NAGPUR METRO RAIL PROJECT

BID DOCUMENTS FOR

DESIGN, MANUFACTURE, SUPPLY, INSTALLATION, TESTING, COMMISSIONING OF MACHINERY AND PLANTS FOR 02 (TWO) NUMBERS OF ROLLING STOCK DEPOTS AT MIHAN AND HINGA OF NAGPUR METRO RAIL PROJECT AND TRAINING OF PERSONNEL

TENDER NO. N1M&P-1/2016

PART-2: WORKS REQUIREMENTS

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Contents of Part-II

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TENDER NO.
N1M&P-1/2016

PART 2: WORKS REQUIREMENTS SECTION
VII-A: EMPLOYER'S REQUIREMENT –
GENERAL SPECIFICATION

June 2016

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CHAPTER 1

1.0 SCOPE OF THE GENERAL SPECIFICATION

1.1 General

1.1.1 This Specification covers the general aspects of the Tender viz., description of the Works, submittal requirements of Design & Drawings, Management Plans, Project Planning and Progress Monitoring, Site Management, Drafting and CAD Standards, and Contractor's obligations for safety and health etc. This General Specification shall be read in conjunction with the General Conditions of Contract (GC), Particular Conditions of Contract (PC), Technical Specification, and Instructions to Bidders. The abbreviations used in this General Specifications are given in Appendix 8 to this Specification.

1.1.2 General Description of the Works: The Scope of Works under this Contract covers Design, Manufacture, Supply, Installation, Testing and Commissioning of Machinery & Plants with Mandatory and Recommended Spares for 02 (Two) Nos. of Rolling Stock Depot at Mihan and Hingna of NMRCL, including Training of Personnel, Maintenance during DLP, Comprehensive Annual Maintenance Contract for a period of 5(Five) Years After DLP and Operation of the M&Ps for a period of 2(Two) years.

1.1.3 For this Project, the Machinery & Plant requirement for both the depots at Mihan & Hingna is mentioned in Table 1-1below:

Table 1-1: Requirements of Machinery & Plant

SN	List of Machines	M&Ps Required		
		For Mihan Depot	For Hingna Depot	Total Quantity
1	Automatic Train Wash Plant	1	1	2
2	CNC Under Floor Wheel Lathe with Synchronised Shunting System	1	1	2
3	Under Floor Train Lifting System for 3 Car Unit	1	1	2
4	Mibile Lifting Jacks for 3 Car Unit	1	1	2
5	Bogie Testing Machine	1	1	2
6	Bogie Turntables (1 set = 4 Nos.)	1	1	2
7	Rescue Vehicle with Re-railing & Allied Equipment	1	-	1
8	Instrumented Catenary Maintenance Vehicle with Train Shunting Capability	1 (4wheeler)	1 (8wheeler)	2
9	Battery Operated Rail Cum Road Shunter (For 3 Cars)	1	1	2
10	Multi Functional Track(only for 1 line)	1	1	2

1.2 Indigenization

1.2.1 The Tenderer are advised **(Not mandatory or compulsory)** to survey manufacturing facilities already existing in India and make use of the same, if considered useful by them.
To facilitate ease in maintenance and easy availability of spares, NMRCL is keen for standardization and requires Contractor to make efforts to source maximum number of equipments and materials from within India. NMRCL expects that efforts will be made by the Contractor to indigenise items. The Tenderers are also advised to look for indigenization of those items that are regularly required for the routine maintenance of the M&P.

1.3 Power supply

25 kV ac 50 Hz single-phase traction power supply shall consist of conventional overhead Catenary system (OCS) in the elevated, at-grade section and Depot.

1.4 Climatic Conditions

1.4.1 The climatic conditions, which need to be taken into account by the Contractor for designing the M&P and the equipment provided therein, are furnished in Section VII B Employer"s Requirements - Technical Specification.

1.4.2 While designing and selection of the equipment and components, special care shall be taken for protecting these items against dust. As per the experience in India, high level of IP protection is required in order to ensure equipment reliability under severe dust conditions prevalent in Nagpur area and the same shall therefore be suitably considered during design.

1.5 Not Used

1.6 Standards and Codes

1.6.1 Machinery & Plants, related equipment and software shall be in accordance with the requirements of the standards and codes specified in the Employer"s Requirements - Technical Specification. The Contractor may propose an alternative equivalent international standard during the design stage. The acceptance of the alternative standard will however be subject to review by Engineer. When a Standard or Code is referred to, it shall be assumed that the revision current on the date of tender submission or the revision made during the design finalization shall be applicable, unless otherwise stated.

1.6.2 Where no standard is identifiable, the Contractor shall make a proposal, based on the best International practice, which shall be subject to review by the Engineer.

1.6.3 During the preliminary design phase, the Contractor shall submit a consolidated list of all the standards that he intends to use for the design, manufacturing and testing and other phases of the Contract, for review of the Engineer.

1.6.4 During the design phase, the Contractor shall provide original copies of the English version (if not available translation shall be made available) of the standards used / referred, as part of the Contract.

1.6.5 The standards shall be provided in electronic format (soft copy). However, in case the same is not available, with the Engineer"s consent, original printed copy can be provided.

1.7 Units

All drawings and design calculations submitted with the tender, or in accordance with the requirements of the Contract, shall use SI units.

1.8 Warranty (Defect Liability)

1.8.1 Warranty (Defect Liability) Period shall start from the Date of Commissioning of **last M&P upto 24 months.**

1.8.2 The Contractor shall be responsible for any defect or failure attributable to defective design, material or workmanship during the Warranty period.

1.8.3 The warranty period of all supplies, mandatory spares, any other item / equipment delivered under this **Contract shall be 24 months from the date of supply / commissioning of last M&P/spares** or upto the expiry of the Defect Liability Period (Clause 1.8.1), whichever is later.

1.8.4 The repair and/or replacement of failed components and equipment and installation of repaired/replaced components/equipment shall be undertaken by the Contractor free of charge at Site. The Contractor shall bear custom duty, freight charges and all other expenses involved in collection of defective components and equipment from the Site, and transportation to the manufacturer"s works in India or abroad for repairs / updation / modification etc. as the case may be and its return to Site after making it good for use.
Further, should any design modification be required to any component or equipment as a consequence of failure analysis, the minimum period of warranty i.e. 24 months shall recommence from the date when the modified part is commissioned into service and modification shall be carried out free of charge. In all such cases, warranty will be applicable on complete sub-assembly; even when only component has been modified/replaced/repaired due to design change.

1.8.5 All replacement and repairs under the warranty shall be carried out by the Contractor promptly and to the complete satisfaction of the Engineer on notification of the defect by the Engineer / Employer so that no Equipment is unfit for service for more than 48 hours. In case of any Machine remains out of operation beyond specified duration above 48 hours, due to reasons attributable to Contractor, Engineer/Employer may at his sole discretion impose a penalty on the Contractor, commensurate with the revenue and opportunity loss to the Employer. Decision of Employer shall be final and binding.

1.9 Optional Items

Employer at its sole discretion will have the option to include/delete supply of Mandatory spares, Recommended spares and any other optional items detailed in Chapter 8.

CHAPTER 2

2.0 MANAGEMENT PLANS

2.1 General

2.1.1 In order to ensure satisfactory execution of the Contract, completion of works within specified targets, and quality in design, manufacturing and execution of work, a series of Management Plans shall be developed. The following Plans shall be developed and submitted by the Contractor for Engineer"s review:

(i) Project Management Plan
(ii) Interface Management Plan
(iii) Work Plan (Work Programme and Design Submission Programme)
(iv) Quality Assurance Plan
(v) Quality Plan
(vi) System Safety Assurance Plan
(vii) Reliability, Availability and Maintainability Assurance Plan
(viii) Site Safety Plan
(ix) Software Quality Assurance Plan
(x) Environmental Plan
(xi) Inspection, Test and Commissioning Plan

2.1.2 The plans and documents shall be co-ordinated with each other and shall collectively define, describe and encompass the Contractor's proposed methods, procedures, processes, organization, sequencing of activities to meet the requirements of the Technical Specification in respect of the subjects listed.

2.1.3 The respective Plans shall be submitted as per the submission schedule furnished in Table 2-1.

Table 2-1: Submission of Plans

SN	Plan	To be submitted within
1.	Project Management Plan	15 days of Commencement Date
2.	Interface Management Plan	30 days of notification from the Engineer of the identity of each Designated Contractor
3.	Work Plan (Work Programme and Design Submission Programme)	30 days of Commencement Date
4.	Quality Assurance Plan	45 days of Commencement Date
5.	System Safety Assurance Plan	45 days of Commencement Date
6.	Manufacturing Schedule and Process Sequence Plan	45 days of Commencement Date
7.	Quality Plan	60 days of Commencement Date
8.	Environmental Plan	60 days of Commencement Date
9.	Software Quality Assurance Plan	75 days of Commencement Date
10.	Reliability, Availability and Maintainability Assurance Plan	90 days of Commencement Date
11.	Site Safety Plan	120 days of Commencement Date
12.	Inspection, Test and Commissioning Plan	120 days of Commencement Date
13.	Integration Tests and Instrumentation Test protocol for M&P.	120 days of Commencement Date

2.2 Project Management Plan

2.2.1 The Project Management Plan shall provide a clear over-view of the Contractor's organization, the management system and methods to be used for completion of the works. The organization resources for the design, procurement, manufacture, installation, testing and commissioning, and setting to work, shall be clearly defined.

2.2.2 The Tenderer shall submit a Project Management Plan as a part of the Tender, which shall provide the following information:

(i) A diagram showing the organizational structure for the management of the Contract, with locations, names and position titles of staff and their line and staff relationship. The diagram shall include associate organizations and sub-contractors and show clearly the individuals and lines of responsibility linking the various groups. It shall also identify the persons designated as contacts with the Engineer.

(ii) The names, qualifications, positions and current resumes of key executive, supervisory and engineering staff to be employed full-time for the works, separately for principals and sub-contractors.

(iii) A narrative describing the sequence, nature and inter-relationship of the main Contract Activities including timing for exchange of information.

(iv) Procedure for documentation control.

(v) The Contractor shall nominate a suitably qualified and experienced English speaking engineer from his staff to be Project Manager. The nominee shall be subject to acceptance of the Engineer, who shall have the right to demand its replacement at any time after the work commences, should Engineer consider this to be in the best interest of the Project.

(vi) The Contractor shall also nominate a senior engineer (“Manufacturing Head”) to co-ordinate activities of the design offices and manufacturing works. The Manufacturing Head shall be responsible to the Project Manager for all works executed outside India and in India for ensuring that effective co-ordination is maintained with the various manufacturing units of the Contractor, Sub-Contractors and Suppliers and that contract delivery schedules are met.

(vii) The Project Manager shall be continuously on site in Nagpur and devote himself full-time to the Project, commencing **not later than Thirty (30) calendar days** from the date of the Commencement Date and shall continue up to the end of Defects Liability Period. Contractor shall also nominate a Deputy Project Manager and be posted at Nagpur site.

(viii) To fulfil the Contractor‟s obligations during the Testing and Commissioning and the Defect Liability Period, the Contractor shall nominate experienced maintenance engineers and organise deployment after obtaining Engineer‟s approval before undertaking testing and commissioning in depots.

(ix) The work of the maintenance engineers of all the depots shall be coordinated by Contractor‟s Chief Maintenance Engineer.

(x) The Chief Maintenance Engineer and maintenance engineers shall coordinate with the Engineer‟s nominated representatives in each depot and provide guidance as may be required to carry out the scheduled and un-scheduled maintenance activities from time to time. The work shall include, but not limited to, finalisation of detailed maintenance plans covering maintenance work instructions, requirements and specifications of tools, plants and test benches, test check sheets, etc.

(xi) Suitable replacement after obtaining approval of Engineer shall be provided by the Contractor in case of absence of the Chief Maintenance Engineer and maintenance engineers from the site for a continuous period exceeding 15 calendar days, for whatever reason. In case of cumulative absence of the Chief Maintenance Engineer and / or maintenance engineers for 40 days in a calendar year, the Engineer may at his sole discretion recover a reasonable amount from the due payments to the Contractor.

2.2.3 The Contractor will submit a Project Management Plan within the specified schedule. The Engineer will review the Contractor's Project Management Plan and shall have the right to require the Contractor to make amendments as deemed necessary by the Engineer. The Contractor shall submit a detailed revised plan within 10 days of the review.

2.3 Interface Management Plan

2.3.1 The Contractor shall interface and liaise with Designated and Other Contractors in accordance with the requirements of Chapter 3 of the Employer"s Requirements General Specification.

2.3.2 The Contractor shall develop and submit to the Engineer within the specified schedule, an Interface Management Plan, which is mutually acceptable to both the Contractors and the Designated Contractors. The Contractor shall appoint an experienced engineer as Interface Manager after approval of the Engineer. The Interface Manager will regularly report at Nagpur site starting from not later than six months from commencement date and atleast till commissioning of all Machinery & Plants and satisfactory resolution of all interface issues. The Interface Management Plan shall:

(i) identify the sub-systems as well as the civil works and facilities with interfacing requirements;

(ii) define the authority and responsibility of the Contractor's and the Designated Contractors' (and any relevant sub-contractors') staff involved in interface management and development;

(iii) identify the information to be exchanged, precise division of responsibility between the Contractor and Designated Contractors and integrated tests to be performed at each phase of the Contractor's and Designated Contractors' works.

(iv) address the works programme of the Contract to meet the key dates of each Contractor and highlight any programme risks requiring management's attention.

(v) After the review of Interface Management Plan with no objections by Engineer, the Contractor shall execute the works in accordance with the Plan.

Refer to the figure below for illustrative interface / organization chart.

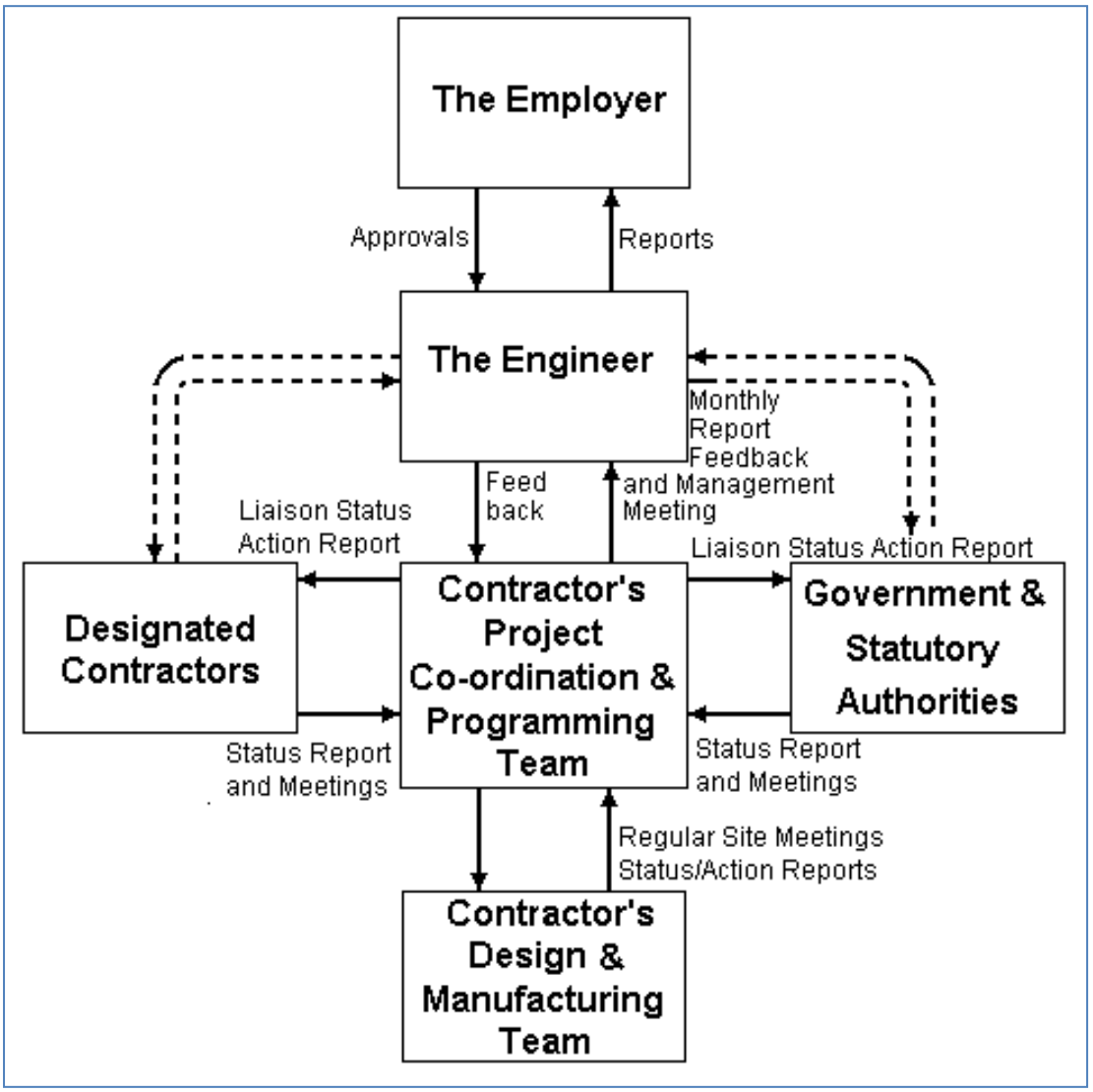

Figure 1: Organization Chart (Interfacing Parties / Agencies)

2.4 Work Plan (Works Programme and Design Submission Programme)

2.4.1 The Tenderer shall submit a Work Plan as a part of the tender which shall contain the following:

(i) Proposed Works Programme.

(ii) Proposed Design Submission Programme

2.4.2 The Tenderer"s proposed Works Programme shall indicate how the Tenderer intends to organize and carry out the Works and achieve stages and complete the whole of the Works by the appropriate Key Dates. The Works Programme shall be prepared in terms of weeks from the Date of Commencement of Works.

2.4.3 The Tenderer"s Design Submission Programme shall cover the Design phase and include a schedule identifying, describing, cross-referencing and explaining the Design Packages and submissions, which he intends to submit.

2.4.4 The Design Submission Programme should take due account of the design coordination interface periods with other Designated Contractors and be consistent with the Works Programme.

2.4.5 The Works Programme and Design Submission Programme shall include details as stipulated in Chapter 4 and 5 of this Employer"s Requirements – General Specification, for review by the Engineer.

2.5 Quality Assurance Plan

2.5.1 The Tenderer shall submit an Outline Quality plan, illustrating the intended means of compliance with Chapter 2 of the Employer"s Requirements - Technical Specification, and setting out in summary form an adequate basis for the development of the more detailed document. The Outline Quality Plan shall contain sufficient information to demonstrate clearly the proposed method of achieving the Tenderer"s quality objectives with regard to the requirements of the Contract.

2.5.2 The Plan shall be based on acceptable International Standards (such as ISO 9001/2008 "Model for Quality Assurance in Design Development, Production, Installation and Servicing" or other relevant standards). The Quality Assurance Plan shall embrace all activities of contractors, sub-contractors of any tiers including its suppliers and design consultants, if any. The Quality Assurance Plan shall indicate the approach and structure that the detailed plan will take and shall include the following:

(i) a summary of the Project requirements including all proposed quality activities;

(ii) all quality assurance and quality control procedures proposed by the Contractor for its use in the execution of the Works;

(iii) a list of all the Codes of Practice, Standards and Specifications that the Contractor proposes to apply to its work;

(iv) the Contractor's proposals for internal and sub-contractor quality assurance audits;

(v) a statement detailing the records that the Contractor proposes to keep, the time during which they will be prepared and the subsequent period and manner in which they will be stored;

(vi) Inspection and test plans for every activity requiring inspection. The plans shall identify the level of inspection required, Quality Control Points and Quality Hold Points.

(vii) procedure for maintenance of records of inspection / tests.

2.5.3 The Quality Assurance System shall be applied without prejudice to, or without in any way limiting, any Quality Assurance System that the Contractor already maintains.

2.6 Quality Plan

2.6.1 The Contractor shall provide the Engineer with a detailed Quality Plan taking into account any directions or requirements from the Engineer on the Quality Assurance Plan. The detailed plan shall be updated as necessary from time to time to incorporate, to the Engineer"s satisfaction, all changes to the Contractor's procedures. The Quality Plan shall comprise:

(i) A Management Quality Plan for control of management related activities;

(ii) A Design Quality Plan for control of design related activities; and

(iii) A Manufacturing (including Inspection and Testing) Quality Plan for the control of related Activities.

(iv) Installation, Testing and Commissioning Quality Plan

2.6.2 Quality Organisation

The Contractor shall submit a detailed organization chart identifying the responsibilities, authority and inter-relation of all personnel who manage, perform and verify work involving quality in respect of all Quality Plans. The organization chart shall be specific to this Contract. The chart shall identify the Quality Management Representative who shall act as the Quality

Coordinator for the Contractor in all dealings with the Engineer. The Contractor shall post the Quality Assurance Manager at production site as well as at Nagpur site.

2.6.3 Quality Audit

The Contractor shall audit all the activities in each Quality Plan at quarterly intervals or at other such intervals as the Engineer may require, to ensure continuing suitability and effectiveness of the quality management system. The Contractor shall make available upon request any document, which relates to its recent internal audits.

The Engineer may require compliance audits of the Contractor's quality system to be conducted. Not less than two weeks notice will be given by the Engineer. During audits, the Contractor shall provide suitably qualified staff to accompany the auditor.

2.6.4 Responsibility of Quality Control during Manufacture, Installation, Testing & Commissioning and DLP shall solely rest with the member of the consortium based on which the consortium/JV got qualified.

2.7 System Safety Assurance Plan

2.7.1 The Tenderer shall submit, as part of its Tender, an Outline Safety Plan, which shall contain sufficient information to demonstrate clearly the Tenderer"s proposals for achieving effective and efficient safety procedures in the Design, Manufacture, Installation, Testing and Commissioning of the Machinery & Plants. The Outline Safety Plan should include an outline of the safety procedures and regulations to be developed and the mechanisms by which they will be implemented for ensuring safety including Hazard Analysis, Fire control, EMC / EMI control, RAM (Reliability, Availability and Maintainability) requirements, site safety, transportation of Machinery & Plants, etc.

The Safety Manager shall be posted at Nagpur site from the stage of receipt of goods up to the expiry of warranty period.

2.7.2 The Outline Safety Plan shall be headed with a formal statement of policy in relation to safety and shall be sufficiently informative to define the Tenderer"s Safety Plan and set out in summary an adequate basis for the development of the site safety and safety in transport.

2.7.3 The Contractor shall submit for review by the Engineer, a System Safety Assurance Plan in accordance with the requirements of Chapter 2 of the Employer"s Requirements - Technical Specification. The Plan shall include Hazard Analysis Plan, Fire Control Plan and EMC / EMI Control Plan.

2.7.4 The Hazard Analysis Plan shall evaluate and ensure that all the hazards are identified and satisfactorily resolved.

2.7.5 The Fire Control Plan shall evaluate and ensure *inter alia* that the fire loadings of material proposed to be used, and the fire withstand ratings etc. are as per the requirements specified in the Employer"s Requirements - Technical Specification and also are compatible with currently accepted international practices.

2.7.6 The EMC / EMI Control Plan shall evaluate and ensure that the requirements for electromagnetic compatibility and interference as specified in the Employer"s Requirements - Technical Specification for all elements of the system are met.

2.8 Reliability, Availability, Maintainability and Safety (RAMS) Assurance Plan

2.8.1 The Contractor shall submit for review by the Engineer, a Reliability, Availability, Maintainability and Safety Assurance Plan as per EN 50126 and in accordance with the requirements of Chapter 2 of the Employer"s Requirements - Technical Specification.

2.8.2 The Contractor shall describe procedures required to perform the specific tasks necessary to achieve RAMS requirements in the Reliability, Availability, Maintainability and Safety Assurance Plan.

2.8.3 Contractor shall also submit Project Management system plan for smooth management of the maintenance and DLP issues for the Engineer"s approval. Changes suggested by the Engineer for improving management flow shall be implemented. The broad preferred guidelines are as under.

The system may be divided into different functional groups say Inspection data management group, functions for commissioning, maintenance record (DLP), Failure control, drawing management, material management, Modifications & review / change, design document management. Links amongst the above functional groups may be developed by the Contractor and be got approved from the Engineer. Contractor can suggest alternative as well.

2.9 Site Safety Plan

The Contractor shall also submit Site Safety Plan and a plan for safe transport of Machinery and Plants to the depot as per requirements of Chapters 10 and 11 of this Employers Requirement, General Specification.

2.10 Software Quality Assurance Plan

The Contractor shall submit a Software Quality Assurance Plan in accordance with the requirements of Chapter 5 of this Employer"s Requirements - **General Specification, and Chapter 14 of the Employer's Requirements - Technical Specification.**

2.11 Environmental Plan

2.11.1 The Tenderer shall submit as part of this Tender an Outline Environmental Plan illustrating the intended means of compliance with the Employer"s Environmental Quality Management Manual. Outline Environmental Plan shall also contain sufficient information to demonstrate clearly the proposed method of achieving the Environmental objectives with particular reference to Noise, Vibration, EMC/EMI etc. to meet the stipulations of Chapter 2 of Employer"s Requirements **Technical Specification. (TS)- Section VII-B.**

2.11.2 The Contractor shall submit the Environmental Plan, in accordance with the requirements of Chapter 2 of the Technical Specification with particular reference to Noise, Vibration, EMC/EMI etc. The Environmental Plan shall include Noise and Vibration Plan and Environmental EMC Control Plan as per details furnished in Chapter 2 of Employer"s Requirements -Technical Specification.

2.12 Inspection, Installation, Testing and Commissioning Plan

2.12.1 The Contractor shall submit an Inspection, Installation, Testing and Commissioning Plan in accordance with Chapter 7 of this Employer"s Requirements-General Specification and Chapter 15 of the Employer"s Requirements – Technical Specification.

2.12.2 The Contractor shall position the Testing and Commissioning Engineer-in-charge at Nagpur site during the commissioning Period.

2.13 Submittals

Following plans shall be submitted by the Tenderers along with the bids:

Table 2-2: Submissions

SN	Description	Clause ref.
1	Project Management Plan	2.2.2
2	Works Plan: a. Works programme b. Design submission programme	2.4.1
3	Outline Quality Plan	2.5.1
4	Outline Safety Plan	2.7.1
5	Environmental Plan	2.11.1

CHAPTER 3

3.0 COORDINATION WITH DESIGNATED AND OTHER CONTRACTORS

3.1 General

3.1.1 The Contractor is responsible for detailed co-ordination of its design and manufacturing activities with those of the System-wide Contractors, Civil Contractors, Consultants and other Contractors whether or not specifically mentioned in the Contract, who may be working on or adjacent to the site for the purpose of the Project.

3.1.2 All of the above parties are referred to as Designated Contractors. A list of some of the main Designated Contractors and some of the identified major interfaces are given in Appendix 7. The Contractor shall note that there are other contractors, consultants, agencies etc. which the Employer may engage from time to time, and with whom the Contractor shall have to similarly co-ordinate. Such co-ordination responsibilities of the Contractor shall include the following, but need not be limited to:

(i) To provide all information reasonably required by the Designated Contractors in a timely and professional manner to allow them to proceed with their Design, Manufacturing, Construction activities, and to meet their milestones and key dates.

(ii) To ensure that the Contractor's requirements are provided to all other Designated Contractors, in a timely and reasonable manner.

(iii) To obtain from the Designated Contractors information reasonably required, to enable the Contractor to meet its own design submission dates.

(iv) Where the execution of the work of the Designated Contractors depends upon the site management or information to be given by the Contractor, the Contractor shall provide to such Designated Contractors the services, or the correct and accurate information required, to enable them to meet their own programme or construct their own works.

(v) To ensure that there is no interference with the works of Designated Contractors.

(vi) To attend regular co-ordination meetings convened by the Designated Contractors and the Engineer. The Contractor shall conduct separate meetings with the Designated Contractors as necessary to clarify particular aspects of the Designated requirements of the Works. A record of the decisions taken in each such meeting shall be furnished to the Engineer. The party who convenes the meeting shall prepare minutes recording all matters discussed and agreed at the meeting.

(vii) To ensure that all correspondence, drawings, meeting minutes, programmes, etc. relating to the Contractor's co-ordination with the Designated Contractors are issued to all concerned parties and four copies issued to the Engineer no later than seven calendar days from the date of such correspondence and meetings.

3.1.3 The Contractor shall in carrying out its co-ordination responsibilities raise in good time and provide sufficient information for the Engineer to decide on any disagreement between the Contractor and the Designated Contractors as to the extent of services or information required to pass between them.

3.1.4 If such disagreement cannot be resolved by the Contractor despite having made all reasonable efforts, then the decision of the Engineer shall be final and binding on the Contractor.

3.1.5 Where a Designated Contract has yet to be awarded, the Contractor shall proceed with the co-ordination activities with the Engineer until such time as the Designated Contractor is available. The Contractor shall provide the Designated Contractor with all information

necessary to enable the Designated Contractor to follow-on and proceed with their coordination.

3.1.6 Any claim of additional costs by the Designated Contractors as a result of the Contractor's failure to keep to specified dates shall be borne by the Contractor. The Contractor shall note that the information exchange is an iterative process requiring the exchange and updating of information at the earliest opportunity and shall be carried out on a regular and progressive basis in order for the process to be completed for each design stage by the specified dates. Employer shall have full right to impose liquidated damages on the Contractor should there be an impact of these delays in achieving the key dates. Decision of Employer shall be final and binding.

3.2 Dedicated Coordination Team

3.2.1 The Contractor shall establish a dedicated co-ordination team, led by a Coordinator reporting to the Contractor's Project Manager. The primary function of the team is to provide a vital link between the Contractor's design and manufacturing teams and the Designated Contractors. The Contractor shall provide the Engineer with particulars of the Coordinator. The Engineer shall have the right to require the replacement of the Coordinator if in its opinion the Coordinator is unable to meet the co-ordination requirements of the Contract. The Contractor's attention is drawn to the need for the Coordinator to establish effective dialogues and communication links with the Designated Contractors. The Contractor's co-ordination team shall comprise a mix of personnel with experience in both design and manufacture of Machinery and Plants necessary for effective coordination.

3.2.2 The Coordinator shall assess the progress of coordination with Designated Contractors by establishing lines of communications and promoting regular exchange and updating of information so as to maintain the Contractor's programme.

3.2.3 The complexity of the project and the importance of ensuring that work is executed within time limitations require detailed programming and monitoring of progress so that early programme adjustments can be made in order to minimize the effects of potential delays.

3.2.4 The Co-ordinator in conjunction with the Designated Contractors shall identify necessary provisions in the Works for plant, equipment and facilities of the Designated Contractors. These provisions shall be allowed by the Contractor in its design of the Works.

3.2.5 During the course of the Contract, information will be obtained in a number of ways, including direct inspection, regular site meetings, the obtaining of progress reports and the use of turn round documents to obtain design and programme data. Turn round documents shall be issued to the Designated Contractors to be returned giving the current positions on their programme.

CHAPTER 4

4.0 PLANNING, PROGRAMME AND PROGRESS MONITORING

4.1 Works Programme Submission Requirements

4.1.1 The Works Programme submission requirements are organised into two parts. Part One is a requirement for all Tenderers and shall be submitted as part of their Tender. Part Two describes a series of reports to be submitted by the Contractor during the execution of the Contract.

4.1.2 In compiling its Works Programme, and in all subsequent up-dating and reporting, the Contractor shall make provision for the time required for coordinating and completing the Design, Manufacturing, Installation, Testing, Commissioning and Integrated Testing of the Works, including *inter alia*, design co-ordination periods, during which the Contractor shall coordinate its design with those of Designated Contractors, the review procedures determining and complying with the requirements of Government Departments and all others whose consent, permission, authority or licence is required prior to the execution of any work. The Works Programme shall take full account of the Design Submission Programme.

4.1.3 All terminology, definitions and conventions shall be in accordance with BS 4335 (Glossary of terms used in Project Network Techniques) or the Associated General Contractor's (AGC) manual entitled "The use of CPM in Construction".

4.1.4 All submissions shall be in six (6) paper copies and shall be in A0, A1, A3 or A4 size, as appropriate except as may otherwise be agreed by the Engineer. In addition, the submissions shall also be made in electronic format in a medium acceptable to the Engineer.

4.1.5 All programme submissions shall, unless otherwise specified, conform to the format and level of detail specified in Appendix 1.

4.2 IT Requirement of Employer

4.2.1 Employer is in the process of implementing an Enterprise wide cloud based IT system project titled “Integrated Project Management Platform”. The objective of the IT project is to develop a working environment that enables higher efficiency and effectiveness, not only in internal functions, but also across the entire ecosystem of the Employer including Contractors. The IT project envisaged following application stack:

(a) Scheduling services (using Oracle Primavera P6 Enterprise Project Portfolio Management (EPPM) or equivalent)
(b) Collaborative document control and management services (using Bentley ProjectWise and AssetWise solution or equivalent)
(c) Progress and performance reporting (using RIB iTWO 5D BIM solution or equivalent)
(d) Enterprise wide ERP implementation

4.2.2 The proposed IT system has been conceptualized for facilitating preservation of important artifacts (plans, drawings, notes, documents, reports etc.) in a secure and manageable environment in digitized format. Appropriate triggers shall generate dashboards and management reports every time an event causes a substantial shift in the project risk or a deviation in processes is developed. The envisaged system would expedite decision-making, ensure better planning and coordination between different functions, better data management, effective reporting, knowledge management etc. Program management shall provide senior management with critical information related to various contracts, activities and funds in the form of management dashboards with inbuilt triggers to ensure timely decision-making.

4.2.3 The effective use of such IT platform requires availability of front end of web-based system at all requisite locations i.e. with Employers" various offices, Engineer"s offices, Contractors" end, major sub-contractors" end, design consultant ends etc. with certain definite users" rights. Data uploading by various authorized and trained users is key to effective implementation of the IT system. Employer has recognized this aspect, and the Contractors are required to

consider in their proposal the cost of software licenses and IT staff for data uploading as under:

Table 4-1: Software licenses and IT staff (minimum requirement)

SN	Contract value	User licenses (below or equivalent software packages)				IT staff
		P6	SAP ERP	Bentley ProjectWise & AssetWise	RIB iTWO 5D BIM	
1	Rs 25 to Rs 50 crore	1	1	5	5	3 (three)
2	Rs 50 crore to Rs 100 crore	1	3	5	5	3 (three)
3	Rs 100 crore to Rs 250 crore	3	5	8	8	6 (six)
4	Rs 250 crore to Rs 400 crore	3	8	8	10	6 (six)
5	Rs 400 crore and above	3	10	10	10	6 (six)

4.2.4 In view of the above, the Contractor shall be required to:

(a) Follow and comply the system guidelines to be issued by Employer
(b) Comply all the software system competency requirement by taking training from Employer"s Training Academy.
(c) Upload / definition of Project Plans as per the template and using software defined by the Employer;
(d) Maintenance and updating of uploaded Project Plans in software used by the Employer;
(e) Upload of drawings / designs created by the Contractor as per the classification and on the software platform defined by the Employer;
(f) Key contract related communication and progress related data as per processes defined on the software platform deployed by the Employer
(g) Asset details need to be updated in the system in the format prescribed by the Employer;

4.2.5 Employer, his IT Project Team and IT Implementation Agency shall render necessary assistance (including providing trained IT staff with requisite skills at Contractor"s cost) and handhold the Contractor for usage of the IT system.

4.3 Part One Submission by Tenderers

4.3.1 The Tenderer shall clearly demonstrate in itsTender submission the following:

(i) The scheduling approach to the Design, Manufacture, Installation,Testing and Commissioning.These shall contain sufficient detail to assure the feasibility of the Tenderer's approach to meeting the contractual obligations.

(ii) The Tenderer's capability to manage the Execution of the Works to meet the specified Key Dates. Details are given in Appendix 3.

(iii) A means to show the dates and periods relating to the Interfaces and Works of Designated Contractors. An Assumption Report accompanying the network should clearly indicate key dates, specific activities of other contracts, if any, which precede the commencement of activities listed in the Tender Submission.

(iv) Show submission for review and review period for all major documentation required by the Contract.

(v) Clearly identify the critical path in the programme and fully described in the accompanying narrative.

4.3.2 The Works Programme in the Tender shall be accompanied by a narrative statement that shall describe Programme activities, assumptions and logic, and highlight the Tenderer's perception of the major constraints and critical areas of concern in the Design, Organization,

Manufacture, Supply, Installation, Testing, Commissioning and Completion of the Works. This narrative statement shall also indicate which elements of the Works the Tenderer intends to carry out off-shore and/or in India, with details of the proposed locations of where any such work is to be carried out, the facilities available and any third party undertaking the Tenderer may have in this regard. In particular the Tenderer must state the assumptions made in respect of the interfaces with the Employer, Engineer, Other Contractors and third parties both in detail and time, and any requirements for information on matters, which would affect its works.

4.3.3 The Tenderer's attention is drawn to the Programme Logic Diagrams, as shown in Part I, Section IV: Bidding Form No. 4.3. These diagrams are indicative only to assist the Tenderer in its appreciation of the Programming requirements of the Contract.

4.4 Part Two Submission by Contractor

4.4.1 Work Programme Plan

The Contractor shall prepare a plan, illustrated by sample schedules, charts, tables, etc., detailing its proposals for staff and their responsibilities to support the programming functions, for submission of works programmes for the execution of the Works, for the design, manufacture, supply, testing & commissioning, training, in accordance with the Key Dates for co-coordinating its programmes with those of the System-wide and Civil Contractors, for measuring, monitoring and reporting progress, for revisions to the programmes to ensure completion of the Works within the specified times.

The Contractor shall submit the Works Programme Plan as per the Employer"s Requirement mentioned in Chapter2 of this GS for review of Engineer. Based on the review, the Contractor shall promptly make all amendments as required by the Engineer for his acceptance of the plan.

4.4.2 Preliminary Programme

The Contractor shall make a preliminary Works Programme submission in accordance with the principles set out in its accepted plan. Such submissions may make use of the Tender submissions, suitably amended, to the requirements of the Engineer. The submission shall be made in accordance with the respective plans as indicated in Table 2-1.

The Contractor shall note that at the time of submission of its preliminary networks and bar charts, it may be that such Programmes have yet to be coordinated with the System-wide and Civil Contractors. These shall not prevent the Contractor from submission of detailed preliminary programmes using approximate dates for work of the System-wide and Civil Contractors (where such dates are not available), which has impact on the Contractor's programmes. Such programmes shall be amended subsequently to take into account the actual schedules of the System-wide and Civil Contractors. It is the Contractor's responsibility to ensure timely co-ordination with the System-wide and Civil Contractors to finalise its preliminary programmes so as not to affect the progress of the Works or those of the System-wide and Civil Contractors.

4.4.3 Baseline Programme

Following the Contractor's preliminary programme, submissions, no later than 90 days from the date of Notice to Proceed, the Contractor shall make re-submissions of these programmes suitably amended to take into account the programmes of the System-wide and Civil Contractors. It is the Contractor"s responsibility to ensure timely co-ordination with the System-wide and Civil Contractors to review, revise and finalize its preliminary programmes so as not to affect the progress of the Works and those of the System-wide and Civil Contractors.

The resubmitted programmes when accepted by the Engineer shall form the Baseline Programme against which actual progress of the Works is measured.

As the Works progresses, it may be necessary for the Contractor to update the Baseline Programme but such updating shall only be carried out with the prior approval of the Engineer or when directed by the Employer.

4.4.4 Baseline Schedule Report

(i) The Contractor shall submit a Baseline Schedule Report in accordance with the approved format which will quantitatively document the Baseline network and bar charts submitted. The activities in the report shall be grouped into the various phases e.g. design, manufacturing, delivery, commissioning etc.

(ii) Also required with the submission of the Baseline Schedule Report is a narrative sufficient to explain the basis of the Contractor's determination of duration and to describe the Contractor's approach to meeting specified Key Dates. The reasons for the main logic links and outline method statements shall be provided.

(iii) The Baseline Schedule Report and narrative shall be submitted together with the preliminary programme.

(iv) Notwithstanding the above, the Engineer may at any time during the course of the Contract require the Contractor to reproduce the computer-generated Baseline Schedule Report to reflect actual activity dates and generate schedules based upon "what if" statements.

4.4.5 Progress Reports

Progress reports, as detailed in Appendix 2, shall be regularly submitted by the Contractor, on a monthly basis.

4.5 Review Periods for Contractor's Submissions

4.5.1 The Engineer shall review those Contractor's programme submissions which require his acceptance and shall signify his acceptance or otherwise within 30 days. The Contractor shall, when required by the Engineer, re-submit its programmes within 14 days of receipt of the Engineer"s comments.

The Engineer will endeavour to review and respond to the Contractor on the adequacy and acceptability of the Contractor's submissions and re-submissions as soon as reasonably possible but the Contractor should always allow for a 30 day review period.

4.5.2 Unless otherwise specified, the Contractor shall allow in its programme a 30-day review period for all submissions to the Engineer.

4.6 Failure to make Submissions

Failure of the Contractor to submit any programme, or any required revisions thereto within the time limits stated shall be sufficient reason for certification that the Contractor is not performing the work required in a timely manner. The Engineer may certify retention of payment under the Milestone-related Schedule of Payments proposed for the Contractor, until the programmes are accepted by the Engineer, and may also cause imposition of Liquidated Damages.

4.7 Programme revision

The Contractor shall revise its programmes whenever necessary, with the consent of, or as required by the Engineer to ensure completion of the Works within the times for completion prescribed in the Contract

4.8 Project Calendar

4.8.1 Project Weeks shall commence on a Monday. A day shall be deemed to commence at 0001 hours on the morning of the day in question. Where reference is made to the completion of an activity or Milestone by a particular week, this shall mean by midnight on the Sunday of that week.

4.8.2 Requirements for the computation of Key Dates are given in Appendix 3 to the Employer"s Requirements General Specification.

4.8.3 A 7-day week calendar shall be adopted for various Work Programme Schedules for scheduling purposes.

4.8.4 For Project purposes, the presentation shall be in "Week" units.

CHAPTER 5

5.0 DESIGN SUBMISSION REQUIREMENT

5.1 General

5.1.1 The objective of the design submission process is to ensure that the proposed resulting works comply with the specifications, are capable of being produced consistently to exacting quality standards and can be operated safely to the satisfaction of the Engineer.

5.1.2 The design submissions include Design Calculations, Design Reports and Design Drawings.

5.1.3 In the event that a statutory body (e.g. Government of India Ministry of Railways, RDSO, Commissioner of Railway Safety etc.) requires design information in a particular format, it shall be incumbent upon the Contractor to provide the same, as directed by the Engineer.

5.2 Review of Data

5.2.1 As soon as practicable after Contract Award, the Contractor shall review all applicable data, criteria, standards, directives and information provided to him as the basis for design. Any apparent inconsistencies or erroneous information shall be brought to the attention of the Engineer. Such information shall not alleviate the Contractor from its responsibilities under the Contract.

5.3 Format of Deliverables

5.3.1 Drawings and CAD data shall comply with the requirements of Appendix 4 of this General Specification: Drawing and CAD Standards. Reports, calculations, specifications, technical data and similar documents shall be provided in A4 format, and one of the copies shall be ring bound to facilitate photocopying. A3 size drawings included in documents shall be folded to A4 size.

5.3.2 Drawing and CAD Data Format

Within 30 days of Notice to Proceed, the Contractor shall have prepared and submitted the drawing and CAD procedures together with sample drawings and corresponding CAD data to demonstrate its understanding and compliance with Appendix 4 of this General Specification: Drawing and CAD Standards.

5.4 Number of Copies

The following quantities of drawings and other documents shall be submitted to the Engineer, including preliminary, pre-final, and final design submissions, the final contract document, and all other submissions. These drawings and documents are in addition to those required for the exchange of information between Designated Contractors and other submissions to statutory, governmental and local authorities.

(i) 7 full-size sets of paper drawings (folded and collated)
(ii) 7 sets of design documents and calculations.
(iii) 5 copies of Design Status Report and Design Statement.
(iv) 5 sets of all other submissions.
(v) 2 sets of each of the above in electronic format

5.5 Design Submission Programme

5.5.1 The Contractor shall prepare the Design Submission Programme, which is to set out fully the Contractor's anticipated programme for the preparation, submission and review of the Design Packages, the Final Design Submission and the Installation and Manufacturing Drawing Submissions and for the Issue of Notices in relation thereto.

