02-JUN-17

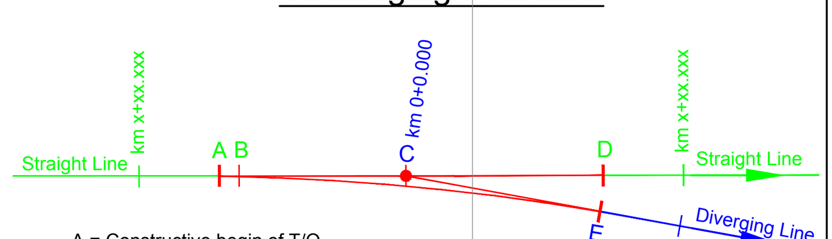
LEGENDS

- (T/O no., Radius,Crossing Angle) — R190-1:7
- Tangent Track (Depot)
- Curved Track (Depot)
- Track (Main Line)
- Begin/End of Curve in Turnout
- Fouling Point
- Aarey Station
- New Land Boundary
- Limit Between Mainline & Depot
- Buffer Stop
- Turntable
- Fence
- Special Track form
- DP1 — Depot Track line no.
- 40 60 — Chainages every 20 m.
- Shunting loc (L = 15 m approx)
- Train car (L = 22.6 m)
- Barrier
- Trackform to be defined by Depot Equipment

Sr.No.	Facility Of Aarey Depot	Footprint Area	Paved Area	Ballasted Area Unpaved
1	OCC, Administration Building	3001.264		
2	Delivery Track		555.000	
3	Depot Auxiliary Substation ASS 1	765.280		
4	Test Track	0.000		
5	Vehicular parking		1221.801	
6	Access Control Building	144.000		
7	Stabling Line Zone 1	0.000		
8	Stabling Line Zone 2	0.000		
9	Stabling Line Zone 3	0.000		
10	Maintance-Inspection Workshop & Central Store + Shed	15924.708		
11	Under Floor Wheel Lathe Shed	560.000		
12	Heavy Washing Shed	2003.234		
13	Depot Traction switching station SSP-05	216.000		
14	Auto Wash Plant	128.646	476.000	
15	Aarey Depot Station & ASS 27	4567.486	1000.000	
16	Outdoor Storage (Only Surface,not a building)		1170.001	
17	Infrastructure Maintenance Building + Shed	4390.182		
18	Depot Auxiliary Substation ASS 2	608.000		
19	Hazardous Store Building	230.000		
20	Under Ground Tank	149.910		
21	Over Head Tank	41.375		
22	Underpass	0.000		
23	Treatement Plant	120.000		
24	Receiving Sub Station RSS 3(Under System Contract)	2200.000		
25	Roads Paved		28715.781	
26	total	35050.085	33138.583	
27	Track Area Ballasted	0.000	0.000	85071.426



Chainaging Definition



A = Constructive begin of T/O.
B = Geometrical BC (Begin of Curve).
C = IP (Intersection Point).
D = E = Ends of T/O (Straight and diverging Lines).
C = Begin of the diverging track line (Chainage = km 0+0.000)

Distance C-E = C-D = 13.503 m for T/O 190 - 1:7

DEPOT LINE NO.	LENGTH (m)	DEPOT LINE NO.	LENGTH (m)	DEPOT LINE NO.	LENGTH (m)
DP 1	1125.898	DP 18	254.720	DP 35	261.671
DP 2	1201.316	DP 19	313.205	DP 36	513.917
DP 3	66.159	DP 20	283.318	DP 37	128.531
DP 4	226.056	DP 21	436.212	DP 38	506.744
DP 5	66.035	DP 22	377.982	DP 39	319.260
DP 6	218.736	DP 23	292.590	DP 40	246.145
DP 7	365.000	DP 24	291.794	DP 41	279.042
DP 8	241.636	DP 25	355.553	DP 42	546.964
DP 9	299.062	DP 26	297.247	DP 43	312.361
DP 10	268.081	DP 27	331.626	DP 44	247.735
DP 11	394.262	DP 28	216.438	DP 45	280.635
DP 12	260.547	DP 29	296.957	DP 46	767.000
DP 13	271.718	DP 30	228.481	DP 47	57.405
DP 14	271.487	DP 31	515.400	DP 48 (Test Track)	614.640
DP 15	334.575	DP 32	275.387	DP 49 (Del. Track)	213.680
DP 16	275.933	DP 33	245.053	DP 50	49.503
DP 17	307.822	DP 34	287.670	**TOTAL**	16939.189

SR NO.	EASTING	NORTHING
1	E = 276876.981	N = 2116753.711
2	E = 276876.981	N = 2116746.932
3	E = 276888.061	N = 2116753.262
4	E = 276902.640	N = 2116746.741

CURVE NO.		26/27-ULC 02	26/27-DLC 02
COORDINATE OF APPEX	EASTING	276730.396	276761.872
	NORTHING	2116776.320	2116767.481
DEFLECTION ANGLE		69°08'04''	65°54'55''
RADIUS		260.000	250.000
TRANSITION LENGTH		40.000	40.000
CURVE LENGTH		273.723	247.609
CANT		80	90
CANT DEFFICIENCY		84	80
OPERATING SPEED		60.000	60.000

Note:
This drawing represents the Track layout as its main purpose. Buildings, roads, all the other constructions and details are shown here only indicatively.
* Alignment data to be retrieved from UGC-07.

0 5 10 20 30 40 60 80 100m

REV.	DATE	PREP.	CHECKED	DESCRIPTION
I	29.03.2019	SB	VKS	Mainline and Depot Boundary Clarified
H	28.09.2018	SB	VKS	For Main Line, Ramp and Curve Details incorporated
G	24.11.2017	SB	MVD	Main Workshop & Infra-Building Track distances.
F	19.09.2017	SB	MVD	General re-arrangement Main Workshop & Infra-Building.
E	14.07.2017	SB	MVD	General re-arrangement to limit tree-cutting.
D	21.04.2017	SB	MVD	Aarey Station Arranged for 3 Tracks.
C	20.02.2017	KCS	MVD	Rreview of Scissor Crossover, Amendment of incongruences.
B	24.12.2016	KCS	MVD	General review.
A	02.12.2016	KCS	MVD	First Issue.

MMRC

maple — MUMBAI METRO LINE-3 GENERAL CONSULTANT

GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT,LINE 3 COLABA- BANDRA-SEEPZ

	NAME	SIGN
DRAWN BY	ABK	
CHECKED BY	VKS	
REVIEWED BY	SY CHANG	
APPROVED BY	RJM	

DATE: 28-09-2018

SCALE: 1:1000 (A0 Size)

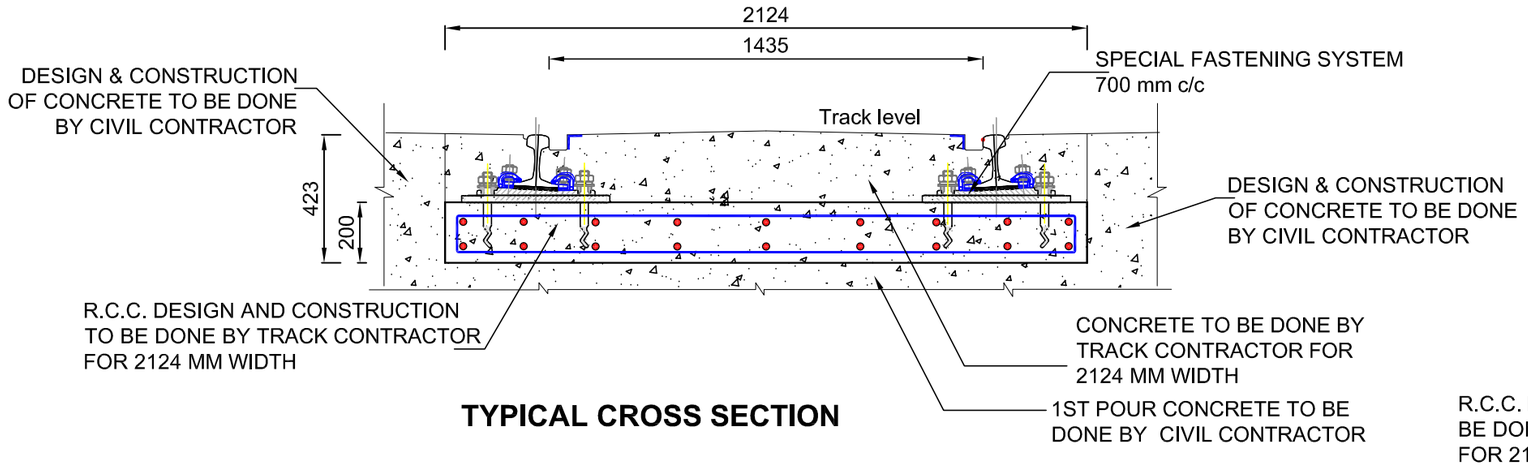
PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ

TITLE: TRACK LAYOUT DEPOT

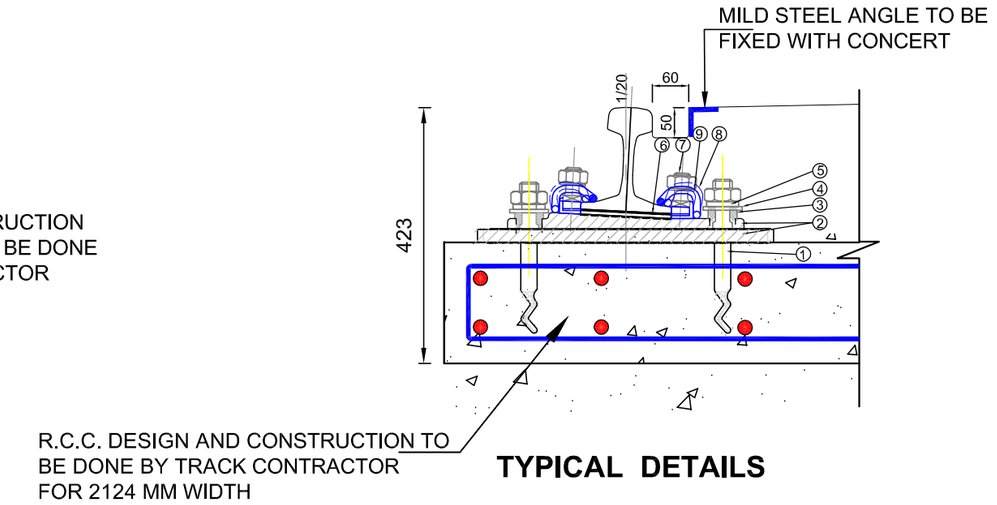
DRAWING TITLE: AAREY DEPOT LAYOUT

DRAWING NO: MM3-GC-DTR-GD-8-D03-2001-I

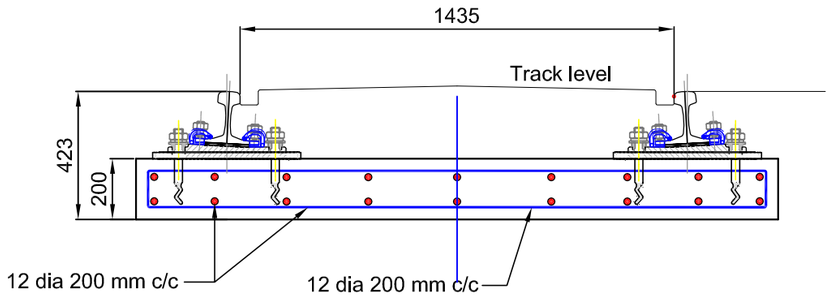
TYPICAL CROSS SECTION OF EMBEDDED TRACK



TYPICAL CROSS SECTION



TYPICAL DETAILS



TYPICAL REINFORCEMENT DETAILS

REQUIREMENT FOR ONE RAIL SEAT FASTENING (VOSSLOH-336)		
POS.	Qty.	Description
1	2	INSERT (WITH SPLIT PIN)
2	1	CAST IRON BASE PLATE
3	2	INSULATING BUSH
4	2	STEEL WASHER
5	2	SPRING STEEL WASHER
6	1	RAIL PAD
7	2	T - HEAD BOLT WITH WASHER AND NUT
8	2	TENSION CLAMP
9	2	WASHER

NOTES:

1. FURTHER CONCRETE AT BOTH SIDE OF THE EMBEDDED TRACK (WIDTH 2134 MM) TO BE DONE BY THE CIVIL CONTRACTOR.
2. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE NOTED.
3. MINIMUM COVER TO REINFORCEMENT = 40mm.
4. CONCRETE M35 GRADE BY TRACK & CIVIL CONTRACTOR.
5. REINFORCEMENT FE 415 GRADE.

REF.:- AAREY DEPOT MASTER PLAN -DEPOT-AAA-D00-0001

VERSIONS	DATE	DESCRIPTION
-	27 September 2018	FOR APPROVAL
A	31 October 2018	FOR APPROVAL
B	11 JULY 2019	DUE TO INTERFACE CONCRETING BY DEPOT CIVIL

Maple Mumbai Metro 3
General Consultant
LINE 3 TRANSIT OFFICE, WING 'B' NORTH SIDE OF CITY PARK
'E'- BLOCK, BANDRA-KURLA COMPLEX,
BANDRA (EAST) MUMBAI 400 051, INDIA

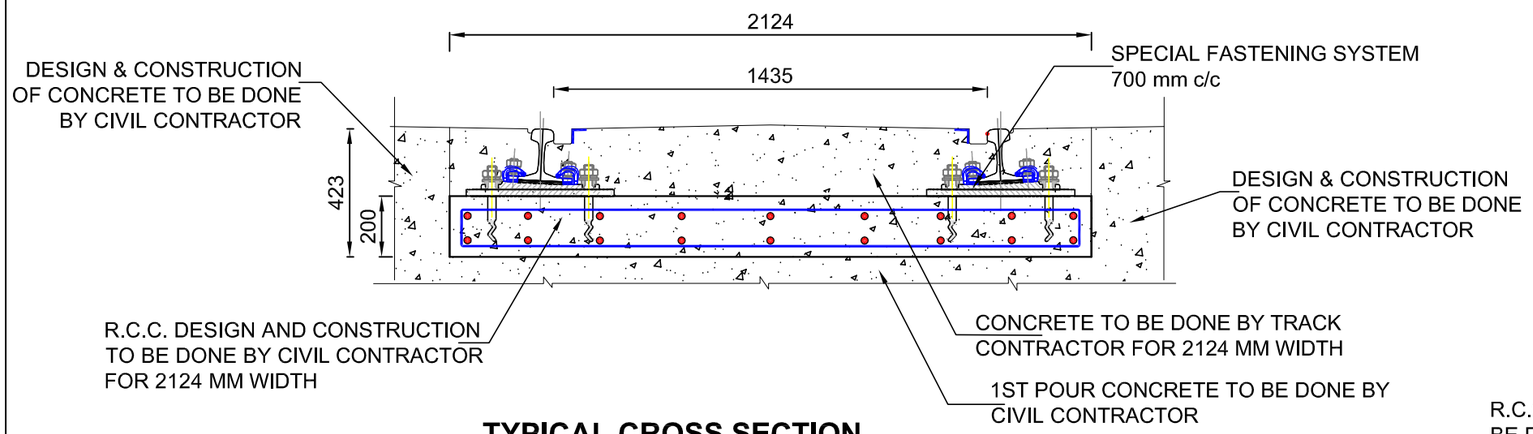
MUMBAI METRO RAIL CORPORATION LIMITED,
LINE 3 TRANSIT OFFICE, WING 'A' NORTH SIDE OF CITY PARK
'E'- BLOCK, BANDRA-KURLA COMPLEX,
BANDRA (EAST) MUMBAI 400 051, INDIA

DRAWING STAGE	DETAILED DRAWING	
DESCRIPTION	NAME	SIGNATURE
DRAWN BY	SVM (TI)	
CHECKED BY	VKS (CTE)	
CHECKED BY	KULDEEP MISRA (CM DEPOT.)	
REVIEWED BY	SY CHANG (TRACK EXPERT)	
APPROVED BY	RJM (PM)	

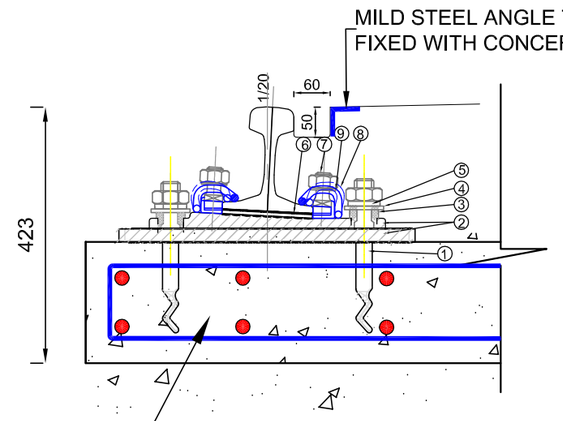
TITLE: **TYPICAL CROSS SECTION OF EMBEDDED TRACK**

DRG No.	MM3-GC-TR-GD-0 101 0013		
SHEET	01 OF 01	SCALE	1:50
DATE	11 JULY 2019	REV.	B

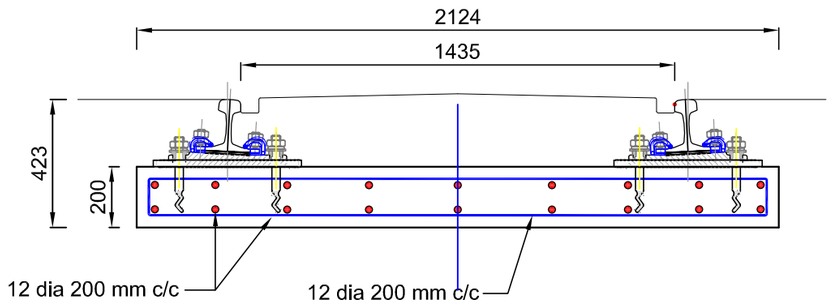
TYPICAL CROSS SECTION OF EMBEDDED TRACK AT JACK PIT LOCATION IN MAINTENANCE WORK SHOP & CENTRAL STORE



TYPICAL CROSS SECTION



TYPICAL DETAILS



TYPICAL REINFORCEMENT DETAILS

REQUIREMENT FOR ONE RAIL SEAT FASTENING (VOSSLOH-336)		
POS.	Qty.	Description
1	2	INSERT (WITH SPLIT PIN)
2	1	CAST IRON BASE PLATE
3	2	INSULATING BUSH
4	2	STEEL WASHER
5	2	SPRING STEEL WASHER
6	1	RAIL PAD
7	2	T - HEAD BOLT WITH WASHER AND NUT
8	2	TENSION CLAMP
9	2	WASHER

NOTES:

1. THE RCC OF THE EMBEDDED TRACK IN THE JACK PIT LOCATION WILL BE DONE BY THE CIVIL CONTRACTOR, THE TRACK CONTRACTOR WILL FIX INSERTS OF THE FASTENING BY DRILLING HOLE ON RCC.
2. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE NOTED.
3. MINIMUM COVER TO REINFORCEMENT = 40mm. CONCRETE M35 GRADE BY TRACK & CIVIL CONTRACTOR .
4. REINFORCEMENT FE 415 GRADE.
5. OPENING OF 16 NOS. WILL BE KEPT IN JACK PIT
6. THE RAIL AT JACK PIT OPENING BE FIXED AND SUPPORTED BY DEPOT EQUIPMENT CONTRACTOR.
7. JACK PIT WILL BE PROVIDED ON ONE LINE IN WORKSHOP AS PER MASTER PLAN

REF.:- AAREY DEPOT MASTER PLAN -DEPOT-AAA-D00-0001

VERSIONS	DATE	DESCRIPTION
-	27 September 2018	FOR APPROVAL
A	31 October 2018	FOR APPROVAL

Maple Mumbai Metro 3 General Consultant

LINE 3 TRANSIT OFFICE, WING 'B' NORTH SIDE OF CITY PARK 'E'- BLOCK, BANDRA-KURLA COMPLEX, BANDRA (EAST) MUMBAI 400 051, INDIA

MUMBAI METRO RAIL CORPORATION LIMITED,

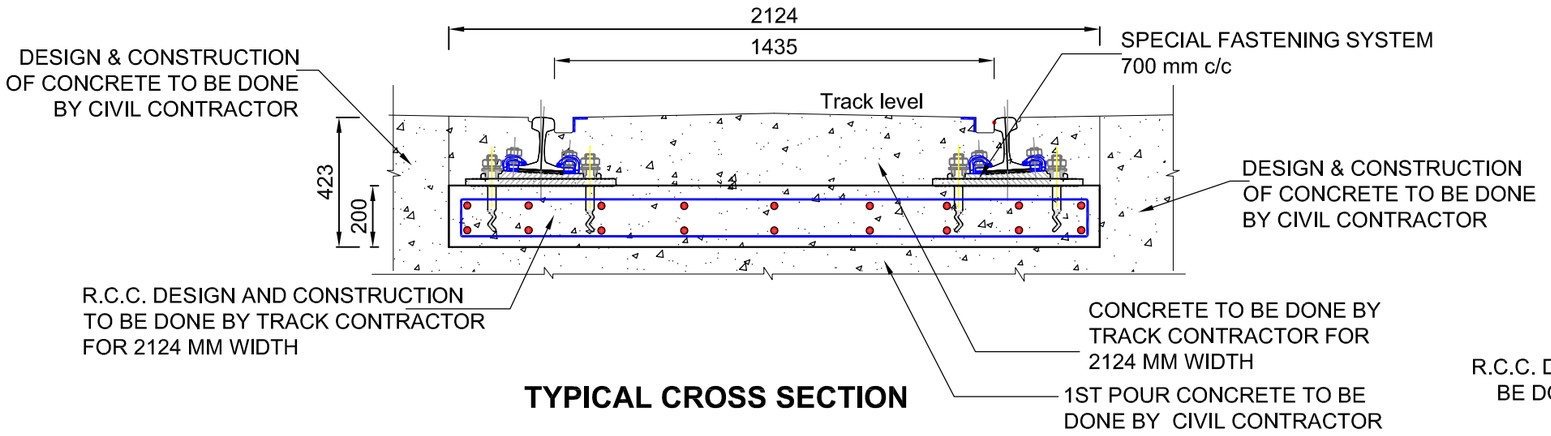
LINE 3 TRANSIT OFFICE, WING 'A' NORTH SIDE OF CITY PARK 'E'- BLOCK, BANDRA-KURLA COMPLEX, BANDRA (EAST) MUMBAI 400 051, INDIA

DRAWING STAGE DETAILED DRAWING			DRAWING STAGE DETAILED DRAWING		
DESCRIPTION	NAME	SIGNATURE	DESCRIPTION	NAME	SIGNATURE
APPROVED BY	RJM (PM)		DRAWN BY	SVM (TI)	
			CHECKED BY	VKS (CTE)	
			CHECKED BY	KULDEEP MISRA (CM DEPOT.)	
			CHECKED BY	M S SHRMA CDE(M&P)	
			REVIEWED BY	SY CHANG (TRACK EXPERT)	

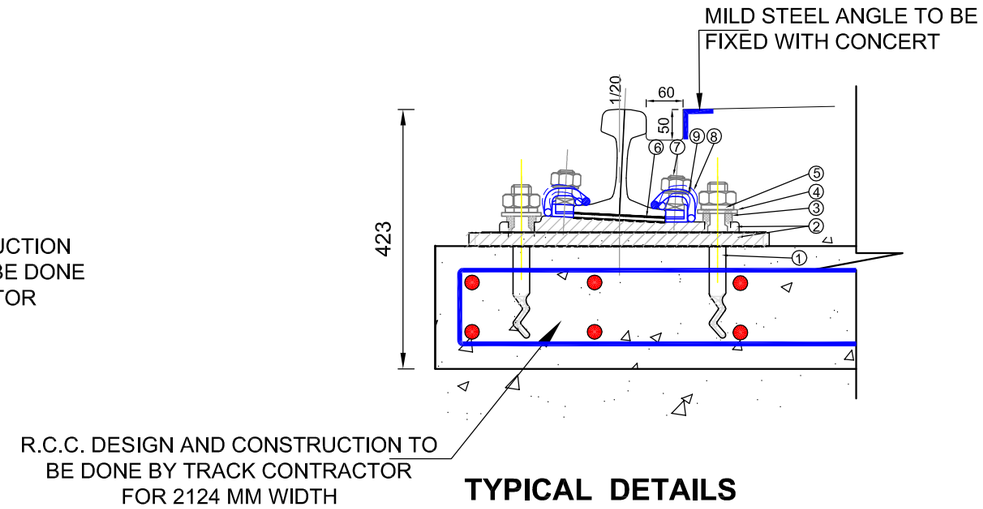
TITLE: **TYPICAL CROSS SECTION OF EMBEDDED TRACK AT JACK PIT LOCATION IN MAINTENANCE WORK SHOP & CENTRAL STORE**

DRG No.	MM3-GC-TR-GD-0 101 0013A		
SHEET	01 OF 01	SCALE	1:50
DATE	31 October 2018	REV.	A

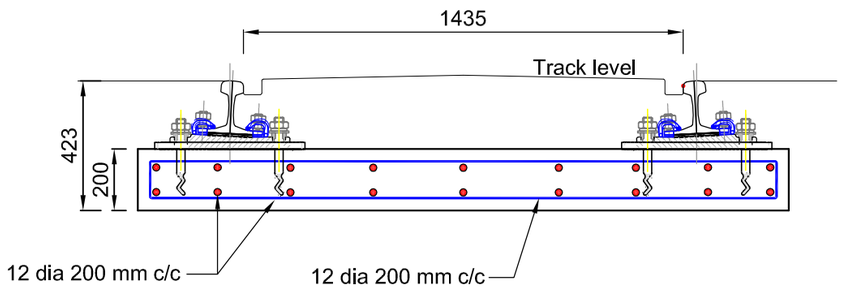
TYPICAL CROSS SECTION OF EMBEDDED TRACK AT DELIVERY TRACK LOCATION



TYPICAL CROSS SECTION



TYPICAL DETAILS



TYPICAL REINFORCEMENT DETAILS

REQUIREMENT FOR ONE RAIL SEAT FASTENING (VOSSLOH-336)		
POS.	Qty.	Description
1	2	INSERT (WITH SPLIT PIN)
2	1	CAST IRON BASE PLATE
3	2	INSULATING BUSH
4	2	STEEL WASHER
5	2	SPRING STEEL WASHER
6	1	RAIL PAD
7	2	T - HEAD BOLT WITH WASHER AND NUT
8	2	TENSION CLAMP
9	2	WASHER

NOTES:

1. FURTHER CONCRETE AT BOTH SIDE OF THE EMBEDDED TRACK (WIDTH 2134 MM) TO BE DONE BY THE CIVIL CONTRACTOR.
2. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE NOTED.
3. MINIMUM COVER TO REINFORCEMENT = 40mm.
4. CONCRETE M35 GRADE BY TRACK & CIVIL CONTRACTOR.
5. REINFORCEMENT FE 415 GRADE.

