



MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

DESIGN, DEVELOPMENT, SUPPLY, INSTALLATION, TESTING & COMMISSIONING OF STANDARD GAUGE TRACKWORKS (BALLASTED AND BALLASTLESS) IN KASHELI DEPOT TRACKS FOR LINE 5 CORRIDOR OF MUMBAI METRO RAIL PROJECT OF MMRDA, MUMBAI

CONTRACT NO: MMRDA/MPIU/ML5/CA-303

TENDER DOCUMENTS VOLUME 4

TECHNICAL SPECIFICATIONS

- **SECTION A: OUTLINE DESIGN SPECIFICATIONS**
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 - **ANNEXURES**

MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY
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SECTION A

OUTLINE DESIGN SPECIFICATIONS

1 PROJECT OVERVIEW

1.1 INTRODUCTION

1.1.1 SCOPE AND PURPOSE

1. This specification defines the objectives, guidelines, and requirements for the trackwork design for the contract for Design, Development, Supply, Installation, Testing and Commissioning of Standard Gauge Trackwork's (Ballastless and Ballasted) in Kasheli Depot track for Line 5 Corridor of Mumbai Metro Rail Project of MMRDA,Mumbai
2. The works to be executed under the contract include Design, construction, `manufacturing & supply of materials, verification, delivery, installation, testing, including integrated testing and commissioning, technical support, and documentation for a complete system necessary to deliver the requirements of this specification.
3. Supply and installation of all track materials like rails, Sleeper, Ballast, turnouts, scissor crossover with diamond crossing, buffer stop all fitting and fastening, (fixtures required for signaling and OHE work), required for ballasted, Ballastless and special track in Depot.
4. Security of all track material supplied and put into the track lies with the contractor till the track is handed over to Maha Mumbai Metro Operation Corporation Limited (MMMOCL).
5. Scope shall also include inspection and testing of all the incoming materials as well as in-process construction activities as required according to RDSO and Metro CMRS guidelines, applicable IRS Codes, & approved Field Quality Plans & Quality Assurance Plan for the project and documentation of all reports as required by Engineer.

1.1.1 RELEVANT DOCUMENTS

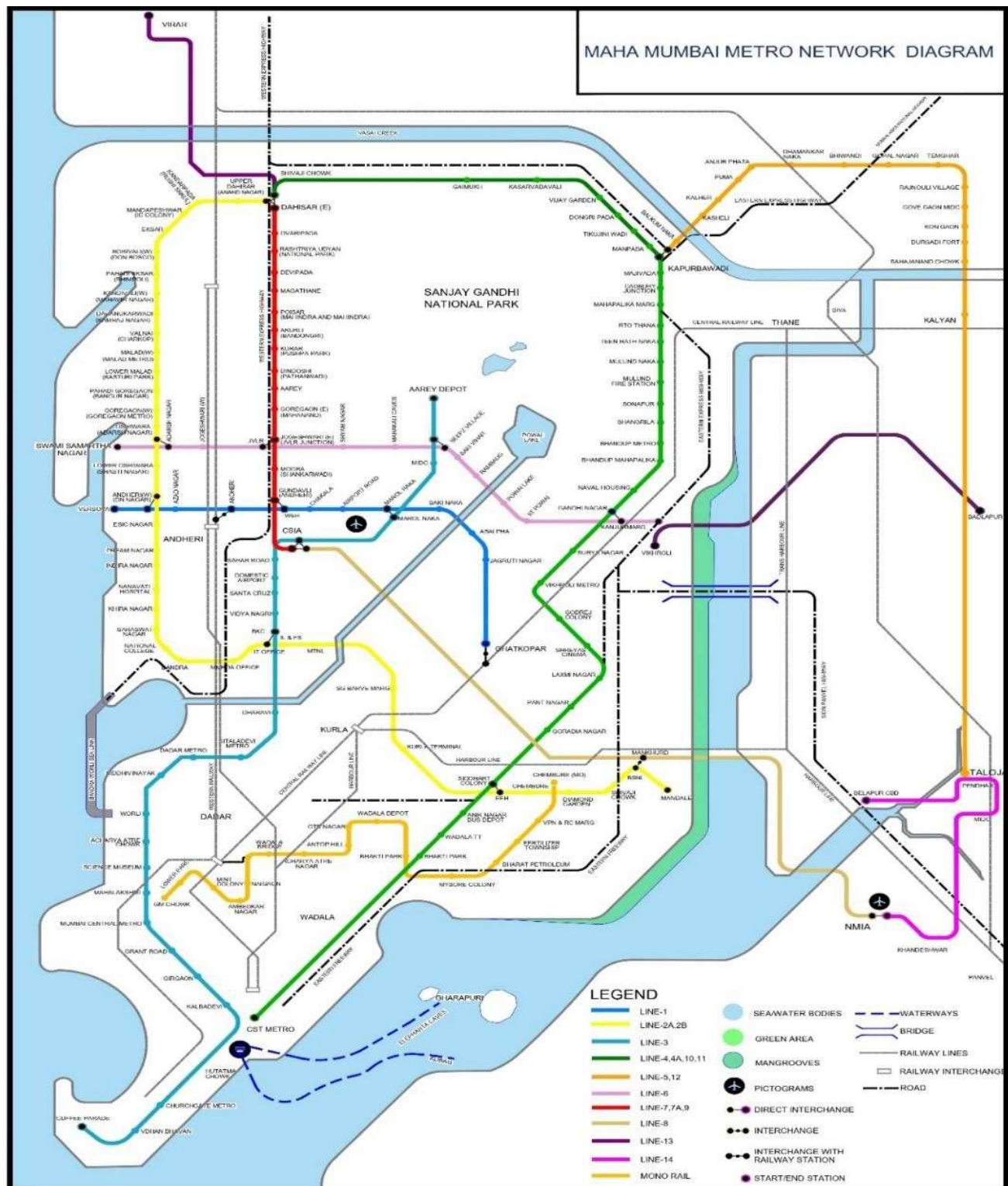
1. This specification shall be read in conjunction with the Employer's Requirements (ER), the General Specifications (GS), Employer's Drawings (Tender Drawings) and any other document forming part of the Contract. Outline Specifications and Particular Specification, meaning the combined Specifications will be prepared by the Contractor combining the Technical Specifications (Outline Design & Outline Construction Specifications of Tender Documents) contained in this document and the Contractor's Technical Proposals.
2. In the event of a conflict between the General Specifications (GS) and this Specification, this specification shall prevail.
3. The order of precedence, with item (a) below having the highest priority, is:
 - a. Technical Specifications
 - b. Employer Requirement
 - c. Indian Railway Standards/ RDSO specifications or guidelines
 - d. International Standards reference herein.
 - e. Indian Standards
 - f. Other National Standards
 - g. Other International Standards
4. Notwithstanding the precedence specified, the contractor shall always immediately seek advice from the Engineer in the event of conflicts between specifications.

1.2 OVERVIEW OF THE PROJECT

1.2.1 GENERAL

1. This Section gives an overview of the Project and the information provided in this Section is for reference only.
2. Mumbai Metropolitan Region Development Authority is implementing Mumbai Metro Rail project in the city of Mumbai in Maharashtra, India. Multiple lines of the Mumbai Metro Project are under implementation. A Mumbai Metro Network Map is annexed in this section, which illustrates the existing, under operation metro rail line, metro rail lines which are currently being implemented as well as future network of planned metro rail lines in the city of Mumbai. However, this contract is only for the Design and build for Trackworks within Kasheli Depot and contains the following salient features:
 - a. Kasheli Depot with ballasted and ballastless track on standard gauge on at grade.
 - b. The depot has 30 stabling lines, 4 Future stabling lines, 5 Inspection lines, 4 workshop lines, 2 shunting lines and separate lines for Engineering siding, 2 Car Unloading, RRV, 2 CMV, Diesel Locomotive, 1 Heavy cleaning, 1 Pit wheel lathe.
 - c. There is also a dedicated test track in the depot.
 - d. 25 KV AC overhead traction system with Cab Signaling and Automatic Train Protection (ATP) / ATO/ATS based on CBTC system (Communication based Train Control) will be provided on Standard Gauge Corridor.

1.2.2 MUMBAI METRO NETWORK MAP



Note: This map is for indicative purpose only and is subject to change by MMRDA



1.2.3 RESPONSIBILITY OF THE CONTRACTOR

1. The Contractor shall be fully responsible for all Design of all temporary and permanent works, Supply of Permanent way materials, components, fittings, and fastenings which are necessary for the 100% installation of trackworks, installation of ballasted, ballastless and special trackforms as per the design requirement, testing and commissioning of installed trackworks for Mumbai Metro Kasheli Depot. The responsibilities shall include but are not limited to:
 - a. Design, Supply and Construction of Standard gauge Ballasted Trackworks.
 - b. Design, Supply, and construction of Special trackforms in depot, particularly in covered areas, car loading/ unloading area which may include the following trackforms.
 - i. Embedded tracks
 - ii. Track Discretely supported on steel, concrete columns,
 - iii. Special Track Forms
 - iv. Pit tracks with discrete rail supports on each side of the pit.
 - c. Design, Supply and Construction of turnouts, scissors crossover, derauling switches etc., as per the approved drawing.
 - d. Design, supply, and construction of Level crossings in depot.
 - e. Design, Supply, and installation of Buffer Stops, Check rails with brackets
 - f. Interface, installation, testing and commissioning of trackwork.
 - g. All the works shall comply with MMRDA's Schedule of Dimensions and other approved laid down technical specifications.

1.2.4 NECESSITY OF APPROVAL UNDER METRO RAILWAY ACT.2002

1. In terms of section 7 of Metro Railways Act 2002, the Central Government has appointed the Commissioner of Metro Railway Safety (CMRS) and CMRS under section 8 shall inspect the metro railway with a view to determine whether it is fit to be opened for the public carriage of passengers and report there on to the Central Government as required by or under this Act. Under section 14 of the Act, the metro railway shall not be opened for the public carriage of passengers except with the previous sanction of Government under section 15 of the Act. The Commissioner shall inspect the metro railway and along with other aspects will examine that track structure has been laid and comply with the requirements laid down by the Central Government (Ministry of Railways for this purpose). In view of the extant provisions of the Act, the track structure, section, and fastenings shall comply to Schedule of Dimensions and necessary relevant approvals by Ministry of Railways and/or RDSO guidelines. CMRS-mandated modifications arising from regulatory changes post contract award shall be treated as variations under the GCC. Pre-existing regulatory requirements shall be at the Contractor's cost.

1.2.5 NATURE OF WORKS:

The Permanent Way works to be executed can broadly be grouped as under:

1. Setting out the line and level of Metro Depot track as per GAD for the proposed depot and establishing working, benchmarks, and alignment references, taking the details from benchmarks and alignment references for different lines, turnouts, cross over, level crossing roads, derailing switches, and dead ends etc.
2. Supply, Stacking and laying of ballast along the track in depot and running out this ballast to the top of formation and compacting of ballast with mechanical means. Source inspection of ballast at crusher as well as site inspection shall be done by Engineer as per approved field QUALITY PLANS and specification.
3. Design and Supply of 1 in 7 thick web curved switch, tangential with weldable CMS crossings including derailing switches, Switch Expansion Joints, scissor crossover etc. The cost of Expansion Joints, if required, shall be included in the track laying rate.
4. Supply of all material required for the above works and for installation of track in different buildings and open track in Depot.
5. All transportation, handling, rehandling, stacking materials, watching, protection of the above listed material from the manufacturer's works to the sites of use, including rails entirely as per applicable IRS Codes & Manuals, RDSO guidelines & requirements of Engineer.
6. Design, Supply, Assembling, laying, and linking of new track, turnouts, crossover, scissor crossover, switch expansion joints, derailing switches etc., on newly made-up formation without traffic blocks as per approved methodology, RDSO guidelines, within permissible laying tolerances and acceptance criteria as mentioned in Tender documents.
7. Construction of special type of track like Embedded track, level crossing track with concrete block , Pit Jack track. Track on steel and RCC column track, track for washable apron test track etc. as per drawings given in tender and approved method statement.
8. Dismantling of any small obstruction, cleaning debris etc. in way of laying of track. Making

good / repairing rain cuts and small dips up to 6" depth of already constructed blanket formation including levelling and compaction with required cross slope, the cost of these work is deemed to be included in quoted rates.

9. Diverting utilities if required to avoid delay in work.
10. Through Packing of PSC sleepers, with the specified sleeper density, including lifting and lining of track, turnouts, crossover etc. as required.
11. All joints will be welded by RDSO approved mobile flash butt welding Plant. Alumino thermit weld will be allowed at location where mobile flash butt weld is impossible. All welding work Flash butt and AT welding test has to be done with latest RDSO specification. (last date of bid submission). All test and inspection of rail welding shall be done by Contractor as required in approved field quality plan and RDSO guidelines. All weld has to be USFD tested as per RDSO guidelines. Results of all such test shall be binding on Contractor. All defective rail weld shall be rectified by contractor entirely with his own cost as per satisfaction of Engineer.
12. Laying the sleeper and rails over sleeper as per specification.
13. Neutralization of stress in Rails shall be ensured during construction phase also. For this rail must be handled and stacked as per specification. During construction fastening of Rails shall be fastened to sleeper in range of destressing temperature and ballast shall be compacted to develop ballast resistance.
14. Upon completion of the Works, the Contractor shall carry out de-stressing of Long Welded Rails (LWRs) / Continuous Welded Rails (CWRs). The Contractor shall measure and verify the stress in the de-stressed rails using an approved instrument or method, as directed by the Engineer or in accordance with internationally accepted best practices. The Contractor shall ensure and certify that the rails are in a stress-free condition upon completion of the de-stressing process.
15. Fabrication and installation of check rails/angles /fixtures, fastenings for Level Crossings / and specials tracks in different depot building.
16. All iron track components to be given anti corrosive treatment as per RDSO /BIS specification (refer Section 6.3) cost of which is to be included in cost of installation and laying of track for both ballast less and ballasted track, Anti-corrosive treatment life to be ensured 5 years from date of supply of material. Fastening shall be tested for salt spray test sustaining 1008 hours.
17. Making construction joint at junction of ballasted and ballast less special track.
18. Making and Erection of all type of Sign Boards / Indicators, letter made of luminescent paint visible at night.
19. All other miscellaneous works.
20. Unloading, Loading, and storing and stacking of all procured material by contractor at nominated store as directed by Engineer.
21. Making and supply of 6 sets of approved copies of 'As Built' drawings for the new assets created, getting approval from Engineer, of the same and supplying approved copies of the same to Engineer.

NOTE:

(i) The above is not an exhaustive list comprising of all works to be done under this contract. Major works only have been listed for guidance. Track work includes final track good for operation. All rates inclusive in quoted rate.

(ii) The finished earth work in formation either in bank or cutting with / without blanket shall not be used for transport of materials, especially heavy materials like ballast and P.way components. In unavoidable situation if finished embankment is disturbed then the Contractor shall restore it to the required formation standard with blanket material conforming to RDSO specifications. This requirement shall be kept in mind from the start of work and while planning transportation & handling of Ballast, P. Way components and track linking.

(iii) VERIFICATION OF DESIGN AND /DRAWINGS: -

Although the main responsibility for the design of the Ballastless/ Ballasted track ,within the specified conceptual envelope and dimensions to suit the general arrangement as specified in these documents and to suit the civil structures already under construction, lies with the Civil Contractor, the Track contractor however shall bring out any shortcomings (if any) to the notice of the Engineer before starting the work or as soon as it comes to their notice whichever is earlier and propose fine tuning / modifications in drawings / plans to suit the system for their chosen fastening system and safety requirement of operation.

1.3 DEFINITION

Ballast-less Track	Track elements comprising of running rails, rail-fastening assemblies, insulators, rail pads, sleeper blocks/ plinths / RCC slab, resilient pads, installed upon a concrete at-grade slab, a concrete viaduct deck, or a concrete underground invert.
Glued 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 above 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.
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).
Crossover:	Two turnouts connecting one track to another. Crossovers may be facing or trailing.
CWR:	Continuous Welded Rail, where the rail is welded into a continuous length of rail without bolted joints.

Direct Fixation Track:	Track constructed of rail and direct fixation fasteners attached to a concrete plinth or slab.
Direct Fixation Fastener (DFF):	A resilient device for securing running rail to a concrete track bed in direct Fixation track.
Double Crossovers:	Two-single crossovers in close proximity enabling moves in either direction.
Electrical Isolation:	The electrical resistance required between the running rail and the ground to prevent harmful levels of stray current.
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 railhead.
Scissors Crossover: (Diamond)	A double crossover in which two crossovers are superimposed.

2 SCOPE OF WORK

2.1 SCOPE

1. This Specification summarizes the scope, the process requirements and the overall Track System configuration for the design, procurement, construction and ultimate operation and maintenance of the Track Assets of Railway System in the depot. The contractor shall meet the intent of these requirements, but will be free to offer alternative designs, while meeting all performance criteria. It also summarizes the minimum design requirements and its interfaces with other disciplines of the Railway System. The interfacing elements include Civil contractor, traction power, communications, signaling and rolling stock contractors and any other stakeholder for fulfilling contractual requirements.
2. The details of layout of depot, curves, turnouts, scissors x-overs, etc. have been shown in alignment drawings. The exact locations, and details of which shall be designed by the Trackwork contractor duly interfacing with designated civil contractors. The Contractor shall be required to interface closely with the various Detailed Design Consultants and the designated civil/structural, and system contractors on the Mumbai Metro Part of Line 5 Project appointed by Employer.
3. The scope of work shall include all the temporary and permanent works necessary for the Design, supply, installation and testing and commissioning of track works within the Kasheli depot. The scope of work shall include but not limited to the following:

DEPOT OUTDOOR, STABLING TRACKS & ENTRY/EXIT TRACK AT GRADE

- (i) Prepared subgrade: Inspect prepared formation, test, prepare & maintain condition suitable to start Track installation.
- (ii) Unprepared subgrade: Scrubbing & removing topsoil as required, rolling, compacting base for Track installation
- (iii) Laying and rolling of Ballast, Rail, Sleeper and fastening as per IRPWM
- (iv) Linking welded panels, Turnout etc.
- (v) Adjusting line & level,
- (vi) Recording and correction of track parameters,
- (vii) Destressing of Long Welded Rail, adjusting Rail Expansion Joint gap,
- (viii) Fixing Fouling Mark etc.
- (ix) Final checking of track parameters, rail continuity & insulation test,
- (x) Buffer stop, Wheel stop & GIRJ installation (if required)

DEPOT SPECIAL TRACKS

- (i) Inspect prepared base condition suitable for special track laying,
- (ii) Fixing of steel pedestals/ casting of concrete pedestals,
- (iii) Laying of LWR over prepared base i.e., slot for embedded track/ on steel pedestals/ concrete pedestals,
- (iv) Linking welded panels,

- (v) Adjusting line & level,
 - (vi) Recording and correction of track parameters,
 - (vii) Destressing of Long Welded Rail, adjusting Rail Expansion Joint gap,
 - (viii) Final checking of track parameters, rail continuity & insulation test,
 - (ix) Integrated Testing & Commissioning of track,
 - (x) Buffer stop, wheel stop & GIRJ installation.
 - (xi) Supply and installation of short and long steel columns.
4. The contractor shall submit to the Engineer for each of item or component to be manufactured, the proven service record of the components and full details of the previous relevant experience of the proposed manufacture in the production of that item and also previous experience of manufacturing similar products for the Railway Industry as well as for other Metro Rail Projects.
5. The Contractor shall be required to submit the detailed design as per the design submission requirements and program for all types of track forms and its various components and fixtures within the period stipulated. The design shall conform to the current International/Indian Railway Practice and in various codes and specifications stipulated in this document.
6. During the process of finalizing the detailed design, the Contractor shall constantly interact and make presentations to the Engineer to enable him to issue approvals.
7. The contractor shall interface with designed contractors for the mounting of systems equipment and provision of cable ducts on/within or below the track formation/ track structures. The Contractor shall interface with the designated contractor in accordance with interface requirements required for commissioning of Kasheli Depot. The Contractor shall interface with the designated civil contractor for the requirement of track drainage arrangements, in accordance with interface requirements.
8. Brief scope work is defined in the Volume 6, Pricing document and elsewhere in the Employers requirement.