5.5.2 The Design Submission Programme shall:

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

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

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

(iv) indicate the Design Interface and Co-ordination periods for each Designated Contractor.

(v) include list of requisite design details for each and every component or equipment of all sub-systems and systems.

(vi) Submission of design documentation shall be suitably stagerred.

The Contractor shall update the Design Submission Programme suitably if Engineer observes any deviation.

5.5.3 For System, sub-system and components the Contractor shall submit documents and drawings describing function description, product description, interface requirement description, RAM requirement description, Life cycle calculations, Type & routine test specifications, list and details of spares, related calculations etc., as applicable. The Design Submission Programme shall also include listing of various Plans, processes and other submissions.

5.5.4 The Contractor shall submit the Design Submission Programme to the Engineer as indicated in Chapter 2 of this Employer"s Requirements - General Specification, and thereafter up-dated versions thereof at intervals of not more than one month throughout the Design Phase.

5.6 Design Process

5.6.1 The Contractor shall deploy Design staff having sufficient experience in Nagpur at all times to maintain liaison with the Engineer. The principal requirement of the Design Phase is to undertake the design during this phase in three stages:

(i) the preparation of the Preliminary Design;
(ii) the preparation of the Pre-final Design; and
(iii) the preparation of the Final Design.

5.7 Preliminary Design

5.7.1 The purposes of the Preliminary Design submission are as follows:

(i) State the design criteria;

(ii) Design the overall system, and propose the system configuration;

(iii) Identify the functions of each system, sub-system, equipment or other element within the overall design, and specify the relationships and interfaces between elements of the system;

(iv) Identify the functions of each system, sub-system, equipment or other element within the overall design, and identify the relationships and interfaces between elements of the Contractor"s system and those of other Designated Contractors;

(v) Verify the Tender designs and calculations. In case of simulations, the inputs, relevant formulae, principles, assumptions, algorithm and logic followed shall be submitted with a sample calculation for each case. It shall be obligatory on the Contractor to submit any further details as required by the Engineer to approve the results. Any spreadsheet if submitted shall be supported with the linked formulae and calculations.

(vi) Incorporate the Engineer"s suggestions and changes based on the Technical Specification and/or operational requirements.

5.8 Pre-final Design

5.8.1 In the Pre-final Design stage the conceptual designs (including interfaces with those of Designated Contractors of the Employer, and of the Contractor"s vendors) are required to be fully developed. In this stage, each element of the system will be considered and preliminary specifications with supporting calculations developed. Preliminary electrical and control schematics shall be developed to illustrate how various operational and functional requirements are achieved. Software design and development shall also be carried out at this stage.

5.8.2 Manufacturing units will be allowed to commence production only after receiving 'no objection' advice from the Engineer. This submission shall include sufficient detail from prospective suppliers to demonstrate that they have adequate understanding of the requirements. It will include either evidence of or proposals for design verification. Interfaces with other Designated Contractors shall be finalized by this stage.

5.9 Final Design

5.9.1 The purpose of the Final Design submission is to agree with the Engineer that the equipment is satisfactory, compliant with the specification, fit for purpose and safe. The Final Design shall be the level of design developed to the stage where all manufacturing drawings (including those received from Designated Contractors of the Employer, and vendors of the Contractor) are fully defined and specified and in particular:

(i) calculations and analyses are complete;
(ii) all main and other significant elements are delineated;
(iii) all other work, including studies, investigations and reports are complete

5.10 Design Submission and Review Procedure

5.10.1 All design submissions from the Contractor shall be made under a Design Review Certificate Application (DRCA) notice. The following DRCA numbering system shall be used to identify all submissions:

<Contract No.>/<Subject Code>/<Stage Code>/<Sequence No.>/<Revision No.>

5.10.2 The contract number shall be limited to no more than four digits and reflect the contract number only e.g. BS03, BD01 etc.

5.10.3 The stage code and subject codes should be developed in conjunction with the Engineer to help identify particular types of submissions, e.g., type of service or equipment. A schedule of subject codes for each contract should be submitted to the Engineer for acceptance.

5.10.4 The Contractor shall ensure that all submissions are correctly numbered in accordance with the schedule. The sequence code shall be a unique sequential number for each submission for each particular subject. Revision numbers shall be used when a re-submission is required, i.e. a DRCA was awarded "Not Accepted". For the initial submission the revision code of DRCA number shall be left blank.

5.10.5 Upon receipt of design submissions from the Contractor, a copy of the DRCA will be signed, dated and returned by the Engineer.

5.10.6 The Engineer shall issue Design Certificate Consent (DCC) Sheet properly dated and numbered to Contractor for each of the DRCA. The DCC will carry status as “Notices of No Objection", "Notices of No Objection, subject to…." and decisions made by the Engineer in response to a Design Review Certificate Application made by the Contractor shall be transmitted to the Contractor on a Design Certificate Consent (DCC) Sheet properly dated

and numbered. The consent sheet number shall be the same as the Design Review Certificate Application number except that the letters "DRCA" are replaced by "DCC".

5.10.7 When significant comments are noted by the Engineer on the design submission, the "DRCA" shall be returned "Not Accepted", and signed by the Engineer. One copy of the "DRCA" shall be returned to the Contractor together with the comments on why the submission was rejected.

5.10.8 When minor comments are noted by the Engineer on the design submission and it is "No Objection, but Subject to Comments" the "DRCA" will have the appropriate decision indicated upon it and be signed by the Engineer. One copy of the DCC, together with comments, will be returned to the Contractor.

5.10.9 A submission will be rejected automatically if not signed by the Contractor"s Authorised Design Representative.

5.10.10 Upon receipt of a decision sheet from the Engineer, the "DCC" will be signed, dated by the Contractor, and returned to the Engineer.

5.11 Engineer's Review

5.11.1 The Engineer will complete his review of the submission within 45 calendar days), after which the review comments in writing or on marked up drawings and specifications will be furnished to the Contractor. The Contractor shall then meet with the Engineer to discuss the review comments. Within two weeks of the receipt of the Engineer"s comments the Contractor shall submit its proposals for implementation in the next submission. Where the comments are minor, such proposals may be clarified by calculations, part prints, etc. acceptable to the Engineer and included in the Contractor's next submission. Should the Engineer deem the submission to be unacceptable, the Contractor shall revise and resubmit the entire submission within two weeks, unless otherwise agreed with the Engineer.

5.11.2 After Engineer"s review of the design submissions, the Contractor shall update the documentation incorporating Engineer"s observations and also other design requirements. For all subsequent submissions, the Contractor shall demonstrate that all the previous comments by Engineer has been incorporated. The Comments previously issued by Engineer shall also become part of the submission.

5.11.3 It is Employer"s understanding that the Contractor will need to depute a team of its design engineers for interaction with Employer"s experts at Nagpur. Employer at its discretion may also consider to depute a team of engineers (around six) to Contractors design office or at Sub vendor"s office for requisite duration with a view to expedite finalization of designs. In such case, Contractor shall provide office facilities at their own cost. The Employer shall bear full expenditure towards out of pocket allowance, travel expense (as per entitlement), boarding, lodging etc. by the Employer or his Representative for such visits. Such visit(s) as described above shall not be considered as part of inspection activity.

5.12 Final Design Document Delivery

5.12.1 To achieve agreement with the Engineer on the completion of the design and to allow the formal submission of the Final Design, the Contractor shall submit a list of all accepted Design Submissions to the Engineer for review along with self adhesive stickers signed by the Contractor"s Representative (CR). If there is no objection by the Engineer, he shall then sign and return the self-adhesive stickers to the Contractor for affixing to the amended Final Design Drawings (original) prior to their submission under the Final Design Document Delivery.

5.12.2 Based on the Engineer"s review of the Final Design Submission, the Contractor shall then re-submit the entire Final Design Submission together with the following documents:

(i) joint statements of completed design interface with the Designated Contractors of the Employer;

(ii) a signed statement confirming that he has incorporated all comments of the Engineer.

(iii) a Design Certificate duly endorsed, as shown in Appendix 5.

This above jointly will be known as "Final Design Document Delivery"

5.13 As-Built Drawings and Documents

5.13.1 As-built drawings are intended to show the works exactly as constructed. These are prepared by amending the manufacturing drawings to take into account changes necessitated by manufacturing methodology. These drawings shall be completed on a regular basis as the works progress, and not left until the completion of the Defect Liability Period.

5.13.2 At least 1 months but not more than 3 months prior to the anticipated date of delivery of the prototype rake, the Contractor shall compile and submit to the Engineer for recording purposes all those documents and drawings which in the opinion of the Contractor, constitute the complete record of the design and manufacture of the Works.

5.13.3 The updated compilation of the complete record of the design and manufacture of the Works shall be submitted at the end of the Defect Liability Period.

5.14 Manufacturing Drawings

Detailed manufacturing drawings will not normally be required for acceptance but shall be submitted for comment if the Engineer so requires.

5.15 Post Acceptance Changes

5.15.1 Changes to accepted drawings, whether they are initiated by the Contractor or the Engineer, shall be submitted through the DRCA system. The same process of submission, review and acceptance as described above shall be adopted. Upon acceptance of the post acceptance change, the Engineer shall issue a DCC to this effect. Submission as a result of a post acceptance change shall use a new DRCA number, i.e. not a previously used one.

5.15.2 The Contractor may propose an alternative procedure for implementing post acceptance changes (hardware and software) for review of the Engineer.

5.15.3 For requesting any change to the accepted design the Contractor shall submit the relevant design details for review of Engineer. The Contractor shall not implement any change without receiving „No objection" from the Engineer.

CHAPTER 6

6.0 SOFTWARE MANAGEMENT AND CONTROL

6.1 Perspective Framework

6.1.1 The Contractor shall, within 30 days of Notice to Proceed, submit a Software Assurance Plan for review by the Engineer.

6.1.2 All software to be developed or modified (re-engineered software) shall follow the standardisation requirements of EN 50128 (Railway Applications: Software of Railway Control and Protection Systems). The Contractor shall define within the Software Quality Assurance Plan what techniques and measures are to be applied for software development.

6.1.3 The Plan shall require the Contractor to provide all changes, bug fixes, up-dates, modifications, amendments and new versions of the programmes, as required by the Engineer. Engineer may also direct to provide the copy of previous version of software till such time the new version of software is proven.

6.1.4 The Contractor shall provide all tools, Laptop computers or any special device to upload / download the software, Control data, equipment, manuals and training necessary for the Employer and Engineer to maintain and re-configure all software provided under this Contract. The documentation of software may be supplied after the expiry of the warranty period, under terms and conditions to be mutually agreed at Contract pre-award stage.

6.1.5 When a fault is discovered in delivered software, or an error in the associated documentation, the Contractor shall take the necessary steps to rectify such faults and errors at the earliest opportunity. The Contractor shall supply to the Engineer, full details, in writing, as to the nature of the corrective action proposed or taken. These changes shall be documented in the form of Software Engineering Change Proposal (SECP), which shall be got approved from Engineer. The documentation of software may be supplied after the expiry of the warranty period, under terms and conditions to be mutually agreed at Contract pre-award stage.

6.1.6 It will be incumbent upon the Contractor to take responsibility for any changes required to software.

6.2 Software Framework

6.2.1 As defined in EN 50128, all software produced or supplied for the Project shall be subject to a defined quality framework. ISO 9000-3 shall be considered appropriate for low criticality software (safety integrity level 0 or 1) whilst the application of a more stringent framework shall be required for higher criticality software (safety integrity level 2 or above). The quality framework requirements for safety integrity level 2 and above are supplementary to the requirements of EN 50128.

6.2.2 SIL level of all software used in different sub systems shall be defined and certified.

6.3 Software Management Control

6.3.1 The Contractor shall ensure a full time Software Project Manager and Software Quality Manager are appointed for software development, if software development or modification are required under the Contract.

6.4 Auditing

6.4.1 The Engineer shall carry out an audit of the Software. Further external independent audits may also be arranged at the Engineer"s discretion.

6.5 Software Acceptance

6.5.1 The Contractor also shall submit an Operational Safety Report (Software) for software acceptance by the Engineer.

6.5.2 The Operational Safety Report (Software) shall include, as a minimum:

(i) OSR(S) - Introduction

Shall describe the nature of software sufficiently to ensure that the Engineer is given a comprehensive overview of primary characteristics such as structure, functions, criticality, volume and language.

(ii) OSR(S) - Evidence of Quality Management

Shall provide evidence to demonstrate that the software development has been subject to acceptable quality assurance.

(iii) OSR(S) - Evidence of Safety Management

Shall provide evidence to demonstrate that the software development has been subject to acceptable safety management.

(iv) OSR(S) - Technical Report

Shall describe how software integrity has been achieved.

(v) OSR(S) Operation and Maintenance Report

Shall describe the Software operation and maintenance characteristics.

(vi) ORS(S) - Restrictions for Use

Shall define what restrictions are applied to the use of the software.

6.6 Application Software and Development Tools

6.6.1 With the exception of commercial, “Off The Shelf" Software, the Engineer shall be provided with full access to application software(s) and any other software / hardware tools which may be specifically required for the intended purpose specified in this specification. For commercial software the Contractor shall provide all available documentation for the application and maintenance of that software. In case any commercially available software has been modified for being used in the M&P, the same shall be supplied to all depots.

Complete documentation along with the software to be supplied by the Contractor shall comprise of Signal flow diagram, flow charts, functional blocks, details of signals, interpretations so as to enable Engineer to debug and implement M&P level modifications based on experience in India and to carry out operational & maintenance requirements. Full access to the application software shall be provided for this purpose.

It shall be possible for NMRCL to modify / change various parameters / logics used in the software and implement the changes on M&P. Full facilities including any software / hardware tools, simulation / test bench which are essential for this purpose shall be supplied. NMRCL may depute their engineers during the software development. They shall be fully exposed and given hands-on experience of software modification, simulation and implementation. Details shall be finalised during design. Complete set of parameters along with necessary changes that may be required to be made in the supplied software, shall be furnished so that different makes of equipments if need be, can be integrated. It shall also be possible for Engineer to connect / interface additional peripheral equipment as required by NMRCL with M&P software as the case may be, and implement system integration for the same. Contractor shall demonstrate to entire satisfaction of the Engineer that NMRCL will be able to integrate peripheral equipments of makes other than that have been used by Contractor in the M&P. Any hardware / software tool required for this purpose shall also be supplied.

NMRCL engineers shall be given the required training by the Contractor to the entire satisfaction of Engineer and made conversant with the software and other related issues as

found necessary during the Contract execution. The documentation of software shall be supplied at the time of testing and commissioning of M&P and this shall be considered as a pre-requisite for accomplishment of Key Date 3 (KD3). The final document including all changes that may be done during the currency of the Contract shall be supplied after the expiry of the warranty period and this shall be considered as a pre-requisite for issue of Performance Certificate.

6.6.2 After loading, and the satisfactory functioning of the software, the Contractor shall supply two back-up copies of the software, including any new versions adopted. The documentation of software may be supplied after the expiry of the warranty period.

6.6.3 All software(s), irrespective of contractor"s own software or of sub-suppliers, shall be compatible with latest version of Windows Operating software and shall also have upward compatibility. In case, the compatibility of installed software(s) with latest version of Windows is not available, the Contractor shall replace the installed software(s) that are compatible with latest version of Windows OS without downgrading the train performance. Contactor shall commit to support and supply free of cost any special hardware / software required for ensuring compatibility with new version of Windows for atleast a period of 5 years beyond DLP of the last M&Ps .

6.6.4 Beyond the above period of 5 years, in case of obsolescence suitable alternatives solutions shall be implemented (at mutually agreed terms and conditions) and full support shall be provided by the Contractor so as to ensure that M&P performance are not affected adversely.

Diagnostic tools to be provided as per the Cost Centre C shall include all hardware / software required for the purpose of:

(i) Uploading / downloading of all software used in the M&P / system / sub-systems.

(ii) Downloading of faults and any other information required for trouble shooting and diagnostic purpose.

(iii) Data analysis and investigation tools of real-time downloads on central computer.

6.7 Re-Use of Existing Software

6.7.1 Where existing software (defined to module level) is to be re-used without modification, the Contractor shall provide acceptable evidence to the Engineer as to why that software is suitable for use in the proposed application. This evidence may be historical (certified evidence of previous satisfactory use in a similar environment and application), or it may be sought as cross acceptance from another railway authority or statutory body. Software re-use shall not be acceptable, without detailed review, where the proposed application is of the same or lower safety integrity level than the current application.

6.8 Re-Engineered Software

6.8.1 Re-engineered software may be used for applications at all safety integrity levels where the proposed application is of the same or lower safety integrity level than the current application. However, this shall be subject to quality assurance testing as defined above.

6.9 Test Software

6.9.1 All test software, with the exclusion of built-in test software, shall be produced in accordance with a quality system controlled under the requirements of accepted international standards. Test software shall be developed and documented using structured techniques and shall be designed to be maintainable throughout the duration of the Contract. All test software shall be documented to be supportive of maintenance. Any test software, which is to be delivered to the Employer (for long term testing use), shall be fully documented including source code listings to allow the Employer to maintain the software for the life of the supported system.

6.10 Software Rights

6.10.1 The Contractor shall ensure that the Employer or its licensee is granted all necessary rights to use Software embodied in the equipment and there are no restrictions attached to the use of any information supplied by the Contractor which might later prevent or hinder the Employer or its licensee from modifying or adopting or extending the system. The Contractor shall indemnify the Employer, its heir or Licensees against claim of any party, Sub-contractor for the unauthorised possession or use of the software supplied.

CHAPTER 7

7.0 INSPECTION, TESTING AND COMMISSIONING

7.1 General

7.1.1 The Contractor shall submit Inspection, Testing and Commissioning Plan as per schedule provided in Table 2-1.The Inspection, Testing and Commissioning Plan shall be prepared in accordance with the requirements of Employer"s Requirements – Technical Specification.The Plan shall contain, but not limited to, the following topics:

(i) the Contractor"s methodology for inspection, testing and commissioning;
(ii) all Inspections and Quality Hold Points;
(iii) the interdependency and inter-relationship with Designated Contractors and their commissioning programme;
(iv) the objectives of each test and criteria for successful tests;
(v) organisation chart and CV of key personnel in the Testing and Commissioning team;
(vi) documentation for conducting tests and submission of Testing and Commissioning procedures.

7.1.2 The Engineer will then check the plans to see whether, it meets the requirements. The Engineer shall inform the Contractor in writing within a reasonable period after receipt of the above information:

(i) that the Contractor's proposed methods of inspection, testing and commissioning (including Integrated Testing and Commissioning) have the consent of the Engineer; or
(ii) in what respects, in the opinion of the Engineer the Contractor's proposed methods etc fail to comply with the Employer's Requirements and/or the Final Design Document;
(iii) would be detrimental to the Works and/or to the other works comprising the Project;
(iv) do not comply with the other requirements of the Contract; or
(v) as to the further documents or information which are required to enable the Engineer to properly assess the proposed methods of inspections, etc.

7.1.3 In the event that the Engineer does not give his consent, the Contractor shall take such steps or make such changes in the said methods or supply such further documents or information as may be necessary to meet the Engineer's requirements and to obtain his consent. The Contractor shall not change the methods of inspection, testing and commissioning which have received the Engineer's consent without further review and consent in writing of the Engineer.

7.1.4 Notwithstanding the foregoing provisions of this Clause, or that certain of the Contractor's proposed methods of inspection etc. may be the subject of the consent of the Engineer, the Contractor shall not be relieved of any liability or obligation under the Contract.

7.2 Sequence of Tests

The sequence of tests shall be:

(i) Stage Inspection at Manufacturing Stage as decided by Engineer.
(ii) Factory Acceptance Tests (FAT) of Machinery and Plants prior to dispatch.
(iii) Installation, Testing and Commissioning of Machinery and Plants in Depot.
(iv) Final Site Acceptance Tests (SAT).

INDICATIVE TEST PLAN

Factory Acceptance Tests (FAT) and Site Acceptance Tests (SAT)

SN	Description	FAT	SAT	Remarks
A	**AUTOMATIC TRAIN WASH PLANT (ATWP)**			
A1	Visual & Dimensional Inspection of all Assemblies, Sub-Assembles, Components and Spares, as applicable.	✓	✓	
A2	Functional Tests without load		✓	
A3	Full Functional Tests with load		✓	
A4	Static Load Tests			N/A
A5	Dynamic Load Tests			N/A
A6	Reference Documentation, as applicable	✓	✓	
A7	Statutory Documentation / Compliances, as applicable.		✓	
A8	Civil Foundation Work		✓	
B	**CNC UNDER FLOOR WHEEL LATHE (UFWL)**			
B1	Visual & Dimensional Inspection of all Assemblies, Sub-Assembles, Components and Spares, as applicable.	✓	✓	
B2	Functional Tests without load	✓	✓	
B3	Full Functional Tests with load		✓	
B4	Static Load Tests		✓	
B5	Dynamic Load Tests		✓	
B6	Reference Documentation, as applicable	✓	✓	
B7	Statutory Documentation / Compliances, as applicable.		✓	
B8	Civil Foundation Work		✓	
C	**UNDER FLOOR LIFTING SYSTEM (UFLS)**			
C1	Visual & Dimensional Inspection of all Assemblies, Sub-Assembles, Components and Spares, as applicable.	✓	✓	

SN	Description	FAT	SAT	Remarks
C2	Functional Tests without load			
C3	Full Functional Tests with load			
C4	Static Load Tests	✓		
C5	Dynamic Load Tests		✓	
C6	Reference Documentation, as applicable	✓	✓	
C7	Statutory Documentation / Compliances, as applicable.		✓	
C8	Civil Foundation Work		✓	
D	**MOBILE LIFTING JACKS (MLJ)**			
D1	Visual & Dimensional Inspection of all Assemblies, Sub-Assembles, Components and Spares, as applicable.	✓	✓	
D2	Functional Tests without load	✓	✓	
D3	Full Functional Tests with load	✓	✓	
D4	Static Load Tests	✓		
D5	Dynamic Load Tests		✓	
D6	Reference Documentation, as applicable	✓	✓	
D7	Statutory Documentation / Compliances, as applicable.		✓	
D8	Civil Foundation Work			N/A
E	**BOGIE TESTING MACHINE (BTS)**			
E1	Visual & Dimensional Inspection of all Assemblies, Sub-Assembles, Components and Spares, as applicable.	✓	✓	
E2	Functional Tests without load	✓	✓	
E3	Full Functional Tests with load		✓	
E4	Static Load Tests		✓	E3
E5	Dynamic Load Tests			
E6	Reference Documentation, as applicable	✓	✓	

E7	Statutory Documentation / Compliances, as applicable.		✓	
E8	Civil Foundation Work		✓	

F	**BOGIE TURN TABLE**			
F1	Visual & Dimensional Inspection of all Assemblies, Sub-Assembles, Components and Spares, as applicable.	✓	✓	
F2	Functional Tests without load		✓	
F3	Full Functional Tests with load		✓	
F4	Static Load Tests		✓	F3
F5	Dynamic Load Tests		✓	
F6	Reference Documentation, as applicable	✓	✓	
F7	Statutory Documentation / Compliances, as applicable.		✓	
F8	Civil Foundation Work		✓	
G	**RAIL CUM ROAD RESCUE VEHICLE (RRV)**			
G1	Visual & Dimensional Inspection of all Assemblies, Sub-Assembles, Components and Spares, as applicable.	✓	✓	
G2	Functional Tests without load	✓	✓	
G3	Full Functional Tests with load	✓	✓	
G4	Static Load Tests			N/A
G5	Dynamic Load Tests			N/A
G6	Reference Documentation, as applicable	✓	✓	
G7	Statutory Documentation / Compliances, as applicable.		✓	
G8	Civil Foundation Work			N/A
H	**INSTRUMENTED CATENARY MAINTENANCE VEHICLE**			
H1	Visual & Dimensional Inspection of all Assemblies, Sub-Assembles, Components and Spares, as applicable.	✓	✓	
H2	Functional Tests without load	✓	✓	
H3	Full Functional Tests with load	✓	✓	

H4	Static Load Tests			N/A
H5	Dynamic Load Tests			N/A
H6	Reference Documentation, as applicable	✓	✓	
H7	Statutory Documentation / Compliances, as applicable.		✓	
H8	Civil Foundation Work			N/A
I	**BATTERY OPERATED RAIL CUM ROAD SHUNTER**			
I1	Visual & Dimensional Inspection of all Assemblies, Sub-Assembles, Components and Spares, as applicable.	✓	✓	
I2	Functional Tests without load	✓	✓	
I3	Full Functional Tests with load	✓	✓	
I4	Static Load Tests			N/A
I5	Dynamic Load Tests			N/A
I6	Reference Documentation, as applicable	✓	✓	
I7	Statutory Documentation / Compliances, as applicable.		✓	
I8	Civil Foundation Work			N/A

J	**MULTI-FUNCTIONAL WORK STATION**			
J1	Visual & Dimensional Inspection of all Assemblies, Sub-Assembles, Components and Spares, as applicable.	✓	✓	
J2	Functional Tests without load		✓	
J3	Full Functional Tests with load		✓	
J4	Static Load Tests	✓	✓	
J5	Dynamic Load Tests			N/A
J6	Reference Documentation, as applicable	✓	✓	
J7	Statutory Documentation / Compliances, as applicable.		✓	
J8	Civil Foundation Work		✓	

NOTE:

1. The above General Tests are for indicative purpose only, as applicable for each respective M&P.
2. Final Plans / Schedules for FAT & SAT will be finalised during the Design Review Phase, based on the Technical requirements of the tender.
3. All the facilities required for carrying out the FAT, should be available at the Manufacturer's premises and will have be extended to the Inspection team during Factory Inspection.
4. All additional facilities required for carrying out the SAT, except Train or Train Components, should be arranged by the M&P contractor, at his own costs.

CHAPTER 8

8.0 SUPPLY OF SPARES, SPECIAL TOOLS AND TESTING EQUIPMENT

8.1 General

8.1.1 The Contractor shall supply the following items of spares:

(i) Consumables / spares for maintenance of all Machinery and Plants during Installation, Commissioning, Testing and upto completion of Warranty period;
(ii) Mandatory spares;
(iii) Recommended spares;

8.1.2 Not Used

8.1.3 The relevant list of the spares mentioned above shall be submitted in the technical bids after blanking the prices, where applicable. The financial bid shall have the price details.

8.1.4 Contractor shall submit purchase and technical specifications of bought out items used in this project. Engineer"s views, if any, shall be suitably incorporated.

8.2 Not Used.

8.3 Consumable Spares

8.3.1 The consumable spares shall include lubricants, oils, greases, sealants, filter medias, gaskets, lamps, wearable parts like Rubber Items etc. and such items, whose declared life is one year or less.

8.3.2 The consumable spares shall be stored at respective depots.

8.3.3 The Tenderer shall provide a recommended list of consumable spares as noted above for maintenance, repairs and overhaul of Machinery and Plants. Any consumable item if required but not included in the above recommended list by the Tenderer will be deemed to have been included and shall be supplied as per the provisions of this Contract without any extra financial implication to the Employer. Contractor will be required to supply only the requisite quantity of spares, as required irrespective of the quantities indicated by the Contractor in the recommended list. Employer"s decision in determining any particular item as consumable(s) in line with Clause 8.3.1 above will be final and binding. In case any changes are required in the supply of consumables on account of changes at design stage, the Contractor shall have to supply the required consumables within the quoted cost. No increasein quoted cost shall be made due to any change in the list of consumables arising due to change/modification of design.

8.3.4 Unpriced list of consumable spares shall be furnished in the Technical Package. List of consumable spares shall contain following information as a minimum:

(i) Names, addresses, telephone numbers and other particulars of manufacturers and their local representatives;
(ii) Models and part numbers,
(iii) Full description of spares including a note whether it is sealed unit or an assembly or sub-assembly which can be broken down into component parts;
(iv) Quantity installed in the system;
(v) Expected consumption rates;
(vi) Overall dimensions and weight including minimum packing (if any) for shelf space purposes;
(vii) Interchangeability or otherwise with similar parts;
(viii) Normal manufacturing and shipment lead times; and
(ix) Shelf life.

8.3.5 It shall be the responsibility of the Contractor to maintain sufficient stock of consumable spares during DLP, at the respective depots of different lines.

8.3.6 Recommended Spares List shall be furnished by the Contractor as part of design submission for respective systems and subsystems.

8.4 Mandatory spares

8.4.1 The Contractor shall supply the Mandatory Spares as listed in the Appendix 6 of this Employer"s Requirements - General Specification. The Spares shall be supplied in the Depot nominated by the Engineer. The items and quantity required are mentioned in the list in Appendix 6. The price of these spares shall be quoted at actual.

8.4.2 No change in quoted cost of any spare will be allowed even when there is change in design of any equipment/sub-system during execution of the Contract.

8.4.3 Contractor will furnish complete details during Contract execution (detailed design stage) as noted below for the listed spares:

(i) Names, addresses, telephone numbers and other particulars of manufacturers and their local representatives;
(ii) Models and part numbers
(iii) Full description of spares including a note whether it is sealed unit or an assembly or sub-assembly, which can be broken down into component parts;
(iv) Quantity installed in the system;
(v) Overall dimensions and weight including minimum packing (if any) for shelf space purposes;
(vi) Designed/ shelf life;
(vii) Interchangeability or otherwise with similar parts;
(viii) Normal manufacturing and shipment lead times;
(ix) Purchase Technical Specification with relevant drawings

The information as above shall also be given for all other components / equipments etc. which may have to be changed / replaced during maintenance as decided by the Engineer based on the proposed maintenance practices of the Contractor.

8.5 Recommended spares

8.5.1 The Tenderer shall furnish price list of the recommended spares, not covered consumables and mandatory spares but are expected to be required during two years of defect liability period and for five years after the expiry of defect liability period, along with the bid as per format enclosed in Appendix 6 of this Employer"s Requirements - General Specification. The Spares shall be supplied in the Depot nominated by the Engineer.

8.5.2 Contractor shall supply all the spares recommended by equipment/sub-system manufacturers within the quoted cost for recommended spares. Contractor shall furnish list of spares recommended by equipment/sub-system manufacturers at design submission stage.

8.6 Not used.

8.7 Not used.

8.8 Not used.

8.9 Manufacture, Delivery and Warranty

8.9.1 The major spare parts ordered under the Contract shall be manufactured, works tested and inspected in accordance with the relevant quality system, suitably packed and labelled in accordance with Employer"s Requirements General Specification “Storage, Packing, Crating and Marking" and delivered by the Contractor to the depot as directed by Engineer. All spares

shall be subject to inspection by the Engineer. In the event that any item is known to be going out of production, then the Contractor shall give advance notice to the Engineer.

8.9.2 The warranty period of mandatory spares, recommended spares or any other item / equipment delivered shall be:

(i) either 24 months from the date of receipt of material or
(ii) upto expiry of the Defect Liability Period (DLP) whichever is later.

8.10 Purchase of Spares from Vendors

8.10.1 The Contractor shall furnish an undertaking that he has no objection whatsoever to and shall not in any way deter or obstruct the Employer, its licensee or its representative from dealing directly with the Contractor's Vendors for the purchase of the spares during the Contract period. The spares purchased shall be subject to inspection by the Engineer.

8.10.2 Contractor shall obtain an undertaking from vendors, OEMs etc. at detailed design submission stage that they will deal directly with Employer for supply of spares, equipments and/or sub-systems.

8.11 Commissioning and DLP Spares

8.11.1 The Contractor shall submit to the Engineer for review a list of minimum spare parts that he intends to make available during the installation, erection, commissioning and defect liability periods.

8.11.2 The Contractor shall keep on Site, at its own cost, throughout the installation, erection, commissioning and defect liability periods, stocks of spare parts, as per the list to enable rapid replacement of any item found to be defective or in any way in non-conformance with the Specification.

8.11.3 The Contractor shall generally not be entitled to use any of the Employer's spare parts during the installation, erection and commissioning periods, nor during the Defects Liability Period.

8.11.4 Contractor shall not be permitted to remove any working/healthy equipment / components / sub-systems / systems from any of the train available at any of the depot for any reason whatsoever without specific approval in writing from NMRCL"s depot in-charge or Engineer"s authorised representative.

8.11.5 Stocks of spares as available in Contractor"s stores will be jointly checked with Engineer every three months. Certificate by Engineer confirming availability of the spares in Contractor stores in Depots as per agreed list will be a pre-requisite for release of interim payments of the Contractor. However, this condition will not be applicable for six months before the expected expiry of the DLP period.

8.12 List of Spares

8.12.1 The Contractor shall ensure availability of spare parts for a period of ten years from the last date of taking over of whole of Works by the Employer. The Tenderer shall furnish an unpriced list of spares for maintenance, overhaul and repair of Machinery and Plants separately (if there are difference in items) for a period of ten years from the date of taking over, in the Technical Package. The spares shall be in kit form. The Tenderer shall also quote unit prices for the kit of spare at the Depot along with escalation clause in the Financial Package. The Employer at its discretion, during a period of ten years from the date of taking over of the whole works, purchase as many kits of spare parts as required by him, at the rates indicated in this schedule.

8.12.2 If during the period of ten years, the Contractor intends to discontinue the manufacture of spare or replacement parts for the Machinery and Plants, the Contractor shall immediately

give notice to the Employer of such intention. The Employer shall be given the opportunity of ordering at reasonable prices such quantities of such spare or replacement parts as the Employer shall reasonably require in relation to the anticipated life of the Machinery and Plants.

8.12.3 In the event of Contractor failing to supply the spare parts in accordance with this Clause, he shall in respect of each item of spare, furnish free of cost to the Employer, the drawings, specifications, patterns and other information to enable the Employer to make or have made such spare parts. The Employer shall be entitled to retain the aforesaid drawings etc., for such time only as is necessary for the exercise by the Employer of its rights under this clause and the drawings, if the Contractor so requires, shall be returned by the Employer to the Contractor in good order and condition (fair wear and tear excepted).

8.12.4 Under such circumstances, the Contractor shall also grant to the Employer, without payment of any royalty or charge, full right and liberty to make or have made spare or replacement parts as aforesaid and for such purposes only to use, make and have made copies of all drawings, patterns, specifications and other information supplied by the Contractor to the Employer pursuant to the Contract.

8.12.5 The Contractor will so far as it is reasonably able to bind its sub-contractors to conform with the requirements of this Clause and shall, prior to entry into any sub-contracts, provide the Employer with full details of any sub-contractor who will not so conform in which event the Employer may direct the Contractor to seek an alternative sub-contractor.

8.12.6 If the Contractor fails to provide spare or replacement parts as described in this Sub-clause and these are available from the Contractor"s sub-contractor, the Employer shall have the right to obtain such spare and replacement parts from the sub-contractor or any other supplier and any additional cost incurred by the Employer shall be recoverable from the Contractor.

8.12.7 In case the Contractor is unable to supply spares in accordance with Clause above, he shall furnish, free of cost to the Employer, the drawings, specifications, and other technical details, to enable the Employer to manufacture parts, or have them manufactured. Such drawings and technical data shall be provided free of any charge or royalty, on the understanding that the Employer will use such data and drawings, only for the manufacture of parts for its own use.

8.12.8 The foregoing shall hold equally good for the Contractor, any or all of its subcontractors, and vendors.

8.12.9 In the event that technological progress results in improved versions of spares and replacement parts, the latest version shall have the same plug compatibility, and spatial needs of its predecessor, to avoid modifications being required, to accept the up-graded version of the part.

CHAPTER 9

9.0 TRAINING

9.1 Training Requirements

9.1.1 The Tenderer shall include and price in its tender submission a Training proposal, for O&M aspects of similar Machinery and Plants, to meet the following requirements:

(i) Training of Employer"s Operation & Maintenance Personnel in Contractor"s Works (90 Man Days in total considering all Machinery and Plants).
(ii) Training of Employer"s Operation & Maintenance Personnel on Site during Installation, Testing and Commissioning at NMRCL (300 Man Days in total considering all Machinery and Plants)
(iii) Submission of Training Manuals (hard bound coloured five hard copies) and in Electronic format.

9.1.2 The Tenderer shall list the cost for each component module of the Training in terms of Man-Days in Financial Package. The travel, boarding and lodging expenses for the Employer"s trainees will be borne by the Employer. The Employer may at its absolute discretion delete any or all of the training modules while accepting the tender.

9.1.3 Facilities such as classrooms, LED projectors and video monitors will be made available for imparting training in Employer"s depots in India free of cost to the Contractor. However, for training in the Contractor"s works, such facilities shall be arranged by the Contractor at its own cost. The Contractor is however, required to provide at its own cost all other necessary training aids such as written and printed notes, video programmes, transparencies, slides, films, models and drawings, CDs and other training aids etc.

9.1.4 The Employer"s personnel required to undergo training will be qualified electrical, mechanical and electronics engineers, technicians, supervisors or instructors, with relevant practical experience. The training syllabus should therefore concentrate on familiarisation with particular systems and equipment of the M&P and technologies outside of their experience.

9.1.5 Training Instructors provided by the Contractor shall be fully qualified and experienced electrical, mechanical and electronics engineers and experts in the relevant field with experience in training of engineering graduates and technicians to the level of competency essential for operation and maintenance of Machinery & Plants of similar specifications. The Instructors shall be preferably English speaking. If any interpreter is required, it shall be arranged by the Contractor at its cost. The appointment of Instructors shall be confirmed only after its detailed *curriculum vitae* have been accepted by the Engineer. In the event that an Instructor is subsequently deemed not to be competent, he shall be replaced forthwith.

9.1.6 The Contractor shall submit a detailed Training proposal in the Technical package to meet the above requirements.

9.2 Training Objectives: Train Operating Staff

9.2.1 The objective of training of M&P operating staff is that the batches of operators and instructors should be able to operate the M&P safely under all operating conditions. The training should also enable them to acquire full capability for identification and trouble shooting of the faults in the specified duration. In order to achieve the above objective, the Operating Staff and instructors should be trained in the Contractor"s Works off-shore and on a Test Track. It will be preferred that after classroom instructions, which include mock-ups of M&P, the staff are trained in actual operation of M&P in a MRTS depot or on a test track, having similar M&P, to acquire the required confidence.

9.2.2 The Contractor"s Instructors deployed for training of operating Staff in India shall provide training in classroom, as well as actual operation of M&P during and after commissioning of M&P in India. The instructors shall also train the operating staff in trouble shooting of the faults and emergency procedures.

9.3 Training Objectives: Maintenance Staff

9.3.1 The training should enable the engineers, inspectors and staff to achieve the following broad objectives:

(i) Full understanding of all aspects of the system design and functions of all the equipment including proprietary and third party equipment, software etc.
(ii) Full understanding of all aspects of programmed maintenance and overhaul requirements of M&P and equipment.
(iii) Procedures to be followed for unscheduled maintenance and repair of M&P and equipment.
(iv) Identification of failed components and sub-systems in electronic equipment by use of special test equipment, as necessary.
(v) Modification in the software to extend or modify the control and monitoring functions.
(vi) Maintenance Management Information System and documentation.
(vii) Monitoring and scheduling of M&P in the Progress Planning and Investigation Organisation.
(viii) Stores inventory planning and control.

9.3.2 The training of Employer"s personnel off shore shall include direct exposure to engineers, technicians, inspectors and staff in actual repair, maintenance and overhaul of similar M&P in the Depots and Workshops of an operational Mass Rapid Transit System.

9.3.3 The Contractor"s Instructors deputed to train Employer"s personnel in India shall impart theoretical as well as practical training so as to enable them to develop skill and expertise necessary for satisfactory maintenance, repairs and overhaul of M&P.

9.4 Training Methods

9.4.1 As a general guide, training shall be based upon a “two-stage” concept:

(i) Stage one shall consist of training in the basic concepts and principles. These shall include system configuration and specification, operation and control of all equipments installed in the M&P, preventive maintenance procedures, overhaul and repair concepts, fault diagnostic and trouble shooting and emergency procedures, overhaul and repair concepts, fault diagnostic and troubleshooting and emergency procedures. The training shall consist of class room (theory) training; computer based inter-active training and mock-up training.

(ii) Stage two shall consist of “hand-on” site-based practical training on preventive and corrective maintenance and operating procedures.

(iii) The Contractor shall also include the training of the staff in the correct procedures of maintenance and repair of different equipment based on the Training Manual supplied against the contract.

(iv) Contractor shall arrange the experts from the OEMs of the systems to impart the “hands on” training at site for the agreed durations during the Contract execution.

(v) Training evaluation shall be carried out at regular intervals to monitor the progress and suitability of the training programme, and of the trainees.

(vi) The performance of Contractor"s Instructors shall also be evaluated by the Engineer at regular intervals.

Contractor shall depute a training manager for complete management of the training throughout the project. Contractor shall propose a comprehensive training programme comprising of different modules and prospectus for approval. The programme shall be reviewed by the Engineer based on the operational and maintenance needs and feedback of the completed training modules.

9.4.2 Contractor shall provide training for maintenance on models with CBT etc. and overhauling of the equipments.

9.5 Training Manual

9.5.1 The Contractor shall provide one original and five coloured copies of the Training Manual for use by the Employer for conducting in-house training. The Manuals shall cover all requirements specified in this chapter.

9.6 Transfer of Training Aids

9.6.1 After completion of the training, training aids and materials used shall become the property of Employer to enable and further training to take place.

9.7 Training Location and Facilities

9.7.1 Training shall be carried out at such locations as will provide the maximum benefit to the trainees. Such locations may be in India, or abroad, at places of manufacture, assembly or testing, or at other locations as may be necessary. All locations proposed for training shall be subject to the consent of the Engineer. Details of the facilities proposed to be provided, shall be included within the detailed Training Proposal submitted by the Contractor.

9.8 Administration

9.8.1 The Contractor shall be responsible for the reception, office facilities etc. for the trainees, when in countries other than India.

9.8.2 The Contractor shall be responsible for the general welfare, health and safety of trainees under its control.

CHAPTER 10

10.0 SITE AND SITE MANAGEMENT

10.1 Access to Site

10.1.1 The Contractor will be given access to the Site in accordance with Clause 2.2 of the General Conditions of Contract.

10.2 Site Facilities

10.2.1 The Contractor will be provided, free of cost, approximately 200 sqm of total space at each depot for the setting up of Contractor"s site offices and covered stores, and for the staff working on the Machinery and Plants. These site offices shall be built commensurate with the architecture of the surrounding buildings and after obtaining the approval of Engineer for its broad design. The structure shall be handed over to Employer after the completion of the Defect Liability Period (DLP).

10.2.2 The Contractor shall arrange its furnishing, security etc. Charges for the electricity consumption shall be payable by the Contractor at the prescribed rates.

10.2.3 Offices shall be contained in one building and each office shall be accessible only from a corridor within the building. An external double door with reception area shall be provided to the corridor.

10.2.4 Materials used for the construction of the offices shall be new and of good quality. Materials shall be chosen such that the buildings when erected shall give good temperature and sound insulation.

10.2.5 Windows to each room shall be of an area not less than 10% of the floor area. All the rooms shall be adequately ventilated. All windows to ground floor offices shall be fitted with burglar bars firmly attached to the structure of the building.

10.2.6 The Contractor shall also arrange for the constant and hygienic disposal of all effluent, sewage and rubbish from the buildings.

10.2.7 All buildings shall be supplied with electricity 240V, 50Hz that shall be distributed to each room in accordance with the Regulations. Lighting and electrical power points shall be provided to each room.

10.2.8 Fire-fighting equipment shall be provided in accordance with the recommendations of the Maharashtra Fire Service.

10.2.9 The Contractor shall provide, erect and maintain appropriate name boards as specified for each of the offices.

10.2.10 Three Phase and Single Phase Power (as required) will be made available to Contractor free of charge for Installation, testing and commissioning. The Contractor shall liaise with Designated Contractors for availing of the power and assuring compliance of all safety procedures. The Contractor shall provide his own M&P operators for Testing, Commissioning and Trials.

10.2.11 The Contractor shall provide its own lifting facilities for unloading of Machinery and Plants and any heavy equipment, at the port of arrival, transhipment point, and depot. The Contractor shall however, be allowed to use any necessary Depot facilities free of charge for assembly, commissioning, inspection, repairs to Machinery and Plants and related Equipment, subject to availability. The Employer shall, however, not be responsible for adequacy, reliability and safety of the facilities provided to the Contractor.

10.2.12 Reasonably lit access to the areas and to rail sidings, if applicable,will be provided by others. If lighting is not provided in the specific areas allocated to the Contractor, he should make its own arrangements. The Contractor shall be solely responsible for the security and

housekeeping of the area, plant and possessions allocated to him. The Contractor shall provide and maintain all facilities required by him in the area allocated for its exclusive use and all other work required to allow the Contractor to fulfilits obligations under the Contract.