REF.:- AAREY DEPOT MASTER PLAN -DEPOT-AAA-D00-0001

VERSIONS	DATE	DESCRIPTION
-	27 September 2018	FOR APPROVAL
A	31 October 2018	FOR APPROVAL
B	18 July 2019	FOR APPROVAL

Maple Mumbai Metro 3 General Consultant
LINE 3 TRANSIT OFFICE, WING 'B' NORTH SIDE OF CITY PARK 'E'- BLOCK, BANDRA-KURLA COMPLEX, BANDRA (EAST) MUMBAI 400 051, INDIA

MUMBAI METRO RAIL CORPORATION LIMITED,
LINE 3 TRANSIT OFFICE, WING 'A' NORTH SIDE OF CITY PARK 'E'- BLOCK, BANDRA-KURLA COMPLEX, BANDRA (EAST) MUMBAI 400 051, INDIA

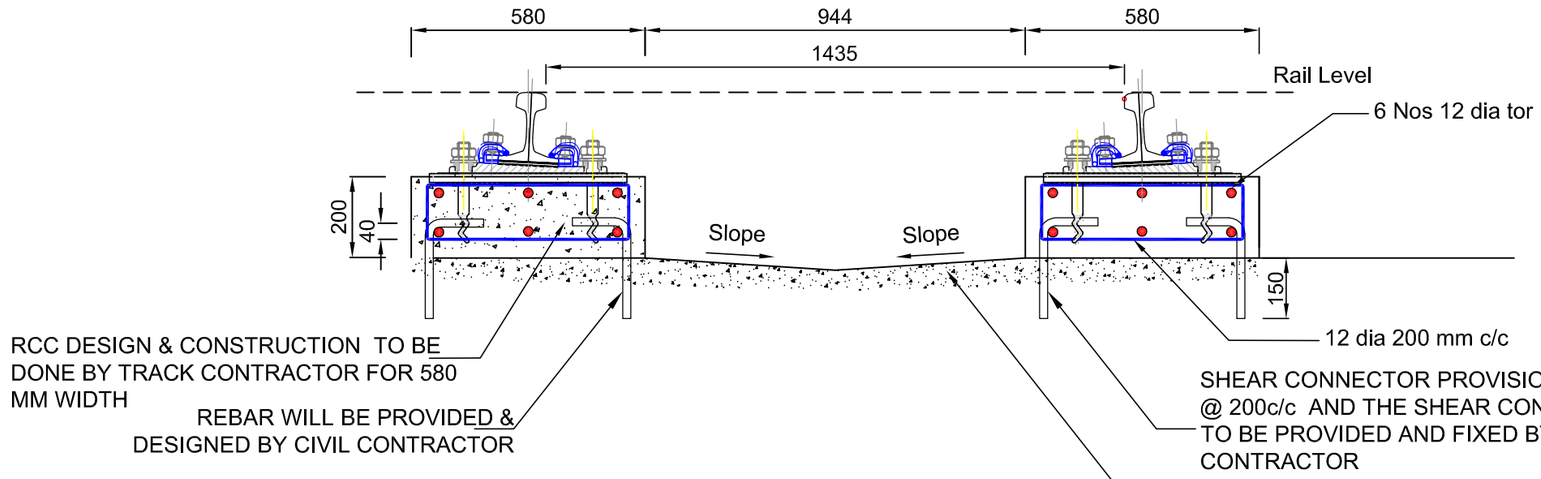
DRAWING STAGE	DETAILED DRAWING	
DESCRIPTION	NAME	SIGNATURE
DRAWN BY	SVM (TI)	
CHECKED BY	VKS (CTE)	
CHECKED BY	KULDEEP MISRA (CM DEPOT.)	
REVIEWED BY	SY CHANG (TRACK EXPERT)	
APPROVED BY	RJM (PM)	

TITLE: **TYPICAL CROSS SECTION OF EMBEDDED TRACK AT DELIVERY TRACK LOCATION**

DRG No.	MM3-GC-TR-GD-0 101 0013B		
SHEET	01 OF 01	SCALE	1:50
DATE	31 October 2018	REV.	A

Tracing

PLINTH TYPE BALLASTLESS TRACK ON HEAVY WASHING SHED & AUTO WASH PLANT



NOTES:

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE NOTED.
2. MINIMUM COVER TO REINFORCEMENT = 40mm.
3. CONCRETE M35 GRADE BY TRACK & CIVIL CONTRACTOR.
4. REINFORCEMENT FE 415 GRADE.

REF.:- AAREY DEPOT MASTER PLAN -DEPOT-AAA-D00-0001

VERSIONS	DATE	DESCRIPTION
-	27 September 2018	FOR APPROVAL
A	31 October 2018	FOR APPROVAL
A	31 October 2018	FOR APPROVAL

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT
Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruiz East, Mumbai. MAH 400098

MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
NaMTTRI Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

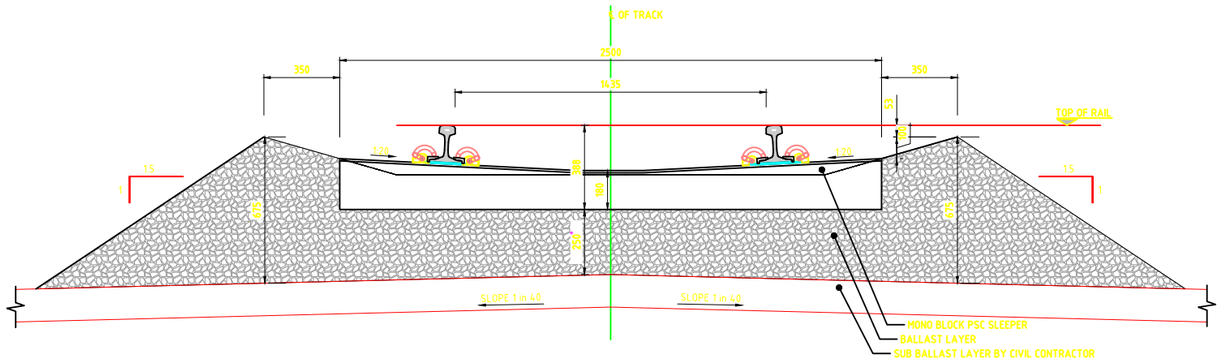
DRAWING STAGE	DETAILED DRAWING	
DESCRIPTION	NAME	SIGNATURE
DRAWN BY	HRM (TI)	
CHECKED BY	VKS (CTE)	
CHECKED BY	KULDEEP MISRA (CM DEPOT.)	
REVIEWED BY	SY CHANG (TRACK EXPERT)	
APPROVED BY	RJM (PM)	

TITLE: **PLINTH TYPE BALLASTLESS TRACK ON HEAVY WASHING SHED**

DRG No.	DRAWING NO. :- MM3-GC-TR-GD-0 101 0014		
SHEET	01 OF 01	SCALE	NTS
DATE	31 October 2018	REV.	A

File Location-D:\WORK\7.Depot Drawings 29.06.2019\MODIFIED EMBEDDED TRACK 29062019\04.07.2019\HEAVY- AUTO WASH_BALLASTLESS TRACK.dwg
Last Saved by:-EGIS On 15 July 2019 16:48:43

TYPICAL CROSS SECTION OF BALLASTED TRACK



* Cushion Depth 300 mm for Mainline & Test Track
* Cushion Depth 350 mm for RCC Slab
* Cushion Depth 250 mm for Depot Other Lines

Notes

1. All Dimensions are in mm unless otherwise mentioned.
2. Fastening System representation is only indicative.
3. All Dimensions have to be checked, confirmed or redesigned from DDC.

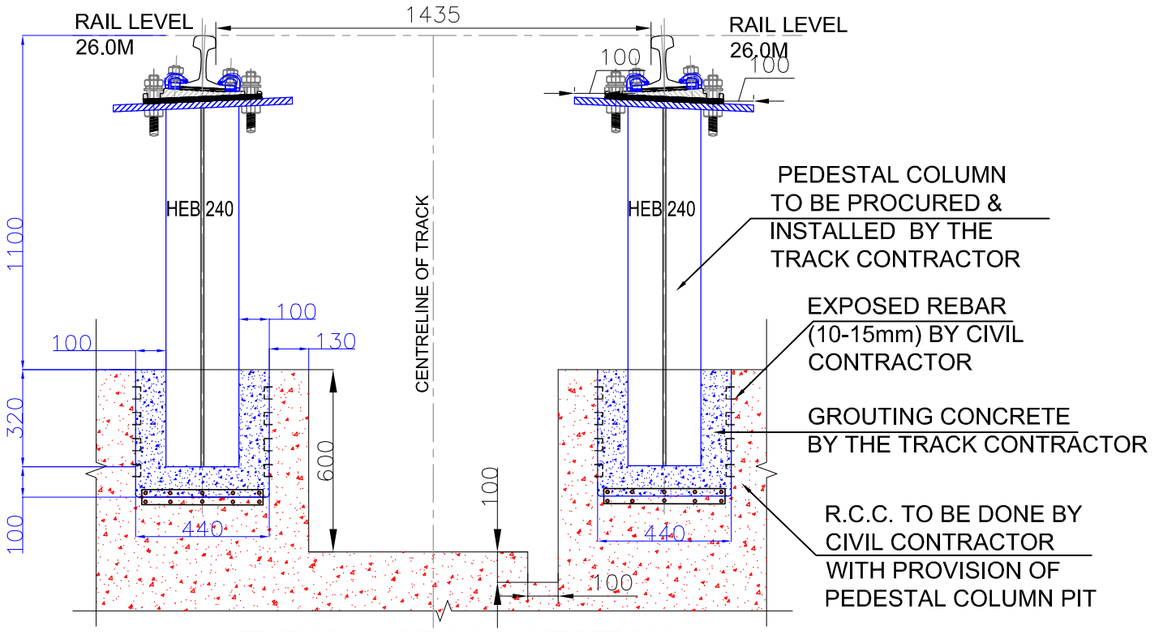
VERSIONS	DATE	DESCRIPTION

Maple Mumbai Metro 3
General Consultant
MMRCL LINE 3 TRANSIT OFFICE, WING 'B',
NORTH SIDE OF CITY PARK, 'E' BLOCK
BANDRA KURLA COMPLEX, BANDRA (E), MUMBAI - 400051

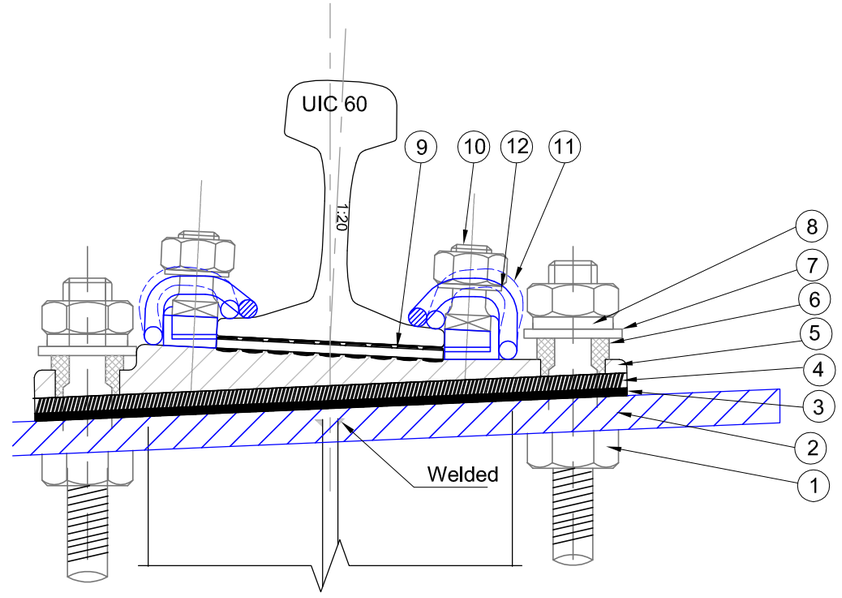
MUMBAI METRO RAIL CORPORATION LIMITED,
MMRCL LINE 3 TRANSIT OFFICE, WING 'A',
NORTH SIDE OF CITY PARK, 'E' BLOCK
BANDRA KURLA COMPLEX, BANDRA (E), MUMBAI - 400051

DRAWING STAGE	DETAILED DRAWING		TITLE	TYPICAL CROSS SECTION OF BALLASTED TRACK	
DESCRIPTION	NAME	SIGNATURE			
DRAWN BY	SVM (TI)				
CHECKED BY	VKS (CTE)		DRG No.	MM3-GC-TR-DDC-0 101 0005	
REVIEWED BY	S. CHANG (TRACK EXPERT)		SHEET	01 OF 01	SCALE 1:10
APPROVED BY	RJM (PM)		DATE	27 September 2018	REV.

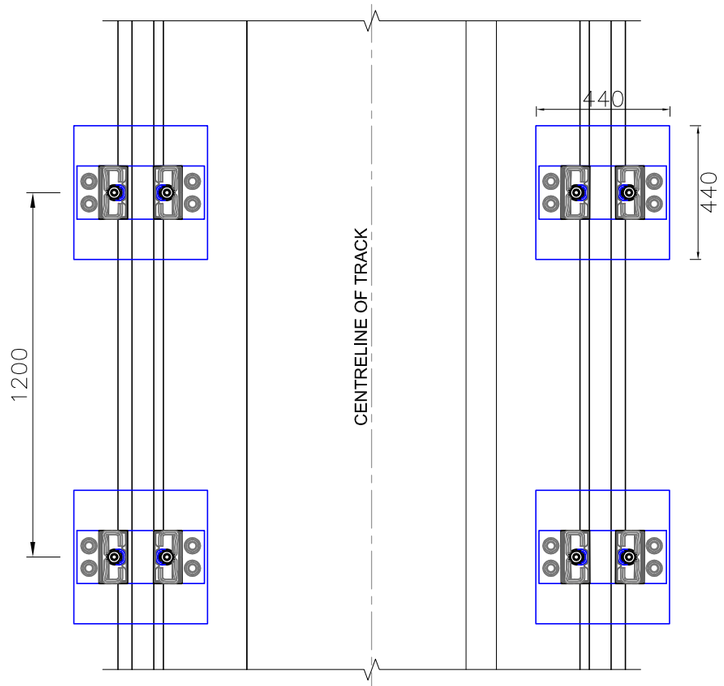
TYPICAL DRAWING OF INSULATED TRACK ON PEDESTAL (STEEL COLUMN)



TYPICAL CROSS SECTION



DETAIL 'A'



SPACING PITCH

REQUIREMENT FOR ONE RAIL SEAT FASTENING (VOSSLOH-336)		
POS.	Qty.	Description
1	2	BOLT (WITH SPLIT PIN)
2	1	COLUMN MS BASE PLATE
3	1	INTERMEDIATE PAD
4	1	ELASTIC PLATE
5	1	RIBBED PLATE
6	2	INSULATING BUSH
7	2	STEEL WASHER
8	2	SPRING STEEL WASHER
9	1	RAIL PAD
10	2	T - HEAD BOLT WITH WASHER AND NUT
11	2	TENSION CLAMP
12	2	WASHER

Legends:

TRACK CONTRACTOR

CIVIL CONTRACTOR

Notes:

1. CIVIL CONTRACTOR WILL CAST THE RCC WORK BELOW 1.0 M FROM THE RAIL LEVEL WITH GROOVE.
2. THE STEEL PEDESTAL COLUMN WILL BE PROVIDED & INSTALLED BY TRACK CONTRACTOR.
3. CIVIL CONTRACTOR WILL PROVIDE REBAR TOWARDS GROUTING AREA FOR ABOVE 10 TO 15mm.
4. CEMENT GROUTING / CONCRETE GROUTING / R.C.C. WILL BE DESIGNED & INSTALLED BY TRACK CONTRACTOR.
5. CIVIL & TRACK CONTRACTOR WILL INTERFACE THE REINFORCEMENT.

REF.:- AAREY DEPOT MASTER PLAN -DEPOT-AAA-D00-0001

VERSIONS	DATE	DESCRIPTION
-	27 September 2018	FOR APPROVAL
A	31 October 2018	FOR APPROVAL
B	12 April 2019	Steel Column Height 100 mm Adjusted as Per Civil Architectural Drawings

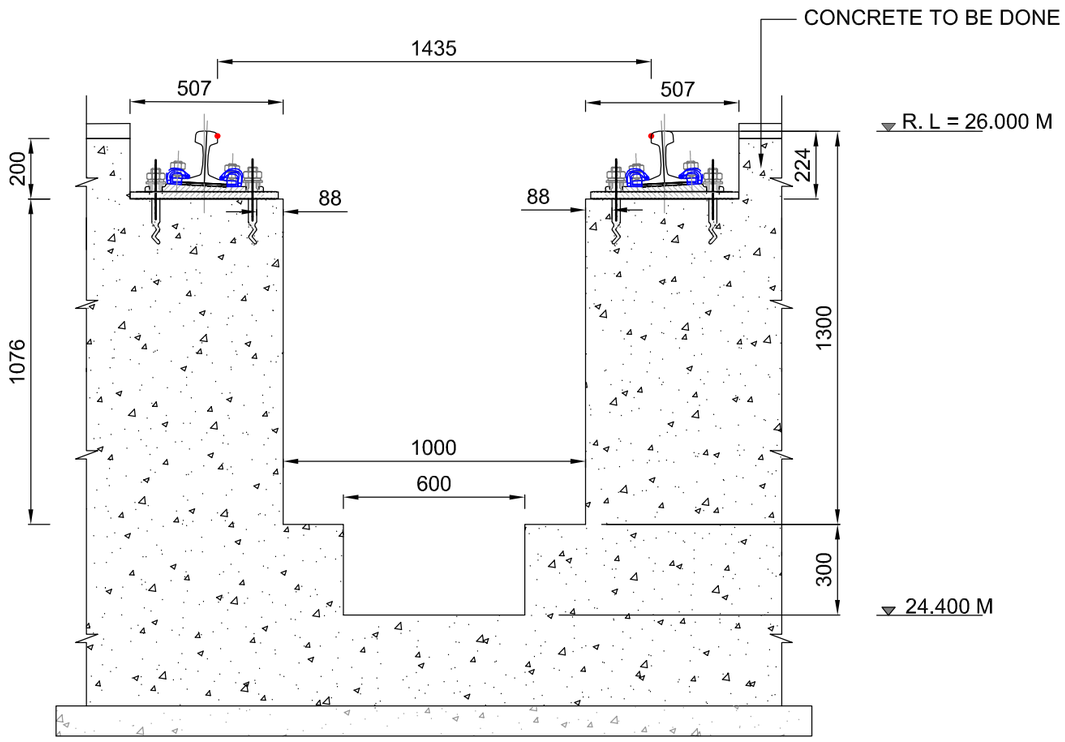
Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruiz East, Mumbai. MAH 400098

MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
NaMTTRI Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

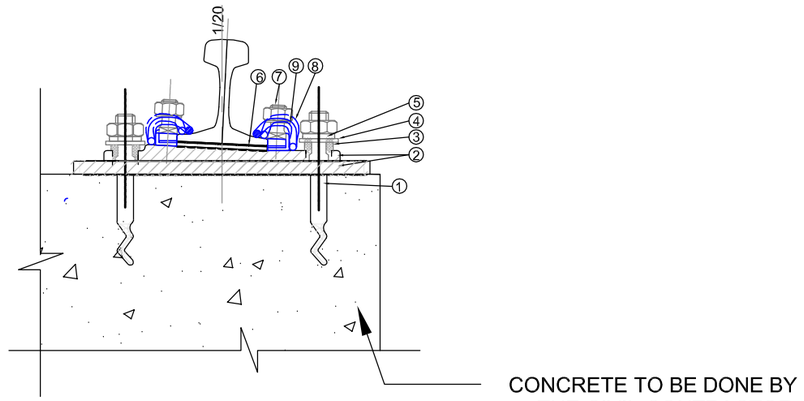
DRAWING STAGE	DETAILED DRAWING	
DESCRIPTION	NAME	SIGNATURE
DRAWN BY	HRM (TI)	
CHECKED BY	VKS (CTE)	
CHECKED BY	KULDEEP MISRA (CM DEPOT.)	
REVIEWED BY	SY CHANG (TRACK EXPERT)	
APPROVED BY	RJM (PM)	

TITLE	TYPICAL DRAWING OF TRACK ON PEDESTAL (STEEL COLUMN)	
DRG No.	DRAWING NO. :- MM3-GC-TR-GD-0 101 0026	
SHEET	01 OF 01	SCALE 1:50
DATE	12 April 2019	REV. B

TYPICAL CROSS SECTION OF PIT TRACK



TYPICAL CROSS SECTION OF PIT TRACK



TYPICAL DETAILS OF FASTENING SYSTEM

REQUIREMENT FOR ONE RAIL SEAT FASTENING (VOSSLOH-336)		
POS.	Qty.	Description
1	2	INSERT (WITH SPLIT PIN)
2	1	CAST IRON BASE PLATE
3	2	INSULATING BUSH
4	2	STEEL WASHER
5	2	SPRING STEEL WASHER
6	1	RAIL PAD
7	2	T - HEAD BOLT WITH WASHER AND NUT
8	2	TENSION CLAMP
9	2	WASHER

NOTES:

1. ANCHORING OF INSERTS TO BE DONE BY THE TRACK CONTRACTOR BY DRILLING THE HOLE IN THE R.C.C SLAB.
2. THE DRILL HOLE POINTS TO BE GIVEN BY THE TRACK SURVEYOR .
3. THE HOLE WILL BE FILLED WITH THE HIGH STRENGTH GROUTING MATERIAL AFTER PLACING THE INSERTS.
4. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE NOTED.

LEGENDS:

CONCRETE TO DONE BY CIVIL CONTRACTOR.

VERSIONS	DATE	DESCRIPTION
-	21 JUNE 2019	FOR APPROVAL

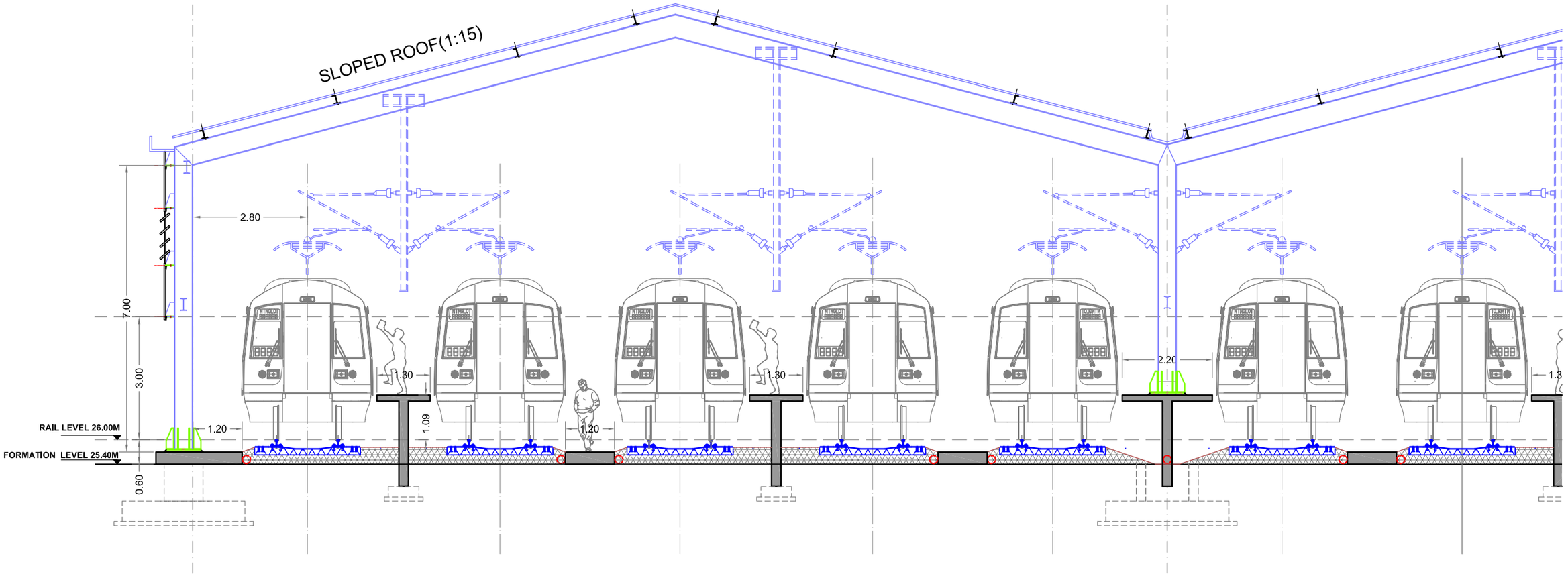
Maple Mumbai Metro 3 General Consultant
Wing 'B' NorthSide of City Park, 'E' Block, Bandra Kurla Complex, Bandra (East) Mumbai. 400051

MUMBAI METRO RAIL CORPORATION LIMITED,
WING 'A' NORTHSIDE OF CITY PARK, 'E' BLOCK, BANDRA KURLA COMPLEX, BANDRA (EAST) MUMBAI. 400051

DRAWING STAGE			DRAWING STAGE: DETAILED DRAWING		
DESCRIPTION	NAME	SIGNATURE	DESCRIPTION	NAME	SIGNATURE
	SVM		DRAWN BY	SVM (TI)	
			CHECKED BY	VKS (CTE)	
			REVIEWED BY	SY CHANG (TRACK EXPERT)	
CHECKED BY	MSS (DEPOT EQPT.)		APPROVED BY	RJM (PM)	

TITLE: **OCC & INFRASTRUCTURE BLDG. TYPICAL CROSS SECTION FOR PIT TRACK**

DRG No.	MM3-GC-TR-GD-0 101 0027		
SHEET	01 OF 01	SCALE	1:50
DATE	21 JUNE 2019	REV.	-



VERSIONS	DATE	DESCRIPTION

Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MAH 400098

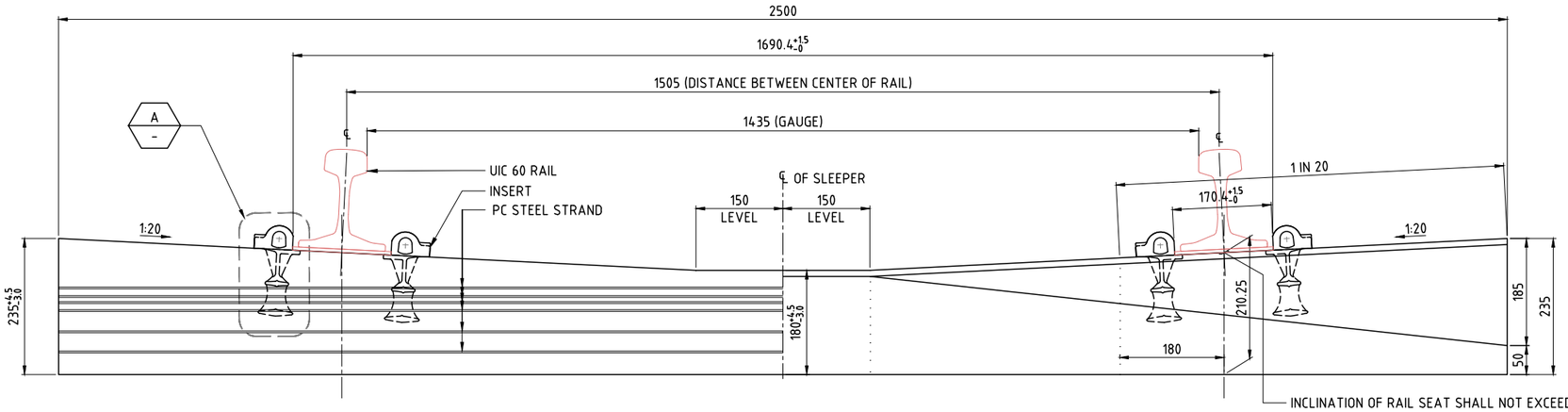
MUMBAI METRO RAIL CORPORATION LIMITED,
NaMTTRI Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

DRAWING STAGE		
DESCRIPTION	NAME	SIGNATURE
DRAWN BY	HRM (TI)	
CHECKED BY	VKS (CTE)	
REVIEWED BY	P. LEEMPUT (TRACK EXPERT)	
APPROVED BY	RJM (PM)	

TITLE

CROSS SECTION OF MULTIPLE TRACK BALLASTED IN DEPOT

DRG No.			
SHEET	01 OF 01	SCALE	NTS
DATE	27 September 2018	REV.	-

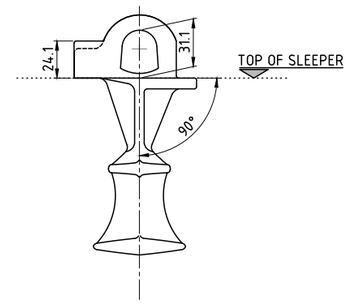


REINFORCEMENT LAYOUT

EXTERNAL LAYOUT

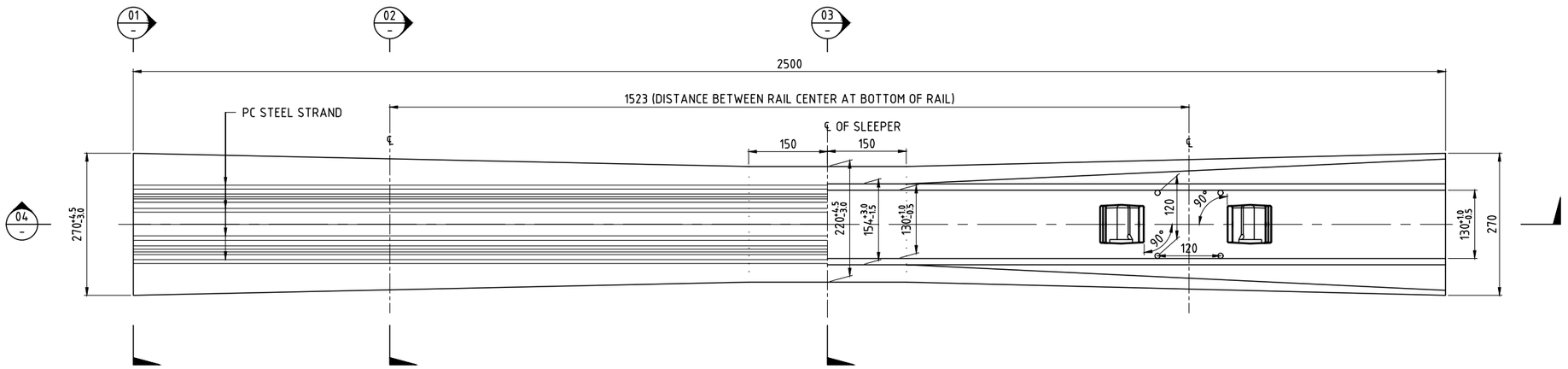
INCLINATION OF RAIL SEAT SHALL NOT EXCEED 1 in 19.75 NOR BE LESS THAN 1 in 20.25 (MEASUREMENT TO BE TAKEN AS INDICATED IN PLAN)

SECTION 04
SCALE 1: 5



DETAIL A
SCALE 1: 2

(STEEL CAST-IN SHOULDER DETAIL)

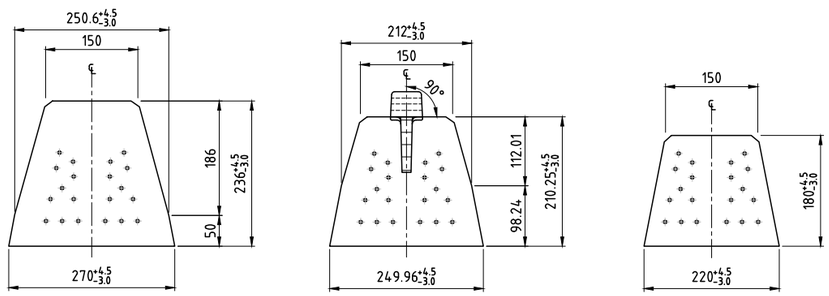


REINFORCEMENT LAYOUT

PLAN
SCALE 1:5

EXTERNAL LAYOUT

TYPICAL DRAWING OF PSC SLEEPER FOR STANDARD GAUGE FOR BALLASTED TRACK



SECTION 01
SCALE 1: 5

SECTION 02
SCALE 1: 5

SECTION 03
SCALE 1: 5

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE MENTIONED.
2. THIS DRAWING IS PREPARED BASED ON RDSO DRAWING T-8225
3. FOR DETAILS OF FASTENING SYSTEM REFER TO DRAWING NO. MML3-TRW-DWG-GEN-0082

SCALE 1:2 — 0.2 0 0.2 0.4 0.6 0.8 0.1

SCALE 1:5 — 0.05 0 0.10 0.20

VERSIONS	DATE	DESCRIPTION
A	05 March 2018	FOR APPROVAL
B	31 October 2018	SIGNATURE BLOCK UPDATED
.	.	.
.	.	.
.	.	.