2.2 ALIGNMENT

- 1. The Employer has developed the depot alignment and provided the same in the Employer's Drawings, which shall be adopted by the Contractor. The alignment has been established to satisfy the prescribed operational and technical criteria.
- 2. The Contractor is required to evaluate the alignment for compliance with these criteria and shall review it with respect to his own design and construction proposals and shall also satisfy himself that there is no conflict with any existing structures which are to be preserved.
- 3. Any deviations shall be brought to the notice of Engineer before commencing track work Installation.
- 4. The contractor shall be responsible for modifying the alignment as per site conditions or based on observations or infringements and to closely coordinate with the respective system contractors if there is any change in alignment.

2.3 CLEARANCES

1. The Permanent Works shall not infringe the Structure Gauge as shown on the drawings and Schedule of Dimensions. Extra clearance shall be provided on curved alignment as per the Schedule of Dimensions of MMRDA.
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.

2.4 DURABILITY AND MAINTENANCE

1. The Permanent Works shall be designed and constructed such that, if maintained reasonably, they shall endure in a serviceable condition throughout their minimum "Design life" as described.
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.

2.5 OPERATIONAL REQUIREMENTS

1. The Permanent Works shall be designed and constructed to permit the railway to operate satisfactorily at a permissible operational speed where applicable.
2. During construction the Contractor shall be responsible for providing and maintaining adequate flood protection to ensure protection of the works.

2.6 ENVIRONMENTAL CONSIDERATIONS

1. The design and construction of the Permanent Works shall be undertaken with high environmental standards and shall comply with the requirement of severe environmental exposure conditions
2. Mumbai has high humidity and experiences heavy rainfall during monsoon. Corrosion, deterioration, decay, and ageing processes will occur at accelerated rates compared to those normally experienced in more moderate climates. Determination of the required level of protection against these various forms of degradation due to the environmental effects shall be considered in the design.

2.7 MATERIAL SUPPLY BY ENGINEER/EMPLOYER

1. The Contractor shall make his own arrangements at his cost for all materials required for execution, completion, and maintenance of all items of work included in his scope of work to the complete satisfaction of the Engineer. Employer/Engineer shall not supply any materials nor shall assist for procurement of any materials other than item mentioned in Bill of quantity (Volume-6) required for execution, completion of works.

2.8 MATERIAL SUPPLY FOR THE TRACKWORK CONTRACTOR

1. This being a design & build-contract for construction of ballasted and Ballastless tracks in depot lines, all the components of track sub-system shall be supplied by the contractor as per specification, technical & functional requirement in this document.
2. Contractor shall make his own arrangements at his cost for all Plant and Machinery required for execution, completion of all items of work included in his scope of work to the complete satisfaction of the Engineer. Engineer shall neither supply any Plant and Machinery nor assist for procurement of any Plant and Machinery required for execution

and completion of works.

2.9 STORAGE OF MATERIAL

- 1** The Employer shall make available, free of charge, an area of approximately 5000 m² within the depot for use by the Contractor as temporary work and storage space. The Contractor shall, at his own cost, design, prepare, level, secure, light, fence, and manage this area, including all stacking handling and protection of P-way materials in accordance with this Specification and relevant guidelines.

Apart from above any other requirement of space, area shall be arranged by the contractor. In no case contractor can claim any additional payment with regards requirement of additional space.

2.10 RECORD OF MATERIALS

1. The Contractor shall keep record of all the materials procured for this project. The Contractor shall ensure the materials brought to site are in sealed containers/packing's bearing manufacturers marking.
2. The above obligations are without prejudice to the other obligations of the Contractor.

2.11 LABORATORY

1. Contractor will be required to establish a field laboratory at his own cost at work site or at any other location as directed by the Engineer to carry out all requisite tests at his own cost. The laboratory shall be equipped with necessary equipment to carry out various tests such as sieve analysis, compression test on cubes, slump test, workability test etc. on aggregates, cement, water and concrete as required for ensuring the required quality and standard conforming to codal provisions and specifications. All the pressure gauges, machines, equipment, and other measuring and testing equipment of laboratory shall be got checked/calibrated regularly as directed by the Engineer and necessary certificates shall be furnished to him.
2. All tests required as per relevant IS Codes/specifications on cement and steel shall be carried out by order of the Contractor from authorized Technical Institutions/Test houses as approved and directed by the Engineer. For other materials such as sand, aggregates, concrete etc. tests shall be carried out by Contractor in his field laboratory as per relevant specifications

3 DESIGN CRITERIA AND TRACK PARAMETERS

3.1 GENERAL

1. Track on Metro Systems is subjected to intensive usage with very little time for day-to-day maintenance. Thus, it is imperative that the track system shall be suitable & long lasting for this level of traffic and shall require minimum maintenance and at the same time, ensure highest level of safety, reliability, and comfort. In selection/design of the track system and its components, considerations are to be given to the following factors, but not limited to: -
 - a. Durability
 - b. Reliability & riding quality
 - c. Ease of maintenance
 - d. Availability and cost of track materials and components
 - e. Successful use of similar components in other transit railways
 - f. Compatibility with the rolling stock, traction and signalling systems.
 - g. Mitigation of Noise and vibration propagation to adjacent properties
 - h. Track alignment and
 - i. Electrical insulation & stray current control.
2. Minimum design life of various components of track subsystem shall be as per [Para 3.3](#) of this specification. An adequate margin shall be built into the design, particularly to take care of the operating environment parameters of Mumbai's climatic condition. Anti-corrosive measures shall be taken in the design of track components.

3.2 SERVICE PROVEN DESIGN, DESIGN PHILOSOPHY

1. The track design shall be based on proven track technology and the components to be supplied by the Trackwork Contractor shall have been in service in other comparable transit systems, similar to that of MMRDA. The bidder shall establish to the satisfaction of the Engineer that the system design and components meet this requirement.
2. The Trackwork Contractor shall procure materials to be installed only from the reputed/established original Manufacturer whose products specifications and manufacturing processes fully conform to the relevant Indian/International standards stipulated.
3. Single point responsibility: The turnout system, fastening assembly, Buffer stops assembly, shall have a single point complete system performance responsibility from the original manufacturer.

3.3 DESIGN LIFE

1. The design life of track form elements shall be that period for which they are designed to fulfil their intended function when inspected and maintained in accordance with the relevant Operations and Maintenance Manuals. Design life is the theoretical life expectancy of products based on their design within the specified parameters. The track form shall be designed to provide optimum performance with minimum maintenance by ensuring full compatibility of components, particularly with respect to tolerances and effects of vibration from dynamic loading.
2. Service life is the projected life expectancy of products based on operating experience and real-world conditions. This is usually specified as a median of service life of the given product committed by the manufacturer. Projected service life will be provided in the

manufacturer's O&M as a reference to Operations in asset management.

3. The required minimum design life of each track form component of track shall be:

Sl.No.	Trackform Component	Design life
1	Special Ballastless track Plinth	100 years
2	Prestressed Mono-block concrete sleepers for plain track and turnout	50 years
3	Ballastless Track Fastening System	30 years
4	Ballastless & Ballasted Track-Rail seat pad, liners & elastic rail clips	15 years
5	Buffer stop	20 years

- a) General. The 'design life' of a structure or component is that period for which the item is required to fulfill 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.
- b) All sources for property enhancers of concrete shall be approved by the Employer's Representative.
- c) Serviceability of track shall be as per Annexure C-1 and C-2 of these Tender Documents.

3.4 DESIGN CRITERIA

3.4.1 GENERAL

1. The purpose of this section is to define the general approach and specific requirements for the design of the permanent way for MMRDA. In addition, track configuration is defined for co-ordination with other design disciplines.
2. The scope includes defining the required performance of materials and installation standards and tolerances for the various types of standard track, turnouts and crossovers, and appurtenances. Non-standard designs shall be based on these Criteria and supplemental requirements issued by the MMRDA as necessary.
3. The type of trackform to be used on each section shall be determined by the type of infrastructure on which the trackform is located.

3.4.2 BALLASTED TRACKFORM

1. Ballasted trackform comprises running rail, rail fastenings, insulator, rail pads, concrete sleepers, ballast.
2. The profile of the ballasted track shall comply with the relevant drawings and standards.
3. Minimum depth of ballast under rail seat is 250mm except for the test track where it is 300mm. Shoulder ballast as per design shall be provided in order to increase the lateral stability of the track on curves and wherever required ballast retainers shall be provided.
4. Rail support spacing 600 ± 5mm in test track and 650 ± 5mm for all other tracks.

3.4.3 BALLASTLESS TRACKFORM

1. Ballastless trackform incorporates the track elements comprising running rails, rail fastenings, insulators, rail pads, baseplates, resilient pads, RCC track plinth/track slab and

special trackforms within the depot buildings etc.,

2. Rail support spacing $1200 \pm 20\text{mm}$ maximum at the track on steel/concrete columns and $650 \pm 5\text{mm}$ for all other tracks.
3. Parts of the connecting track between the main line and the depot are constructed as ballastless track. At the interface between ballastless and ballasted tracks suitable measures for transition are to be installed coordinated with the Civil Contractor by the Track Contractor. Contractor shall provide design of transition arrangements for acceptance by the Employer's Representative.

3.4.4 FASTENING SYSTEM

1. The fastening system installed in the track shall comply to the performance criteria issued by Ministry of Railways, Govt. of India at Annexure-C1 & C2 of "Procedure for Safety Certification and Technical Clearance of Metro Systems" issued by Urban Transport and High-Speed Directorate of the Research Designs & Standards Organization (RDSO) Ministry of Railways and must be approved by Ministry of Railways. This document is also annexed at Annexure-C1 & C2 of these Tender Documents.
2. Fastening system for the ballasted track shall be as per RDSO specifications and drawings and procured from RDSO approved Vendor.
3. The fastening system for ballast-less track including their components thereof, which is already approved by Ministry of Railways, up-to the date of opening of Tender, shall only be considered, for this purpose. Approval letters of Ministry of Railways, Govt. of India, along with Drawings and Documents, Design Calculations, Test Reports of each component, Inspection and Test Procedure etc shall be furnished by the Tenderer. No deviations will be accepted regarding the same.
4. The Contractor shall submit test reports for the fastening system, from reputed institute/laboratory. Test report for a fastening system is specific to that fastening system encompassing a set of components of that fastening system, i.e., change in any component of a Performance Criteria compliant system will require a fresh test report. Further, the fastening shall be of proven track record.
5. The Contractor must submit specification and drawing for all the components of the proposed fastening system along with test certificate/documentary support and RDSO/Railway Board approval.
6. The Contractor must submit a Material Approval Request showing compliance to the ER, Technical Specifications, Acceptable Indian/International standards, including the test reports.
7. MMRDA is under obligation to report RDSO/Railway Board regarding adoptability of fastening system.
8. Dimensions of all materials and equipment shall be specified in the System International (SI) units. Standard components available as an industry standard only in imperial units shall remain specified in imperial units with metric equivalents stated.
9. The MMRDA operating requirements for speed, frequency, comfort, and reliability demand tight tolerances and high levels of workmanship and quality during construction, facilitated by an effective construction management programme.

3.4.5 POINTS AND CROSSINGS

1. Turnouts, Crossovers, Scissors Crossovers and Diamond Crossings shall conform to stipulations included in the Railway Board's Technical Standards enclosed at Annexure C-1 of this volume.
2. The Switch and Crossing Manufacture's design shall follow the guidance to relevant provision of EN 13232 Parts 1 to 9 with respect to geometries and dimensions of switch components and crossing components where relevant, particularly for flangeways and crossing nose protection dimensions, the Manufacture's design shall take account of rolling stock and wheelset information duly interfacing with the Contractor.
3. Stock rail, lead rails used in turnouts shall be Class A, 60E1, 1080 HH grade manufactured and tested in accordance with IRS T-12-2009 with latest amendment, suitable for welding by Alumino thermic and Flash butt welding techniques.
4. The switch rails shall be Class A, 1080 HH grade, manufactured and tested in accordance with IRS T-12-2009 with latest amendment. The section of the rail shall be 60E1A1(ZU1-60)/60E1A4.
5. Fastening system for the concrete sleepers shall conform to RDSO guidelines and shall follow the guidance to relevant provision of EN 13481-2 and EN 13481-7 for Special Fastening system for switch and crossings and check rails.
6. The check rail section shall be 33C1 (UIC33) of 1080 HH grade or similar without any direct connection with running rails and shall conform to EN 13674-3.
7. No part of the switches, switch operating gear or crossing nose shall be over a structural movement joint.
8. Turnouts shall be designed to take the CWR through turnouts. In order to limit the relative displacement between switches and stock rails or at crossings, anti-creep devices are to be designed and installed in such a way that, they start to work only when the defined allowable displacement of a component is reached and therefore the track components are kept free from unnecessary loads.
9. All turnouts and diamond crossings on main lines shall be designed and installed with canted rails with an inward slope of 1 in 20. The detailed design drawings shall be supplied to the Engineer for granting Notice of No Objection.
10. Slide chairs in the switch portion shall be coated with an appropriate All slide chairs under the switch rail should be nickel chromium plated of suitable thickness and have steel rollers to reduce friction.
11. The manufacturer/supplier has to interface with the respective switch machine designer/provider and implement the requirement in the design/manufacturing of switch

and crossings.

12. Detail design of the layouts and manufacturing drawings of the Turnouts, crossovers and scissor crossovers including design of Diamond Crossing shall be submitted by the Contractor for approval of the Employer.

All switch and crossing procured for spare maintenance purpose shall be supplied with extended leg (Minimum 600mm) ends as per Standards/OEM feasibility and as approved by engineer. Further At locations if required contractor shall procure the extended switch and crossing to avoid rail closure and same shall be submitted for approval of Employer.

The contractor shall procure Turnouts/Crossovers only from reputed / established Manufacturers, whose products specifications and manufacturing processes fully conform to the relevant Indian/International Standards stipulated. The contractor shall produce all evidence required to the satisfaction of the Engineer for granting approval.

13. The Turnout Manufacturer's design shall provide supplementary information including the following:
 - a) Durability assessment for the complete turnout for minimum design life
 - b) Qualification test reports for the rails used.
 - c) Complete Technical Description of the turnout assembly with part drawings
 - d) Scissors crossover and normal crossover general layout drawing and part drawings
 - e) Method of corrosion protection implemented.
14. Installation instructions and guidance
15. Listings and supply of special tools and gauges needed for Installation and maintenance.
16. Weights of components or sets of components for lifting purposes together with (when necessary for safe lifting without damage) designated lifting points for particular components.
17. Maintenance instructions and guidance

3.4.6 BUFFER STOPS AND WHEEL STOPS

1. Buffer stops incorporating sliding friction end stops shall be proposed by the Trackwork Contractor, taking into account interface requirements, design impact mass and speed, and the available track occupancy length. The Trackwork Contractor shall coordinate with the Rolling Stock Contractor to establish and confirm all necessary input parameters required for the design of the buffer stops.
2. All the buffer stops are of insulated type unless otherwise specified by the Engineer.
3. The simulation for the design, Structural FEM analysis of buffer stop and its component has to be carried out with 6 car scenarios respectively. The components including the buffer stops structural frame and friction elements are to be supplied with 6 car scenarios.
4. The buffing face of the buffer stop must match the coupler face of the passenger rolling stock. Generally, the buffing head of the buffer stop shall be slightly larger than the rolling stock coupler face.
5. Buffer stops shall have two buffer ends to match the Rolling Stock. Necessary interface to be done with designated Rolling Stock Contractor for the details required for the design of buffer stops.
6. All buffer stops to be mounted on the rail of cross-section 60E1 with 1 :20 inclination or vertical.
7. The design and specification of buffer stops, and wheel stops shall be submitted by the contractor for Engineer's approval.

As information, the following data shall be used for the design of buffer stop/wheel stop. Actual requirements shall be confirmed/established through interface during the design stage by the Trackwork Contractor.

Location	No of buffer stops/ Wheel Stops	Impact Speed (kmph)	Track Occupancy Length (m)
Test Track	2	25	25
Stabling shed	30+4	10	10
Inspection Lines *	5	5	13
Pit Wheel Lathe	1	10	10
Heavy Cleaning	1	10	10
Shunting neck	2	10	20
Coach delivery	2	10	10
CMV line*	2	5	5
Workshop lines	4	10	10

*Note: Impact speed for wheel stopper- 5 Kmph

- Weight of empty train is equal to 11 tonnes per axle for 6-car train set without passengers.
- Weight of train is equal to 17 tonnes per axle for 6-car train set with passengers.
- For Test track fully loaded weight to be considered and for other empty loaded to be considered

3.4.7 TRACKFORM DESIGN

1. The Contractor shall provide design of ballastless special track form and ballasted track form for the Depot.
2. The track gauge along the entire length (except for curve alignments where gauge widening is required) shall be standard gauge. (1435mm measured between the two rails 14mm below top of rail).
3. The principal requirements for the design are production of design in stages example (Preliminary, definitive etc.), preparation of GFC/working drawings/BIM models, as-built drawings, and BIM models.
4. The track form design shall ensure that the design life is achieved for each component with due consideration taken of their interaction, the track form performance requirements, dynamic characteristics of the rolling stock, and any influences due to the type of track support structure.
5. Static structural analysis of rail and support systems of all types of track form shall be based on the concept of a beam on spring support. Dynamic analysis of rail and support systems of track forms, shall be generally based on the concept of the 'Zimmermann theory'. Due cognizance shall be taken of the dynamic behavior of the supporting structure and the interaction of the track form and supporting structure during dynamic loading.
6. The design speed for Test Track shall be 95 Km/h and for depot track it shall be 25 km/h.
7. The Contractor shall submit design concepts and calculations in support of the selected track form and its component parts for Depot Line tracks including the effect on fastenings/sleeper behavior of the lateral and vertical forces generated at the wheel and rail. The Contractor shall evaluate the suitability of the proposed track forms for the projected design life.
8. The contractor shall submit all calculations necessary to support proposals relating to the construction method.
9. The Works shall be designed, manufactured, and installed to minimize the amount and costs of maintenance whilst not compromising the performance characteristics and ride quality of the railway.
10. Gauge widening will be as per SOD, 5 mm and 9 mm depending on the sharpness of the curve. Generally, no gauge widening shall be provided in the turnouts. Gauge widening shall be incrementally done duly ensuring minimum gauge variation between sleepers is limited to $\pm 2\text{mm}$.
11. The Axle load for the design of tracks and turnouts shall be 17 Tons.

3.4.8 CONTINUOUS WELDED RAILS

1. All tracks shall be continuously welded. The Trackwork contractor shall perform the Stability analysis for continuing the CWR/LWR over the ballasted track.

2. Where mechanical joints are required for electrical isolation, they shall be designed to accept the forces associated with CWR.

3.4.9 DESIGN INTERFACE

1. The track System shall be so designed as to provide continuous electrical contact between the Train and traction power supply, especially over turnouts.
2. The Trackwork shall be compatible with the electrical and mechanical requirements established during design interface with the signaling and traction power supply contractors.
3. Track insulation issues and stray current control are vital to avoid serious long term irreversible corrosion to railway and third-party infrastructure.

3.4.10 INSTALLATION

1. Track shall be laid to high quality of line, level and surface meeting Specifications and Standards set forth and Good Industry Practice, for identical system and operating speeds.

3.4.11 TESTS

1. The Contractor shall carry out tests in accordance with the Contractor's proposals approved by the Engineer/Employer's Representative, to demonstrate that the installed track form has achieved the standards set out in its submitted design calculations.

3.4.12 PROTECTION

1. Mumbai has high humidity and experiences heavy rainfall during monsoon. Corrosion, deterioration, decay, and ageing processes will occur at accelerated rates compared to those normally experienced in more moderate climates. Determination of the required level of protection against these various forms of degradation due to the environmental effects shall be considered in the design.
2. Contractor shall propose appropriate corrosion protection measures taken while procuring the materials for the approval of Engineer/Employer.

3.5 CODES AND STANDARDS

1. A list of Codes & Standards has been provided at [Para 6.3](#) of this document. The list is not exhaustive. Any other standards which may be proposed by the Contractor will be required to be approved and accepted by the Employer.
2. The design and construction of permanent works shall comply with codes of practice and standards current at the time of submission of tender documents. Regulations made and requirements issued by the Indian Government and by relevant utility companies shall be followed and specified.
3. Alternative or additional codes, standards and specifications proposed by the Contractor shall be internationally recognized codes and shall be equivalent to or better than, Indian standards issued by the Bureau of Indian standards, Indian Railways, subject to being, in the opinion of the Engineer, suitable for incorporation into the specification.