10.2.13 The Contractor shall arrange at its own cost all Site services necessary and appropriate for the assembly, testing and commissioning of M&Ps, which shall include, but not necessarily be limited to:

(i) Electricity at site-area (other than traction & inside the shed)
(ii) Compressed air other than the depot inspection shed;
(iii) Communication facilities; and
(iv) Instrumentation.

10.2.14 The Contractor shall be responsible for making applications or requests to the concerned Authorities for availing of the above facilities. In the event that electricity or water supplies are arranged by another Designated Contractor in the Depot area, the Contractor may avail himself of those supplies from the Designated Contractor, either directly on agreed terms and conditions. The Contractor shall comply with all regulations of the utility companies and Government departments concerned.

10.2.15 The Contractor shall allocate at its Works, and those of its major subcontractors, adequate office space, furniture and equipment for the use of the Employer"s Inspection Engineers. Such accommodation shall include secure filing for Contractual and other sensitive documents, and secure telephone with net connectivity, computer and facsimile facilities. Such facilities shall apply equally to the overseas and the local building phases of the Works.

10.3 Site Management

10.3.1 The particular use to which the Site is put shall be submitted to the Engineer for review within 120 days of the Date of Notice to Proceed. The Contractor shall:

(i) confine its use of the areas of the Site to purposes having been reviewed without objection by the Engineer who reserves the right to extend, amend or restrict the uses to which areas of the Site will be put;

(ii) where required under the Contract, provide and maintain fencing and lighting around and within the areas of the Site when or where necessary for the safety and convenience of the public or others or as directed;

(iii) refrain from depositing rubbish or causing nuisance or permitting nuisance to be caused and, except where reviewed without objection by the Engineer, depositing earth on or removing earth from areas of the Site;

(iv) refrain from felling trees, other than those specifically identified in the Contract to be felled, and refrain from depositing earth around the trunks of trees and protect all trees remaining on Site to the satisfaction of the Engineer.

(v) except where otherwise provided, not permit any person to reside on the Site.

(vi) unless otherwise stated, pay all rates and charges of any nature whatsoever arising out of his use of the Site and all work areas provided therein under the Contract.

(vii) not use any part of the Site or Works for advertising purposes except with the acceptance of the Engineer.

10.3.2 The Site shall be maintained in a clean and tidy condition. Materials, including those required for Temporary Works, shall be stored in an orderly manner. The Contractor shall, throughout the period of the Contract, provide a central collection point on Site, as reviewed without objection by the Engineer, for collecting all empty cans, drums, packing and other receptacles capable of holding water. The Contractor shall ensure the regular collection and removal of such debris from the Site. After every shift of works, all work areas shall be cleaned and made tidy to the satisfaction of the Engineer.

10.3.3 The Contractor shall ensure that gases, fuels, explosives and other dangerous goods are stored and handled in a safe manner and in accordance with the Statutory Regulations pertaining to their storage and handling. The Contractor shall be responsible for obtaining the requisite licences at its own cost.

10.3.4 The Contractor shall provide all necessary protective clothing, safety equipment, hand tools, ladders, trestles, power supply, and replacement equipment for the staff engaged on Site maintenance.

10.3.5 Because of the multi-disciplinary nature of the Project, several different parties may require access to the same portion of the Site during the construction phase, for the installation, erection and testing of the Works.

10.3.6 To facilitate the organization and co-ordination of access and occupation requirements, the Contractor shall maintain a close liaison with other Contractors.

10.3.7 As soon as any or all of the Contractor's installations are no longer required for the execution of the Works, the Contractor shall remove those facilities and ensure that the area is left free of debris, excess materials, and obstructions.

10.4 Site Safety

10.4.1 The Engineer will issue to the Contractor with the latest edition of the Employer‟s Project Safety Manual. The Contractor shall, as a minimum, comply with the Safety Manual. However, this shall not relieve the Contractor of any of its statutory duties, obligations or responsibilities under the Contract. The Engineer reserves the right to order the immediate removal and replacement of any item of Contractor‟s equipment, which is deemed to be in an unsafe condition.

10.4.2 The Contractor shall submit, as part of its Safety Plan, a Site Safety Plan, and also designate a member of its staff as Safety Officer.

10.4.3 The Contractor shall establish and maintain and staff at all times when personnel are on site, a First Aid Post. Portable First Aid Boxes shall be maintained in a fully equipped state at each site work centre. The Contractor shall ensure that at least one employee on every working shift, is a trained First Aider, capable of administering First Aid competently until the arrival of professional help, in an accident situation.

10.4.4 The Contractor shall be fully responsible for the safety of the Works, its personnel, its sub-contractors‟ personnel, the public, and any persons directly or indirectly associated with the Works, or on or in the vicinity of the depot site. The Contractor shall treat safety measures as high priorities in all its activities throughout the execution of the work.

10.4.5 The Contractor shall submit to the Engineer, regular Site Safety Reports, and shall notify immediately the occurrence of an accident involving its staff or that of its sub-Contractors, or to any person within the area of the depot for which the Contractor is responsible.

CHAPTER 11

11.0 TRAFFIC, ROAD & APPURTENANCES

11.1 General

11.1.1 The Contractor shall conform to the applicable requirements of the Motor Vehicle Act 1988. The Contractor shall ensure compliance with the requirements regarding the licensing of drivers and the registration of vehicles. Vehicle size and load limitations shall be in accordance with all statutory requirements.

11.2 Transportation to Site

11.2.1 The Contractor shall make all arrangements and assume full responsibility for transportation to the site at nominated depots of the Machinery and Plants, and all related plant, equipment, materials and supplies needed for the proper execution of the Works. Procedures for access to and from the Site shall be co-ordinated with the relevant Authorities.

11.2.2 The Contractor shall use such routes and rights of entry to the Site as may be decided by the Engineer from time to time. Routes for 'very large' or 'very heavy' loads shall be discussed with the Engineer in advance and all arrangements thereafter shall be submitted to the Engineer. In this context, the definition of the terms "very large" and "very heavy" refer to articles that cannot be transported by normal road vehicles or be handled by readily available methods. Where doubt exists, it shall be the responsibility of the Contractor to notify and discuss the nature of the load in question with the Engineer for possible solutions.

11.2.3 The Contractor shall be responsible for obtaining permission from the Traffic Police and other relevant authorities to move “very large” and “very heavy” loads and for arranging police escorts if required. The Contractor shall ensure that all roads and pavements, etc. leading to and around the Site are kept free from obstructions and shall not cause inconvenience or hindrance to traffic or persons either by its vehicle or its workmen, scaffolding, plant, materials, equipment, etc. All Workmen working on the road shall wear approved reflective safety vests at all times.

11.2.4 The Contractor shall repair damage caused, if any to existing roads, footpaths, steps, cables, sewers, drains, etc. and shall reinstate the same at its own expense to the satisfaction of the relevant authorities.

11.2.5 The Contractor is to ensure that supplier of the contracted material/ supplies should transport goods only though registered common carriers, as per the provisions of carriage by road act, 2007 and carriage by road rules, 2011.

CHAPTER 12

12.0 OPERATION AND MAINTENANCE MANUALS

12.1 General

12.1.1 The Contractor shall provide Operation and Maintenance manuals, for use by supervisory, operating and technical staff of NMRCL, in English.

12.1.2 Thirty days before the date of commencement of Installation and Commissioning of the Machinery and Plants, the Contractor shall deliver the originals and 6 coloured copies each of the final Operation and Maintenance manuals. These manuals shall have been submitted for proof reading and training purposes prior to delivery. It is accepted that further amendments may subsequently be required.

12.1.3 Each and every manual shall be divided into indexed sections explaining the subject matter in logical steps. Most manuals shall consist of A4-size printed sheets bound in stiff-cover wear-resistant binders clearly and uniformly marked with the subject matter and reference number. Where alternative sizes are proposed, (e.g. A5/A6 pocket books of schematic wiring diagrams) these shall be for review and acceptance. The binding shall allow for all subsequent changes and additions to be readily effected.

12.1.4 Information shall be provided in pictorial form wherever whenever possible and shall include step-by-step instructions and views of the particular equipment including exploded views. Programmable equipment shall be supplied with sufficient flow charts and fully documented programmes to enable faults to be quickly identified and system modification to be undertaken at any time.

12.1.5 The Contractor shall provide clarifications and amendments to the Operation and Maintenance manuals as necessary during the execution of contract. Updates shall be provided for the originals and all copies.

12.2 Operation Manuals

12.2.1 The Contractor shall provide operation manuals explaining the purpose and operation of the complete system together with its component subsidiary systems and individual item of equipment. The characteristics, ratings and any necessary operating limits of the Equipment and Sub-systems shall be provided.

12.3 Maintenance Manuals

12.3.1 The Contractor shall provide maintenance manuals showing details of all the various systems and sub-systems from a maintenance and fault finding standpoint, with particulars of operating parameters, tools for dismantling and testing, methods of assembly and disassembly, tolerances, repair techniques and all other information necessary to set up a repair and servicing programme.

12.3.2 The Contractor shall provide documentation for all hardware and software for computer systems and other associated electronic equipment to meet the following requirements. Contractor shall ensure the any hardware(s)/software(s) required for the purpose as covered in the maintenance manuals are supplied free of cost. Such documents shall include but not be limited to:

(i) manufacturers' documentation supplied as standard with the equipment;
(ii) hardware configuration with details of expansion capabilities and options;
(iii) programme loading instructions, including runtime environment configuration;
(iv) programme listing including comprehensive 'comment statements' in hard copy and soft format for source code, compilers and development tools necessary to modify and recompile software;
(v) flow charts, data flow diagrams and state diagrams as appropriate;
(vi) description of software modules including purpose, linkage with other modules, error routines and any special considerations;

(vii) memory maps for both internal and peripheral memory showing description of all programmes, data files, overlay areas, memory available for expansion and the like;
(viii) loading and operating instructions for diagnostic programmes and specifically developed debugging tools; and
(ix) programming manuals relevant to operating systems, languages, development tools, etc.

12.3.3 The documentation of software may be supplied after the expiry of the warranty period, under terms and conditions to be mutually agreed at Contract pre-award stage. The manual shall also include inspection/overhaul procedure and periodicity of various inspection/overhaul schedules in detail including the tools, special tools/plants, and facilities required. The manual shall be subject to review by the Engineer.

12.3.4 A preliminary maintenance schedule specifying the frequency of inspections and the scope of work during such inspections, including facilities, manpower and down-time required shall be included within the Tender.

12.3.5 The maintenance manual shall also include an illustrated parts catalogue of all equipment and components supplied and shall contain sufficient information to identify and requisition the appropriate part by maintenance staff. The catalogue shall comprise 3 subsections. The first sub-section shall be an alphanumeric parts list, which shall include the following information:

(i) Part number
(ii) Description
(iii) Name of manufacturer
(iv) Quantity and Unit
(v) Part number of next higher assembly (usually a line replaceable unit).
(vi) Cross-reference to figure number.
(vii) Category e.g. consumable, line replaceable unit, repairable.
(viii) Life-expected life, Mean time between failure or mean distance between failure where available.
(ix) General or specific purpose
(x) Purchase and technical specification

The second sub-section is a series of illustrations to indicate the location of each replaceable item, which shall be clear and progressive with exploded views to enable parts to be identified easily by cross-reference with the alpha-numeric list.

And the third sub-section, an indicative price list which shall list in alpha-numeric sequence the part number with the price, lead time and vendor.

12.4 Electronic Manuals

12.4.1 The Contractor shall provide manuals in electronic format. This is in addition to the submission of manuals in hard-copies.

12.4.2 The format of the electronic copies shall be proven in at least two other applications and shall allow for links between parts catalogue and maintenance instructions.

12.4.3 The Documents Management System

The Documents Management System (DMS) shall be PC based, menu driven and user friendly with extensive linkages between OEM"s documents, spare parts catalogues, test certificates, HECPs, SECPs etc. The DMS to be used shall be demonstrated and approval of the Engineer obtained. After Taking Over Certificate, one copy of the DMS, fully functional shall be handed over. The Contractor shall however keep another set updated & handover the second set to NMRCL one month before the expiry of DLP. Language used shall be subject to Engineer"s review.

CHAPTER 13

13.0 STORAGE, PACKING, CRATING AND MARKING

13.1 General

13.1.1 The Contractor shall be fully responsible for the provision and maintenance of acceptable storage facilities for the Plant and any materials or equipment he intends to use for the carrying out of the Works.

13.1.2 The Contractor shall prepare, protect and store in a manner to be accepted by the Engineer, all equipment and materials so as to safeguard them against loss or damage from repeated handling, from climatic influences and from all other hazards arising during shipment or storage on or off the Site. Secure and covered storage shall be provided for all equipment and materials other than those accepted by the Engineer as suitable for open storage.

13.1.3 The Contractor shall provide all packing, crating and markings. In so doing he shall comply with the following requirements:

(i) All packing procedures shall be subject to acceptance by the Engineer.

(ii) Spare parts shall be tropicalized in their packing for prolonged storage in accordance with BS 1133 or equivalent and shall be suitably labelled to indicate :

- Ownership (NMRCL)
- Shelf life
- Type of storage
- Description of item and relevant part number
- Serial number, if applicable
- Inspection Certificate number and batch number, that is, the number allocated by the Contractor's Inspector at the time of manufacture or packing

(iii) Protection requirements shall include but not be limited to:

a. Electrical and other delicate items or equipment shall be properly protected to the Engineer acceptance.

b. Tube ends, cable ends, cable entry points into equipment and other similar terminations and openings shall be blanked off to prevent ingress of dirt, moisture, vermin or insects and to provide protection against damage.

c. Flanged ends shall be protected by adhesive tape or jointing material covered by a properly secured wooden blank not smaller than the flange itself. Plain tube ends shall be closed off with bungs or plugs or suitable materials firmly fixed in position.

d. Particular care shall be taken to prevent damage to or corrosion of shafts and journals where they rest on timber or other supports, which may contain moisture. At such points, wrappings impregnated with anti-rusting composition shall be used. Wrapping shall be of sufficient strength to resist chafing under the pressures and movements likely to occur in transit.

e. Spare ball and roller bearings and similarly protected items shall not be removed from the manufacturer's wrappings or packing.

(iv) Each case, crate or package shall be legibly and indelibly marked in large letters with the name (NMRCL), address, Contract Number, "right way up", opening points and other markings as necessary to permit materials and Plant to be readily identified and handled during transit and when received at Site.

(v) Each case, crate or package shall contain a comprehensive packing list showing the number, mark, size weight and contents together with any relevant drawings. A

second copy of the packing list shall be enclosed in a watertight enclosure on the outside of each case.

(vi) All items heavier than 100 kg shall be marked on the outside of the case to show the gross and net weights, the points for slinging, and where the weight is bearing.

(vii) Care shall be taken to prevent movement of equipment within cases, crates or packages by the provision of bracings, straps and securing bolts as necessary. Bags of loose items shall be packed in cases and shall be clearly identified by well-secured labels on which the quantity and name of the part and its index or catalogue number have been stamped.

(viii) In order to reduce fire risk and prevent obstruction, all empty cases, crates, or packages whether or not returnable shall be removed from the Site as soon as possible. If this requirement is not complied with, after due notice, the Engineer will instruct the Civil Contractor or others to remove them and the Employer will back-charge the Contractor the costs incurred together with handling charges.

13.1.4 If sea transportation of Machinery and Plants from manufacturer"s works to site at Nagpur is required, seaworthy packing/ treatment of Machinery and Plants shall be carried out for the safe transportation of Machinery and Plants. It shall apply to sea transportation of spares and other materials also.

CHAPTER 14

14.0 PUBLIC RELATIONS MATTERS AND PROGRESS PHOTOGRAPHS

14.1 General

14.1.1 The Contractor shall, in conjunction with the Engineer, liaise with Public Relations Officer, NMRCL on all press and public relations matters in connection with the Contract.

14.1.2 All press releases, press statements, articles or printed material prepared by the Contractor shall be submitted to NMRCL, in consultation with the Engineer prior to publication or release to the news media.

14.1.3 All press queries relating to the Contract received by the Contractor must be referred to NMRCL for clearance, in consultation with the Engineer. The Contractor is not allowed to be interviewed by the press or divulge any information freely to reporters without first seeking clearance from NMRCL.

14.1.4 Use of the NMRCL logo in the Contractor"s publications shall be subject to approval of NMRCL.

14.1.5 The Contractor shall provide NMRCL and the Engineer with schedules relating to night works, traffic diversions, closure of road etc. that may cause inconvenience to the public.

14.1.6 The Contractor shall extend to NMRCL all the necessary assistance and cooperation with regard to requests for photo-taking, video-taking and visits to the Site by the NMRCL official photographer or appointed film-maker, in consultation with the Engineer.

14.1.7 The Contractor shall include a section on matter concerning Public Relation in its monthly report to the Engineer.

14.1.8 All hoardings and signboards put up by the Contractor shall be maintained in good condition.

14.1.9 All public complaints should be thoroughly investigated and acted upon by the Contractor on an urgent basis.

14.1.10 The Contractor shall give full support to all functions and events e.g. community talks for residents, Site visits for the media etc., organised by the NMRCL during the period of the Contract.

14.1.11 The Machinery and Plants or any part thereof shall not be branded in any manner to advertise, display or reflect the name or identity of the Contractor.

14.2 Progress Photographs

14.2.1 After design, manufacturing and testing activities start, the Contractor shall furnish photographs showing the progress of the Works during the month. The actual number of photographs taken and the subjects photographed shall be as directed by the Engineer.

14.2.2 Each photograph shall have forty millimeters by eighty millimeters title block in the lower right-hand corner, which shall show the following information:

NMRCL CONTRACT No :
CONTRACT NAME :
CONTRACTOR :
PHOTOGRAPH No. :
DATE :
DESCRIPTION :

14.2.3 Two colour prints of each photograph shall be submitted. Prints shall be standard commercial quality on single-weight glossy paper 200mm by 250mm in size inserted back-to-back in clear

plastic envelopes made for the purpose. Diskettes capturing Office software shall be provided together with the colour prints.

14.2.4 Detailed photographs (date and time stamped) of each M & Ps on its arrival at the depot and before introducing for revenue operation shall be archived and copies handed over to the Engineer. The photographs must include all such items that are incomplete / defective etc. Complete set (soft copy) shall be submitted every month to the Engineer.

NAGPUR METRO RAIL CORPORATION LIMITED

DESIGN, MANUFACTURE, SUPPLY, INSTALLATION, TESTING, COMMISSIONING OF MACHINERY AND PLANTS FOR 02 (TWO) NUMBERS OF ROLLING STOCK DEPOTS AT MIHAN AND HINGA OF NAGPUR METRO RAIL PROJECT AND TRAINING OF PERSONNEL

CONTRACT NO.
N1M&P-1/2016

PART II: TECHNICAL SPECIFICATONS SECTION VII-A: EMPLOYER'S REQUIREMENT – GENERAL SPECIFICATION

APPENDICES TO GENERAL SPECIFICATION

Nagpur Metro Rail Corporation Limited
Metro House, Bungalow No: 28/2, Anand Nagar, CK Naidu Road, Civil Lines,
Nagpur-440001
Maharashtra, INDIA
Website: http://www.metrorailnagpur.com

APPENDIX 1

1.0 PROGRAMME

Note: Contractor shall refer to Para 4.2 of General Specifications regarding Employer's IT Requirements. The requirements pursuant to this Appendix shall be effected through the „Integrated Project Management Platform", if and as applicable.

1.1 Time-scaled Network / Bar Chart

1.1.1 All programmes shall be developed by computerised Critical Path Method (CPM) using the Precedence Diagramming Method (PDM) and shall be presented in either bar chart or time-scaled network diagram format, suitably coloured to enable easy reading. All duration for the purpose of programming shall be in calendar days. All reference to network shall mean time-scaled network unless otherwise specified.

1.1.2 The coding structure shall be such that the activities can be summarised to the various levels.Each level shall be summarised and collapsed to the next level using the programming software. The Contractor shall propose essential codes and activity codes to be used for review of the Engineer. The Engineer may require additional activity codes subject only to restrictions imposed by the programming software. Additional codes where necessary may be created by the Contractor with the approval of the Engineer. Each activity in the network shall be coded, as a minimum, with the following:

(i) Contract number, activity type, and unique identification numbers.

(ii) Activity codes to indicate Unit, Segment, Stage or Phase, for e.g. design, manufacturing, delivery, installation, etc.

(iii) The Contractor shall note that breakdown of system into sub-systems is essential and shall be carried out not through further coding but through activity descriptions in a consistent manner such as to allow storing. However, the Engineer shall have the right to require the Contractor to code sub-systems, using codes approved by him, if necessary.

(iv) Area, location and location details under Activity Code – Unit.

(v) Cost and resources

(vi) Cost and resources codes shall be submitted for the approval of the Engineer. For Tender purposes, the Tenderer shall use its own codes.

1.1.3 All logical and necessary relationships between activities shall be shown.

1.1.4 All key dates indicated in the Contract shall be shown. In addition to the key dates, the Contractor may require certain events that are critical to its work to be reflected in its programmes. These shall be reflected as "milestones". Appropriate activity codes shall be used to distinguish "milestones" from the Key Dates.

1.1.5 The level of programme development, information and detail shall be sufficient to permit the Engineer to have a good appreciation of the Contractor's project management plan especially with regard to the co-ordination and timing of its work in relation to the work of the other Designated Contractors and the obtaining of necessary approvals from the relevant local authorities. It shall demonstrate ability to meet specified Key Dates through a logical work sequence that has taken account of the Project constraints.

1.1.6 Activities pertaining to review/acceptance by the Engineer and local authorities shall be identified. Where duration for review of the Contractor's submissions are specified elsewhere in the Contract, they shall be used. Where they are not specified, a duration of 30 days for review of each submission shall be used.

1.1.7 Activities outside the scope of the Contract that may affect the Contractor's progress shall be shown.

1.1.8 The activity network shall be organised so that major work sections are carefully coordinated with the Civil Contractor and the System-wide Contractors to allow opportunity for all to work with as minimal disruption as possible.

1.1.9 Critical paths shall be identified.

1.1.10 Activity descriptions shall be brief (<48 characters) and shall convey the nature and scope of the work. Uncommon abbreviations shall be explained in the legend. Float time shall be distinguished from schedule performance.

1.1.11 The CPM Network Diagram shall be developed to permit modification to the schedule and allow for impacts on the schedule to be analysed by introduction of "what if" statements into the input data.

1.2 Time Scaled Network/Bar Chart Details

1.2.1 Design

The Design network/bar chart shall detail the various design, submission and acceptance stages including approval by local authorities and the Engineer, preparation, submission and approval of drawings, manuals and all other activities related to the design.

1.2.2 Manufacturing

The manufacturing network chart shall indicate the relationship and duration of the activities necessary to procure, fabricate manufacture, assemble equipment/complete tests, ship and delivery of M&Ps in time to support the activities at site. It shall establish milestones for monitoring the progress of the manufacturing process. Major areas of work shall be shown as separate and distinct activities. The network shall also cover activities of Sub-Contractor as appropriate, including testing.

1.2.3 Testing and Commissioning

The Factory and On Site Testing and Commissioning network/bar chart shall present the relationship and duration of those items relating to Commissioning tests including those related to other Designated Contractors. The network/bar chart shall present testing approach to be used, the deployment of resources in accordance with M&P delivery dates.

1.2.4 Not Used**.**

1.2.5 Integrated Testing

The Integrated Testing network/bar chart shall indicate the activities required to verify the functioning of the Rolling Stock in conjunction with activities of the System-wide and Civil Contractors

1.2.6 Not Used**.**

APPENDIX 2

2.0 MONTHLY PROGRESS REPORT

Note: Contractor shall refer to Para 4.2 of General Specifications regarding Employer"s IT Requirements. The requirements pursuant to this Appendix shall be effected through the „Integrated Project Management Platform".

2.1 Contract Stages

2.1.1 General

The Contractor shall submit to the Engineer, a Monthly Progress Report. This Report shall be submitted by the end of each calendar month and shall account for all work actually performed from 26thday of the last month and up to and including the twenty-fifth (25th) day of the month of the submission. It shall be submitted in a format to which the Engineer shall have given consent and shall contain sections/sub-sections for, but not be limited to, the topics listed in the clauses below.

2.2 Financial Status

2.2.1 A narrative review of all significant financial matters, and actions proposed or taken in respect to any outstanding matters.

2.2.2 A spread sheet summarising each Cost Centre, the budget, costs incurred during the period, costs to date, costs to go, cost forecast (total of costs to date and costs to go) and cost variance (difference between cost forecast and budget).

2.2.3 A spread sheet indicating the status of all payments due and made.

2.2.4 A report on of the status of any outstanding claims. The report shall in particular provide interim updated accounts of continuing claims.

2.3 Physical Progress

2.3.1 It shall describe the status of work performed, significant accomplishments, including critical items and problem areas, corrective actions taken or planned and other pertinent activities, and shall, in particular, address interface issues, problems and resolutions.

2.3.2 It shall include a simplified representation of progress measured in percentage terms compared with percentage planned as derived from the Works Programme.

2.4 Programme Update (for Entire Project)

2.4.1 Programme updating shall include:

(i) The monthly Programme Update which shall be prepared by recording actual activity completion dates and percentage of activities completed up to the twenty-fifth (25th) of the month together with estimates of remaining duration and expected activity completion based on current progress. The Programme Update shall be accompanied by an Activity Report and a Narrative Statement. The Narrative Statement shall explain the basis of the Contractor"s submittal:

a. Early Work and Baseline Submittals – explains determination of activity duration and describes the Contractor"s approach for meeting required Key Dates as specified in the Contract.

b. Updated Detail Programme Submittals – state in narrative the Works actually completed and reflected along Critical Path in terms of days ahead or behind allowable dates. Specific requirements of narrative are:

- If the Updated Detailed Work Programme indicates an actual or potential delay to Contract Completion date or Key Dates, identify causes of delays and provide explanation of Work affected and proposed corrective action to meet Key Dates or mitigate potential delays. Identify deviation from previous month"s critical path.

- Identify by activity number and description, activities in progress and activities scheduled to be completed.

- Discuss Variation Order Work Items, if any.

(ii) the Programme Status which shall:

a. show Works Programme status up to and including the current report period, display Cumulative progress to date and a forecast of remaining work.

b. be presented as a bar-chart size A3 or A4 and as a time-related logic network diagram on an A1 media, including activity listings;

(iii) Activity Variance Analysis which shall analyse activities planned to start prior to or during the report period but not started at the end of the report period as well as activities started and/or completed in advance of the Works Programme.

2.5 Milestones Status

A report on the status of all Milestones due to have been achieved during the month and forecasts of achievement of any missed Milestones, and those due in the next month.

2.6 Three Month Rolling Programme

The monthly issue of the Three Month Rolling Programme.

2.7 Planning and Co-Ordination

2.7.1 A summary of all planning/co-ordination activities during the month and details of outstanding actions.

2.7.2 A schedule of all submissions and consents/approvals obtained/outstanding.

2.8 Procurement Report

2.8.1 A summary of all significant procurement activities during the month, including action taken to overcome problems.

2.8.2 A report listing major items of plant and materials, which will be incorporated into the Works. The items shall be segregated by type as listed in the Specifications and the report should show as a minimum the following activities, as applicable:

(i) purchase Order Date - Scheduled/Actual,
(ii) manufacturer/Supplier and Origin,
(iii) letter of Credit Issued date,
(iv) manufacturer/Supplier Ship Date - Scheduled/Actual,
(v) method of shipment,
(vi) arrival date in India- Scheduled/Actual.

2.9 Production and Testing

2.9.1 A review of all production and manufacturing activities during the month.

2.9.2 Summaries of all production and manufacturing outputs during the month together with forecasts for the next month.

2.9.3 Review of all testing activities (both at site or at the manufacture's premises) during the month.

2.10 Areas of concern & Critical Issues

A review of all areas of concern and critical issues during the month including appropriate details of such issues for drawing attention of the Engineer.

2.11 Safety

A review of all safety aspects during the month including reports on all accidents and actions proposed to prevent further occurrence.

2.12 Environmental

A review of all the environmental issues during the past month to include all monitoring reports, mitigation measures undertaken, and activities to control environmental impacts.

APPENDIX 3

3.0 KEY DATES

Refer to Section IX. Particualr Conditions, Part A – Contract Data; „Table – Summary of Sections"

APPENDIX 4

4.0 DRAFTING AND CAD STANDARDS

Note: Contractor shall refer to Para 4.2 of General Specifications regarding Employer"s IT Requirements. The requirements pursuant to this Appendix shall be effected through the „Integrated Project Management Platform", as applicable.

4.1 Introduction

4.1.1 The purpose of this document is to define the minimum Drafting and CAD standard to be achieved by the Contractor for all drawings produced by the Contractor for the purpose of the Works.

4.1.2 By defining a common format for the presentations of drawings and CAD files, the exchange of drawn information is improved and will maximise the use of CAD in the co-ordination process.

4.1.3 All submissions shall be made to the Employer's Requirement in a format reviewed without objection by the Employer's Requirement and in accordance with the requirements in:

(i) the Contract;

(ii) the Document Submittal Instructions to Consultants and Contractors.

4.1.4 Paper and drawing sizes shall be "A" series sheets as specified in BS 3429.

4.1.5 The documents shall be submitted in the following software unless otherwise stated, for the various electronic submissions required. Any formulae / micros / programmes used therein shall not be hidden / masked and must be visible and transparent without any compromise and shall be validated for the submissions. The following software compatible for use with Intel-Windows based computers shall be used, unless otherwise stated, for the various electronic submissions required:

Document Type	Electronic Document Format
Text Documents	MS office Professional (latest version)
Spread Sheets	MS office Professional (latest version)
Data Base Files	MS office Professional (latest version)
Presentation Files	MS office Professional (latest version)
Programmes	Primavera enterprise (latest version) for Windows (latest)–
AutoCAD Graphics	AutoCAD 2016 OR latest
Photographic	Adobe Photoshop CC(2015.5) OR latest
Desktop Publishing	Adobe Page Maker 7.0 OR latest
CADD Drawings	AutoCAD 2016 OR latest

4.1.6 Media for Electronic File Submission: One copy shall be submitted unless otherwise stated in CD-ROM / DVD / USB Stick / Pen Drive.

4.1.7 Internet File Formats/Standards

(i) The following guidelines shall be followed when the Contractor uses the Internet browser as the communication media to share information with the Employer.

(ii) All the data formats or standards must be supported by Microsoft Internet Explorer or other web browser (latest version) running on latest version of Windows.

(iii) The following lists the file types and the corresponding data formats to be used on the Internet. The Contractor shall comply with them unless prior consent is obtained from the Employer's Requirement for a different Data format :

File Type	Data Format

Photo Image	Joint Photographic Experts Group (JPEG)
Image other than Photo	GIF or JPEG
Computer Aid Design files (CAD)	Computer Graphics Metafile (CGM)
Video	Window video (.avi)
Sound	Wave file (.wav)

4.1.8 The following states the standards to be used on Internet when connecting to database(s). The Contractor shall comply with them unless prior consent is obtained from the Employer's requirement for a different standard:

Function to be Implemented	Standard to be Complied With
Database connectivity	Open Database Connectivity (ODBC)
Publishing hypertext language on the World Wide Web	Hypertext Markup Language (HTML)

The hard copy of all documents shall be the contractual copy.

4.2 General Requirements

4.2.1 General

(i) The Contractor shall adopt a title block similar to that used in the Drawings for all drawings prepared under the Contract.

(ii) Each drawing shall be uniquely referenced by a drawing number and shall define both the current status and revision of the drawing.

(iii) The current status of each drawing shall be clearly defined by the use of a single letter code as follows:

P - Preliminary Design Drawing
D - Definitive Design Drawing
C - Construction Reference Drawing
W - Working Drawing
B - As-Built Drawing
M - As Manufactured Drawing
E - Employer's Drawing

4.2.2 Drawing Numbering System

A suitable drawing numbering systems shall be evolved by the Contractor and submitted to Engineer for his review. It shall present unique numbers and take care of revisions.

4.2.3 Types of Drawing

(i) „Design drawings" mean all drawings except shop drawings and as-built drawings.

(ii) „Working drawings" are design drawings of sufficient detail to fully describe the Works and adequate to use for construction or installation.

(iii) Site drawings and sketches" are drawings, often in sketch form, prepared on site to describe modifications of the Working drawings where site conditions warrant changes that do not invalidate the design.

(iv) 'Shop drawings' are special drawings prepared by the manufacturer or fabricator of various items within the Works to facilitate manufacture or fabrication.

(v) „As-built drawings" show the Works exactly as constructed or installed. They are usually prepared by amending the working drawings to take into account changes necessitated by site conditions and described in Site drawings. These drawings shall

be completed on a regular basis as the works progress, and shall not be left until completion of the entire works.

4.3 Computer Aided Design & Draughting (CAD) Standards

4.3.1 Introduction

Scope of Use

Data input procedures between the Engineer and Contractor must be coordinated, and the key parameters used to form CAD data files must be standardised. The production of all CAD data files shall comply with the following requirements.

4.3.2 Objectives

The main objectives of the CAD standards are as follows:

(i) To ensure that the CAD data files produced for Project are coordinated and referenced in a consistent manner

(ii) To provide the information and procedures necessary for a CAD user from one discipline or external organization to access (and use as background reference), information from a CAD Data file prepared by another discipline or external organization.

(iii) To standardize the information contained within CAD data files which may be common to More than one discipline such as drawing borders, title boxes, grid lines etc.

(iv) To establish procedures for the management of CAD data files.

(v) To ensure all contractors use „Model space" and „Paper space" in the production of their CAD files".

4.3.3 General

(i) To facilitate co-ordination between contractors, it is a requirement that all drawings issued by contractors for co-ordination or record purposes shall be produced using CAD methods. Drawings shall be issued in digital format in addition to the paper copies.

(ii) The intent of the issue of digital information is to aid the related design by others.

(iii) Drawings and drawing packages issued for co-ordination, record purposes or for acceptance shall be accompanied by a complete set of the corresponding CAD data files.

(iv) Any contractor or organization making use of the CAD data from others shall be responsible for satisfying himself that such data is producing an accurate representation of the information on the corresponding paper drawing which is satisfactory for the purpose for which he is using it. Provided the general principles of this section have been achieved by the originator of the CAD data, contractors making use of the CAD data from others shall not be entitled to require alterations in the manner in which such CAD data is being presented to them.

(v) In particular, automatic determination of physical dimensions from the data file shall always be verified against the figured dimensions on the paper or polyester drawings. Figured dimensions shall always be taken as correct where discrepancies occur.

4.3.4 Terminology & Associated Standards / Guidelines

Any terminology used within this section that is ambiguous to the user shall be clarified with the Employer's Requirement. British Standard BS1192 is used in principle as a guide for drawing practice, convention, CAD data structure and translation.

4.3.5 Paper Drawings

(i) For the Project “Paper” drawings are considered to be the main vehicle for the receipt and transmittal of design and production information, typically plans, elevations and sections.

(ii) The Project wide accepted media for the receipt and transmittal of “Paper” drawings will be paper and polyester film of various standards ISO „A" sizes. The composition of this information shall be derived from a CAD “Model”.

(iii) The CAD derived “Paper” drawing composition will reflect a window of information contained within a CAD “Model Space” file together with a selection of information contained within the associated CAD “Paper Space” file.

4.3.6 CAD Data Creation, Content & Presentation

A consistent method of CAD data creation, together with content and presentation is essential. The method of CAD “Model Space and Paper Space” creation is as follows:

(i) Model Space Files

Typically CAD “Model Space” files are required for general arrangement and location plans and will consist of a series of other “Model Space” referenced CAD files covering the total design extents at a defined building level (the number of referenced files should be kept to an absolute minimum). Data contained within a CAD “Model Space” files is drawn at full size (1:1) and located at the correct global position and orientation on the Project Grid / or defined reference points.

Each CAD “Model Space” file will relate to an individual discipline. Drawing border / text, match / section lines or detailed notation shall NOT be included within a CAD “Model Space” file. Dimensions shall be included within a CAD “Model Space” but located on a dedicated layer. Elevations, Long Sections and Cross Sections shall also be presented in CAD “Model Space” as defined above, but do not need to be positioned and orientated on the Project Grid.

(ii) Paper Space CAD Files

Paper Space” CAD files are utilized to aid the process of plotting “Paper” drawings and are primarily a window of the CAD “Model Space” file. A “Paper Space” CAD file will typically contain drawing borders, text, match or section lines & detailed notation. Once these files are initially set up and positioned, the majority of “Paper Drawing” plots at various approved scales are efficiently and consistently generated by displaying different combinations of element layers and symbology contained within the “Paper Space” file and the referenced “Model Space” files.

The purpose is to ensure that total co-ordination is achieved between the CAD “Model Space” file and the “Paper Drawing” output during the revision cycle of the design and production process. Duplicated data in “Model and Paper Space” files will not be acceptable unless an automatic update link exists between the two data sets. “Paper Space” files are not typically required as part of the CAD Media Receipt from contractors, unless specifically requested.

4.3.7 CAD Quality Control Checks

Random CAD Quality Control Audits will be carried out by Engineer on all CAD media received and transmitted.

These checks DO NOT verify the technical content of the CAD data received or transmitted (as this is the responsibility of the originating organization), however compliance with Project CAD and Drafting Standards shall be checked.

In addition, all contractors who transmit and receive CAD data from the Project shall have CAD quality control procedures in place. A typical quality control procedure shall contain CAD data quality checking routines coupled with standards for CAD data transmittal and archiving.

4.3.8 CAD Data Transfer Media and Format

When CAD data is received & transmittal between Engineer and the Contractor, the media shall be as follows:

(i) Data Exchange Format - AutoCAD (latest) (.DWG).

(ii) Operating System - / Window NT 4 /Windows2007/2010 (latest version)

(iii) Data Transfer Media: DVDs / Hard Disc (or other better means)

a. All media must be labeled on the data shield with:
   i. Name of Company
   ii. Project Title
   iii. Drawing Filenames (for diskettes only)
   iv. Diskette No. / Total No. of diskettes or Tape No. / Total No. of Tapes

(iv) All media shall be submitted with a completed Form (CAD Disk/Tape Sheet).

(v) The Contractor must ensure the supplied media is free from virus.

(vi) Sub-directories on tapes or disks are not permitted. If CAD Data is created using UNIX, archive commands must be uprooted.

4.3.9 CAD Media Receipt & Transmittal

(i) CAD Media Transmittal (from the Contractor to Engineer) - this will consist of the following:

a. CAD Digital Media (disk(s), CD"s or tape (s)) shall typically contain CAD “Model Space” and “Paper Space” files.
b. CAD data sheet
c. CAD issue / revision sheet
d. CAD Quality Checklist confirming compliance.
e. Plot of each “Model Space” file issued on an A1 drawing sheet (to best fit).

(ii) The above CAD media will be collectively known as “CAD Media Transmittal Set”. The CAD data file transmittal format required by Employer' Representative from all contractors shall be in AutoCAD version as stated in Clause 4.1.5 above.

(iii) All CAD media received from contractors will be retained by Engineer except for SCSI disk (if used) as an audit trail / archive of a specific contractor"s design evolution.

(iv) CAD Media Receipt (from Engineer to the Contractor)

a. CAD media should normally be obtained from the respective Designated contractor(s), but should Engineer issue CAD media it will consist of the following:

   i. CAD Digital Media (disk (s) or tape (s)) typically contain only CAD “Model Space” files
   ii. CAD data sheet
   iii. CAD issue / revision sheet

b. The above CAD media will be collectively known as the “CAD Media Receipt Set”. The CAD Data file transmittal format used by Engineer to all contractors will be in AutoCAD version as stated in Clause 4.1.5above.

c. Each CAD transmittal disk / tape will be labeled with proper disk label as approved by the Engineer. Any CAD data transmitted without this label is assumed to be provisional information not to have been quality checked and therefore not formally issued.

4.3.10 Revisions

(i) All „Revisions‟, „In Abeyance‟ and „Deletions‟ shall be located on a common layer. This layer can be turned on or off for plotting purposes.

(ii) The following example text indicates the current CAD file revision, i.e. „Revision [A]‟. This shall be allocated to a defined layer on all CAD “Model Space” files, in text of a size that will be readable when the CAD “Model Space” file is fitted to the screen, with all levels on.

4.3.11 Block Libraries, Blocks, & Block Names

(i) All Construction Industry symbols produced as CAD Cells shall typically conform to British Standard BS1192 - part 3.

(ii) All Blocks created shall be Primitive (i.e. NOT Complex) and shall be placed Absolute (i.e. NOT Relative).

(iii) The Contractor's specific block libraries shall be transmitted to Engineer together with an associated block library list containing the filename (max. 6 characters) and block description. The Contractor shall ensure that the library is regularly updated and circulated to all other users, together with the associated library listing.

(iv) All Blocks of a common type, symbols or details should initially be created within a CAD “Model Space File” specifically utilized for that purpose. These files will be made available on request by Engineer.

(v) All Blocks created will typically be 2D unless 3D is specifically requested. In both instances they shall have an origin at a logical point located within the extents of each Block‟s masked area or volume.

4.3.12 CAD Dimensioning

Automatic CAD Dimensioning will be used at all times. Any dimensional change must involve the necessary revision to the model space file. If the CAD Quality Control Checks find that the revisions have not been correctly carried out, the rejection of the entire CAD submission will result.

4.3.13 CAD Layering

All CAD elements shall be placed on the layers allocated for each different discipline. The layer naming convention to be adopted by the Contractor shall be submitted for acceptance and inclusion within these standards.

4.3.14 Global origin, Location & Orientation on the Alignment Drawing

(i) Location or Plan information in “Model Space” files shall coincide with the correct location and orientation on the Project grid for each specific contract.

(ii) Location plans shall have at least three setting out points shown on each CAD “Model Space” file. Each setting out point shall be indicated by a simple cross hair together with related Easting and Northing‟s co-ordinates. The Civil Contractor(s) will establish

the three setting out co-ordinates for their respective works, which will then be used by all other contractors including the Contractor.

4.3.15 Line Thickness and Colour

To assist plotting by other users, the following Colour codes will be assigned to the following line thickness / pen sizes:

Colour	Code No.	Line Thickness
Red	10	0.18
White	7	0.25
Yellow	2	0.35
Brown	34	0.5
Blue	130	0.7
Orange	30	1.0
Green	3	1.4
Grey	253	2.0

4.3.16 CAD Utilisation of 2D & 3D Files

Although the project standard is 2D CAD files, certain disciplines and contractors may use 3D CAD files for specific applications or where the isolated use of 3D aids the design and visualisation process (i.e. Architecture, Survey and Utilities). In these specific instances 3D CAD data will only be transmitted if all other users can use this data. If this is not the case, 3D to 2D translation shall be processed by the creator prior to issue.

4.3.17 CAD File Numbering

(i) Contractors CAD File Numbering shall be as described in Clause 4.2.2 above.

(ii) Employer CAD File numbering unlike most of the contractors, Employer will not be required to produce numerous CAD files. This will follow the numbering system Except that the status of the drawing in Clause 4.2.1(iii) shall be "E".

4.3.18 CAD File Naming Convention - General

CAD “Model Space” files shall be named in accordance with general drawing conventions.

APPENDIX 5

5.0 DESIGN CERTIFICATE

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

[Description of the Works to which the submission refers]

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

Section A: Submission No..…. Comprises the following:

Drawings: (Title, drawing number and revision)
Other : (Title, reference number and revision)

(i) .....
(ii) .....
(iii) .....
(iv) .....
(v) .....
etc.

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

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

Item Reference: (Title, reference number and revision)

(i) .....
(ii) .....
(iii) .....
(iv) .....
(v) .....
etc.

Contractor's Statement

We certify that:

(a) The design of the Works, as illustrated and described in the documents scheduled in Section-A above, complies with the Employer's Requirements General /Technical Specification:

Clause ……
Covering .....
.....
.....

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

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

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

Name : ……
Position/ Designation : ……
Date : ……..

Signed by Contractor's Authorised Representative

Contractor's Certification

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

Name (for Contractor)
Position/Designation
Signed by „Authorized Representative" Date

Note 1

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

(i) the Contractor's Technical Proposals

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

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

(iv) The Definitive Design

Section C

[Contractor to attach copies of necessary and required approvals]

(i) .....
(ii) .....
(iii) .....
(iv) .....
(v) .....
etc.