DESIGNED BY

SMEC
Member of the Surbana Jurong Group

SMEC India Pvt. Ltd
41/7, Above Maruti Showroom
Varun Motors Pvt Ltd, 15th cross,
MES College Road, Malleshwaram,
Bengaluru, Karnataka 560003, India

DRAWING STAGE
DETAILED DRAWING

DESCRIPTION	NAME	SIGNATURE
DESIGNED	Gururaja N. (Sr. DE)	
DRAWN	Musaib A. (Sr. TO)	
APPROVED	Shivakumar GC. (GM)	

GENERAL CONSULTANT

maple
MUMBAI METRO LINE-3
GENERAL CONSULTANT

Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MH 400098

STAMP

DESCRIPTION	NAME	SIGNATURE
DRAWN	HRM (TI)	
CHECKED	VKS (CTE)	
REVIEWED	P. LEEMPUT (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER

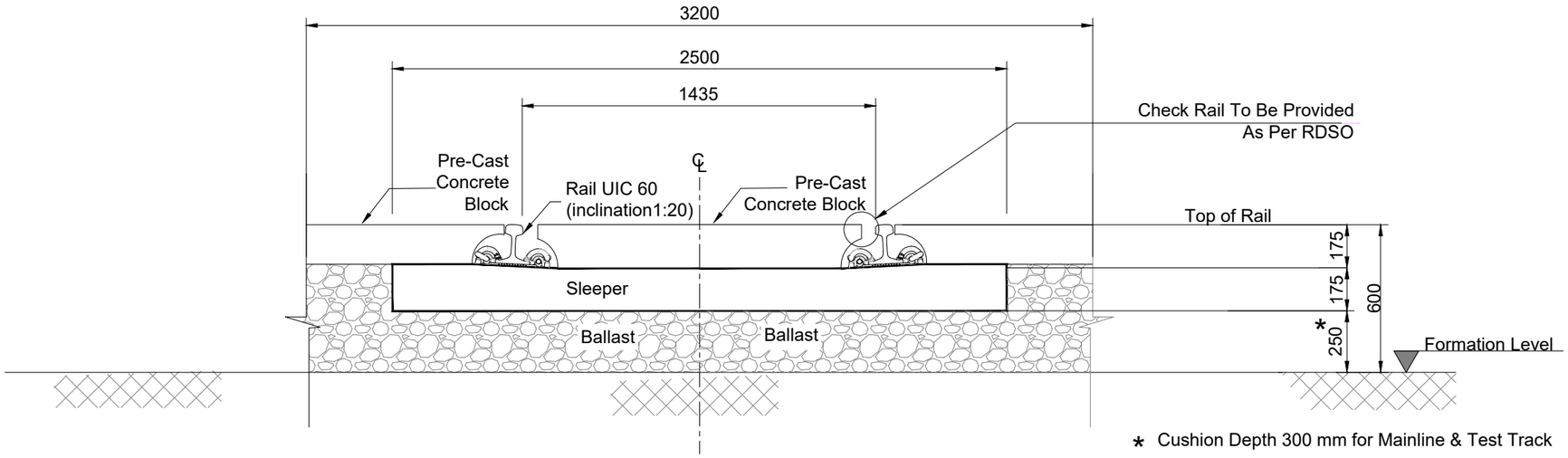
MMRC

MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

TITLE
TYPICAL DRAWING
OF PSC SLEEPER FOR STANDARD GAUGE
FOR BALLASTED TRACK IN DEPOT

DRG No.	MML3-TRW-DWG-GEN-0083		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	31 October 2018	REV.	B

Rev_ D:\MML3_TRW_DWG_GEN_0083.dwg



* Cushion Depth 300 mm for Mainline & Test Track
* Cushion Depth 350 mm for RCC Slab
* Cushion Depth 250 mm for Depot Other Lines

TYPICAL CROSS SECTION OF LEVEL CROSSING

Notes

1. All Dimensions are in mm unless otherwise mentioned.
2. Fastening System representation is only indicative.
3. All Dimensions have to be checked, confirmed or redesigned from DDC.

VERSIONS	DATE	DESCRIPTION
A	12 APRIL 2019	Typical Cross Section of Level crossing in Depot

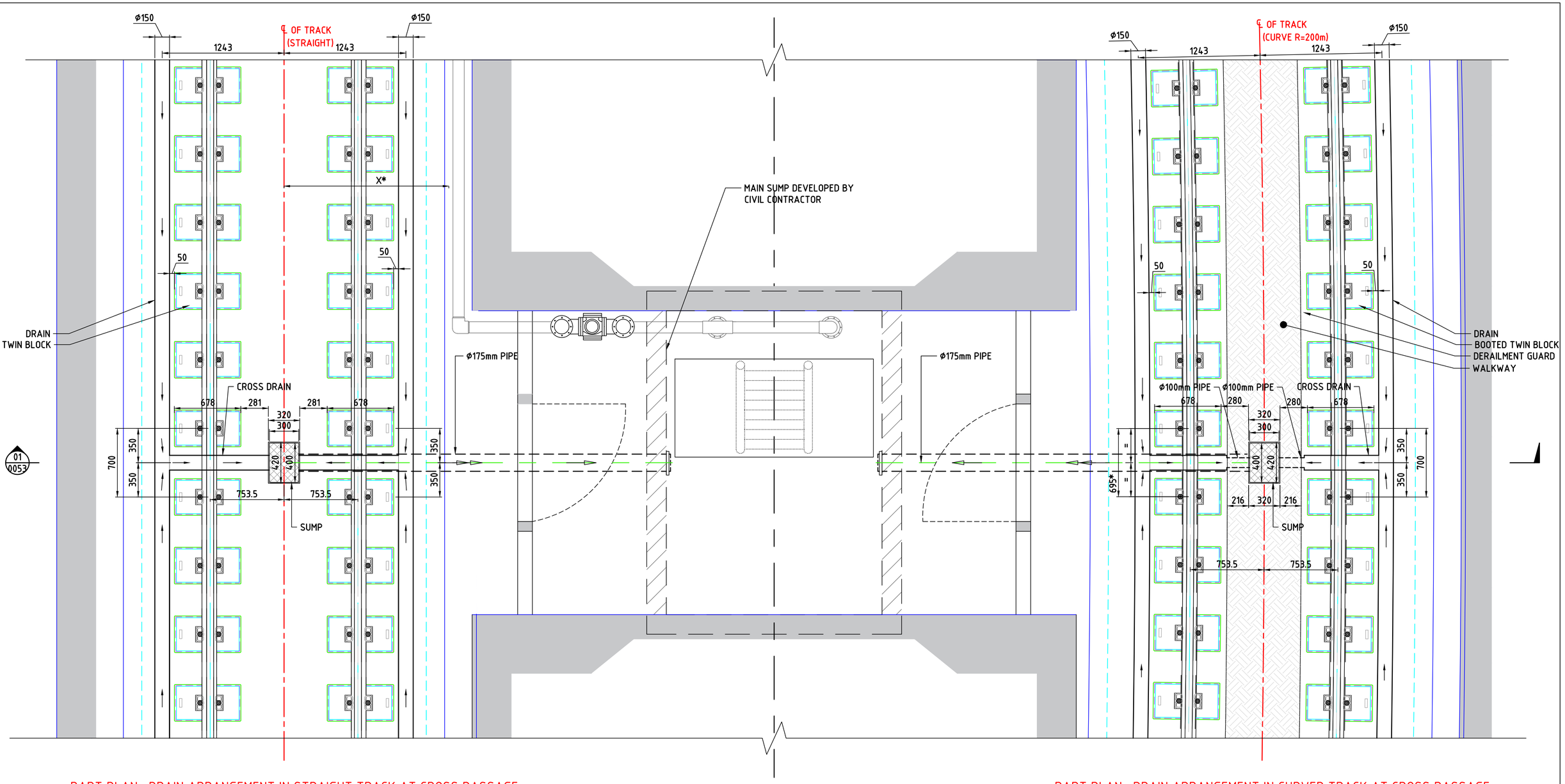
Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MAH 400098

MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
NaMTTRI Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

DRAWING STAGE	DETAILED DRAWING	
DESCRIPTION	NAME	SIGNATURE
DRAWN BY	YGP (TI)	
CHECKED BY	VKS (CTE)	
REVIEWED BY	SY CHANG (TRACK EXPERT)	
APPROVED BY	RJM (PM)	

TITLE: **TYPICAL CROSS SECTION OF LEVEL CROSSING.**

DRG No.	MM3-GC-TR-DDC-0 101 0006		
SHEET	01 OF 01	SCALE	1:10
DATE	12 APRIL 2019	REV.	A



PART PLAN- DRAIN ARRANGEMENT IN STRAIGHT TRACK AT CROSS PASSAGE

TYPICAL PLAN OF DRAIN ARRANGEMENT AT CROSS PASSAGE

SCALE 1:20

PART PLAN- DRAIN ARRANGEMENT IN CURVED TRACK AT CROSS PASSAGE

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE MENTIONED.
2. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT INTERFACE DRAWINGS.
3. THE CROSS SLOPE SHALL BE 1%.
4. FOR LOCATION (CHAINAGE) OF CROSS PASSAGE REFER TO ALIGNMENT DRAWING.
5. ALL THE DRAIN AND PIPES SHALL BE SPECIFIED BY TRACK CONTRACTOR.

THE ARRANGEMENT HAS BEEN SHOWN IN PART-PLAN TO ACCOMMODATE DETAILS OF BOTH (TANGENT & CURVED) TRACK IN ONE DRAWING.

*VALUES SHOWN ARE INDICATIVE. THESE DIMENSIONS SHOULD BE WORKED OUT AS PER SITE CONDITION.

STRUCTURE SHOWN ACCEPT TRACK IS INDICATIVE ONLY, TRACK CONTRACTOR SHALL COORDINATE WITH THE CIVIL CONTRACTOR TO PROVIDE DETAILS OF CROSS PASSAGE..

SCALE 1:20 0.2 0 0.2 0.4 0.6 0.8 1.0

VERSIONS	DATE	DESCRIPTION
A	29 Mar 2018	FOR APPROVAL
B	18 Sep 2018	FOR APPROVAL
.	.	.
.	.	.

DESIGNED BY

SMEC

Member of the Surbana Jurong Group

SMEC India Pvt. Ltd

41/7, Above Maruti Showroom
Varun Motors Pvt Ltd, 15th cross,
MES College Road, Malleshwaram,
Bengaluru, Karnataka 560003, India

DRAWING STAGE

DETAILED DRAWING

DESCRIPTION	NAME	SIGNATURE
DESIGNED	Gururaja N. (Sr. DE)	
DRAWN	Musaib A. (Sr. TO)	
APPROVED	Shivakumar GC. (GM)	

GENERAL CONSULTANT

maple
MUMBAI METRO LINE-3
GENERAL CONSULTANT

Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MH 400098

STAMP

DESCRIPTION	NAME	SIGNATURE
DRAWN	HRM (TI)	
CHECKED	VKS (CTE)	
REVIEWED	P. LEEMPUT (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER

MMRC

MUMBAI METRO RAIL CORPORATION LIMITED,

Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

TITLE

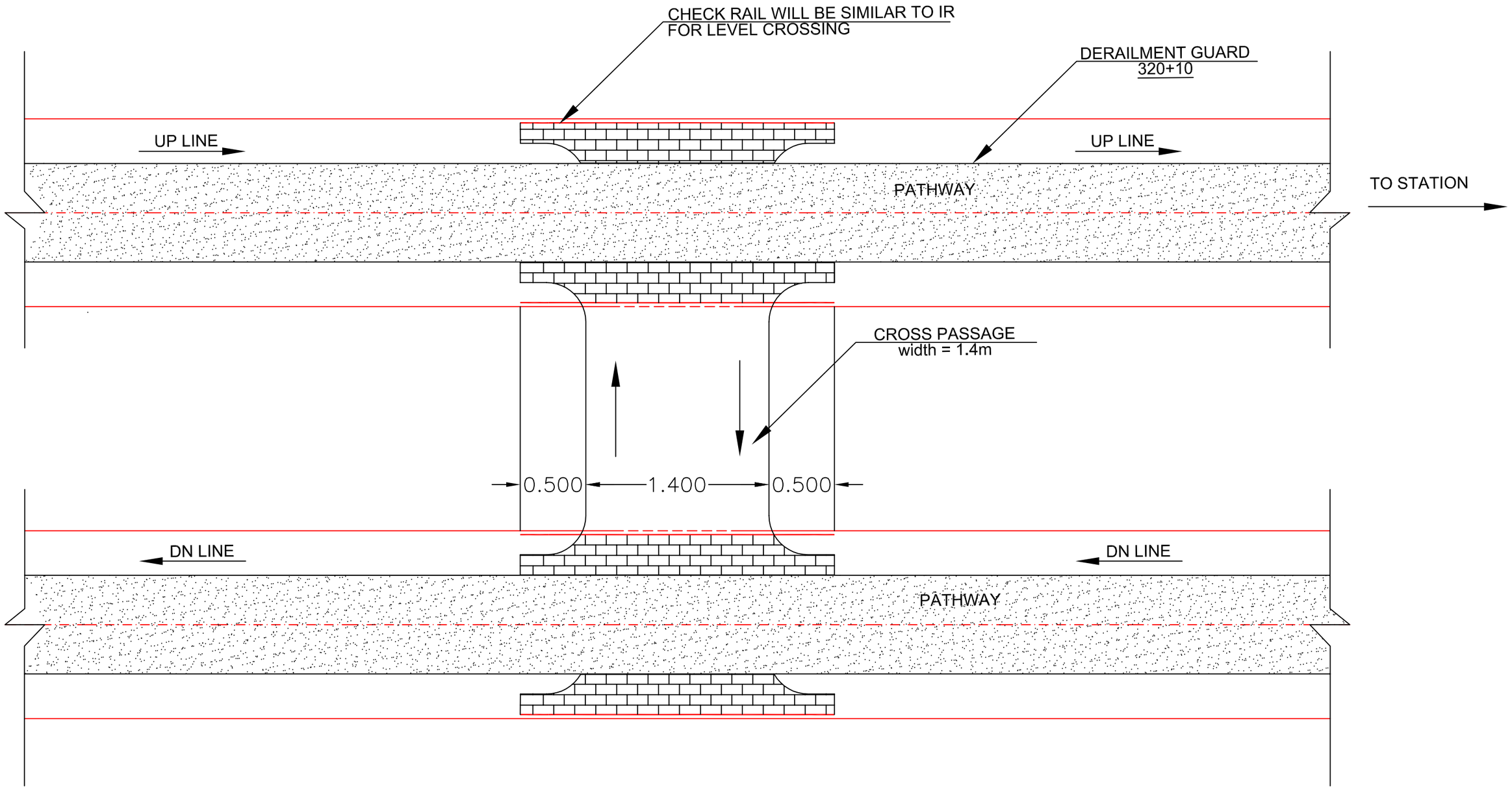
TYPICAL PLAN OF DRAIN ARRANGEMENT AT CROSS PASSAGE

DRG No.	MML3-TRW-DWG-GEN-0052		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	18 September 2018	REV.	B

File Location:-D:\MML3\Deliverables Drawings\Detailed Drawings\CAD Rev B\MML3-TRW-DWG-GEN-0052.dwg

Last Saved by:-MA5560347 On 08 October 2018 16:34:39

Drawing of Pathway at Cross Passage & Walkway to Station



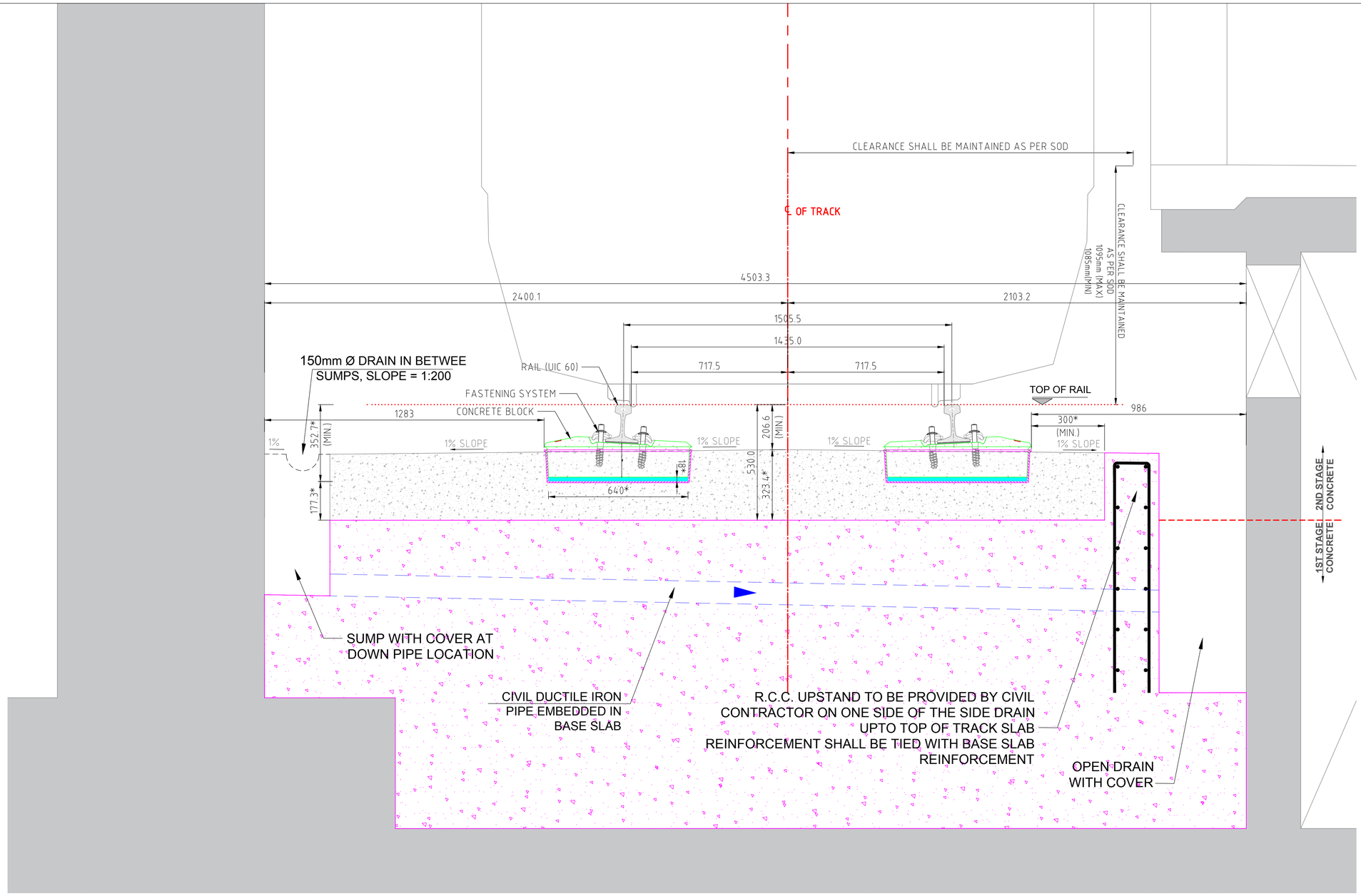
VERSIONS	DATE	DESCRIPTION

Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MAH 400098

MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
NaMTTRI Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

DRAWING STAGE		
DESCRIPTION	NAME	SIGNATURE
DRAWN BY	HRM (TI)	
CHECKED BY	VKS (CTE)	
REVIEWED BY	P. LEEMPUT (TRACK EXPERT)	
APPROVED BY	RJM (PM)	

TITLE			
Drawing of Pathway at Cross Passage & Walkway to Station			
DRG No.			
SHEET	-	SCALE	-
DATE	27 September 2018	REV.	-



LEGENDS:

BY TRACK CONTRACTOR

BY CIVIL CONTRACTOR

*VALUES SHOWN ARE INDICATIVE. THESE DIMENSIONS SHOULD BE WORKED OUT AS PER DETAIL DESIGN / SITE CONDITION

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE MENTIONED.
2. RAIL INCLINATION SHALL BE 1 IN 20.
3. AN EXPANSION GAP OF 20mm SHALL BE MAINTAINED AT 20m INTERVAL BY TRACK CONTRACTOR BETWEEN CONSECUTIVE SLABS AND FILLED WITH SUITABLE COMPRESSIVE MATERIAL.
4. DIMENSIONS OF BOOT AND BLOCKS ARE INDICATIVE ONLY.
5. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT TRACK & CIVIL DRAWINGS.
6. THE CROSS SLOPE SHALL BE 1% ON BOTH SIDE.
7. THE CONCRETING TOLERANCE ±5mm IN HEIGHT AFTER COMPLETION OF FIRST STAGE CONCRETE.
8. THE SIZE OF OPEN DRAIN AND DRAIN COVER WILL BE DESIGNED BY CIVIL CONTRACTOR.
9. R.C.C. UPSTAND WILL BE DESIGNED BY CIVIL CONTRACTOR BASED ON THE FORCES GIVEN BELOW.

S.NO	DESCRIPTION	FORCE
1.	TOTAL LONGITUDINAL FORCE	118.000 KN/M
2.	TOTAL LATERAL FORCE	121.162 KN/M

THE TOP OF FIRST STAGE CONCRETE WILL BE 530 MM BELOW THE TOP OF RAIL

SCALE 1:10 0.1 0 0.1 0.2 0.3 0.4 0.5

VERSIONS	DATE	DESCRIPTION
.	.	.
C	17.09.2019	INCLUSION OF NOTES
B	14.02.2019	INCLUSION OF R.C.C. UPSTAND

GENERAL CONSULTANT

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

Maple Mumbai Metro 3 General Consultant

LINE 3 TRANSIT OFFICE, WING 'B' NORTH SIDE OF CITY PARK 'E'- BLOCK, BANDRA-KURLA COMPLEX, BANDRA (EAST) MUMBAI 400 051, INDIA

DESCRIPTION	NAME	SIGNATURE
DRAWN	SVM (TI)	
CHECKED	NKV (TE)	
REVIEWED	VKS (CTE)	
REVIEWED	Sy CHANG (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER

MMRC

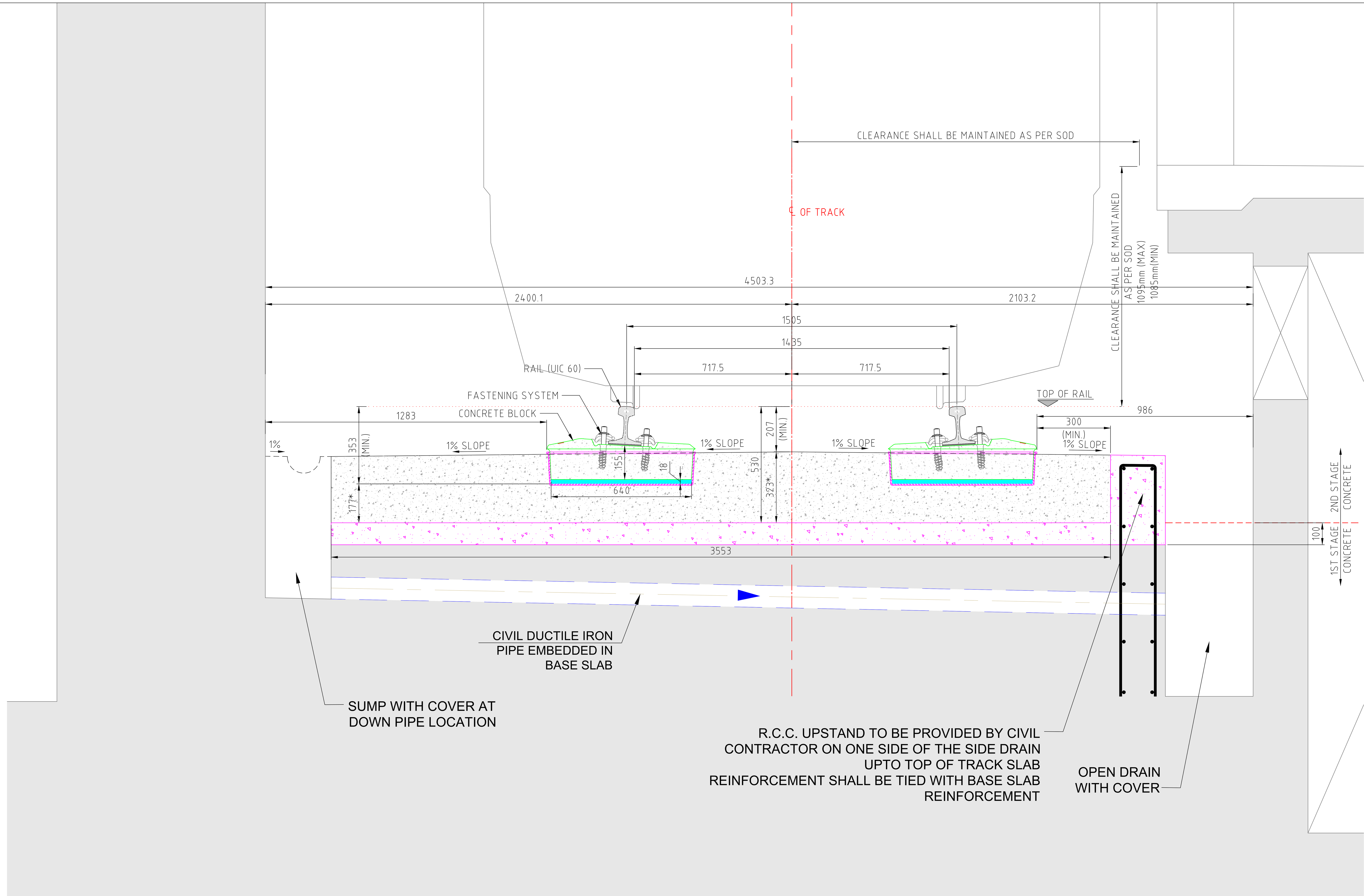
MUMBAI METRO RAIL CORPORATION LIMITED,

LINE 3 TRANSIT OFFICE, WING 'A' NORTH SIDE OF CITY PARK 'E'- BLOCK, BANDRA-KURLA COMPLEX, BANDRA (EAST) MUMBAI 400 051, INDIA

TITLE

TYPICAL CROSS SECTION OF TRACK STRUCTURE INCLUDING DRAINAGE IN UNDERGROUND STATIONS WITH R.C.C. UPSTAND AT SUMP ON ONE SIDE OF OPEN DRAIN

DRG No.	MML3-TRW-DWG-GEN-0051A		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	17 July 2019	REV.	C



LEGENDS:

BY TRACK CONTRACTOR

BY CIVIL CONTRACTOR

* VALUES SHOWN ARE INDICATIVE. THESE DIMENSIONS SHOULD BE WORKED OUT AS PER SITE CONDITION.