3.6 TECHNICAL CRITERIA AND OPERATING STANDARDS

CRITERIA	DIMENSION
Gauge	1435 mm Standard Gauge,
Max. train speed Test Track	
a) Maximum (Design)	95 Kmph
b) Maximum (Operating)	85 Kmph with speed restrictions wherever required
Depot	
a) Maximum (Design)	25 Kmph
b) Maximum (Operating)	15 Kmph
c) Shunting	5 Kmph
Max. axle load, loaded condition	17 tonnes Standard Gauge
Electric power	25KV AC overhead traction
Inclination of Rail	1 in 20
Wheel profile	IRS type - to be interfaced with Rolling Stock Supplier.
Rail profile	UIC 60E1
Design Rail Temperature	8 Deg C to 54 Deg C (as per rail Temperature Zones IRPWM)

3.7 TRACK STRUCTURE PARAMETERS

Description	Standard Gauge Corridor
Rail type Depot line	UIC 60E1, IRS-T-12-2009 with all correction slips, 880 /R260 grade
Rail Type Turnout including lead rail & Test Track	UIC 60E1, IRS-T-12-2009 with all correction slips, 1080 HH grade
Tentative Base Plate Spacing (Shall be reviewed by Contractor as per detailed design, following approval from Engineer for varying curvature)	i) Depot Test Track – 600mm ii) Depot Column Line – 1200 mm iii) Other Depot Lines – 650 mm
Standard Rail Length Main line	18m
Type of turnouts – Standard Gauge	UIC60-190R 1:7 turnouts suitable for ballasted tracks
Description	Standard Gauge Corridor
Type of Scissor Crossover	UIC60-190R 1:7 Scissors x-over consisting of 4 standard gauge turnouts and 1 diamond crossing (ballasted) ~4.9m* track center.

	(UIC60-190R 1:7 Scissors x-over consisting of 4 standard gauge turnouts and 1 diamond crossing (ballasted) ~4.5m* track center. * Track center as per approved drawing
Type of sleeper	60 kg. PSC sleepers for Standard Gauge and wide Gauge up to 9 mm for curves Sleeper for check rails and level crossing tracks. Minimum design life of sleeper 50 years. Grade of Concrete As per latest specification IRS T45 and IRS T-39
Sleeper Spacings	For Depot – 650 mm Test Track – 600 mm (for curve spacing can be reduced as per design requirement.
Ballast cushion	Depot - 250 mm Ballast Cushion at rail seat location Test Track – 300 mm Ballast Cushion at rail seat location
Spacing of Fasteners at special Track like steel column track and RCC column track	@1200 mm center to center - as per design requirement.
Fastening	
Ballasted Fastening for 60 Kg Rail ERC Mark V GFN Liner Grooved Rubber Pad	RDSO Drawing T-5919 as per IRS T31 RDSO Drawing T-3711 as per IRS T44 RDSO T-3706 as per IRS T47
Ballastless Fastening	As per C1 & C2,

3.8 METRO RAILWAY ALIGNMENTS

1. The layout drawing of Kasheli Depot is provided in Volume 5- Tender Drawings subject however to minor modifications approved by MMRDA towards improvement to track geometry and mitigation of constraints at Civil construction sites. The Contractor shall consider any such alterations from the Tender stage, for which no additional cost will be payable. The Contractor shall verify their geometric correctness and suitability with respect to the Standards mentioned herein. The Contractor shall design the engineering works to these given alignments.
2. Prior to the start of Detailed Design, the Contractor shall ensure from the Employer's Representative and Designated Contractors that he has the latest Alignment and shall consider any alterations made since Tender Stage, at his own cost.
3. The Contractor shall co-ordinate with the Interfacing contractors to find the permanent survey points, coordinates, and levels to proceed with the track work in advance.
4. The Contractor shall survey the as-built civil structure, following which, the centerline alignment of both tracks as per GAD shall be checked for suitability on the as-built civil structure considering Railway Cross-sections and Structure Gauges and align/realign the track accordingly, if necessary. While doing so, Contractor shall not modify by large extent and shall not propose major alignment changes and if necessary, shall apply a best fit

curve to suit the built structure. The Contractor shall submit Detailed Track Engineering Drawings with Track Layout Plans, Track parameters etc. upto the satisfaction of the Engineer.

5. Structure Gauge: Clearance on tangent track and widened gaps for curved tracks, as well as the corresponding height above rail level, shall be as prescribed in the SOD. The clearances shall be interfaced with the Civil Infrastructure Contractors for the alignment and subsequently the Contractor shall take measurements from the installed track to demonstrate compliance with requirements.
6. Standard Structure Gauge: The structure gauge (SG) is an envelope around the track which is reserved for the rolling stock. The SG is widened through curves as necessary for end throw and Mid-throw of the rolling stock. It is measured perpendicular to the track and must be tilted to correspond with the cant of the track. With the exception of certain designated railway operational structures, no permanent structures are allowed inside the structure gauge. The Contractor shall survey the original ground level i.e., Formation level and ensure that the designed alignment is accommodated and shall take measurements from the installed track to verify that there are no infringements. The Kinematic Envelope for rolling stock of the railway and Structure Gauges for straight and curved track will be coordinated with Interfacing Contractors followed by due issue of Notice of No Objection by the Employer's Representatives.
7. The Contractor shall ensure that there is adequate space outside the Structure Gauge for placement, installation, containment, and maintenance of the equipment required.
8. Track Alignment shall comply with the requirements of SOD of MMRDA.

3.8.1 HORIZONTAL ALIGNMENT

1. Horizontal Transitions shall be clothoid transitions.
2. Refer MMRDA SOD and Annexure C-1 and C-2 for stipulations.

3.8.2 VERTICAL ALIGNMENT

1. The vertical alignment refers to the top of the reference rail.
2. In both canted and non-canted curved tracks, the reference rail is the inner rail.
3. Vertical curves are required at all points of change of different grades.
4. Length of Vertical Curve. Absolute minimum length of vertical curve: 20m
5. Refer MMRDA SOD and Annexure C-1 and C-2 for stipulations.

3.9 SCHEDULE OF DIMENSION

1. The Schedule of Dimensions (SOD) of MMRDA is attached along with Tender document.
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. The Contractor shall submit the swept envelopes of the kinematic and structure gauges at various heights from the rail level to the satisfaction of the Engineer.

3.10 LOADS AND REQUIREMENTS (Ballastless Special Track forms)

1. Dead load of Track structure shall be as per relevant Indian and International codes.
2. Loading Combinations. The Track structure shall be designed and checked for all possible combinations of applied loads and forces up to the satisfaction of the Engineer. They shall resist the effect of the worst combination. However, all combinations of rolling stock loading shall be coordinated by Interfacing with Designated contractor.
3. Types of Loads: For the purpose of computing stresses and deformations, the following minimum load types and consequential effects shall be taken into account as applicable. Civil Design basis report shall be consulted with Designated Contractor.
 - i. Dead Loads
 - ii. Live Loads
 - iii. Lurching force
 - iv. Racking force as per IRS Bridge Rules
 - v. Centrifugal loads
 - vi. Dynamic (impact) loads.
 - vii. Earth quake load
 - viii. Traction and braking loads
 - ix. Forces due to Track Curvature or eccentricity.
 - x. Derailment loads.
 - xi. Thermal expansion of curved rail
 - xii. Long Welded Rail forces
 - xiii. Wind loads as per IRS Bridge Rules

4 INTERFACES

4.1 OBJECTIVE

1. This Section describes the principal interfaces limit of scope between the track contractor of Kasheli depot and the designated contractors. This Section shall be read in conjunction with the General specification.
2. The work has to be carried out in parallel with other works in the project area and the Trackwork Contractors will have to interface with the works being executed by other Contractors.
3. Trackwork contractor shall interface with the respective Civil and System Contractor for the successful installation of trackworks and prepare and implement the interface requirements.
4. Expected interface items to be performed by the Trackwork contractor with the designated (i) Civil contractor (ii) Electrical Contractor (iii) Rolling stock Contractor (iv) S&T Contractor (v) depot minor machine suppliers are listed below for the reference to the Trackwork Contractor. However, during the design, Construction and Testing and Commissioning phase, it is the responsibility of the trackwork contractor to prepare, implement the interface requirements.

4.2 EXPECTED INTERFACE REQUIREMENTS

4.2.1 TRACKWORK CONTRACTOR VS POWER SUPPLY CONTRACTOR

SN.	Item description	Contractor A	Contractor B
		Electrical (Traction)	Track work
1	Location of mast	Electrical Contractor shall make use of this drawing for making pegging plan and design of OHE system.	Track contractor shall provide the necessary track geometry drawings to Electrical Traction Contractor.
2	Cables welded with Running rails (Bonding Cables, Negative return cable, Traction Bonding cables, Cross bonding cables or any other cables)	Shall interface and agree upon with the Track work Contractor on the Methodology of welding cables with running rail. Supply and install the necessary cables at appropriate location	Track work Contractor shall interface and agree upon with the Electrical Contractors proposal for the locations and Methodology in consultation with the Engineer.
3	Cable Crossing.	Traction Contractor shall ensure conduit is laid at location of cable crossing before track Work are executed.	Trackwork Contractor shall Confirm all conduits are already laid below the formation level as approved by the Engineer, before execution of Track works.
4	Electrical and physical clearances	Shall provide necessary designs and drawings of electrical and physical clearances.	Shall complete the works as per the required clearances.

4.2.2 TRACK WORK CONTRACTOR VS DEPOT CIVIL CONTRACTOR

SN.	Item description	Contractor A	Contractor B
		(Depot Civil)	(Track work)
1	Depot Layout Drawing.	Contractor A shall supply detailed interface drawing of utility & depot construction. Depot Contractor shall modify the depot layout based on any discrepancy noticed by Track Contractor	Contractor B Shall install track based on depot layout drawing maintaining the clearance based on interface drawing supplied by Contractor A
2	Survey Control Points	Contractor A – Shall provide coordinates of the control points used for the Construction of civil works to the Contractor B	Contractor B – shall receive, validate, and agree upon the coordinates provided by Contractor A – Any discrepancy shall be brought to the notice of Engineer.
3	Handing over of site	Contractor-A Shall handover the Completed stretch to the Contractor B duly clearing all debris to the satisfaction of Engineer	Shall take over the location from Contractor-A for starting the track works and confirm with Engineer.
4	Shear connector for Special Track forms	Contractor-A Shall provide shear connectors and proper roughened surface on top at locations where Special Track forms are to be constructed by the Track Contractor.	Contractor-B Shall confirm with Contractor-A, if not stipulated shall be done by contractor B via drilling and grouting to be included in track installation.
5	As-built information	Contractor-A shall provide the as-built data of the earthwork/deck slab to the Track Contractor in an agreeable format. Any deviations observed by the Contractor B shall be rectified by Contractor A Any deviations that, requires Engineers advise shall be brought to the notice of Engineer.	Contractor-B Shall validate the as-built of earthwork/deck slab provided by Contractor A, check for track construction feasibility, SOD clearance with respect to Design Centre line and arrive plinth/slab height. Any deviations shall be brought to the notice of Engineer and Contractor A
6	Handing over of site	Shall hand over to the Track contractor (Contractor-B) the earthwork/deck slab for track structure to designated levels / clearances within the tolerances permitted. 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	Shall arrange for taking over after joint verification with Contractor-A and take up construction of the track work

7	Services	Shall provide services (water, power, and light) for construction of Track on a mutually agreed terms and Conditions.	If mutually agreed with Contractor A, furnish details of requirement of services to Contractor -B. If not, Contractor B shall make his own arrangement.
8	Clearances	Shall ensure that levels of platform in stabling lines, Inspection lines confirm to the design levels and tolerance. Shall furnish completed levels, curvature & cant, if any, to track contractor (contractor B) for any adjustment in rail/ alignment while laying track	To check the levels of platform and track base concrete at the time of taking over from Contractor-A and ensure that the heights and clearances from rail level / center of track are within acceptable limits as per the approved S.O.D. Shall give intimation to contractor A and rectify
9	Storage facility	Contractor-A Shall provide adequate storage facilities for the Track materials and also permit access to contractor-B for installing track works as per jointly agreed access schedule.	Contractor-B Shall jointly decide and ensure with contractor-A.
10	SOD related [Wing Clearances etc]	Contractor A – shall coordinate with Contractor B for Gauge and Clearance Check	Contractor B- shall carryout Gauge and Clearance Check in coordination with Contractor A
11	Design, supply, and Installation	In respect of track in locations like heavy washing lines, inspection bay, workshop lines etc. Contractor A shall complete the concrete base to the required levels for the installation of trackwork, including installation of shear connectors, etc. as required.	Shall coordinate with Contractor A for the track work requirement and takeover for installation.
12	Drainage	Shall design and execute drainage arrangement in the vicinity of track works in consultation with Track work Contractor.	The track contractor shall ensure that the civil contractor constructs drainage across the track without disturbance to track structure
13	Pathway/Level crossing	Contractor A shall make track form supporting structure at the pathway/level crossing locations	Contractor B shall coordinate with Contractor A and install the check flat, level crossings as per the approved drawing for the Pathway & (Level crossings) and ensure the minimum flangeway clearance Slab /block with in Level Crossing and maximum distance of 5 m from the centre line of the track are in scope of Track Contractor.
14	Depot utilities such as Toe Wall, Kerb stone, LC, Ballast Retainer , CC blocks etc.	Depot Contractor A shall plan depot utilities such as Toe Wall, Kerb stone, LC, Ballast Retainer , CC blocks etc. in consultation	Contractor B shall use this information for planning and executing the track works accordingly

		Contractor B. and share details/drawing of such utility.	
15	Test data of Formation-Subbase Soil -: Compaction Achieved, Plate load test (Ev2,)	Civil contractor shall provide all testing data required for track works	Contractor B shall use and validate this information for planning and executing the track works accordingly
16	Transition Slab	Civil contractor will execute the Transition slab work	

4.2.3 TRACK WORK CONTRACTOR & SIGNALLING CONTRACTOR

Sl.No.	Item description	Contractor A	Contractor B
		Signaling	Track work
1	Electrical properties of track assemblies	Shall furnish the electrical requirements for track circuits. Shall conduct the test and verify	Shall provide the same so as to meet electrical requirements of Contractor A Shall coordinate and participate with Contractor A for verification and testing
2	Bonding plan	Shall prepare the bonding plan based on the alignment drawing	Shall provide the approved Alignment drawing to the Contractor A
3	Final as-built track alignment, Plan and profile, Details of curves, gradients etc., speed on curves etc., in agreeable format	Shall incorporate the same in Train Control & Signaling design.	Contractor B shall provide the requested information to Contractor A in an agreeable format.
4	Turn out assemblies and their mounting & driving arrangements.	Shall design supply and install the point machine and associated assembly including the leading, second driving Roding, stretcher bar, external locks, and pedestals.	Track shall supply all Turnouts/Trap assemblies with due consultation with Contractor A for the position of drilling for point machine driving rods and associated assemblies. Track work Contractor facilitates for connecting of point machine to the switches. Also, interfacing to be done regarding the sleepers for mounting point machines in turnout and crossover locations.

5	Insulated glued Joints	Shall furnish the requirement & locations of all insulated glued joints to Track Contractor. Electrical testing of IRJ shall be done by Contractor A	Shall supply & install all insulated glued joints at the designated locations as per requirements of Signaling Contractor.
6	Track cable Crossings	Shall furnish all cable crossing requirements across the track form to Track Contractor and provide pipe and supports	Shall facilitate to provide necessary cable crossings under the supervision of Contractor A.
7	Buffer stops	Shall provide the requirements for the installing the buffer signals on the buffer stops. Shall supply and install the buffer signal on the buffer stop including the mounting arrangements	Shall incorporate the requirements in the design of buffer stop.
8	Joint test of point machine and associated assemblies with switch device	Jointly test with Track Contractor during installation and while commissioning of points machines & during integrated testing & commissioning.	Jointly test with Track Contractor during installation and while commissioning of points machines & during integrated testing & commissioning and rectify defects if any pertaining to track.
9	CAD welds for signalling bonds	Shall prepare the detail with drawings for the requirement and location of CAD welds on the Tracks and interface with the Track work contractor before carrying out CAD welds on the track	Shall coordinate and ensure that, the CAD welds are not falling within 350mm on either side of any rail welds and Viaduct Expansion joints.
10	Buffer Stop	Shall co-ordinate with Track Contractors for installation of Buffer Stop Signals.	Shall supply and install the buffer stops at terminal stations and other Designated locations in Mainline in co-ordination with S&TC Contractor.
11	Track Length Adequacy	Shall determine the track length required at all terminus, sidings, turn back facilities and stabling for tracks for accommodating the trains for Overrun protection.	Shall coordinate with S&TC Contractor to assure sufficient track length for accommodating the trains.

4.2.4 TRACK WORK CONTRACTOR VS ROLLING STOCK CONTRACTOR

Sl. No.	Item description	Contractor A	Contractor B
		Rolling Stock	Track work
1	Contact Geometry	Switch and crossing geometry shall be compatible with the wheel set geometry	The wheel set geometry shall be compatible with the switch and crossing geometry
2	Kinematic Envelope and SG envelope	RS contractor shall provide the details of KE and SG to track contractor for various design speeds such as 25kmph, 45kmph, 55 kmph and 80 kmph	TWK shall use this information in his design for ensuring clearances
4	Buffer stops and wheel stops	RS contractor shall share the details of couplers including anti-climbers as required by TRW contractor.	TRW Contractor shall design Buffer stop & other related equipment according to the details of Rolling stock.
5	Wayside Equipment: Hot Axle Box detection system	RS Contractor shall provide the detail drawings of way side equipment to be installed on to the track form to TWR contractor if there is any provision is required in the track form	TWR can accommodate this requirement in the track design and construction and facilitate for the installation by the Rolling stock.
6	Integrated testing & commissioning	Shall provide results of test runs including those pertaining to track conditions.	Shall associate during integrated testing & commissioning and carryout necessary rectification of track.
7	Detailed Interface document (DID)	RS contractor shall prepare DID and shall ensure that it covers Design, Interface Hazard log, Construction, Testing & Commissioning, Test report formats, Maintenance, etc.,	TRW contractor shall provide the necessary information as requested by RS contractor.
8	Wheel and rail materials shall be optimized to give the minimum whole-life cost.	The grade and hardness of the wheel shall minimize wear while being compatible with the grade and hardness of the rail.	The grade and hardness of the rail and of cast crossings shall minimize wear while being compatible with the grade and hardness of the wheel.

9	Wear and track damage: The system design shall minimize wear and track damage.	The train suspension design shall minimize track forces, wear, and rolling contact fatigue (RCF) in curves.	Track Contractor shall share the relevant data of Track required by RS Contractor for simulation.
10	Lubrication: Effective lubrication shall be achieved to minimize wear of wheels and rails.	Train borne flange lubricators shall achieve effective lubrication of the flange of the wheel.	Track Contractor shall coordinate with RS Contractor.
11	Wheel / Rail interface	Shall share information on wheel profile, hardness, etc. and ensure compatibility as indicated in the Technical Specification.	Shall share information on rail profile, hardness, etc. and ensure compatibility as indicated in the Technical Specification.
12	Track parameters related with wheel profile i.e., check rail, wing rail clearances etc.	Shall provide wheel profile details for new wheels and other required details.	Shall take account of wheel profile details for working out related track parameter details such as

4.2.5 TRACK WORK CONTRACTOR VS COMMUNICATION CONTRACTOR

Sl. No.	Item description	Contractor A	Contractor B
		Communication Contractor	Track work
1	Installation of trackside equipment (radio masts etc. if any)	Shall furnish the final size of trackside equipment's and co-ordinate with Track Contractor(s) to ensure the compliance of schedule of dimensions.	Shall co-ordinate with Telecom Contractor to ensure the compliance of schedule of dimensions.