APPENDIX 6

6.0 SPARES

6.1 Not used.

6.2 Mandatory Spares

For details, refer to Cost center B in „Pricing Document". Prices of spares shall be actual prices and not apportioned prices. The spares shall be delivered at the nominated depots by the Employer. The delivery is linked to the key dates indicated in the notes under Cost Centre B of „Pricing Document".

6.3 Recommended Spares

Tenderers shall submit list of recommended spares and quote for the same as per Cost center C in „Pricing Document". Prices of spares shall be actual prices and not apportioned prices. The spares shall be delivered at the depots nominated by the Employer. The delivery is linked to the Key Dates indicated in the notes under Cost Centre C of „Pricing Document".

6.4 Not Used.

6.5 Not Used.

APPENDIX 7

7.0 DESIGN AND MANUFACTURING INTERFACES

7.1 General

7.1.1 The Contractor shall interface the Design, Manufacture, Supply, Installation and Commissioning, covering with that of other contractors, principally the Contractors for the Designated Contracts as defined in the General Conditions of Contract. The Contractor shall keep the Engineer fully informed in respect of such interfaces, such information being given to the Engineer in a manner and form and at such intervals as stated in the Contract or as required by the Engineer.

7.1.2 The Turnkey Machinery and Plants Contractor shall support NMRCL for the interface of the Design, Manufacture, Supply, Installation,Testing and Commissioning with that of other contractors, principally the Depot and Trackwork Contractors as well as Train Supplier. The M&P Contractor shall keep NMRCL fully informed in respect of such interfaces, such information being given to NMRCL in a manner and form and at such intervals as stated in the Contract or as required by NMRCL.

7.1.3 NMRCL will assume the primary role as contractual focal-point between the various Designated Contractors. However, NMRCL will rely on the M&P Contractor and other Designated Contractors to advise NMRCL, in advance, the dates for which it needs design interface information, manufacture interface information, supply of equipment, testing and commissioning from the other Designated Contractor„s so that work will not be delayed. NMRCL will monitor the M&P Contractor obtaining interface information from the Designated Contractors. Conversely, the M&P Contractor will be expected to provide, in a timely manner, the necessary interface information described in this Appendix, for design, manufacture, supply, testing and commissioning to the other Designated Contractors so as not to delay their progress.

Major Designated Contractors for the N1M&P-1/2016 Contract as mentioned below:
Depot Contractor
Train Contractor
Track Contractor
OHE Contractor

7.1.4 Other Contracts

Besides above there are several designated contractors who would need the information regarding the design features and other parameters of the M&P . Their contracts shall have the provisions to interface directly with N1M&P-1/2016 Contractor for the exchange of information. A list of contractors and contracts is provided in thisAppendix-7. It is not exhaustive and many more contractors shall be added. N1M&P-1/2016 Contractor shall do the required interface with them as and when required.

7.2 Interface Responsibilities

7.2.1 The responsibility for specification and provision of the requirements for the works that interface with Designated Contractors equipment are tabulated in this appendix.

7.2.2 This Appendix shall be read in conjunction with the relevant clauses of the Employer's Requirements including General Specifications and Technical Specifications. The M&P Contractor shall be responsible for ensuring that all requirements of the specifications pertaining to interfaces are satisfied.

7.2.3 The requirements specified herein are by no means exhaustive and it remains the Contractors„ responsibilities to develop and execute jointly an Interface Plan after the commencement of the works and throughout the execution of works, to ensure that:

(i) all interfacing issues between the two Contracts are satisfactorily resolved;

(ii) supply, installation and testing of equipment and software are fully coordinated; and

(iii) that all equipment supplied under the Contracts are fully compatible with each other, whilst meeting the requirements of the respective Specifications.

7.2.4 Notwithstanding the requirements described elsewhere in the Contract regarding document precedence the provisions contained in the drawings and elsewhere in the Employer"s Requirements shall prevail over the provisions contained in this Appendix.

7.2.5 This Appendix outlines the interfacing requirements during the execution of the Works. However the requirements herein specified are by no means exhaustive and it remains the M&P Contractor's responsibility to develop, update and execute jointly an Interface Management Plan (IMP) after the commencement of the Works and throughout the execution of the Works to ensure that:

(i) all interface issues between the M&P and the Designated Contractors are satisfactorily identified and resolved; and

(ii) all the construction tolerances at the interface shall meet the requirements of the respective specifications relating to the interface points.

7.2.6 The IMP shall be submitted to Engineer for review and comments. Engineer will play a lead role in ensuring that the Designated Contractors perform in a timely and cooperative manner.

7.2.7 Where details of the M&P design are required to enable the Designated Contractor to implement interface works, the M&P Contractor shall provide the Designated Contractors with the necessary information including, but not necessarily limited to, those described in the summary table appended to this requirement. The level of information provided shall be in sufficient detail to enable the Designated Contractors to design and / or construct the required interface work.

7.2.8 The M&P Contractor shall take a lead in developing the Interface Management Plan. (IMP), which will be prepared in conjunction with the Designated Contractors to cover all aspects of the implementation of the interface works required. The Plan will define the interface works necessary to complete all the works in this contract and may not be limited to those listed in the summary table attached.

7.2.9 The IMP shall be fully conforming with the Works Program and shall, in respect of the Contractor and each of the Designated Contractors, show and be in logical agreement with Key Dates and Handover Dates for M&P. The IMP shall indicate dates for the commencement and completion of each principal activity by each contractor, and delivery and installation of principal items of equipment.

7.2.10 The IMP shall be submitted by the Contractor to Engineer, in a preliminary form, as per schedule furnished in Table 2-1. Thereafter, the IMP shall be updated by the Contractor at regular intervals, not exceeding 4 weeks, agreed with Designated Contractors and submitted to the Engineer. Should it appear to Engineer that the progress of the Works, Works Program or the Three Month Rolling Program does not conform with the IMP, the Contractor shall be required to revise all such programs and plans such that they do reflect that the progress of the Works is mutually consistent and conforms to other provisions of the Contract.

7.2.11 The M&P Contractor shall review the details of interface works and notify the Engineer of any amendments to the summary table required in the process of its works. Unless such requests are reviewed without objection by the Engineer, the M&P Contractor shall design and construct the M&P works in accordance with the provisions outlined in this Appendix and the attached summary table

7.3 Scope of Work of Integrated Management Plan

7.3.1 The information and scope of works to be provided by the M&P Contractor include but may not necessarily be limited to those outlined in the attached summary table. This table only

defines those tasks at the interface point and is not a complete itemization of the Scope of Work.

7.3.2 The Designated Contractors shall liaison with the M&P Contractor in the Design, Installation, Commissioning, Testing and Acceptance of the M&P Works.

7.3.3 The M&P Contractor shall provide all access and attendance necessary in accordance with the Contract requirements to enable the Designated Contractors to complete those activities defined under the summary table attached to this interface specification in a timely manner.

7.3.4 Where M&P Contractor works are identified as failing to meet the requirements of the Contract and which will impact the Designated Contractor's works, the M&P Contractor shall submit the proposed remedial measures to the Engineer for review and shall copy the same to the Designated Contractors.

7.4 Interfaces with Signalling and Telecommunication Contractors

If Applicable.

7.5 Interface with Asset Management System (AMS) Contractor

7.5.1 NMRCL has plans to implement state-of-the-art IT-based Enterprise Asset Management System (AMS), which shall enable NMRCL to manage and optimize various processes (viz. maintenance management, engineering management, O&M relationship management, supply chain management, reporting etc.)

7.5.2 The M&P Contractor shall be required to coordinate and interface with AMS Contractor for successful integration of M&P Assets into the Asset Management System.

7.5.3 The M&P components/equipment to the required levels of breakdown shall be entered into the AMS.

7.5.4 The M&P data shall be fed into the AMS broadly in three forms:

(a) Predetermined set of active failures shall be transmitted to OCC. AMS shall be able take in this data for processing.
(b) Data shall be downloaded from Control Console of each M&P through GPRS or WLAN at predetermined intervals or locations. AMS shall be capable of interfacing with the concerned database and take in filtered data as per design.
(c) Other data will be fed manually in the AMS.

7.5.5 Preventive and corrective maintenance data generated by the Control Console of each M&P to raise the work request /work orders, and to update the equipment data.

7.5.6 The point of interface to the AMS will be the AMS depot (or other location) rack via Ethernet LAN connectivity.

7.5.7 Responsibilities of Interfacing Parties:

7.6 Interface Responsibility between M&P and AMS Contractor

As Applicable.

7.7 Interface with Platform Screen Gate (PSG) Contractors

Not Applicable for M&Ps.

7.8 Interfaces with Overhead Collection System (OCS) Contractor

As Applicable.

7.9 Interface with Track Contractor (TRW)

As applicable

7.10 Interface with Viaduct Contractor / Designer

Not Applicable

7.11 Interface with Station Contractor

Not Applicable

7.12 Interface with Depots Detailed Design Consultants and Construction Contractor(s)

7.12.1 Engineer with experience and help of Detail Design Consultants (DDC) will design the facilities in depots and workshops. This interface is to improve it further to meet the requirements.

7.12.2 In order to perform the work, the Contractor will be required to communicate directly with Engineer. The Contractor will record the details of all these meetings, and provide a copy to Engineer. The Contractor will also give the notice for meetings with sufficient time to enable Engineer to attend these meetings.

7.12.3 Engineer will provide the Contractor with authorization; assistance and the support of its own personnel should the Contractor request Engineer to intervene on its behalf with such meetings.

7.12.4 Not Used.

7.13 Interface between M&P Contractor and Other Contractors:

7.13.1 Besides above there are several designated contractors who would need the information regarding the design features and other parameters of the M&P.

7.13.2 Their contracts shall have the provisions to interface directly with the M&P Contractor for the exchange of information.

7.13.3 The details of these contracts and contractors shall be made available during the execution of the contract

These shall include the following but not limited to:

Table 7-7: Interfaces between M&P and Other Contractors

NMRCL - List of M&Ps - Interface Requirements					
Sr No.	**Name of Equipment**	**QTY. PER DEPOT**	**Location / Shop**	**Interface With**	**Interface Description**
1	Automatic Train Wash Plant	1.0	Separate Location on Incoming / Outgoing Line as per Depot Layout	Depot Contractor	1) Demarcation of ATWP area according to Depot layout. 2) Control Room for operating station of ATWP. 3) Cable Trench for laying of Cables & wires of the plant. 4) Inlet Water Reserve to be provided & suitable piping to the Inlet point / Tank of the ATWP as per the suppliers GAD. 5) Collection point for waste water. 6) Waste water drain / piping to transfer the waste water to the Depot ETP. 7) Power connection within 15 Mts of the plant pannel, as per the electrical load ratings provided by the supplier.
				Train Supplier	1) Define special water quality requirements if any. 2) Drawing of the train. 3) To provide details of infringing objects if any, which cause hindrance to the washing.
				Track Contractor	1) To provide details of infringing objects if any, which cause hindrance to the washing.

2	CNC Under Floor Wheel Lathe with Synchronised Shunting System	1.0	Separate Pit Wheel Lathe Shed on Incoming / Outgoing Line as per Depot Layout	Depot Contractor	1) Suitable shed as per depot layout with sufficient illumination and ventilation considering Day and Night Working. 2) EOT Crane of 5 Ton capacity, with travel along the shed bay length. 3) Plain Concrete Workshop Floor outside the Pit area with colour as per NMRCL choice. 4) Electrical supply point within 15 mts from the pit (120 KVA) with common Earthing connection point. 5) Both side entry openenings to be sufficient for entering of 25 Ton Mobile Crane. 6) Floor to fush with Rail to the level of TOR. 7) Drain point at two sides of the shed and related drainage system to be provided.
				Train Supplier	1) Train Data / Drawing as required by supplier 2) Wheel Cross Section Drawing 3) Type of Brake for machining, 4) Coupler details for shunting
				Track Contractor	1) Laying and Alignment of track as per the shed layout 2) Positioning / Cutting of track to accommodate pit wheel lathe auxiliary rails
3	Under Floor Train Lifting System for 3 Car Unit	1.0	Repair Shop on Line 1	Depot Contractor	1) Supplier will provide the GAD of the UFLS. Acoordingly space should be left for civil work of UFLS by supplier 2) Plain Concrete Workshop Floor outside the Pit area with colour as per NMRCL choice. 3) Electrical supply point within 15 mts from the Control Panel (75 KVA) with common Earthing connection point.

				Train Supplier	1) Train Data / Drawing as required by supplier, 2) Lifting Points details with Lifting Pad diemnsions, 3) To ensure that there is no infringement in the vertical plane below the lifting points,
				Track Contractor	1) Laying and Alignment of track as per the shed layout 2) Positioning / Cutting of track to accommodate the concrete rail bridge and its rails
4	Mobile Lifting Jacks for 3 Car Unit	1.0	Repair Shop on Line 2	Depot Contractor	1) Supplier will provide the GAD of the MLJ System. 2)Plain Concrete Workshop Floor in the working area with colour as per NMRCL choice, 3) Electrical Cabling Conduits as per GAD along with pockets for connection points, 4) Main Electrical supply point within 15 mts from the pit (40 KVA) with common Earthing connection point.
				Train Supplier	1) Train Data / Drawing as required by supplier, 2) Lifting Points details with Lifting Pad diemnsions, 3) To ensure that there is no infringement in the vertical plane below the lifting points,
5	Bogie Testing Machine	1.0	Bogie Repair Shop Auxiliary Repair Shop	Depot Contractor	1) Supplier will provide the GAD of the BTM. 2) Plain Concrete Workshop Floor outside the Pit area with colour as per NMRCL choice. 3) Electrical supply point within 15 mts from the Control Panel (20 KW) with common Earthing connection point.
				Train Supplier	1) Bogie Data / Drawing as required by supplier, 2) Wheel Data / Drawing

				Track Contractor	1) Laying and Alignment of track as per the shed layout 2) Positioning / Cutting of track to accommodate the machine auxiliary rails
6	Bogie Turntables (1 Set = 4 Nos.)	1.0	Repair Shop Line 1 & 2 and Auxiliary Shop Line 1 & 2	Depot Contractor	1) Supplier will provide the GAD of the BTT. 2) Plain Concrete Workshop Floor outside the Pit area with colour as per NMRCL choice.
				Track Contractor	1) Laying and Alignment of track as per the shed layout 2) Positioning / Cutting of track to accommodate the BTT
7	Rescue Vehicle with Rerailing & Allied Equipment	1.0	Movable	Train Supplier	1) Train Data / Drawing as required by supplier
				Track Contractor	1) Supplier will provide the GAD. Track contractor to ensure there is no infringement of any condition monitoring equipment within the specified envelope.
8				M&P supplier	CRS requirements to be complied
	Instrumented Caternery Maintenance Vehicle with Train Shunting Capability	1.0	Movable (However, Separate Shed for Parking is desireable)	Train Supplier	1) Train Data / Drawing as required by supplier, 2) Coupler details, 3) Pantograph Drawing / details

				OHE Contractor	1) Drawings / Details of OHE and its layout required.
				supplier of M&P	1) CRS Requirements for Compliance
9	Battery Operated Rail Cum Road Shunter RRM 2000 (For 3 Cars)	1.0	Movable	Train Supplier	1) Train Data / Drawing as required by supplier, 2) Coupler details
				Track Contractor	1) Supplier will provide the GAD. Track contractor to ensure there is no infringement of any condition monitoring equipment within the specifed envelope.
10	Multi-Functional Work Station with Retractable Catenary and Elevated Track (one Track System)	1.0	Inspection Shop (1 Line)	Depot Contractor	1) Drawing of the Inspection Bay required, 2) Supplier will provide the GAD and the load requirements of the shed roof structure. Depot contractor to provide the structure accordingly. 3) Plain Concrete Workshop Floor on the Shop Floor level area with colour as per NMRCL choice. 4) Electrical Point within 15 Mts from the control panel.
				Train Supplier	1) Train Data / Drawing as required by supplier, 2) Pantograph Drawing / details
				Track Contractor	1) Laying and Alignment of track as per the shed layout on the fabricated Elevated Track structure
				OHE Contractor	1) Drawings / Details of OHE as required.

7.13.4 Interface with Designated Civil Contractor

As Applicable

7.13.5 In order to perform the work, the Contractor will be required to communicate directly with Engineer"s representative. The Contractor will record the details of all these meetings, and provide a copy to Engineer. The Contractor will also give the notice for meetings with sufficient time to enable Engineer to attend these meetings.

7.13.6 Engineer will provide the Contractor with authorization; assistance and the support of its own personnel should the contractor request Engineer to intervene on its behalf with such meetings.

7.14 Interface / coordination with Branding Consultant / Agency

7.14.1 Not used.

OPERATIONAL SERVICES for M&Ps at NMRCL MIHAN & HINGNA Depots.

Sr. No.	Name of Machine	Contractor Scope	NMRCL Scope
1	Under Floor Wheel Lathe	• Complete Operation of the UFWL Machine, including all its accessories, Hold Down Cylinders, Chip Conveyor, etc. • Wheel Diameter Measurements and Turning of Wheels as per NMRCL's instructions. • Wheel Turning operations as per the required profile. • Operation of Shunter in Manual as well as synchronised mode during wheel turning operation, as required. • Chip disposal from the Machine and stacking / storing at the area designated by NMRCL within the depot. • Calibration of the Machine from time to time. • Maintenance & Upkeep of the UFWL and the surrounding within the UFWL Shed area.	• Handing over of Train with necessary Wheel Turning instructions. • Verification of Pre & Post Measurement results and issuing necessary instructions. • Taking over of Train after completion of turning operation and acceptance of wheel turning results. • Maintaining the stock of Toolings & Consumables at Depot and issuing to the contractor as per schedule. • Ensuring satisfactory working conditions including provision of stable and good quality power supply.
2	Under Floor Lifting System	• Complete Operation of the Under Floor Lifting System. • Lifting / Lowering of Train / Bogie as required on NMRCL instructions. • Maintenance & Upkeep of the UFLS and the surrounding area including the pits, and etc. .	• Handing over of Train with necessary instructions. • Taking over of Train after completion of work. • Maintaining the stock of Consumables at Depot and issuing to the contractor as per schedule. • Ensuring satisfactory working conditions including provision of stable and good quality power supply.
3	Mobile Lifting Jacks	• Complete Operation of the Mobile Lifting Jacks in sets as required. • Lifting / Lowering of Train as required on NMRCL instructions. • Maintenance & Upkeep of the MLJ and the surrounding area and etc. .	• Handing over of Train with necessary instructions. • Taking over of Train after completion of work. • Maintaining the stock of Consumables at Depot and issuing to the contractor as per schedule. • Ensuring satisfactory working conditions including provision of stable and good quality power supply.

NOTE:

- The above scope is indicative. The work of operation services will include all the associated activities related to the operational use of the respective M&P.
- Any damage caused to the M&P or to any Train / Train Component, subjected due to faulty operation of the M&P, will be to contractor's account.

APPENDIX 8

8.0 ABBREVIATIONS

Abbreviation	Description
A0, A6	International Document Paper Sizes
BS	British Standard (s) (Institution)
CAD	Computer Aided Design and Drafting
CBT	Computer Based Training
CGI	Computer Generated Image
CPM	Critical Path Method
CR	Contractor Representative
DCA	Design Certificate Application
DCC	Design Certificate (of) Consent (Sheet)
DLP	Defect Liability Period
DLP	Defect Liability Period
DMD	Depot Manual Driving mode
DRCA	Design Review Certificate Application
DRCA	Design Review Certificate Application
EMU	Electric Multiple Unit
EN	European Standards (Organization)
ERD	Emergency Rescue Device
FOR	Free On Rail
GCC	General Condition of Contract
GoA	Grade of Automation
HECP	Hardware Engineering Change Proposal
Hz	Hertz(Frequency)
ISO	International Standards Organization (Standard)
MRTS	Metro Rail Transport System
NTP	Notice To Proceed
OCS	Overhead Collection System
OEM	Original Equipment Manufacturer
OEM	Original Equipment Manufacturer
OSR-S	Operational Safety Report (Software)
PDM	Precedence Diagramming Method
PSD	Platform Screen Door
PSG	Platform Screen Gate
RAM	Reliability availability and maintainability
RDSO	Research, Design and Standards Organization
RS	Rolling Stock (Passenger Cars)
SCC	Special Condition of Contract
SECP	Software Engineering Change Proposal

Abbreviation	Description
SI	International System (of Metrication)
SI	Static Inverter
V	Volts

NAGPUR METRO RAIL PROJECT

BID DOCUMENTS
FOR
DESIGN, MANUFACTURE, SUPPLY, INSTALLATION, TESTING, COMMISSIONING OF MACHINERY AND PLANTS FOR 02 (TWO) NUMBERS OF ROLLING STOCK DEPOTS AT MIHAN AND HINGNA OF NAGPUR METRO RAIL PROJECT AND TRAINING OF PERSONNEL

TENDER NO.
N1M&P-1/2016

PART 2: WORKS REQUIREMENTS SECTION VII-B: EMPLOYER'S REQUIREMENT – TECHNICAL SPECIFICATIONS

June 2016

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Chapter-1
Scope of Work

1.1. List of Machinery and Plants to be supplied under this Turnkey Project:

SN	Item Code	List of Machines	M&Ps Required		
			For Mihan Depot	For Hingna Depot	Total Quantity
1	NMRCLMNP001	Automatic Train Wash Plant (ATWP)	1	1	2
2	NMRCLMNP002	CNC Under Floor Wheel Lathe with Synchronised Shunting System (UFWL)	1	1	2
3	NMRCLMNP003	Under Floor Train Lifting System for 3 Car Unit (UFLS)	1	1	2
4	NMRCLMNP004	Mobile Lifting Jacks for 3 Car Unit (MLJ)	1	1	2
5	NMRCLMNP005	Bogie Testing Machine (BTS)	1	1	2
6	NMRCLMNP006	Bogie Turntables (1 set = 4 Nos.)(BTT)	1	1	2
7	NMRCLMNP007	Rescue Vehicle with Re-railing & Allied Equipment (RRV)	1	-	1
8	NMRCLMNP008	Instrumented Catenary Maintenance Vehicle with Train Shunting Capability (CMV)	1 (4 wheeler)	1 (8 wheeler)	1 set
9	NMRCLMNP009	Battery Operated Rail Cum Road Shunter (For 3 Cars) (BORRV)	1	1	2
10	NMRCLMNP010	Multi-Functional Work Station with Retractable Catenary & Elevated Track (1 Track System) (MFWS)	1	1	2

1.2. General Description of Turnkey work for above M&Ps at both Depots:

This work comprises of:

1) Design, Manufacturing and Supply of M&Ps on DDP (Incoterms 2010) basis: including Sea Freight, Insurance, Custom Clearance, Payment of Customs Duties, Port Handling and related charges, Inland Transport to the sites.
2) Unloading at-site and safe storage (in Covered shed provided by NMRCL), till Final Commissioning.
3) Installation, Commissioning and Testing of M&Ps.
4) Supply of Mandatory & recommended spares.
5) All civil foundation work related to Installation and Commissioning of M&Ps, as applicable.
6) Training of NMRCL Personnel at Manufacturer"s works and on-site.
7) Operation of Specific M&Ps (UFWL, UFLS, and MLJ) on 2 Shift working basis, for a period of 2 Years from the date of Commissioning.
8) Preventive & Breakdown Maintenance Services during 24 Months DLP.
9) Comprehensive Annual Maintenance Contract for a period of 5 Years after DLP.
10) Any other work found necessary for the project to bring it to a satisfactory completion stage.

1.3. Standards, codes & statutory requirements:-

Work related to the production of the equipment shall comply with the relevant European Standards, Codes of Practice and latest statutory requirements of India including the following:

BSEN287 - Approval testing of welders for fusion welding.

BSEN288 - Specification and approval of welding procedures for metallic materials.

BS4575 - Fluid power transmission and control systems.

BS5304 - Code of practice for safety of machinery.

BS5395 - Stairs, ladders and walkways.

BS5950 - Structural use of steelwork in building

BSEN60073 - Specification for coding of indicating devices and actuators by colours and supplementary means.

EN60204 – Electrical equipment

BSEN60529 - Specification for degrees of protection provided by enclosures (IP code).

ISO9001-3: 1991 - Guideline for the Application of ISO9001 to the Development, Supply and Maintenance of Software.

1.4. RAMS (Reliability, Availability, Maintainability & Safety) Requirements: All the M&P mentioned in clause 1.1 above are expected to meet the RAMS target as mentioned in the Technical Specifications of individual M&P during DLP & AMC period. Availability shall be calculated on monthly basis excluding the downtime planned for Preventive Maintenance Services. A Penalty as decided by the Engineer will be applicable subjected to maximum limit of 10% of contract value of DLP/AMC.

Chapter- 2

Automatic Train Wash Plant (Item code-NMRCLMNP001)

Name of the Equipment: Automatic Train Wash Plant

Chapter-2 Automatic Train Wash Plant

CONTENTS

2.1. Operating Principle

2.1.1. The Train Washing Plants shall be designed to carry out automatic washing of the car body sides in stop and go mode of the Electrical Multiple Unit Coaches for standard gauge/ Corridor. Rolling stocks for these corridors is under procurement; the relevant key parameters will be advised during detail design stage. A drawing of Kinematic Envelope (KE) for standard gauge is placed at subsequent chapter for Rolling Stock for vital notional dimensions.

2.1.2. No fixed structure of the plant shall be installed within the specific structure gauge, for Standard Gauge train of Nagpur Metro. Copy of SOD of SG is attached **as APPENDIX – A** is applicable for Nagpur depot but final SOD will be provided during the detailed design stage.

2.1.3. The Plant shall be of drive-through type and operated in a single direction from one side to other. The entry and exit directions are marked on the drawing. The plant shall be designed to satisfactorily wash & clean the train/driver less train running through the Plant under its own power at a speed of 3 km/h. The power to the train will be supplied via an overhead 25 kV AC line covering the full length of the washing siding. In case of driver less train, the contractor of wash plant need to interface with signaling contractor for all issues related to movement of train through the washing bay apron. The wash plant contractor shall provide potential free contacts to signaling contractor for smooth operation of train movement during the entry/exit to washing bay apron in addition to any other interface requirement of signaling contractor.

2.1.4. The train-washing plant shall be designed for both automatic and manual mode. In automatic mode, the wash cycle shall be activated and stopped by the train movement through limit switches which will act as entry /exit controls. In manual mode individual section can be activated/ deactivated. Ultrasonic devices, photo electric cells or other proven approved means to enable the full length of train to complete the entire wash cycle. The limit switch/proximity switch/sensors etc which are required to be provided by the contractor in the tracks for sensing of the movement of trains shall have enough passage for the movement of the rolling stocks of 300mm tyre width.

The entire plant shall be stopped automatically if the train approaches at a speed more than the specified speed as mentioned in clause no 2.1.3. The plant shall automatically shut down after a pre-set time of 30-60 sec in the event of a train stopping inside the washing bay apron.

2.1.5. The following facilities/ operation by the control console are required at the Depot Control Center. (i.) Auto enabling of train wash plant so that the plant is being activated by the presence of train for ensuring complete wash:-

(ii.) Selective disabling of plant so that the train can pass through the plant in either direction at a maximum speed of 25 km/h without the washing process taking place.

(iii.) Monitoring of details i.e. status/health, operating hours of the plant shall be monitored at control panel along with audio, VDU and also printing facility to be provided by the contractor.

(iv.) Complete graphical Indication of completion of washing cycle shall be available at control console.

(v.) No staffs shall be required to manage the plant, other than to clean and replenish the stocks of cleaning media.

2.1.6. Manual operation of the Plant shall be allowed at the local control console, which shall be located at the wash area, for maintenance work. Provision shall be made to switch over to „manual" mode of operation, in which the various sequences shall be regulated by individual controls. The design shall provide for by-passing any one or more stages of washing if warranted.

2.1.7. Plant brushes shall able to follow the contour of the body sidewalls of the train.

2.1.8. Remote downloading of the diagnostic and status/ health of plant, through Wi-Fi/internet access shall be provided within the depot premises, necessary arrangement for this purpose shall be provided so that commercially available laptop is used for the same .Any special hardware, software if any required for this purpose shall be provided by the contractor. During operation of the plant if it becomes inevitable to isolate a particular sub system, the same should be possible thorough simple operation. Details of such requirements shall be finalized during design.

2.1.9. The plant and its accessories shall have necessary provisions for interlocking of entry and exit controls with the spray nozzles manifold so that the plant may not operate in the event of failure of the entry and exit controls

2.1.10. The brushes shall automatically retract to their gauges in the event of any malfunction or activation of emergency stop buttons

2.1.11. The pumps shall automatically shut down in the event of lack of water or detergent solution

2.2. Plant Capacity

2.2.1 The Plant shall wash the lateral sides of the coaches from the cant level to the deck level.The trains to be washed will consist of 3 cars with train lengths of approximate 70m.

2.2.2 The Plant shall be capable of allowing trains to pass through the plant in either direction at a maximum speed of 25 km/h without the washing process taking place.

2.3. Plant Assemblies

2.3.1 Assemblies by Train Washing Plant Contractor

The Plant shall comprise the following equipment, which shall be provided by the Contractor.

2.3.1.1 Control Console at Depot Control Centre

2.3.1.2 Local Control Console

2.3.1.3 Pre-wet Station

2.3.1.4 Detergent Brush Station

2.3.1.5 Water Brush Station

2.3.1.6 Final Rinse Station

2.3.1.7 Water Recycle Module

2.3.1.8 Detergent Dosing Module

2.3.1.9 Water Streak Removal Module (Reverse Osmosis Plant)

2.3.1.10 Accessories such as sensing device/ switches, control gears and signage

2.3.2. Provisions by Other Contractors

The Plant shall also include the following provisions, which will be provided by other Designated Contractors to the Washing Plant Contractor for integration into the Plant.

2.3.2.1 Underground Water Tank

2.3.2.2 Used water collecting tanks

2.3.2.3 Track work

2.3.2.4 Over headline

2.3.2.5 Drain points and pipes for effluents discharged to the Effluent Treatment Plant of the Depot.

2.4. Plant Layout

The assemblies of the Plant, except some signage, shall be laid out in the locations as indicated on the Drawings.

- A wash area not exceeding 60m by 10m, shall be provided at the entry track of stabling area of the Depot. **However for construction of washing bay at ramp, only 3.3m space on either side from the centre of the track will be available for the installation of automatic train wash plant. Tenderer may kindly note the space availability for the design of plant accordingly.**
- Underground water storage tanks for collection of water under the plant room.
- **Control console with cabling in suitable cable ducts at the Depot Control Centre, which is approx 1000m from the wash area.**

The wash area shall accommodate the, all washing stations. Local control console water recycle module, detergent dosing module , water tank, used water collecting tanks, water streak removal module and associated pumps, valves, meters etc inside a plant room.

If store for any other items is required, it shall be accommodated in the plant room.

The Depot Control Centre at the main depot building shall accommodate the control console for master control of the Plant at a remote location.

All the cables and pipes linking the two areas shall run parallel to the track in a trench and cross the track in corrosion resistant sleeve pipes, perpendicularly under the tracks. Such crossings shall preferably be at either ends of the wash bay area and NMRCL"s approval for the same shall be taken during the design stage.

In addition, the layout of the plant shall be arranged to enable acid washing to be added at a later stage when it is found necessary. Space shall be reserved for the installation of an additional set of pre-wet station, a set of acid station and associated assemblies. The reserved space for acid station shall be at a minimum distance of 30m ahead the water brush station.The system should be modular and capable for modification in the futurefor electrical ,mechanical,hardware and software when needed for acid washing .

2.5. Reference Data of Coaches

The configuration of the Plant shall be designed to fit the characteristics of the EMU coaches. The car body is made of stainless steel/Aluminum for standard gauge. Final specification of the car body material shall be advised during design stage. Indicative dimensions of Rolling Stocks being purchased are given for reference in the general specifications Schedule-7 and the exact dimensions shall be obtained from the EMU Coach Contractor during the detail design stage.

2.6. Washing Process Station

a The tender shall submit detail process flow of the complete system along with the reasons attributed to each step and additional measures taken in design for improving design to suit specified ambient conditions.

b The washing process of the Plant shall be optimized, for maximum cleanliness of the coaches, with the parameters of the detergent composition, rotation of brush, spraying pressure and flow rate of each single process and water consumption.

c The indicative flow rates of the washing stations are given below. Further optimization (considering the dusty weather condition as prevail in the city of Nagpur) will be preferred with advance design features without compromising on the cleaning quality.

- Pre-wetting 300litre/min
- Detergent Solution 80litre/min
- Water brushing –first stage 180litre/min
- Water brushing –second stage 200litre/min
- First Rinsing 300litre/min
- Final rinsing(from R.O) 100litre/min

The contractor shall carry out all necessary work complete with tanks (except civil work as specified clause no 1.2), pumps, pipes, valves, filters, meters and accessories as required in each station.
The contractor has to provide a **water consumption meter of reputed make** at water inlet line to the plant.

2.6.1. Pre-wet Station

A pair of spray poles, one on each side, shall be provided for pre-wetting of the car body surfaces. The pre-wetting shall be performed by spray nozzles to break down surface tension for even adherent of further washing medium.

The pre-wetting process shall adopt fresh water /recycled water, which shall be supplied fresh water from depot .

The pre wet station shall be activated automatically only after the ambient temperature reaches above 10 degree C. The lowest nozzles of spray poles of the pre wet station shall be at a height of 1250mm from top of rail so that mist /water does not trickle down to the under frame parts of train.

2.6.2 Detergent Station

2.6.2.1 This station shall consist of one pair of vertical brushes (one on each side) with stainless steel spray poles, suited to cleaning the lateral faces of the trains. The motors rotating the spindle & side movement of the brush shall be mounted on the top of the brush. The electrical current to the side motor is controlled in such a way that the brush shall have a consistent lap with lateral side of the train. The brushes shall also follow the shape of the train if it changes. Each brush shall include an arrangement to spray water mixed detergent solution evenly on the car surface. Drawings shall be provided in the technical offer for better understanding of the design. Any alternative of proven design for 5 years may be submitted with detail justification elaborating advantages and past experience. The provision shall be made to vary the chemical application from HMI panel from 0.1 to 2.3 %.

2.6.2.2 The contractor shall interface with Rolling Stock contractor for selecting detergent suitable for cleaning Rolling Stocks body taking into account the environmental condition of Nagpur Metro. The contractor shall use Indian detergent. In case contractor uses imported detergent then contractor shall propose equivalent Indian detergent within 6 months from the date of commissioning plant. In case of imported detergent, technical & purchase specification shall be provided.

2.6.2.3 The detergent solution shall not exceed a pH value of 7; so as to eliminate risks of detrimental chemical reactions but it will be finally decided after interface with Rolling Stock contractor strictly. The detergent shall preferably be chemically neutral with capability of emulsifying the adhering dirt, with capability of loosening the adhering metal particles for easy removal.

2.6.2.4 The lowest nozzles of spray poles of the detergent section station shall be at a height of 1250mm from top of rail so that mist /water does not trickle down to the under frame parts of train.

2.6.2.5 The detergent process shall adopt soft water.

2.6.3. Water Brush Station

Two pairs of vertical brushes, two on each side, shall be provided for water brushing on the car body surfaces. Each brush shall be integrated with a spray pole with simultaneous operation. The water brushing process shall be divided into two stages. The first stage shall use fresh water/ recycled water while the second stage shall use soft water supplied from the water tank. These brushes shall have motors driving the brushes from the top. **The brush rotor shall be controlled by pneumatically or electrically to ensure that the brush follows the contour of the train profile**. The motors rotating the spindle & side movement of the brush shall be mounted on the top of the brush. The brush section lengths are profiled to suit the train outline. The two stages of water brush station shall be separated with appropriate distance such that the water sprayed at each stage can be individually collected by separate drain.

The lowest nozzles of spray poles of the water brush section station shall be at a height of 1250mm from top of rail so that mist /water does not trickle down to the under frame parts of train.

2.6.4 Final rinse station:

Final rinsing shall be in two stages, first stage rinsing with soft water &second stage rinsing with R.O water. For first stage rinsing with minimum one set of spray pole and for second stage rinsing, with minimum two sets of spray poles to be provided but details may be worked out during the design stage as per train cleaning requirement to the satisfaction of employer.

The final rinsing process shall be designed with the consideration of water streak removal. A portion or all of the water for final rinsing shall be supplied from the water streak removal module.

The lowest nozzles of spray poles of the water brush 2 and final rinsing section station shall be at a height of 1250mm from top of rail.

2.7. Detergent Dosing Module

The detergent-dosing module shall be equipped with tools to facilitate dosing of the detergent agent in the designed proportion controlled through PLC. Pump shall be of metering adjustable pumps. Any adjustment of detergent quantity metering shall be available through HMI.

The module shall be complete with all necessary tanks of approx. 1000 Litres capacity, pumps, pipes, valves, meters and accessories. Stainless steel tanks with sufficient thick gauge walls shall be used for detergent storage.

2.8. Water Streak Removal Module

The water streak removal technique to be adopted shall effectively eliminate the possibility of water streaks after final rinsing. This can be achieved by providing series blowers of minimum air flow capacity 4.5 cubic meters per sec at 0.8 bars in both sides of the train to eliminate the possibility of water streaks after final rinsing. The adoption of the technique shall be taken into account the quality and ingredients of the water supply in Nagpur Metro.

Filtration of water shall be done with Reverse Osmosis system for the final wash of train coaches in the Auto train wash plant. The system shall be from reputed suppliers only. The plant shall be design after checking the water quality of the site only. Treated water from R.O shall be collected in a separate suitable tank of 10000
Litres or more capacity. The amount of water output from R.O plant for washing of trains shall be sufficient enough to meet the plant capacity as mentioned in clause no-2.2 above. Tender shall describe the entire process, supported by calculation in the technical offer. Before final rinsing process, total dissolved solids of water shall be generally less than 5 ppm. The minimum capacity of R.O plant shall not be less than 1000 Liters/hour. The rejection water from R.O will be diverted to ETP.

The module shall be complete with all necessary tanks, pumps, pipes, valves, meter and duct accessories.

All the stations shall be enclosed by three sides with SS 316 L sheet of 3mm thickness.

2.9. Water Recycle Module

The water recycle module shall be provided to minimize the water consumption of the depot.

Fresh water from the main shall be used for R.O. Plant reservoir.

Used water from the first & final rinse station & second stage water brush station shall be collected in underground reinforced concrete recycling tanks after proper screening. The recycling of the water shall be treated as per the process specified in clause no 2.9.1 of schedule of requirement. The final recycled water shall be reused for work stations of wash plant or depot horticulture. Soft water from softener plant shall be used for detergent wash, for first rinse station and second water brush station and input to R.O plant. The input to softener plant shall be taken from the fresh water storage tank with a provision for make up by fresh water. A provision to bypass soft water and to use fresh water in place soft water shall be made if circumstances warranted.

All water from the stations of pre-wetting, detergent spraying and first-stage water brushing shall be collected in a sump to discharge to the effluent treatment plant.

The module shall filter the used water to eliminate the possibility of clogging of spray nozzle at the respective stations.

The module shall be complete with all necessary tanks, pumps, pipes, valves, meters and accessories.

Sufficient care shall be taken to prevent rusting at the plant design itself. Details will be elaborated in the proposal during the detailed design submission.

2.9.1. Water recycle Module using Filtration/ Adsorption /Aeration

The use of the various stages of water recycling module is given below. This is only indicative. Vendor may suggest his own methodology in order to achieve chloride content as permissible as mentioned at clause 2.13a of schedule of requirement. The water recycle module shall be provided to minimize the water consumption of the depot and ensure that recycled water does not contain sediments, free oil viz. grease etc., residue detergent and odour.

i. Particulars

The unit shall be designed to treat wastewater coming from train washing. The aim is to recycle part of treated water and discharge the excess. The use of soft water should be limited to first rinsing and water brush section & detergent wash only.

Treatment shall include the following:

- Filtration through Quartzite or similar
- Adsorption through activated carbon
- Oxidization by air injection

The cleaning action is aimed at the reduction/destruction of:

- Suspended substances,
- Surface-active agents,
- Anaerobic bacteria, responsible for the formation of unpleasant odours

The excess water can be discharged in to the drainage system connected to the effluent treatment plant (ETP).

ii. Procedure Description

This will be in three stages.

Stage I

a. Removal of sludge

The water used during the train wash phases shall be collected in the underground tank where heavy solids, sand and slurry settle by gravity. The sludge removal from the tanks shall be easy and fully accessible. The procedure of sludge removal shall be simple and should be mechanized. Tender shall include details of the sludge removal system.

Stage II

b. Removal of suspended particles, oils, hydrocarbon and residue detergents & filtration of used water from stage I.

The water shall then be further processed for removal of free oils and hydrocarbons. After pre- treatment of sedimentation and degreasing, the water shall be processed for removal of suspended particles, oils and residue detergents. For this the water shall be taken to the filtering column by using a pump and then to the activated carbon filter and then collected to the underground tank, shall then be collected in a tank to remove/withheld surface-active agents & organic pollutants. The filters shall have facility of automatic back washing (preferably minimum once a day but frequency will decided as per the field trial) using fresh water.

Stage III from stage II

c. Removal of unpleasant odours

An oxidizing line shall be used by the accumulation tanks to ensure that no unpleasant odours arise, particularly during the hottest period of the year caused by the inevitable decomposition of the organic substances (e.g. surface active agents) contained in the waste water.

Stage IV

d. Water softening plant.

The water softening plant shall be used to reduce the hardness of the water of partially treated water coming from the fresh water from mains. The level of hardness of the water from softener plant shall be generally less than 5mg/L. The discharge or rejection from the softener plant normally shall be diverted to ETP unless vendor suggest otherwise. In that case vendor has to elaborate as how they shall control the chloride content in the recycled water within the permissible limit as mentioned at clause no 2.13a.

e. The contractor shall provide the detailed maintenance schedule for Water recycle Module in the design proposal.

2.10. Control Console

The control console at the Depot Control Centre (DCC) shall be provided for normal automatic operation of the Plant and the local control console at the wash area for manual operation during maintenance work of the Plant.

The console of the Plant shall be fitted with PLC to safeguard and sequence all

automatic processes and movements. The changes required in sequencing or timing of various operations shall be implementable through control panel HMI touch screen Control of related and conflicting operation functions shall be interlocked to enable logical operation of wash cycle. The screen shall be selectable from menu and shall also provide diagnostic /faults messages. The control shall have the provision to revert back to a pre determined setting of the plant if there be any wrong setting by an operator.

The contractor shall furnish complete details of flow chart sequencing ladder diagram etc developed for plant operation. Necessary hard ware & software program shall be provided to incorporate changes in installed application software.

The consoles shall be provided with HMI touch screen display /pushbuttons switches for various operations as well as indicating lamps / meters for monitoring the operations in progress.

The consoles shall allow spare spaces for apparatus installation, such as intercom & telephone, in the future.

DCC Control Console

The DCC Control Console shall be provided with the following minimum control functions and monitoring functions.

- Main isolator key switch on /off
- Console selection DCC console / local console
- Washing plant mode: wash / no wash
- Detergent spray station on /off
- Emergency stop button turn to release
- Washing in process flashing amber light
- Train passing by complete graphic display showing the positioning of train while washing.
- Common major fault signal flashing red light &E-stop
- Common minor fault signal flashing yellow light for repair
- Lamp test button pushbutton.

Local Control Console

A single control panel monitors (HMI) with predefined PLC programme shall be able to operates the wash plant. The operation is fully automatic but panel shall also allow manual override so that plant can be controlled from plant room. The local Control Console shall be provided with the following minimum control

functions and monitoring functions.

- Console power on /off
- Plant power key switch on /off
- Plant operation auto /manual
- Washing plant mode wash / no wash
- Detergent level low

- Individual washing process on /off
- Emergency stop button turn to release
- Status of individual process flashing amber light
- Fault signal for each sub-assemblies flashing red light
- Pressure gauge for each pump line meter
- Lamp test button pushbutton
- Supply failure (water, pneumatic system, electricity) flashing red light

2.11. Signage

Signage shall be provided along the track of the washing plant for the notice of the train drivers regarding the operational status of the plant. The letters of the signage legends shall be of adequate size to be read at a distance of 20m.

A single illuminated digital signage with legends shall be erected at the entrance end of the washing plant. The legends shall indicate following messages depending on operational status of the plant;

- WASHING MODESTART
- ”WASHER DISABLED: DEPOT SPEED” if the Plant is switched off,
- ”DO NOT ENTER” if the Plant is engaged for a trains coming from exit end direction, or
- “TRAIN WASH: SPEED 3km-5km/h MAX.” at all other times.