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE MENTIONED.
2. RAIL INCLINATION SHALL BE 1 IN 20.
3. AN EXPANSION GAP OF 20mm SHALL BE MAINTAINED AT 20m INTERVAL BY TRACK CONTRACTOR BETWEEN CONSECUTIVE SLABS AND FILLED WITH SUITABLE COMPRESSIVE MATERIAL.
4. DIMENSIONS OF BOOT AND BLOCKS ARE INDICATIVE ONLY.
5. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT TRACK & CIVIL DRAWINGS.
6. THE CROSS SLOPE SHALL BE 1% ON BOTH SIDE.
7. THE CONCRETING TOLERANCE ±5mm IN HEIGHT AFTER COMPLETION OF FIRST STAGE CONCRETE.
8. THE SIZE OF OPEN DRAIN AND DRAIN COVER WILL BE DESIGNED BY CIVIL CONTRACTOR.
9. R.C.C. UPSTAND WILL BE DESIGNED BY CIVIL CONTRACTOR BASED ON THE FORCES GIVEN BELOW.

S.NO	DESCRIPTION	FORCE
1.	TOTAL LONGITUDINAL FORCE	118.000 KN/M
2.	TOTAL LATERAL FORCE	121.162 KN/M

SCALE 1:10 0.1 0 0.1 0.2 0.3 0.4 0.5

VERSIONS	DATE	DESCRIPTION
-	-	-
-	-	-
B	14.02.2019	INCLUSION OF R.C.C. UPSTAND

GENERAL CONSULTANT

Maple Mumbai Metro 3 General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MH 400098

DESCRIPTION	NAME	SIGNATURE
DRAWN	ABK (CAD)	
CHECKED	SB (TE)	
REVIEWED	VKS (CTE)	
REVIEWED	Sy CHANG (Track Expert)	
APPROVED	RJM (PM)	

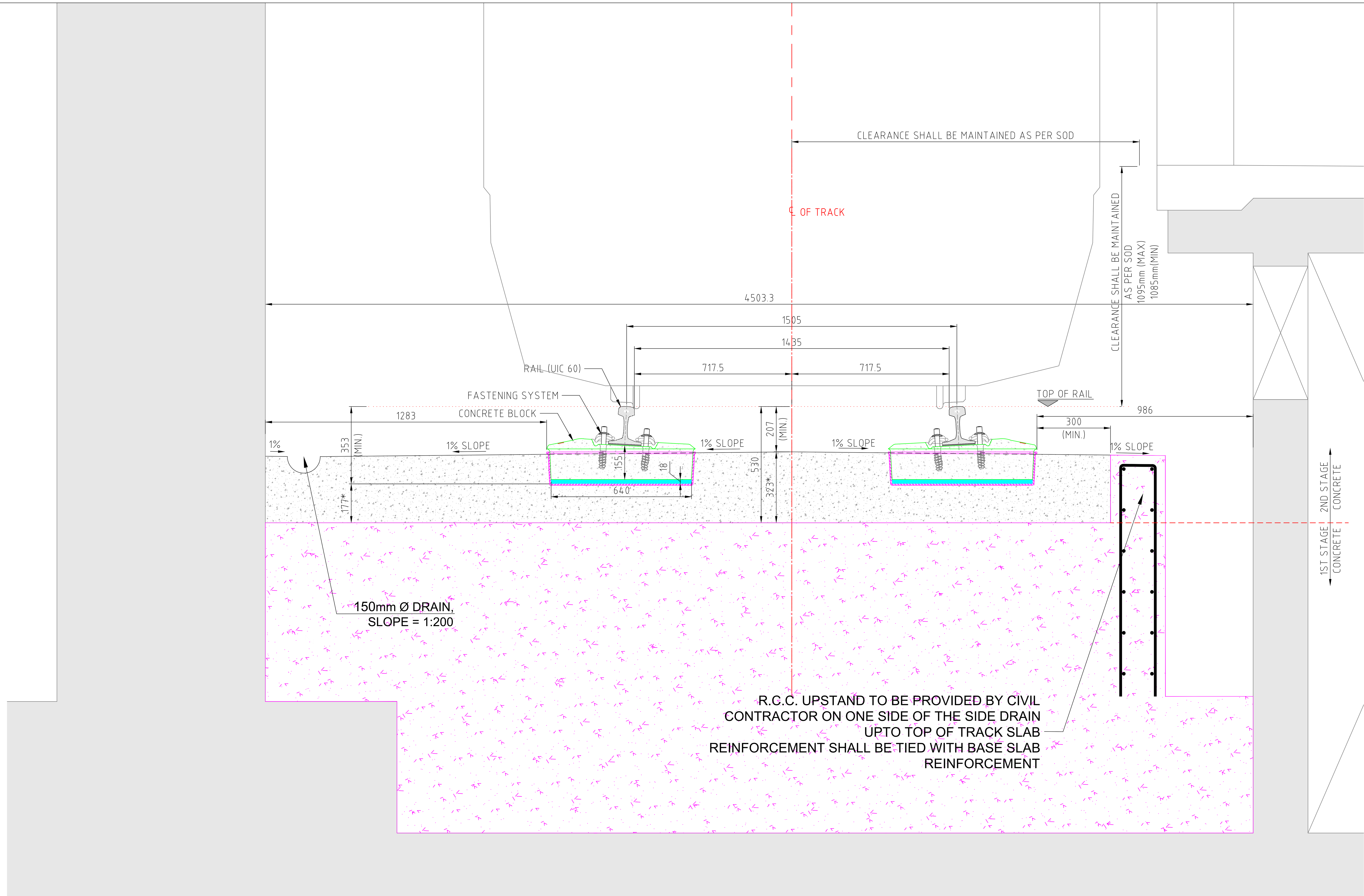
EMPLOYER

MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

TITLE: TYPICAL CROSS SECTION OF TRACK STRUCTURE INCLUDING DRAINAGE IN UNDERGROUND STATIONS WITH R.C.C. UPSTAND AT SUMP ON ONE SIDE OF OPEN DRAIN

DRG No.	MML3-TRW-DWG-GEN-0051B		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	19 November 2018	REV.	B

Last Saved by:-AKHANDARE On 15 February 2019 12:29:31



LEGENDS:

- BY TRACK CONTRACTOR
- BY CIVIL CONTRACTOR

*VALUES SHOWN ARE INDICATIVE. THESE DIMENSIONS SHOULD BE WORKED OUT AS PER SITE CONDITION.

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE MENTIONED.
2. RAIL INCLINATION SHALL BE 1 IN 20.
3. AN EXPANSION GAP OF 20mm SHALL BE MAINTAINED AT 20m INTERVAL BY TRACK CONTRACTOR BETWEEN CONSECUTIVE SLABS AND FILLED WITH SUITABLE COMPRESSIVE MATERIAL.
4. DIMENSIONS OF BOOT AND BLOCKS ARE INDICATIVE ONLY.
5. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT TRACK & CIVIL DRAWINGS.
6. THE CROSS SLOPE SHALL BE 1% ON BOTH SIDE.
7. THE CONCRETING TOLERANCE ±5mm IN HEIGHT AFTER COMPLETION OF FIRST STAGE CONCRETE.
8. THE SIZE OF OPEN DRAIN AND DRAIN COVER WILL BE DESIGNED BY CIVIL CONTRACTOR.
9. R.C.C. UPSTAND WILL BE DESIGNED BY CIVIL CONTRACTOR BASED ON THE FORCES GIVEN BELOW.

S.NO	DESCRIPTION	FORCE
1.	TOTAL LONGITUDINAL FORCE	118.000 KN/M
2.	TOTAL LATERAL FORCE	121.162 KN/M

SCALE 1:10

VERSIONS	DATE	DESCRIPTION
-	-	-
-	-	-
B	14.02.2019	INCLUSION OF R.C.C. UPSTAND

GENERAL CONSULTANT

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

Maple Mumbai Metro 3 General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MH 400098

DESCRIPTION	NAME	SIGNATURE
DRAWN	ABK (CAD)	
CHECKED	SB (TE)	
REVIEWED	VKS (CTE)	
REVIEWED	Sy CHANG (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER

MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

TITLE	TYPICAL CROSS SECTION OF TRACK STRUCTURE INCLUDING DRAINAGE IN UNDERGROUND STATIONS WITH R.C.C. UPSTAND IN BETWEEN SUMPS ON ONE SIDE OF OPEN DRAIN		
DRG No.	MML3-TRW-DWG-GEN-0051C		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	19 November 2018	REV.	B

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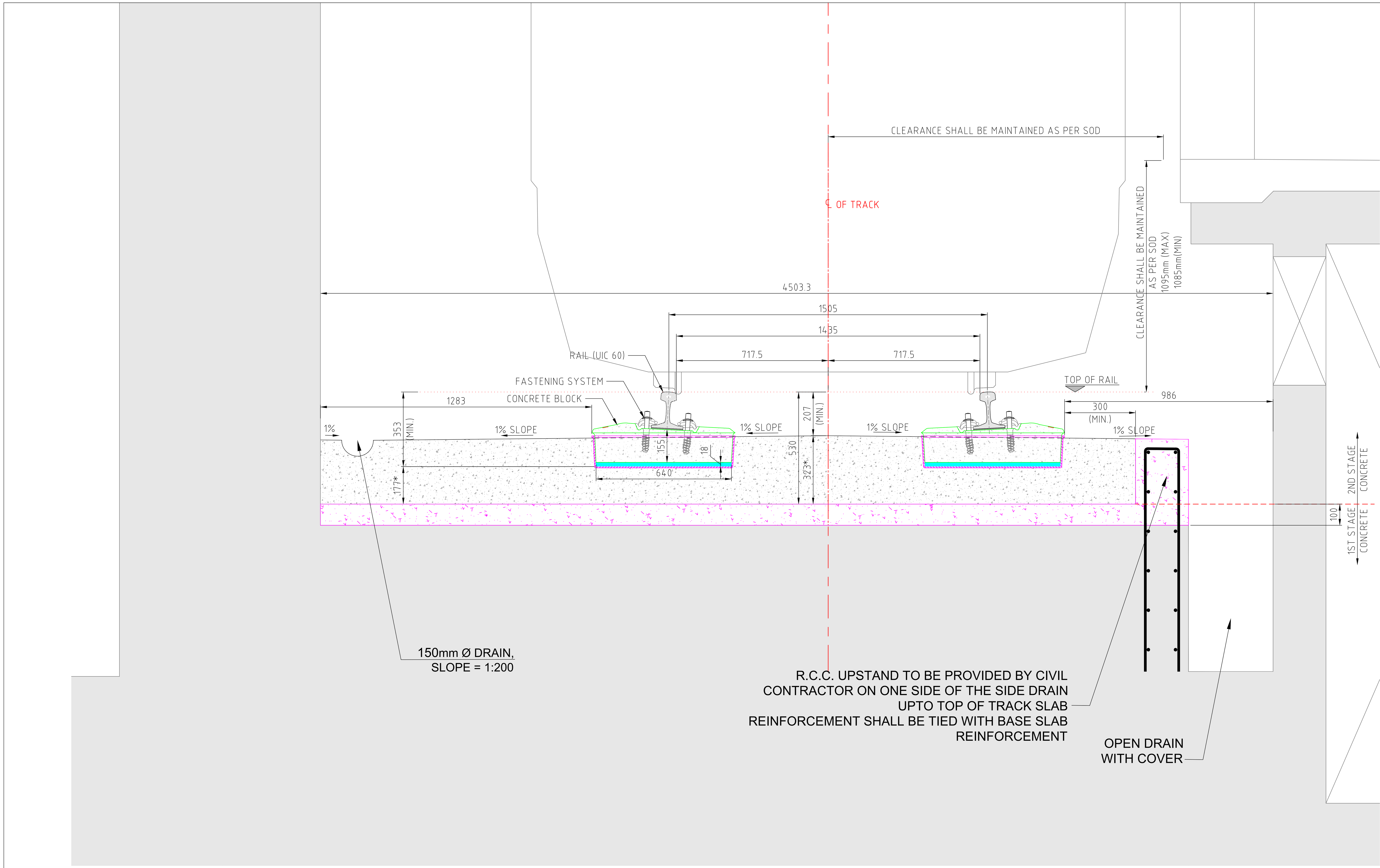


LEGENDS:

- BY TRACK CONTRACTOR
- BY CIVIL CONTRACTOR

* VALUES SHOWN ARE INDICATIVE. THESE DIMENSIONS SHOULD BE WORKED OUT AS PER SITE CONDITION.

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE MENTIONED.
2. RAIL INCLINATION SHALL BE 1 IN 20.
3. AN EXPANSION GAP OF 20mm SHALL BE MAINTAINED AT 20m INTERVAL BY TRACK CONTRACTOR BETWEEN CONSECUTIVE SLABS AND FILLED WITH SUITABLE COMPRESSIVE MATERIAL.
4. DIMENSIONS OF BOOT AND BLOCKS ARE INDICATIVE ONLY.
5. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT TRACK & CIVIL DRAWINGS.
6. THE CROSS SLOPE SHALL BE 1% ON BOTH SIDE.
7. THE CONCRETING TOLERANCE ±5mm IN HEIGHT AFTER COMPLETION OF FIRST STAGE CONCRETE.
8. THE SIZE OF OPEN DRAIN AND DRAIN COVER WILL BE DESIGNED BY CIVIL CONTRACTOR.
9. R.C.C. UPSTAND WILL BE DESIGNED BY CIVIL CONTRACTOR BASED ON THE FORCES GIVEN BELOW.

S.NO	DESCRIPTION	FORCE
1.	TOTAL LONGITUDINAL FORCE	118.000 KN/M
2.	TOTAL LATERAL FORCE	121.162 KN/M

SCALE 1:10   0.1 0 0.1 0.2 0.3 0.4 0.5

VERSIONS	DATE	DESCRIPTION
-	-	-
-	-	-
B	14.02.2019	INCLUSION OF R.C.C. UPSTAND

GENERAL CONSULTANT

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

Maple Mumbai Metro 3 General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MH 400098

DESCRIPTION	NAME	SIGNATURE
DRAWN	ABK (CAD)	
CHECKED	SB (TE)	
REVIEWED	VKS (CTE)	
REVIEWED	Sy CHANG (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER

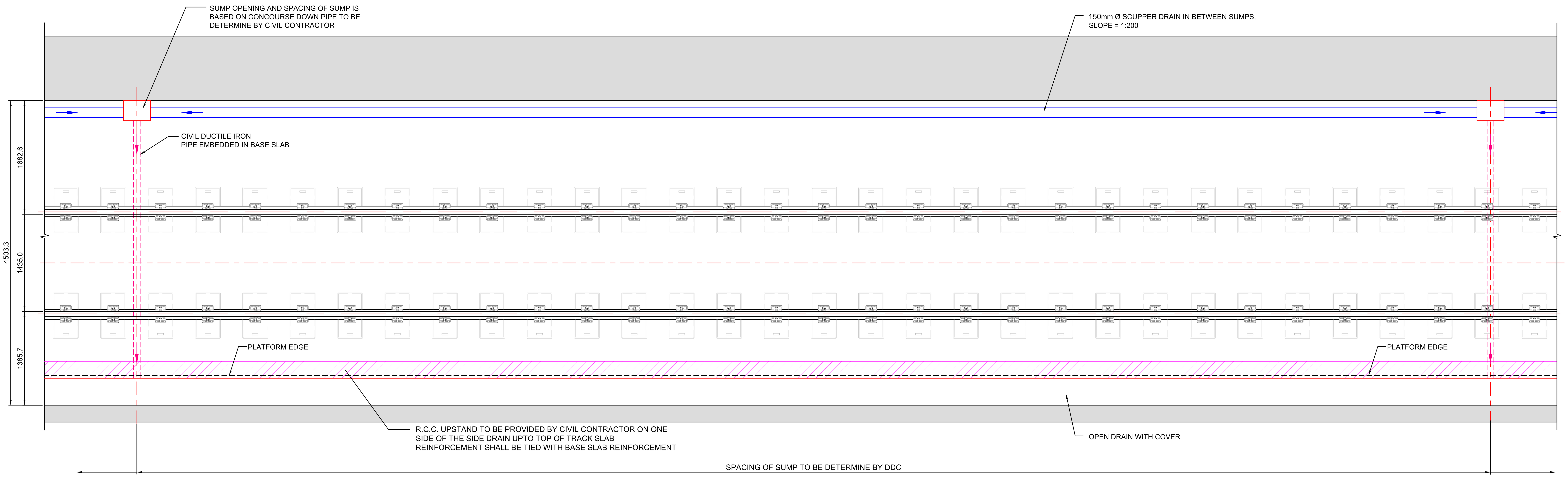
MMRC

MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

TITLE: TYPICAL CROSS SECTION OF TRACK STRUCTURE INCLUDING DRAINAGE IN UNDERGROUND STATIONS WITH R.C.C. UPSTAND IN BETWEEN SUMPS ON ONE SIDE OF OPEN DRAIN

DRG No.	MML3-TRW-DWG-GEN-0051D		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	19 November 2018	REV.	B

Last Saved by:-AKHANDARE On 15 February 2019 12:29:38



TYPICAL PLAN

SCALE 1:30

LEGENDS :

- 150mm Ø DRAIN
- CIVIL DUCTILE IRON PIPE EMBEDDED IN BASE SLAB

0 0.3 0.6 0.9 1.2 1.5m
SCALE 1:30

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE MENTIONED.
2. RAIL INCLINATION SHALL BE 1 IN 20.
3. AN EXPANSION GAP OF 20mm SHALL BE MAINTAINED AT 20m INTERVAL BY TRACK CONTRACTOR BETWEEN CONSECUTIVE SLABS AND FILLED WITH SUITABLE COMPRESSIVE MATERIAL.
4. DIMENSIONS OF BOOT AND BLOCKS ARE INDICATIVE ONLY.
5. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT TRACK & CIVIL DRAWINGS.
6. THE CROSS SLOPE SHALL BE 1% ON BOTH SIDE.
7. THE CONCRETING TOLERANCE ±5mm IN HEIGHT AFTER COMPLETION OF FIRST STAGE CONCRETE.

VERSIONS	DATE	DESCRIPTION
.	.	.
.	.	.
B	14.02.2019	INCLUSION OF R.C.C. UPSTAND

GENERAL CONSULTANT

Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai, MH 400098

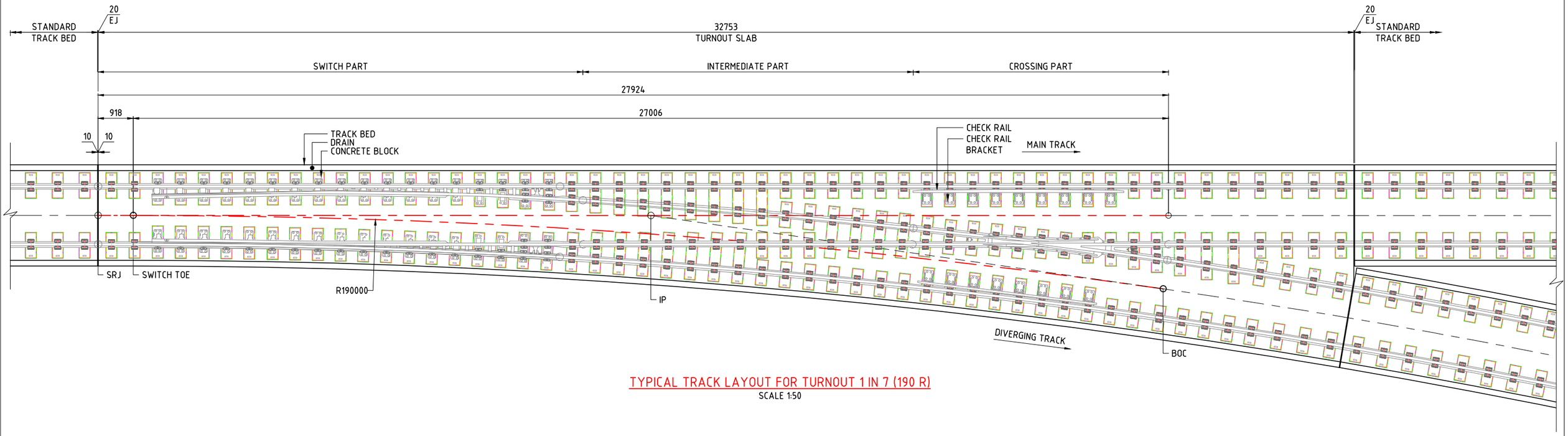
DESCRIPTION	NAME	SIGNATURE
DRAWN	ABK (CAD)	
CHECKED	SB (TE)	
REVIEWED	VKS (CTE)	
REVIEWED	Sy CHANG (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER

MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

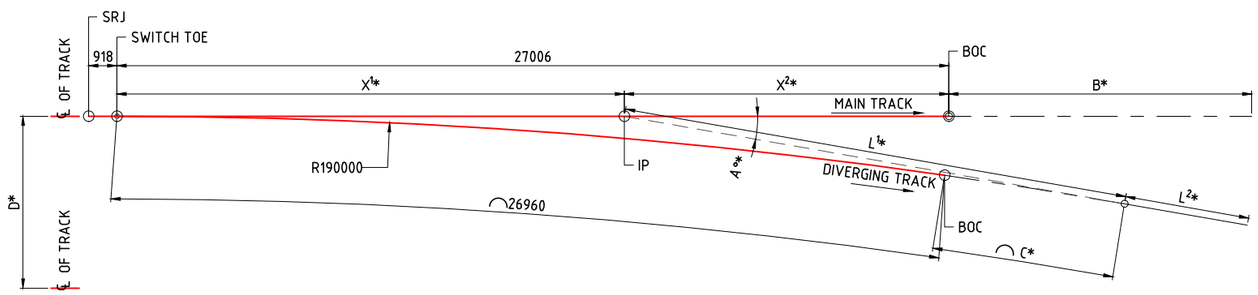
TITLE	TYPICAL PLAN OF TRACK STRUCTURE INCLUDING DRAINAGE WITH R.C.C. UPSTAND
DRG No.	MML3-TRW-DWG-GEN-0051E
SHEET	01 OF 01
SCALE	AS SHOWN
DATE	28 November 2018
REV.	B

Last Saved by:-AKHANDARE On 15 February 2019 12:29:34



TYPICAL TRACK LAYOUT FOR TURNOUT 1 IN 7 (190 R)

SCALE 1:50



D = DISTANCE BETWEEN TRACKS
L^1 = TANGENT BETWEEN MAIN LINE TO END OF EXTENDED CURVE
L^2 = TANGENT BETWEEN BOC AT DIVERGING LINE
C = EXTENDED CURVE LENGTH
B = TANGENT BETWEEN BOC AT MAIN LINE
A = ANGLE OF DEFLECTION
X^1 = DISTANCE FROM SWITCH TOE TO IP
X^2 = DISTANCE FROM IP TO BOC

* DIMENSIONS VAERYING AS PER SITE CONDITION.

TYPICAL GEOMETRY OF TURNOUT 1 IN 7 (190 R)

SCALE 1:100

THE TRACK WORK CONTRACTOR SHALL COORDINATE WITH THE TURNOUT SUPPLIER FOR THE SPACING OF FASTENERS.

AT THE LOCATION OF SWITCHES / POINT MACHINES THE TRACK BED DEPTH SHALL BE MODIFIED AS PER THE TURNOUT SUPPLIER SPECIFICATION.

SHOP DRAWING SHALL BE PREPARED FOR THE SPECIFIC CROSSOVER LOCATION AS PER ALIGNMENT AND SHALL BE COORDINATED WITH INTERFACE TEAM

ALL LENGTH OF TRACK BED SEGMENT SHOWN ARE INDICATIVE ONLY. THE FINAL LAYOUT AND DIMENSIONS OF TRACK BED SEGMENTS SHALL BE ARRIVED IN COORDINATION WITH THE TURNOUT SUPPLIER.

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE MENTIONED.
2. FOR LOCATION OF CROSS OVERS AND SCISSORS CROSSOVER REFER TO ALIGNMENT DRAWING.
3. FOR STANDARD TRACK BED ARRANGEMENT REFER TO DRAWING NO. MML3-TRW-DWG-GEN-0011

SCALE 1:50 0.5 0 1 2

VERSIONS	DATE	DESCRIPTION
A	05 March 2018	FOR APPROVAL
B	28 June 2018	REVISED AS PER GC COMMENTS
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.	.	.