4.2.6 TRACK WORK CONTRACTOR VS TRW CONTRACTOR OF ADJACENT PACKAGES

Item No.	Item Description	Contractor A	Contractor B
		Track Contractor of adjacent package	Trackwork Contractor (Depot)
1	Interface boundary and control points	Shall coordinate with Contractor B, share, and validate the primary and secondary control points at the junction of the stretch jointly and agree upon by both the parties and get it approved by the Engineer.	Shall coordinate with Contractor A, share, and validate the primary and secondary control points at the junction of the stretch jointly and agree upon by both the parties and get it approved by the Engineer.
2	Alignment	Shall coordinate, share, and validate the track alignment at the junction of the stretch jointly and agree upon by the both the parties and get it approved by the Engineer	Shall coordinate, share, and validate the track alignment at the junction of the stretch jointly and agree upon by the both the parties and get it approved by the Engineer
3	Welding of rails	Shall derive the methodology with Contractor B in consultation with the Engineer so as to carryout closure welds, distressing and other track related activities at the junction of stretch	Shall derive the methodology with Contractor A in consultation with the Engineer so as to carryout closure welds, distressing and other track related activities at the junction of stretch

4.2.7 TRACK WORK CONTRACTOR VS MEP

Item No.	Item Description	Contractor A	Contractor B
		Track Contractor	Trackwork Contractor (Depot)
1	Installation of track in i. Workshop ii. Inspection Bay iii. Stabling Lines iv. ETU Workshop v. Washing Plant vii. Pit Wheel lathe viii. other depot areas	Shall supply and install the track On Depot lines. As per the requirement of Depot M&P Contractor, considering equipment load, clearance, etc., in design & drawings of Trackwork	Shall provide the requirement & coordinate with Track work Contractor for laying track.
2	Any other Track work	Shall Interface with Depot M&P contractor for necessary requirements	Shall Interface with Trackwork contractor for necessary requirements.

5 INSTALLATION AND CONSTRUCTION SCHEDULE

5.1 REQUIREMENTS

5.1.1 GENERAL REQUIREMENTS

1. The Contractor shall comply with all Enactments in executing the works, including but not limited to all statutory provisions on occupational health and safety.
2. The Contractor shall co-ordinate with designated Contractors in the execution of the Works.
3. The Contractor shall also co-operate with all relevant authorities in the execution of the works.
4. All machinery and equipment shall be always operated by suitably trained and competent employees of the contractor and to the satisfaction of the Engineer.
5. Only appropriate tools, plant, machinery and equipment and vehicles shall be used.
6. The works of laying, levelling and consolidation of ballast in two layers of 150mm and 100 mm each by Roller, before laying of track. It shall be ensured while laying ballast, no high point is created in ballast surfacing. The installation of track, aligning levelling and packing of ballast. regulation of ballast profile. Installation of turnouts, cross over aligning and packing of turnouts, crossover shall be done using suitable mechanical manual means, like small track machine, Track master, Digitalized track parameter measuring machines, compaction by light weight tampers shall be used. Approval of the Engineer shall be taken for the type of machinery and the methodology proposed to be deployed / adopted for these works. Contractor shall ensure the designed final cushion of ballast thickness throughout the length of track.
7. The contractor shall, prior to starting any installation and construction work, identify any possible hazards, and implement measures of eliminating and/or controlling such potential hazards, in line with safe working practices.
8. Further details on Site Safety management are described in these documents. The Contractor shall ensure that all areas of work are sufficiently illuminated for the works to be undertaken and that a safe system of working is employed for all activities.
9. The contractor shall operate a suitable system for the control of persons entering or working on the site. The system shall include as a minimum:
 - a) Register of all employees
 - b) Personal identification with photograph and signature / thumb impression
 - c) Levels of competence.
 - d) Date of joining
 - e) Date of discharge.
 - f) Register of all visitors
10. The Contractor shall co-operate, at all times, with the Engineer and designated Contractors to ensure that the site is protected from unauthorized admission, either willfully or otherwise.
11. The Contractor shall make due provisions for safe access to and egress from the site of works for its staff and subcontractors. This access shall be maintained such that it is free of all hazards and is in a safe condition throughout the duration of the works.

12. As the work of installation of track as plain track or in yards, where other connected works like installation of loops, turnouts etc. are to be done in the extreme vicinity of running rail system involving safety of trains, Contractor shall adhere to all the safety related instructions issued to him directly or through the Engineer from time to time. Contractor shall take immediate action in implementing these instructions.

5.1.2 SPECIFICATION REQUIREMENTS

The installation and construction work pertaining to this contract shall include, but not be limited to the following: -

1. Survey on site and review the technical requirements shown in this specification and the Employer's drawings.
2. Finalization of the construction and installation program
3. Production of the calculation sheets and installation drawings for site installation.
4. Procurement of fastening system, switches and crossings, buffer stops, permanent way markers and equipment for ballast-less track and installation in track at specified density.
5. All P-Way material for ballasted track shall be purchased from RDSO approved vender and shall be inspected by RDSO/ RITES as applicable or third party as per approved QAP/FIELD QUALITY PLANS as per requirements of Engineer. All testing results shall be submitted in hard as well in soft copies for records.
6. P-Way materials may be randomly inspected by Engineer, both at source as well as at site on receipt. Contractor shall give inspection calls to Engineer sufficiently in advance to enable him to conduct the inspection.
7. All receipt inspections shall be facilitated by Contractor (including prior intimation to Engineer, provide all inspection tools/equipment, etc. & to be recorded in approved format of RDSO.
8. The Contractor shall replace with immediate effect all defective materials detected at receipt inspection at site, irrespective of whether the material was inspected at source. The decision of the Engineer in this regard shall be final, subject to the Contractor's right of referral under the GCC.
9. Rail welding plants and QAP of Plant & testing devices shall be RDSO approved. Contractor shall submit to Engineer all required documents as evidence of the RDSO approval of the plants as well as any other document establishing the traceability of the plant as required by Engineer. Testing records of rail welds shall also include automatic printouts from welding plants.
10. Schedule of the material supply.
11. Installation in accordance with the approved installation drawings.

12. Co-ordination with designated contractors.
13. Submission of the installation reports and records.
14. Testing and commissioning as per finalized protocol and programme.
15. Production of as built drawings, documents, calculations sheets, and records.

5.1.3 CONSTRUCTION AND INSTALLATION PLAN

1. The contractor shall undertake installation work in stages as per the Contractor's detailed installation program. Installation, testing and commissioning of later stages shall have no impact on revenue operations of earlier stages.
2. As a minimum, the detailed construction and installation plan shall include all the activities, installation details and methods of all activities, equipment, and tools to be used for installation, safety issues, supervision, temporary land occupation needed and the vehicles to be used for transportation of material & installation.

5.1.4 TEMPORARY WORKS

1. The design of temporary works shall be submitted to the Engineer for approval.
2. All temporary works shall be removed on completion of permanent works, or as directed by the Engineer.
3. All temporary works shall be clearly distinguishable from permanent works.

5.1.5 SITE SUPERVISION AND SAFETY ISSUES

1. The contractor shall set up a site supervision system, which shall be part of the overall safety, system assurance and quality management system.
2. Details of Health and Safety requirements at site are described in the General conditions of contract

5.1.6 QUALITY MANAGEMENT

1. The Contractor shall adopt an appropriate quality management system conforming to ISO 9000 or equivalent & to ensure that the System performance requirements as specified in this Technical Specification are achieved.
2. The Contractor shall provide sufficient number of suitably experienced supervisors and skilled workers to ensure that the progress and quality of the work, both on site and in the Contractor's workshops, are maintained to the satisfaction of the Engineer.
3. The supervisors shall work on a fulltime basis during the entire installation process as directed by Engineer.

4. The Engineer reserves the right to undertake, at any time, checks on the proficiency of the Contractor's staff, licensing, and all associated documentation. Shall any of the Contractor's own staff (and not sub-contractor staff) be found incompetent by the Engineer or unlicensed they shall be removed from the site until their competence has been established or competent staff are posted.
5. Contractor shall submit quality management system manual in line with the Standard Quality Manual submitted with Tender document as a guideline. Also, the quality requirements mentioned in the Contract document shall be complied & implemented.
6. The Engineer may undertake, at any time, checks on the proficiency of the Contractor's staff, their licensing, and all associated documentation. Shall any of the Contractor's staff be found incompetent or unlicensed by the Engineer, they shall be removed from the site till their competence has been established.
7. Contractor shall ensure submission of all material quality testing certificates of bought-out materials (switches, fasteners and accessories, etc.) and Field Quality Plans for all workmanship activities, prior to commencement of work
8. Contractor shall ensure to obtain Source approval for specific materials as required by Engineer before commencement of work. Such materials shall include, but not be limited to, track ballast and all consignment items not listed under RDSO approved list. Contractor shall provide all assistance and support facilities to Engineer for the approval process. (By joint sampling, cost of testing submission of documents as required, etc.)
9. All materials subject to source inspections at Contractor's works done by Engineer's inspection, Engineer shall be supplied at site with due MDCC from Contractor along with all other documents (Inspection reports, test reports, datasheets, applicable commercial documents, etc.).
10. Contractor shall ensure all the required control & monitoring at ballast quarry to ensure supply of specified materials at site. Apart from source approval, ballast shall be tested at site for each stack as per specification in witness of Quality Engineer. Decision of Engineer's quality Engineer on test results shall be final & binding on Contractor. Contractor shall remove all rejected materials from site as required by Engineer as soon as possible, if contractor does not remove rejected material within 3 days, penalty of Rs.100 per m.sq per day shall be deducted from RA bills.
11. Contractor shall have adequate Lab set-up at site to test all P-Way materials as required by Engineer (Ballast and any other material as instructed by Engineer). Contractor shall test materials from approved independent lab as required by Engineer. All test reports, duly signed & approved by Engineer, shall be submitted to him regularly as required as per RDSO guideline.
12. NCR management & closure for the project shall be strictly followed as required by MMRDA. Engineer shall ensure that all deviation from required drawings, specifications, & quality norms are identified and recorded in approved format of NCR. Contractor shall ensure that all NCRs and any other notification of deviations communicated by Engineer

by any means (verbal instructions, mails, field notes, etc.) are closed within the specified duration as required by Engineer. The NCRs & deviations shall be rectified & closed as per the specified corrective action (including dismantling & redoing the work), as required by Engineer, entirely to his satisfaction, Engineer on intimation, shall verify the corrective actions taken and shall validate the closure of the NC if found complying with the agreed terms of NCR closure. Contractor shall maintain all documentation regarding the complete NCR management process as required by Engineer. Engineer shall hold/deduct appropriate amounts from Contractor's RA bills on account of open NCs or delay in closure of same.

13. Quality records documentation shall be totally as per approved Manufacturing Quality Plans & field quality plans and as required by Engineer. Contractor shall ensure submission of all quality records to Engineer regularly (weekly or as required by him).
14. Contractor shall conduct all tests & inspections of rail welding as per approved field quality plans & requirements of Engineer. Specific additional tests and NDT shall be conducted by the Contractor as & when required by Engineer. Engineer may even engage an independent testing agency for testing of Rail welds cost of which has to be borne by contractor. The results of such tests shall hold good as final validation for acceptance or rejection of works as the case may be and shall be binding on Contractor. The rectifications or any corrective actions as required by Engineer, based on such test results shall be made good by Contractor entirely as required by MMRDA all the weld test as per RDSO guideline and maintain the register with weld number mention on the rail flange.

5.1.7 WORKMANSHIP

1. The style and procedure of workmanship shall be appropriate and consistent throughout the works.

5.1.8 SITE CLEARANCE AND ENVIRONMENTAL REQUIREMENTS

1. The Contractor shall from time to time dispose of the debris. Contractor shall stack sleepers Turnouts and any other P-Way materials properly at designated locations as directed by the Engineer.
2. The Contractor shall ensure full compliance with environmental guidelines issued by the local authority, including measures to reduce noise pollution, air pollution, and other environmental impacts.
3. Disposal of debris shall be carried out periodically. All debris must be cleared within **14 days**; failing which, a penalty shall be imposed on the Contractor as per contract conditions.
4. Water sprinklers shall be installed and operated at the site in accordance with the requirements of the environmental authorities to control dust and maintain environmental standards.

5.2 SURVEY EQUIPMENT

1. The contractor shall provide the survey equipment, track measuring equipment and other accessories as per the instructions of Engineer as and when required. The contractor shall also provide all necessary help and manpower as required by the Engineer for checking

the works.

5.3 OTHER EQUIPMENT

1. For other equipment like Buffer Stops, etc. a complete set of documentations must be supplied with each System. The documentation shall be self-tutorial in nature and be readily understood by non-computer personnel.
2. The following manuals must be supplied with the system:
 - a) Manual on how to operate the equipment; and
 - b) Manual on how to use the facilities and software provided by the supplier. (Including languages and utilities).

5.4 ANTI CORROSIVE PAINTING OR TREATMENT FOR TRACK COMPONENTS

1. Since Mumbai comes under severe corrosion prone zone it is mandatory to address corrosion in effective manner to ensure trouble free operation as well as to ensure durability of iron track parts/components including turnouts. Therefore, contractor has to give all ballastless and ballasted track iron component effective anticorrosive painting or treatment as per IRS/EN/IS based on severe environment condition for coastal areas as approved by Engineer.

The cost of this treatment deemed to be included in item of installation and laying for both ballast less and ballasted track. No Extra cost will be paid.

5.5 PROGRAM REQUIREMENT

In addition to the requirements specified in the General Conditions of contract and Specifications, the Contractor shall program the works in accordance with a pre-determined sequence to meet various key dates and Access dates so as to meet the target dates. The program shall be prepared by the Contractor and finalized in consultation with the Engineer. The same may be summarized as under

- c) Establish work site and get shared access to work jointly for the relevant works. All the civil works may not be complete at the same time and may be completed in stages to facilitate the track laying operation
- d) Partial completion of track work to provide shared access for the works of other agencies. Completion of track work, which can be, completed without non-interlocking of the station yards.
- e) Completion of track works and compliance of CRS observations jointly with Signalling work and Facility works, with or without non-interlocked working during CRS sanction in phases.
- f) Completion of Acceptance tests after completing necessary testing and integrated testing in phases.
- g) Commissioning of works after meeting all the requirements of operation and maintenance. (In Phases)
- h) Final commissioning of the track work.

SECTION B

OUTLINE CONSTRUCTION SPECIFICATIONS

6 MATERIAL AND WORKMANSHIP: GENERAL

6.1 INTRODUCTION

1. This Materials and Workmanship Specification for Track work shall be read in conjunction with all the documents forming part of the Contract.
2. No Permanent Works shall be carried out until all methods and materials have been approved.
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 approval of Engineer.
4. The test results of each test to be carried out as per Employer's requirement shall be recorded and submitted in a format approved by the Engineer and shall include graphical presentation of results as well as numerical base data wherever required.
5. All drawings, records, reports, documents, proforma etc. shall be submitted in both hard copy and electronic copy.

6.2 ABBREVIATIONS

S. No.	Abbreviation	Full Name
Trackwork Abbreviations		
1	BS	British Standards
2	MMRDA	Mumbai Metropolitan Region Development Authority
3	CMS	Cast Manganese Steel
4	CW	Civil Works
5	CWR	Continuous Welded Rail
6	DFF	Direct Fixation Fastener
7	ERQ	Employer's Requirement
8	EN	European Norms
9	FAT	Factory acceptance Tests
10	FTA	Federal Transit Administration
11	GMT	Gross Million Tons
12	HH	Head Hardened Rail
13	IRJ	Insulated Glued Rail Joint
14	LWR	Long Welded Rail
15	MSL	Mean Sea Level
16	N&V	Noise and Vibration
17	P & C	Points & Crossing
18	PSC	Prestressed Concrete Sleeper
19	QA	Quality Assurance
20	QC	Quality Control
21	QMS	Quality Management System
22	QP	Quality Plan
23	R	Radius
24	RAMS	Reliability, Availability, Maintenance and Safety
25	RCC	Reinforced Cement Concrete
26	REJ	Rail Expansion Joint
27	RSI	Rail Structure Interaction
28	SOD	Schedule of Dimensions of MMRDA
29	SRJ	Stock Rail Joint
30	TMT	Thermo Mechanically Treated
31	TOR	Top of Rail

32	USFD	Ultrasonic flaw detector
Standards Abbreviations		
1	ANSI	American National Standard Institute
2	ASTM	American Society for Testing of Materials
3	BS	British Standard
4	EN	European Standard
5	DIN	German Standard
6	IRS	Indian Railway Standard
7	IEC	International Electro technical Commission
8	IS	Indian Standard
9	ISO	International Organization for Standardization
10	JIS	Japanese Industrial Standard
11	UIC	International Union of Railways

6.3 STANDARDS

1. Track work materials, components and assemblies shall comply with the requirements and Standards given in the present Specification; however, it shall be the responsibility of the contractor to adopt the latest version of the technical specification with all correction slips.
2. The Trackwork Contractor might propose standards different from those as mentioned herein after, however the application of these standards is subject to the approval of the Employer.
3. Where no specification or standard is given the Contractor shall propose a standard for Approval based on the accepted industry standard for the material, component, or assembly.
4. Where standards are proposed which are published in other than the English language, a certified translation of the document shall be provided to the Engineer and Employer.
5. The below list is not exhaustive. The Contractor shall also keep note of any other codes and practice mentioned in various paragraphs of this volume.
6. All materials shall be suitable for ballast-less track Standard Gauge, the codes / standards/manuals mentioned above are not to be considered in limited sense. Any other relevant code / standard may also be considered with the proper approval of the Engineer.
7. It shall be the responsibility of the Contractor to adopt the latest revision of relevant Codes and Standards. The Contractor shall be responsible for obtaining relevant Codes, Standards and documents at his own cost and shall submit them to the Employer for approval before starting associated design or construction work.

8. The relevant RDSO drawings shall be followed, wherever required, for those trackwork / track items which may be required to be manufactured / procured based on Indian Railway specifications.
9. The Contractor shall be responsible for collecting the relevant drawings from RDSO at his own cost and shall submit them to the Engineer for his approval before starting of the work.

1. International Union of Railways Standard Codes (UIC)

Code & Standard	Description
UIC Code 860 – 0	Technical Specification for the supply of Rails
UIC Code 861-3	Standard 60 kg/m Rail Profile Types: UIC 60 and 60E
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 for use 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 Specification for the Supply of Rail Seat Pads
UIC Code 864 – 8	Rolled Profiles for Fishplates for 54 kg/m and 60 kg/m Rails
UIC Code 866 – 0	Technical Specification for the supply of cast manganese steel crossings for switch and crossing work

2. International Organisation for Standardisation (ISO)

Code & Standard	Description
ISO 1113	Information Processing – Representation of the 7-bit coded character set on punched tape
ISO 9001	Quality System- Model for Quality assurance in design/development, production, installation, and servicing
ISO527-1:2012	Testing of Plastics – Tensile Test
ISO1191	Plastics – Polyethylene and Polypropylenes in dilute Solution Determination of viscosity number and of limiting viscosity number.