Similarly a single illuminated signage with legends shall be erected at the exit end of the washing plant. The legends shall indicate the following messages depending on operational status of the plant.

- ”DO NOT ENTER” if the Plant is engaged for entry end trains, or
- “DEPOT SPEED” at all other times.

One no. of panel duly painted with fluorescent paint shall be erected at 70 m, from the Plant with the legends of “END OF WASHING FOR 3-CAR”, in the DEPOTs. All the signage marked on metallic sheet shall be on stainless steel.

2.12. Connection to Wash plant

The plant will be connected from the water mains at a pressure of about 3 bars.

2.13. Wash Pit

The wash pit shall be designed by washing plant contractor with appropriate partitions, grating and drain valves for drainage of wastewater, the drainage of storm water and collection of recycle water. The wash pit shall be designed with reinforced concrete structure for the support of the railway track running through the facility.

The wash pit will be constructed by a Designated Contractor of NMRCL/Nagpur.

2.14. Connection to Effluent Treatment Plant

The effluents to be discharged from the Train Washing Plants will be drained to the Effluent Treatment Plant (ETP) of the Depot. The ETP, which is not part of this Contract, will be located 600m from the washing plant. The piping for such drainage will be provided by the other contractors.

All water from the stations of pre-wetting, detergent spraying and first-stage water brushing shall be discharged to the ETP.

2.15. Technical alternatives

The tenderer may propose technical alternatives in the offer with cost, operation and maintenance advantages provided that the technical alternatives do not degrade the performance requirements as stipulated in the Employers requirements. The technical alternatives shall be submitted as per **Schedule -IV which** shall include but not limited to:

Full description of the technical alternative ;and

Changes to the Employers requirements and drawings.

2.16. RAMS (Reliability, Availability, Maintainability & Safety) Requirements:

The Plant is expected to meet the RAMS target of 96% Availability, which will be calculated excluding the downtime planned for Preventive Maintenance Services. Standard Penalty will be applicable as per the Penalty Clause.

Note: The bidder shall submit the complete technical detail of offered M&P for technical evaluation.

Chapter-3

CNC Under Floor Wheel Lathe (Item Code- NMRCLMNP002)

Name of the Equipment: CNC Under Floor Wheel Lathe

Sample Image

TECHNICAL SPECIFICATION OF

CNC UNDER FLOOR WHEEL LATHE

CONTENTS

GENERAL DESIGN REQUIREMENTS

SPECIFIC REQUIREMENTS

GENERAL DESIGN REQUIREMENTS

The following general requirements on equipment design shall apply to all equipment.

The Equipment shall be of proven design shall be designed for a 30-year design life of heavy-duty workshop use and shall be available throughout the year without any limitation in day to day wheel re-profiling process of rolling stock.

Equipment that requires an electricity supply shall be compatible with the supply voltage 360V to 440V, surge protection, low voltage protection to be included whenever necessary , TPN, 47.5 to 51.5 Hz. Any regulation or protection required shall be the responsibility of supplier

Equipment shall incorporate means of adjustment in order to allow for building movement and concrete beam deflections. The maximum expected movement of any section of any building will be ±25mm vertically, ±25mm longitudinally and ±25mm laterally.

Work related to the production of the equipment shall comply with the relevant European Standards, Codes of Practice and latest statutory requirements of India including the following:

BSEN287 - Approval testing of welders for fusion welding.

BSEN288 - Specification and approval of welding procedures for metallic materials.

BS4575 - Fluid power transmission and control systems.

BS5304 - Code of practice for safety of machinery.

BS5395 - Stairs, ladders and walkways.

BS5950 - Structural use of steelwork in building

BSEN60073 - Specification for coding of indicating devices and actuators by colours and supplementary means.

EN60204 – Electrical equipment

BSEN60529 - Specification for degrees of protection provided by enclosures (IP code).

ISO9001-3: 1991 - Guideline for the Application of ISO9001 to the Development, Supply and Maintenance of Software.

The layouts given on the Drawings shall be used for conceptual purposes. The Contractor shall furnish their requirements in accordance with the Schedule of Key Dates in the Particular Specification.

The contractor shall closely study the ambient condition of Nagpur with special attention, like high temperature reaches up to 50 degree C within the covered shed, heavy dust and poor quality of water and shall suitably consider for such consideration during design of the equipment.

The equipment shall be designed and/or selected to allow operation without over stressing, damaging or interfering in any way whatsoever with other equipment in the Depot.

Components of equipment of similar construction or similar application shall be mutually interchangeable.

The Contractor shall, to the extent that he is responsible for the design or for the selection of particular components of equipment items, recognise and implement all safety requirements and ensure that the design and performance of the equipment are compatible with the appropriate international safety standards and ambient condition specified.

Equipment shall be “fail-safe” and “overload protected”. The equipment shall incorporate all necessary safety devices to protect the equipment, operators, and all other people and things in the vicinity of the equipment. No failure of the equipment shall cause or give rise to any damage or catastrophe of any nature whatsoever.

Equipment design shall take into considerations of fire protection, elimination of dust and dirt by means of suitable traps or the like, minimum maintenance requirements and ease of access for cleaning, routine maintenance and general disassembly.

Guards shall be fitted to all exposed moving parts of the equipment where the environment and working processes dictate that there is a foreseeable risk of injury or causing ill health to personnel from sources such as moving parts, electricity, coolant, swarf, noise and vibration, dust and fumes, etc.

Moving parts of the equipment shall be efficiently lubricated to ensure quiet operation as well as durable and reliable life. Lubrication points shall be clearly identified for easy replenishment with minimum removal of other equipment components. A Centralised lubrication system shall be designed to last for 30 years of operation.

The environment within which the equipment is to be operated shall be taken into consideration in the equipment design.

The machine shall also be capable of re-profiling of the wheel set assembly with unbalance wheel loadings as permitted in international standards.

3.1. Use of drawings and data

3.1.1. All data in concern with the rolling stock written in this specification is for information only and there may be slight variations.

3.1.2. The compatibility of the equipment with the rolling stock characteristics is the responsibility of the Contractor and he shall obtain the required data / documents from the Rolling Stock Contractors.

3.1.3. All information or documents related to the Rolling Stock deemed necessary are to be taken from the rolling stock supplier by the Contractor.

3.1.4. The drawings shown on the plans define the operating conditions and are provided for indicative purpose only. These may be adapted by the Contractor in consultation with the Employer.

3.2. Reference Data of Tracks

The Locomotive/ trains / wagon /Road vehicle shall be operated on the tracks with the following specifications. The track specification may however vary

slightly and the Contractor shall obtain the details from the Track Work Contractor.

Track Gauge	1435 (nominal)
Max. gradient	4%
Curve radius	100m in Depot
Empty rail car weight (DMC & TC)	47t (appox.)
Max. Axle load	16 tonnes
Rail Type	UIC-60 kg Grade 880 conforming to specification IRS/T-12

Note: These data are indicative only & actual data will be supplemented during detail design stage.

3.3. Principal Notional Vehicle Dimensions.

Machine configuration for Rolling Stock (Standard Gauge)*

The machine shall comply with the following configurations:-

Maximum width of rolling stock	2900 mm
Distance between axles on a bogie	2200mm to 2600mm
Axle length (range)	1880 mm to 2500mm
Track gauge (standard gauge)	1435mm
Maximum axle load of vehicle to be machined	16 tonne
Maximum tread diameter	860mm
Tread Profile-	As per recommendation of Appendix 2, UIC 510-2
Minimum tread diameter	780mm

Though interface shall be carried out with Rolling Stock supplier, the machine shall be able to cope with the following Rolling Stock data, which are provided for information and reference.

Weight of the empty car	47 T each (appox)
Length over body	21940 mm (Max)
Distance between bogies centers	(14600-15100) mm
Width of tyre	135 ± 1 mm
Wheel gauge (distance between inside face of flanges)	1358 -1360 mm
Wheel Specification	UIC812-3/EN13262

***These values are indicative only & it will be confirmed during design stage.**

SPECIFIC REQUIREMENTS OF UFWL

The machine shall be of robust construction capable of withstanding severe duty over long years of service. Machine bed and support structure shall be of

specified casting / welded construction, duly stress relieved, so as to nullify the effect of vibration on performance during lifetime of machine. All major castings like base frame & adjacent column shall be of cast iron grade FG-260 of IS:210/ Welded Steel Construction or better and of rigid structure to ensure vibration free operation. Constructional details and material specification shall be furnished in the bid. In case the tenderers prefers to offer any other better construction method, it will have to be a proven technology which will have to demonstrate with documents and test report to the satisfaction of clients in the technical offer.

The machine shall be so designed to ensure an effective and efficient work sequence. Each work phase shall be reliable, durable and safe in operations. Following is a description of the operation of the fully automatic CNC under floor wheel lathe. The level of functions shall be completed under the Contract.

3.4. Operating requirements

3.4.1. The machine shall be capable of re-profiling in situ & also in isolation, simultaneously at both wheels of a wheel set, old work hardened and new wheels of all types of rolling stocks without the need of removing any components such as wheel sets, bogie brake gear, axle box covers etc. It shall be capable of machining wheel mounted brake disc or axle mounted brake disc in situ and otherwise. For this, exact & complete arrangement shall be provided during detail design stage. The tenderer shall describe details of machining procedure for brake disc machining of both the faces of discs. Machine shall be capable of machining the inside faces of the wheels in continuation of the profile turning of the wheel tread. In addition, it shall also be capable of re-profiling wheel sets removed from the coaches by means of suitable holding down devices. It should be possible to control cut manually so as to achieve some intermediate profile. MMI/HMI (Human machine interface) should enable to determine the profile with cuts of different depths**.** The machine shall be able to calculate the required depth of cut after the measuring the wheels parameter of a given axle.

3.4.2. NMRCL shall use the machine for re-profiling the wheels of its Rolling Stock of Standard Gauge, diesel locomotive, battery locomotive, and other Maintenance Vehicle (with wheel profile SK 91146 or UIC profile EN 13715-S1002 or any other related wheel profile), wagon and other rail vehicles. Drawing of wheel profiles (CAD or PDF) of above-mentioned profiles of the vehicles, used on the system shall be supplied by NMRCL, the machine's CNC shall have the capability store CNC profile in the machine's computerised numeric control (CNC). The employer shall be trained to convert any desired wheel profile into CNC profile and store in the machine memory for further wheel profiling. Machine shall be able to generate all the above profiles electronically. The machine shall have the intermittent profiles of variable flange thickness starting from 29.4 mm of profile SK-91146, and the machine shall have the intermittent profiles of variable flange thickness from 28.5-32.5 mm of UIC profile EN13715 S1002, with proper operational manuals for different profile cutting.

3.4.2.1 Different vehicles of different weights/ axle load (within maximum specified) may have to be re-profiled. The machine should either automatically set different relevant parameters or the contractor shall furnish detail procedure for such adjustment to NMRCL and impart training to employer's staff to do such adjustment in the machine.

3.4.3. The machine shall have the capacity to re-profile 4 wheel sets of a coach in less than 4 hours from fully worn profile to completely new profile. The total time of a single complete cycle required for a wheel set with normal worn wheels in one cut and heavy worn wheels in two to three cuts shall be optimised for efficient operation. Details of calculation of cycle time in order to complete the same within the target time shall be described and same shall be demonstrated by the contractor at site during the commissioning. The claimed productivity shall be achieved with the accuracies as specified in clause no. 3.9. The exact sequence of operation including multiple cuts shall be explained in the offer.

3.4.4. The machine shall have capacity for removal of 6 mm material radially (diameter reduction up to 12 mm) from wheels. The details of automatic mode of operation of machine during one complete cycle, the no. of operators required to achieve specified productivity and the cutting parameters; type and make of tools, speed and feed should be indicated in the bid.

3.4.5. The machine shall have the provision of manual over ride in re-profiling to generate the intermittent profile.

3.4.6. The fully automatic CNC under floor wheel lathe shall be capable to perform, even without the integration of the shunting electric shunter.

3.4.7. The machine shall have remote diagnostic feature to enable remotely interaction with manufacturer/supplier end for rectification of faults. The contractor shall provide all the Software & Hardware for remote diagnostic & provide hands on training to client's staff to enable the same. The machine supplier/its Indian counterpart shall be responsible for the provision of communication set up to enable the supplier and employer to interact remotely with machine computer for rectification of a fault**.**

3.4.8. Supply of application software & its backup, hardware & the training as required to generate tooling path profiles for re-profiling of wheels of vehicles mentioned shall be provided to employer's staff & change in application oriented parameter to be mutually decided during design stages.

3.5. Machine control

Operation of the fully automatic CNC under floor wheel lathe and related equipment shall be by computerised numerical control (CNC). All functions of the machine shall be controlled from a centralised ergonomically designed CNC control panel / through push buttons and selector switches, provided on each side of the Machine. The control panel shall allow a full and clear view of the cutting points and the drive rollers to the operator. The control panel shall be preferably pendent type / machine mounted & shall not be floor mounted.

Independent machining / operating CNC controls one on either side shall be provided and should be able to operate independent of each other. The CNC controller shall be of latest series from M/s SIEMENS or Similar. Details of the CNC controller and its Layout Arrangement shall be described in offer.

Main function of the CNC software shall be:

i. Interface with the operator.

ii. Command of UFWL and accessories.

iii. Control on the safety device.

iv. Data storage for profile & history of profiled wheel sets.

v. Profiling cycle.

vi. Auto diagnosis of UFWL and accessories.

vii. Printing or exporting of profile reports.

viii. Data exchange with wheel sets management database.

3.6. Principle of the machine operation cycle

3.6.1 The railway vehicle shall be driven inside the UFWL building by means of a remote controlled electric Shunter. The operator shall enter the identification of vehicle & wheel set on the CNC control panel. On operators command from the pit the electric Shunter shall position the wheel set for re-profiling on the UFWL running on their flanges on retractable rails within the tolerance of $\pm$ 25 cm.

3.6.2 The pair of mobile rails with automatic translation shall ensure the continuity of the rail track over the machine for positioning of the wheel sets. Thereafter the load of wheel sets shall be taken over on to a pair of friction rollers. Hydraulic jacks shall be interlocked with the retraction of mobile rails. These rails shall be electrically insulated from the UFWL.

3.6.3 Profiled friction rollers shall then drive the train wheels on the machine. The rollers shall be equipped with anti slip system. The wheel sets shall be kept in position laterally by a pair lateral guide rollers.

3.6.4 The axle box supports shall be commanded by the CNC and shall be integrated in the operation cycle of the UFWL. These shall be in locked position during the machining processes to keep the axle boxes steady, even in case of power failure.

3.6.5 Axle box hold down device shall allow increasing the pressure between the driving rollers and the wheel sets to increase the torque during the re-profiling. The CNC shall calculate the hold down force required according to the wheel set load.

3.6.6 Before the actual profiling cycle, the operator shall perform a pre measurement of all wheel sets. After calculation of wheel set dimensions and of acceptable tolerances, the UFWL shall propose an economical depth of cut for re-profiling wheel sets to the operator.

3.6.7 The machine shall be operated for profiling via a CNC control panel on any one of the two sides so that the operator shall have continuous access to all machine functions for the safety & efficiency. During re-profiling, the 4 driving roller arms shall be made independent by CNC to compensate the

wheel tread wear and defects e.g. wheels with heavy wear, normal wear and others like profiling flat tread, brake disc, only flange, tread with the flange.

3.6.8 Measuring shall be done after completion of machining. The whole parameters defining the wheel set geometry shall be measured. The new dimensions of the profiled wheels shall be displayed on the CNC control panel.

3.6.9 The CNC shall compute and deliver a complete profiling report, which shall be printed by an industrial printer.

3.6.10 All the data concerning to re-profiling cycle shall be stored in the CNC of the PC hard drive and thus shall be protected against electrical shut down.

3.6.11 The profiling report stored in the PC hard drive shall be able to be exported to and industrial laptop via USB port. The dedicated software for the data downloading shall be provided by the supplier.

3.6.12 The Electric Shunter shall move the vehicle to profile the next wheel set or drives away the vehicles out of the shed.

3.7. Description of measurement cycles

Wheel profile measurements

3.7.1 Each tool post of machine shall be equipped with suitable contact type electronic measuring device (retractable type) of proven design. Contact type scanning of wheel profile of worn wheel from the flange top to outer edge shall be determined by CNC machine for optimum cutting depth, and electronic measurement of wheel set's circumference shall be determined by CNC in order to determine the actual diameter.

3.7.2 The machine shall be able to measure the parameters like flange height, flange thickness, wheel back to back distance, tread diameter, root wear, flange wear, tread wear, QR etc.

3.8. Description of machining cycle

3.8.1. Wheel machining

3.8.1.1 The machine first measure the profile of wheel set to be machined. Rail-wheel contact causes different types of wear on the wheel tread and on the active sides of the flanges. Certain limits are prescribed for the allowed variation from one wheel set to another in a bogie and from one bogie to another and from one coach of rake to another.

3.8.1.2 The machine shall measures the actual profile of worn wheels and CNC control system determines the new optimum wheel set diameter by means of measured data. This nominal machine diameter is indicated at the operator control console, and it can be accepted and rejected by operator. The machine shall compare the measured actual profile with the nominal machining diameter and determine the optimum cutting depth and automatically perform preliminarily and finished cuttings. The alteration by operator shall be allowed. The profile shall be user programmable. Machine shall be capable of machining newly manufactured un-mounted wheel sets using hold down device.

3.8.1.3 During wheel machining, tool damaging or sudden cycle stopping actuated by the machine station shall take place with retraction of tool. This provision shall make it possible to replace tools, etc. Automatic tool retraction and backup power to HMI in case of power failure shall be provided. The scheme employed for this shall be explained in bid.

3.8.2 Screen page

The CNC display screen page shall display the pre- and post-machining values to the operator simultaneously. It shall be operator friendly.

Display principle

OP = given by the operator

NC = given by the numeric control system.

1- Vehicle number:	OP
2- Type of vehicle/equipment:	OP
3- Line number:	OP
4- Date & time	NC, operator correction possible
5- Axle number:	OP
6- Axle position:	OP
7- Faults:	OP
8- Remainder of wheel diameter:	NC
9-Wheel position (left or right):	OP / NC
10-Wheel diameter:	NC
11- Height, thickness, QR dimensions of flanges, wheel wrap:	NC
12-Wheel profile	NC

This information enables the operator to display the wheel diameters pre- and post-machining.

Depending on the accepted tolerances for the wheels of a given vehicle, it is possible that the wheels already machined would be out of tolerance, thus requiring re-machining. To avoid this, the machine will have capability to measure four wheels of a same bogie in a coach and decide the optimum turning requirement.

The software shall store the new measurements of an axle already machined and replace with the previous measurements with post machining.

3.9. Machine configuration.

The machine shall comply with the configurations as mentioned in Technical Specification.

3.10. Mechanical part

The machining technique should normally restore the worn wheel profile to true profile conditions. However it should be possible to restrict the cuts depth without achieving the true profile. The profile obtained shall not depend on the wheel wear status and shall be in accordance with the specified tolerance.

The additional mechanical installation shall make it possible to simultaneously re-profile two wheels of a given axle, dress the inner sides of the wheels, machine the inner and outer sides of brake discs on wheels or brake discs mounted on axle.

For all these machining works, no dismantling will be required on wheel; axle box and the wheel drive system.

3.10.1 Setting up the axle

- The railway vehicle shall be hauled inside the UFWL building by means of an Electric Shunter. The operator commanding remotely from the machine pit at the machine control panel shall be able to position the wheel set for re profiling within a tolerance of ± 25 mm.
- The wheels shall be positioned for re-profiling shall run on their flange on mobile retractable rails (hydraulically / electrically actuated & operation interlocked with the vehicle movement from the machine control panel).
- The axle boxes shall be supported by lifting with hydraulic actuated jack.
- The wheel set shall be positioned and centred by synchronised lifting of the driving rollers.
- The mobile rails shall be retracted to home position.
- The hold down arms shall hold the axle boxes in position by applying force from top.
- The wheel sets shall be kept in position laterally by a pair lateral guide rollers.
- The operational sequence shall be fully described in the offer considering the full safety of the system.

3.10.2 Axle centering

During centre less profile turning

Axle centring during centre-less re-profiling shall be achieved by means of the drive rollers and lateral guide rollers locating the axle in the vertical and horizontal planes. Only one train wheel setting-up operation shall be required for a particular type vehicle.

Concentricity of the profile shall be provided by the vertical movements of the drive rollers mounted on the slide blocks by suitable arrangement, which shall be described in detail along with the offer.

Irregularities in the wheel treads may be thermal cracks, splits or out-of round areas. All these faults should be corrected in a single machining pass with minimum tool wear/damage.In case of flats ,faults should be corrected in two machining passes.

During machining, the axis of the axle shall not move, in any case whatsoever, in the track direction. The Contractor shall give full details on the method used to impede any longitudinal movement.

3.10.3 Axial support of the axle

Centre less- profile turning

A side-securing device for axles shall be designed and proposed by the

Contractor for facing turning.
In particular, this device should:

- Lift the wheel set from retractable rails.
- Maintain the axle in the axis of the lathe during turning,
- Enable movement of the axle to position it in the axis of the lathe,
- Centre the axles, no matter what might be the spacing between the inner sides, wheels.
- Transfer of torque from drive roller onto the wheel set during machining. The

loads applied to the inner sides of the wheels shall not cause deformation of the wheel.

This device shall be designed to leave operators with very good visibility and to make it possible monitor tools during wheel machining.

Axle drive

- The machine shall rotate the wheels by means of a pair of rollers on the wheel tread/flange.
- Considering the maximum torque required for wheel re-profiling, especially at hard points on the wheel tread at the tool, it is necessary that all provisions be taken so that the drive roller-wheel adherence remains effective in all configurations.
- The axle drive shall be monitored to avoid any slippage during turning. Any slippage conditions shall warn the operator by displaying an error message, stop the feed or retract the tools depending on the extent of the slippage.
- The drive arrangement shall be direct driven by servomotor. Detail shall be described in the offer.

3.11. Tooling

3.11.1 The machine shall be capable of turning wheel profiles with throw away type carbide inserts with built in chip breakers. The chips that are yielded from the machining process shall not exceed 300 mm in length before entering the chip crusher. The total number and type of inserts required for each tool holder shall be indicated. The tools and tool holders shall preferably be available in India. Sandvik / Widia make tooling shall be accepted.

3.11.2 The profiling tool saddle shall be of standard reversible tools, designed to provide short broken chips. The saddles horizontal & vertical motions shall be obtained with ball screws controlled by AC motor and transducer. In case of power failure CNC shall command the retraction of the tool holder.

3.11.3 Tool-holders shall be easy to remove and their positioning on the tool-holder carriages shall be very precise to provide accurate machining of wheels.

3.11.4 Each tool-holder carriage shall be fitted with a spare tool-holder. Interchanging tool-holders shall not require readjustment of the machine.

3.11.5 Cutting tools shall be mounted vertically between the drive rollers.

3.11.6 Special care shall be taken in the design and construction of the tool holder carriages to facilitate any disassembly required for maintenance purposes or for replacement of components (ball screw, screw block, etc.).

3.11.7 Spare cutting tools- Five spare sets of cutting tools shall be supplied.

3.12. Wheel Measurement devices

The machine shall be fitted with suitable retractable type of proven design to make the wheel measurements. The devices shall be designed to protect from dust and chips. The Contractor shall indicate the selected types of protection systems.

(i)Wheel diameter measurement

The machine shall be provided with suitable retractable type of proven design for wheel diameter measurement device. The contractor shall spell out detailed methodology in the offer.

(ii)Measurement of wheel profile

Measurement facility shall be provided for measuring wheel profile before and after machining. The facility shall be capable of pre-loading of reference profiles, comparing the measured data with reference profiles, displaying the comparison and recording the results. Standard Test piece shall be used for calibration.

A wheel set for the calibration of the machine numeric controls shall be supplied along with the machine. The machine shall be capable to recalibrate the three axis using above test pieces. The wheel set and axle shall be pre calibrated and certified from a reputed test house only. A suitable stand shall be provided for keeping the wheel axle set when not in use. Calibration schedule, procedure and tools requirement shall be supplied

3.12.1 Result editing

After the machining or measurement operations have been performed on a vehicle (from 1 to 4 axles), the pre- and post-machining measurement results shall be printed on an A-4 size sheet of paper in table form of details parameters like flange height, flange thickness, wheel back to back distance, tread diameter, root wear, flange wear, tread wear etc of newly profiled wheel. A printer compatible to CNC machine shall be supplied for the same.

The-profiling reports that are stored in the machine hard drive shall be possible to be exported to an Industrial laptop/ microcomputer via interface software with hardware like USB port.

3.13. Machine Performance Requirements

After wheel machining, the difference between the profile obtained and the theoretical profile should not exceed $\pm$0.1mm on the wheel tread and the active side of the flange. The facility shall be available for pre-loading the reference profiles, comparing the measured data with reference profiles, displaying the comparison and recording the results

Maximum tolerances are as follows;

- difference between the diameters of the wheels of a given axle : $\leq$ 0.2mm

-difference between the diameters of the wheels of a given bogie: $\leq$ 0.3mm

-out-of round: ≤ 0.2mm

-Surface finish ≤ 25 µm (Ra)

- A suitable load meter to indicate load on the machine shall be provided. The load meter shall have an indication to indicate the maximum load the machine can take.

Suitable templates shall be provided to check each profile after machining.

3.13.1 Chip Disposal

Chip Crusher

- An integrated chip crusher of proven design shall be provided to crush the chips produced from turning the wheels to small chips with a maximum length of 100mm.
- The chip crusher shall be capable to handling a volume of chips produced under any machining condition of the machine.
- The crusher shall be a box type steel casing with number of high-grade special steel blades running at slow speed. It shall be mounted under the fully automatic CNC under floor wheel lathe hopper. The construction of a linking duct between this hopper and the crusher shall form part of the supply.
- The structure of the crusher shall have strength for long lasting operation without denting and deformation. The plate thickness shall not be less than 3mm.
- The crusher shall incorporate with safety measures to handle the blocking situation of chips at the crusher or the chip conveyor.
- The electrical switchboard and other accessories, which require operator to attend during operation, shall be located at safe places and protected from human injuries.
- An electrical overload load trip shall be provided to save the crusher against accidental overload due to some foreign material. Detail design of chip crusher shall be described in the offer.
- The noise level shall not exceed 75 dBA thresholds at the operator's workstation.

3.13.2 Chip conveyor

A chip conveyor shall be provided in the gallery under the lathe for chip removal. The chips shall be conveyed and discharged to a skip located outside the fully automatic CNC under floor wheel lathe pit / shed. It needs to be designed as per the site drawings.

A wheeled chip trolley with unloading by tilting mechanism shall be provided.

An electrical contactor shall be provided in order to slave its operation to that of the lathe machining cycle. Nonetheless, manual control shall be allowed.

The flow capacity of chip conveyer shall not be less than 20 Kg/hr or weight of chip cutting per hour.

3.14 Rails

3.14.1 A track rail running from one side of the pit wheel lathe shed to the other shall be used to enter and exit trains.

3.14.2 All sliding rails and fixed rails, which are an integral part of the Wheel Lathe, shall be supplied and laid by the Contractor.

3.14.3 The foundation and columns supporting the track and attachment of the columns to the ground are the responsibility of the Contractor. It"s design shall be interfaced with designated contractors for the required civil work.

3.15. Holding Down devices

Holding down devices shall be an integral part of the machine and will be meant for force applied to the external axle box cases at locations scheduled for this purpose in order to make re-profiling of un-mounted wheel sets and the lightest vehicle wheels possible, also re-profiling of mounted wheel sets. All types of adaptation tooling /claws shall be designed & made available for various types of axle boxes on the NMRCL Rolling Stock, Locomotive, wagon, rail-road vehicle and other maintenance vehicles. Contractor shall design and supply the adaptation tooling /claws for various types of rolling Stock, required data for design the same may taken during detailed interface requirement. The travel distances of hold down device shall make it possible to apply the loads on the various types of axles involved. It should be clear of the Kinematic profile of the train coach as per SOD , and other vehicles as mentioned above, when shunting is being done. This needs an interface with Rolling Stock supplier and collection of data for other vehicles from Engineer.

3.16 Hydraulic Installation

3.16.1. Hydraulic unit

The unit shall be preferably inbuilt & integrated into the machine and mounted at a height sufficient for easy drainage.

The unit shall be fitted with temperature and level control systems. Filters shall be compatible with distribution and regulation apparatus and pumps (filtering less than 12 microns). A pan shall be provided to recover fluid in the event of leakage.

The hydraulic system shall be equipped with the following protection devices:

1. Overheating
2. Overpressure
3. Low oil level
4. Surge protection if required

Preferably, hydraulic pumps shall operate during controlled movements. Accumulators shall compensate for component movement during machining and any possible leaks. Other solutions may be suggested.

Commissioning of the hydraulic installation shall be the responsibility of the Contractor who, consequently, shall provide the hydraulic fluid recommended by the manufacturer of the hydraulic unit:

- for initial filling,

- for initial draining after operation of the number of hours scheduled by the manufacturer of the hydraulic unit. The Contractor shall perform all operations recommended by this manufacturer (replacement of filters, cleaning of the hydraulic unit tank, etc.).

The complete hydraulic power pack shall be from proven supplier like REXROTH or equivalent.

Filter clogging alarms shall be provided to warn the operator.

Hydraulic unit tank filling shall be via a port protected with a filter (12 microns).

The oil shall be readily available in India.

3.16.2. Hydraulic gear

Hydraulic gear shall be homogeneous throughout the entire installation.

As much gear as possible shall be installed close to the machine and shall be grouped on distribution blocks for easy access for maintenance purposes. Additional outlets shall be provided for future extension.

Piping shall be integrated within the machine enclosure or run in the gutter and the technical ducting. It should be concealed and suitably protected.

Each hydraulic circuit shall be fitted with an easy to access test plug.

All supplies, assembly of pipes and connection components concerning the hydraulic installation are the responsibility of the Contractor.

All supplies shall be physically identified (riveted labels or numbers stamped on components). The same identification shall be indicated on electrical and hydraulic diagrams and in supply nomenclatures.

3.16.3. Jacks

All hydraulic and pneumatic jack pistons shall be protected from dust and chips. Scrappers shall stop foreign bodies from entering into the jack barrels. Jacks shall be easy to access for maintenance operations.

Jack links by rigid piping or hoses shall be of easy access for all maintenance operations.

3.16.4. Pressure sensors

Pressure sensors shall be installed on the drive roller-holder sliding block supply piping. Sensors shall be connected to the converters, which shall indicate the load in tons with a precision to within two decimal points. Calibration shall provide a zero display reading when the roller-holder sliding blocks, not loaded, are lifted. The converters shall be integrated in the control panel.

Pressure sensors shall be installed on any hydraulic circuit requiring permanent monitoring for good machine operation.

3.16.5. Lubrication

The machine shall be provided with an automatic lubrication system for lubrication of sliding/ rolling surfaces. The system shall be complete including filters, level indicator etc.

The machine guide ways shall be lubricated for life and shall require no wet lubrication from the system. **Arrangement shall be provided to indicate**

failure of the lubricating system and displaying the adequate information on control panel for the operator and protecting the machine.

i. Periodicity of cleaning/replacement of filters
ii. Periodicity of replenishing lubricating oil in the sump
iii. Other necessary information.

If it endangers the safety of machine, the operation shall stop. The lubrication system shall be explained in the bid with a lubricating diagram. Indian equivalent of lubricant & hydraulic shall be advised.

3.16.6. Electrical part

3.16.7. Computerized Numeric Control (CNC)

The CNC shall be built to satisfy the technical specification. The workstation touch screen of each side is proposed to be minimum 15" LCD or better. There should be redundancy in operating the system from each side. Tenderer shall give the standard scheme available with their design of machine.

Each tool-holder carriage shall be independent during the turning operations.

The CNC shall be designed for maximum reliability and easy maintenance.

i. The CNC controllers shall be protected from the effects of overheating by operator alarm and by power cut off.

To facilitate CNC use and maintenance, the following types of diagnostic and test circuitry shall be provided:

i. System integrity diagnostics (verification of the software, machine adjustment data, tool corrections, part program, etc.) at equipment power-up,
ii. Hardware diagnostics (cards fitted, normal operation of critical cards, power supply current and voltage),
iii. Non-resident diagnostics (test bands which may be loaded in the equipment to locate a defective card),
iv. Test circuits (display of machine position and tracking error, display of memory contents, etc.),
v. Access to the various BUSES for connection of an analyser.

Also, emergency thresholds and limits shall be provided to avoid feeding the tool in the machine and in the axle to be re-profiled.

The CNC shall be designed in such a manner that the modification of the profile of a wheel, the replacement of a profile, the modification of a cycle or basic data concerning the definition of profile, can be carried out. (Program for modifications available: guided operator mode).

i. Connectors for the addition of a data input keyboard, a suitable connector of latest technology output and a laser printer shall also be provided. The software shall be designed to enable these hardware.
ii. The operator-machine dialogue shall be by means of a keyboard and display control touch in operator panel/pendant.
iii. Operation running cycles and sequences shall be displayed in real time and in plain English language on screen pages. A screen page per

operation (setting up of an axle, measurement, machining, etc.) shall be provided.

iv. Interrupts in the sequence shall be reported. Manual sequences shall be guided by means of operator messages.

Parameter input shall be by means of masks intended to guide the operator.

3.16.8. Roller drive motor

4 of each roller drive-sliding block shall be fitted with a drive motor rotating the axle to be machined by means of wheels.

The adherence of the wheels-drive rollers is provided by the weight of the vehicle and additionally by the axle box holding down devices as required.

The circumferential speed of the drive rollers (cutting speed of the tooling) is proposed to be adjustable from 10 to 120m/min for wheel machining. Tenderer shall propose speeds as per their design to meet the specified output. The maximum cutting load for each wheel shall be 2,000 daN .

The difference in the diameters of the wheels to be re-profiled on a given axle may be relatively important. Machine should be capable to handle diameter difference up to 16mm, i.e. a difference of 50.27mm in circumference.

The selected drive etc. the machine with brush less motors (SERVO AC) from Siemens, ABB. This will be integrated with CNC system. Ventilation of motors is left to the initiative of the Contractor. However, the Contractor shall supply the maintenance and technical documentation.

Axis motors and axis coders shall be designed to suit the required machining precision.

3.16.9. Voltage Stabilizing Device

An Ultra Isolation Transformer with Automatic Servo Voltage Stabilizer of suitable capacity, according to the machine load shall be provided along with machine to **stabilize** the input power in particular the fluctuation of the voltage of the incoming supply**.**

3.16.10. Control panels

Panels shall be provided for control and monitoring of the machine from each side and shall be sized to take environmental conditions into account. There should be redundancy in operating the system from each side. The panels shall be dust & water splash tight & the ambient temperature outside may go up to 50 deg. C. The IP level for the control panel shall be at least IP55.

All panels shall be designed to accommodate ambient temperature and humidity conditions, by having heating cum air conditioning systems of reputed international makes only.

The design shall suitably consider all aspects, which shall be discussed and tested during design stages. In addition the panels shall have the following:-

-It shall have an earthing terminal.

-It shall comply with the regulations in force.

-The front panel shall be fitted with three indicating lights for the three incoming phases of power supply, lit when power on.

-All the control panels should include special button for testing mode.

-A three-pole isolating switch pad lockable in the open position will supply power to the installation.

-Doors will have removable keys and compartments for storage of electrical diagrams.

-Material for cabinet shall be metallic anticorrosion and painted / powder coated.

-Wire marking must be engraved type.

-The Contractor shall provide galvanic insulation between the different components. The electronic blocks and boards must be quickly replaceable without requiring dismantling of any other neither component nor removal of a cable or set of cables.

-The sub-assemblies performing the same function shall be strictly identical and interchangeable.

-The design of the electronics shall be such as to facilitate troubleshooting. In particular, for the technical boards:

-the functions shall be distributed on boards connected to the cabling by connectors, this distribution shall be designed so as to limit the troubleshooting time (each function clearly delimited per board),

The cabinet shall comprise:

-a main three-pole isolating switch which can be padlocked in the open position, fitted each with high rupturing capacity (HRC) fuses and single-phasing preventer,

-a main circuit breaker,

-an isolating switch for each component,

-the contactors and relays used for operation of the installation,

-magnetic/thermal protection specific to each movement,

-a programmable logic controller (type and brand to be specified),the transformer shall be designed with protection as per European standard EN 60204, the 415 V/230 V transformer (lighting, PLC or relays, etc. A light shall be interlocked with cabinet door opening.

The dimensions of the cabinet shall be designed for future expansion by about 20%. All the electrical equipment specifications will have to be submitted for approval, before assembling.

3.16.11. Electrical switchboards

All control and regulation electronic and electrical devices, etc. shall be mounted in dust-proof switchboards of IP-55 protected and shall include an earthing terminal. Switchboards shall be designed so that inspection, repair and maintenance shall be easy after doors have been opened.

Switchboards shall be in accordance with the regulations in force and on the front fitted with power on indicators.

A general three-pole isolating switch, latchable in open position, supplies the installation.

The inside of the switchboards shall be illuminated by means of compact florescent tubes controlled by door opening. Doors shall be locked with

removable keys. Locations shall be provided for storage of electrical diagrams. All glands to the panel shall be of double compression type.

A power socket shall be installed separately from the power source.

3.16.12. Switchboard equipment

Electronic cards or blocks must be designed for quick and easy replacement without requiring disassembly of other apparatus or gear, or the movement of a cable or bundle of cables.

Subassemblies performing the same function must be fully interchangeable and perfectly identical.

Machine electronics must be designed to facilitate repair and troubleshooting.

The equipment shall normally be able to operate at the ambient temperature of the workshop.

In particular, with regard to the technical cards:

- functions shall be distributed on cards connected to cabling with connectors,
- distribution shall be studied to limit the troubleshooting and repair time (functions effectively limited per card),
- during card replacement, adjustments must be limited to those which are strictly necessary,
- technologies used by the various sub-contractors must be homogeneous (same card format, same connectors, etc.).

Note: A time counter shall be installed on the roller drive control and on movements of all mobile components of the under floor wheel lathe.

3.16.13. Machine wiring

All outside cables shall be protected from any damage, which could be caused by chips, oil and grease. Protection sheaths shall be mounted on the machine so as not to hinder or retain machining chips. Connections made on protection sheaths and components controlled or junction boxes shall be of a mechanical type and removable (screws, nuts).

The maximum amount of machine wiring shall be laid inside the machine frame.

Machine, panel and electrical switchboard wiring shall be laid inside the machine frame.

Limit switches shall be installed in areas where chips do not reach. Protection systems shall be installed in all areas where there are hazards.

All cables, apparatus, gear and terminal strips shall be identified with relation to each connection. The same identification system shall be marked on the hydraulic and electrical diagrams.

Cabling and connection of the installation are the responsibility of the Contractor.

3.16.14. Machine Earthing

The fully automatic CNC under floor wheel lathe equipments shall be earthed as per relevant IS standards, shall have loop earthing. The point of connection for Earthing will be provided by the Purchaser.

3.16.15. Data processing Equipment

The data processing equipment of the machine CNC Systems of each side shall have the following configuration: -.

- The machine CNC shall be PC based and shall offer all PC interface like LAN/ WAN connectivity and shall have ample storage capacity to store wheel profiling data. It shall be compatible with IBM standard software, suitable for remote diagnostic
- 102-key keyboard.
- 15″ LCD or better
- Windows latest version
- Industrial grade Laser jet printer or equivalent.
- Provision of Uninterrupted Power Supply for PC system with 1hour back up time.

The Contractor will provide the programming consoles, application software, which should be compatible with and seen on windows platform and should be upwardly compatible. It shall be possible for engineers to modify specific parameter through application software. Full access to the application software should be provided to this extent. The engineers shall be fully trained for using application software to its full potential. The application programs designed for micro-controllers, PLD & PLA devices shall be supplied. All the PLC used on the workshop equipment have to be unified for maintenance and spare parts as far as possible, including 20% of input/output for future extension and 20 % for spare equipment.

3.16.16. Maintenance and upkeep conditions

All component parts of the machine must be appropriately protected to stop ingestion of metal dust and chips. All covers, slide caps, hoods and neighbouring boxes of tool holders shall be made sufficiently hermetic to stop metal dust from entering into these areas. All covers and hoods shall be easy to remove.

The machine and its accessories (hydraulic unit, electrical switchboards, numeric control system cabinets, etc.) shall be designed to facilitate maintenance operations.

All anomalies shall be reported to the operator by means of messages on the numeric control system screen.

A centralised and automatic lubrication device, with pressure and flow control for each lubrication point and display of faults on the numeric control system screen, shall lubricate the maximum number of moving components. Non-centralised lubrication points shall be located so that they do not call for the removal of any components to obtain access.

3.16.17. Requirements of interface with Electric Shunter

The machine shall have the provision of wireless interlocking with an electric Shunter for the movement of the Rolling stocks during the re-profiling of wheel sets i.e. the machine shall be able to generate and propagate signal (radio wave) through an antenna which can be traced for making the necessary adjustment in the control circuit of Electric Shunter for disabling the movement either by remote or local panel. The supplier shall ensure the details interface requirement as described in the interface design chapter.

3.16.18. Dust /Fume exhaust system

The dust and fumes emitted during the machining of wheels are needed to be disposed, situated in direct distance the machining area.

3.17. PROTECTION AND SAFETY

3.17.1. Machine safety

The sliding rails shall be locked in the extended and retracted positions.

A device shall be provided to impede any accidents during sliding rail operation if an obstacle is encountered. In the event of power failure or component failure all holding down device stop in their current position . All the push button shall be of “dead man” type.

The following conditions must be satisfied for vehicle hauling:

- continuity of the track provided by the sliding rails,
- mobile parts of the machine viz. roller-holder sliding block, tool-holder sliding block, reader head, etc., in retracted position.

Safety devices shall be provided to impede any damage to the machine and serious personnel injury in the event of false manoeuvres.

Interlocking of electric Shunter with lathe machine shall ensure that

- the shunting will not take place when the lathe is working on Rolling Stock wheel.
- when the shunting is being done using the electric Shunter the Lathe shall not work and its rails shall be in closed position.

Fully automatic CNC under floor wheel lathe shall be provided with alarm system in case of water flooding in underground sump with subsequent operation of the float operated sump pump along with flexible drainpipe for 40m approx from the pit, which shall be provided by the contractor.

3.17.2. Personnel safety

In relate to operator’s protection, the machine shall meet the condition. The

machining area and workstation shall be appropriately illuminated.

Protection against movement of vehicle when retracting rails are not locked.

Automatic tool retraction device to withdraw the tool in the event of sudden power failure .Arrangement to ensure adequate support to the vehicle in the event of sudden power failure or failure of the hydraulic system. In these eventualities, the vehicles shall continue to be securely supported.

Protection against faulty sequence of operation

3.17.3. Emergency stop pushbuttons (key lockable) shall be installed:

- on the control panel,
- at the workplace.
- At the chip disposal system

Protection against chips, the machine shall have the system of swarf- protection guards against the direct influence of chip from the cutting area.

Work ergonomic- operators stand is located in a way, allowing for optimum use of area of pit type foundation.

Fire protection- on the basic body of the machine, the design parameter of electrical installation shall be in safer range to protect from fire.

Mechanical protection-dangerous state of break in track continuity over the machine (displaced retractable rails of the machine).

Tenderer shall give the scheme proposed.

3.18. Noise Level

The noise level of the machine shall not exceed 75 dBA when measured at a distance of one meter from the machine. Minor variation to above limits is acceptable on discretion of employer. This will not include the noise of chip removal.

3.19. FINISH

3.19.1. Painting

The machine and related equipment (electrical switchboards, sliding rails, piles, hydraulic unit, etc.) shall be painted in a colour to be defined. The exact colours shall be determined during the execution study.

The following shall be provided:

- one polyurethane primer coat (thickness 40 microns dry),
- two polyurethane lacquer top coats, thickness 50 microns dry each.

Paint touch-ups shall be provided after assembly.

3.19.2. Identification

All machine components (pump, electro-valve, etc.) shall be identified and marked, corresponding to the panel, by means of durable engraved labels.

The manufacturer"s identification plate and the year of manufacture shall be affixed to the machine.

3.20 Technical alternatives : Minor deviation in technical specification is permitted . However,minor deviation shall not affect SOD and performance parameter of machines.

3.21. RAMS (Reliability, Availability, Maintainability & Safety) Requirements:

The Plant is expected to meet the RAMS target of 96% Availability, which will be calculated excluding the downtime planned for Preventive Maintenance Services. Standard Penalty will be applicable as per the Penalty Clause.