DESIGNED BY

SMEC
Member of the Surbana Jurong Group

SMEC India Pvt. Ltd
41/7, Above Maruti Showroom
Varun Motors Pvt Ltd, 15th cross,
MES College Road, Malleshwaram,
Bengaluru, Karnataka 560003, India

DRAWING STAGE
DETAILED DRAWING

DESCRIPTION	NAME	SIGNATURE
DESIGNED	Gururaja N. (Sr. DE)	
DRAWN	Musaib A. (Sr. TO)	
APPROVED	Shivakumar GC. (GM)	

GENERAL CONSULTANT

maple
MUMBAI METRO LINE-3
GENERAL CONSULTANT

Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruz East, Mumbai. MH 400098

STAMP

DESCRIPTION	NAME	SIGNATURE
DRAWN	HRM (TI)	
CHECKED	VKS (CTE)	
REVIEWED	P. LEEMPUT (Track Expert)	
APPROVED	RJM (PM)	

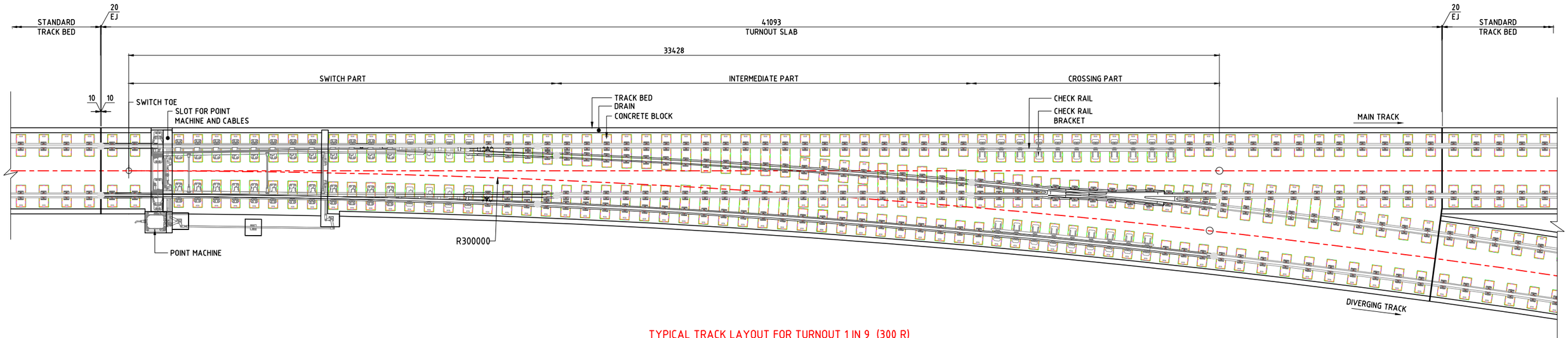
EMPLOYER

MMRC

MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

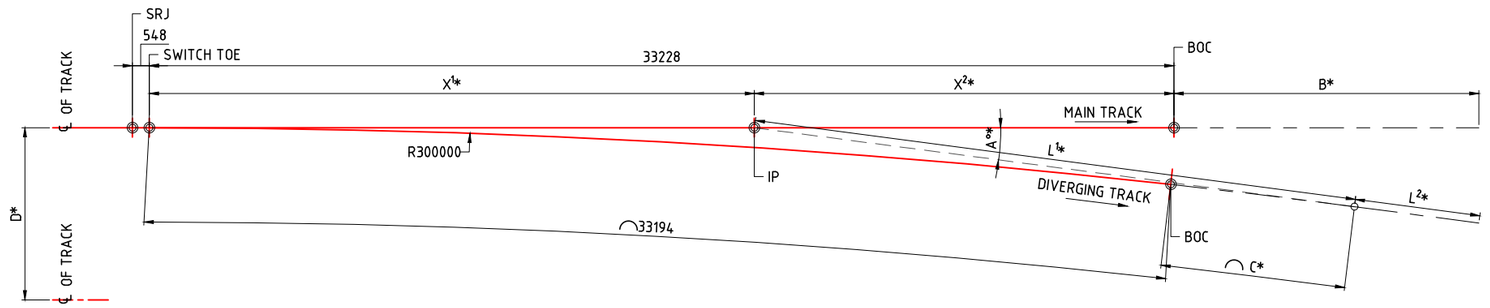
TITLE
TYPICAL TRACK LAYOUT
FOR TURNOUT 1 IN 7 (190 R)

DRG No.	MML3-TRW-DWG-GEN-0061		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	28 June 2018	REV.	B



TYPICAL TRACK LAYOUT FOR TURNOUT 1 IN 9 (300 R)

SCALE 1:50



D = DISTANCE BETWEEN TRACKS
L^1 = TANGENT BETWEEN MAIN LINE TO END OF EXTENDED CURVE
L^2 = TANGENT BETWEEN BOC AT DIVERGING LINE
C = EXTENDED CURVE LENGTH
B = TANGENT BETWEEN BOC AT MAIN LINE
A = ANGLE OF DEFLECTION
X^1 = DISTANCE FROM SWITCH TOE TO IP
X^2 = DISTANCE FROM IP TO BOC

* DIMENSIONS VAERYING AS PER SITE CONDITION.

TYPICAL GEOMETRY OF TURNOUT 1 IN 9 (300 R)

SCALE 1:100

THE TRACK WORK CONTRACTOR SHALL COORDINATE WITH THE TURNOUT SUPPLIER FOR THE SPACING OF FASTENERS.

AT THE LOCATION OF SWITCHES / POINT MACHINES THE TRACK BED DEPTH SHALL BE MODIFIED AS PER THE TURNOUT SUPPLIER SPECIFICATION.

SHOP DRAWING SHALL BE PREPARED FOR THE SPECIFIC CROSSOVER LOCATION AS PER ALIGNMENT AND SHALL BE COORDINATED WITH INTERFACE TEAM

ALL LENGTH OF TRACK BED SEGMENT SHOWN ARE INDICATIVE ONLY. THE FINAL LAYOUT AND DIMENSIONS OF TRACK BED SEGMENTS SHALL BE ARRIVED IN COORDINATION WITH THE TURNOUT SUPPLIER.

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE MENTIONED.
2. FOR LOCATION OF CROSS OVERS AND SCISSORS CROSSOVER REFER TO ALIGNMENT DRAWING.
3. FOR STANDARD TRACK ARRANGEMENT REFER TO DRAWING NO. MML3-TRW-DWG-GEN-0011

SCALE 1:50 0.5 0 1 2

VERSIONS	DATE	DESCRIPTION
A	05 March 2018	FOR APPROVAL
B	28 June 2018	REVISED AS PER GC COMMENTS
.	.	.
.	.	.
.	.	.

DESIGNED BY
SMEC
Member of the Surbana Jurong Group
SMEC India Pvt. Ltd
41/7, Above Maruti Showroom Varun Motors Pvt Ltd, 15th cross, MES College Road, Malleshwaram, Bengaluru, Karnataka 560003, India

DRAWING STAGE
DETAILED DRAWING

DESCRIPTION	NAME	SIGNATURE
DESIGNED	Gururaja N. (Sr. DE)	
DRAWN	Musaib A. (Sr. TO)	
APPROVED	Shivakumar GC. (GM)	

GENERAL CONSULTANT
maple MUMBAI METRO LINE-3 GENERAL CONSULTANT
Maple Mumbai Metro 3 General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village, Santacruz East, Mumbai. MH 400098

STAMP

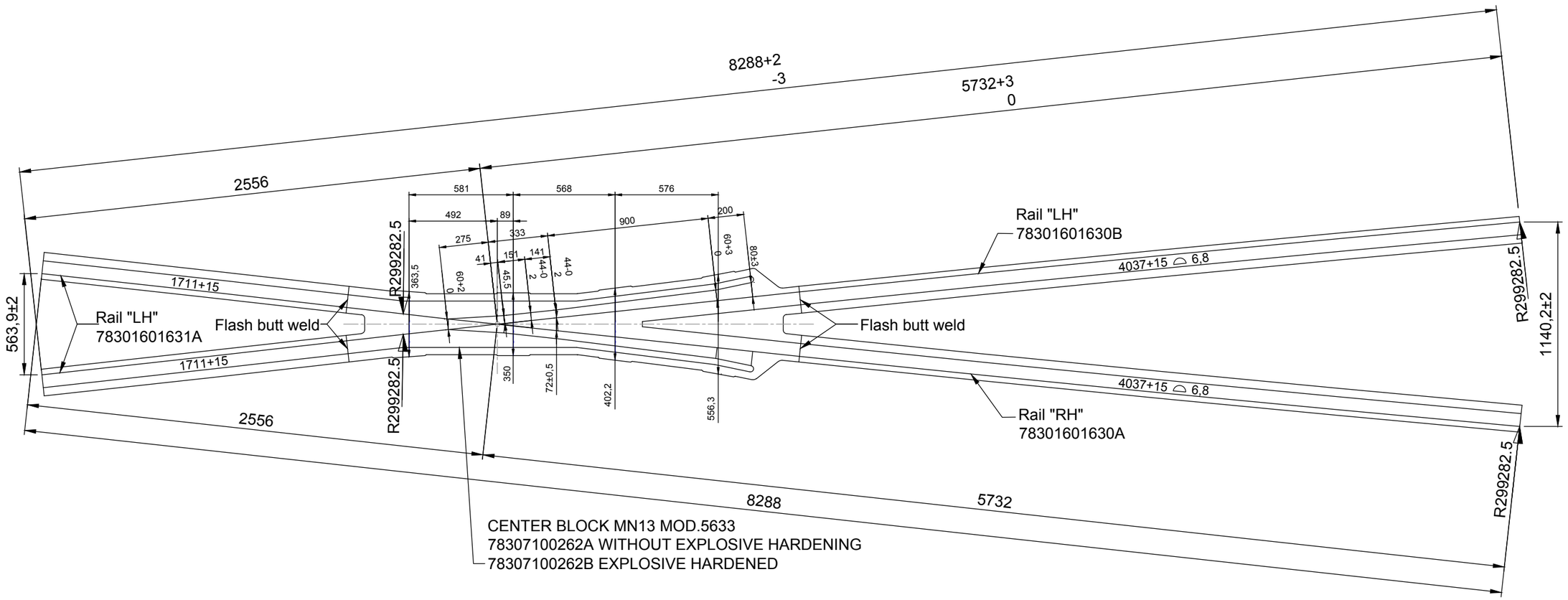
DESCRIPTION	NAME	SIGNATURE
DRAWN	HRM (TI)	
CHECKED	VKS (CTE)	
REVIEWED	P. LEEMPUT (Track Expert)	
APPROVED	RJM (PM)	

EMPLOYER
MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
Namttri Building, Plot No. R-13, 'E'- Block, Bandra Kurla Complex, Bandra (East), Mumbai 400051

TITLE
TYPICAL TRACK LAYOUT FOR TURNOUT 1 IN 9 (300 R)

DRG No.	MML3-TRW-DWG-GEN-0062		
SHEET	01 OF 01	SCALE	AS SHOWN
DATE	28 June 2018	REV.	B

TYPICAL DRAWING OF CMS CROSSING



VERSIONS	DATE	DESCRIPTION

Maple Mumbai Metro 3
General Consultant
Kumar Plaza Unit no 201
2nd Floor Air India Road Jamilpada, Kalina village,
Santacruiz East, Mumbai. MAH 400098

MMRC
MUMBAI METRO RAIL CORPORATION LIMITED,
NaMTTRI Building, Plot No. R-13, 'E'- Block,
Bandra Kurla Complex, Bandra (East),
Mumbai 400051

DRAWING STAGE	DETAILED DRAWING		TITLE		
DESCRIPTION	NAME	SIGNATURE	TYPICAL DRAWING OF CMS CROSSING		
DRAWN BY	YGP (TI)				
CHECKED BY	VKS (CTE)		DRG No.	MM3-GC-TR-GD-0 101 0015	
REVIEWED BY	SY CHANG (TRACK EXPERT)		SHEET	01 OF 01	SCALE 1:25
APPROVED BY	RJM (PM)		DATE	27 September 2018	REV. -

BIDDING DOCUMENTS

MUMBAI METRO LINE 3
(COLABA-BANDRA-SEEPZ)

CONTRACT MM3-CBS-TWK-03
(Package 10C)

Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of Ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and Ballasted Track in the area of at-grade Aarey Station and in the Depot area of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ).

and

Procurement and Supply of Turnouts, Scissor Crossovers and Buffer Stops for the entire Mainline for Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ) including Package 10 B.

Part 3

CONDITIONS OF CONTRACT AND CONTRACT FORMS

Section VII	General Conditions Of Contract(GC)
Section VIII	Particular Conditions Of Contract (PC)
Section IX	Contract Forms

July 2019

JICA LOAN AGREEMENT ID - P 268

Mumbai Metro Rail Corporation Ltd

Line 3 Transit Office, Wing 'A'North Side of City park 'E'- Block, ,
Bandra-Kurla Complex,
Bandra (East) Mumbai 400 051, India

BIDDING DOCUMENTS

Composition of Documents

Part 1	**Bidding Procedure**
Section I	Instructions to Bidders
Section II	Bid Data Sheet
Section III	Evaluation and Qualification Criteria
Section IV-A	Bidding Forms
Section IV-B	Pricing Document
Section V	Eligible Source Countries of Japanese ODA Loans
Part 2	**Employer's Requirements**
Section VI (1)	General Specifications A. General B. Functional C. Design D. Construction E. Inspection Testing and commissioning F. Appendices
Section VI (2)	Outline Design Specifications
Section VI (3)	Outline Construction Specifications
Section VI (4)	Bid Drawings
Part 3	**Conditions of Contract and Contract Forms**
Section VII	General Conditions of Contract (GC)
Section VIII	Particular Conditions of Contract (PC)
Section IX	Contract Forms
Part 4	**Reference Documents**
Section X	OHS&E Manual

MUMBAI METRO LINE 3

(COLABA-BANDRA-SEEPZ)

CONTRACT MM3-CBS- TWK-03

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Part 3 – CONDITIONS OF CONTRACT AND CONTRACT FORMS

BIDDING DOCUMENTS

MUMBAI METRO LINE 3 (COLABA-BANDRA-SEEPZ)

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Part 3
CONDITIONS OF CONTRACT AND CONTRACT FORMS

Section VII
GENERAL CONDITIONS (GC)

July 2019

JICA LOAN AGREEMENT ID - P 268

Mumbai Metro Rail Corporation Ltd
Line 3 Transit Office, Wing 'A' North Side of City park 'E'- Block,
Bandra-Kurla Complex,
Bandra (East) Mumbai 400 051, India

BIDDING DOCUMENTS

Composition of Documents

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Part 3	**Conditions of Contract and Contract Forms**
Section VII	**General Conditions of Contract (GC)**
Section VIII	Particular Conditions of Contract (PC)
Section IX	Contract Forms
Part 4	**Reference Documents**
Section X	OHS&E Manual

GENERAL CONDITIONS (GC)

The General Conditions governing this Contract are the Standard General Conditions of Contract set forth in Part 3, Section VII of the Standard Bidding documents for procurement electrical and mechanical pant, and for Building and Engineering works, designed by the contractor (Trial Version) published by JICA in July 2015. The General Conditions of Contract is available in JICA's website shown below:

http://www.jica.go.jp/english/our_work/types_of_assistance/oda_loans/oda_op_info/guide/tender/index.html

A copy of these General Conditions is not attached to these Bidding / Contract Documents for convenience. The GC will form part of contracts.

BIDDING DOCUMENTS

MUMBAI METRO LINE 3 (COLABA-BANDRA-SEEPZ)

CONTRACT MM3-CBS-TWK-03
(Package 10C)

Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of Ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and Ballasted Track in the area of at-grade Aarey Station and in the Depot area of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ).

and

Procurement and Supply of Turnouts, Scissor Crossovers and Buffer Stops for the entire Mainline for Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ) including Package 10 B.

Part 3

CONDITIONS OF CONTRACT AND CONTRACT FORMS

Section VIII

PARTICULAR CONDITIONS (PC)
July 2019

JICA LOAN AGREEMENT ID - P 268

Mumbai Metro Rail Corporation Ltd
Line 3 Transit Office, Wing 'A'North Side of City park'E'- Block, ,
Bandra-Kurla Complex,
Bandra (East) Mumbai 400 051, India

BIDDING DOCUMENTS

Composition of Documents

Part 1	**Bidding Procedures**	
	Section I	Instructions to Bidders(ITB)
	Section II	Bid Data Sheet(BDS)
	Section III	Evaluation and Qualification Criteria
	Section IV- A	Bidding Forms
	Section IV- B	Pricing Document
	Section V	Eligible Source Countries of Japanese ODA Loan
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	Section VI (1)	General Specifications A. General B. Functional C. Design D. Construction E. Inspection Testing and commissioning F. Appendices
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	Section VI (3)	Outline Construction Specifications
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	Section VII	General Conditions of Contract (GC)
	Section VIII	**Particular Conditions of Contract (PC)**
	Section IX	Annex to the Particular Conditions - Contract Forms
Part 4	**Reference Documents**	
	Section X	OHS&E Manual

Table of Contents

Particular Conditions (PC)

Part A - Contract Data

Serial No.	Conditions of Contract.	Sub-Clause of GC	Data
1	**Employer's name and address**	1.1.2.2 & 1.3	**MMRCL LINE 3** **MML3 Transit Office** E-Block, Wing 'A', North Side of, City Park Road, E Block BKC, Bandra Kurla Complex, Bandra East, Mumbai, Maharashtra 400051. Telephone: +91 22 26575123
2	**Engineer's name and address**	1.1.2.4 & 1.3	**Project Manager,** **MAPLE General Consultant** **MML3 Transit Office** E-Block, Wing 'B', North Side of, City Park Road, Bandra Kurla Complex, Bandra East, Mumbai, Maharashtra 400051.
3	**Bank's name**	1.1.2.11	Japan International Cooperation Agency (JICA)
4	**Borrower's name**	1.1.2.12	Government of India.
5	**Time for Completion**	1.1.3.3	731 days
6	**Defects Notification Period**	1.1.3.7	2 Years
7	**Sections**	1.1.5.6	The sections of works have been indicated in the keys dates placed below and the same is given in the Appendix 2B Part 2
8	**Electronic transmission systems**	1.3	By Fax/ Electronic mail followed by hand delivery/ air mail/ courier/ speed post. *[insert Contractor's name and address:* to be filled later]
9	**Governing Law**	1.4	Laws of India
10	**Ruling language**	1.4	English
11	**Language for communications**	1.4	English

Serial No.	Conditions of Contract.	Sub-Clause of GC	Data
12	**Time for access to, and possession of all parts of the Site**	2.1 and 8.1 (c)	Refer to Access Dates given below this table inthis Section VIII., This is also given in Appendix 2B – Part 2 – Section VI(1)
13	**Engineer's Duties and Authority**	3.1(B)(ii)	Engineer is Authorized to approve the variation, upto 0.5% of the accepted Contract Amount for each variation upto maximum of 2% of the Accepted Contract Amount.
14	**Performance Security**	4.2	'The Performance Security will be in the form of a "Bank Guarantee" in the amount(s) of 10% of the Accepted Contract Amount and in the same currency(ies) of the Accepted Contract Amount . The Performance security will be valid till 28 days after completion of DNP, with the provision that: i. The performance security shall be 10% of the Accepted Contract Amount for the period of the contract period and further half of the DNP i.e 1 year beyond the contract period ii. The performance security shall be reduced to 5% of the Accepted Contract Amount during balance period of DNP.
15	**General Design Obligations**	5.1	Period for notifying errors, faults and defects in the Employer's Requirements: 60 days.
16	**Normal working hours**	6.5	"normal working hours", are considered 24 Hrs of a day subject to any restriction by the competent authorities
17	**Delay damages for the key dates**	8.7	0.1 % per day of the Accepted Contract Amount for not achieving the milestones. However if the overall period of completion of contract is met then the Delay Damages would be refunded after completion of the contract. Refer to Milestones given below this table in this Section VIII.
18	**Maximum amount of delay damages**	8.7	10 % of the final Contract Price
19	**Provisional Sums**	13.5.(b)(ii)	13.5 (b)(ii) The overhead charges and Profit will be

Serial No.	Conditions of Contract.	Sub-Clause of GC	Data
			calculated 15%
20	**Adjustments for Changes in Cost**	13.8	Please refer Sub-Clause PC 13.8
21	**Total advance payment**	14.2	Not Applicable as the percentages are stated in PC 14.2.1
22	**Mobilization Advance payment**	14.2	10% of the Accepted Contract Amount payable in the currencies and the proportions of the advance in the respective currencies shall be in the proportion of the total price in the respective currencies and is payable against submission of Equivalent Bank Guarantee.
23	**Repayment amortization rate of advance payment**	14.2(b)	The Mobilization and /or any other advances will be recovered from each RA bill @ 16.67% of the Bill amount, between bills for 30% to 90% of work.
24	**Percentage of Retention**	14.3(c)	6% of RA bill amount
25	**Limit of Retention Money**	14.3(c)	5% of Accepted Contract Amount.
26	**Plant and Materials**	14.5	Not Applicable
27	**Minimum Amount of Interim Payment Certificates**	14.6	Not applicable
28	**Periods for submission of insurance:** a. evidence of insurance. b. relevant policies c. Value of the Professional Indemnity Insurance	18.1	a. 14 days b. 28 days c. 3% of the Accepted Contract Amount for the period till end of DNP (refer PCC 18.1)
29	**Minimum amount of third party insurance**	18.3	Rs. 1.0 Million for any one incident, with number of incidents unlimited
30	**Date by which the**	20.2	28 days after the Commencement Date

Serial No.	Conditions of Contract.	Sub-Clause of GC	Data
	Dispute Board (DB) shall be appointed		
31	**The DB shall be comprised of**	20.2	One Sole Member
32	**List of potential DB sole members**	20.2	The Employer will provide a list of 3 members (excluding Government Employees or Ex-MMRCL staff) from which one member shall be selected by the Employer and the Contractor by mutual consent to act as DB. The list of members shall be provided after the contract is awarded. The fee payable to DB (including all taxes) shall be INR 50,000 per month. The fee per year shall be Rs5, 000 plus travel and hotel expenses. All the above expenses shall be shared equally by both the parties. Secretarial services shall be provided by the Employer.
33	**Appointment (if not agreed) to be made by**	20.3	Appointment will be done by FIDIC

Contract Key Dates, Milestones and Completion Date			
Notice to Commencement of Work from the date of signing of contract agreement is Effective date			
Key Date Ref.	**Description**	**No. of Days from Effective Date**	**Milestones**
1. Schedule of Key Dates			
	Design		
KD1	Complete Preliminary Design of trackwork (including agreed preliminary interface details of related interface systems)	**30**	
KD2	Complete Detailed Design of trackwork (including agreed interface details of related interface systems)	**76**	
KD3	Complete all Construction Reference Drawings for trackwork in Area-1 of Aarey Depot	**76**	
KD4	Complete all Construction Reference Drawings for trackwork in Aarey Depot areas including at grade section of the main line	**122**	
KD5	Complete of Construction Reference Drawings for trackwork on main line from area at Aarey Station to BKC station (including) of Phase 1 Revenue Service	**152**	
	Procurement and Delivery to Site		
KD6	Complete delivery to site of rail sleepers and fittings for installation of ballasted tracks in Area-1 of Aarey Depot	**91**	**-**
KD7	Complete delivery to site of turnouts/crossovers (40%) for installation of ballasted tracks in Aarey Depot area	**122**	**-**
KD8	Complete delivery to site of all rail sleepers and fittings for installation of ballasted tracks in Aarey Depot area (including the at grade section of the mainline)	**151**	**Milestones**
KD9	Complete delivery to site of turnouts/crossovers (75%) for installation of ballasted tracks in Aarey Depot area	**213**	**-**
KD10	Complete delivery to site of all turnouts/crossovers for installation of ballasted tracks in Aarey Depot area	**274**	**Milestones**
KD11	Complete delivery to site of all turnouts/crossovers to Contract MM3-CBS-TWK-10C for installation on main line from area at Aarey Station (including the at grade section) to BKC station (including) of Phase 1 Revenue Service	**335**	**Milestones**
KD12	Complete delivery to site of all turnouts/crossovers to Contract MM3-CBS-TWK-10B for installation on main line from BKC Station (excluding) to Cuffe Parade Station of Phase 2 Revenue Service	**335**	**Milestones**

	Installation, Testing and Commissioning		
	Phase 1 Revenue Services (Aarey Depot)		
KD13	Complete the setting out of all tracks and construction of all setting out reference points in Area-1 of Aarey Depot for OCS foundation construction and other interfacing contractors	**60**	**Milestones**
KD14	Complete the setting out of all tracks and construction of all setting out reference points in Area-2 and Area-3 (including Area-B) of Aarey Depot for OCS foundation construction and other interfacing contractors	**91**	**Milestones**
KD15	Complete the setting out of all tracks and construction of all setting out reference points in Area-4 and Area-5 of Aarey Depot for OCS foundation construction and other interfacing contractors	**152**	**Milestones**
KD16	Complete installation and testing of trackwork for the test track (after OCS foundation installation along the test track) and make the track available to Interfacing Contractors	**152**	**Milestones**
KD17	Complete installation and testing of trackwork in outdoor Area-1 (excluding stabling lines in Zone 1) of Aarey Depot (after OCS foundation installation along tracks) and make the tracks available to Interfacing Contractors	**182**	**Milestones**
KD18	Complete installation and testing of trackwork in outdoor Area-2 and Area-3 of Aarey Depot (after OCS foundation installation along tracks) and make the tracks available to Interfacing Contractors	**303**	**Milestones**
KD19	Complete installation and testing of trackwork in outdoor Area-4 (excluding stabling lines in Zone 2) and Area-5 of Aarey Depot (after OCS foundation installation along tracks) and make the tracks available to Interfacing Contractors	**335**	**Milestones**
KD20	Complete installation and testing of trackwork for all the Stabling Lines in Zone 1 (after OCS foundation installation along tracks) and make the tracks available to Interfacing Contractors	**289**	**Milestones**
KD21	Complete installation and testing of trackwork for all the Inspection Lines and make the tracks available to Interfacing Contractors	**243**	**Milestones**
KD22	Complete installation and testing of trackwork for all the Maintenance Lines and make the tracks available to Interfacing Contractors	**335**	**Milestones**
KD23	Complete installation and testing of trackwork for Aarey Station track area and make the tracks available to Interfacing Contractors	**335**	**Milestones**
KD24	Complete installation and testing of trackwork for all remaining workshops/sheds (including underfloor wheel lathe shed, Work Train Workshop Shed, Heavy Washing Shed, Automatic Washing Plant, Maintenance Vehicular Stabling Shed) and make the tracks available to Interfacing Contractors	**395**	**Milestones**

KD25	Complete installation and testing of trackwork for all the Stabling Lines in Zone 2 (after OCS foundation installation along tracks) and make the tracks available to Interfacing Contractors	**548**	**Milestones**
	Phase 1 Revenue Services [Aarey Station to BKC Station (Including)]		
KD26	Complete installation and testing of trackwork for approximately 1km twin tunnel structures of Interfacing Contract UGC-07 and make the tracks available to Interfacing Contractors	**213**	**Milestones**
KD27	Complete installation and testing of trackwork of all remaining twin tunnel structures, cut and cover tunnels and ramp section (approximately 2.4km) of Interfacing Contract UGC-07 and make the tracks available to Interfacing Contractors	**305**	**Milestones**
KD28	Complete installation and testing of trackwork for all intermediate station track areas of Interfacing Contract UGC-07 and make the tracks available to Interfacing Contractors	**365**	**Milestones**
KD29	Complete installation and testing of trackwork for approximately 1.5km twin tunnel structures of Interfacing Contract UGC-06 and make the tracks available to Interfacing Contractors	**259**	**Milestones**
KD30	Complete installation and testing of trackwork of all remaining twin tunnel structures (approximately 2km) of Interfacing Contract UGC-06 and make the tracks available to Interfacing Contractors	**426**	**Milestones**
KD31	Complete installation and testing of trackwork for all intermediate station track areas of Interfacing Contract UGC-06 and make the tracks available to Interfacing Contractors	**472**	**Milestones**
KD32	Complete installation and testing of trackwork for Cross-over tunnel structures of Interfacing Contract UGC-06 and make the tracks available to Interfacing Contractors	**517**	**Milestones**
KD33	Complete installation and testing of trackwork for approximately 0.85km twin tunnel structures between BKC Station and Vidya Nagri Station of Interfacing Contract UGC-05 and make the tracks available to Interfacing Contractors	**152**	**Milestones**
KD34	Complete installation and testing of trackwork of all remaining twin tunnel structures (approximately 1.4km) between Vidya Nagri and mid Ventilation Shaft (including) of Interfacing Contract UGC-05 and make the tracks available to Interfacing Contractors	**243**	**Milestones**
KD35	Complete installation and testing of trackwork for all intermediate station track areas of Interfacing Contract UGC-05 (excluding Dharavi Station) and make the tracks available to Interfacing Contractors	**305**	**Milestones**
KD36	Complete Integrated Testing and Commissioning of tracks with all interface Rail Systems for Phase 1 Revenue Service	**669**	**Milestones**

KD37	Complete Service Trial and achieve issuance of Completion Certificate for Phase 1 Revenue Service	**731**	**Milestones**

Schedule of Access Dates

2. Schedule of Access Dates		
Access Date Ref.	**Description**	**No. of Days from Effective Date**
	Access to be Given by Depot Contract DPT	
AD1	Shared access to Depot outdoor Area-1 (including test track) for setting out works	**30**
AD2	Shared access to Depot outdoor Area-2 and Area-3 (including Area B) for setting out works	**60**
AD3	Shared access to Depot outdoor Area-4 and Area-5 for setting out works	**122**
AD4	Shared access to Underfloor Wheel Lathe Shed	**152**
AD5	Shared access to Maintenance and Inspection Workshop Shed	**152**
AD6	Shared Access to Aarey Station track area	**243**
AD7	Shared access to all remaining workshops/sheds (including Work Train Workshop Shed, Heavy Washing Shed, Automatic Washing Plant, Maintenance Vehicular Stabling Shed)	**304**
	Access to be Given by OCS Contract PST-02 after OCS Foundation Installation in Aarey Depot	
AD8	Shared access to test track area (after OCS foundation installation)	**91**
AD9	Shared access to outdoor track areas in Area-1 (excluding Stabling Lines in Zone 1) of Aarey Depot (after OCS foundation installation along tracks)	**91**
AD10	Shared access to outdoor track areas in Area-2 and Area-3 (including Area-B) of Aarey Depot (after OCS foundation installation along tracks)	**151**
AD11	Shared access to outdoor track areas in Area-4 (excluding Stabling Lines in Zone 2) and Area-5 (after OCS foundation installation along tracks)	**213**
AD12	Shared access to track areas in all Stabling Lines (10 No.) in Zone 1 (after OCS foundation installation)	**228**
AD13	Shared access to track areas in all Stabling Lines (20 No.) in Zone 2 (after OCS foundation installation)	**411**
	Access to be Given by Civil Contract UGC-07	
AD14	Shared access to track areas in all twin tunnels, cut and cover tunnels, ramp section and temporary shaft at Pali Ground to be provided by Interfacing Civil Contract UGC-07	**122**
AD15	Shared access to track areas in all stations to be provided by Interfacing Civil Contract UGC-07	**274**

	Access to be Given by Civil Contract UGC-06	
AD16	Shared access to track areas in approximately 1.5km twin tunnels to be provided by Interfacing Civil Contract UGC-06	**152**
AD17	Shared access to track areas in all twin tunnels to be provided by Interfacing Civil Contract UGC-06	**335**
AD18	Shared access to track areas in all stations to be provided by Interfacing Civil Contract UGC-06	**365**
AD19	Shared access to track areas in Cross-over to be provided by Interfacing Civil Contract UGC-06	**456**
	Access to be Given by Civil Contract UGC-05	
AD20	Shared access to track areas in approximately 0.85km twin tunnels between BKC Station and Vidya Nagri Station to be provided by Interfacing Civil Contract UGC-05	**30**
AD21	Shared access to track areas in all twin tunnels between BKC Station and mid Ventilation Shaft (including) to be provided by Interfacing Civil Contract UGC-05	**91**
AD22	Shared access to track areas in all stations (excluding Dharavi Station) to be provided by Interfacing Civil Contract UGC-05	**152**

Particular Conditions (PC)

Part B - Specific Provisions

PC 1. Definitions	
PC 1.1.1.6	**Replace Sub-Clause 1.1.1.6 with the following:** **"Contract Forms", "Schedules", "Annexures" and "Annexes"** means the document(s) entitled Contract Forms, Schedules, Annexures and Annexes completed by the Contractor and submitted with the Letter of Bid, as included in the Contract. Such document may include data, lists and schedules of payments and/or prices.
PC 1.1.1.11	**Add a new Sub-Clause 1.1.1.11:** **"Design and Design Data"** means all specifications, plans, drawings, details, graphs, sketches, models, levels, setting-out dimensions, calculations duly checked by the Contractor and other documents relating to the design of the Works prepared or to be prepared by or on behalf of the Contractor.
PC 1.1.1.12	**Add a new Sub-Clause 1.1.1.12:** **"Drawings"** means the Employer's Drawings and the Drawings submitted by the Contractor and any modification of such drawings as may be required by the design review process.
PC 1.1.2.13	**Add a new Sub-Clause 1.1.2.13:** **"Interfacing Contractors and Designated Contractors"** means any of the following whose activities or the works they are engaged to carry out in any way or at any time affect or are affected by the Works: (a) Project contractors and design or specialist consultants engaged on the Project from time to time by the Employer, the Government of the Republic of India, the Government of Maharashtra; (b) Utility providers; (c) Developers or franchisees appointed on the Project from time to time by the Employer; (d) Subcontractors of any tier of the contractors within category (a) above, and contractors and subcontractors of any tier of utility providers, developers and franchisees within category (b) and (c) above; provided that the definition shall exclude the Contractor and his subcontractors of any tier in relation to the Works and in any other capacity which would otherwise fall within categories (a) to (d) above in relation to other works.
PC 1.1.2.14.	**Add a new Sub-Clause 1.1.2.14:** **"Relevant Authority"** or **"Authority"** means any Government department or public body (other than the Employer) having jurisdiction in relation to the Works.