3. Indian Standards (IS)

Code & Standard	Description
IS 456	Code of Practice for Plain and Reinforced Concrete
IS 800	Code of Practice for General Construction in Steel

4. European Standards (EN)

Code & Standard	Description
EN1561	Founding–Grey Cast Iron
EN1562	Founding–Malleable Cast Irons

EN1563	Founding – Spheroidal Graphite Cast Irons
EN1183-1:2013	Testing of Plastics and Elastomers – Determination of Density
EN16432-1 & 2: 2016	Railway applications — Ballast-less track systems — Part 1&2: General Requirements and System design, Subsystems and components
EN13146 – 1 ~ 7	Railway Applications – Track: -Test methods for fastenings
EN13230 - 1 & - 2	Design Manufacturing & Testing of sleepers
EN 13481-5	Railway Applications – Track: Performance requirements for fastening system
EN 50122-1	Railway Applications-Fixed Installations-Part-1-Protective Provisions Relating to Electrical Safety and Earthing.
EN 50122-2	Railway applications. Fixed installations. Protective provisions against the effects of stray currents caused by d.c. traction systems

5. American Standard

- AASHTO LRFD Manual

6. German Standard (DIN)

Code & Standard	Description
DIN 53455	Testing of Plastics – Tensile Test
DIN 53479	Testing of Plastics and Elastomers – Determination of Density
DIN 53508	Testing of rubber - Accelerated ageing

7. International Electrotechnical Commission (IEC)

Code & Standard	Description
IEC 60167:1993	Method of testing for volume resistivity and surface resistivity of solid electrical insulating materials (Formerly DIN 53482)
IEC 60093	Method of testing for volume resistivity and surface resistivity of solid electrical insulating materials (Formerly DIN 53482)

8. Indian Railway Standards

Code & Standard	Description
IRS T-1-2021	IRS Specification for Fishplates & Fishplate Bars
IRS T-10-2025	Indian Railway Standard Specification for Fabricated Switches and Crossings, Welded/Heat Treated Crossings and Switch Expansion Joints (SEJ)
IRS T-12-2009	specification for Flat bottom rails - Reprint Oct 2021 (upto ACS No.5 and corrigendum No.1 to and 5)
IRS T-19-2021	Indian Railway Standard Specification for Fusion Welding of Rails by Alumino-Thermic Process

IRS T-23-2021	Specification for Track Bolts and Nuts (Having Metric Screw threads with ISO profile)
IRS T-28-1973	IRS Specification for High Tensile Fish Bots and Nuts
IRS T-29-(revised 2024)	Indian Railway Standard specification for Cast Manganese Steel Crossings
IRS T-31-2021	Indian Railway Standard Specification for Elastic Rail Clips (Fifth Revision) with corrigendum no. 1
IRS T-37-2022	GR sole plate (for 6mm sole plate pad and any other relevant specification)
IRS T-39-2021	IRS specification for pre-tensioned pre-stressed concrete sleepers for BG, MG & NG (6th Revision March 2021)
IRS T-42-2020	IRS Specification for Single Coil Spring Steel Washers for Track (Revision-01)
IRS T-44-2025	IRS Specification for Glass filled Nylon-66 Insulating Liners (Third Revision)
IRS T-45-2021	IRS specification for pre-tensioned pre- stressed concrete sleepers for turnouts B.G. and M.G (4th Revision March 2021) with corrigendum No. 1
IRS T-46-2025	IRS specification for Spheroidal Graphite Cast Iron Inserts (4 th Revision)
IRS T-47-2020	IRS specification for Spheroidal Graphite Cast Iron Inserts with Correction Slip
IRS T-49-2019	Technical Specification for Stationary Flash Butt Welding Plant and connected Machines & Accessories
IRS T-53	Indian Railway Standard Specification for Ultrasonic Testing of Rails / Welds, Revised - 2020
IRS T-55-2025	IRS Specification for Rail pads for placing beneath Rail, SI. No. T-55-2023
IRS T-56-2020	IRS specification for Metal Liner for use with Elastic Rail clips along with Corrigendum No. 1
IRS T-57-2020	IRS specification for Polyethylene Dowels for concrete sleepers
IRPWM	Indian Railway Permanent Way Manual
Indian Railway Manuals, Procedures & Specifications	Manual For Fusion Welding of Rails by The Alumino-Thermic Process (Revised-2022)
	Manual for Flash Butt Welding of Rails,2022 (Upto ACS2)
	IRS GE 1 2004 Specifications For Track Ballast (Upto ACS-04)
	Manual for Ultrasonic Testing of Rails and Welds (Revised-2022) (Upto ACS2)
	Manual For Glued Insulated Rail Joints (Upto Acs-08)
	Comprehensive Guidelines and Specifications for Railway Formation: Specification No. RDS Revision March004, Sept.-2020 (Up to ACS 01)
	Provisional Specification for Retro-Reflective Indicators (May 2011)
	Functional Specification for Rubberised Surface at Level Crossings
	Procedure for Safety Certification and Technical Clearance of Metro Systems Jan-2013
	IRS Specification for 6mm thick Nylon Cord Reinforced Grooved Rubber Sole Plates for placing beneath rails at turnouts (Provisional) — 2020 (Revision 1.0), Serial no. RDSO/M&C/RP-201/2020 (Revision 1.0)

	Provisional Specification for Retro-Reflective Indicators (May 2011)
GE: G-1	GUIDELINES FOR EARTHWORK IN RAILWAY PROJECTS
GE/0001:2023	Specification for Track Ballast
GE: IRS-004	Comprehensive Guidelines and Specifications for Railway Formation (With ACS 01 Dated 16.12.2021)
No. CT-35	Guidelines for handling and stacking of Rails
RDSO M&C/PCN/120-2020 (Rev.1)	Specification for Anticorrosion Primer (Epoxy Zinc Phosphate)
RDSO M&C/PCN/123-2011	Specification for High Performance Anticorrosion Epoxy Coating (Two Pack)
ISO 9227	Corrosion tests in artificial atmospheres — Salt spray tests

OTHERS

A. CEMENT

IS: 269	Specifications for 33 grades ordinary Portland cement.
IS: 650	Specifications for standard sand for testing of cement.
IS: 4031	Methods of physical tests for hydraulic cement
IS: 4032	Methods 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 grades ordinary Portland cement.
IS: 12269	Specifications for 53 grades ordinary Portland cement.

B. CONCRETE

IS: 383	Specifications for coarse and fine aggregates from natural sources for concrete.
IS: 456	Codes 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 – III cement concrete (plain & reinforced (first revision)
IS: 9103	Specifications for admixture for concrete

C. FORMWORK

IS: 456	Codes of practice for plain and reinforced concrete
IS: 4990	Plywood for concrete shuttering work

IRC: 87	Guidelines for design & erection of false work for road bridge.
IS: 806	Codes 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.

D. STEEL REINFORCEMENT

IS: 280	Mild steel wires for general engineering purposes.
IS: 432	Parts I mild steel and medium tensile steel bars. part II hard drawn steel wire.
IS: 456	Codes of practice for plain and reinforced concrete.
IS: 814	PARTS I & II electrodes for metal arc welding of structural steel.
IS: 816	Codes of practice for use of metal arc welding for 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 for 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.
RDSO M&C/PCN/12 6-2008	Specification for Bipolar Concrete Penetrating Corrosion Inhibiting Admixture

10. The relevant technical specifications and manuals etc. of Indian Railways have been mentioned in these specifications, however, it shall be the responsibility of the contractor to adopt the latest revision of relevant technical specification/manual of Indian Railways with all correction slips and alterations. The contractor shall be responsible for collecting the relevant technical specification from Indian Railways at his own cost and shall submit them to the engineer for his approval before starting of work.

6.4 TESTING AND INSPECTION

1. All materials and components shall be tested and inspected in accordance with [Section 10](#)
2. The Contractor shall submit to the Engineer for each item or component to be manufactured, full details of the previous relevant experience of the proposed manufacture in the production of that item, and also previous experience of manufacturing similar products for the Railway industry.

6.5 PACKAGING, SHIPPING AND STORAGE

1. All materials, components, or assemblies to be supplied by the contractor shall be packed & transported without causing any damage to it. The materials shall be offered for Engineer's inspection at contractor's storage depot for this project in Mumbai before installation. The material classified as damaged by Engineer shall not be used for the work.

2. All materials including the material supplied by the Employer shall be stored and protected in neat, well-maintained stacks, bundles or enclosed stores with markings clearly visible.
3. Materials shall be so stored as to ensure no deterioration due to water or any other reason.
4. All material storage arrangements shall be with prior approval of the Engineer.
5. The materials and equipment having specific provisions of packaging & storage shall be packed and stored in accordance with their technical specifications in addition to that described above.

6.6 SUPPLIER APPROVAL

1. Details of proposed suppliers shall be submitted, and Approval shall be obtained, prior to the confirmation of any order with any supplier.
2. The proposed manufacturers of the items to be supplied by the Trackwork contractor such as Rails, fastening system, Turnouts etc., shall have a proven record of supplying the same for the Metro/Railway and furnish documentary evidence to demonstrate that it meets the performance requirements and technical capacity. The details of supplies made along with performance certificate, details of current work commitments, plant and manufacturing capacity, organization setup, statement and details of equipment and other facilities available in manufacturing plant, quality control system and quality assurance plan of the proposed suppliers shall be submitted to the Engineer for his review.

6.7 MATERIAL APPROVAL

1. Details of proposed materials for the design and construction of trackwork shall be submitted, and Approval shall be obtained, prior to the confirmation of any order with any supplier.
2. The Contractor shall submit all necessary technical documents, which shall prove that the design, manufacture, and supply are complying with relevant International/Indian Standards.

7 MATERIAL & WORKMANSHIP: MATERIALS AND COMPONENTS

7.1 RAILS

7.1.1 GENERAL

1. The Contractor shall be responsible for supply of 60 E1 Profile, 1080 HH Grade and Grade R260/ 880 rails duly conforming to the IRS T-12-2009 with latest amendments for the quality of the steel, manufacturing process, chemical composition, acceptance test/retests, qualifying criteria, and other technical conditions of supply.
2. The credentials of the rail supplier shall be submitted to the Employer/Engineer for prior approval. Once the Employer/Engineer approves the credentials of the supplier, the Supply of rails shall begin.

7.1.2 TECHNICAL REQUIREMENTS

1. The rail procured for this project shall comply to IRS T-12-2009 with latest amendments. Some of the salient features are listed below.
2. The rail shall be class 'A' rails as per IRS-T-12-2009 specification with latest amendments.
3. Standard length of rail shall be 18m.
4. The rails shall be with ends un-drilled.
5. The rails shall be of 1080 HH Grade and Grade R260/ 880 and be suitable for being welded by aluminothermic or flash butt welding technique.
6. The rail shall be manufactured and tested in accordance with IRS-T-12-2009 (with latest amendment). The chosen manufacturers shall be required to submit their inspection and test plan for approval by Engineer as per IRST- 12-2009.
7. Color code shall comply with Color code requirements as stated in Annexure IV of IRS T12-2009 with latest amendments.
8. The Contractor shall submit detailed Inspection & Testing Plan (ITP) to purchaser for approval before commencement of manufacturing of rails. The following inspections and tests shall be performed.
9. Contractor shall submit the templates, profile gauge used during inspection at Factory.

7.1.3 TRANSPORTATION AND PACKAGING

1. Rails are longer than conventional trailers and the road transportation shall not have rails overhanging the end of trailers to the degree that the rails could be permanently bent or permanently distorted during transport. The rails must be supported at spacing such that permanent bending or permanent distortions will not occur.
2. Rails shall be protected from additional corrosion during transportation, in particular being protected from the extreme pitting corrosion that can result from sea-water heavy spray during sea shipping. Rails shall not be shipped as deck cargo but must be shipped in

closed holds protecting the rails from seawater.

3. The Contractor shall take necessary approval/permission from concerned authority for transportation of rails in Mumbai by Road.

7.1.4 STORAGE YARD PREPARATION AND SAFE HANDLING

1. The Track work Contractor will be provided 5000 sqm space inside the depot partly for storage Contractor shall use and develop that space as Temporary work space and storage yard, this shall include stacking of all Rails as per RDSO specifications, with proper safety and security arrangement and prepare the level bed for the storage of track components.
2. The contractor shall be responsible for preparing the firm and level ground for stacking of Rails as approved by the engineer. The contractor shall also arrange the required wooden battens/spacers for keeping rails in layers as directed by the engineer. Before the stacking of the rails, Contractor shall submit method statement of handling and stacking of rails and receive approval of the same from Employer upto the satisfaction of the Engineer.
3. Handling and storage of materials shall comply with Manufacture's recommendations and best accepted International and Indian Standards.
4. The Trackwork Contractor is responsible for the proper handling, transportation, and storage of materials.
5. Rail stacking shall be in accordance with RDSO drawing No. RDSO/T- 6219
6. The rails shall be stacked on level and well drained base platform. For stacking on the level ground, unserviceable 90R or 52 kg rails shall be embedded in the concrete bed of M20 grade concrete keeping rail head embedded in concrete and rail flange projecting above concrete surface as shown in Drawing No. RDSO/T-6219.
7. Intermediate distance between them shall be 4.0 m. A slope of 1:400 may be given in the concrete bed across the length of rails for drainage of water as mentioned in the drawing.
8. Separation layer of suitable materials like MS flat, timber block of 100x25 mm size shall be used between two successive layers of rails and kept at a distance not more than 4.0 m centre to centre.
9. Number of layers in a stack shall not be more than 10. One rail panel shall be reduced after every third layer to achieve proper stacking of rails.

7.1.5 CONTROL OF MATCHING ASYMMETRIES OF RAILS BY BRANDING MARKS

1. For the purpose of facilitating alignment of rail ends for welding and maintaining control of track gauge during installation, the Contractor shall ensure that the asymmetry of rails within each steel rolling production batch is consistently oriented on the same side throughout all stages of handling, transportation, and storage.
2. This consistency of rail asymmetry can be achieved by keeping the branding marks of rails from the same batch on the same side.

7.1.6 PROTECTION OF STORED/STACKED RAILS

1. Rails stored for prolonged durations, particularly in environments prone to corrosion or exposure to rainfall, shall be suitably covered and protected to mitigate the risk of additional corrosion
2. Rails shall not be stacked directly in the ground but must be stacked to keep the whole length of the rail clear from any wet ground surface to avoid additional corrosion of the rail.

7.2 BALLAST

3. Ballast for ballasted tracks, (Plain line, Turnout and Level Crossing) shall be machine crushed, and shall be manufactured, tested, delivered, and installed in accordance with latest Indian Railway Standard IS/RDSO-GE/0001: 2023 "Specifications for Track Ballast".
4. Only new ballast shall be used for the ballasted tracks and turnouts. The installation of recycled ballast is not permitted.
5. Basic Quality: The ballast shall be hard durable and as far as possible angular along edges/corners, free from weathered portions of parent rock, organic impurities, and inorganic residues.
6. Particle Shape: Ballast shall be cubical in shape as far as possible individual pieces shall not be flaky and shall have generally flat faces with not more than two rounded /sub rounded faces.
7. Mode of Manufacture: The Ballast shall be machine crushed.
8. Physical Properties: Ballast sample shall satisfy the following physical properties when tested in accordance with IS: 2386 Pt IV-1963
9. Aggregate Abrasion Value: 30% Max.
10. Aggregate Impact Value: 20% Max.
11. Size and Gradation: Contractor shall ensure that Ballast is well graded between 65mm & 20mm size. The Contractor shall further ensure the following size & gradation of ballast:
12. Retained on 65mm Sq. mesh sieve 5% Maximum.
13. Retained on 40mm Sq. mesh sieve 40 - 60%
14. Retained on 20mm Sq. mesh sieve Not less than 98%
15. Before commencing the supply of ballast, the Contractor shall get the source / quarry approved by the Employer/Engineer duly submitting the samples and impact & abrasion test result values (to be conducted in a mutually agreed independent lab/institution of repute) along with the proposed gradation of the ballast to demonstrate compliance with specifications.
16. Once the source / quarry is approved by the Employer the Contractor shall ensure

that the supply is taken from the same source / quarry to ensure that the supply conforms to the same standards / specifications as initially approved by the Employer. Any change of source/quarry shall be subject to approval by the Employer following the same procedure as mentioned above.

17. The Contractor shall set up his own quality assurance procedures to ensure the compliance to the stipulated specifications.
 1. The sampling and testing of the supplied ballast shall conform to “Section 5 – Sampling and Testing” of IS/RDSO-GE/0001: 2023 “Specifications for Track Ballast”.
 2. Such of those tests for which Employer/Engineer has opined to witness, shall be carried out only in the presence of Employer. However, Employer may at his discretion conduct test checks to be organized by the Contractor for validation of test results. The cost of such tests shall be borne by the Contractor.

7.3 RAIL FASTENING SYSTEM

7.3.1 GENERAL

1. The Track work Contractor shall procure fastening system only from the reputed/established Manufacturer whose products specifications and manufacturing processes fully conform to the relevant Indian/International standards stipulated. The Contractor shall ensure that all Ballasted fastening materials, components, and associated track fittings are sourced from RDSO-approved vendors.
2. The Contractor shall procure fastening system from only those Manufactures who are approved by the Engineer/Engineers representative.
3. The contractor shall produce all evidence required to the satisfaction of Engineer for granting approval.
4. The proposed Ballastless fastening system shall have a proven track record of satisfactory performance record. In this regard, the certificate of performance from the user railway administration including proof of use of fastening system shall be submitted to the Engineer.
5. Single point responsibility: The fastening system as a whole shall have a single point complete system performance responsibility from the original fastening system supplier.
6. The fastening system shall be procured and stacked at least 3 months in advance before the commencement of track installation activities as per the construction programme, without any impact to the track installation activities.
7. The Contractor shall be responsible for the mechanized handling and transportation of all supplied materials from the manufacturing plant to the Site of Delivery, including all associated manpower, machinery, equipment, consumables, lead and lift. The Contractor's scope shall further include transit and storage insurance, port handling, customs clearance, and proper unloading, handling, and stacking of materials at the stores or at locations nominated and approved by the Engineer.
8. The Track work Contractor shall use the space provided in depot. If additional space is required, the Contractor shall make his own arrangements at his own cost.

9. The contractor shall make necessary protection like covered shed for the stacked materials including the fire and flood protection.
10. The Contractor shall be responsible for the safety and security of the materials purchased under this Contract.
11. The Contractor at his own cost shall make a proper safety and security arrangement for the protection of stacked materials. The contractor shall submit the detailed Plan and Procedure for the safety and security arrangement proposed to be followed by the Contractor for the stacked materials for the approval of Engineer.
12. The location and size of the storage area proposed by the Contractor shall be subjected to Engineer's approval. Before commencing operations, the Contractor shall submit detail drawings of the locations for the stockpiling of materials, together with the proposed method of operation, including stockpile heights, angles of repose, runoff, dust control measures, access road layout, drainage, and measures to be taken for restoration, all verified by appropriate calculations and analysis.
13. Rail Fastening System for Special Track in Depot shall be such that rail foot shall be 1 in 20 cant and in case of embedded tracks shall not cause thermal forces in turn out zone for stabling lines and other LWR/CWR through turnout for other lines. The breathing length will be at dead ends, therefore filled concrete shall be isolated with rails and fastening, by suitable arrangement for rail and for fitting so that concrete/filling material (GP2 or similar) shall not jam fittings and rails. There shall be free space min 300 mm at dead end of rail track for expansion.
14. The Contractor shall submit all necessary technical documents, which shall prove that the design, manufacture, and supply are complying with relevant International/Indian Standards.

7.3.2 RAIL FASTENING FOR BALLASTED TRACKS

1. The fastening system for ballasted tracks shall be suitable for all applications in ballasted tracks and under all alignment conditions.
2. It shall transfer all longitudinal and lateral loads resulting from the train operation and due to thermal effects from the rail into the sleeper without affecting the function of the fastening system.
3. All components of the fastening system shall be able to withstand the forces applied during the lining and tamping procedure.
4. All ballasted plain line tracks laid on PSC sleepers shall be equipped with the following fastening components:
 - i. ERC MK V clips as per RDSO drawing no. T-5919
 - ii. SGCI inserts as per RDSO drawing no. T-3781
 - iii. 6mm thick grooved rubber sole plate as per RDSO drawing no. T-3706
 - iv. GFN liners as per RDSO drawing no. T-3711
5. The ERC MK V, GFN liner, GR sole plate and SGCI inserts shall be manufactured in accordance with the relevant Technical Specifications of Indian Railway mentioned in [Section 6.3](#). Anti-corrosive treatment life to be ensured 5 years from date of supply of material. Fastening shall be tested for Salt Spray Test sustaining 1008 hours
6. The embedded items shall be incorporated into the sleeper during the manufacturing

process.

7. The Trackwork Contractor shall review the spacing between the sleepers in respect to the lateral resistance of the track and longitudinal resistance of the rail within the rail seat.
8. Where necessary to increase the lateral stability of the ballasted track on very sharp curves the spacing between the sleepers shall be reduced as per the detailed design of the contractor to minimize/eliminate the length of jointed track to the maximum extent possible.
9. Standard Joggled fish plate, plate Rail screw shall be as per RDSO specification and shall be procured from RDSO approved vendor.
10. Joggled fish plate shall be with double clamp and manufactured with RDSO approved vendor as per latest specification for UIC 60E1 Rail.

7.3.3 RAIL FASTENING SYSTEM FOR BALLASTLESS TRACKS

1. The fastening system for ballastless track is to be chosen by the Contractor for this Contract. The fastening system is to conform to "Performance criteria of fastening system for ballastless track on Metro Railways/MRTS System" as detailed in "Procedure for Safety Certification and Technical Clearance of Metro Systems issued by Ministry of Railways, Government of India in Dec- 2015" with any latest version/correction slips. The proposed fastening system shall preferably have the approval of the Ministry of Railways, Government of India. The bidder shall submit the copy of the approval of Ministry of Railways along with compliance on the observations, if any, appended by the Ministry of Railways while according its approval.
2. The Contractor shall submit the specifications, Drawings and Testing & Inspection Plan of the Fastening System proposed by the Contractor for the approval of Employer.
3. The proposed fastening system shall have a provision of vertical and lateral adjustment for the maintenance purpose.