Note: The bidder shall submit the complete technical detail of offered M&P for technical evaluation.

Chapter- 4

Under floor Lifting Systems (Pit Jacks)(Item code- NMRCLMNP003)

Name of the Equipment: Under floor Lifting Systems (Pit Jacks) 1 No. 3-Car Unit

Sample image

PARTICULAR SPECIFICATION OF

UNDER FLOOR LIFTING JACKS (3-CAR UNIT) AT NAGPUR METRO

CONTENTS

GENERAL DESIGN REQUIREMENTS

The following general requirements on equipment design shall apply to all equipment.

- The equipment shall be of proven design and designed life shall be 30-years without rusting & corrosion in foundation, base frame and structural components. The design life for mechanism, driving components and others parts of the equipment shall be at least 15 years. No major structural repairs and major component replacement shall normally be required during the respective design life. The material & parts used for the same shall be specified in detail design stage.

- The Equipment shall be designed for heavy-duty workshop use and shall be available throughout the year without any limitation in day to day lifting frequencies. Availability of >96% is required.

- Equipment that requires an electricity supply shall be compatible with the system voltage 360 to 440V, three phase 4wire,frequency from 47.5 to 51.5 Hz.
- Equipment shall incorporate a means of adjustment in order to allow for foundation differential settlement of maximum 25mm.

- Work related to the production of the equipment shall comply with relevant European standards, Codes of Practice and the latest statutory requirements of India including, but not be limited to, the following:

  BSEN287 - Approval testing of welders for fusion welding.

  BSEN288 - Specification and approval of welding procedures for metallic materials.

  BSEN4575 - Fluid power transmission and control Systems.

  BSEN5304 - Code of practice for safety of machinery.
  BSEN5395 - Stairs, ladders and walkways.
  BSEN5950 - Structural use of steelwork in building
  BSEN60073 - Specification for coding of indicating devices and actuators by colours and supplementary means.

  BSEN60204 – Electrical equipment.

  BSEN1493 – Vehicle Lifts

  BSEN60529 - Specification for degrees of protection provided by enclosures (IP code).

  ISO9001-3:1991 - Guideline for the Application of ISO9001 to the Development, Supply and Maintenance of Software.

- The layouts given on the Drawings shall be used for conceptual purposes. The Contractor shall furnish their requirements in accordance to the Schedule of Key Dates in the Particular Specification.

- The equipment shall be designed and/or selected to allow operation without over stressing, damaging or interfering in any way whatsoever with other equipment in the Depot.

- Components of equipment of similar construction or similar application shall be mutually interchangeable. The Contractor shall, to the extent that he is responsible for the design or component selections of equipment items, recognize and implement all safety requirements and ensure that the design and performance of the equipment are compatible with the suitable International safety standards.

- Equipment shall be “fail-safe” and “overload protected”. The equipment shall incorporate all necessary safety devices to protect the equipment, operators, buildings and all other people and things in the vicinity of the equipment. No failure of the equipment shall cause or give rise to any damage or catastrophe of any nature what so ever.

- Equipment design shall take into consideration elimination of dust and dirt by means of suitable traps or the like, minimum maintenance requirements and ease of access for cleaning, routine maintenance and general disassembly.

- Guards shall be fitted to all exposed moving parts of the equipment where the environment and working processes of the system dictate that there is a foreseeable risk of injury or causing ill health to personnel from sources such as moving parts, electricity, coolant, swarf, noise and vibration, dust and fumes, etc.

- Moving parts of the equipment shall be efficiently lubricated to ensure quiet operation as well as durable and reliable service life. Lubrication points shall be clearly identified for easy replenishment with minimum removal of other equipment components.

- The environment within which the equipment is to operate shall be taken into consideration in the equipment design. The contractor is advised to carefully examine the air pollutants and deposits generally encountered in Nagpur’s ambience.

- Based on the experience gain during test, trials and use of machine or any problem arises during operation of the machine which warrants re- check of the design /manufacture/ quality of the equipment, the contractor shall be responsible for all modification as required and these shall be done without any extra cost to the employer.
- Any modification required to be done for satisfactory functioning of the fully automatic pit jacks shall be mutually decided & carried out by the contractor free of cost to the satisfaction of NMRCL engineer. Therefore contractor shall carefully consider local ambient condition and pollution, dust etc . All the major brought out items which are required to be used in the machine shall be of proven make and shall be procured only after taking employers‟ approval for the same , with a complete submission of each item mentioning, make, country of origin, parts numbers, catalogues etc.

4.1. Use of drawings and data

4.1.1 All data in concern with the rolling stock written in this specification is for information only and there may be slight variations.

4.1.2. The compatibility of the equipment with the rolling stock characteristics is the responsibility of the Contractor and he shall obtain the required data/documents from the Rolling Stock Contractors.

4.1.3. All information or documents related to the Rolling Stock deemed necessary are to be taken from the rolling stock supplier by the Contractor.

4.1.4. The drawings shown on the plans define the operating conditions and are provided for indicative purpose only. These may be adapted by the Contractor in consultation with the Client.

4.2. Reference Data of Tracks

The Locomotive/ trains/wagon /Road vehicle shall be operated on the standard gauge tracks with the following specifications. The track specification may however vary slightly and the Contractor shall obtain the details from the Track Work Contractor. Track Gauge 1435 mm Standard gauge (Nagpur Metro)

4.3. Principal Notional Vehicle Dimensions*

*** For Nagpur Metro depot, details will be supplied during design stage.**

SPECIFIC REQUIREMENTS OF FULLY AUTOMATIC PITJACKS

The fully automatic pit jacks (under floor lifting system) shall be designed to lift and support an EMU train unit of **three-car length** for Nagpur Metro. Lifting may be carried out either one single car, **two coupled cars, three coupled car** at one time. Each car weighs 45 tonnes maximum. Unbalancing of weight within the wheels shall be as per international standards. New fleet of Rolling Stock (for standard gauge) for the expansion of the new corridors of Nagpur Metro is under procurement. The principal notional vehicle dimensions for standard gauge for Nagpur Metro will be provided later on. The fully automatic pit jacks shall be capable to lift two-car units of designated type of rolling stock fleets for Nagpur Metro.

4.4. Jack Configuration

The pit jack equipment shall consist of 6 nos. (3 sets for 3-car unit) complete individual lifting platforms for bogies (bogie hoist) and 12 nos. body stands (6 pairs) for supporting the car bodies six bogie hoists for lifting stand and lowering the rail car units by the wheels and Six pair of body stand for lifting/lowering 3 rail coaches for Nagpur Metro depot.

4.4.1. Each bogie hoist shall be raised or lowered via 4 independent lifting columns . Lifting columns shall consist of a spindle-lifting element, a lifting beam, guiding box, one automatic following gap

cover and associated electrical equipment. Two motors power the spindle lifting system via mechanical connection of the few lifting gears to provide absolute synchronization.

4.4.2. Each bogie hoist shall have a bogie-lifting platform sized for bogies. Each pair of bogie hoists shall be capable of lifting a 45 T railcar. The lifting platform shall be of cantilevered type that provides a clear passage for transport of bogie and bogie tractor underneath the raised railcars. Lighting (florescent tube) shall be done on the face of cantilever lifting head for the illumination of complete under frame of the railcars and also lighting arrangement shall be made inside the pits by the contractor for smooth maintenance of the installation.

4.4.3. Each body stand shall have a supporting pad for lifting railcar body at its jacking points. Each body stand consists of one spindle-lifting element, one lifting beam, one guiding box, one automatic following gap cover and associated electrical equipment. Each double pairs of body stands shall be capable of supporting a 45 T railcar. The locations of jacking pockets shall be near the edges of the car body (clearly marked) in the vicinity of the bogies. The exact locations shall be determined by interfacing with the rolling stock manufacturer.

4.4.4. The equipment shall be installed inside simple square pits and flush with the shop floor while not in operation.

4.4.5. Auxiliary rails/ split rails shall be provided to allow for towing of bogies with a rail bound bogie tractor beneath the lifting platforms while the bogie lifting platforms are raised. The rails between the pits shall be in the scope of supply of the pit jack supplier & shall not be welded to the shop floor rails.

4.4.6. Tenderers shall provide the scheme of their design of the fully automatic pit jacks in the offer. GA drawing shall be provided supporting the scheme. Minor deviation on the specified parameters will be permitted to suit the standard equipment available. The deviations should be clearly specified in the offer.

4.5. Operating Principle

4.5.1. The jacks shall be electrically linked together to allow various combinations of synchronous lifting/lowering services. The combinations shall include the following modes, which shall be selected from a master control console.

- Three Coupled Car
- Two coupled car
- Single car
- Independent control of Bogie Hoist and Body Stand.

4.5.2. The lifting operations of 3 coupled cars, 2 Coupled Cars and a single

car, which are categorized as group control, shall be commanded at the master control console.

4.5.3. The lifting operations of individual Bogie Hoists and Body Stands, which are categorized as local control, shall be commanded at a local control pendant of the corresponding pit.

4.6. Key Parameters

The equipment shall comply with the following requirements on dimensions and tolerances:

- Bogie Hoist lift 1.8m
- Body Stand lift Not less than 2.7m

Note: The body Stand lift should match the Rolling Stock needs to hold the car body when maximum hoisting is done at bogie Hoist.

- Bogie Hoist lifting speed -Not less than 0.4m/min
- Body Stand lifting speed Not less than 0.8 m/min

- Railcar track gauge 1435mm/ +3-0
- Bogie wheel base to be advised
- Auxiliary track capacity 170 kN/axle
- Main Track capacity with bogie hoists lowered 170kN/axle
- Gap between platform rails and shop rail 5mm
- Bogie Hoist level tolerance within individual bogie +/-3mm
- Bogie Hoist level tolerance within adjacent bogies +/-4mm
- Bogie Hoist level tolerance within two/ three cars +/-5mm
- Body stand are not Synchronized.

The jack equipment shall allow clearances underneath raised railcar for transport of dismantled bogie by electric bogie tractor. Minimum clearances shall be:

* 3000mm wide x 1450mm high for bogie passage,
* 3000mm wide x 1450mm high for bogie tractor passage.

4.7. Jack Structure

4.7.1. Each Bogie Hoist shall consist of four lifting spindle elements which are always operated together .

4.7.2. Each pair of Body Stands shall consist of two lifting spindle elements, which may be operated together or individually.

4.7.3. The structural design of the equipment shall withstand

the weights, and other forces from movement of railcar.

4.7.4. While the jacks are at the lowered positions, the shop area, where the fully automatic pit jacks locate, shall provide a safe and clear passage for railcars and workshop vehicles. The pit areas shall be covered with jack structures or galvanized steel chequered plates. The maximum weight of workshop vehicles will be 100kN with a maximum axle load of 60kN. The maximum deflection of floor covers shall not exceed 1/750 of the covers pans.

4.7.5. While the jacks are at the raised positions, the floor openings that result from the displacement of lifting elements shall be covered automatically by steel covers (following gap covers). General clearances between structural elements at the floor level, except wheel flange grooves, shall not exceed 10mm under all operation conditions.

4.7.6. The structure of the equipment shall be fabricated by welding of steel connections.

4.7.7. All floor covers shall be solid steel plates with a minimum `thickness of 15mm set flush with floor level. The surface of these cover plates shall be non-skid with diamond pattern.

4.7.8. The static structural calculation of lifting elements shall be made to verify that the stresses permissible are according to European Standards (EN1493) for the chosen material.

4.7.9. The equipment to be installed at the pits shall adopt an approved corrosion prevention coating system to cope up with the possibility of water logging for long hours.

4.7.10. The spindle shall be a robust, vertical, self-locking screw shaft driving a spindle load-lifting nut. A safety nut shall follow the lifting nut. The load screw shall be of class 3A as per IS 2004/78 having threads in accordance with IS 4696 or equivalent international / European / British standard Load screw shall be covered with protection boots.

The spindles shall be fitted with flexible bellows for protection. The bellows shall be grease, acid, water and steam resistant. The fastening of the bellows shall be designed to facilitate quick disassembly for inspection of the spindles.

4.8. Hoisting Mechanism

4.8.1. Lifting spindle elements shall be of screw type (absolute self locking through an angle of inclination related to the exterior diameter of the screw and driven

by geared electric brake motor.

4.8.2. Magnetic brakes shall be used to precisely control the stopping of the lifting elements but shall not be used for self locking. The brakes shall be applied in the event of power failure.

4.8.3. The synchronization of lifting spindles shall be monitored and corrected by motor wiring circuit, which shall be controlled by means of level measurement devices.

4.8.4. In case of failure of any one motor/ control during hoisting operation, suitable mechanism shall be available to safely lower the railcar to floor level for clearing the track. The system shall be in operation until the damaged motor is replaced.

4.9. Control and Interlock Provision

4.9.1. The master control console shall be provided at the central area of the fully Automatic Pit Jacks for mode selection and group controls. The console shall only be accessible by a unique key, which shall be latched into the console during operation.

4.9.2. A local control pendant shall be provided at each pit, which accommodates one bogie hoist and one pair of body stands. The pendants shall be linked by 3-metre long cables and easily retrieved from the pits by opening hinged steel covers, which shall be set flush with the shop floor.

4.9.3. Operation of the bogie hoists shall be interlocked with operation of the body stands ensuring the safety and not permitting incorrect operation.

4.9.4. An sensor device shall be provided to sense the bogie wheel lifting points to confirm that the wheels are correctly located over the bogie lifting platforms. Upon this verification, the device shall permit the lifting operation to proceed.

4.9.5. The bogie hoist shall not be operable unless the body stands of the same pit are either fully lowered or under load supporting the vehicle.

4.9.6. The selected body stands shall be raised in pairs and stopped once contacts with jacking pockets of the railcars are detected by sensors at the pads of the body stands.

4.9.7. The controls, interlock functions and monitoring of the jacks shall be executed failsafe, which allows simplicity in wiring and expandability in future control alterations.

4.9.8. All pushbuttons for motion control shall be of non-latch and spring- return type.

4.9.9. All control stations shall be of robust enclosures not standard housing and suitably braced to form a rigid structure. Exterior corners and edges shall be rounded to give a smooth overall appearance. Interior edges shall be smooth.

4.9.10. All pushbuttons shall be electrically interlocked to prevent inadvertent operation of opposing motions. All movements shall be clearly indicated on the control pushbuttons by means of labels in English/ signs.

4.9.11. A fault display panel shall be provided at the master control console. When a fault occurs, a buzzer on the panel shall sound and a lamp shall flash indicating the location and the nature of the fault. By pressing an acknowledge button, the buzzer shall become silenced and the flashing lamp shall become steady. After the fault is rectified, the display shall revert to the normal state by pressing a reset button.

4.10. Safety Provision

4.10.1. Locking devices shall be provided to lock the body stands and bogie lifting platforms on removal of the power supply. The devices shall be capable of taking the full system load.

4.10.2. Failsafe wheel stops shall be provided at the bogie platforms and fully activated and locked to prevent the railcar from rolling off the platforms whenever the rail car is raised from the shop floor. While lowering, once the bogie hoist has reached bottom most position, the locking shall be released and stops retracted.

4.10.3. Approaching signals shall be provided and activated whenever any part of the railcars or jacks has reached a clearance of 150mm or less from the floor. The Signals shall include an automatic stop of lowering and audible intermittent alarm for approx 10 seconds. Further lowering shall only be possible by pressing an over ride button.

4.10.4. Motion limit switches shall be provided in spindle units to prevent over- lifting and over-lowering of any lifting element. The upward and downward level limits shall be predetermined and adjustable.

4.10.5. Lifting nut limit switches shall be provided to prevent the up lifting operation of the system once any of the lifting nuts has worn to a predetermined amount. The

fault shall be indicated on the fault display panel. The advance safety features like optical wear & tear indicator of working nut and automatic cut off (electrical) due to wear in safety nut shall be offered.

4.10.6. Overload cut-out devices shall be provided to protect the equipment against damages in the event of equipment being overloaded. Once any of the overload devices are activated, overload lights and buzzers on corresponding panels shall be turned on and all operation modes except lowering shall be prohibited. On removal of the overload, the jacks shall resume normal operation automatically.

4.10.7. A set of traffic signal shall be provided on the wall on the entry side of Unscheduled Repair Bay. The signal shall include one red light and one green light and give directions to operators for safe entry of Railcar with the lifting hoists at lowered position.

4.10.8. Main control panels shall be fitted with through door electrical isolation switches for the safety of maintenance personnel.

4.10.9. Emergency stop buttons of mushroom type shall be provided on all control stations.

4.10.10. In case of fault in PLC, the operation of lifting or lowering of all the system shall be cut off simultaneously both for bogie hoist and body hoist.

4.10.11 In the event of power failure or component failure, all jacks under operation shall emergency stop and lock the anvils. All the push button shall be of “dead man” type.

4.11. Maintenance Provision

4.11.1. The equipment installation shall adopt an open pit design to allow adequate space for maintenance of equipment components through steel structural ladders. Scheme for sufficient illumination of the pits for human comfort and ease of Maintenance shall be adopted. All components including motors, gearboxes and shafts shall be easily accessible.

4.11.2. The equipment shall be of modular design, with components manufactured into sub-assemblies to facilitate easy assembly and removal for maintenance purposes.

4.11.3. An automatic lubrication system shall be provided in each pit to assure proper lubrication of equipment Spindle. All other moving parts shall be effectively lubricated by either oil or grease.

4.12. Noise Level

The noise level of the fully automatic pit jacks during its operation shall not exceed 75dBA when measured at a distance of one meter from the machine.

4.13 Technical alternative: Minor deviation in technical specification is permitted . However,minor deviation shall not affect SOD and performance parameter of machines.

4.14. RAMS (Reliability, Availability, Maintainability & Safety) Requirements:

The Plant is expected to meet the RAMS target of 96% Availability, which will be calculated excluding the downtime planned for Preventive Maintenance Services. Standard Penalty will be applicable as per the Penalty Clause.

Note: The bidder shall submit the complete technical detail of offered M&P for technical evaluation.

Chapter-5

Mobile Lifting Jacks (item code- NMRCLMNP004)

Name of the Equipment: **Mobile Lifting Jacks**

Sample Image

PARTICULAR SPECIFICATION OF

MOBILE LIFTING JACKS AT NAGPUR METRO

CONTENTS

SPECIFIC REQUIREMENTS OF MOBILEJACKS

5.1. Jack Configuration

Mobile jacks shall be provided for the lifting tracks at the Nagpur Metro Depot. Each set of jacks shall be designed for lifting 3 cars either single or coupled for Nagpur Metro Depot.

One set of mobile jacks of 12-tonne capacity consist of **12nos of mobile jacks** along with one set of central control unit and associated cabling for Nagpur Metro.

Each set consists of the following minimum elements:

Mobile jacks for Nagpur Metro, each with a main frame, lifting spindle with driving gear, lifting carriage with anvil, lifting nut, safety nut, travelling gear and local control box.

5.1.1. Within the frame of jacks, there shall be suitable encoders, limit switches, emergency limit switches and other safety features as required.

5.1.2. One trolley-mounted control console with failsafe synchronization control, various indications, controls and troubleshooting mechanism as mentioned.

5.1.3. Underground concealed cables in pre laid galvanized conduit pipes, which are for both power cables and control cables of the jacks, linking outlet socket points for the jacks and the console at a central area respectively for one set of jacks. The cable connecting jacks shall have connector at both ends.

5.1.4. The power cables, connecting isolator and the jacks, the portion of the cables running on the ground shall be in concealed galvanized conduits. The isolator for the power cables shall be provided by building E&M contractor but sockets/ plugs etc will be provided by the mobile jacks contractor.

As stated in the scope of works above, the quantity of jacks one set for Nagpur Metro Depot and the control wiring in the floor shall be laid for 1 lifting track/line for one set of jack.

5.2. Operating Principle

The jacks of any set shall be possible to operate either individually or in a group of 4 or 8 or 12 jacks together in synchronous mode for railcar lifting lowering and sustaining loads at any point between the travel limits. It shall be possible to transport each jack manually by one person towards the railcar and to align the anvil with the jacking pocket on the railcar. The jack shall be raised by means of the pushbuttons on the local control box. The raising motion of the anvil shall stop automatically once a contact with the jacking pocket is detected by a switch on the anvil. The control console shall be plugged into the socket at the central area of the three railcars for Nagpur for synchronous group operation of the selected jacks. The group control shall only be allowed if all of the selected jacks are in contact with the railcar.

5.3. Key Parameters

The jacks shall comply with the following requirements:

Quantity of lifting jacks:	12 nos.
Lifting capacity per jack:	12 tons
Lifting capacity per set:	144 tons
Lowest position of cantilever (claw)above upper edge of rail (floor):	400 mm
Highest position of cantilever (claw)above upper edge of rail (floor):	2500 mm
Vertical stroke:	2115 mm
Cantilever adjustable range should be atleast :	475 mm
Lifting/lowering speed:	approx. 300 mm/min
Operating voltage:	415 V, 50 Hz, 3ph
Control voltage:	230 V, 50 Hz, 24 V DC
Power rating per set:	40 kVA
Protection of electrical equipment:	IP 54

*Note: The Jacks supplier shall interface with the Rolling Stock supplier (Contract NRS-1 new Rolling stock supplier for Nagpur) for the exact size of the contact head of the anvil.

The main frame of the jack body shall be of welded steel construction and shall consist of side plates with guides for the lifting carriage.

The jacks shall be provided with suitable means to prevent relative sliding of coach and the lifting pad.

The base of the frame shall substantially spread the load over the workshop floor, which will be constructed of reinforced concrete. The approximate area for reinforced floor shall be 1300mm x 1600mm under each jack.

The design and installation of the jacks shall be based upon heavy-duty workshop application with high safety factors to ensure minimum deflection and low stress values. The jacks shall be designed in accordance with BSEN1493 or DINEN1493.

The steel used shall conform to Indian Standard IS 226, IS 2062 or European standards. The welding shall conform to IS 816 or IS 823 or equivalent international / European / British standards. The welding shall be compatible

to steel used.

The jacks shall be provided with lifting eyes and fork pockets to allow easy transport within the workshop. An easy access shall be available to lifting nut and safety nut for the required monitoring of them.

Description of Mechanical Parts

5.4. Lifting Spindle &Drive

The spindle shall be driven through a fully enclosed reduction gear running in an oil bath by a squirrel cage flanged brake motor designed to IP55. All motor and gear bearings shall be of roller type. **It shall be placed at the top of the jack frame and preferably motor shall be horizontal to the floor.** The motor and drive gear shall be easily removable without requiring dismantling of the jack. **The braking system of the drive motor of offered jacks shall be explained in offer.**

The spindle shall be a robust, vertical, self-locking screw shaft driving a spindle load-lifting nut, which shall be manufactured from cast bronze. A safety nut shall follow the lifting nut of cast bronze.

The load screw shall be of class 3A as per IS 2004/78 having threads in accordance with IS 4696 or equivalent international / European / British standard. According to EN 1493 Load screw shall be covered with protection boots.

The spindles shall be fitted with flexible bellows for protection. The bellows shall be grease, acid, water and steam resistant. The fastening of the bellows shall be designed to facilitate quick disassembly for inspection of the spindles.

5.5. Lifting Carriage

A carriage shall be mounted on each body. The carriage shall be fitted with a bronze nut guided by the lower rollers of the body running on sections added to the jack framework.

The carriage shall be guided up and down the columns by plain and flanged rollers fitted with bearings. The guiding system shall stop any carriage longitudinal or transverse inclination, which may cause seizure or abnormal wear to the screw or to the nut.

The shape of the contact heads shall be compatible with the jacking pockets of the rolling stock. The maximum deflection of the cantilever when laden shall not exceed 1/500 of the span.

5.6. Travelling Gear

The jacks shall be mounted on 3-roller type travelling gears with steering wheels for one- man operation on the concrete floor. The travelling gears shall allow a minimum of 15mm clearance from the floor for movement of jack.

Handles shall be fitted to the jacks for easy raising, lowering, steering and transporting the jacks. The jacks shall be equipped with ground-support monitoring

devices to prohibit carriage movement when one of the jacks is still bearing on one of the travel wheels. The controls shall ensure that the synchronous lifting shall start only when all the jacks have touched the load pads and are ready for the lifting.

The jacks shall be easily transported and safely operated on the flat concrete floor with a level tolerance of +/-5mm in any length of 2m.

5.7. Control Provision

The operation of the jacks in a group of four, eight, twelve unit only shall be controlled at the control console. The operation of an individual jack shall be controlled at the jack- mounted local control box.

The control gear shall be protected against phase failure (single phasing), under-voltage, over-current, motor overload and wrong direction movements due to wrong rotation of drive motor as a result of phase reversal etc.

5.8. Synchronization controls:

The jacks shall be provided with a levelling synchronization system ensuring the control and automatic correction of the height of the lifting claws. This system shall detect any obstacle or mechanical locking.

Each jack will be equipped with an encoder driven by a notched belt and sending impulses to the PLC corresponding to the carriage movements. Failsafe compares the information coming from each jack and corrects any possible height difference. At any time the height of the 12 claws is within +/-5mm.

If for any reason, the height difference exceeds, the lift will stop and a fault will appear.

Both logical control chains and synchronization controls will be realized by a stored-program control failsafe of good make. Integration of the synchronization control into the PLC can do without a separate, particularly manufactured electronic component (such as microprocessor control).

The failsafe installed will monitor the complete connected hardware (input units, output units, contactors etc) with regard to errors. Furthermore, the control itself is monitored with regard to correct functioning via second independent control equipment.

In the event of a PLC failure when the vehicle is lifted, the operator will have the option to lower the four unit for one car,eight unit for two car and twelve unit for three car only, each jack stops on its lower limit switch. Only lowering is authorized in this mode.

The control panel will be equipped with a troubleshooting system. It shall suitably indicate the fault occurred. Tenderer shall explain their type of system in the offer.

5.9. Control Console

The control console shall be mounted on a trolley for the operator to move around for effective monitoring of the operation. It shall be fabricated of sufficiently thick steel sheets and duly treated and painted (epoxy paint or powder coated) for longer life.
The control console shall be equipped with a plug for connecting all jacks through the socket on the floor at the central area of the three cars. **The cable of the plug shall be 10- meter long and coiled onto a console-mounted cable reel and this shall be provided by mobile jacks' contractor**.The door of the control console shall be key-lockable. The door shall be connected

to the switchboard via an earth braid and the power-on indicator lights shall be mounted on the front.

The control console shall include but not limited to the following controls and indicators.

- Lockable main power switch c/w indicating light
- Selector switch for operation of a group of four or eight and 12 jacks
- Shrouded pushbuttons for raising and lowering operation
- Individual jack status lamps in blue
- Emergency stop button
- Fault message c/w indicator in amber
- Overload cut-out indicator in red
- The control of lifting operation from the control console shall be prohibited with any of the following conditions.
- Any of the selected jacks are under the local control mode
- Any of the selected jacks are not in contact with the railcar lifting pads (jacking pockets),
- Any of the selected jacks are over loaded,
- Any single fault signal, trip of travel limit switch, obstruction under anvil.

5.10. Local Control Box

The local control box shall be permanently fixed type mounted on the jack. Pendent type Local control box with suitable length of cable, which can be hooked on jack frame, is also acceptable. Such a box can be portable with a handle for easy carriage.
The jacks shall be connected to the outlet points of concealed cable network by plugs with approx 5m cable lengths.

A selector switch shall be installed at each jack-mounted local control box for remote or local control selection. When the remote control is selected and contact with the railcar jacking pocket is also detected, a signal shall be transmitted to the control console.

The local control box shall include but not limit to the following controls and indicators.

- Power switch c/w indicating light
- Selector switch for local or remote control
- Shrouded pushbuttons for raising and lowering operation
- Fault message c/w indicator in amber
- Overload cut-out indicator in red.
- The control of lifting operation from the local control box shall be prohibited with any of the following conditions..
- The jack is under the remote control mode.
- The jack is over loaded

- Any single fault signal, trip of travel limit switch, obstruction under anvil of the jack

5.11. Safety Provision

Safety nuts shall be fitted on the spindles to monitor the wear on the load nuts. The safety nuts shall be able to support the full working load in the event of the failure of the load nuts. The safety nut that take up the load shall also activate a switch to allow only lowering of the load.

Nut wear sensor will activate when the gap between the Lifting nut and safety nut reaches the low limit. It shall then allow lowering but not raising operation. It is, then, compulsory to change worn nuts.

Visible and audible signals shall be provided to personnel in vicinity during lifting operation. The audible signal shall be adjustable in volume.

The jacks shall be equipped with two stage switches for both upper and lower limits of travel. The first stage shall be designed for normal operation and the second stage for emergency. The travel limits shall be adjustable within the designed travel range.
Alternative to above, the PLC stops the motion by counting the encoder impulses; the first jack stops the others. Different height can be easily adjusted from PLC. In case, the PLC doesn"t stop the motion, a safety limit switch is mechanically activated and stops. A fault is indicated on central control panel. The lower limit switch stops the lift when it reaches the down position. In case the carriage is stopped or if one of the lower limit switches doesn"t work, the jacks are stopped and a fault is indicated.

Overload devices shall be provided to protect the equipment against damages while the equipment is overloaded. Once the devices are activated, the jacks shall only allow the anvil to be lowered until the devices are re-set by unloading.

In the event of power failure or component failure, all jacks under operation shall emergency stop and lock the anvils. All the push button shall be of “dead man” type.
Safety chain to stop the whole unit in case of wrong connection shall be provided. This device also switches off the jack operation in case of any plug being disconnected or connecting cable being damaged during the operation.

Each jack shall be fitted with an emergency stop button, one of which when activated shall cut off the power to all jacks.

The Safe Working Load (SWL) of each jack shall be clearly marked in English prominently on the jack.

5.12. Maintenance Provision

Lubrication nipples shall be provided at each jack for lubricating the lifting spindle and moving parts.

The assembling method of lifting spindle shall be designed to facilitate quick and easy changing of the spindle nuts, without additional lifting equipment.

5.13 **Technical alternative:** : Minor deviation in technical specification is permitted . However,minor deviation shall not affect SOD and performance parameter of machines.

5.14. RAMS (Reliability, Availability, Maintainability & Safety) Requirements:

The Plant is expected to meet the RAMS target of 96% Availability, which will be calculated excluding the downtime planned for Preventive Maintenance Services. Standard Penalty will be applicable as per the Penalty Clause.

Note: The bidder shall submit the complete technical detail of offered M&P for technical evaluation.

Chapter-6

Bogie Test Stand (Item Code: NMRCLMNP005)

Name of the Equipment: Bogie Test Stand

TECHNICAL SPECIFICATION

BOGIE TEST STAND

CONTENTS

SPECIFIC REQUIREMENTS

The machine shall be so designed to ensure an effective and efficient work sequence. Each work phase shall be reliable, durable and safe in operations. Following is a description of the operation of the “Bogie Test Stand” that represents the expected level of functions of the Bogie Test Stand to be supplied under the Contract.

The overall dimensions of the machine shall be furnished by the bidder in the offer.

6.1 Description of NMRCL Rolling Stock and Bogie:

The NMRCL trains are configured as units. Two driving motor coaches & one trailer coach forms a unit. The unit formation of train-set consists of three type of car.

DMC-TC-DMC

3 cars train-set

DMC (Driving Motor Car)- Motorized car with Driving Cab

TC (Trailer Car)- Non motorized car with pantograph

Each car consists of two bogies and a car body fitted with equipment for the transportation of passenger.

The train-set can be controlled as a complete unit or as separate units for various maintenance activities at the depot.

Details of Bogies:

The bogie design is based on the service proven bogies which are currently running in several cities in the world. Subsystems applied are well-proven system and their performance and suitability have been proved through previous projects.

The bogies are of bolster-less type incorporating a steel-and-rubber/helical primary suspension system, and a secondary pneumatic suspension system, and with axle bearings outboard of the wheels.

The bogies are of the motor bogie and the trailer bogie, which have similar bogie frame configuration except the motor brackets and the driving gear brackets in the motor bogie.

The bogie is equipped with the necessary equipment for safe, comfortable and efficient running of the vehicle and designed to be easily accessible to the parts of the bogie.

The bogie is mainly composed of as follows.

- Fabricated bogie frame.
- Wheel set.
- Suspension system including the anti-roll bar.
- Center pivot device
- Mechanical driving system and braking system.
- Auxiliary equipment on Journal box.

The car body is supported on both sides of the bogie frame via the pneumatic secondary suspension. The traction and braking force is transmitted to the car body by means of the center pivot device including the mono – link.

The main characteristics of the bogie are as following table

Track gauge	1435 mm	
Maximum Axle load	16 Tonne	
Maximum design speed	With inflated secondary suspension	90km/h
	With deflated secondary suspension	80km/h
Maximum service speed	With inflated secondary suspension	80km/h
	With deflated secondary suspension	70km/h
Wheel base	2,200mm-2600mm	
Wheel Diameter(new/worn)	860 / 780mm	
The minimum clearance of bogie mounted equipment	75mm(at worn wheel and fully loaded static)	
Approximate un-sprung	M bogie : 3,920 kg	DT bogie : 3,300kg
Approximate bogie weight	M bogie : 8,500 kg	DT bogie : 6,150kg

Note: These values of bogies as mentioned above are indicative only and it shall be confirmed from the Rolling Stock Contractor during designing stage.

The major components of the bogie are as following table:-

	Motor bogie	**Trailer Bogie**
Bogie Frame	Conventional H frame with end beam	Conventional H frame with end beam
Wheel sets	Monobloc wheel + Solid Axle	Monobloc wheel + Solid Axle
	Taper roller Bearing	Taper roller Bearing
Driving system	Driving Gear + Flexible Coupling	Not applicable.
Friction Brake system	Wheel Mounted disc Brake/Tread brake	Wheel Mounted disc Brake/ Tread brake
Primary suspension	Conical rubber /Helical coil steel spring	Conical rubber /Helical coil steel spring
Secondary suspension	Air spring + Vertical damper + Anti-roll bar	Air spring + Vertical damper + Anti-roll bar
Traction system	Center Pivot + mono-link + Lateral damper	Center Pivot + mono-link + Lateral Damper
Additional items	Wheel flange lubrication system	Wheel flange lubrication system

Note: These values of bogies as mentioned above are indicative only and it will be confirmed during designing stage

6.2 Operating Requirements:

The Bogie test stand machine shall be capable of load testing the Trailer car bogies, Motor Bogies etc of NAGPUR Metro Rail Corporation"s Rolling Stocks on various loads.

The Bogie Test Stand shall be used to carry out the height adjustment of trailer and on the motor bogies of NMRCL passenger cars.

The machine shall be capable to carry out the required tests in case of New Wheel diameter of 860mm and in case of fully worn out wheel condition of wheel diameter of 780 mm from tare to fully loaded conditions.
Since the design axle load of NMRCL bogies is 16 tones; the test stand shall be capable of putting 20 tons of load at one test point i.e. 40 tons of total load capacity.

The total time of a single complete cycle required for a Bogie with normal test shall be minimized for efficient operation. The machine shall have capability for add-on similar type bogie for load testing facility in future.

6.3. Description of operation and measurement Cycles

The Bogie test stand measures the parameters of Bogie like compression of primary springs, **crown height measurement** etc. under different loading conditions. The load testing shall be done after overhauling of bogies whenever warranted. Various types of clearances are checked during above testing. After taking the various measurements, the data is recorded /stored in a PC for future references or printing the records.

6.3.1. Setting up the Bogie

The bogie has to be moved and positioned manually underneath the stand. For this the rail level at workshop floor and the test surface of the bogie test stand shall be at the same level. A submerged version of the bogie test stand shall be most suited to these requirements

To carry out the testing, both hydraulic rams of Bogie Test Stand shall be vertically driven by automatically PLC control system. Once the load to be applied on the load points of bogie are set on PLC system, the load of required capacity can be applied and displacement and various clearances of the bogies shall be measured.

The Bogie Test Stand is operated via a control panel so that operator has continuous access to all Bogie Test Stand functions.

The testing shall be user programmable. Bogie Test Stand shall be capable of load testing of NMRCL Rolling Stock and also capable to test similar type bogies of other NMRCL Rolling Stock.

Following are the details of measurement cycles expected in the Bogie Test Stand:

6.3.2. Bogie preload Test Measurements

On start of the bogie test stand machine, a preload test shall be carried out before any measurement is done. Supply and commissioning of this preload stand shall be under the scope of this contract. Centre adaptor and bogie adaptor shall be part of stand for initial calibration measurements. All the four-wheel load cells must show „0" value at this stage. If the value is not zero it should be re-set to zero by the reset button. Further the height measurement of pressing spindle shall be done with spindle retracted in top position. The details of preload test shall be explained by the tenderer in his bid document.

6.3.3. Bogie Testing:

Bogie shall be placed centrally under the test bed. In order to register a new measurement or to process measurement not finished yet, type of bogie (Motor bogie, Trailer bogie or other bogie of NMRCL Rolling Stock have been incorporated in the program menu) can be selected on menu screen.

There should be a provision in the system of Bogie Test Stand to enter manually

the bogie number, name of the operator and test Sheet No. before starting the measurement. Without entering this information in the system no measurement should be started.

In case of automatic test procedure only if the “Automatic” position and “test procedure” is selected plant should go into “touch load position”. It shall also be possible that measurement can be started manually during an automatic test procedure. Before starting the automatic type procedure the system shall be capable to check the different conditions:

6.3.3.1. Test sheet no, type of bogie, Bogie no. and entering the name of operator

6.3.3.2. For motor Bogie carry out the oil check

6.3.3.3. Unit is in “touched mode” (“touched load”) on every hydraulic cylinder.

6.3.3.4. Bogie is on the wheel load scales

6.3.3.5. Operation mode should be in the “Automatic” position.

The system shall be capable to carry out the selected test procedure and should take the measurement values automatically. The test procedure should be continued until the report is confirmed. If all value are entered and are correct, then the examination should be completed with the help of the “Complete” button of the system. The system shall be capable to test that all values are within the tolerances and all values should show the status “complete”. After the end of the test procedure, the protocol can be printed with button “Print”. The test protocol shall include all data as well as status:

6.3.3.6. Manual examination results

6.3.3.7. Automatic examination results which are outside the tolerances

6.3.3.8. Inspection results of automatic examination which are within the tolerances

6.3.4. Rework from Measurement

System shall be incorporated to correct the measurement and there should be a provision in the system to have a correction measurement. Further processing after all measurements have been taken, shall be available in the “correction” menu then the test report can be printed again.

6.3.5. Result Editing

After the load testing or measurement operations on the bogies have been performed (from 1 to 4 wheels), the pre- and post-testing measurement results shall be possible to be edited or printed in table form. Data shall be transferred to a microcomputer via interface software and it should not be possible at the user level to edit the test results.

6.4. Parameters of Bogie to be Measured and their Tolerances:

At least following parameters shall be measured and displayed on the PC screen of the bogie test stand.

Wheel load on tare and loaded Conditions:

The bogie test stand shall measure the actual wheel load in tare and loaded conditions. Also it shall indicate the deviation of load from the average value.

Wheel back to backspacing:

For NMRCL Rolling Stock, it is 1358 +2/-0 mm both. Laser sensors shall be used for this measurement the output of which shall be fed to recording system automatically. The bogie test stand shall be capable to measure this distance over the range of 1300mm to 1400 mm.

Height of Air suspension form Rail level

This data shall be measured automatically. The height of the air suspension on NMRCL bogies is 754 mm when there is no air in secondary suspension and only emergency spring is in use. The Bogie test Stand shall make this measurement taking into account the thickness of the adapter inserted between the Hydraulic cylinder and top of the air suspension.

6.4.1 Shim Height at Secondary Suspension

Bogie Test Stand shall advise this based on other measurements. Shims at secondary suspension are inserted to meet the bogie height variations due to wheel diameter reduction.

The wheel diameter differences permitted on NMRCL bogies are:

	DM CAR	**T CAR**
On one axle:	0.5 mm	0.5 mm
On one bogie:	3 mm	3 mm
Between two bogies:	6 mm	6 mm

Note: These values are indicative only, confirmatory values shall be provided during designing stage.

The permissible range of shims to be inserted at Secondary suspension is: 0 - 30 mm. Bogie Test Stand shall advise the shim height to be inserted after other measurements are taken.

6.4.2 Primary suspension gap

This data shall be measured by the machine manually. This dimension is to be measured at tare load conditions. The prescribed value of above gap is 45.5 mm with max permissible variation of 3 mm among 4 points of measurements on a bogie.

6.4.3 Shim height at bottom of Primary Spring

Bogie Test Stand shall advise this requirement based on other measurements. The permissible range: 0 - 5 mm. Bogie Test Stand to advise the shim height to be inserted.

6.4.4 Height difference of shaft centers between motor and pinion:

This shall be measured in tare load conditions and that too for motor bogie. This shall be measured manually. The permissible range is 71.5 mm. (To be confirmed from RS contractor during detail design stage)

6.4.5 Gear case oil check for Motor Bogies

This shall be done manually. The information shall then be fed in the PLC of Bogie test stand.

6.4.6 Air Leakage Test

This shall be done automatically with each side individually. The information shall then be fed in the PLC of Bogie test stand.

6.4.7 Axle resistance test function

This equipment can realize the automatic measurement and record the resistance of every axle, automatic measure the axle resistance between two wheels by reasonable design, the support wheel shall be insulation against ground, test the wheel set resistance under the wheel rotating status.

The resistance test function shall nature and reliable, the tenderer shall provide the principle of the resistance test, design plan, end user's information that use machine more than half year and picture

6.5 Accuracy of Measurements

Measurements	Test load
	Rail scales
	Height measurements
	Axis measures
	Accuracy of indication
	Accuracy of measurement
	Accuracy of measuring
	Accuracy of wheel positioning
	1 to 40 Ton in partial steps of 0.01 Ton
	1 to 40 Ton in partial steps of 0.01 Ton
	Work height of 500 mm in partial steps of
	X, Y, Z
	+-0.1mm
	+-1.0mm
	0.01 Ton
	+-0.1mm

tolerances / Partial steps for the bogie test stand are given below:

CONSTUCTION OF THE BOGIE TEST STAND:

Various parts of the Bogie Test Stand are explained below

6.6 Mechanical Part of Test Stand:

This Bogie Test Stand installation should make it possible to load test the NMRCL Bogies after overhaul / repair, new or fully worn out wheels on various types of load. In case of New Wheel Dia. 860 mm and fully worn out wheel Dia. 780 mm.

Detailed drawing shall be provided during detailed design. The constructions of various mechanical parts of the bogie test stand are given below:

6.6.1 Construction of load yoke:

The mechanical structure of the bogie test stand shall be of the design, which requires minimum construction activities during installation and commissioning. For this, rigid “Circulating Steel Structure” as specified in the general design requirement shall be used for mechanical structure. The horizontal girders, supported by the vertical columns, carry both hydraulic cylinders, horizontal distance measuring units etc. While designing the size of the steel construction of the Bogie Test Stand, own weight of Bogie Test Stand shall be taken in the consideration in addition to the loading requirements. All the Bogie Test Stand subparts shall be installed above floor level and no equipment (except load sensing devices) shall be installed in a pit below Bogie Test Stand. Own total weight of the Bogie Test Stand is to be furnished in the offer. The “Circulating Steel Structure” shall be modular in nature. Tenderer shall explain the details of structure in his offer document.

6.6.2 Foundation:

Foundation details of the installation of the bogie test stand including General and Electrical Layout shall be submitted in the offer document. The foundation details shall be prepared considering the version of test stand, which suits NMRCL requirement . The contractor shall provide fencing around the pit for Bogie Test Stand with suitable painting on the fencing. The foundation requirement for the test stand shall be kept to minimum.

6.6.3 Wheel load Sensing Device:

As mentioned above only the load sensing devices shall be installed below the floor level. Weighing shall be done on each of the wheel flange by individual load sensing device. Load sensing device shall be fitted in the Rail tracks on specified places under the Bogie Test Stand to measure up to 40 Ton (max of 10 Ton on each point). The position of these on the side of the rails shall be shown in the offer. Tenderer shall explain the details in bid document.

6.6.4 Horizontal movement of Spindles:

Because of the higher capability of the pressing cylinders, the pressure within the hydraulic system will be limited to prevent the bogies and the preload stand from overload or damage. The pressure range within the hydraulic system will be pre adjusted so that the load applied on the bogie is not exceeded.