PC1.1.4.14	**Add a new Sub-Clause 1.1.4.14:** **"Pricing Document"** means the document in Part 1 - Bidding Procedures, Section IV-b, including the preamble thereto, identified as such, with prices completed by the Contractor and attached to the Letter of Bid.
PC 1.1.6.11	**Add a new Sub-Clause 1.1.6.11:** **"Key Date"** means a date identified as such in the Contract Documents as the same may be extended by the Engineer pursuant to Sub-Clause 8.4 [*Extension of Time for Completion*]..
PC 1.1.6.13	**Add a new Sub-Clause 1.1.6.13:** **"Works Programme"** means the programme showing the sequence, method and timing of investigations, design, issue of Notice of No Objection, execution, manufacture, delivery to site, erection, installation, testing, commissioning of the Works and related activities in the form and content prescribed by the Employer's Requirements, or any amended or varied version thereof, as submitted by the Contractor and for which the Engineer has issued a Notice of No Objection.
PC 1.1.6.14	**Add a new Sub-Clause 1.1.6.14:** **"Outline Environmental Plan"** means the environmental plan forming part of the Bid, setting out in summary form, the Contractor's proposed means of complying with his obligations in relation to environmental management as prescribed in the Employer's Requirements.
PC 1.1.6.15	**Add a new Sub-Clause 1.1.6.15:** **"Outline Quality Plan"** means the quality plan forming part of the Bid, setting out in summary form, the Contractor's proposed means of complying with his obligations in relation to quality assurance as prescribed in the Employer's Requirements.
PC 2.2 Permits, Licenses or Approvals	
PC 2.2	**Add the following after sub-paragraph 2.2 (b):** (c) The Contractor is responsible for the preparation of necessary documents and, if required, explanations to the relevant authorities to get Permits, Licenses or Approvals from the relevant authorities in the approval process.
PC 4.4 Subcontractor	
PC 4.4	**Add a new Sub- Clause 4.4(d):** (d). The Contractor shall undertake that it shall not sub-contract the Track Works under the Contract on en-bloc basis and the member(s) of the Joint Venture/Consortium (the Contractor) shall manage / execute the Works as provided in Sub-Clause 4.4of GC. For execution of those activities, for which appointment of subcontractor(s) has been consented to by the Engineer, the Contractor shall continue to manage and control all the important aspects of these activities including but not limited to overall planning, management, progress and Program management, alignment and survey control, site

	management/supervision/control, safety, quality, environment protection, key site supervision personnel, and compliance to all the provisions of the Contract documents.
PC 4.13 Right of Way and Facility	
PC 4.13	**Add Sub-Clause 4.13 with the following:** 1. The Employer shall provide plots of land measuring at Mumbai/Mahape/Bhiwandi area for storage of track material, site offices for Contractor, Employer and Engineer. Additional land as required for casting of Twin block sleeper and storage of track material for use only during the contract period, at the nominal rate of INR 1 per Sq.m per year. Contractor shall make its own arrangement for casting of Twin Block sleepers. The use of ready mix concrete is permitted. The contractor shall be issued a certificate when all the works under the subject contract are put to Revenue Services at respective design speeds. This certificate shall be called the " Completion Certificate for Revenue Services". The Contractor shall vacate the plot and restore in original condition within two months of Issuance of Completion Certificate. On issuance of completion certificate the completed works will be taken over by the employer.
PC 4.15 Access Route	
PC 4.15	**Insert the following paragraph at the end of Sub-Clause 4.15:** (f) If any damage occurs to any bridge or road communicating with or on the routes to the Site arising from the transport of materials, equipment or plant, the Contractor shall notify the Engineer with a copy to the Employer, as soon as he becomes aware of such damage or as soon as he receives any claim from the Authority entitled to make such claim.
PC 4.17 Contractor's Equipment	
PC 4.17	**Insert the following at the end of Sub-Clause 4.17:** The Contractor shall submit the following information to the Engineer, for a Notice of No Objection, within the time stipulated against each item given below: (a) A general layout plan for construction plant and equipment required for the execution of the Works, within 60 days from the Commencement Date; and (b) Drawings showing the locations of major facilities, including the Contractor's, Employer's and Engineer's site offices, which he proposes to build/erect on site, within 60 days from the Commencement Date; and (c) Any other details and drawings as required under the Contract, within the time as specified in the Contract.
PC 4.20 Employer's Equipment and Free-Issue Material	
PC 4.20	**Add the following Para's at the end of the clause:**

	1. The following material will be supplied by the employer through other packages at the nominated depot at Mumbai at no cost to the contractor: a) The rail fastener system for Ballastless track will be supplied free of cost at store depot of 10C package by the contractor of 10B package. The unloading will be done by the 10C package contractor. b) The Rails UIC60E1 1080 HH will be supplied free of cost at store depot of 10C package by the contractor of 10D package. The unloading will be done by the 10C package contractor. c) The Rails UIC60E1 880 will be supplied free of cost at store depot of 10C package by the contractor of 10E package. The unloading will be done by the 10C package contractor. d) The unloading and stacking of Rails at the nominated depot at Mumbai shall be arranged by the contractor of Package 10D & 10E, however the handling and transportation from the depot to the site of the work will be arranged by the contractor of Package 10C. **Note:** For above point b) & c), the Rails supplied shall be as per installed length, based on standard weight of rail and extra 0.35% of the wastage shall be supplied for welding etc.
PC 4.21 Progress Reports	
PC 4.21	**Insert the following at the end of Sub-Clause 4.21:** The Contractor shall furnish to the Engineer, a detailed cash flow estimate in respect of the Works, within 3 months from the Commencement Date. This shall be up-dated and submitted every three (3) months thereafter until the Completion of the Works is achieved or at any time upon the request of the Engineer. No progress payment will be certified until the Monthly Progress Report is received, and in accordance with the requirements of this Sub-Clause.
PC 4.23 Contractor's Operations on Site	
PC 4.23	**Insert the following paragraph at the beginning of Sub-Clause 4.23:** For the purposes of this Sub-Clause only, "Site" shall include off-Site places of manufacture or storage and the Contractor's Work Areas and shall include areas provided to the Contractor by others. All work-sites required by the Contractor outside the Right-of-Way (ROW) shall require approvals of relevant parties, and the Employer may support the Contractor to obtain such approvals without any cost and time implications to the Employer **Insert the following two paragraphs between the second and third paragraphs of the original Sub-Clause:** The Contractor, after obtaining any necessary consent from any relevant authority, shall submit to the Engineer proposals showing the layout of pedestrian routes, lighting, signs, and guarding any road opening or traffic diversion which may be required in connection with the execution of the Works and which the Contractor intends to construct. Any consent given by the Engineer to such proposals shall not relieve the Contractor of any

	obligation under the Contract or absolve the Contractor from any liability for or arising from such proposals or the implementation thereof. The Contractor shall also consult with any relevant authority and shall take all reasonable and proper steps for protecting, securing, lighting and watching all places on or about the Works and the Site which may be dangerous to workers or any other person whomsoever. All lights provided by the Contractor shall be so placed or screened as not to interfere with signs, signals or displays. The Contractor shall not in any way obscure or affect signs, signals or displays, in use by any relevant authority. In the event that the Contractor does so, the Contractor shall pay all costs associated with the re-siting, re-instating or provision of alternatives for any sign, signal or display, obscured or affected.
PC 5.5 Training	
PC 5.5	**Add new paragraph at the end of Sub-Clause 5.5:** Training and Maintenance shall be carried out as described in the Employer's Requirements – Section VI (1) A – General
PC6.4 Labour Laws	
PC 6.4	**Add new paragraphs at the end of Sub-Clause 6.4:** Any liability that falls on the Employer as the result of the failure of the contractor in this regard shall be recoverable from the contractor from this contract after the issuance of the notice to the contractor. The Employer is the main employer of labour for this Contract. Hence any issues related to labour can be issued directly from the Government to the Employer, who shall then copy the same to the Engineer for distribution to the Contractor. The Contractor shall formally register with the appropriate labour department, listing the Employer as the principal employer of labour for this Contract.
PC 6.5 Working Hours	
PC 6.5	**Replace Sub-Clause 6.5 with the following:** In accordance with Part A - Contract data of Particular Conditions, multiple shifts involving work at night or outside "normal working hours", are considered 24 Hrs of a day subject to any restriction by the competent authorities, is permitted for all operations (subject to local regulations), provided that temporary lighting equipment as per a layout issued with a Notice from the Engineer, shall be provided, installed, maintained for the duration of the Contract and removed after completion of work by and at the expense of the Contractor. The Contractor shall allow in his construction programme for local festivals that are not included in the list of Maharashtra public holidays. No extra payment will be made to the Contractor for such measures.
PC 8.7 Delay Damages	

PC 8.7	**Insert the following at the end of Sub-Clause GC8.7:** Where the Works are required to be completed within particular Key Dates, as specified in Part 3 Section VIII, Part A Contract Data this Sub-Clause shall apply to these Key Date completions, and the Part 3, Section VIII, Part A - Contract Data, Particular Conditions shall include a sum or percentage in respect of each Key Date which represents the damages likely to be suffered by the Employer if the said Key Date is not accomplished within the time prescribed or by any extension granted under Sub-Clause 8.4. If the Contractor fails to substantially achieve any Key Date within the time so prescribed, subject to any extension granted under Sub-Clause 8.4, he shall pay to the Employer the appropriate stated sum for every day which shall elapse between the dates on which the prescribed time expired and the date of achieving that Key Date. Delay Damages in respect of two or more Key Dates relating to a track works may run concurrently, and the Contractor shall be liable for the aggregate of Delay Damages for all delayed Key Dates. All sums payable by the Contractor to the Employer shall be paid as Delay Damages and not as a penalty.
PC 13.1 Right to Vary	
PC13.1	**Insert Sub-Clause 13.1.1 with the following:** **(i)** In case the Engineer introduces an item for which the Contract does not contain any rates or prices applicable to the varied Works, the rate of such items shall be derived, wherever possible, from the rate for similar items as submitted by the Contractor under Sub-Clause 13.3.
PC 13.5 Provisional Sums	

	Insert the following Sub Clauses to GC 13.5 **13.5.1** The Contractor shall request payment for Provisional Sums items, if any, undertaken either on a Day work basis or through approved Sub-contractors through a separate "Application for Payment of Provisional Sums" at not less than monthly intervals. **13.5.2** The Contractor shall, in respect of Day work items, substantiate the amount included in the Application for Payment of Provisional Sums by producing all quotations, invoices, vouchers and receipts, and other supporting documents including the agreed daily rates of labour and hourly hire charges of plant and machinery. The Contractor shall, during the continuance of such work, deliver on each working day to the Engineer a list, in duplicate, of the names and occupations of and time worked by all workmen employed on such work on the previous working day and a statement, also in duplicate, showing the descriptions and quantity of all materials and Contractor's Equipment used thereon or therefore. The Engineer shall agree as correct or reject with stated reasons such lists and statements and shall sign and return to the Contractor one copy thereof. The Contractor shall submit copies of such statements along with the Application for Payment of Provisional Sums. The Contractor shall inform the Engineer in writing before the Contractor proposes to carry out day work ordered by the Engineer and shall afford every facility for the Engineer to check all time labour, plant and materials in respect of which the Contractor proposes to charge. **13.5.3** In respect of Provisional Sums items undertaken through Approved Sub-contractors, the Contractor shall submit with the Application for Payment of Provisional Sums, documents in support of the amount included in the said application. The Contractor shall also enclose evidence in support of progress of work for which payment is claimed. The Contractor shall furnish evidence that all sums included in previous certificates have been paid to the approved Sub-contractor. **13.5.4** The Engineer shall certify the Application for Payment of Provisional Sums after exercising due checks and submit the same to the Employer for payment to the Contractor
PC 13.6 Day Work	
PC 13.6	**Insert the following paragraph between the first and second paragraph of Sub-Clause 13.6:** The Engineer shall decide which items of work are to be done on a Daywork basis. In such cases, the Contractor shall furnish to the Engineer vouchers to prove the expenditure incurred. Before ordering material or hiring labour, plant, etc., the Contractor shall get the quotations (minimum of 3 quotes) and rates together with Contractor's percentage for his overhead, profit, etc., accepted by the Engineer, if the same is not already covered by the agreed rates (inclusive of Contractor's overhead, profit, etc.). The Contractor shall submit to the Engineer a priced statement of labour, material, plant, actually used on the work, together with Contractor's overhead, profit, etc. as also the output of work at the end of each calendar month and / or as soon as the work is completed. The payment for the items of work done on Daywork basis will be certified by the Engineer based on this submission after necessary checks.

PC 13.8 Adjustments for Changes in Costs	
PC 13.8	**Replace Sub-Clause 13.8 with the following:** **13.8.1** The rates for individual schedules and the sub-divisions thereof, as derived from the lump-sum bid submitted by the bidder, shall be payable for the work done from the date of issue of Letter of Acceptance and till the end of original Completion Date or extensions granted by the Employer. The price adjustment will be payable on the Indian currency component and on foreign currency component. . Price adjustment is applicable to variation in the market rates of inputs like labour, cement, steel, machinery, and fuel / energy during the currency of the Contract. The first scheme, detailed in **13.8.2**, below, is for adjustment of prices of all items in **Schedule 3 of Section IV-B - pricing document, Part Procurement Part Design, Installation, Testing and Commissioning,** based on these variations. The second scheme, given in **13.8.3**, is for regulating prices of **Schedules 1 and 2 - supply of materials.** Provided that for the supply of spare twin block sleepers, it is the scheme of 13.8.2 that will apply. **13.8.2** Payment as per the Contract shall be subject to adjustment in accordance with the following Price Adjustment formula, and other terms given herein. Pn = a + b(Ln/Lo) + c(Sn/So) + d(Cn/Co) + e(Fn/Fo) Where: "Pn" is the adjustment factor to be applied to the estimated value of the work carried out in month "n" which shall be applied to each different currency; For Indian and foreign currency component b + c + d + e= 0.85, balance a= 0.15 shall be fixed component representing the nonadjustable portion in contractual payments; b = Cost Coefficient of Labour to the Total Cost = 0.35 c = Cost Coefficient of Steel Long to the Total Cost = 0.25 d = Cost Coefficient of Cement to the Total Cost = 0.17 e = Cost Coefficient of Fuel and Lubricant to the Total Cost = 0.08 a) Ln, Sn ,Cn & Fn are the CPI for Industrial workers for labour, and the WPI for steel, cement & Petroleum Products (Fuel)as notified by Reserve Bank of India for the month of the bill under consideration.. b) "Lo", "So", "Co" and "Fo" are the base cost indices on date 28 days prior to date of opening of technical bids. **13.8.3** Deleted Note: 1) No price adjustment shall be made to the advance payment amount. 2) The Price adjustment clause shall not be applicable to any extra item of works, not included in the Pricing Document, and for which the rates are fixed separately under Clause 13 of these Conditions. 3) The responsibility of obtaining the OEA (Office of Economic Advisor) Price Index, Labour Indices or other relevant references desired by the Engineer shall rest with the

	Contractor. **13.8.4** Procedure in case of delay in availability of Price Index or Indices Where the final price indices are not available while making payment towards Interim Payments, payment towards Price adjustment will be made based on the provisional indices / previous months Indices available, to be adjusted in subsequent payments as and when the final indices figures become available. **13.8.5** Adjustment on Account of Price Change Price adjustment may be positive (in which case extra amount shall be paid to the Contractor), or negative (in which case the amount of reduction shall be recovered from the Contractor). Price adjustments shall be calculated separately, for each Interim Payment, and paid along with each Interim Payment. After verifying the Interim Payment Invoice, the Engineer shall certify the Price adjustment amount and advise the same to the Employer. Should any extra amount be due to Contractor, the Employer shall pay the same within 28 days of certification by the Engineer. Any amount due from Contractor on account of negative adjustment shall be recovered from his pending or other bills at the earliest. **13.8.5.1** Price adjustment during extended period of Completion granted under Sub-Clause 8.4 [Extension of Time for Completion]. The Price adjustment as worked out above, i.e. either increase or decrease shall be applicable up to the Completion Date including the extended period where such extension has been granted under Sub-Clause 8.4 [Extension of Time for Completion].
sPC 13.9 Price Schedules	
PC 13.9	**Insert additional Sub-Clause 13.9:** **13.9.1** It has to be ensured that the whole of the Works (except items included in Schedule of Provisional Sums) have been covered by the Price schedules and the Items of Payment included in each Price schedules. In order to meet the Employer's Requirements, and if it becomes necessary during the course of execution, to add another Price Schedule or to add more Items of Payment in the Price Schedule, the Lump Sum Contract Price of the whole of Works, shall remain unaltered, shall be redistributed amongst the affected Price Schedule and further redistributed under the Items of Payment in each Price Schedule. **13.9.2** Other than for Sub-Clause 13.8 [*Adjustments for Changes in Cost*], the liability of the Employer will be limited to the fixed Lump Sum Contract Price already accepted and the Contractor will have no right to claim anything over and above the Lump Sum price for any such addition of Price Schedule or Items of Payment in any Price Schedule
PC 14.2 Advance Payment	
PC 14.2	**Replace the existing Sub-Clause 14.2 with the following:** **14.2.1** The Mobilization Advance shall bear no interest and shall be paid as the percentage stated in CD. The proportion of the advance in the respective currencies shall be in the proportion of the total price in the respective currencies

	14.2.2 The Mobilization Advance shall be paid within 28 days after receipt of an irrevocable bank guarantee from an entity and from within the country (or other jurisdiction) approved by the Employer. The bank guarantee shall be in an amount equal to 100% of the Advance Payment amount, in a form similar to the Form of Bank Guarantee for Advance Payment in Annex to the Particular Conditions of Contract, in either Indian Rupees or the equivalent amount in Japanese Yen and/or maximum two other specified currencies in which the Contract may have been priced. **14.2.3** The amount of the Mobilization Advance Payment Guarantee shall be progressively reduced by the amount recovered by the employer as below:. deductions shall be made at the amortisation rate stated in the Contract Data of the amount of each Interim Payment Certificate (excluding the advance payment and deductions for its repayments as well as deductions for retention money) in the currencies and proportions of the advance payment until such time as the advance payment has been repaid; provided that the advance payment shall be completely repaid prior to the time when 90 per cent (90%) of the Accepted Contract Amount less Provisional Sums has been certified for payment. **14.2.4** The Guarantee shall be returned to the Contractor immediately after its expiry when the full amount for the Advance Payment has been recovered by the Employer.
PC 14.7 Payment	
PC 14.7	**Replace the sub Clause 14.7 b) and c) and third paragraph with the following** After issuances of Interim payment certificate, payment of 80% of the certified interim amount shall be made by the Employer within 14 days. The balance 20% shall be paid within 28 days, from the date of the Interim payment certificate. The Employer shall pay the amount certified in the Final payment Certificate within 56 days from the date of issue of the Certificate. Payment shall be made into bank account, nominated by the Contractor. However no payment will be made unless all kinds of insurance as stated in the insurance schedule in contract data is taken and submitted (PC 18.1). **Insert the following at the end of Sub-Clause 14.7** From payment made by the Employer, deduction towards Income Tax and any other tax may be made at source from each payment made by the Employer, as may be directed by Income Tax Department and other statutory bodies or as provided in statute, relevant acts, rules, circulars and directions issued thereunder. The Employer reserves the right to carry out a post payment audit and/or technical examination of the Works, and the Final account, including all supporting vouchers, abstracts, etc., and to make a claim on the Contractor for the refund of any excess amount paid to him, if as a result of such examination, any over-payment to him is discovered to have been made in respect of any work done or alleged to have been done by the Contractor, under the Contract. If any under-payment is discovered, the same shall be paid by the Employer to the Contractor. Such payments or recoveries, however, shall not be subject to any interest.
PC 18.1 General Requirements for Insurances	

PC 18.1	**Insert additional first paragraph to Sub-Clause 18.1:** The Contractor shall effect and maintain professional indemnity insurance, jointly in the name of the Employer, for the amount stipulated in Contract Data, Part A Particular Conditions in respect of any design of the works to be carried out by, or on behalf of the Contractor. This insurance, which shall insure the Contractor's liability by reason of professional negligence and errors in the design of the works, shall be valid from the date as specified in Contract Data. Alternately the Contractor shall redeem the Insurance before the expiry of the Yearly Insurance in such a way that the entire validity period is covered. The Engineer will not issue the Final Payment Certificate until the Contractor has produced evidence that coverage of the Professional Indemnity Insurance has been provided for the aforesaid period.

BIDDING DOCUMENTS

MUMBAI METRO LINE 3 (COLABA-BANDRA-SEEPZ)

CONTRACT MM3-CBS-TWK-03 (Package 10C)

Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of Ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and Ballasted Track in the area of at-grade Aarey Station and in the Depot area of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ).

and

Procurement and Supply of Turnouts, Scissor Crossovers and Buffer Stops for the entire Mainline for Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ) including Package 10 B.

PART 3

CONDITIONS OF CONTRACTS AND CONTRACT FORMS

Section IX
Annex to the Particular Conditions-Contract Forms
July 2019

JICA LOAN AGREEMENT ID - P 268

Mumbai Metro Rail Corporation Ltd
Line 3 Transit Office, Wing 'A' North Side of City park 'E'- Block, ,
Bandra-Kurla Complex,
Bandra (East) Mumbai 400 051, India

BIDDING DOCUMENTS

Composition of Documents

Part 1	**Bidding Procedures**	
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	Section II	Bid Data Sheet (BDS)
	Section III	Evaluation and Qualification Criteria
	Section IV- A	Bidding Forms
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CF1 Letter of Acceptance

[Insert date]

To: *[Insert name and address of the Contractor]*

This is to notify you that your Bid dated *[insert date]* for execution of the *[insert name of the Contract and identification number, as given in the Contract Data]* for the Accepted Contract Amount of the equivalent of *[insert amount in words and figures] [insert name of currency]*, as corrected and modified in accordance with the Instructions to Bidders, is hereby accepted by our Agency.

You are requested to furnish the Performance Security within 28 days in accordance with the Conditions of Contract, using for that purpose one of the Performance Security Forms included in Section IX, Annex to the Particular Conditions - Contract Forms, of the Bidding Documents

Authorized Signature: _____
Name and Title of Signatory: _____
Name of Agency: _____

Attachment: Contract Agreement

CF-2 Contract Agreement

THIS AGREEMENT made the *[insert day]* day of *[insert month]*, *[insert year]*, between *[insert name of the Employer]* (hereinafter "the Employer"), of the one part, and *[insert name of the Contractor]* (hereinafter "the Contractor"), of the other part:

WHEREAS the Employer desires that the Works known as *[name of the Contract]* should be executed by the Contractor, and has accepted a Bid by the Contractor for the execution and completion of these Works and the remedying of any defects therein,

The Employer and the Contractor agree as follows:

1. In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the Contract documents referred to.

2. The following documents shall be deemed to form and be read and construed as part of this Agreement. This Agreement shall prevail over all other Contract documents.

(i) **the Letter of Acceptance;**

(ii) **the Letter of Bid ;**

(iii) **the addenda Nos *[insert addenda numbers, if any]* (if any);**

(iv) **the Particular Conditions ;**

(v) **the General Conditions;**

(vi) **the Employer's Requirements;**

(vii) **the completed Schedules;**

(viii) **the Contractor's Proposal and any other documents forming part of the Contract**

(ix) **the Acknowledgement of Compliance with Guidelines for Procurement under Japanese ODA Loans.**

3. In consideration of the payments to be made by the Employer to the Contractor as specified in this Agreement, the Contractor hereby covenants with the Employer to execute the Works and to remedy defects therein in conformity in all respects with the provisions of the Contract.

4. The Employer hereby covenants to pay the Contractor in consideration of the execution and completion of the Works and the remedying of defects therein, the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

IN WITNESS whereof the parties hereto have caused this Agreement to be executed in accordance with the laws of *[insert the laws of the borrowing country]* on the day, month and year specified above.

Signed by _____
for and on behalf of the Employer in
the presence of

Witness, Name, Signature, Address, Date

Signed by _____
for and on behalf the Contractor
in the presence of

Witness, Name, Signature, Address, Date

CF-3 Performance Security

(Demand Guarantee)

[Insert Guarantor letterhead or SWIFT identifier code]

Beneficiary: *[Insert name and Address of the Employer]*

Date: *[Insert date of issue]*

PERFORMANCE GUARANTEE No.: *[Insert guarantee reference number]*

Guarantor: *[Insert name and address of place of issue, unless indicated in the letterhead]*

We have been informed that *[insert name of Contractor, which in the case of a joint venture shall be the name of the joint venture]* (hereinafter called "the Contractor") has entered into Contract No. *[Insert reference number of the contract]* dated *[insert date]* with the Beneficiary, for the execution of *[insert name of the contract and brief description of the Works]* (hereinafter called "the Contract").

Furthermore, we understand that, according to the conditions of the Contract, a performance guarantee is required.