7.4 PSC SLEEPERS FOR THE PLAIN TRACK AND TURNOUTS

A) GENERAL

1. Pre-stressed precast mono-block sleepers shall be used on plain line, turnouts, scissors crossovers, derailing switches, level crossings for ballasted depot line track.
2. The Contractor shall be responsible for the design and supply of mono block PSC sleepers for the standard gauge ballasted plain line tracks, turnouts, and crossovers with 1:20 rail inclination to be compatible with the fastening system supplied. The minimum length of the track sleeper shall be 2.50 m with a minimum thickness below rail seat of 200mm.
3. The Contractor shall be responsible for the design and supply of PSC bearers for the ballasted turnouts and crossovers (including scissors crossovers) compatible with the approved fastening details and arrangements of the turnout manufacture. Turnout bearers shall be arranged in a fan layout and to the greatest extent possible, the fastenings shall incorporate similar components to those provided for the plain line.
4. The sleepers shall be compatible to the fastening system adopted. All sleepers for plain line track, as well as switches and crossings shall be designed for a static axle load of 17 tons.

5. IRS T-39 and T45 shall be referred for manufacturing and supply of PSC sleepers. For the design of PSC Monoblock sleepers EN 13230 Part 6 shall be referred.
6. Grade of Concrete for the PSC shall be as per IRST T 39 and T45.
7. Prestressing strands shall be as per IS 6006-1983
8. The contractor shall submit his production method statement, inspection and test plan and Technical specification of all associated materials and components for the approval of Engineer.
9. The manufacturing firm of PSC sleeper shall have a RDSO approved QAP and shall obtain the requisite ISO certificate (ISO:9001-2008) Clearly showing the name of the certifying agency and date of validity of certificate. The Internal Quality Audit of plant shall be done by firm at frequency at least once a year.
10. Only those sleepers which have been passed, properly marked, and accepted by the Inspecting Officer shall be loaded for dispatch.
11. The sleepers design life shall be of 50 years and shall be guaranteed by the manufacturer for a period of five years from the date of manufacturing / 3 years from the date of placement in service (whichever is earlier). If during the guarantee period, sleepers in general are found to develop defects attributable to bad material and workmanship as established during investigation, leading to large scale withdrawal from service, the cost of sleepers and their replacement shall be borne by the Contractor. The defective sleepers withdrawn from service can be taken over at site by the Contractor for their disposal. The Contractor shall make good the cost due within 60 days of advice of defects.
12. The sleeper manufacturer will also be involved during inspection / investigation and his view will be considered by the Employer before taking decision. The decision of the Employer shall be final and binding in this regard.
13. Sleepers shall be stacked / stored duly separated by hardwood dunnage placed on each rail seat in such a manner as to avoid damage to the sleeper or its fittings.
14. The Contractor shall ensure his proposed handling and transportation methods do not cause any damage to the sleepers and /or its fittings. The damaged sleepers as decided by Employer may be appropriately repaired by the Contractor, but no repaired sleepers shall be incorporated in the works without the Employer's approval. Any repaired sleepers which are rejected by the Employer shall be indelibly marked as rejects and shall not be incorporated in the works but shall be removed from the site forthwith.

B) PSC SLEEPERS FOR PLAIN TRACK

1. The materials to produce PSC sleepers shall comply to the Clause 3 of IRS T-39
2. Manufacturing process shall comply to Clause 4 of IRS T-39
3. Inspection and testing of PSC sleepers shall comply to Clause 5 of IRS T-39
4. List of IRS & BIS codes referred to shall be as per Annexure VI of IRS T-39

C) PSC SLEEPERS FOR THE TURNOUTS AND CROSSOVERS

1. The materials to produce PSC sleepers shall comply to the Clause 3 of IRS T-45

2. Manufacturing process shall comply to Clause 4 of IRS T-45
3. Inspection and testing of PSC sleepers shall comply to Clause 5 of IRS T-45
4. List of IRS & BIS codes referred to shall be as per Annexure VI of IRS T-45

7.5 GLUED INSULATED RAIL JOINTS (If required)

1. Glued insulated rail joints shall be shop manufactured.
2. Minimum length of Glued insulated rail joints shall be 6.0m.
3. Glued insulated rail joints proposed by the Contractor shall comply to "Manual for Glued Insulated Rail Joints" issued by RDSO with latest correction slips.
4. Only G3(L) type of Glued insulated rail joints shall be used in Depot trackworks.
5. The Glued Insulated Rail Joints (GIRJ) shall be manufactured in accordance with the RDSO Drawing no. T - 5843 and relevant Technical Specifications/manuals of Indian Railways for the Supply of Glued Insulated Rail Joints.
6. All the components required for the manufacture of Insulated Rail Joints shall only be procured from RDSO approved vendors. The credentials of the proposed vendor shall be submitted to the Engineer for his approval.

7.6 SIGNAL AND TRACTION RETURN RAIL BONDS:

1. At locations shown on the Drawings, and/or specified, signalling and/or traction return rail bonds are to be attached to the rail through approved methodology without drilling holes, brazing or any other suitable technique by designated Contractors as approved by Engineer.

7.7 TURNOUTS, CROSSOVERS AND DIAMONDS

1. The Track work Contractor shall procure turnouts only from the reputed/established original Manufacturer whose products specifications and manufacturing processes fully conform to the relevant Indian/International standards stipulated.
2. The Track work Contractor shall propose the credentials of the turnout manufacturer from whom he intends to procure the material for the approval of the Engineer/Employer.
3. The rails for the turnouts and scissor crossover including the lead rails shall be procured only from the vendor who has the credentials of having supplied 60E1, 1080 HH rails with satisfactory performance of minimum 3 years in service in regular revenue operation on ballastless/ballasted track on any Metro or Railway for a length of at least 10 track km.
4. The Contractor shall procure turnouts only from those Manufactures who are approved by the Engineer/Engineers representative.
5. The contractor shall produce all evidence required to the satisfaction of Engineer for granting approval.
6. Single point responsibility: The turnout system as a whole shall have a single point complete system performance responsibility from the original manufacturer.
7. The turnout shall be procured and stacked at least 3 months in advance before the commencement of track installation activities as per the construction programme, without

any impact to the track installation activities.

8. The Contractor shall be responsible for mechanized handling, all modes of transportation of these supply materials from Manufacturing plant to site of delivery including all men, material, machinery, consumables, lead and lift necessary, transit, storage insurance, port and customs clearance and properly transporting at stacking at stores/nominated location approved by the Engineer.
9. However, any other requirement for Work Area Contractor is required to make his own arrangements. The Contractor shall negotiate with the landowners or other appropriate government agencies to seek temporary occupation of land for storage of various track materials and its transportation.
10. The contractor shall make necessary protection like covered shed for the stacked materials including the fire and flood protection.
11. The Contractor shall be responsible for the safety and security of the materials purchased under this Contract.
12. The Contractor at his own cost shall make a proper safety and security arrangement for the protection of stacked materials. The contractor shall submit the detailed Plan and Procedure for the safety and security arrangement proposed to be followed by the Contractor for the stacked materials for the approval of Engineer.
13. The location and size of the storage area proposed by the Contractor shall be subjected to Engineer's approval. Before commencing operations, the Contractor shall submit detail drawings of the locations for the stockpiling of materials, together with the proposed method of operation, including stockpile heights, angles of repose, runoff, dust control measures, access road layout, drainage, and measures to be taken for restoration, all verified by appropriate calculations and analysis.
14. The Contractor shall submit all necessary technical documents, which shall prove that the design, manufacture, and supply are complying with relevant International/Indian Standards
15. The Contractor shall be responsible for Site Specific Design, supply of Turnouts, crossovers, scissors crossover, trap switches for 60kg, 60E1 rail profile with 1 in 20 rail inclination suitable for ballasted track structure conforming to Indian Railways, Ministry of Railways, Procedure for Safety Certification and Technical Clearance of Metro System and other International and Indian codes and standards with all fittings and fastenings.
16. All turnouts, diamond crossings shall be compatible to be installed in PSC Sleepers or on cast in-situ trackform as appropriate according to the design.
17. The Contractor is required to maintain the housing of switches and shall be responsible to make provision for fixation of point driving machines, secondary drive arrangements, and any other arrangements required for the installation of S&T equipment, duly interfacing with the designated Signalling Contractor and subject to the prior approval of the Engineer.
18. Turnouts on depot lines shall be designed to accommodate the passage of Long Welded Rail (LWR) through the turnout.
19. All turnouts, diamond crossings and derailing switches on main lines shall be laid with canted rails with an inward slope of 1 in 20.

20. All exposed Rails, Switch, Stock and Fastening system shall be as per approved IRS Specifications and Annexure C1 & C2 CMRS Circular for Metro Safety specifications including anti- corrosive treatment for coastal exposure.
21. The design of the switch rail shall be with tangential entry. Switch Entry Angle in any case shall not exceed 0 20" 00". The CMS Crossings shall have welded leg extensions for maintenance purpose.
22. The turnouts shall have fan-shaped layout throughout the turnout so as to have same sleepers / base plates and slide chairs for both LH and RH turnouts.
23. All ballasted turnout layouts, and the scissors crossover shall be provided on PSC sleepers / Bearers.
24. Crossing protection check rails shall be of normal 33C1(UIC 33) profile mounted 25mm above the running rails on specially designed bearing plates / brackets without any direct connection with running rails.
25. The check rail supports shall provide for up to 10mm of shimming adjustment to the flange-way gap to allow for wear.
26. The entry to the check rails shall be shaped and flared by machining as required to provide for smooth running.
27. The overall length and position of the check rails shall be designed to give safe running and adequate protection to the noses of common crossings and the point rails of obtuse crossings in all circumstances.
28. The width of flange-ways for check rails and wing rails shall be as given in the SOD.
29. The stock rails of switch assemblies shall be manufactured from 60E1 profile, 1080HH Grade, Class A rails whilst the switch rails shall be manufactured from 1080HH Grade rail with a complementary asymmetrical low height thick web 60E1A1(ZU1-60)/60E1A4 profile.
30. The heel end of the switch rail shall be hot forged to the standard rail profile for connection to the intermediate rails of the turnout. Both ends of the stock rail and the heel end of the switch rail shall be undrilled to facilitate welding.
31. The switch / stock rail assembly shall be designed to accommodate the CWR forces in the adjacent rails and shall be designed with an anti-creep device at the heel of switch.
32. A special spring steel clip shall be provided to fit under the sliding baseplates to hold down the foot of the stock rail on its gauge side.
33. Sliding baseplates for switch rails shall be designed as low friction, lubrication free switch rail baseplates duly providing appropriate and service proven coating for this purpose.
34. All crossings and diamonds shall be supplied with Austenitic Cast Manganese Steel (CMS) monobloc crossings manufactured in accordance with UIC Code 866 and provided with leg extensions shall be undrilled to facilitate welding to the internal rails of the special trackwork and the rails of the adjoining plain tracks.
35. In the area between the throat and nose of the crossings, the shape of the castings shall be optimized for the new and worn wheel profiles of the rolling stock so as to give a smooth transfer of the wheel load from the wing rails to the nose.
36. According to the design and designation of the turnout, the crossings shall be straight or

curved, left or right.

37. All Turnouts assembly shall be inspected and tested in accordance with the approved Test Plan prior to shipment.
38. The Contractor shall provide all gauges and measuring equipment and labour necessary to completely check the preassembled turnouts, crossovers, diamond crossings and rail expansion joints. Contractor shall handover/provide all above sets of gauges and measuring equipment, clip extractor as a spare tools, which will be used for measurement during DLP and operation.
39. All switch and crossing components procured for spare maintenance purpose shall be of extended length. Further, at some locations if required, contractor should plan the extended switch and crossing to avoid rail closure and same shall be submitted for approval of Engineer before procurement.

7.8 BUFFER STOPS AND WHEEL STOPS

1. The Contractor shall be responsible for the design, supply, manufacture, transport, storage, and installation buffer stops; wheel stops required for this project under this Contract.
2. The buffer stops/wheel stops shall be procured only from the Original manufacturer, approved by the Engineer, who has proven record of having supplied buffer stops and wheel stops with satisfactory performance to any Metro or Railway. Buffer stops/wheel stops shall have been proven in service under similar or more severe performance criteria over a period not less than 5 years of operations.
3. The friction and friction buffer stop shoe layout is shown on the Drawings and is designed to provide constant energy absorption between the buffer stop and the rolling stock over the sliding length in order to minimize injury to passengers and limit the damage to rolling stock in the case of impact. The buffer stops shall also be fitted with an override device to prevent vehicles riding up over the buffer stop in the event of a collision.
4. All buffer stops shall be of insulated type to ensure electrical isolation from the rails, in compliance with the electrification and signaling requirements. All the buffer stops are of insulated type unless otherwise specified by the Engineer.
5. The Contractor shall seek Employer's Notice of No objection for buffer stop supplier approval, Material approval and the detailed technical specification of the proposed buffer stop/wheel stops.
6. The design service life, including reconditioning under maintenance period if any, of the buffer stop shall be minimum 20 years.
7. Full-service life to be attained under Atmospheric UV radiation, Proximity of track up to 10m from saltwater source and contact with oil, grease or distillate dropped from track vehicles.
8. Multi shoe Friction buffer with, sliding friction end stop i.e., mechanical impact absorption (non-hydraulic type) shall be used.
9. The simulation for the design of buffer stop must be carried out and the all the components including the buffer stops structural frame and friction elements are to be designed and supplied.

10. All buffer stops to be mounted on the rail of cross-section 60E1 with 1 :20 inclination or vertical.
11. Track structure varies but can include (i) ballasted (ii) ballastless (iii) rails in channels. As such other than necessary clearance each side of the rail for friction elements and clamps, the sliding buffer stop structure must not be below the top of the rail.
12. For running lines there shall be no Alumino-thermic weld within the rail length of the buffer stop or the rail sliding length behind the buffer. Any flash butt welds that fall within the friction buffer stop rail sliding length shall be ground by the Contractor to produce a smooth and uniform standard rail cross section to ensure the performance of the buffer stop is unaffected.
13. Rail protective coating in the friction shoe operating area shall be removed by the Contractor within the buffer stop length and for the full length of the sliding distance.
14. Buffer stops shall be assembled and installed with the sliding shoe bolts torqued strictly in accordance with the manufacturer's instructions.
15. Method of Corrosion protection for the Buffer stops, wheel stops, and its components shall be proposed by the Manufacturer for the approval of Employer considering the environmental conditions of Mumbai.
16. The proprietary manufacture shall provide installation instruction and maintenance manuals and or Manufacture's Specification to ensure that the buffer stops are installed so that they will operate as intended.
17. Track work Contractor has to carry out the necessary interface with the Rolling Stock Contractor.

7.9 LEVEL CROSSING /PATHWAYS

1. The Contractor shall provide the level crossings within the depot strictly in accordance with the approved drawings. The Contractor shall submit the requirements and design of RCC slabs/RCC blocks to be provided within and outside the track at level crossings for the approval of the Engineer. The Contractor shall also be responsible for providing these slabs/blocks within the track and up to a maximum distance of 5 m from the track centerline.
2. Wherever roads within the depot area cross ballasted tracks, the Contractor shall propose a suitable level crossing design for the Employer's approval, keeping in view the periodic maintenance requirements
3. The Level crossings shall be over the ballasted track as per the specification approved by the Employer based on the sensitivity of the operation requirement at the respective crossing locations.
4. Further, the contractor shall also ensure that sleepers for the level crossings are provided with necessary dowels for check rails and the design of Level crossing sleepers to be done including the loads from road traffic.
5. The Contractor shall be responsible for providing road level crossings and pathways within the depot at the access and approach portions of tracks leading to the workshop, inspection shed, plant, and equipment areas as embedded tracks. The design of such level

crossings shall be carried out by the Contractor and submitted for approval by the Employer/Engineer.

6. The Contractor may propose an alternative proven methodology for the Level Crossing, subject to approval by the Employer/Engineer and without any additional cost implication to the Employer.

7.10 RAIL WELDING

1. All rails shall be welded into a continuous long length by flash butt welding process. Exceptions to flash-butt welding of rails shall be at the following locations and it shall be done with Alumino thermit welding process

- i. within the switch and crossings,
- ii. destressing welds,
- iii. installation of shop manufactured Glued Insulated rail joints,
- iv. insitu welding of depot produced long welded rails,

as directed by Employer. Welding process shall be suitable for 60E1 rail section and rail grade of 880/R260 and 1080 HH. Weld plan shall be submitted by Trackwork contractor before installation

2. Alumino thermic welding shall conform to "Manual for Fusion Welding of Rails by The Alumino-Thermic Process (Revised-2022)" with latest amendments. Technical requirement for the Thermit welding portions, acceptance test for the joints welded at site, shall conform to IRS T-19 with latest amendment.
3. Thermit welding portions shall only be procured from RDSO approved sources and welds shall be carried out only by RDSO approved welders.
4. Flash butt welding shall conform to "Manual for Flash Butt Welding of Rails" with latest amendments.

7.11 BALLASTLESS TRACKS IN DEPOT

CONCRETE

1. Ballastless Tracks shall be with reinforced concrete cast in-situ track plinth resting on civil structure or embedded track or track on steel/RCC columns etc., according to the site-specific design.
2. Minimum grade of concrete shall be as per the Indian Standard IS-456 – 2000 for Prestress as per IS 1343 Construction of special type of track like Embedded track, Level crossing, level crossing track with concrete block (M45, minimum density 2.5 gm/cm³).
3. The concrete shall be in accordance with the provisions mentioned in Annexure "D" of Technical Specifications. If concreting is from existing Batching plant, the batching plant must be exclusively nominated for Mumbai Metro work and work to be carried out in the batching plant as per approved MMRDA quality procedure and mix design.

REINFORCEMENT

1. Reinforcement & shear connector between Civil work interface and concrete plinth shall be of IS1786 in accordance with relevant IS codes.

2. In addition to above, following to be followed:
 - a. To protect the reinforcement bar from corrosion for the track plinth and slab the concrete shall be mixed with “Bipolar Concrete Penetrating Corrosion inhibiting Admixture” (RDSO specification No: M&C/PCN/126-2008)
 - b. The corrosion inhibitor should have been tested at RDSO against the above specification.
 - c. The corrosion inhibitor shall have been tested for Indian Tropical Conditions and for capability with cements available in the Indian Market and shall have a history of minimum 5-7 years usage in the country.

ELECTRICAL INTERFACE:

1. The plinth electrical continuity shall be ensured by the contractor.
2. The Contractor shall supply and weld an earth terminal to the ballastless track reinforcement comprising of M.S. flat (40x6mm) with a 12mm diameter predrilled hole at the end projecting outside the concrete.
3. This M.S. flat shall be well embedded in concrete with 80mm projection outside the concrete. The terminal shall be installed at each plinth / RCC slab unit extremity.
4. The electrical continuity between the consecutive plinths shall be provided by connecting these terminals by means of cable/MS flat duly interfacing with the designated electrical contractor.

SIGNAL AND TRACTION RETURN RAIL BONDS

1. At locations specified during interface, signalling and/or traction return rail bonds are to be attached to the rail through CAD Welding, brazing, thermo welds or any other suitable technique by designated contractors as approved by Engineer.

7.12 MISCELLANEOUS MATERIALS

1. For any other miscellaneous materials, which are necessary for the installation of trackworks for which the specifications are not available in this document, the track work contractor may propose suitable specification for the approval of Engineer based on the standard industry practice.

8 MATERIAL AND WORKMANSHIP: SURVEY AND SETTING OUT

8.1 GENERAL

1. 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.

8.2 FUNCTIONAL RESPONSIBILITIES

2. The planning organization and process of surveys for transferring the alignment for track construction on finished at viaducts/tunnel/stations/earthwork/HBL shall be the sole responsibility of the Contractor. He shall at all times maintain common survey interface with the Civil Contractors.
3. Survey and setting out of works shall be carried out by surveyors of appropriate experience and qualification as approved by the engineer.
4. The Engineer may carry out random checks to verify the accuracy of the setting out and Contractor's 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.

8.3 SURVEY CONTROLS IN GENERAL

1. The contractor shall interface with designated civil contractors to take over the reference co-ordinates system (x, y, z) of the project area as defined by the Mumbai Metro Part of Line 5 project. The Secondary Survey Control Markers are additional points to be established by the contractor along alignment from the reference co- ordinate system including benchmark 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.

8.4 SECONDARY SURVEY CONTROLS

As each section of track becomes available the contractor shall submit a schedule of secondary Control Markers and Bench Markers for that area duly interfacing with designated contractor. The Survey Control Markers and Bench Markers 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. Post handover of site in case of any existing errors in the benchmarks or survey control markers/points or in the survey of the site, the Contractor shall amend such benchmarks values, control point values and/or in the case of faulty constructed positions of the civil works due to survey mismatch, Trackwork contractor must re-align the tracks in the existing already constructed civil structure according to functional requirement and with in the structural adequacies like eccentricity to the centerline of track alignment etc., as well as taking proper care of the stipulations by RDSO and the Schedule of Dimensions of the MMRDA and shall have to acquire approval from the Engineer.