The movement of Hydraulic Cylinder Ram shall be capable for lateral/horizontal adjustment to cover the specified parameters on the moving crossbeam to maintain accuracy within +/-0.1 mm. The vertical hydraulic cylinders shall be movable horizontally with spindle gear manually or automatically. These shall be equidistant from the centre line of track and always move synchronously. Proper arrangement shall have of such type so that the said accuracy of the movement can be maintained over a long period. The position of vertical cylinders shall be shown by a scale on the horizontal beam of “Circulating Steel Structure” and also by display on PLC system.

A suitable locking arrangement shall be provided to lock the hydraulic cylinder ram at any position to cover the specified distances.

The system shall be fully explained in the offer through supporting drawings/diagrams.

6.6.5 Load sharing of the test load on pressure points of the Bogie:

The methodology adopted for the load sharing of the test load on pressure points by using the pressure pads / pressure bevels of the bogie shall be explained in the bid document.

6.6.6 Load adaptors and height adjustment of Bogie:

Suitable machine measurement adaptors shall be mounted for the testing of NMRCL bogie,for interface of loading spindles with pressure points, which shall be adjusted through these adapter / pressure levels.

6.6.7 Wheel back to back Measurement System:

Laser sensors shall be used for assessing the back spacing of wheels. The output of this measurement shall be picked up by PLC control system automatically .The accuracy desired is +-0.1 mm or better. The details of the measuring system shall be submitted by the bidder in his bid documents.

6.6.8 Calibration system of the Machine

The tenderer shall explain the requirement of the calibration of the system for various measurements. Any tools required for calibrations shall be included in the tender offer.

Bogie Test Stand should be able to calibrate itself at regular intervals. The bogie test stand shall be capable to calibrate on all the required axes, load cells, measuring software etc. If any special test piece is required for this purpose, it shall be under the scope of supply of the contractor. Bogie Test Stand must calibrate followings:-

1) Calibration of the load cells

2) Calibration of the air leakage test unit
3) Calibration of axle to axle distance
4) Calibration of wheel back to back distance
5) Calibration/updation of measuring software.

6.6.9 Rails

Pair of UIC-60 kg rails are already existing in the workshop location where this Bogie Test Stand is proposed to be installed. If this set of rails cannot be used by the firm in their offer of Bogie Test Stand, it shall be in the scope of supply of the firm. Full details of the proposed system shall be explained in the bid document

6.6.10 Final Finish of the Installation Area:

After the installation of the machine, the uncovered area surrounding the machine shall be covered with hot dip GI chequered plates of 12 mm matching with the aesthetics of the area. The plates should be able to withstand normal workshop loads. The plates shall be painted with PU paint, the colour of which shall be determined during execution stage.

6.7 Hydraulic Installations

6.7.1 Hydraulic Unit

Hydraulic test unit of this equipment shall consist of following:

- Hydraulic pump of suitable capacity as per NMRCL requirements operating from power supply as advised in the technical specifications. Hydraulic tank of suitable storage capacity shall be part of hydraulic unit. The unit shall be integrated into the Bogie Test Stand and mounted at a height sufficient for easy drainage.
- Two (2) hydraulic cylinders including operator's console and manual control. Cylinder shall be double - acting hydraulic cylinders with hard-chrome plated piston rod with ground surface of 0.25 microns or better. These shall be provided with attached force / way-measuring unit. Surface hardness shall not be less than 65 HRC. Cylinders to be of suitable diameter and up to 500 mm stroke length.
- Control block (4/3 approach valve, holding valve)
- Valve adjustable pressure control for test pressure
- Suitable pressure gauge &display
- The unit shall be fitted with temperature and level control systems. Filters shall be compatible with distribution and regulation apparatus and pumps.

  (Filtering less than 12 microns).A pan shall be provided to recover fluid in the even to leakage Hydraulic unit tank filling shall be via a port protected with a filter (12 microns). Filter clogging alarms shall be provided to warn the operator.
- Any other component to make the bogie test stand fully function

6.7.2 Hydraulic Gear

Hydraulic gear shall be homogeneous throughout the entire installation.

As much as possible gear shall be installed close to the Bogie Test Stand and shall be grouped on distribution blocks for easy access for maintenance purposes.

Piping shall be integrated within the Bogie Test Stand enclosure or run in the gutter and the technical ducting. It should be concealed and suitably protected. Each hydraulic circuit shall be fitted with an easy to access test plug.

All supplies, assembly of pipes and connection components concerning the hydraulic installation are the responsibility of the Contractor.

All supplies shall be physically identified (riveted labels or numbers stamped on components). The same identification shall be indicated on electrical and hydraulic diagrams and in supply nomenclatures.

6.7.3 Hydraulic lay–out:

2 hydraulics load yokes of min load capacity 20 Ton each with working stroke up to 500 mm (stroke under pressure) shall be part of the Bogie Test Stand. Fast speed operation shall be possible by means of hand-controlled pendent. The Hydraulic cylinder ram assembly should be effectively sealed to prevent any leakage of oil. Full details of the system shall be explained in the offer by the tenderer.

6.7.4 Pressure Sensors

Pressure sensors shall be installed on the load measurement system. Sensors shall be connected to the converters, which shall indicate the load in tons with a precision to within two decimal points. Calibration shall provide a zero display reading when the wheel are not loaded or load is lifted. The converters shall be integrated in the control panel.

Pressure sensors shall be installed on any hydraulic circuit requiring permanent monitoring for good machine operation.

6.7.5 Other details for Hydraulic System:

Hydraulic and its controls shall be as per EN 692 +A2**.** Preferably hydraulic pumps shall operate during controlled movements. Accumulators shall compensate for cylinder movement during loading and any possible leaks. Other solutions may be suggested.

Commissioning of the hydraulic installation shall be the responsibility of the Contractor who, consequently, shall provide the hydraulic fluid recommended by the manufacturer of the hydraulic unit:

- For Initial Filling,
- For refilling after initial draining after operation of the machine for scheduled number of hours as recommended by the manufacturer of the hydraulic unit. The Contractor shall perform all operations recommended by his manufacturer (replacement of filters, cleaning of the hydraulic unit tank, etc.).

6.8 Pneumatic System:

This system shall be used for applying the required pressure to the air springs for leakage test etc. A compressed air supply of 8 bars is available at workshop columns where this Bogie Test Stand is proposed to be installed. Any other requirement of pneumatic supply like pressure regulation, monitoring etc shall be under the scope of supply of the successful bidder. Its control shall be integrated on the operator's control system. It shall have all the required interlocks, safety provisions for the smooth working.

The integration and interface pneumatic connections from shop supply to bogie shall be part of scope of work. The details of proposed pneumatic system of the bogie test stand shall be explained in the bid document.

6.9 Electrical Part

The power requirement of the bogie test stand shall be furnished in the bid document. Following is a description of different electrical accessories expected from tenderers:

6.9.1 Power Stabilizing Device

Power stabilizing device shall be provided and integrated into the equipment installation to stabilize the power in particular the fluctuation of the voltage of the supply of control equipments.

6.9.2 Control Panels

Panels shall be provided for control and monitoring of the Bogie Test Stand and shall be sized to take environmental conditions into account. On one outside of a column and lateral side of the yoke, an electric control unit with a panel inclusive of a display shall be fixed in an ergonomically working position. This arrangement shall be provided for better utilization of shop floor.

All panels shall be designed to work satisfactorily under all ranges of ambient temperature and humidity conditions and if appropriate, by having air conditioning systems, which shall be under the scope of the contractor.

6.9.3 Electrical switch boards

All control and regulation electronic and electrical devices, etc. shall be mounted in dust-proof switchboards and shall include an earthing terminal. Switchboards shall be designed so that inspection, repair and maintenance shall be easy after doors have been opened.

Switchboards shall be in accordance with the regulations in force and on the front fitted with „power on" indicators.

A suitable three-pole isolating switch, latch-able in open position, shall be supplied along with the installation.

The inside of the switchboards shall be illuminated by means of CFLS controlled by door opening. Doors shall be locked with removable keys. Locations shall be provided inside panels for display of electrical diagrams.

6.9.4 Switch Board Equipment

Electronic cards or blocks must be designed for quick and easy replacement without requiring disassembly of other apparatus or gear, or the movement of a cable or bundle of cables. Subassemblies performing the same function must be fully interchangeable and perfectly identical. Machine electronics must be designed to facilitate repair and troubleshooting. In particular, with regard to the technical cards:

- Functions shall be distributed on cards connected to cabling with connectors,
- Distribution shall be studied to limit the troubleshooting and repair time (functions effectively limited per card),
- During card replacement, adjustments must be limited to those which are strictly necessary,
- Technologies used by the various sub-contractors must be homogeneous (same card format, same connectors, etc.).

Note: A time counter shall be installed on the Bogie Test Stand control to count the time taken during complete measurement of the Bogie Pressing.

6.9.5 Bogie Test Stand Wiring

All outside cables shall be protected from any damage, which could be caused by oil and grease. Protection sheaths shall be mounted on the Bogie Test Stand. Connections made on protection sheaths and components controlled or junction boxes shall be of a mechanical type and removable (screws, nuts).

Bogie Test Stand, panel and electrical switchboard wiring shall be laid inside the Bogie Test Stand frame. The maximum amount of Bogie Test Stand wiring shall be laid inside the Bogie Test Stand frame. Protection systems shall be installed in all areas where there are hazards.

All cables, apparatus, gear and terminal strips shall be identified with relation to each connection. The same identification system shall be marked on the hydraulic and electrical diagrams. Power supply cables to the main board shall be in the scope of supply. Cables shall be laid in trenches.

6.9.6 Bogie Test Stand Earthling

The Bogie Test Stand equipment shall be earthed as per relevant IS standards.

6.10 Controls and Data Processing Equipment:

6.10.1 Industrial Personal Computer (IPC) and Electronics Control Cubicle:

The control system consists of an Industrial Personal Computer (IPC) with a

latest Window- type Man-machine-Interface and a state-of-art PLC. All data shall be stored in Database. If the main computer of the Bogie Test Stand does not store and process the data, the Contractor shall provide separate equipment for

measurement data processing and storage. The PC shall be industrial type and integrated into the Bogie Test Stand. The main features of control cubicle are as under:

- Lockable PC control cubicle, which will have view windows for monitor. All parts shall be installed in an ergonomic electric cabinet and shall be placed nearest to the Bogie Test Stand.
- Weighing electronic system, including PC interface
- IPC to the connection of load sensing devices etc
- Measuring cards for data analysis of the heights and length measuring facilities
- Industrial grade **COLOR Laser jet** printer or equivalent

- Industry-specific software (under windows), including a dynamic process visualization
- Connectors for the addition of a data input keyboard, an RS 232 connector output and a printer shall also be provided. The software shall be designed to enable these additions.
- **General Navigator**: Following General Navigator shall also be provided in the IPC for easy operation.

  Navigation for Sorting the data, Search the data, Navigation to first data, Navigation to previous data, Navigation to next data, Navigation to last data, Navigation for Delete a record after confirmation, Edit data sheet, Inserting data sheet, Only view, Accept / continue, Cancel edit, data update, Prints, Window close, Grid View, Form View, Calculator etc.

- PC shall have following specifications
  - Industrial PC, Intel i5, core duo, 2.52 GHz, 2 x 500 GB Hard disk , 2GB RAM, 2 x RS 232, 5 x USB interface
  - 102-key keyboard, mouse,
  - 19 Inches Industrial touch screen
  - USB drive
  - Windows 7 version
  - Industrial grade Laser jet printer or equivalent
  - Latest antivirus software.
  - Provision of Uninterrupted Power Supply for PC system with 1hour back up time.

6.10.2 PLC control

The PLC control shall be built to satisfy the technical specification. The workstation screen is proposed to be 10 to 12 inches, color. Tenderer shall give the standard scheme available with their design of Bogie Test Stand.

- The control shall be protected from the effects of overheating by operator alarm and by power cut off.

- To facilitate PLC control use and maintenance, the following types of diagnostic and test circuitry shall be provided:
  - System integrity diagnostics (verification of the software, Bogie Test

Stand adjustment data, tool corrections, part program, etc.) at equipment power-up,

- Hardware diagnostics (cards fitted, normal operation of critical cards, power supply current and voltage),
- Non-resident diagnostics (test bands which may be loaded in the equipment to locate a defective card),
- Test circuits (display of Bogie Test Stand position and tracking error, display of memory contents, etc.),
- Access to the various BUSES for connection of an analyzer.

- The PLC control shall be designed in such a manner that the modification of bogie test stand measurements**,** the replacement of a measurements, the modification of a cycle or basic data concerning the definition of measurements, can be carried out without any major modification (plain language program for modifications available: guided operator mode).
- The operator-machine dialogue shall be by means of a keyboard and display control.
- Operation running cycles and sequences shall be displayed in real time and in plain English language on screen pages.
- Interrupts in the sequence shall be reported. Manual sequences shall be guided by means of operator messages.
- Parameter input shall be by means of masks intended to guide the operator.

6.10.3 Automatic Switching:

Adjustment of the test load nominal value at the OP (given by the operator) on PC shall adjust the test load automatically during the test.

6.10.4 Software “Bogie loading “for static check of Bogies

With the relevant software of “Bogie loading”, several dynamic or static tests can be operated.

Performances of the software “Bogie loading “, will include process visualization. It shall have:

- Database stocked software which include the latest logic prescriptions for the check of bogies
- Automatic software takeover of several independent measuring system with simultaneous processing of the data
- Menu led examining process according to limiting values and established steps of checks on bogie
- Colour changes after reaching limiting values
- Protocol expression as a work protocol or test protocol

6.10.5 Adjusting of the software:

In software , the current values, test pressure, Wheels load, axis measures, inclusive of the defined permissible deviation which are visible e.t.c. are to be permanently stored. The software should have flexibility to change them whenever warranted. The possibility posses a work protocol or printing a termination logs.

6.10.6 Screen Page

The screen page displays the pre- and post-testing values to the operator. It shall be operator friendly.

Display principle:

OP = given by the operator

NC = given by the PLC control system.

1 – Test sheet no: NC

2 -Date: NC, operator correction Possible

3 -Bogie Type: OP

4- Line number: OP

5- Car number: OP

6- Bogie number: OP

7-Wheel no (1, 2,3,4) OP in tabular index

8-Oil check (for motor bogie): Gearcase1&2 OP

9- Air leakage test OP

10-Wheel load applied (Axle 1&2; Left & Right) NC

11-Actual deviations from mean value NC (Axle 1&2; Left & Right)

12-Measurements Both OP and NC

(Rated value, measured value, deviation remarks**)**

This information enables the operator to display the testing details pre- and post-testing. The tenderer shall however propose the scheme used by him for display of measurements.

6.11 Civil Works:

A concrete hardened shop floor with a pair of rails embedded will be made available at the installation site of this Bogie Test Stand by the depot contractor of NMRCL. The foundation for vertical column sand load cells shall be simple ones requires making of a simple foundation. Preferably no deep excavation should be required to be done for installation of BTS. The installation details including foundation works of the Bogie Test Stand shall be submitted to NMRCL in advance.

6.12 Maintenance and Upkeep Conditions

All component parts of the Bogie Test Stand must be appropriately protected to stop ingress of metal dust and dirt. All covers, slide caps, hoods and neighboring boxes of tool holders shall be made sufficiently hermetic to stop dust from entering into these areas. All covers and hoods shall be easy to remove.

The Bogie Test Stand and its accessories (hydraulic unit, electrical switchboards, PLC control system cabinets, etc.) shall be designed to facilitate

maintenance operations.

All anomalies shall be reported to the operator by means of messages on the PLC control system screen.

PROTECTION AND SAFETY

6.13 Bogie Test Stand Safety

In case of power failure all movable parts are to be retracted to its original position.

A device shall be provided to impede any accidents during load application cycle (klaxon and stop cell operated if an obstacle is encountered).

The following conditions must be satisfied before load is applied on bogie:

- Correct positioning of the bogie on the track provided where the bogie to be placed for load testing.
- All mobile parts of the Bogie Test Stand shall be in retracted position.
- Safety devices shall be provided to impede any damage to the Bogie Test Stand and serious personnel injury in the event of false manoeuvres.
- When the load is applied on the bogie, it shall not be able to move.

6.14 Personnel Safety

The Bogie Test Stand shall be provided will suitable protection for operator. The Testing area and workstation at NMRCL workshop are appropriately illuminated by the lighting provided on the workshop truss up to 300 Lux. If any further illumination is considered as required, the Bogie Test Stand contractor shall provide it.

Emergency stop pushbuttons (key lockable) shall be installed:

- On the control panel,
- At the work place.

Tenderer shall give the scheme proposed.

6.15 Technical alternative : : Minor deviation in technical specification is permitted . However,minor deviation shall not affect SOD and performance parameter of machines.

6.16 RAMS (Reliability, Availability, Maintainability & Safety) Requirements:

The Plant is expected to meet the RAMS target of 96% Availability, which will be calculated excluding the downtime planned for Preventive Maintenance Services. Standard Penalty will be applicable as per the Penalty Clause.

Note: The bidder shall submit the complete technical detail of offered M&P for technical evaluation.

Chapter -7
Bogie Turn Tables (Item code: NMRCLMNP 006)

Name of the Equipment: Bogie Turn Table.

TECHNICAL SPECIFICATION

BOGIE TURN TABLE AT NAGPUR METRO

CONTENTS

Specific Requirement of Bogie Turntables……

SPECIFIC REQUIREMENTS OF BOGIE TURN TABLES

Bogie turntables shall be provided at the Bogie Shop of the depot workshop building as laid out on the Drawing. The bogie turntables shall be installed at the Repair Bay and at auxillary repair shop. The requirement shall be as

S. No.	Site	Gauge	Capacity- 25Ton
1	Nagpur Metro depot cum work shop	Standard Gauge (1435 mm)	1 Set =4 Nos Each Depot

7.1 Operating Principle

The turntables shall be designed for rollover of Rail Car and bogies from one track to another track in the Bogie Shop area. Each turntable will consist of a mechanical assembly bearing on a centre pivot and several carrier rollers running on a circular platform. Rotary movement through 360° and locking in two positions will be undertaken manually, and depending on the load, operation will require up to one persons to rotate the turntable in the loaded condition.

The structural design of each turntable shall withstand the weight of 25 Ton, and other forces from movement of rail car, bogie and other workshop vehicles.

All turntables shall be designed for manual turning by one person with load of bogie of weight 10Ton by an operating lever. The turning shall be endless in both clockwise and counter-clockwise direction.

The turntables shall be integrated with manual-operated locking arrangement for securing the turntables in place during bogies being rolled on or off the turntables.

7.2 Turntable Construction

The turntables shall be constructed of circular platform decks with approximate 3500 mm in diameter for SG. The decks shall sit on center pivots at the centers and castors on the peripheries for turning.

Two pair of square/rectangular bars of specified gauge shall be mounted and positioned in perpendicular to each other across diameter on the deck of each turntable to accommodate bogies. The track gauge shall be 1435mm for SG as specified for particular workshop site.

7.3 Platform Deck

The turntable and supporting frame shall be constructed of welded structural steel box section, wide flange beam, standard 'I' beam or reinforced beam fabricated from structural shapes. The turntable platform shall be designed to sustain the rollover load of workshop vehicles, such as forklift trucks, with a maximum axle load of 10 ton at any point.

The turntable platform shall be covered with steel chequered plates and flush with the rail top level to allow normal traffic. The plates shall be stiffened and minimum 10mm thick with maximum deflection not exceeding 1/1000 of the span.

7.4 Center Pivot

Center pivot shall be provided and equipped with a self-aligning spherical roller thrust bearing to facilitate turning operation . Center pivots shall be designed to take up any horizontal loads.

7.5 Castor

Eight Castors shall be provided along the periphery to facilitate turning operation. The castor wheels shall be manufactured from high quality steel for reliability during the service life and equipped with anti-friction bearings for quiet operation.

7.6 Running Surface

Running surface for castors shall be designed with considerations of surface wearing and load bearing without deformation. Surface replacement if necessary shall be made possible.

7.7 Automatic Locking

Automatic mechanical locking shall be provided and located at periphery of turntables. The tracks on turntable shall be aligned with adjacent embedded tracks when bogie turntables are in their locked position (4nos.) at any 90º of rotation. Locking arrangement shall be accessible with the bogies on the turntables for locking and unlocking operations.

Locking arrangement shall be flush with the shop floor level for both locked and unlocked positions. The locking bars shall not be removable from the turntables.

7.8 Wheel Stop

Wheel Stoppers shall be provided against any movement of bogie during turning. The arrangement shall not hindrance for rollover of train and other workshop vehicle.

7.9 Tolerance

The gap between the turntable deck periphery and the pit ring shall be within 5 to 10 mm. The track rails on turntable decks shall be aligned with the rails embedded on the shop floor. The rails shall be positioned within tolerances of 2.5mm for track alignment, 2mm for rail top and 1.5mm for track gauge. The maximum difference in the horizontal and vertical alignment shall be to a maximum of 5 mm.

7.10 Pit Ring

The edges of the turntable pits shall be protected with pit rings of steel angle section. The curb angles shall be notched on the field side of the rails in addition to the gauge side to accommodate worn wheels, which may strike the curb angle.

7.11 Operating Lever

One operating lever shall be provided to each turntable for manual turning operation. An inbuilt provision shall be provided for storage of the levers in the turntable.

7.12 Maintenance Provision

7.12.1 Maintenance access shall be provided for inspection and lubrication of center pivot and casters.

7.12.2 Lubrication shall be made by pressure grease fittings to all bearing of pivoting shaft and all castors. The greasing point shall be accessible to routine maintenance.

7.12.3 The turntables shall be constructed to allow the entire assembly, except supporting structures, be conveniently removed from the pit as a single unit. The turntables shall be equipped with lifting eyes, which shall be removable or flush with the decks.

7.13 Colour

The turntable and related equipment shall be painted in Yellow colour of Polyurethane lacquer top coats and as per general specification. Paint touch-ups shall be provided after assembly.

7.14 Technical alternative : : Minor deviation in technical specification is permitted . However,minor deviation shall not affect SOD and performance parameter of machines.

7.15. RAMS (Reliability, Availability, Maintainability & Safety) Requirements:

The Plant is expected to meet the RAMS target of 96% Availability, which will be calculated excluding the downtime planned for Preventive Maintenance Services. Standard Penalty will be applicable as per the Penalty Clause.

Note: The bidder shall submit the complete technical detail of offered M&P for technical evaluation.

Chapter-8

Rescue Vehicle with Re-railing & Allied Equipment (item code-NMRCLMNP007)

Name of the Equipment: Rescue Vehicle with Re-railing & Allied Equipment

TECHNICAL SPECIFICATIONS

RESCUE VEHICLE WITH RE-RAILING AND ALLIED EQUIPMENT

CONTENTS

SPECIFIC REQUIREMENTS OF RESCUE EQUIPMENT

The Rescue equipment shall be capable of quickly lifting, displacing, tilting and slewing into position the de-railed rolling stock operating on **Nagpur Metro** (Metro Corridor and Rail Corridor as well as inside depot areas). The equipment shall be suitable for use in tunnel as well as on viaducts.

The Rescue equipment shall be suitable for operation under dusty/smoke filled atmosphere at accident site.

Rescue equipment shall include all the equipment as detailed in this specification and any other equipment considered essential for satisfactory operation of equipment. The Rescue shall comprise the items described in 8.4 to 8.13 below. Minor deviation in parameters specified would be permissible.

The rescue vehicle shall be of UNIMOG Make or equivalent.

The dimensions of rescue vehicle should not exceed the limits in kinematic envelope mentioned in Part-2, Schedule of Dimensions (SOD) of the tender document.

8.0 Technical Specification of Rescue Vehicle

8.0.1 Base Vehicle

Engine: Mercedes Benz or Similar 4-cylinder diesel engine, according to Euro 5 emissions standards with NOx -sensor, with minimum of 130 kW (177 hp), with 2200 rpm, with exhaust turbo charger and air cooled, electronic injection governor (MR), water cooler; interlock starter switch; exterior noise dampening ,electronic accelerator; electronic hand throttle; electronically governed, max. vehicle Speed on road should be atleast 80 km/h; max. vehicle speed on rail should be atleast 40 Kmph ,cooling fan, elec. regulated, hydraulic drive; air filter with pre- separator; air pressure – spur gear driven, water cooled, 310 l/min at 18 bar; 2- step exhaust brake, with exhaust cut-out and cylinder head valve; governor characteristic for driving (RQV) and implement operation (RSV) elect. Controllable and switchable; Bio diesel capable (RME); extremely long maintenance intervals - after atleast 1200 (engine) service hours.

Transmission: MB- All synchromesh reversing transmission, 8 gears forward and 6 gears reverse; single- disc clutch; permanent all- wheel drive with lockable interaxle differential; Telligent shifting (electro-pneumatic shifting/EPS); cruise control/speed limiter, Electronic Quick Reverse (EQR - fast reversing mode).

Drive: coil springs, telescopic shock absorbers, stabilizers on front and rear axle; differential locks on rear axle, engageable electro-pneumatically while in motion; helical springs with progressive characteristic line; power steering.

Chassis: Wheelbase 3600 mm; aluminum fuel tank 200 l; front towing jaw with pin; anti-slip steps with handle for windshield cleaning; frame-integrated standardized mounting points for Unimog implements and body building; front integral support for fitting front mounting plate (adjustable); air-intake pipe; anti - corrosion fenders; underbody coating (Dinol) for anti –corrosion.

Brake: Dual circuit brake system, high pressure (18 bar;) antilock brake system (ABS); brake system, automatic load responsive (ALB); spring loaded parking brake; compressed air connection for aux. use; com-pressed air dryer; disc brakes on both axles.

Cabin: Compound fibre cab - corrosion free, structural integrity of cab ECE-29/2, cab tiltable; heated rear view mirrors, electrical adjustable, ramp mirror, wide angle rear mirrors, heat-ed. Storage compartments: large storage compartments under dash, bottle and holder integrated in door molding, storage area behind driver's seat and storage box on rear cab wall. Armrest integrated in door molding; roof console with 2 shafts for radio and speedometer- recorder; driver and passenger seat height, tilt, backrest tilt and longitudinal adjustable; large rear window; multi- setting heater and blower, with dust filter, air recycling and residual engine heat usage; interior lighting with reading light for driver and passenger; level cab floor; sealed entering channels for cables in the cab (rear wall and foot compartment on right side); cab suspension with shock absorbers, rear; 3 coat hooks, head rests; integrated air conditioner; ergonomic middle console, centrally arranged, with all controls; middle console with 2 installation shafts i.e. for CB, incl. ashtray; panorama windshield multi-layered; windshield wipers 3 settings with intermittent setting and wind--shield washer; seats with integrated 3-point safety belts; 3 sun visors; deep windows in door; all-round heat reducing glass.

Instruments: Elec. controls located in centre console; adjustable dash board illumination. Multi-combination lever: steering column, right: hand throttle, cruise control, speed limiter and exhaust brake, steering column, left: headlight beams, blinker, windshield wash/wipers, and horn. Large instrument panel LCD-displays and gauges for: speedometer km/h and mph, RPM, brake reservoir pressure, coolant temperature, fuel level, hydraulic oil temperature, differential locks, brake pad wear, brake fluid level, coolant level, steering fluid level,

air filter maintenance, engine oil level, windshield wiper fluid level, trans- mission gear, service hour counter, km and trip km counter, clock.

Electrical system: Rear trailer socket 24 V, 15 pin; exterior mirrors heatable disengageable) electrically adjustable; batteries 2 x 12 V/135 Ah, low maintenance; vehicle elec. system 24 V; permanent power plug 24 V in middle console; electric and electronic parts (elec. magnetic compatible); electronic powertrain management system with diagnostic interface and on board diagnostics; 28 V/ 100 A (2800 Watt) generator; centrally located elec. Box protected within cab.

Lights: Panoramic headlights; headlight range adjustment; additional side indicators; clearance lamps; six chamber rear lights with clearance lamps, blinker, rear lights, rear fog lights, rear reflector reversing lights.

Special Equipment for Vehicle:

differential lock in front axle

preparation parts for rail/road application

fuel tank lockable

implement mounting plate

battery main switch at battery box

permanent power plug

implement plug

tilting device for cab

Universal holder for control panel

7th + 8th reversing gears open

- tachograph

-reverse warning buzzer

-flash lights yellow, left and right, with supports

-Fuel pre- heating and water separator

-BlueTec 5 (Euro 5)

-live engine PTO to rear (with flange)

-platform subframe, high

-trailer coupling with big jaw

-rims for road - rail application

-comfortable driver's seat, air

-twin passenger's seat

-Rear window, sliding from both sides

-mirror brackets lengthened

-spare rim for road- rail application

-fire extinguisher 2 kg, with brackets

-tyre filling hose with manometer

-hydraulic jack 10 t

-warning triangle and signal lamp

8.0.2 Road/Rail Equipment

8.0.2.1 RAIL GUIDANCE SYSTEM

8.0.2.1.1 Rail Guidance System

• for standard track gauge 1,435 mm

• Highly sophisticated, articulated twin- assembly guide wheels with UIC- profile

• Wheel with suitable diameter

• Twistable swivel arm/rail axle system

• Life guards

• Hydraulic control with pressure compensation and damping

• Front and rear to be controlled separately from driver´s cab

• Optical and acoustical warning system in case of pressure Decrease

• locking of steering wheel

• Mechanical suspension for road operation

• Suitable for operation on min. track curve radius of approx. 60 m

8.0.2.1.2 Hydraulic Hand Pump

For emergency operation of rail guidances.

8.0.2.2 SIGNAL LIGHT AND WARNING SYSTEM

8.0.2.2.1 Signal Light and Warning System

• Railway lighting as triple top light and with red back light for both running directions

• Automatic change- over of lighting for forward and reverse

• Scope: at the front side white signal light as top light in Connection with the low beam of the vehicle, at the rear side three white signal lights, at both sides one red signal light each

• Automatic change change-over of lighting when changing between rail and road and vice versa

• Pneumatic Signal Horn

8.0.2.3 ADDITIONAL EQUIPMENT

8.0.2.3.1 Wheel Base Extension

• from 3600 mm to 4200 mm, incl. reinforcement of the chassis Frame

• Modification acc. to Daimler prescriptions

8.0.2.3.2 Searchlight 2 pcs.

- two searchlights installed on driver’s cab

- to be switched on and off and adjusted from driver’s cab

8.0.2.4 Bodywork - Outer dimensions:

Complete bodywork:

Length: approx. 4,400 mm

Width: approx. 2,300 mm

Height: approx. 1,900 mm

Double cab:

Length: approx. 1,200 mm

Width: approx. 2,300 mm

Compartment for rerailing equipment and tools:

Length: approx. 3,200 mm

Width: approx. 2,300 mm

Rear flap:

Width: approx. 1,000 mm

Height: approx. 1,400 mm

Base construction:

- Bodywork made of strong sheet steel sandwich elements
- based on a stable subframe
- Thickness of lateral walls approx. 28 mm
- Thickness of roof sandwich elements approx. 60 mm

Crew cab:

- located directly behind the drivers cab
- Seating bench for four personnel with backrest and safety belts
- Access door at right or left side, with safety lock
- One sliding window (600 x 700 mm) on each side
- one large sliding window at the front side of the compartment, to enable the personnel to communicate with the personnel in the drivers cab via a rear sliding window of the Unimog

- Illumination of the compartment by two transistor lights

- Air conditioning for personal compartment

Compartment for Rerailing equipment and tools:

- located behind the personnel compartment

- side-boards made of section profiles, to be hinged down by means of toggle levers to a height of approx. 500 mm (anti-skid cover inside made of light metal checker plate)

- 1 sealed light metal sliding shutter on each sides, with spring shafts underneath the roof

- One folding door at the rear side consisting of two parts each opening approx. 90°

- Rubber buffers at the rear side

- Rollers immersed in the body sub frame serving as guide for the Rerailing bridge

- Storage facilities for Rerailing equipment and tool

- Four transistor lights for the illumination of the inner body

- Two telescopic searchlights mounted at the rear of the bodywork

- Ventilation of body

- under ride protection

- One handle on the each corner

8.1. Air Bags

8.1.1. One set of air bags comprising two bags of each of the following sizes shall be provided.

8.1.2. Size of approx. 600x600mm - 650x690mm with 300kN lifting capacity and 350mm lifting height and an Insertion Height of 25 mm. Weight shall be max. 13kg

8.1.3. Size of approx. 900x900m - 950x950 mm with 670kN lifting capacity and 500mm lifting height and an Insertion Height of 28 mm, Weight shall be max. 25 kg

8.1.4. The set of air bags shall be complete with an air compressor of minimum 230 l/m at 10 bars. The air compressors shall be driven by 4-stroke petrol engine. One control box connecting and operating each set of

air bags at a time and reinforced air hoses of required numbers of 10 m length. The air hoses shall be capable of reaching 10m into tunnel beyond the entrance for connection between the air compressor and the air bags.

8.2. One Rescue Device Set

8.2.1 The rescue device set shall comprise of hydraulically operated one cutter of minimum 392 kN and one spreader of minimum 230 kN powered generally from the re-railing system complete with a pair of 10 m long high pressure hoses, one pair of replacement blades for cutter, one set (one pair of) pulling chains for attachment to spreading arms, one pair of spare tips for the spreading arms and one pair of peeling tips for spreading arms. The hydraulically operated cutters shall be powered generally from the re-railing system but if a separate Power Pack required for the same then the cost of the power pack will be added to the offer rate for rescue device set.

8.3. Power Pack for Rescue Device Set

8.3.1. The tenderer may quote for a rescue device set.

8.3.2. A small power pack of 4-stroke petrol engine of suitable capacity for the use for rescue device with a minimum operating pressure of 630 bar Suitable for simultaneous and independent operation of 2 rescue tools and weight shall not be more than 25 Kgs. Rescue Tools can be connected and disconnected, even under running engine.

SPECIFIC REQUIREMENTS OF RE-RAILING EQUIPMENT

The Re-railing equipment shall be capable of quickly lifting, displacing, tilting and slewing into position the de-railed rolling stock operating on Nagpur Metro (Metro Corridor and Rail Corridor as well as inside depot areas). The equipment shall be suitable for use in tunnel as well as on viaducts.

The re-railing equipment shall be suitable for operation under dusty/smoke filled atmosphere at accident site.

Re-railing equipment shall include all the equipment as detailed in this specification and any other equipment considered essential for satisfactory operation of equipment. The re-railing shall comprise the items described in 8.4 to 8.13 below. Minor deviation in parameters specified would be permissible.

8.4. One Hydraulic Pump Set

8.4.1. The hydraulic pump set shall be of 4-stroke petrol engine driven. The engine shall develop at least 4.5 - 5.0 BHP. The pump shall be capable of operating on unleaded petrol readily available in India.

8.4.2. Portable two stage radial pistons pump capable of generating pressure of 30 MPa (300 bars) or higher, and the system should have an output of at least, 2.5 l/min at high pressure.

8.4.3. Power Pack should have built in pressure shut-off valve, pressure relief valve and venting valve etc. , or any bypass valve shall be switched to idle position when jack was not in operation

8.4.4. Oil tank shall have a minimum usable capacity of 20 litres and an oil filter with optical clogging indicator, a filling filter with integral venting filter, oil sight glasses and oil drain screw.

8.4.5. The weight shall be less than 105 kg.

8.5. One Auxiliary Hand Pump

8.5.1. Auxiliary hand pump shall have a minimum pressure rating of 30 MPa and be complete with minimum 2 connections and minimum **10**-litre tank . The hand pump should be capable to work a complete re-railing procedure including lifting, lowering in dangerous areas where any pump unit cannot be used.

8.5.2. Portable hand pump with minimum **two connections** shall be suitable for two jacks operation. Oil tank shall have a minimum capacity of 10 liters and a filling filter with integral venting filter. The weight shall be less than 40 kg.

8.6. One Control Console

8.6.1. The control console shall be complete with all necessary valves, controls and safety features including dead man switch operable with automatic spring reset in the event of operator inabilities.

8.6.2. The control console shall have a minimum of four control valves for simultaneous/ independent operation of lifting, lowering and moving horizontally, up to 4 lifting and displacing operation. Safety valves, pressure gauges for pressure monitoring and color coded hose connections shall be provided.

8.6.3. A high-pressure filter shall be used to prevent the dust and sand from the pump unit to get into the hydraulic system during lifting, lowering and displacing procedures.

8.6.4. The control console shall have a sturdy portable frame/stand shall be light in weight and the weight of control console shall be less than 70 kgs

8.7. High Pressure Hoses

8.7.1. Pairs of high-pressure hoses each 10m long of required numbers

to connect the jacks between the power pack and control console (bound in pairs) with quick connect couplings **/** screwed couplings, including oil retaining valves to prevent the leakage of oil when uncoupled and protective caps to prevent soiling shall be provided. The hoses shall be color coded and capable of withstanding a working pressure provided by hydraulic pump. The hoses shall be equipped with non-interchangeable safety couplings.

8.7.2. Tenderer shall be the manufacturer of quick connect coupler. However if tenderer is not the manufacturer of the same, then same shall be procured from a proven source and shall take approval of the same from NMRCL before supply. Tenderer shall provide complete credential of the proven source in their technical proposal along with the address and telephone number of the end user to whom the high pressure hose have been supplied for use in the re-railing equipment.

8.7.3 Tenderer shall provide complete technical details of hoses & safety couplings including the company catalogue in their offer.

8.8. Telescopic Jacks

8.8.1. The following telescopic jacks having the following nominal ratings shall be provided. The working pressure shall be 30 MPa or above. 2 nos. of maximum close height including Piston protection plate 250mm, minimum stroke 185mm Capacity: Piston-1: 55 – 65 tons and Piston-2: 25 – 25 tons. Stacking set of 260mm shall be provided if required to achieve maximum closing height of second jacks. 2 nos. of maximum close height including Piston protection plate 495 mm, minimum stroke 500mm.

8.8.2. Capacity: Piston-1: 55 – 65 tons and Piston-2: 25 – 25 tons

8.8.3. The jacks with similar overall rating will also be considered. The telescopic jacks shall have hydraulically releasable non-return valves for safe holding of the load even in the event of hose ruptures. Pressure relief valves shall also be provided.

8.8.4. The jacks shall have coupling connector with overload valves to prevent an overpressure on pressure line.

8.8.5. Jacks with integrated Base Plates and separate Base Plate are acceptable.

8.8.6. The maximum stroke including supporting set of the smaller jack types shall be more than the maximum closed height of the taller jack types to make sure that the higher jacks can be used for a continuous lifting operation when the lower jacks have reached their limits.

8.8.7. The telescopic jacks shall have carrying handles, colour coded

connections, and the weight shall be less than 40 kg.

8.9. Displacement Jacks and Roller Carriages

8.9.1. Pair of displacing jacks shall be provided each with 12/6 tones (pushing force 12 tones and pulling 6 tones) capacity, maximum closed height 580mm, minimum stroke 300mm with steel counter support.

The displacing jacks shall have color coded connections and the weight shall be less than 20 kg. The working pressure shall be 30 MPa or above.

8.9 a Four roller carriages shall be provided each with 60-ton or above capacity, and removable top plate. The height shall be less than 110mm (without plate) -
140mm (with plate) and the weight less than 60 kg (without plate) and 85 kg (with plate). The width shall be 260mm.

The roller carriages shall have carrying handles, shall be equipped with low friction rollers and guiding pin to ensure a linear movement.

The following accessories shall be provided:

- Four counter supports,
- One stopping device with carrying handle,
- One distance bar having an adjustable length from 1,050mm up to 2,600 mm and weight less than 50 kg.

8.10 Re-railing Bridges and Couplers

Re-railing bridge of carrying capacity 60 tons at a free span of 1.5m shall be provided for each of the following sizes.

- 3.30m Long (one no.) or (2.5m + 1.0m)
- 2.20- 2.5 m Long

The Re-railing bridges shall be manufactured out of high quality light metal alloy in hollow body construction designed to ensure ability to couple one bridge with another. Construction height shall not exceed 180 mm and width shall be between 250 - 350mm.The load capacity of re-railing bridges shall be tested to 25% overload capacity.The re-railing bridges shall be fitted out with carrying handles and mounting points for bridge couplings.

The maximum weight for the longest bridge shall not be more than 135 kg. Pair of bridge couplers / one set of connection element shall be provided and coupler shall be designed for joining together two re-railing bridges. The coupler weight of one set of connection element shall be less than 40 kg.

The bidder shall indicate the test facilities available at manufacture's site / third party test laboratory to carry out the load test conforming the load carrying capacity of re-railing bridges at a free span of 1.5 meters as per details above and tenderer shall submit details in the technical offer as per the as per requirement for bidder's technical submission annexure –IV-C.

8.11. Single Piston Step Jack (claw jack)

8.11.1. The Piston Step Jack shall have a capacity of minimum 30 Tones , Minimum working pressure 35 Mpa,height of 1000 mm to 1150 mm or to approx. 850 mm with claw and stroke of 825 including accessories:

- Integrated high capacity claw
- One round Head Piece for single piston step jack
- **Radius plate** as swivel base plate for the above **claw jack**.
- The single piston step jack shall have carrying handles, colour coded connections and the weight shall be max. 70 kg.

8.12 Two Lifting Cable Ladders

8.12.1. The lifting cable ladders shall be provided complete with accessories. The carrying capacity shall be 35-40 tones with a factor of safety not less than 3. The length shall be at least 3m.

8.13 Generator

8.13.1 One generator shall be provided along with the equipments. The generator shall be a portable petrol engine driven unit, skid mounted with protective frame.

8.13.2. The output rating shall be not less than 3.2kW, 220V, 50Hz single phase. The unit shall be manually started by means of a retractable toggle starter. A minimum of two panels with three in panel mounted industrial waterproof socket outlets shall be provided. Equipments of lighter weights are preferable.

8.14 Technical alternative : Minor deviation in technical specification is permitted . However, minor deviation shall not affect SOD and performance parameter of machines.

8.15 RAMS (Reliability, Availability, Maintainability & Safety) Requirements:

8.15.1 The Plant is expected to meet the RAMS target of 96% Availability, which will be calculated excluding the downtime planned for Preventive Maintenance Services. Standard Penalty will be applicable as per the Penalty Clause.

Note: The bidder shall submit the complete technical detail of offered M&P for technical evaluation.

Chapter-9
Catenary Maintenance Vehicle (item code- NMRCLMNP008-A)

OHE Catenary Maintenance Vehicle – 8 Wheelers (item code- NMRCLMNP008-A)

Sample image

TECHNICAL SPECIFICATIONS OF OHE CATENARY MAINTENANCE VEHICLE (8 WHEELERS) AT NAGPUR METRO

CONTENTS

9.1. GENERAL

The scope of this specification is to reflect the performance and quality requirements for an Over Head Equipment (OHE) Maintenance Vehicle, which will also be used as an emergency and rescue Shunter .

9.2. VEHICLE DESCRIPTION

The vehicle will be a self-propelled full rail borne vehicle composed by a steel frame, lying over four axles (8- Wheeler Vehicle)

9.2.1 Vehicle frame

The frame of the vehicle will be composed of standard steel sections and transversal beams. The material will be of standard steel of different qualities, depending on the mechanical requirements over the frame.
The frontal parts of the frame will be designed in order to make the assembly of the coupler easier. They are made to support the efforts indicated in the UIC 577 – OR leaflet.
The vehicle will have a loading platform in the middle part of the vehicle. The height from the platform surface to the running plane will be 1200 mm when the vehicle is unloaded.
Regarding to the surface treatment and painting, the following treatment will be applied to the frame and cabin:

- Sand blasting SA 2.5 according to SIS 055900 standard
- Primer coat of anticorrosion painting based in zinc phosphate,
- Final coat treatment composed by an epoxy coating and a finish coating black RAL 9005.

9.2.2 Vehicle equipment

The vehicle will have a working platform in the middle section. The vehicle will include a hydraulic crane for cargo handling. The vehicle will have a measuring pantograph, and measuring equipments for the overhead equipment and track geometry.
The four axles of the vehicle will be powered with hydrostatic transmission and a main diesel engine.

9.2.3 Vehicle performance

The vehicle main duty will be:

- To transport material and workers from the maintenance sites in the tracks to the workshops and train depots
- To tow up to 3 Metro cars (47 t each) in rescue mode

- To carry track and OHE test equipment for analyzing the Track and OHE geometry. For the crew and worker transportation, the vehicle will feature a ten people capacity cabin.

9.3 GAUGES AND DIMENSIONS

The profile and cross section of the Maintenance Vehicle will comply with the Nagpur Metro Rail Schedule of Dimensions.
Any equipment, structure or element of the vehicle which could infringe the gauge while extended in running condition will be labeled and painted in a bright colour in order to remind the crew about them after the work is finished.
The only equipment which could infringe the gauge is the crane, the working platform and the stabilizers, so they will be all retracted and stowed when switching from working speed to running speed.The vehicle will have enough clearance from the rail level to the underside of the vehicle.