At the request of the Applicant, we as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of *[insert amount in figures]* (*[insert amount in words]*),[1] such sum being payable in the types and proportions of currencies in which the Contract Price is payable, upon receipt by us of the Beneficiary's complying demand supported by the Beneficiary's statement, whether in the demand itself or in a separate signed document accompanying or identifying the demand, stating that the Contractor is in breach of its obligation(s) under the Contract, without the Beneficiary needing to prove or to show grounds for its demand or the sum specified therein.

This guarantee shall expire, no later than the *[insert the day]* day of *[insert month], [insert year]*[2], and any demand for payment under it must be received by us at this office indicated above on or before that date.

---

[1] *The Guarantor shall insert an amount representing the percentage of the Accepted Contract Amount specified in the GCC clause 4.2, less provisional sums, if any, and denominated either in the currency(cies) of the Contract or a freely convertible currency acceptable to the Beneficiary.*

[2] *Insert the date twenty-eight days after the Completion date plus DNP as per GC 11.9*

This guarantee is subject to the Uniform Rules for Demand Guarantees (URDG) 2010 Revision, ICC Publication No. 758, except that the supporting statement under Article 15(a) is hereby excluded.

_____
[signature(s)]

[Note: All italicized text (including footnotes) is for use in preparing this form and shall be deleted from the final product.]

CF-4 Mobilization Advance Security

[Guarantor letterhead or SWIFT identifier code]

Beneficiary: The Mumbai Metro Rail Corporation Ltd. (MMRC) NaMTTRI Building, Plot No. R-13, 'E'- Block, Bandra Kurla Complex, Bandra (East), Mumbai 400051, India

IFB No.: [MM3-CBS-TWK-03]

Date: [insert date of issue]

Mobilisation advance GUARANTEE No.: [insert guarantee reference number]

Guarantor: [insert name and address of place of issue, unless indicated in the letterhead]

(Demand Guarantee)

We have been informed that [insert name of Contractor, which in the case of a joint venture shall be the name of the joint venture] (hereinafter called "the Contractor") has entered into Contract No. [insert reference number of the contract] dated [insert date] with the Beneficiary, for the execution of [insert name of the contract and brief description of the Works] (hereinafter called "the Contract").

Furthermore, we understand that, in terms of the contract, the Beneficiary and Employer has agreed to make to the Contractor and advance of [insert the amounts and the currencies of the mobilization advance being released].

In terms of the contract, the said advance is to be recovered from payments due to the contractor, under the contract.

At the request of the Applicant, we as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of [insert amounts and currencies in figures] ([insert amounts and currencies in words]),upon receipt by us of the Beneficiary's complying demand supported by the Beneficiary's statement, whether in the demand itself or in a separate signed document accompanying or identifying the demand, stating that the Contractor is in breach of its obligation(s) under the Contract, and it has become necessary to recover in full or in part the amount of the mobilization advance that is outstanding, without the Beneficiary needing to prove or to show grounds for its demand or the sum specified therein.

This guarantee shall expire, no later than the [insert the day] day of [insert month], [insert year][1], and any demand for payment under it must be received by us at this office indicated above on or before that date.

This guarantee is subject to the Uniform Rules for Demand Guarantees (URDG) 2010 Revision, ICC Publication No. 758, except that the supporting statement under Article 15(a) is hereby excluded.

_____

[signature(s)]

[Note: All italicized text (including footnotes) is for use in preparing this form and shall be deleted from the final product.]

[1] *Insert the date twenty-eight days after the expected completion date as described in the Key Dates*

CF-5 Retention Money Security (Bank Guarantee)

(To be stamped in accordance with the Stamp Act of the Country of Issuing Bank)

[Guarantor letterhead or SWIFT identifier code]

Beneficiary: The Mumbai Metro Rail Corporation Ltd. (MMRC) E-Block, Wing 'B', North Side of, City Park Road, E Block BKC, Bandra Kurla Complex, Bandra East, Mumbai, Maharashtra 400051.

IFB No.: [MM3-CBS-TWK-03]

Date: [*insert date of issue*]

BID GUARANTEE No.: [*insert guarantee reference number*]

Guarantor: [*insert name and address of place of issue, unless indicated in the letterhead*]

We have been informed that [insert name of the Contractor, which in the case of a joint venture shall be the name of the joint venture (whether legally constituted or prospective) or the names of all members thereof] (hereinafter called "the Contractor") has been awarded by the Beneficiary the contract (hereinafter called "the Contract") for the execution of "Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and ballasted Track in the area of at-grade Aarey Station and in the Depot area, excluding the procurement and supply of the, Head Hardened rail 60 E1 (UIC 60), 1080 grade HH, 60 E1 (UIC60) 880 grade rails, and Rail fastener System for Ballastless Track of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ).

and

Procurement and Supply of Turnouts, Scissor Crossovers and Buffer Stops for the entire Mainline for Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ) including Package 10 B".

Project under Loan Agreement No. [ID-P268].

Furthermore, we understand that, in terms of the contract, from the payment against each bill submitted for work done under the contract, an amount of 6% of the value for which the bill is passed shall be retained by the Beneficiary. And, in terms of the one half of the total of the said sums so retained from the bills submitted and paid shall be paid to the contractor upon the "Taking over certificate" of the contracted work, as proved by the issue of Completion Certificate (as defined in SP 4.13, Section IX of the contract documents) by the Beneficiary to the Contractor.

"The payment of the 2nd half or if the amount guaranteed under the performance Guarantee when the Taking-Over Certificate is issued is less than half of the Retention Money, the difference between half of the Retention Money and the amount guaranteed under Performance Security is to be made against a Retention Money guarantee."

The remaining, second half of the money retained, as above described, shall be paid to the Contractor upon successful completion of the Defect Notification Period, as defined in the Contract. This second half of the amount retained, as above described, however, may be paid to the Contractor after the issue of the Completion Certificate and before the completion of the Defect Notification Period upon submission by the Contractor to the Beneficiary, a Bank Guarantee for the same amount and valid till the end of the Defect Notification Period and a further period of 28 days.

In this context, at the request of the Contractor, , we, as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of *[insert amount in words, (insert amount in figures)]* upon receipt by us of the Beneficiary's complying demand, supported by the Beneficiary's statement, whether in the demand itself or a separate signed document accompanying or identifying the demand, stating that the Contractor has failed, in any manner, to honour his liability during the Defect Notification Period, as required under the contract;

This guarantee shall be valid till (*here enter a date 28 days after the end of the Defect Notification Period*).

This guarantee is subject to the Uniform Rules for Demand Guarantees (URDG) 2010 Revision, ICC Publication No. 758 *(or subsequent ICC Publications).*

[Signature]

MUMBAI METRO LINE 3 (COLABA-BANDRA-SEEPZ)

CONTRACT MM3-CBS-TWK-03 (Package 10C)

Part Design, Procurement and Part Supply, Installation, Testing and Commissioning of Ballastless Track on the Mainline from Aarey station (excluded) until BKC station (included) and Ballasted Track in the area of at-grade Aarey Station and in the Depot area of Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ).

and

Procurement and Supply of Turnouts, Scissor Crossovers and Buffer Stops for the entire Mainline for Mumbai Metro Line 3 (Colaba – Bandra – SEEPZ) including Package 10 B.

TENDER DOCUMENTS
Part 4
Section X
REFERENCE DOCUMENT'S OCCUPATIONAL HEALTH &SAFETY ENVIRONMENTAL

July 2019

JICA LOAN AGREEMENT ID - P 268

Mumbai Metro Rail Corporation Ltd

Line 3 Transit Office, Wing 'A'North Side of City park 'E'- Block, ,
Bandra-Kurla Complex,
Bandra (East) Mumbai 400 051, India

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Part 4

Section–X

REFERENCE DOCUMENT'S

OCCUPATIONAL HEALTH &SAFETY ENVIRONMENTAL

July 2019

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Occupational Health &Safety Environmental

1.1 Scope

1.1.1 The Employer's Requirements OHS&E Chapter 18, Section VI Part 2 details the requirements of the Employer for Safety, Health and Environmental control measures associated with the Contractor and any other agency, to be practiced on all Mumbai Metro Rail Corporation construction sites or associated premises.

1.1.2 Application of this document

1) The Employer's Requirements, OHS&E Chapter 18 applies to all aspects of the Contractor's scope of work, including that conducted by their appointed sub-Contractor and other agencies on their behalf. There shall be no activity associated with the Mumbai Metro Line 3 Project, which is exempted from the purview of this document. The Employer's Requirements OHS&E Chapter 18 is supplemented with a further 2 OHS&E parts for ease of reference (refer to Appendix 15 of this Section) Their individual scope and applicability is as follows;
2) OHS&E Chapter 18 is the controlling document for all Contracts and is fixed throughout the term of the project. Compliance with OHS&E Chapter 18 is mandatory.
3) OHS&E (Refer to Appendix 18) provides Safety & Health guidelines that the Contractor may choose to use unless stated as mandatory within Chapter 18. The contents of OHS&E chapter remain subject to revision by the PM in the event of new Legislation or changing circumstances. The information contained within chapter 18 shall be used by the PM in assessing the sufficiency and suitability of the Contractor's management systems and performance.
4) OHS&E this chapter and appendix 18 provides Environmental guidance and procedural requirements for the project. This document remains subjected to periodic revision and updating.

1.2 Purpose of this document

1.2.1. The purpose of this document, the Employer's Requirements, OHS&E Chapter 18 is to provide Contractors and other interested parties with the mandatory requirements relating to Health, Safety and the Environment practices and performance expectations on the Mumbai Metro Line 3 project.

1.2.2. This chapter describes the OHS&E interfaces between the Employer, PM and the Contractor;

1.2.3. Details the processes by which the Contractor shall manage OHS&E issues while carrying out the works under the contract and;

1.2.4. Describes by reference, the practices, procedures and requirements pertaining to the Mumbai Metro Line 3 Project.

1.3 Mumbai Metro Rail Corporation OHS&E Objectives

1.3.1 There are five principle objectives for attainment during the Mumbai Metro Line 3 project. These long term objectives shall be supported with quarterly, short and medium term objectives to enable structured advancement in overall performance. Our Short and

medium term objectives also aims to facilitate effective monitoring and measurement to identify where a directional change may be necessary. The Long term objectives are:

1.3.2 To eliminate or minimize the unwanted effects of hazards and risks to personnel, members of the public and other stakeholders who may be exposed to the undertakings associated with the construction of the Mumbai Metro Line 3 project

1. Establish an effective and robust OHS&E management system that will enable Contractors to achieve international recognition and registration to the BS EN 18001:2007Series.
2. Actively contribute to Contractors development through support, encouragement, determination in control and transfer of knowledge and skills in order to make the move from traditional compliance driven management through to risk managed processes.
3. To simplify the risk concept, to ensure a sensible approach to risk management and simplify hazard awareness training through adoption of the ALARP (As low as reasonably practicable) principles.
4. To practice 'Best Practice' within the construction industry - Establishing a work environment that conforms to international health & safety standards and make recommendation to improve effectiveness of regulations both nationally and locally.

1.4 Reference publications

1.4.1. BS EN ISO 9000:2005, Quality management systems — Fundamentals and vocabulary
1.4.2. BS EN ISO 9001:2008, Quality management systems —Requirements
1.4.3. BSENISO 14001:2004, Environmental management systems — Requirements with guidance
1.4.4. BS EN ISO 19011:2002, Guidelines for quality and/or environmental management systems auditing
1.4.5. BS OHSAS 18001:2007, Occupational health and safety management systems Requirements
1.4.6. BS OHSAS 18002, Occupational health and safety management systems – Guidelines for the implementation of BS OHSAS18001
1.4.7. PAS 99, Specification of common management system requirements as a framework for integration
1.4.8. International Labour Organization: 2001, Guidelines on occupational health and safety management systems — ILO-OSH2001
1.4.9. Health & Safety Guidance (HSG) Health and Safety Executive publications United Kingdom

1.5 Terms and definitions

Acceptable risk. Risk that has been reduced to a level that can be tolerated by the organization having regard to its legal obligations and its own OHS&E policy
Accident. Incident giving rise to injury, ill health or fatality
ALARP (As low as reasonably practicable) principles.

Audit. Systematic, independent and documented process for obtaining "audit evidence" and evaluating it objectively to determine the extent to which "audit criteria" are fulfilled

BOCWA. Building and Other Construction Workers (Regular Employment and Conditions of Service) Act, 1996

BOCWR. Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Central Rules, 1998

Chief Safety Expert. An officer nominated by MMRC who is the overall responsible for monitoring all OHS&E functions prescribed in this document.

MMRC. Mumbai Metro Rail Corporation

Competent person. Person with the appropriate combination of skill, knowledge, qualifications and experience

Continual improvement. Recurring process of enhancing the OHS&E management system in order to achieve improvements in overall OHS&E performance consistent with the organization's OHS&E policy

Corrective action. Action to eliminate the cause of a detected nonconformity or other undesirable situation

Design Risk Assessments. Used to record the actions of designers when reducing risks in construction and for future repairs and maintenance issues.

Employer. Mumbai Metro Rail Corporation (MMRC).

Hazard. Source, situation, or act with a potential for harm in terms of human injury or ill health, or a combination of these

Hazard identification. Process of recognizing that a hazard exists and defining its characteristics

Health surveillance. Monitoring health of employees to detect signs or symptoms of work-related ill health so that steps can be taken to eliminate, or reduce the probability of, further harm

Ill health. Identifiable, adverse physical or mental condition arising from and/or made worse by a work activity and/or work-related situation

Incident. Work-related event(s) in which an injury or ill health (regardless of severity) or fatality occurred, or could have occurred. An accident is an incident which has given rise to injury, ill health or fatality. An incident where no injury, ill health, or fatality occurs may also be referred to as a "near-miss", or "dangerous occurrence".

Interested party. Person or group, inside or outside the workplace, concerned with or affected by the OHS&E performance of an organization

Nonconformity. Non-fulfilment of a requirement; A nonconformity can be any deviation from: relevant work standards, practices, procedures, legal requirements, etc. or OHS&E management system requirements. Nonconformity can be any deviation from: — relevant work standards, practices, procedures, legal requirements, etc. — OHS&E management system criteria.

OHS&E management system. Part of an organization's management system used to develop and implement its OHS&E policy and manage its OHS&E risks. A management system is a set of interrelated elements used to establish policy and objectives and to achieve those objectives. A management system includes organizational structure, planning activities (including for example, risk assessment and the setting of objectives), responsibilities, practices, procedures, processes and resources.

OHS&E objective. OHS&E goal, in terms of OHS&E performance that an organization sets itself to achieve.

OHS&E performance. Measurable results of an organization's management of its OHS&E risks

OHS&E policy. Overall intentions and direction of an organization related to its OHS&E performance as formally expressed by top management

Preventive action. Action to eliminate the cause of a potential nonconformity (3.19) or other undesirable potential situation

Procedure. Specified way to carry out an activity or a process

Record. Document stating results achieved or providing evidence of activities performed

Risk. Combination of the likelihood of an occurrence of a hazardous event or exposure(s) and the severity of injury or ill health that can be caused by the event or exposure(s)

Risk assessment. Process of evaluating the risk(s) arising from a hazard(s), taking into account the adequacy of any existing controls, and deciding whether or not the risk(s) is acceptable

Risk control. Selection and application of suitable measures to reduce risk

Shall. Indicates a mandatory requirement within this document

Stakeholders. Those with an interest in an organization's achievements that includes, but is not limited to, internal and "outsourced" employees, customers, suppliers, partners, employees, distributors, investors, insurers, shareholders, owners, government and regulators.

Status review. Formal evaluation of the OHS&E management system

Top management. Person or group of people who direct and control an organization at the highest level

Worker representative. Representative of employee occupational health and safety

1.6 OHS&E management system requirements

1.6.1 The Contractor shall define and document the scope of its Occupational Safety Health and Environmental (OHS&E) management system to meet legal requirements and the requirements of Mumbai Metro Rail Corporation as stated within this document.

1.6.2 The Contractor's OHS&E management system shall determine how the organization shall document, implement, maintain and continually improve upon performance in accordance with the requirements of the International OHSAS Standard to which the Employer is committed.

1.7 Not used

1.8 Planning

1.8.1 Hazard identification, risk assessment and determining controls

1.8.2 The Contractor shall submit a procedure detailing the process in place for the identification of Hazards and Risks and the determination of control measures including the relevant standards. The Procedure shall incorporate the Employer's Requirements within this and other applicable OHS&E chapter.

1.9 Management of Change

All temporary and permanent changes to organizational, personnel, systems, procedures, equipment, products, materials or substances shall be evaluated by the Contractor and managed to ensure that health, safety and environmental risks arising from these changes remain at an acceptable level. Changes made by the Contractor are subject to submittal and notice of no objection by the PM prior to adopting change.

1.10 Risk Register & Hazard Log

The Contractor's Construction Health and safety Plan shall contain a detailed 'Risk Register' and 'Hazard Log' specific to the project. The register and log shall be assessed against the MMRC OHS&E requirements Part 2, Section VI-A Appendix 18.

The Hazard Log shall identify future method statement, risk assessment and operational procedures pertaining to specific equipment and operations in relation risk and local environmental constraints. Construction phase OHS&E Plans shall not be accepted without a fully completed Hazard Log and Risk Register.

1.11 Method Statements

1.11.1 Method statements are to be submitted to the PM a minimum of 21 days prior to task commencement to ensure sufficient time is available for review and notice of no objection.

1.11.2 Method statements shall contain the information requirements as prescript within the OHS&E chapter 18.

1.11.3 Method statements shall incorporate the control measures within the process methodology as identified within the risk assessment.

1.11.4 A copy of the relevant method statement for the activity being undertaken shall be available on site for reference by all site management and supervisors.

1.12 Risk Assessment production &submittal

1.12.1 Risk assessments shall contain as a minimum, the information as specified within the OHS&E Chapter 18. The Contractor may choose to use their own format however the risk tolerances, probability and consequences must be included.

1.12.2 Risk assessments shall be produced and submitted to the Employer's a minimum of 21 days prior to task commencement for notice of no objection. Risk assessments may be submitted independently or as part of a Method Statement.

1.12.3 Generic risk assessments other than routine activities of low risk shall not be accepted by the Employer.

1.12.4 Risk assessments shall be regularly reviewed to ensure they remain suitable and sufficient. Risk assessment reviews shall be undertaken where an incident has occurred and when a change in location may introduce additional risks from construction activities.

1.12.5 Substances hazardous to health shall be subject to assessment by the Contractor. Where Hazardous substances are identified for use within a process the assessment and determining controls shall be included within the relative method statement.

1.13 Design Risk Assessment

Design Risk Assessments shall be submitted to the PM for granting of no objection. Design risk assessments shall accompany all drawing submittals for operations involving;

a. Temporary works,
b. Formwork &false-work
c. Heavy lifting equipment.
d. Drawings shall not be accepted by the PM without an accompanying design risk assessment.

1.14 Legal and other requirements

Contractor shall comply with all legal obligations and the requirements of Mumbai Metro Rail Corporation as contained herein; Indian statutory requirements.

The Contractor shall abide by all national, state and local bye-laws. It is the duty of the Contractor to ensure that all Sub-contractors appointed also comply with their legal obligations as listed below but not limited to:

1.14.1 Indian Electricity Act 2003 and Rules1956
1.14.2 National Building Code,2005
1.14.3 Factories Act,1948,
1.14.4 Motor Vehicles Act as amended in 1994, The Central Motor Vehicles Rules, 1989.
1.14.5 Indian Road Congress Code IRC: SP: 55-2001 'Guidelines on Safety In Road Construction Zones.
1.14.6 The Petroleum Act, 1934 and Rules1976
1.14.7 Gas Cylinder Rules,2003
1.14.8 Indian Explosives Act. 1884, along with the Explosives substance Act 1908 and The explosives Rules1983
1.14.9 The (Indian) Boilers Act,1923
1.14.10 The Public Liability Insurance Act 1991 and Rules1991
1.14.11 Minimum Wages Act, 1948 and Rules1950
1.14.12 Contract Labour Act, 1970 and Rules1971
1.14.13 Child Labour (Prohibitions & Regulations) Act, 1986 and Rules1950
1.14.14 Environment Protection Act, 1986 and Rules1986
1.14.15 Air (Prevention and control of Pollution) Act,1981
1.14.16 Water (Prevention and Control of Pollution) Act,1974
1.14.17 The Noise Pollution (Regulation & Control) Rules,2000
1.14.18 Notification on Control of Noise from Diesel Generator (DG) sets,2002
1.14.19 Recycled Plastic Usage Rules,1998
1.14.20 Notification, Central Ground Water Board, Act January1997
1.14.21 Manufacture, Storage & Import of Hazardous Chemicals Rules,1989
1.14.22 The Hazardous Waste (Management & Handling) Rules,1989
1.14.23 Hazardous Waste Management Rules 1989 (as amended in1999)
1.14.24 Batteries (Management and Handling)Rules
1.14.25 Fly ash utilization notification, Sept 1999 as amended in August 2003
1.14.26 Workman Compensation Act, 1923 along with allied Rules

1.15 International Standards, Guidelines & ISO Certifications

1.15.1 If the requirements stated in this document are in conflict or inconsistent with the requirements of applicable laws, the more stringent requirements shall apply. The works shall be undertaken in accordance with the applicable international guidelines, standards and specifications on OHS&E and every Contractor shall actively pursue the achievement of:

1. BS EN OHSAS 18001:2007 - OHS Management Systems
2. ISO 14001-2004: Environmental Management Systems

1.15.2 The process of international certification to BS EN 18001:2007 and ISO 14001-2004 standard is not mandatory however obtaining the certification is desirable.

1.16 Objectives and programme(s)

The Contractor shall maintain procedures to establish detailed OHS&E objectives and performance criteria. Such objectives and performance criteria shall be developed to incorporate the Mumbai Metro Rail Corporation policy and strategic OHS&E objectives. The Contractor's objectives shall be quantified, wherever practicable, and identified with defined timescales. The Contractor is required to submit for notice of no objection their procedure and objectives as per chapter 4 of this control document.

1.17 Implementation and operation

The Contractor shall provide details within the Construction Health, Safety and Environmental Plan the planned roles and resources allocated for this project In addition to the staffing arrangements the Contractor shall prescribe the responsibilities specific to role, accountability and the authority under which they operate.
Safety, health & environmental resources shall be provided by the Contractor as per the Contract value in table1.

Table 1 Mandatory Contractor OHS&E Management Resource Requirement

	1	2	3	4	5	6
Contract Value in (Cr.)	Chief OHS&E Manager	Senior OHS&E Manager	Junior OHS&E Manager	Safety Steward	Senior Electrical Engineer	Junior Electrical Engineer
Up to 2	-	-	1	Refer to note 1	-	1
Up to 10	-	1	Refer to note 1		1	Refer to note 2
Up to 25	1	Refer to note 1			1	
Up to 100	1				1	
Up to 250	1				1	
250 or More	1				1	

	7	8	9	10	11
Contract Value in (Cr.)	Occupational Health Officer with necessary Nursing Assistants (Refer Note 3)	Environmental Manager	Senior OHSE&E Traffic Manager (Refer Note 4)	Housekeeping & Barricade Maintenance	Labour Welfare Officer
Up to 2	-	-	-	Refer to Note 5	-
Up to 10	1 (PT)	1	1		1
Up to 25	1 (PT)	1	1		1
Up to 100	1 (PT)	1	1		1
Up to 250	2 (FT)	1	1		1 with support staff
250 or More	2 (FT)	1 with support staff	1		1 with support staff
Note 1	Qualified and trained OHS&E Professionals as per Table 2 with required support staff to be deployed at each worksite at each shift. Qualifications of appointed OHS&E personnel shall be in accordance with section 4.4.2 Competence, Awareness and Training within this document.				
Note 2	Qualified and trained Electrical Engineers/Supervisors to be deployed at each worksite for each shift.				
Note 3	(PT) means Part- Time and (FT) means Full-Time.				
Note 4	Senior OHS&E (Traffic) Engineer Post and Barricade Manager posts are applicable to contracts where the work has to be executed either below or over the public right-of way such as Viaduct, Station contracts.				
Note 5	One Housekeeping Manager/ Barricade Manager supported by required supervisors and workmen necessary to maintain a clean and tidy site or yard.				

1.18 Responsibility

1.18.1 The Contractor's Representative is responsible and accountable for compliance with the conditions and clauses within this document.

1.18.2 The Contractor's Representative is responsible to ensure that the necessary resources are allocated and made available to meet the requirements as laid out within this document and other referenced materials to include Legal Requirements.

1.18.3 For all works carried out by the Contractor and appointed Sub-contractors, the responsibility for ensuring OHS&E resources remains with the main Contractor. Activities undertaken by the Contractor's Sub-contractors shall be monitored by the Contractor at all times to ensure compliance with agreed safe systems of working.

1.18.4 All the Contractor's OHS&E personnel shall report to the Chief OHS&E Manager who shall report directly to the Contractor's Representative or Corporate Safety Director of the

Contractor's organization. This shall be reflected in the Contractor's organization charts within the OHS&E plan and Quality Management Plan.

1.18.5 The PM may monitor adherence to the provisions of Table 1. Where deviation is evident this shall be recorded as anon-conformance.

1.18.6 The Contractor shall provide all OHS&E personnel with such facilities, equipment and information that are necessary to enable them to dispatch their duties effectively.

1.18.7 The Contractor's Safety Managers, Safety Advisors and Officers are responsible for ensuring that reports on the performance of the OHS&E management system are presented to top management for review and used as a basis for improvement of the OHS&E management system.

1.18.8 The Contractor's Safety Managers, Safety Advisors and Officers are responsible for independently monitoring the operations of the Contractor, where deficiencies are identified they are responsible to report their findings immediately to the Site PM in charge who then must take action as directed.

1.19 Accountability

1.19.1 In cases where the Contractor fails to provide the minimum required manpower as may be provided by the PM at the Contractor's cost. Any administrative expenses involved in providing the same for example, vacancy advertisements or recruitment consultant charges, shall also be at the cost of Contractor.

1.19.2 No OHS&E personnel shall be permitted to do any work which is unconnected to, inconsistent with or detrimental to the performance of the OHS&E duties.

1.19.3 Supervisors must ensure that the employees under their direct supervision are working incompliance with the approved safe systems of working.

1.20 Authority

1.20.1 The authority of the Contractor's Safety Managers, Safety Advisors and Officers shall be stated within the Construction Health and Safety Plan and such authority level shall be communicated to all Contractor's Staff including Sub-contractors.

1.20.2 The Contract Project Manager shall delegate the authority to the Contractor's Safety Managers, Safety Advisors and Officers to suspend works where deviation from an approved method of working occurs that presents a risk of injury, equipment or property damage.

1.20.3 The PM shall have the right to stop the work if in his opinion the work is being carried out in such a way that a risk of injury, property and or equipment damage may exist. The Contractor shall not proceed with the work until remedial works have been complied with under the direction and satisfaction of the Employer. Should the Contractor continue to work without implementing the PM's instruction, the contractor shall be liable and responsible for the decision to proceed.

1.20.4 The Contractor shall not be entitled to any damages or compensation for stoppage of work, due to safety reasons. The period of such stoppages of work shall not be taken as an extension of time for completion of the facilities and will not be the ground for waiver of levy of liquidated damages.

1.21 Competence, training and awareness

1.21.1 The Contractor shall ensure that the recruitment, selection and placement processes shall be in place to ensure that personnel are qualified, competent, and physically fit for assigned tasks. The Contractor shall produce a procedure that shall be made available to the PM for notice of no objection in accordance with the requirements of the specification. The procedure shall define the processes in place to ensure competence.

1.21.2 The Contractor's attention is drawn to Part 3 General Conditions Clause 17.2.5 whereby any person employed thereon, who in the opinion of the PM, misconducts himself or is incompetent or negligent or fails to conform with any particular provisions with regard to safety, health or environment which is set out in the Contractor's OHS&E Plan or a requirement of the Contract, or persists in any conduct which is prejudicial to safety or health, shall be removed from site immediately, and such persons shall not be employed again upon the Works. The decision of the PM in this regard shall be final.