All the Survey control markers and benchmarks provided within the project area by the

designated civil contractor shall be surveyed, with survey computations based on the adopted co-ordinates system. Any Change in values shall be supported by technical evidence and on consultation with all affected parties.

In particular, any changes in co-ordinate values of secondary survey markers shall only be adopted with the concurrence of the Engineer. The contractor shall be responsible to prepare modified drawings/proposals in this regard for information to all concerned parties and for approval of the engineer.

It shall be the Contractor's responsibility to protect and preserve the integrity of all the Control Markers. 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.

8.5 SETTING OUT

8.5.1 Setting out points shall be established by transfer from the survey control Markers. The Contractor shall establish physically on site such track siting 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 lines are destroyed or rendered unusable, the Contractor shall re-establish them at his own cost without delay.

8.5.2 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.

8.5.3 The track siting marks corresponding to both the theoretical centre 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 said markings shall be put in:

- | | | |
|---------|-----------------------|-------------|
| 8.5.3.1 | In straight sections: | every 25-m, |
| 8.5.3.2 | In curved sections: | every 10-m. |

8.5.4 The track siting marks for the centre of the track shall be shown by plates or nails sealed on viaducts/tunnel/stations/earthwork/HBL or as approved by Engineer. They shall be referenced by the Cartesian co-ordinates of each point identified in this manner and registered in the topographical logbook. Shall there be any discrepancy found by the contractor with reference to the geometry of civil structure, the same shall be 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 final decision.

8.5.5 The track siting marks for the vertical siting of the track running surface shall be shown by angle plates sealed on sidewalls. They shall be referenced with respect to the theoretical track level as approved by Engineer.

8.5.6 Given that the precision of the spatial siting of track laid directly on concrete is of the utmost importance, the Contractor shall position the above markings as follows.

8.5.6.1 Levelling

The markings show the track altitude and 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.

8.5.6.2 Layout

The markings show the centre line of each track and 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.

- 8.5.7 The inner rail for curve and any rail for straight shall first be set out in its absolute position from track siting marks using co-ordinates computed from the alignment geometry, the elevation of the rail shall be checked using a level, the other rail shall be set correctly relative to the first rail.

8.6 CONTROL OF TRACKWORKS

- 8.6.1 The Contractor shall ensure that critical dimensions for the Mumbai Metro Part of Line 5 project are met. Regular checking shall be carried out during the construction stages to ensure that the specified permissible deviations are not exceeded.
- 8.6.2 The Contractor shall ensure that all survey and track siting 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.
- 8.6.3 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 Acceptance at least one month prior to the commencement of track laying.
- 8.6.4 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 centre line position and the design alignment computed from latest accepted alignment geometry. Derived cant, gauge and twist values shall also be compared against design values on the same spreadsheet.
- 8.6.5 Any out of tolerance condition shall be flagged up on the spreadsheet.

8.7 SURVEY INSTRUMENTS

- 8.7.1 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.
- 8.7.2 It is essential that before starting any initial surveys, and at frequent intervals of not more than three months, all measuring equipment shall be tested for their accuracy.
- 8.7.3 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.
- 8.7.4 Notwithstanding the above, instruments shall again be checked to ensure good condition before the Contractor proceeds to carry out a critical survey task.
- 8.7.5 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 (2+2ppm xD) mm. Precise levelling runs shall be carried out in both directions using digital level

with an accuracy not inferior to 1.5mm 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 all such standards.

- 8.7.6 For track surveys Track master or its equivalent or any other method approved by the Engineer shall be used.

8.8 QUALITY PLAN

- 8.8.1 The Contractor shall submit to the Engineer, for acceptance a separate quality plan related specifically to survey matters. The plan shall address for following:

- 8.8.1.1 Identification of the Contractor's key survey staff and the lines of communication
 - 8.8.1.2 Scope of the surveying section including interface with designated contractors
 - 8.8.1.3 List of proposed surveying equipment & computer hard / software.
 - 8.8.1.4 List of surveying procedures.
 - 8.8.1.5 List of detailed method statements for all critical surveying activities.
 - 8.8.1.6 Survey test and inspection plan.
 - 8.8.1.7 Control of survey data and records.

9 MATERIAL AND WORKMANSHIP: INSTALLATION

9.1 INTRODUCTION

1. The proposed method statements, installation procedures and installation plans for the Works shall be submitted for the Approval of the Engineer in accordance with this Chapter. These submissions shall be summarized and detailed in the Contractor's Submission Schedule (CSS). The documents forming the submissions shall use a standard format which shall be submitted by the Contractor for the approval of the Engineer.
2. Notwithstanding the nominal track to supporting structure dimensions indicated on the Drawings, the as constructed dimensions may vary subject to the allowable tolerances. In addition, the supporting structure may contain ramps, steps, channels, drains, anchor bolts, manholes, upstands, and the like. The methods of construction shall accommodate these constraints.
3. All temporary/service tracks, if required for track work on main lines, shall be arranged & laid by the contractor with prior approval of the Engineer. The contractor shall remove these temporary/service track after completing the track work as approved by Engineer.

9.2 METHODS OF WORKING

1. Method statements detailing the proposed methods of working and incorporating all temporary works required shall be submitted to Engineer for his approval. No Permanent Work shall commence until the method statements are approved by the Engineer.
2. Method statements for track laying shall, as a minimum, cover the following items, wherever applicable:
 - i. handling & transport (including for materials to be supplied by Employer)
 - ii. stacking/storage/accountal/reconciliation of materials
 - iii. pre-assembly/assembly
 - iv. delivery
 - v. surveying
 - vi. setting out
 - vii. welding
 - viii. track installation
 - ix. concreting/packing
 - x. as-constructed records
 - xi. cleaning
 - xii. de-stressing
 - xiii. Cutting of rails, which may render generation of unusable small cut pieces.
3. Method statements shall, as a minimum, incorporate hold points, tolerances, finishes required, temporary works, false works, formworks, test, and inspection plans and shall include safety and quality control requirements for each activity.
4. Method statements are also required as a minimum for the following production or installation activities:

- i. Each trackforms
 - ii. Turnouts, crossovers, and derailing switches if any
 - iii. Rail welding
 - iv. Buffer Stops
 - v. Surveying
 - vi. Tests on Completion
5. Method Statements shall be prepared and submitted in a standard format as described in these specifications 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. Proforma / check sheets
 - viii. Falseworks / Formwork
 - ix. Temporary Works
 - x. Reference Drawings
 - xi. Reference Documents / Clauses
6. Method Statements shall be itemized and have Document / Clause reference column as the right-hand side margin. Each method statement shall be referenced to the relevant clauses of the documents forming the Contract.
7. 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.

9.3 TRACK INSTALLATION – GENERAL

9.3.1 GENERAL

1. The track gauge throughout shall be 1435 mm standard gauge or as per SOD measured between the running edge gauge point of each rail and normal to the centre line of the track 14 mm below top of Rail.
2. Appropriate gauge widening shall be proposed by the Trackwork contractor for the approval of Engineer.
3. All mainline tracks including turnouts, crossovers and diamond crossings shall be laid with canted rails of 1 in 20 inward rail slopes.
4. The Contractor shall take due cognizance of his proposed rail jointing system and the rail fastening assembly spacing in the selection of the appropriate length of long welded rail panels.
5. The minimum closure rail length in plain line shall be 6 meters except for specific locations as shown on the Drawings or as approved by the Engineer.

9.3.2 RAIL JOINTING

1. All rail joints, including turnouts, except at locations approved by the engineer, shall be welded.
2. Rails shall be welded into the longest strings that can be readily handled according to the

Contractor's method statement for track laying, generally 200 metres or more long.

3. CWR strings shall not be less than 120 metres except where bonded joints are less than 120 metres apart where the rail shall be welded into lengths which require the minimum site welds.
4. The welding of nominal rail lengths into long welded rail panels shall be by flash butt welding. Alumino-thermic welding shall only be used in exceptional circumstances with prior approval of the Engineer. Temporary joints between rails shall be by 1m long fish plates & clamps without drilling of holes in rails.
5. All the welded joint for welding less than 18m rail length shall have prior approval of Engineer. The Contractor shall prepare and submit the weld plan for the approval of Engineer.

9.3.3 LOCATIONS OF WELDS

1. 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.

9.3.4 LONG WELDED RAILS

1. Long welded rail panels (LWR) shall generally be a minimum of about 120m. Shorter panels shall only be permitted when dictated by site conditions/site constraints and as Approved by the Engineer.

9.3.5 RAIL TEMPERATURE

1. Rail temperatures shall be measured using appropriate dial type magnetic rail thermometers placed on the web of the rail on the shaded side. A minimum no. of thermometers required to be used per rail for measuring average rail temperature of a segment of track shall have the prior approval of Engineer. A rail embedded thermometer may be kept at an approved location to calibrate the dial type thermometer and monitor the accuracy of the temperature measurements. Contractor shall submit proposal to Engineer and get approval upto Engineer's satisfaction.

9.3.6 CUTTING OF RAILS

1. Rails shall only be cut by using rail cutting machines. The proposed method and equipment for the cutting of rails shall have the prior approval of the Engineer.
2. Rails required to be cut shall be cold sawn square and vertical across the rail. A deviation from square or vertical of more than 0.50 mm, measured about the rail head, shall not be permitted. All burrs shall be removed from the rail ends.
3. Quality of cutting shall be such as to ensure tolerances in flash butt and Alumino-thermic welding manual.

9.3.7 CAD WELDING ON RAILS:

1. The Rails shall not be drilled for Power supply or S&T cable connections. Instead, the Power supply and/or S&T contractors shall provide CAD Welding in the web of the Rails with the prior approval from Track contractor and the Engineer.

2. In case of unavoidable circumstances, with the approval of Engineer, holes in rails shall be drilled using proper jigs and drilling machines. The proposed method and equipment for the drilling of rails shall have the prior approval of Engineer.
3. All holes in the rails shall be chamfered using chamfering kit & procedure approved by the Engineer.
4. The Power supply and/or the S&T Contractor shall finish the CAD welding activity as per the satisfaction of Track contractor and the Engineer.

9.3.8 FISH PLATED RAIL JOINTS (if required)

1. Standard fish plated joints wherever required temporarily in plain track shall be square.
2. Standard fishplates joints shall be installed centrally between two adjacent fastenings and shall be manufactured and installed to permit the use of standard rail fastening assemblies.
3. All fish plated joints shall be fitted with the nuts on the inside of the track.

9.3.9 GLUED INSULATED RAIL JOINTS (if required)

1. The minimum length of Glued insulated rail joints shall be 6 m, 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.
2. GIRJ's must not be located at moving bridge or viaduct joints and shall be preferably located so that there are two fastening seating between the insulated joints of GIRJ and the structure joint.
3. The actual insulation point between rail ends must not be placed over rail fastening seating and the insulated joints shall be cleared enough from the fastening so that it will not enter seating under thermal longitudinal movements of the deck and fastening.

9.3.10 DESTRESSING OF CWR

1. Destressing of CWR shall be carried out as per the procedures laid down in Indian Railway Permanent way Manual.
2. 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.
3. The final welding of joints within turnouts shall be undertaken as per sequence as approved by Engineer and within the stress-free temperature range.
4. 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 baseplates.
5. 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.

9.3.11 FINAL CONDITION OF TRACK

1. Throughout construction generally and immediately after installation of the track, the rails, rail fastenings, the concrete track base, including 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 and depending on whether the viaduct drainage system is ready for use.
2. Once a section has been cleaned, tested and the insulation values accepted by the Engineer, the accepted level of cleanliness shall be maintained until the taking over of the section.

9.4 TRACK INSTALLATION – BALLASTED TRACK

9.4.1 GENERAL

1. The Contractor shall submit the Method statement before executing the work. The Contractor shall provide all necessary mechanical equipment, machinery for the laying of trackworks.

9.4.2 SETTING OUT

1. The track Contractor shall take over the formation for laying of the track from the civil Contractor after jointly checking & confirming finished formation levels.
2. The Contractor shall carryout all necessary work and alignment computations to enable the detailed setting out of the track.
3. On taking over of the formation, the track Contractor shall survey the entire Depot, or part of the depot where the track work is to be taken up, with respect to agreed Depot layout, prepare, and submit the sleeper layout drawing for No Objection of the Employer's Representative based on which the sleepers shall be laid.
4. A "Request for Inspection" (RFI), complete with all necessary information to allow assessment, shall be submitted to the Employer's Representative for the following activities and prior No Objection must be obtained before commencing the same:
 - i. Acceptance of supporting structure,
 - ii. Acceptance of bottom ballast
 - iii. Acceptance of the track and turnouts for the movement of plant, machinery & equipment
 - iv. Acceptance of track / turnout for in situ welding
 - v. Acceptance of track for de-stressing

9.4.3 BOTTOM BALLAST

1. The Contractor shall check the formation level with reference to required level and check the required level of density of formation to achieve proper ballast cushion at rail seat below bottom of sleeper. Any discrepancy in level of formation shall be brought to the notice of the Employer's Representative with details for final decision.
2. Bottom ballast shall be laid directly onto the prepared support structure using methods that keep the amount of road traffic over the support structure to a minimum compacted thickness of 150 mm.

3. On completion of the bottom ballast a survey shall be undertaken to demonstrate the acceptability of the bottom ballast for track laying.
4. The bottom ballast survey shall be undertaken on a longitudinal grid of 20 meters along the line of the ends of the sleepers and at the extremities of the specified profile.
5. On completion and acceptance of the bottom ballast for track laying, no vehicle of any type shall be permitted to run over the bottom ballast.

9.4.4 SLEEPER

1. The sleepers shall be placed at right angles to the track centre line properly aligned and with the correct spacings. The sleepers shall have the markings showing to the same side.
2. Sleepers shall be handled in such a way as to avoid damage and shall not be subject to blows or strokes with hammers or other unsuitable tools. All damaged sleepers will be rejected and shall be removed from the track and replaced at the Contractor's expense.
3. Before fixing of the rails, the position of the sleepers shall be adjusted with the aid of templates giving the correct spacing within given tolerances.

9.4.5 RAILS

1. Trackwork Contractor shall transport, unload, and lay the rails/rail panels in a manner that will prevent damage to the rail ends.
2. Prepare and submit the rail laying records.
3. Rails shall be placed with the rolling marks on the same side.
4. Prior to being laid all rails shall be straight and rails that have been bent or deformed in any way shall be returned to the rail yard for straightening.

9.4.6 LAYING WELDED RAILS

1. All welded rails shall be numbered with the number painted on the web of the rail at both ends.
2. As soon as the rails are placed and fastened to the sleepers, rail temperature shall be recorded by approved rail thermometer and the second ballast shall be placed and tamped.
3. Rails laid on curved track shall be properly pre-curved wherever required.
4. At all joints except with insulated fishplate, rail bonds shall be installed in the approved manner.
5. All parts of insulated joints shall conform to the required dimension as shown on Signalling Drawings or as instructed by the Engineer and shall be free from defects that may cause malfunctioning of the insulated joints.
6. On curves, cant shall be given to the outer rail in accordance with the drawings. The cant shall be decreased linearly over the length of transition curve.

9.4.7 LIFTING, TAMPING AND COMPACTING

1. The tracks shall be lifted and tamped in several lifts as specified or as agreed with the Employer.

2. At each lift the ballast shall be tamped, lined, and levelled with an off-track tamping machine with lifting, lining and compacting equipment, or by suitable manual methods as reviewed by the Engineer Without Objection.
3. When all ballast has been distributed, the track shall be accurately aligned, lifted to final level and cant, and tamped. The ballast shall be profiled in accordance with the relevant cross-section drawings.
4. Prior to performing the final ballast lift, the cribs (space between two adjacent sleepers) and sleeper ends shall be compacted.
5. After final lifting, lining, and tamping the final ballast compaction shall be performed.
6. All cribs and sleeper ends shall be compacted.
7. After compaction, ballast shall be finally regulated.

9.5 TRACK INSTALLATION – BALLASTLESS TRACKS AND SPECIAL TRACKS

9.5.1 GENERAL

1. Special tracks include Embedded Track, Pit track, Track on Steel/ RCC Columns and Level crossings.
2. A “Request for Inspection” shall be submitted to the Engineer, complete with all necessary information to allow assessment, after the following activities and Approval must be received prior to the commencement of any follow-on activity:
 - i. Acceptance of specified surface treatment, if any, of support structure by using approved machinery and for approved depth,
 - ii. Acceptance of shear connectors before the construction of plinth/slab
 - iii. Acceptance of the plinth reinforcement,
 - iv. Acceptance of the track for jigs, fixtures, supporting arrangement & concreting,
 - v. Acceptance of the track for the movement of construction plant, equipment, and machinery,
 - vi. Acceptance of the track for in-situ welding,
 - vii. Acceptance of the track for de-stressing.

9.5.2 EMBEDDED RAIL & PIT TRACKS

1. The embedded track shall have its rail and fastenings embedded in the concrete as designed by the track Contractor up to top of rail level in the non-gauge side and leaving clear flange way clearance in the gauge face side.
2. An opening according to the design and interface requirement all along the alignment of the embedded track separately for Left and Right rail will be provided by the civil Contractor for laying of the embedded track by the track Contractor.
3. Track Contractor shall design and install the reinforcement, concrete along with required fastenings & their spacing for the embedded track and obtain No Objection of the Employer’s Representative.
4. Track Contractor shall also design the method of providing the flange way clearance using appropriate size MS Galvanized angle and obtain Employer’s Representative’s No Objection and install it accordingly.
5. The fixation of track special jigs and fixtures, fastenings, reinforcement & concreting of the

embedded track shall be done with proper co-ordination with the Civil Contractor.

6. The Contractor may propose an alternative proven methodology for the embedded track, subject to approval by the Employer/Engineer and without any additional cost implication to the Employer.

9.5.3 TRACK ON RCC PEDESTAL/ STEEL COLUMN

1. The Steel/Concrete Pedestal supporting structure in the Inspection lines shall be designed, supplied, and installed by Civil Contractor.
2. Track contractor shall Interface with the Depot civil contractor and develop the methodology for fixing the Steel/concrete Pedestal into the supporting structure and submit it for the approval of Engineer.
3. Fixing and Grouting of Steel Column, pedestal shall not be taken up until the final alignment has been agreed by the Employer.
4. Predrilling/post drilling on the steel columns with contractors own drilling machine to the correct alignment and fixing the rails and fastening system.
5. Supply and install the rail fastening system along with the running rails.
6. In case of Heavy cleaning line, where the track is to be installed over the RCC column, the Trackwork Contractor shall install the trackwork within the space provided by the Civil contractor in the RCC column duly interfacing with the Depot Civil contractor.

9.5.4 TRACK ON LEVEL CROSSING

1. The Level crossings shall be with ballasted track as per the specification approved by the Employer based on the sensitivity of the operation requirement at the respective crossing locations.
2. Paver block to be as per IS specifications 15658 for roads thickness based on Heavy traffic
3. The contractor shall be responsible to provide the level crossings in depot as per approved drawings. The contractor shall submit the requirement and design of RCC slabs / RCC blocks, to be provided within the track and outside the track at level crossing for the approval of the Engineer. The contractor shall also be responsible to provide these slabs/blocks at level crossing within the track and up to a maximum distance of 5 m from the centre line of the track
4. Based on the type of material selected, the Contractor shall propose a method statement for the installation of Level crossing.

9.5.5 DRAINAGE

1. While designing the track form, due care shall be taken by the Trackwork contractor for the drainage.
2. The trackwork contractor shall interface with the designed civil contractor for the track drainage arrangement to be installed.
3. Particular attention shall be given by the Trackwork contractor for the track drainage near level crossings, turnouts, loading and unloading area etc.,

9.6 TRACK INSTALLATION – TURNOUTS & SCISSOR CROSSOVERS

1. Turnouts on ballast-less track shall be so set out that the line and level of both straight and turnout track are within designed tolerances as approved by Engineer.
2. The work shall include assembling, carrying, and setting at required position, supplying and tamping ballast to the height and lines specified and confirming the switching function. The work shall also include connecting with adjacent tracks at three end points by providing all necessary rail accessories.
3. . Special teams guided by skilled craftsmen shall execute all works in connection with the turnouts. The teams shall be equipped with all necessary tools, track gauges and measuring instruments etc.,
4. The Contractor shall inspect turnouts prior to installation to verify that materials are in conformity with this Specification. The Contractor shall check and correct all defects before proceeding with installation of turnout.
5. Necessary interface shall be in place with respective civil and system contractors by the Trackwork contractor for the design and installation of turnouts and crossovers.
6. In addition to the “Track installation – Ballasted track” as stated in [Section 9.4](#), the following items are to be taken into consideration.
 - i. All sleepers shall be arranged accurately as shown on the Drawings. The rail joint gaps shall be in accordance with the drawings.
 - ii. Turnouts on ballasted track shall be so set out that the line and level of both straight and turnout track are within designed tolerances as approved by Engineer.
 - iii. Check rails shall be set and checked to the correct clearance by using the running edge of the crossing as the datum.
 - iv. The assembly sequence of turnouts and diamond crossings shall be submitted for Engineer’s Approval as part of the overall method statement for pre-assembly, handling, storage, transportation, unloading and installation.
 - v. 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 and as approved by the Engineer. The clamp shall be capable of being padlocked with the switch in the closed position.
 - vi. No on-track Constructional Plant, equipment and machinery shall be allowed to operate over a turnout until it has been inspected and approved by the Engineer.
 - vii. The Contractor shall interface with the designated Signaling Contractor and ensure the designed switch opening is maintained during fixation of the first stretcher bar.
 - viii. All stretcher bars for switches except first stretcher bar shall be installed by the Contractor duly interfacing with designated signalling contractor and approved by the Engineer.

- ix. Switches shall be installed to 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 second drive (if required) and shall co-ordinate and interface with designated signalling contractor to ensure full compatibility with regards to installation requirements and point operating mechanism. The contractor shall also be responsible for fixation of second drive on tongue rails. The opening of switch at toe of switch shall be kept as 160mm.
- x. The contractor shall provide all gauges and measuring equipment and labor necessary to completely check the pre-assembled turnout's crossovers and diamond crossings.

9.7 BUFFER STOPS/WHEEL STOP

1. The proprietary manufacture shall provide installation instruction and maintenance manuals and or Manufacture's Specification to ensure that the buffer stops/Wheel Stop are installed so that they will operate as intended.
2. The installation details for friction buffers stops/Wheel Stop shall be submitted by contractor as per manufacturer's guideline for Engineer's approval.
3. Friction buffer stops/Wheel stop shall not be installed until the track is at the design line and level, as approved. The following requirements shall be complied with:
4. There shall be no thermic weld within the rail length of the buffer stop or the rail sliding length of the buffer. Any weld that falls 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.
5. Friction buffer stops shall be assembled and installed with the sliding shoe bolts torqued strictly in accordance with the manufacturer's instructions.
6. Durable paint markings shall be made on the rails to show the various design positions of the buffer stop frame and of each set of friction elements.

9.8 RAIL WELDING

9.8.1 GENERAL

1. All depot lines shall be welded into a LWR by flash butt welding process except at location as approved by the Engineer. Alumino- thermic welding shall only be permitted in exceptional circumstances when dictated by site conditions/ constraints and as approved by the Engineer.
2. The welding process shall be suitable for UIC60 rail sections of rail grades IRS-T-12-2009 with latest correction slip.
3. Weld records of all welds shall be submitted at intervals not exceeding 1 km of rail welded into long lengths. The proforma for the weld records plan shall be submitted by contractor for Engineer's approval. This record shall contain, as a minimum, the following information:
 - i. Weld chainage to the nearest metre,
 - ii. Weld number,

- iii. The rail grade and section,
 - iv. Date welded,
 - v. Weld test record sheet reference (if different to the weld number),
 - vi. USFD test results and
 - vii. Dimensional check results.
4. 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.
5. The welds shall be finished to final profile by controlled profile grinding as approved by Engineer. The finished weld alignment shall be as per specified tolerances. Railhead profile grinding to produce the finished alignment shall not extend more than 300mm either side of the weld.
6. All welds shall be marked as per the provisions of the relevant welding manuals.
7. All welds shall be ultrasonically tested for acceptance.

9.8.2 FLASH BUTT WELDING

1. General

The Flash Butt Welding of rail joints shall be undertaken in accordance with the relevant Indian Railway Manual for Flash Butt Welding of rail and as supplemented in this section.

For 880/R260/1080HH grade 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 welding.

2. Welder Qualification

All flash-butt welding machine operators shall have the competency certificate issued by the Original Equipment Manufacturer of FBW Plant and also as per RDSO Manual for flash butt welding with latest correction slips.

3. Flash butt welding quality control

- i. 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 probably the Employer's Representative.
- ii. The test scheme and arrangements shall be covered by prior notice of no objection of the Employer's Representative.
- iii. 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 Employer's Representative. The necessary tests, as instructed by the Employer's Representative, 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 Employer's Representative that all similarly affected welds have been removed from the track.
- iv. 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.

- v. 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. Flash-Butt welding Plant

- i. The flash-butt welding machine shall be mobile type (road cum rail) capable of welding even in situ welds.
- ii. 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.
- iii. 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 IRS-T-12-2009, 880/R260/1080HH grade.
- iv. 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.
- v. The records for all the flash butt welds shall be made available to the Employer's Representative on a daily basis.

9.8.3 ALUMINO-THERMIC WELDS

1. General

An Approved Alumino-thermic short preheat 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 a process and portions supply for thermit welding of rails and relevant technical specification for performance and acceptance of thermit welding of rails of Indian Railway.

2. Qualification of welders for Alumino-thermit welds

All Alumino-Thermic welders shall have competency certificate issued as per RDSO Manual for fusion welding of Rails with latest correction slips.

3. Test Welds and Final Profile of Welds

- i. 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.
- ii. 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 300mm either side of the weld.
- iii. All welds shall be marked and painted as per the provisions of the relevant welding manuals.

4. Weld records

- i. 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 Employer's Representative's notice and issue of no objection. This record shall contain, as a minimum, the following information:

1. Weld chainage to the nearest metre,
2. Weld number,
3. Rail grade and section,
4. Date welded,
5. Weld test record sheet reference (if different to the weld number),
6. USFD test results
7. Dimensional check results
8. Rail weld paint
9. Name (code) of welder

9.9 PERMANENT MARKERS

1. As the track is completed permanent markers shall be designed and installed by the Trackwork contractor. The permanent markers shall include the following;
 - i. Kilometer markers,
 - ii. Hectometer markers.
 - iii. Change of gradient markers,
 - iv. Curve Reference markers for Both Horizontal and Vertical curves., which includes station marking of curves on the web of the Rails.
 - v. LWR/CWR reference markers
 - vi. Fouling point markers,
 - vii. Turnout markers which include station markings of Curves Rail for Versine readings and Offset markings as per RDSO Standard.
2. All permanent marker plates/boards shall be of high intensity retro-reflective micro prismatic and conforming to ASTM-4956. Size of permanent marker boards, colour scheme and fixation arrangement proposed to be used shall have prior approval of Engineer.
3. All information to be marked on the markers shall be submitted by the contractor for Engineer's approval.
4. All markers required to be painted on rail for curves and turnouts etc. shall be paint marked by the contractor. The scheme for which shall be submitted by the contractor for Engineer's approval.

9.10 TRACK TOLERANCES

1.1.2 GENERAL

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 approved by the Engineer and submitted both in hard and electronic copy.
2. The variations in horizontal alignment, vertical alignment versine, cross level/cant, twist and gauge shall not exhibit cyclic patterns.
3. All the track parameter measurements shall be taken in the unloaded condition of the track. The base of measurement shall be as below:
 - a) Each sleeper or base plate for the gauge,

- b) 3 metres for the cant, cross-level, and twist,
 - c) 20 metres (half overlapping) for lining and
 - d) 10 metres (half overlapping) for vertical profile.
4. The contractor shall be solely responsible for achieving track tolerances stipulated below with the materials supplied by the contractor and the Employer as per contract.
5. Track tolerances shall comply with the following limits:

S. No	Parameters	Ballastless	Ballasted
1	Gauge	+2, -1 mm	+5, -2 mm
2	Gauge Variation	Base plate to Base plate 1 mm	Sleeper to sleeper variation 2 mm
3	Rail Inclination	1:20 \pm 10%	1:20 \pm 10%
4	Cross level on straight track	\pm 1.5 mm	\pm 3 mm (to be recorded on every 4 th sleeper)
5	Cant on Curved track	\pm 1.5 mm	\pm 3 mm
6	Total Deviation from horizontal alignment on	a) \pm 2mm over 20m (half overlapping chord)	a) \pm 2mm over 10m (half overlapping chord)
	Straight Track	b) \pm 2mm over 20m (half overlapping chord)	b) 5mm variation over theoretical versine on 20m half overlapping chord on curves of radius more than 600m and 10mm variation over theoretical versine on 20m half overlapping chord on curves radius less than 600m
	Curved Track		
7	Vertical alignment over 10 metres chord (half overlapping)	\pm 2 mm	\pm 2 mm
8	Longitudinal level with respect to agreed longitudinal section	\pm 4 mm	Variation upto 8 mm
9	Spacing of Baseplate/ Sleepers	i. \pm 10 mm with respect to theoretical spacing.	ii. \pm 20 mm with respect to theoretical spacing.
10	Welding Tolerances	iii. As per Indian Railway Manuals (with latest amendments) for FBW and AT Welds	
11	Ultrasonic Inspection	iv. As per Indian Railway Manual for USFD with latest correction slips	

12	Twist on 3.6m base	1:500	1:300
13	Tightening of fastening components	v. For bolted fastening system $\pm 5\%$ of designed torque	

9.11 METHODS OF MEASURING AND RECORDING

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 (RH Rail)
 - vi. Vertical unevenness (LH Rail)
2. The proforma for the measurement of track parameter submitted by contractor for Engineer's approval shall consist of the following as a minimum:
 - i. A common base point for recording of location.
 - ii. Cross level / cant
 - iii. Gauge
 - iv. Horizontal alignment(versine)
 - v. Vertical unevenness both for right & left rail.
3. The proforma shall show the design figure, actual figure, and the difference between design and actual and shall allow columns for marking of twist.
4. The horizontal versine shall be measured every 10 m (half chord point) using a 20m 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 rail of straight tracks at points 14mm below top of rails. Where a recording changes its measuring rail there shall be a minimum overlap of readings of 60meters.
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 as directed by the Engineer. Horizontal location readings shall be presented as co- ordinates. Deviation from designed co-ordinates shall also be shown.
6. The vertical and horizontal rail location readings shall be taken at coincidental kilometrages.
7. The recordings of rail level and horizontal location shall be taken at the intervals as proposed by the Contractor and Approved by the Engineer.
8. Longitudinal locations shall additionally include, but not be limited to, switch and crossings locations.
9. Rail inclination shall be measured using a custom-made digital rail inclinometer and the recordings shall be submitted by contractor for the Engineer's approval.

9.12 RECORDS

1. The manual records of rail level, cross-level/cant, gauge, twist, versine along longitudinal location and horizontal alignment with reference to the designed locations shall be presented both electronically and in hardcopy.

10 MATERIAL AND WORKMANSHIP: TESTING AND INSPECTION

10.1 GENERAL

10.1.1 LABORATORY TESTING

1. All materials, components and assemblies shall, unless otherwise noted, be inspected & tested by an Approved independent inspecting agency as approved by Engineer on case-to-case basis to demonstrate that they satisfy the Employer'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 Engineer's Approval.
2. The Employer and/or Engineer will select a few samples of fastening system for ballast-less track and the contractor will get these tested in an independent laboratory / Institution for ascertaining its compliance with the performance criteria issued by Ministry of Railways attached in these documents at Annexure C-2 in presence of employer/authorized representative. Cost of such test shall be borne by contractor. Test of individual components of ballast-less track fittings shall be carried out in presence of employer / authorized representative to ascertain compliance of these as per test plan. Cost of these tests shall also be borne by Contractor.

10.1.2 QUALITY ASSURANCE

1. All materials, components or assemblies shall be tested and inspected at the frequency stated within the present Specification.
2. A comprehensive schedule of all material inspection/tests at the required/specified frequency of testing shall be submitted by the Contractor for engineer's approval.
3. A sample Proforma, with typical examples, for the material inspections/tests shall be submitted by the Contractor for Engineer's approval.
4. On receiving Approval of the material inspection/test schedule, the Contractor shall follow the schedule to prepare the required individual test and inspection plans and submit for Engineer's approval.
5. 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 submitted as directed by Engineer for his approval. However, Engineer may at his discretion conduct test checks to be organized by contractor for validation of test/inspection results. The expense of such tests shall be borne by the Contractor.
6. Suitable Proforma for the recording and witnessing of all tests and inspections shall be submitted for Engineer's Approval. Confirmation of date of a test or inspection shall be presented on an Approved Proforma, not less than 21 Days prior to the date for test /inspection.
7. No material, component or assembly shall be shipped until the clearance for this has been obtained from the Engineer.
8. Shall 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.

9. Periodically, during the Contract the Engineer may conduct inspections of manufacturing 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 be for the purpose of monitoring progress. During each inspection, suitably qualified staff shall be provided by the Contractor.
10. Engineer and Employer reserves right to witness any test, quality procedure etc.

10.2.1 ACCEPTANCE TESTS FOR THE MATERIALS

1. All material and components supplied by the contractor shall be inspected and tested in accordance with the relevant technical specification of Indian Railways as mentioned in **Section 6.3** and respective specifications of the material detailed in **Section 7** of this Document.
2. The Contractor shall submit the Inspection and Test plan (ITP) for the approval of Employer. Based on the accepted ITP, Employer and or Employers Representative shall witness the acceptance test during the Factory Acceptance Test (FAT).
3. The tests and inspection have been divided into categories as defined in the following Clauses. The tests listed are not comprehensive and the Contractors shall include all other Inspection and Tests which shall prove that the materials supplied by the Contractor and the trackworks installed are fit for the purpose and duly complying to the acceptable Indian/International standards.

10.2.2 ASSEMBLY VERIFICATION TESTS FOR THE FASTENING

1. The assembly verification tests for the rail fastening assembly are according to EN 13481 and EN 13146

10.2.3 TESTS FOR PRECAST CONCRETE SLEEPERS

1. The inspection and test for the Precast concrete sleepers for the plain track and turnouts are according to IRS T-39 and IRS T-45

10.2.4 RAILS

1. The rails are subjected to inspection and acceptance according to IRS T-12

10.2.5 WELDING

1. All Welds (Flash butt and Alumino-thermic) shall be tested ultrasonically as per relevant Manual for Ultrasonic testing of rails and welds. A third party RDSO certified agency shall be engaged with prior approval of the Engineer for testing of AT welds.
2. All the defective welds whether identified as a result of USFD testing or otherwise shall be removed from the track and rewelded by the contractor. The cost of all the rewelding 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.

10.2.6 WELDING MATERIALS

1. Welding materials for Alumino-Thermic welding shall be tested in accordance with the relevant technical specification for approval of a process and portion supply for thermit welding of rails of RDSO.

10.2.7 FLASH-BUTT WELD TESTS

1. Tests for Flash-Butt Welding shall be carried out in accordance with the RDSO Manual for Flash Butt Welding of Rails. The contractor is liable to provide all relevant information to get clearance for FBW from RDSO.

10.2.8 ALUMINO-THERMIC WELD TESTS

1. Tests for Alumino-thermic Welding shall be carried out in accordance with the RDSO Manual for Alumino-thermic Welding of Rails.

10.2.9 SWITCHES AND CROSSINGS

1. 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 turnout track.
2. Steel components of the switch and crossings such as Switch assembly, crossing assembly shall be subjected to acceptance based on Factory Acceptance Test (FAT)
3. Running edge offsets shall be taken at maximum 1000 mm intervals. Running edge offsets shall be within +2mm/ - 1 mm of their design value.
4. The inspection of switches and derailing switches (if any) shall include, but not be limited to, the following:
 - i. The switch rail evenly butts with the stock rail throughout the length of the switch planning with the switch lying naturally.
 - ii. The underside of the switches and stock rails bear evenly on all slide baseplates.
 - iii. All 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.
 - iv. The switch rails over their free length are not twisted/bent.
5. The switch toes shall not be out of square/beyond specified tolerances.
6. Crossings shall bear evenly on all baseplates.

10.2.10 BUFFER STOPS

1. The buffer stops shall be inspected by the Engineer before installation. Necessary assistance shall be provided by contractor to facilitate the inspections.
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.
3. Inspection sheets shall be prepared and submitted for Approval of each assembly clearly

showing the design and actual dimensional checks, item number and identification marks.

10.3 TESTS ON COMPLETION

10.3.1 GENERAL

1. Tests on Completion are to be undertaken in accordance with the provisions of General Specification. The Tests on Completion are deemed to include the submission and Approval of all of the documentation identified therein and in the specified format.
2. It is Trackwork Contractor's responsibility to ensure that, all the materials supplied by the Contractors are subjected to Materials Inspection and acceptance by the Employer before putting into track.
3. The acceptance tests have been divided into categories as defined in the following Clauses. The tests listed are not comprehensive and the Contractors shall include all other Inspection and Tests which shall prove that the trackworks installed are fit for the purpose and duly complying to the acceptable Indian/International standards.

10.3.2 INSTALLED TRACKWORKS

1. Track parameters shall be inspected, and reports shall be submitted to ensure that the parameters are within the tolerance limits mentioned in **Section 9** of this document.
2. Acceptance tests for all the ATW and FBW installed at site according to relevant codes stated in this document.
3. Acceptance test for the installed turnouts to ensure that the installation parameters are within the tolerances specified.
4. Successful rail insulation test
 - i. All track work shall be subjected to a rail insulation to earth test. The track shall have a minimum rail-to-earth value of 10 ohms/km of single track for ballastless tracks in worst weather conditions.
 - ii. 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.
 - iii. The test shall be undertaken on rail lengths up to maximum length of 1000m.
 - iv. The track shall not be finally formed into a continuous length, until the rail insulation to earth tests have been undertaken and approved.
5. Successful rail inclination test
 - v. Both rails of all ballastless running line tracks shall be checked, at maximum 10 m intervals, for inclination using a purpose made Approved digital inclinometer in the presence of the Engineer.
 - vi. Shall any reading show the inclination to be outside the specified limits every alternate fastening assembly shall be further checked either side of the non-compliant reading until compliant readings are consistently obtained.

- vii. 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 approved by the Engineer.
 - viii. The procedure / values mentioned above are indicative, and these tests are to be carried out by the designated contractors. The actual values / procedure of these tests shall be interfaced by the contractor with the designated Contractors.
- 6. Compliance to Schedule of Dimensions
 - ix. Compliance to structure gauge clearances with respect to schedule of dimensions of MMRDA

10.3.3 SUBMISSIONS

- 1. Before any Section of the Work is put for inspection and sanction to Commissioner of Metro Rail Safety for acceptance, the following information shall have been submitted for the approval of the Engineer:
 - i. Records and certification for all the tests and inspections identified in technical specifications.
 - ii. As-built records/drawings of the following:
 - 1. As-built records/drawings/BIM models
 - 2. Vertical Alignment
 - 3. Horizontal alignment
 - 4. Recording unit traces of versine, gauge, twist, cant / cross-level and rail top longitudinal profiles
 - 5. Weld record plan
 - 6. All weld test results as detailed in this section, de-stressing records.
 - 7. Distance in kilometers, co-ordinates, offsets of all permanent track markers
 - 8. Rail Inclination records
 - iii. The results and reports of all tests and materials, assemblies, and items/components.
 - iv. The results of all Tests shall be submitted in hard copy and electronic format in accordance with these specifications.
 - v. All other Technical documents as necessary for the successful commissioning of the project.

Annexures A to C

ANNEXURE A: SCHEDULE OF DIMENSIONS OF MMRDA

ANNEXURE B: DELETED

ANNEXURE C-1: TECHNICAL STANDARDS FOR TRACK STRUCTURE, ANNEXURE C-1 OF RDSO GUIDELINES "PROCEDURE FOR SAFETY CERTIFICATION AND TECHNICAL CLEARANCE OF METRO SYSTEMS"

ANNEXURE C-2: PERFORMANCE CRITERIA OF FASTENINGS, ANNEXURE C-2 OF RDSO GUIDELINES "PROCEDURE FOR SAFETY CERTIFICATION AND TECHNICAL CLEARANCE OF METRO SYSTEMS- DECEMBER 2015" INCLUDING CORRECTION SLIPS