1.22 Notice of no objection from the PM

1.22.1 The name, educational qualifications and work experience for Chief OHS&E Manager (Accident Prevention Officer) intended for a Contractor's OHS&E role shall be submitted to the PM for notice prior to employment. Only upon notice of no objection by the PM Chief OHS&E Manager (Accident Prevention Officer) shall be authorized to work on a MMRC site. The contractor shall appoint the required OHS&E personal in accordance with the qualifications and experience as listed in Table 2. The Details of such personnel together with their positions in the Contractor's safety organization shall be submitted to PM for information.

1.22.2 Table 2 OHS&E Personnel Qualifications &Experience

Item	Designation	Qualification	Experience (Years)
1	Chief OHS&E Manager	The Chief OHS&E Manager shall be qualified in any of the following degrees/diplomas: 1) Post Graduate Diploma in Industrial Safety& 2) Environmental Management(PGDISEM) 3) M.E. in Industrial Safety from NIT, 4) B.E. in Fire and Safety Eng. 5) B.E. with advanced Safety Management Diploma 6) B.E / B.Arch., with one year Full Time advanced Safety diploma 7) B.E/B. Tech full time Degree / Diploma in Safety. 8) International qualifications, CSP(Certified Safety Professional), NEBOSH, MIOSH, MSISO etc.	15Years

2	Senior OHS&E Manager	As stated in Item 1 and in addition any of the following categories: 1) B.Sc.(Physics/Chemistry/Math's) with one year Full Time advanced Safety diploma 2) B.Sc. / Diploma in Eng. with advanced safety Management Diploma 3) B.Sc. (Physics/Chemistry/Math's) with One year Full Time diploma in Safety Engineering 4) Any Graduate or diploma holder with 7 years of work experience in OHS&E.	2 years for category(1) (2) and(3)
3	Junior OHS&E Manager	1) Degree in Science / Diploma in Engineering with Govt. recognized safety diplomas 2) Any Graduate or diploma holder with 5 years of work experience in a OHS&E department with prior approval of the Project Manager (on a case to case basis)	1) 2Years
4	Safety	Any basic qualification with any OHS&E related certificate courses.	2Years
5	Senior Electrical Engineer	Degree in Electrical Engineering + Govt. Recognized Electrical Competency Certificate (C License holder)	2Years
6	Junior Electrical Engineer	Diploma in Electrical Engineering +Govt. Recognized Electrical Competency Certificate (C License holder)	1Year
7	Occupational Health Officer	MBBS with Govt. recognized degree/diploma in Industrial/ occupational health	1Year
8	Environmental Manager	Govt. recognized PG Degree/PG Diploma/Degree in Environmental Engineering /Science	2Years
9	Senior Traffic Engineer	Govt. recognized PG Degree/Degree/Diploma in Traffic/Transportation Engineering or Planning	1Year
10	Housekeeping & Barrier Mgr.	Any Diploma in Engineering	1Year

1.22.3 Where a potential candidate has previously worked in a Metro Rail construction environment and does not possess the qualifications and or the necessary experience as listed in Table 2 for the particular role, the PM may upon a successful interview of the candidate grant a waiver subject to successful completion of a probation period of 3months.

1.22.4 In order to effectively interact on labour welfare matters with the PM and the statutory authorities enforcing the labour welfare legislations every Contractor shall employ a full time Labour Welfare Officer duly qualified and experienced

1.23 OHS&E Induction Training

1.23.1 The Contractor shall ensure that all personnel (Workers/Staff/Employees/Sub-Contractors and their personnel) working at the site receive an induction OHS&E training of at least 2 weeks (96 hrs) explaining the nature of the work, reporting &

communication routes the hazards that may be encountered during the site work and the particular hazards attached to their own function within the operation. The training shall cover as a minimum the contents as directed within this Chapter.

1.23.2 Records of all inductions shall be maintained by the Contractor and be made available for inspection by the Employer upon request.

1.23.3 The Contractor shall provide their workforce and management staff with an OHS&E induction Handbook containing the information asper the induction training.

1.23.4 A condensed induction shall be given by the Contractor to all visitors. The induction briefing shall include the risk and hazards associated with the particular site and the operations being conducted.

1.23.5 All personnel shall be issued a temporary ID upon the completion of the Contractor's' induction. The temporary ID shall be signed by the Human Resource Manager or appointed representative and limited to a 2 week validity period at which time the temporary ID shall be replaced with a permanent ID including photograph.

1.23.6 Individuals found on site by the PM without-dated temporary ID cards shall be removed from site.

1.24 OHS&E Training

1.24.1 The Contractor shall assess the training requirements for all the employees, plan and initiate a training program to fulfil the training needs assessment. The assessment of training needs shall incorporate all levels of staff including Sub-contractor's against an individual's role, responsibility, ability, language skill and risk.

1.24.2 The Contractor shall produce a 'Training Implementation Plan' to incorporate the findings of the needs assessment.

1.24.3 The Contractor shall produce training company profile including trainers ,Only upon notice of no objection by the PM shall be authorized to conduct training on a MMRC site

1.24.4 The training needs assessment together with Implementation Plan shall be submitted to the PM for notice of no objection within 4 weeks of commencement. The PM shall evaluate the assessment and plan against the base line training matrix contained within this Chapter 18 and Appendix18.

1.24.5 Records of all training conducted shall be maintained and made available for inspection by the PM upon request.

1.24.6 Should the Contractor fail to provide the training identified within the Contractor's assessment, implementation plan and the Training matrix within the agreed timescales, this shall be reflected in the potential scores awarded with in the monthly audit report.

1.24.7 Specific training with regard to the provisions of the Construction Safety Plan, and associated operational and system procedures shall be conducted by the Contractor for all persons with supervision responsibilities. Records of training including duration shall be maintained.

1.25 Communication, participation and consultation

1.25.1 The Contractor shall produce a 'High Quality' quarterly newsletter on a rotational basis with other Contractors. Rotation shall be announced within the PM's OHS&E Committee meetings.

1.25.2 All Contractors including the PM shall provide input into the rotational Contractor for the newsletter content such as details of accidents, incidents and near misses together with any lessons learned; specific safety initiatives; internal competitions and workforce awards etc.

1.25.3 The PM shall be issued the draft newsletter for review prior to the Contractor's publishing.

1.25.4 The OHS&E Newsletters shall publicise all Contractors OHS&E performances over the previous 3 months in relation to OHS&E Audits and shall form the basis for the PM's Awards programme. Results of audits shall be provided by the PM for inclusion.

1.25.5 The quarterly newsletters shall be issued to all interested parties and be promulgated at site level. Where language barriers exists the contents of the newsletters shall be communicated by the Workforce Representative to ensure understanding.

1.25.6 At site level the Contractor shall erect pertinent awareness signage and posters. Posters shall be changed on a monthly basis to maintain impact.

1.25.7 Poster campaigns shall be discussed and agreed at the PM's Committee Meeting to maintain a consistent improvement programme across all MMRC Sites.

1.25.8 Informational posters, banners etc. shall be provided both in Marathi/Hindi and English.

1.25.9 Toolbox talks or team briefings shall be carried out daily by the Contractor and correspond to the works activities being undertaken or to communicate a specific awareness initiative. Toolbox talks shall not replace professional training.

1.25.10 Records of all toolbox talks undertaken together with the date, topic, participant's names and signatures shall be maintained and made available for inspection by the PM.

1.25.11 Method statement and risk assessment briefings shall be carried out prior to the commencement of a new task and or when a change to the method of working arises. Records of all such briefings shall be maintained by the Contractor.

1.25.12 Visitor information signage shall be posted at site entrances detailing where to report and contact information. Note: visitors shall be accompanied at all times by site security where office locations require walking through operational areas.

1.25.13 Public informational signage and Contractor contact information shall be posted externally to the site.

1.25.14 The Contractor shall appoint an individual as a Public liaison Officer to communicate directly with members of the public regarding forthcoming operations, what to expect, noise expectancy, duration of operations etc.

1.26 Participation and consultation

1.26.1 The Contractor shall establish a Safety Committee within 4 weeks of commencement that shall be chaired by the Contractor's PM.

1.26.2 The Contractor shall notify the PM of the establishment of the Committee together with the committee members' names and designation. The Contractor's Chief Safety Manager, Senior Safety Manager, Plant & procurement Manager and Human Resources Manager shall form the minimum committee members. Site based personal shall be represented within the Committee by the attendance of Construction Manager(s) and the Workforce OHS&E Representative.

1.26.3 The PM shall be invited to attend the Contractor's Safety Committee meetings.

1.26.4 The Contractor's OHS&E Committee shall meet on a monthly basis throughout the duration of the Contract.

1.26.5 The Committee shall review the previous month's performance, to include, inspections and audits undertaken, accidents and incidents and any concerns or complaints that have been raised. Short term objectives and targets for improvement shall be set for completion by the next scheduled Committee meeting.

1.26.6 The Safety committee shall undertake a formal site inspection to be scheduled on a 2 monthly basis. The inspection shall review progress regarding the achievement of short term targets. The Committee shall produce a report stating progress made together with any corrective actions required and issue to the PM within 7 days following the Inspection.

1.26.7 Minutes of the Committee meeting shall be issued within 2 days and promulgated to all members including the PM. The minutes of meeting shall also be posted on all sites within the workforce area. The minutes intended for site communication shall be in both Marathi\Hindi and English.

1.27 Engineer OHS&E Committee

1.27.1 A Safety Health and Environmental Committee shall be established by the PM and shall sit every 3 months throughout the project period. All Contractors shall be required to attend the quarterly meetings who shall be represented by the Contractor's Representatives and Chief Safety Manager.

1.27.2 The Committee shall review previous performances project wide and set short and medium term objectives and targets for achievement within the next reporting period.

1.27.3 The PM reserves the right to call an Emergency Meeting of the Committee members in the event of a serious incident that requires immediate change to the operational methods of working.

1.27.4 Minutes of the PM's OHS&E Committee shall be promulgated to all Contractor's within 3days.

1.28 Workforce Representation

1.28.1. All workers shall have access to a Workforce OHS&E Representative who is responsible to communicate directly with the labour force with regard to safety and health. The representative's name and contact number shall be posted on all sites externally to the site office.

1.28.2. The Workforce OHS&E Representative shall be made a member of the OHS&E Committee and attend all meetings.

1.28.3. The OHS&E Representative shall meet the labour force on a monthly basis to discuss health, welfare, safety initiatives and or concerns the workforce may have. Minutes are to be produced by the Representative and issued formally within 2 days after the meeting date to the Contractor's Representative, Construction Manager and PMs

1.28.4. A lockable site suggestion box to which only the workforce OHS&E Representative shall have access shall be installed on all sites and within any labour accommodation camps. The suggestion box shall be located independent from any offices, in a public area and protected from bad weather. The OHS&E Representative shall inform the workforce that the purpose of the suggestion box is to provide a means of participation, communicating ideas and initiatives and also for raising concerns without fear of reprisal.

1.28.5. The contents of all suggestion boxes shall be collected and collated on a weekly basis. Where concerns or complaints regarding the standards of health, safety or welfare have been reported these shall be immediately reported to the Chief OHS&E Manager and the Contractor‘s Representative who shall investigate the concern(s). Records of such investigations and resultant outcomes shall be maintained.

1.28.6. Ideas, suggestions and concerns raised by the workforce during the OHS&E representative’s on site monthly meetings shall form an agenda item within the Contractor’s OHS&E Committee meeting.

1.28.7. Where an idea or specific suggestion is subsequently adopted for use by the Contractor’s OHS&E Committee, the individual shall receive an OHS&E award as determined by the Contractor.

1.28.8. Where Employee awards are issued this shall be notified to the PM to ensure inclusion within the Quarterly Newsletter.

1.29 Contractor Awards

The Employer shall recognize the effort, participation and commitment demonstrated by the Contractor by nominating awards. The award type shall be at the discretion of the Employer.

1.30 Documentation

1.30.1. Management System procedures

1.30.2. The Contractor is required to submit for notice of no objection, the organisation’s top tier Management System Procedures as listed in Table 3 that shall be adopted for use on the MMRC project.

1.30.3. System procedures shall be submitted to the PM within 4 weeks of commencement.

1.30.4. Construction works shall not commence until such time as a notice of no objection has been received; applicable to all management system procedures as listed in Table 3.

1.30.5. The PM shall evaluate the suitability of the Contractor’s system procedures against the BS EN 18001:2007 and ISO 14001:2004 standards.

1.30.6. The submitted procedures shall be individually identified with a unique reference and detail in sequence the scope, purpose, referenced material and procedure processes.

1.30.7. Where such procedures as listed in Table 3 exist within other areas of the Contractor’s organizational management systems such as quality management, these shall not be subject to replication if the procedure makes specific reference to Health, Safety and Environmental control.

1.30.8. Compliance standards against the Contractor’s management system procedures shall be subject to audit by the PM.

Table 3 OHS&E Management System Procedures

Hazard identification, risk assessment and determining controls	Communication, participati & consultation	Environmental Impact Aspect Assessment	Objectives and program(s)
Training, awareness and competence	Implementation and operation	Accident & Incident Investigation	Legal requirements
Documentation	Monitoring & Measuremen	Emergency Preparedness	Change control
Procurement	Recordkeeping	Audit	Management review

1.31 Control of documents

1.31.1 All plans, procedures and method statements shall be controlled and subject to review and formal approval by the Contractor's Representative prior to issue to the PM.

1.31.2 All documents subject to review by the PM shall be signed by the Contractor's Representative and issued formally.

1.31.3 Documents shall be issued as per the Employer's requirements regarding Quality Management.

1.31.4 OHS&E Documents shall be issued, maintained, traceable and available for retrieval pursuant to the Contractor's ISO accredited Quality Management System.

1.32 Operational Control

Operational control shall be maintained through the implementation of the provisions stated within the Contractor's site specific Construction Health Safety and Environmental Plans, the contents of which are outlined in Safety, Health and Environmental Appendix18 to which the Contractor shall comply.

1.33 Construction Phase Health & Safety Plan

1.33.1 The Contractor shall produce a Contract specific Construction Health & Safety Plan (CHSP) and submit to the PM within 28 days of commencement.

1.33.2 The Construction Health and Safety Plan shall contain the informational requirements as per the CHSP contents as prescript in this Appendix 18 Safety Plan contents.

1.33.3 The CHSP shall be assessed by the PM against the provisions as stated within this chapter and Appendix18. Where deficiencies exist to an extent where an objection is raised, construction activities shall be suspended until such time as the deficiencies are subject to corrective action, re-submittal and notice of no objection by the PM.

1.33.4 Delays incurred as a result of the Contractor failing to achieve a 'No objection' status from failing to submit within the specified timescale or noncompliance with OHS&E Chapter 18 shall be entirely at the Contractor's risk and cost.

1.33.5 The Contractor shall undertake a monthly review of the CHSP. The review shall be recorded and the PM notified of any updates.

1.34 Construction Phase Site Environmental Plan

1.34.1 The Contractor shall produce a Contract specific Site Environmental Plan (SEP) and submit to the PM within 28 days of commencement.

1.34.2 The Site Environmental Plan (SEP) shall contain the informational requirements as per the contents as prescript within the MMRC Environmental Management Arrangements Appendix 18, Environmental Plan contents.

1.34.3 The SEP shall be assessed by the PM against the provisions as stated within the Environmental Management Arrangements Appendix18. Where deficiencies exist to an extent where an objection is raised, construction activities shall be suspended until such time as the deficiencies are subject to corrective action, re-submittal and notice of no objection by the PM.

1.34.4 Delays incurred as a result of the Contractor failing to achieve a 'No objection' status from failing to submit within the specified timescale or noncompliance with Environmental Management Arrangements Chapter 18 and Appendix 15 shall be entirely at the Contractor's risk and cost.

1.34.5 The Contractor shall undertake a monthly review of the SEP. The review shall be recorded and the PM notified of any updates.

1.35 Operational procedures

1.35.1 The Contractor shall identify within the Hazard Log and Risk Register the operational control procedures that shall be applicable for the MMRC project under their individual scope of works.

1.35.2 Operational procedures shall be submitted for review to the PM for notice of no objection together with the Construction Site Safety Plan within 4 weeks of commencement.

1.35.3 The operational procedures shall be evaluated by the PM against the requirements stated within Appendix 18, international safety standards such as the International Labour Organisation, European Norms and British Standards where an equivalent Indian Standard does not exist.

1.35.4 Construction works shall not commence until such time as a notice of no objection has been received; applicable to all operational procedures as identified within Table 4 and the Contractor's Hazard Log & Risk Register.

1.35.5 The submitted procedures shall be individually identified with a unique reference and detail in sequence the scope, purpose, referenced material and procedure processes.

1.35.6 In the event that the Contractor is unable to comply with the 28 day timeframe for submittal of the minimum operational procedures as detailed within Table 4,the Contractor shall assign an individual identification reference for the outstanding procedure within the Construction Health, Safety & Environmental Plan together with the statement 'Under process'. The 'Under Process' procedure shall be required to be submitted for notice of no objection a minimum of 28 days prior to commencement of any activity that involves the application of the procedure.

Table 4 Operational Procedures

Lifting Operations & Lifting Equipment	Plant &Equipment	Occupational Health provisions	Emergency Medical Facilities & First Aid
Personal Protective Equipment	Permit to Work Systems	Site Electricity & Distribution	Welding & Cutting operations
Incident Investigation	Traffic Management	Working at Height	Hazardous Substances
Site Security	Fire Safety	Manual Handling	Site Set-up
Abrasive Wheels	Public Interface	Noise and Vibration	Welfare Arrangements

1.35.7 The Contractor shall adopt the following colour code scheme across all MMRC Sites to ensure efficient recognition of relevant personnel.

Safety Helmet Color with Logo	Designation
White	MMRC Staff and PM and his Engineers
Violet	Contractor's Engineers &Supervisors
Blue	Sub-Contractor's Engineers &Supervisors
Red	All Electricians
Green	Safety personnel
Orange	Security Guards & Traffic Marshals
Yellow	General Workforce
White (With VISITOR Sticker)	Visitors

1.36 Emergency preparedness and response

1.36.1 The Contractor shall prepare a project specific Emergency Plan and submit to the PM for notice of no objection. The Emergency Plan shall be submitted within 4 weeks of contract Commencement.

1.36.2 The plan must identify the potential for emergencies and the provisions for responding to such emergencies, particular to their environment and location. The Emergency planning arrangements shall be assessed as per the provisions in OHS&E chapter 18 and Appendix 18 for suitability.

1.36.3 The Contractor shall ensure that all persons including Sub-contractors on site are aware of the emergency procedure to follow in the event of an emergency. Awareness training shall commence at induction and thereafter through refresher training such as toolbox talks and monthly emergency drills. Records of refresher training and emergency drills shall be maintained.

1.36.4 Site signage shall be erected and detail the emergency process to follow and include emergency telephone numbers, fire, ambulance, police, nearest hospital etc.

1.36.5 Arrangements shall be made by the Contractor for casualty evacuation and emergency medical treatment. The Contractor shall enter into an agreement with a hospital to provide ambulance services. Alternatively the Contractor shall provide a fully equipped

ambulance on-site that shall be manned by a paramedic. This provision shall be subject to the PMs Audit.

1.37 Checking

1.37.1 Performance measurement and monitoring

1.37.2 The Contractor shall submit a Monthly OHS&E Progress Report no later than 7th of each month to the PM. The Report shall contain the minimum information specified within OHS&E chapter 18 and Appendix 18 the report shall contain text, tables and colour photographs.

1.38 Site Inspection

1.38.1 Independent of the plant and equipment inspection, testing and maintenance regimes that shall be stated within the Contractor's Plant and Equipment Procedures, the Contractor shall carry out site monitoring exercises on a daily and weekly basis.

1.38.2 The Contractor shall ensure that all monitoring equipment is calibrated as per the manufactures requirements. The PM shall be provided with test certificates for such equipment

1.38.3 Independent of the Electrical inspection, testing and maintenance regimes that shall be stated within the Contractor's Electrical Procedures, the Contractor shall carry out site monitoring exercises on a daily and weekly basis

1.38.4 The Contractor shall undertake an internal electrical monthly audit in accordance with the plan

1.38.5 Site Engineers shall be required to participate in daily internal OHS&E inspections to facilitate prompt communication and rectification of minor deviations. Records of such inspections and rectification needs shall be maintained at site level and made available for review by the PM other interested parties.

1.38.6 Formal site inspection reports shall be produced on a weekly basis by the Contractor's OHS&E personnel for each site and submitted to the PM and copied to the Contractor's Representative.

1.38.7 The Contractor may choose inspection format of his/her choice, however format shall contain the minimum information as provided within OHS&E chapter 18 and Appendix 18 regarding weekly inspection form.

1.38.8 The Contractor's OHS&E Personnel shall be accompanied during a formal site inspection by the Construction Manager responsible for the particular site. The resulting inspection report shall be signed by both the Construction Manager and the OHS&E officer.

1.38.9 The PM shall formally inspect and report the Contractor's site conditions against the compliance criteria set within the Contractor's operational procedures and the Employer's requirements on a weekly basis. These inspections shall include batching plant and associated yards.

1.38.10 The Contractor shall undertake specific inspections at the PM's request where concerns have been raised regarding the suitability of control measures and or plant or equipment condition. Such inspections shall be carried out with immediate effect. Refer Appendix 15 regarding the maximum permissible age of the plants and equipment.

1.39 Evaluation of compliance

1.39.1 The information submitted by the Contractor within the OHS&E Monthly Progress Report together with the PM's Reports shall be evaluated against the Employer's compliance requirements and OHS&E objectives.

1.39.2 Inspection reports shall be evaluated against the Legal Requirements (4.3.2) to which the Contractor is bound to comply.

1.39.3 The Contractor's OHS&E Committee shall formally evaluate reports and results of accidents and or injury on a monthly basis. The results of this evaluation such as identified changes to safe systems of working' shall be included with the Committee minutes

1.39.4 The PM shall evaluate 'Accident Injury Rates' and 'Frequency Rates' per individual Contractor and as a project to determine performance against the international rates. The international rates used to benchmark performance shall be promulgated to all Contractor's and other interested parties.

1.39.5 A Project Monthly Progress Report shall be produced by the PM. Evaluation results shall be included within the relevant sections for Health Safety & the Environment.

1.39.6 The Contractor's External OHS&E Audits (4.5.5) shall be evaluated by the PM against the internal Standards BS EN 18001:2007 AND ISO14001:2004.

1.39.7 Incident investigation, nonconformity, corrective action and preventive action.

1.40 Incident investigation

1.40.1. The Contractor shall undertake accident investigation for all fatal accidents, major injuries and dangerous occurrences as defined within this chapter and Appendix 18.

1.40.2. In the event of a fatality, major injury or dangerous occurrence, the Contractor shall not disturb the accident scene or remove equipment beyond that required to make the area safe and/or for the treatment and/or removal of casualty(s) to hospital.

1.40.3. Should the PM find an accident scene disturbed beyond that reasonably expected with making an area safe, this shall be subject to thorough investigation by the PM

1.40.4. The PM shall be informed immediately of all fatalities, major injuries or dangerous occurrences. Any delay in reporting to the PM may be subject to disciplinary action.

1.40.5. The Contractor is responsible to report accidents, incidents and dangerous occurrences to the relevant governing bodies as per their statutory obligations. The Contractor shall maintain responsibility for ensuring Sub-contractor's under their direct control also comply with this requirement.

1.40.6. A preliminary accident notification report shall be issued to the PM for all fatal and major injuries and or dangerous occurrences within 12 hours as per OHS&E chapter 18 and appendix 18. This shall be followed by the detailed accident report as per chapter 18 and Appendix 18 within 48 hours of the investigation completion.

1.40.7. Near misses and minor accidents should also be investigated by the Contractor as soon as possible as they are signals that there are inadequacies in the safety management system.

1.40.8. In case of fatal accidents, major injuries or dangerous occurrences the PM shall conduct an independent investigation. The Contractor and his staff shall extend the necessary co-operation.

1.41 Nonconformity, corrective action and preventive action

1.41.1. The Contractor shall conform to their internal procedures regarding nonconformity, corrective action and preventive action. The Contractor shall be audited by the PM for compliance with internal procedures.

1.41.2. Major and Minor non-conformances shall be raised by the PM as per the Employer's Quality Management requirements and the OHS&E Audit criteria as defined within this chapter and Appendix 18.

1.41.3. Open non-conformances shall be reflected in the Contractor's Monthly Audit Report and are subject to verification by the PM as detailed in this chapter and Appendix 18. Failure to successfully take corrective action and close out non- conformances will impact negatively on the Contractor's total quarterly audit score described in clause 4.5.5.

1.41.4. Where non-conformances have been raised by an External Auditor against the BS EN 18001:2007 or ISO 14001 Standard, the Contractor shall produce and submit for review within 2 weeks, an action plan of how and within what timescale shall the non-conformance(s) be closed-out.

1.41.5. Where the corrective action and preventive action identifies new or changed hazards or the need for new or changed controls, the proposed actions shall be taken through the risk assessment process. The associated method statement and risk assessment shall be amended and re-submitted to the PM for notice of no objection.

1.41.6. A change in work methodology shall be communicated to the workforce. Evidence of such communications shall be made available for inspection by the PM. The PM shall also make random enquiries at site level to establish workforce awareness.

1.42 Control of records

The Contractor shall maintain all OHS&E records in accordance with the Contactors ISO 9001 Quality Management System.
Records shall be made available to the PM upon request for the purpose of incident investigation and management review.

1.43 Audit Monthly Audit Report (MAR)

The Contractor shall undertake an internal monthly audit using the process and audit report form (MAR) as prescribed within OHS&E Volume 2.

The Contractor shall submit the completed audit report no later than the 7th of each month within the Contractor's monthly OHS&E Report. Failure to submit the monthly audit report within the stipulated timescale shall result in the PM awarding a 'Zero' scores for the month.

The audit scores awarded internally by the Contractor shall be subject to review and verification by the PM. The PM shall substantiate the awarded scores through making comparison with the results of a physical site inspection against the model audit scores criteria as provided within OHS&E Volume 2.

The PM shall formally verify that the Contractor's self awarded scores comply with the audit scoring system and scoring criteria as defined within OHS&E Volume 2. Where discrepancy exists the PM shall provide supporting evidence (Photographic) and instruct the Contractor to amend the initial awarded score. Following adjustment, the monthly audit report shall be re-submitted to the PM within 3 days

The Contractor shall be required to achieve a minimum 65% overall audit score on a monthly basis.

Monthly audit scores shall be totalled over a 3 month (3 audit results) period. Where the average score for three (3) months of audits is below 65%, then the OHS&E lump sum item in the preliminaries section of Section VI-b, Part 1 pricing shall be withheld.

If non-payment of the lump sum item in preliminaries occurs as a result of failing to achieve the required 65% over a single quarterly reporting period, the PM may reinstate the lump sum item at his discretion should the Contractor achieve above 65% for the following six (6) consecutive monthly OHS&E audits equating to two (2) quarterly reporting periods. This repayment of the lump sum item shall not occur if the quarterly aggregate is less than 50%.

In the event the Contractor fails to achieve a minimum of 65% on a monthly audit, an action plan shall be submitted together with the audit results detailing the actions that shall be taken within timescales.

Monthly audits shall be conducted prior to the sitting of the Contractor's Safety Committee and shall form part of the agenda.

1.44 External OHS&E Audit

1.44.1. The Contractor is required to conduct external audits as per the BS EN 18001:2007 & ISO 14001:2004 international standards on a quarterly basis throughout the Contract period or until the Contractor achieves accreditation to the standard whereby monitoring timescales shall be instructed by the ISO accrediting body.

1.44.2. External audit and follow up audit reports shall be submitted to the PM for review within 7 days of audit completion.

1.44.3. Should the Contractor fail to undertake external audits within the 3 month period the PM shall appoint an ISO accredited 3rd party agency to conduct the audit at the Contractor's cost.

1.44.4. Where 'Major' non-conformances with international standards are identified, a follow-up external audit shall be carried out within 28 days for closing out of the non-conformance(s). Follow-up audits shall continue on a 28 day rotation until such time as Major non-conformances are closed to the satisfaction of the 3rd Party ISO accredited auditor.

1.45 Management review

1.45.1. Management Reviews shall be undertaken annually by the PM in compliance with ISO9001:2008.

1.45.2. The Management Review Report shall make recommendations for improvement.

1.45.3. The Contractor shall carry out a formal Management Review on an annual basis as a minimum. The Management Review may form part of the review under the organizations Quality Management System.

1.45.4. The Contractor shall submit Management Review Report to the PM within 7 days after meeting completion together with the organizations new objectives.