9.4 OPERATIONAL REQUIREMENTS

The vehicle will be able to tow up to 3 Metro cars (47 t each) for a total of 141 t, in a gradient of 4% at least at 8 km/h speed.
To perform the towing duty, the vehicle will feature a Rockinger type coupler for towing Metro Cars. For the design and construction of the vehicle UIC and IRS standards will be applied. Maximum admissible axle load for the vehicle will not be higher than 16 t per axle. The wheel profile will be as per Metro standard wheel profile.

9.4.1 Track requirements

The vehicle will be capable of travelling through the Curves, Cants and Gradients noted in the Nagpur Metro Rail Schedule of Dimensions.
Minimum radius of horizontal curves

- On main running lines
  Elevated and At-Grade Sections ..... 120 m
- Depot and other non-passenger Lines……100 m
- At passenger platforms.....1000 m
- Minimum radius of vertical curve
  On main running lines.....1500 m
  Cant and Cant Deficiency
- Maximum Cant on curves 125mm
- Maximum Cant Deficiency.....100 mm
  Gradient
- Maximum Gradient: 4%

9.4.2 Speed requirements

The vehicle will be able to circulate at the following speeds:

- By its own speed in straight track and curves with a very long radius: ..... 50 km/h
- Towing 141 t of Metro cars in 4% gradient: ..... 8 km/h
- Towing 141 t of Metro cars in level track: ..... 14 km/h
- In a train composition being tow..... .....80 km/h

The vehicle will be able to circulate in both directions at the same speed.

9.5 DRIVE

9.5.1 Diesel engine

The vehicle will be powered by a diesel engine of adequate capacity to meet the performance and operational requirements detailed in the para 9. 4 “Operational requirements”.

The proposed power of the engine will be a minimum of 350 kW. This proposed power can vary depending on the current state of the diesel engine technology.

The diesel engine will be from a top brand OEM, with satisfactory service and repair support facilities available in India.

The Diesel Engine will have a fuel tank with enough capacity to provide 8 hours of continuous operation. The engine starter will be electric, powered by batteries.

The Diesel engine will comply at least with the Euro 4 exhaust emissions standard.

The Driver control panel will have enough monitoring gauges for temperature, rpm, oil pressure etc. for controlling the engine performance at any moment.

The engine, as well as the associated elements (compressor, alternator, etc.) will be assembled over its own frame supported by mean of silent blocks by the frame of the vehicle.

The engine will be easily accessible by every side, with doors and cabinets on the vehicle floor in order to help maintenance operations and to help in the removal of dust and grease.

The cooling circuit of the vehicle will be designed with the radiator in horizontal position. The radiator will have the same performance in both directions.

The radiator surface for the engine will be enough to keep the engine running in working order even with 30% of the radiator surface chocked, and in any case, the cooling fluids will exceed 95 º C temperatures.

The radiator fan will be of electric nature, which will be feed by the auxiliary alternator of the engine.

9.5.2 Transmission

The vehicle will have the diesel engine power relayed to the four axles, by means of a hydrostatic transmission

This hydrostatic drive will be composed of hydraulic pumps, hydraulic motors in each axle, and the software control.

The proposed power of the Transmission Box will be a minimum of 350 kW. The drive mineral oil will be of HLP grade type satisfying DIN 51 524 standards. Every hydraulic systems of the vehicle will be protected by mean of security valves from the pressures in the different working conditions.

The oil tank of the vehicle will have a capacity to provide 8 hours of continuous

operation. It will be designed to allow changes in the volume of the oil which could take place in every running condition, permitting the air outlet in every moment. The capacity will be enough for the first filling of the circuit.
The final mechanical connection between the axle set and the hydraulic motor will be made by mean of an axle gear – box with dual speed.
The dual speed selection will allow the vehicle to shift between low speed, high traction force gear for work and shunting duties and a high speed, low fuel consumption gear for transfer duties and faster arrival at the working place.

9.6 CABIN

The vehicle will have a double cabin with enough space for carrying 10 persons.
The cabin will comply with UIC 617 – 6, 625 – 6 y 651 OR leaflets.
The cabin will be made of steel profiles, with an interior furnishing of phenolic boards.
Enough windscreens and windows will be provided in order to give the best visibility all around from the cabin, in both directions of driving.
Two separate driving desks can be installed, one on each running direction in order to provide good view in both travelling directions.
The passenger seats will be ergonomic and will be able to fold to save space when not in movement.

The visibility from the driving desk will be according to UIC 625-6 leaflet, and the windshields will have windshield wipers. It will also have rear mirrors in order to control the position of the vehicle.
The cabin will have full acclimatization in order to keep the cabin temperature in working levels thought the whole year.
It will include both A/C and heater.

9.7 BRAKE SYSTEM

The vehicle will be fitted with compressed air brakes commanded from the main cabin through the driver's desk.
The vehicle should be able to drive as a head in a towing composition, and as a wagon in a larger train composition. The brake system will be able to brake the vehicle when it is part of a bigger composition.

The brake system will be capable of braking a full towed composition of 3 Metro Cars with 47 t weight each.

The minimum percentages of braked mass of the automatic brake will be according to UIC 543 specifications. The braking coefficient will be of the 70% in the most unfavorable load conditions.
The parking brake will warranty that the vehicle is stopped on a slope of the 4% with a safety factor of 1.45, without overtake an adherence coefficient rail – wheel of 0.12.
The parking brake will work over the same brake blocks or brake cylinder as the service brake by mean of accumulation springs. The service brake will be electro

pneumatic, according to UIC 540 to 543 leaflets.
The service brake system will allow the coupling of the vehicle to a train composition, in such a way that the brake can be activated from the cabin, and to act over the own vehicle and the rest of the composition.
The application of the braking effort will be made by mean of braking blocks with double effect regulator and antagonist spring. They will act directly over the lathes by mean of braking pads according to UIC 541 – 3 y 541 – 4 and 832 standards.
The vehicle will have an emergency brake system installed. These emergency brake buttons will be easily visible and accessible. The emergency brake connects directly the emergency valve to the atmosphere producing an emergency brake.
The whole system will be powered by an onboard air compressor which will comply with prEN 14033 – 1 article 9.4, for a minimum number of 16 axles.
The tank capacity will allow, in every braking condition, three braking / looses at the maximum pressure, with the vehicle isolated, without production of compressed air and with the maximum stroke of the brake blocks.

9.8 DYNAMIC EQUIPMENT

The vehicle will be powered by four axle sets.
The maximum weight per axle will not exceed 16 Tonne .
The four axles will be powered, and be capable of moving the vehicle in both directions at full speed. The wheels will be mono block, and made of forged steel. The axle grease boxes will be fully sealed, and will have installed long life bearings. The damping system will be designed following the UIC leaflets, and will be composed of elastic steel coil springs between the frame and the axle boxes.

9.9 ELECTRIC EQUIPMENT

The electric equipment of the vehicle will comply with all the relevant standards and specifications, and will be suitable for the final destination conditions .The vehicle will be equipped with an electric starter batteries and motor for the diesel engine, capable of starting the engine on its own without any external power.

The internal and external lightning will comply with the line standards, and will be enough to work in night time conditions.

The working platform will have electric sockets on the cradle, and two manual lights mounted in pivoting mounts, one on each opposing corners of the platform .The circulation lightning will be according to the Metro Line standards.

9.10 MISCELANEOUS EQUIPMENT

The vehicle will come equipped with the following auxiliary equipment

9.10.1 Sand boxes

The vehicle will have sand boxes in both running directions and in every wheel to

allow a better traction effort in case of slipping.

9.10.2 Driver Safety Device

The vehicle will feature a double system for the safety of the driver which will accomplishing UIC 641 – O standard.
When activated it will produce an emergency braking (traction cut and maximum service brake).

9.10.3 Acoustic signals (Horn)

The vehicle will have two pneumatic horns, one for each running directions, audible at a distance of minimum 1000 m, with sound intensity between 120 and 125 dB(A) at 5 meters (according UIC-644 leaflet).

9.10.4 Tool Kit

The vehicle will include a set of general tools to make urgent reparation.

9.11 WORKING PLATFORM

The vehicle will have a working platform for inspection and maintenance works in the overhead equipment. The working platform will be constructed by mean of an insulated platform with insulating elements according to DIN standards for the voltage and intensity required.
The platform will have handrails of 1100 mm height, and dimensions of 2500 x 2500 mm. The design and location of the platform, will allow the work with the handrail erected in small gauge tunnels.
The access to the platform will be an insulated ladder with the insulating characteristics of the platform, 800 mm width. The steps will be anti slipping, with a distance between them of 300 mm and a step of 50 mm. The access to the platform will be safe and comfortable.

The platform will have two movements, elevation and translation. The elevation mechanisms will be hydraulic with a scissors like mechanism powered by cylinders of double effect and piston pump to activate them or hydraulic telescopic type.

The platform will be pivot mounted rotating type or translating .The translation system will be powered by a hydraulic motor with negative brake that assures the position of the working platform and a mechanical system with coupler that limits its speed.
The platform floor should be capable of elevating to a maximum height of 5500 mm
The platform floor when retracted should be at 3000 mm from the rail head .The platform will be able to laterally traverse 1500 mm to each side of the track axle.
The working platform will have an emergency system for its own movement in case

of breakdown, consisting of a manual hydraulic pump located in the lateral part of the vehicle. It will allow moving the working platform in case of a failure of the diesel engine.

9.12 CRANE

The vehicle will have a hydraulic operated crane specific for railway vehicles, with low standstill height

The crane operation should be such that there is no infringement to over head electric equipment during crane maneuvering / extension / shortening and there is no infringement to the Metro Schedule of Dimensions

The crane will have the following performance and equipment:

- Max. Lifting capacity:10.4 t m
- Lifting capacity at 9.7 m reach: 1000 kg
- Hydraulic Reach up to 9.7 m.
- Two extensible hydraulic jacks
- Base of the crane for works with an angle of 10º
- High pressure filter. Oil radiator.
- Working light, installed in articulated arm.
- Spinning and height limiter.
- Emergency stops, piloted valves and torque limiter.
- Limit switches to avoid gauge infringement.

9.13 MEASURING PANTOGRAPH

The vehicle will have a measuring pantograph, insulated, calibrated and with precision potentiometer, IP65 protected, and with digital display in the cabin, to measure the height and stager of the catenary, all catenary parameter at crossover/turnout locations.

The actuator of the pantograph will be pneumatic, with pressure regulator.

The pantograph will be able to measure both the lateral and the height deviation of the overhead line, which the driver will be able to check thought a TV camera supplied with the system. This camera will be pointed at both the rules, and the video feed will be shown in a colour monitor in the driving cabin.

It will also have a linear inductive detector in the pantograph which will continuously show in the screen the current height of the pantograph in real time, and will be able to either print the height profile in real time or store the measures in a computer memory.

For the lateral deviation, the pantograph will feature a laser sensor which will provide accurate lateral deviation, also shown in real time in the driver desk screen and with the option to either print the lateral deviation profile in real time or store it in a computer memory.

9.14 TRACK MEASURING DEVICE

The vehicle will be equipped with the following track measuring device.
The device is stored into the cargo platform and can be mounted on the track and attached to the vehicle by a single worker.
The maximum towing speed for the measuring device is 15 km/h.

9.14.1 Track geometry measuring device

The measuring device it is made of a steel frame with several steel wheels with railway profile, which will mount all the sensors and batteries needed for operation.

The measuring device will be able to measure the following track geometry parameters:

- Track gauge: Precision 0,1mm / reproducibility at 95%: +-0.45 mm / Range: 25 mm
- Track cant: Precision 0,1mm / reproducibility at 95%: +-0.7 mm / Range: N/A
- Track twist: Precision 0,1mm / reproducibility at 95%: +-0.7 mm / Range: -+13 mm
- Rail top level on both rails: Precision 0.1mm / reproducibility at 95%: +-0.7 mm / Range: -3 mm
- Versine (alignment) on both rails: Precision 0.1mm / reproducibility at 95%: +-1 mm / Range: +-25 mm All the measuring parameters will have a precision of at least 0.1 mm.
- The measuring device will have a numerical display on the own vehicle, with a PC port for exporting data. The device will have an encoder for measuring the track distance travelled by the device.
- The device also has an independent PDA device which will guarantee:
    - Display of all the measures taken in real time
    - Processing of the signals, including wave filtering and signaling when the tolerances are exceeded
- Storage of numerical variables every 0.25 m, with a total memory for 2000 km.

9.14.2 Ultrasonic measuring device

This measuring device is a dual rail inspection system for tracks.
The device features several ultrasonic sensors which are specialized in detecting defects and cracks in both rails of the same track simultaneously.
The main characteristics of the device are as follow:

- Inspection of both rails at the same time and in a single pass.
- Recording of all the parameters and variables, including defect details, main events and the sensibility programmed.
- Positioning of the defects and cracks due to encoders in the main wheels.
- The device allows inspecting tracks of different gauge with a simple manual adjusting, from narrow tracks to wide tracks, and of course standard UIC gauge.

- GSRM module which will allow direct link communications to a PC in a distant office, in real time.
- 3 different ultrasonic visualization modes, with an option for screen shots of the current visualization and storage of critical images into the device internal memory.
- PC port to download all the data to other PCs via direct link.
- Special channel for manual checking of the events in the track.
- It can be towed up to 15 km/h by a vehicle or it can be handled by a single worker on foot.
- The device is electrically isolated on track.

The device works with 9 ultrasonic sensors located on each measuring wheel. That allows the device to measure dynamically 98% of the rail head and 100% of the rail beam.

The sensors are disposed in several angles, in order to extend the coverage of the ultrasonic wave to the maximum available.

- 1 sensor at 0º
- 6 sensors at 70º in two groups of 3
- 2 sensors at 37º

9.15 RESCUE EQUIPMENT

The vehicle will be equipped with the following rescue equipment, which will include rerailing hydraulic equipment, hydraulic rescue tools, inflatable rescue air bags, and all the power units and control units needed.

9.15.1 Air Bags

One set of air bags comprising two bags of each of the following sizes shall be provided.

Size of approx. 600x600mm - 650x690mm with 300kN lifting capacity and 350mm lifting height and an Insertion Height of 25 mm. Weight shall be max. 13kg

Size of approx. 900x900mm - 950x950 mm with 670kN lifting capacity and 500mm lifting height and an Insertion Height of 28 mm, Weight shall be max. 25 kg

The set of air bags shall be complete with an air compressor of minimum 230 l/m at 10 bars. The air compressors shall be driven by 4-stroke petrol engine. One control box connecting and operating each set of air bags at a time and reinforced air hoses of required numbers of 10 m length. The air hoses shall be capable of reaching 10m into tunnel beyond the entrance for connection between the air compressor and the air bags.

9.15.2 One Rescue Device Set

The rescue device set shall comprise of hydraulically operated one cutter of minimum 392 kN and one spreader of minimum 230 kN powered generally from the re-railing system complete with a pair of 10 m long high pressure hoses, one pair of replacement blades for cutter, one set (one pair of) pulling chains for attachment to spreading arms, one pair of spare tips for the spreading arms and one pair of peeling tips for spreading arms. The hydraulically operated cutters shall be powered generally from the re-railing system but if a separate Power Pack required for the same then the cost of the power pack will be added to the offer rate for rescue device set.

9.15.3 Power Pack for Rescue Device Set

The tenderer may quote for a rescue device set.

A small power pack of 4-stroke petrol engine of suitable capacity for the use for rescue device with a minimum operating pressure of 630 bar Suitable for simultaneous and independent operation of 2 rescue tools and weight shall not be more than 25 Kgs. Rescue Tools can be connected and disconnected, even under running engine.

SPECIFIC REQUIREMENTS OF RE-RAILING EQUIPMENT

The Re-railing equipment shall be capable of quickly lifting, displacing, tilting and slewing into position the de-railed rolling stock operating on **Nagpur Metro** (Metro Corridor and Rail Corridor as well as inside depot areas). The equipment shall be suitable for use in tunnel as well as on viaducts.

The re-railing equipment shall be suitable for operation under dusty/smoke filled atmosphere at accident site.

Re-railing equipment shall include all the equipment as detailed in this specification and any other equipment considered essential for satisfactory operation of equipment. The re-railing shall comprise the items described in 9.15.4 to 9.15.13 below. Minor deviation in parameters specified would be permissible.

9.15.4 One Hydraulic Pump Set

The hydraulic pump set shall be of 4-stroke petrol engine driven. The engine shall develop at least 4.5 - 5.0 BHP. The pump shall be capable of operating on unleaded petrol readily available in India.

Portable two stage radial pistons pump capable of generating pressure of 30 MPa (300 bars) or higher, and the system should have an output of at least, 2.5 l/min at high pressure. Power Pack should have built in pressure shut-off valve, pressure relief valve and venting valve etc, or any bypass valve shall be switched to idle position when jack was not in operation

Oil tank shall have a minimum usable capacity of 20 liters and an oil filter with optical clogging indicator, a filling filter with integral venting filter, oil sight glasses and oil drain screw. The weight shall be less than 105 kg.

9.15.5 One Auxiliary Hand Pump

Auxiliary hand pump shall have a minimum pressure rating of 30 MPa and be complete with minimum 2 connections and minimum **10**-litre tank. The hand pump should be capable to work a complete re-railing procedure including lifting, lowering in dangerous areas where any pump unit cannot be used.

Portable hand pump with minimum **two connections** shall be suitable for two jacks operation. Oil tank shall have a minimum capacity of 10 liters and a filling filter with integral venting filter. The weight shall be less than 40 kg.

9.15.6 One Control Console

The control console shall be complete with all necessary valves, controls and safety features including dead man switch operable with automatic spring reset in the event of operator inabilities.

The control console shall have a minimum of four control valves for simultaneous/ independent operation of lifting, lowering and moving horizontally, up to 4 lifting and displacing operation. Safety valves, pressure gauges for pressure monitoring and color coded hose connections shall be provided.

A high-pressure filter shall be used to prevent the dust and sand from the pump unit to get into the hydraulic system during lifting, lowering and displacing procedures.

The control console shall have a sturdy portable frame/stand shall be light in weight and the weight of control console shall be less than 70 kgs.

9.15.7 High Pressure Hoses

Pairs of high-pressure hoses each 10m long of required numbers to connect the jacks between the power pack and control console (bound in pairs) with quick connect couplings / screwed couplings, including oil retaining valves to prevent the

leakage of oil when uncoupled and protective caps to prevent soiling shall be provided. The hoses shall be color coded and capable of withstanding a working pressure provided by hydraulic pump. The hoses shall be equipped with non-interchangeable safety couplings.

Tenderer shall be the manufacturer of quick connect coupler. However if tenderer is not the manufacturer of the same, then same shall be procured from a proven source and shall take approval of the same from NMRCL before supply. Tenderer shall provide complete credential of the proven source in their technical proposal along with the address and telephone number of the end user to whom the high pressure hose have been supplied for use in the re-railing equipment.

Tender Tenderer shall provide complete technical details of hoses & safety couplings including the company catalogue in their offer.

9.15.8 Telescopic Jacks

The following telescopic jacks having the following nominal ratings shall be provided. The working pressure shall be 30 MPa or above. 2 nos. of maximum close height including Piston protection plate 250mm, minimum stroke 185mm Capacity: Piston-1: 55 – 65 tons and Piston-2: 25 – 25 tons. Stacking set of 260 mm shall be provided if required to achieve maximum closing height of second jacks. 2 nos. of maximum close height including Piston protection plate 495 mm, minimum stroke 500mm.

Capacity: Piston-1: 55 – 65 **tons** and Piston-2: 25 – 25 **tons**

The jacks with similar overall rating will also be considered. The telescopic jacks shall have hydraulically releasable non-return valves for safe holding of the load even in the event of hose ruptures. Pressure relief valves shall also be provided.

The jacks shall have coupling connector with overload valves to prevent an overpressure on pressure line.

Jacks with integrated Base Plates and separate Base Plate are acceptable.

The maximum stroke including supporting set of the smaller jack types shall be more than the maximum closed height of the taller jack types to make sure that the higher jacks can be used for a continuous lifting operation when the lower jacks have reached their limits.

The telescopic jacks shall have carrying handles, colour coded connections, and the weight shall be less than 40 kg.

9.15.9 Displacement Jacks and Roller Carriages

Pair of displacing jacks shall be provided each with 12/6 tones (pushing force 12 tones and pulling 6 tones) capacity, maximum closed height 580mm, minimum stroke 300mm with steel counter support.

The displacing jacks shall have color coded connections and the weight shall be less than 20 kg. The working pressure shall be 30 MPa or above.

Four roller carriages shall be provided each with 60-ton or above capacity, and removable top plate. The height shall be less than 110mm (without plate) - 140mm (with plate) and the weight less than 60 kg (without plate) and 85 kg (with plate). The width shall be 260mm.

The roller carriages shall have carrying handles, shall be equipped with low friction rollers and guiding pin to ensure a linear movement.

The following accessories shall be provided:

- Four counter supports,
- One stopping device with carrying handle,
- One distance bar having an adjustable length from 1,050mm up to 2,600 mm and weight less than 50 kg.

9.15.10 Re-railing Bridges and Couplers

Re-railing bridge of carrying capacity 60 tones at a free span of 1.5m shall be provided for each of the following sizes.

- 3.30m Long (one no.) or (2.5m + 1.0m)
- 2.20 - 2.5 m Long

The Re-railing bridges shall be manufactured out of high quality light metal alloy in hollow body construction designed to ensure ability to couple one bridge with another. Construction height shall not exceed 180 mm and width shall be between 250 - 350mm.The load capacity of re-railing bridges shall be tested to 25% overload capacity.

The re-railing bridges shall be fitted out with carrying handles and mounting points for bridge couplings.

The maximum weight for the longest bridge shall not be more than 135 kg.
Pair of bridge couplers / one set of connection element shall be provided and coupler shall be designed for joining together two re-railing bridges. The coupler weight of one set of connection element shall be less than 40 kg.

The bidder shall indicate the test facilities available at manufacturer's site / third party test laboratory to carry out the load test conforming the load carrying capacity of re- railing bridges at a free span of 1.5 meters as per details above and tenderer shall submit details in the technical offer as per the Bidder's technical submission Annexure IV-C

9.15.11 Single Piston Step Jack (claw jack)

The Piston Step Jack shall have a capacity of minimum 30 Tones , Minimum working pressure of 35 Mpa , height of 1000 mm to 1150 mm or to approx. 850 mm with claw and stroke of 825 including accessories:

- Integrated high capacity claw
- One round Head Piece for single piston step jack
- Radius plate as swivel base plate for the above claw jack.
- The single piston step jack shall have carrying handles, Colour coded connections and the weight shall be max. 70 kg.

9.15.12 Two Lifting Cable Ladders

The lifting cable ladders shall be provided complete with accessories. The carrying capacity shall be 35-40 tones with a factor of safety not less than 3. The length shall be at least 3m.

9.15.13 Generator

One generator shall be provided along with the equipment. The generator shall be a portable petrol engine driven unit, skid mounted with protective frame.
The output rating shall be not less than 3.2kW, 220V, 50Hz single phase. The unit shall be manually started by means of a retractable toggle starter. A minimum of two panels with three in panel mounted industrial waterproof socket outlets shall be provided. Equipment of lighter weights are preferable.

9.16 Technical alternative : Minor deviation in technical specification is permitted . However,minor deviation shall not affect SOD and performance parameter of machines.

9.17 RAMS (Reliability, Availability, Maintainability & Safety) Requirements:

The Plant is expected to meet the RAMS target of 96% Availability, which will be calculated excluding the downtime planned for Preventive Maintenance Services. Standard Penalty will be applicable as per the Penalty Clause.

Note: The bidder shall submit the complete technical detail of offered M&P for technical evaluation.

Chapter-9

Catenary Maintenance Vehicle (item code- NMRCLMNP008-B)

TECHNICAL SPECIFICATIONS OF OHE CATENARY MAINTENANCE VEHICLE (4 WHEELER) AT NAGPUR METRO

CONTENTS

9.1 GENERAL

The scope of this specification is to reflect the performance and quality requirements for an Over Head Equipment (OHE) Maintenance Vehicle, which will also be used as an emergency and rescue Shunter.

9.2 VEHICLE DESCRIPTION

The vehicle will be a self propelled full rail borne vehicle composed by a steel frame, lying over two axles (4- Wheeler Vehicle)

9.2.1 Vehicle frame

The frame of the vehicle will be composed of standard steel sections and transversal beams. The material will be of standard steel of different qualities, depending on the mechanical requirements over the frame.

The frontal parts of the frame will be designed in order to make the assembly of the coupler easier. They are made to support the efforts indicated in the UIC 577 – OR leaflet.

The vehicle will have a loading platform in the middle part of the vehicle. The height from the platform surface to the running plane will be 1200 mm when the vehicle is unloaded.

Regarding to the surface treatment and painting, the following treatment will be applied to the frame and cabin:

- Sand blasting SA 2.5 according to SIS 055900 standard
- Primer coat of anticorrosion painting based in zinc phosphate,
- Final coat treatment composed by an epoxy coating and a finish coating black RAL 9005.

9.2.2 Vehicle equipment

The vehicle will have a working platform in the middle section. The vehicle will include a hydraulic crane for cargo handling. The vehicle will have a measuring pantograph, and measuring equipments for the overhead equipment and track geometry.

The two axles of the vehicle will be powered with hydrostatic transmission and a main diesel engine.

9.2.3 Vehicle performance

The vehicle main duty will be:

- To transport material and workers from the maintenance sites in the tracks to the workshops and train depots

- To tow up to 3 Metro cars (47 t each) in rescue mode
- To carry track and OHE test equipment for analyzing the Track

and OHE geometry. For the crew and worker transportation, the

vehicle will feature a five people capacity cabin.

9.3 GAUGES AND DIMENSIONS

The profile and cross section of the Maintenance Vehicle will comply with the Nagpur Metro Rail Schedule of Dimensions.
Any equipment, structure or element of the vehicle which could infringe the gauge while extended in running condition will be labeled and painted in a bright colour in order to remind the crew about them after the work is finished.
The only equipment which could infringe the gauge is the crane, the working platform and the stabilizers, so they will be all retracted and stowed when switching from working speed to running speed.
The vehicle will have enough clearance from the rail level to the underside of the vehicle.

9.4 OPERATIONAL REQUIREMENTS

The vehicle will be able to tow up to 3 Metro cars (47 t each) for a total of 141 t, in a gradient of 4% at least at 8 km/h speed.
To perform the towing duty, the vehicle will feature a Rockinger type coupler for towing Metro Cars. For the design and construction of the vehicle UIC and IRS standards will be applied.
Maximum admissible axle load for the vehicle will not be higher than 16 t per axle. The wheel profile will be as per Metro standard wheel profile.

9.4.1 Track requirements

The vehicle will be capable of travelling through the Curves, Cants and Gradients noted in the Nagpur Metro Rail Schedule Of Dimensions.
Minimum radius of horizontal curves

- On main running lines
  - Elevated and At-Grade Sections .....120 m
- Depot and other non-passenger Lines.....100 m
- At passenger platforms..... 1000 m

Minimum radius of vertical curve

- On main running lines..... 1500 m

Cant and Cant Deficiency

- Maximum Cant on curves .....125 mm
- Maximum Cant Deficiency.....100 mm

Gradient

- Maximum Gradient: 4%

9.4.2 Speed requirements

The vehicle will be able to circulate at the following speeds:

- By its own speed in straight track and curves with a very long radius: ..... 50 km/h
- Towing 141 t of Metro cars in 4% gradient: .....8 km/h
- Towing 141 t of Metro cars in level track: ..... 14 km/h
- In a train composition being tow..... ..... 80km/h

The vehicle will be able to circulate in both directions at the same speed.

9.5 DRIVE

9.5.1 Diesel engine

The vehicle will be powered by a diesel engine of adequate capacity to meet the performance and operational requirements detailed in the para 9.4 “Operational requirements”

The proposed power of the engine will be a minimum of 200 kW. This proposed power can vary depending on the current state of the diesel engine technology.

The diesel engine will be from a top brand OEM, with satisfactory service and repair support facilities available in India.

The Diesel Engine will have a fuel tank with enough capacity to provide 8 hours of continuous operation. The engine starter will be electric, powered by batteries.

The Diesel engine will comply at least with the Euro 4 exhaust emissions standard.

The Driver control panel will have enough monitoring gauges for temperature, rpm, oil pressure etc… for controlling the engine performance at any moment.

The engine, as well as the associated elements (compressor, alternator, etc.) will be assembled over its own frame supported by mean of silent blocks by the frame of the vehicle.

The engine will be easily accessible by every side, with doors and cabinets on the vehicle floor in order to help maintenance operations and to help in the removal of dust and grease.

The cooling circuit of the vehicle will be designed with the radiator in horizontal position. The radiator will have the same performance in both directions.

The radiator surface for the engine will be enough to keep the engine running in working order even with 30% of the radiator surface chocked, and in any case, the cooling fluids will exceed 95 º C temperatures.

The radiator fan will be of electric nature, which will be feed by the auxiliary alternator of the engine.

9.5.2 Transmission

The vehicle will have the diesel engine power relayed to the two axles, by means of a hydrostatic transmission.

This hydrostatic drive will be composed of hydraulic pumps, hydraulic motors in each axle, and the software control.

The drive mineral oil will be of HLP grade type satisfying DIN 51 524 standards.

Every hydraulic systems of the vehicle will be protected by mean of security valves from the pressures in the different working conditions.

The oil tank of the vehicle will have a capacity to provide 8 hours of continuous

operation. It will be designed to allow changes in the volume of the oil which could take place in every running condition, permitting the air outlet in every moment. The capacity will be enough for the first filling of the circuit.

The final mechanical connection between the axle set and the hydraulic motor will be made by mean of an axle gear – box with dual speed.

The dual speed selection will allow the vehicle to shift between low speed, high traction force gear for work and shunting duties and a high speed, low fuel consumption gear for transfer duties and faster arrival at the working place.

9.6 **CABIN**

The vehicle will have a single cabin with enough space for carrying 4 passengers + the driver seated on the Driver's seat.

The cabin will comply with UIC 617 – 6, 625 – 6 y 651 OR leaflets.

The cabin will be made of steel profiles, with an interior furnishing of phenolic boards.

Enough windscreens and windows will be provided in order to give the best visibility all around from the cabin, in both directions of driving.

Two separate driving desks can be installed, one on each running direction in order to provide good view in both travelling directions.

The passenger seats will be ergonomic and will be able to fold to save space when not in movement.

The visibility from the driving desk will be according to UIC 625-6 leaflet, and the windshields will have windshield wipers. It will also have rear mirrors in order to control the position of the vehicle.

The cabin will have full acclimatization in order to keep the cabin temperature in working levels thought the whole year.

It will include both A/C and heater.

9.7 BRAKE SYSTEM

The vehicle will be fitted with compressed air brakes commanded from the main cabin through the driver's desk.

The vehicle should be able to drive as a head in a towing composition, and as a wagon in a larger train composition. The brake system will be able to brake the vehicle when it is part of a bigger composition.

The brake system will be capable of braking a full towed composition of 3 Metro Cars with 47 t weight each.

The minimum percentages of braked mass of the automatic brake will be according to UIC 543 specifications. The braking coefficient will be of the 70% in the most unfavorable load conditions.

The parking brake will warranty that the vehicle is stopped on a slope of the 4% with a safety factor of 1.45, without overtake an adherence coefficient rail – wheel of 0.12.

The parking brake will work over the same brake blocks as the service brake by mean of accumulation springs. The service brake will be electro pneumatic, according to UIC 540 to 543 leaflets.

The service brake system will allow the coupling of the vehicle to a train composition, in such a way that the brake can be activated from the cabin, and to act over the own vehicle and the rest of the composition.

The application of the braking effort will be made by mean of braking blocks or brake cylinder with double effect regulator and antagonist spring. They will act directly over the lathes by mean of braking pads according to UIC 541 – 3 y 541 – 4 and 832 standards.
The vehicle will have an emergency brake system installed. These emergency brake buttons will be easily visible and accessible. The emergency brake connects directly the emergency valve to the atmosphere producing an emergency brake.
The whole system will be powered by an onboard air compressor which will comply with prEN 14033 – 1 article 9.4, for a minimum number of 14 axles.
The tank capacity will allow, in every braking condition, three braking / looses at the maximum pressure, with the vehicle isolated, without production of compressed air and with the maximum stroke of the brake blocks.

9.8 DYNAMIC EQUIPMENT

The vehicle will be powered by two axle sets.
The maximum weight per axle will not exceed 16Tonne.
The two axles will be powered, and be capable of moving the vehicle in both directions at full speed. The wheels will be monoblock, and made of forged steel.
The axle grease boxes will be fully sealed, and will have installed long life bearings.
The damping system will be designed following the UIC leaflets, and will be composed of elastic steel coil springs between the frame and the axle boxes.

9.9 ELECTRIC EQUIPMENT

The electric equipment of the vehicle will comply with all the relevant standards and specifications, and will be suitable for the final destination conditions.
The vehicle will be equipped with an electric starter batteries and motor for the diesel engine, capable of starting the engine on its own without any external power.
The internal and external lightning will comply with the line standards, and will be enough to work in night time conditions.
The working platform will have electric sockets on the cradle, and two manual lights mounted in pivoting mounts, one on each opposing corners of the platform.
The circulation lightning will be according to the Metro Line standards.

9.10 MISCELANEOUS EQUIPMENT

The vehicle will come equipped with the following auxiliary equipment

9.10.1 Sand boxes

The vehicle will have sand boxes in both running directions and in every wheel to allow a better traction effort in case of slipping.

9.10.2 Driver Safety Device

The vehicle will feature a double system for the safety of the driver which will accomplishing UIC 641 – O standard.
When activated it will produce an emergency braking (traction cut and maximum service brake).

9.10.3 Acoustic signals (Horn)

The vehicle will have two pneumatic horns, one for each running directions, audible

at a distance of minimum 1000 m, with sound intensity between 120 and 125 dB(A) at 5 meters (according UIC-644 leaflet).

9.10.4 Tool Kit

The vehicle will include a set of general tools to make urgent reparation.

9.11 WORKING PLATFORM

The vehicle will have a working platform for inspection and maintenance works in the overhead equipment. The working platform will be constructed by mean of an insulated platform with insulating elements according to DIN standards for the voltage and intensity required.

The platform will have handrails of 1100 mm height, and dimensions of 2500 x 2500 mm. The design and location of the platform, will allow the work with the handrail erected in small gauge tunnels.

The access to the platform will be an insulated ladder with the insulating characteristics of the platform, 800 mm width. The steps will be anti slipping, with a distance between them of 300 mm and a step of 50 mm. The access to the platform will be safe and comfortable.

The platform will have two movements, elevation and translation. The elevation mechanisms will be hydraulic with a scissors like mechanism powered by cylinders of double effect and piston pump to activate them or hydraulic telescopic type . The translation system will be powered by a hydraulic motor with negative brake that assures the position of the working platform and a mechanical system with coupler that limits its speed.

The platform floor should be capable of elevating to a maximum height of 5500 mm The platform floor when retracted should be at 3000 mm from the rail head.

The platform will be able to laterally traverse 1500 mm to each side of the track axle.

The working platform will have an emergency system for its own movement in case of breakdown, consisting of a manual hydraulic pump located in the lateral part of the vehicle. It will allow moving the working platform in case of a failure of the diesel engine.

9.12 CRANE

The vehicle will have a hydraulic operated crane specific for railway vehicles, with low standstill height

The crane operation should be such that there is no infringement to over head electric equipment during crane maneuvering / extension / shortening and there is no infringement to the Metro Schedule of Dimensions

The crane will have the following performance and equipment:

- Max. Lifting capacity:10.4 t m
- Lifting capacity at 9.7 m reach: 1000 kg
- Hydraulic Reach up to 9.7 m.
- Two extensible hydraulic jacks

- Base of the crane for works with an angle of 10º
- High pressure filter. Oil radiator.
- Working light, installed in articulated arm.
- Spinning and height limiter.
- Emergency stops, piloted valves and torque limiter.
- Limit switches to avoid gauge infringement.

9.13 MEASURING PANTOGRAPH

The vehicle will have a measuring pantograph, insulated, calibrated and with precision potentiometer, IP65 protected, and with digital display in the cabin, to measure the height and stager of the catenary, all catenary parameter at crossover/turnouts locations .
The actuator of the pantograph will be pneumatic, with pressure regulator.
The pantograph will be able to measure both the lateral and the height deviation of the overhead line, which the driver will be able to check thought a TV camera supplied with the system. This camera will be pointed at both the rules, and the video feed will be shown in a colour monitor in the driving cabin.
It will also have a linear inductive detector in the pantograph which will continuously show in the screen the current height of the pantograph in real time, and will be able to either print the height profile in real time or store the measures in a computer memory.
For the lateral deviation, the pantograph will feature a laser sensor which will provide accurate lateral deviation, also shown in real time in the driver desk screen and with the option to either print the lateral deviation profile in real time or store it in a computer memory.

9.14 TRACK MEASURING DEVICE

The vehicle will be equipped with the following track measuring device.
The device is stored into the cargo platform and can be mounted on the track and attached to the vehicle by a single worker.
The maximum towing speed for the measuring device is 15 km/h.

9.14.1 Track geometry measuring device

The measuring device it is made of a steel frame with several steel wheels with railway profile, which will mount all the sensors and batteries needed for operation.

The measuring device will be able to measure the following track geometry parameters:

- Track gauge: Precision 0.1mm / reproducibility at 95%: +-0.45 mm / Range: 25 mm
- Track cant: Precision 0.1mm / reproducibility at 95%: +-0.7 mm / Range: N/A
- Track twist: Precision 0.1mm / reproducibility at 95%: +-0.7 mm / Range: -+13 mm
- Rail top level on both rails: Precision 0.1mm / reproducibility at 95%: +-0.7 mm /

Range: -3 mm

- Versile (alignment) on both rails: Precision 0.1mm / reproducibility at 95%: +-1 mm / Range: +-25 mm All the measuring parameters will have a precision of at least 0.1 mm.

The measuring device will have a numerical display on the own vehicle, with a PC port for exporting data. The device will have an encoder for measuring the track distance travelled by the device.

The device also has an independent PDA device which will guarantee:

- Display of all the measures taken in real time
- Processing of the signals, including wave filtering and signaling when the tolerances are exceeded
- Storage of numerical variables every 0.25 m, with a total memory for 2000 km.

9.14.2 Ultrasonic measuring device

This measuring device is a dual rail inspection system for tracks.

The device features several ultrasonic sensors which are specialized in detecting defects and cracks in both rails of the same track simultaneously.

The main characteristics of the device are as follow:

- Inspection of both rails at the same time and in a single pass.
- Recording of all the parameters and variables, including defect details, main events and the sensibility programmed.
- Positioning of the defects and cracks due to encoders in the main wheels.
- The device allows inspecting tracks of different gauge with a simple manual adjusting, from narrow tracks to wide tracks, and of course standard UIC gauge.
- GSRM module which will allow direct link communications to a PC in a distant office, in real time.
- 3 different ultrasonic visualization modes, with an option for screen shots of the current visualization and storage of critical images into the device internal memory.
- PC port to download all the data to other PCs via direct link.
- Special channel for manual checking of the events in the track.
- It can be towed up to 15 km/h by a vehicle or it can be handled by a single worker on foot.
- The device is electrically isolated on track.

The device works with 9 ultrasonic sensors located on each measuring wheel. That allows the device to measure dynamically 98% of the rail head and 100% of the rail beam.

The sensors are disposed in several angles, in order to extend the coverage of the ultrasonic wave to the maximum available.

- 1 sensor at 0º
- 6 sensors at 70º in two groups of 3
- 2 sensors at 37º

9.15: Technical alternative: Minor deviation in technical specification is permitted . However,minor deviation shall not affect SOD and performance parameter of machines.

9.16 RAMS (Reliability, Availability, Maintainability & Safety) Requirements:

The Plant is expected to meet the RAMS target of 96% Availability, which will be calculated excluding the downtime planned for Preventive Maintenance Services. Standard Penalty will be applicable as per the Penalty Clause.

Note: The bidder shall submit the complete technical detail of offered M&P for technical evaluation.

Chapter-10

Battery Operated Rail Cum Road Shunting Vehicle(Item Code: NMRCLMNP009)

Name of the Equipment: Battery Operated Rail Cum Road Shunting Vehicle

Sample Image

TECHNICAL SPECIFICATION

BATTERY OPERATED RAIL CUM ROAD SHUNTING VEHICLE AT NAGPUR METRO

CONTENTS

Technical Requirements Of Battery Operated Road Cum Rail Shunting Vehicle

SPECIFIC REQUIREMENTS OF BATTERY OPERATED ROAD CUM RAIL SHUNTING VEHICLE.

The Battery Operated Road cum Rail Shunting Vehicle shall be designed for shunting and positioning of 3 car trains and bogies on various depot workshop lines or UFWL.

10.1 Operating Requirements

10.1.1 The Battery Operated Road cum Rail Shunting Vehicle shall be designed to start & haul 140 tons 3 cars train on dry & wet tracks with a maximum track gradient of **2.0%** with curve radius of 100m including turnouts and crossings for Nagpur Metro. The vehicle shall be able to generate continuous draw bar pull of 20KN while pulling the cars at straight level track and 39KN uphill at 2% gradient. The tenderer shall submit the performance curves/ trial result in confirmation of above.

10.1.2 The Battery Operated Road cum Rail Shunting Vehicle shall have maximum height above top of rail with cabin it shall not exceed 2850mm and without the cabin it should not be more than 1450 mm. The shunter cabin should be removable type.Shunter width shall not be more than 2200mm while moving on rail.

10.1.3 The Battery Operated Road cum Rail Shunting Vehicle shall be driven by electric motors and powered by batteries. The control of motors shall be through VVFdrives.

10.1.4 The Battery Operated Road cum Rail Shunting Vehicle shall be of rail cum road type with metal/rubber/vulkolan tyre wheels, preferably with separate individual drive for running on tracks and separate drive for travelling on concrete floor/ road of the workshop/depot but tenderer may also propose any other alternative proven design for movement on track as well as on the road and test report for the satisfaction of the client for similar application in the technical offer.

10.1.5 The Battery Operated Road cum Rail Shunting Vehicle shall have a battery capacity for approx. 40 kms travelling under unloaded condition or at least 9 kms travelling under fully loaded condition on single charging straight and flat track conditions.

10.1.6 The Battery Operated Road cum Rail Shunting Vehicle shall have the following Indications at driver desk.

- A speedometer.
- Emergency switch.
- Indication for parking brake
- Indication for battery condition
- Indication for mode of operation (rail/road & remote /manual)

- Indication for low hydraulic oil.
- Indication for engine over temperature.
- Other standard indications as recommended by the tenderer.

10.1.7 The Battery Operated Road cum Rail Shunting Vehicle shall have provision for synchronisation with under floor wheel lathe .

10.2 Reference Data

10.2.1 The technical particulars of the railcars, bogies, track and road are given below for reference.

10.2.2 Track Gauge: 1435+0/-0 mm for standard gauge.

10.2.3 Track grade: 2.0%max

10.2.4 Minimum curve radius: 100m for standard gauge in depot wheel base shall support the requirement.

10.2.5 Rail inclination is1:20

10.2.6 Passage Over switch: 1:7 turn out with 100 meter radius in Nagpur depot

10.2.7 Railcar length 22.60 m(approx)

10.2.8 Railcarwidth: 2.9 m for standard gauge

10.2.9 Empty each railcar weight 45 tons

10.2.10 Maximum axle load (Fully loaded) permissible on track 16 tons

Note: The values are indicative only. Further details to be obtained from Rolling Stock contractor.

10.3 Battery Operated Road cum Rail Shunting Vehicle Traveling

10.3.1. The travel speed shall be infinitely variable from 0 to 5Km/hr running on roads and on tracks under unloaded conditions.

10.3.2. The travel speed shall be infinitely variable from 0 to 3Km/hr running on maximum of 2.0% gradient tracks towing 3-car (140T) train.

10.3.3. The shunting vehicle shall have high degree of maneuverability by means of hydraulic system both for front & rear wheel steering giving a minimum turning radius of not more than 6500mm.

10.3.4. The shunting vehicle travelling under unloaded condition on the ground shall be capable of climbing 10 % gradient over a length up to 20 metres.

10.3.5. Braking shall be hydraulically/electrically(with regenerative feature) actuated and controlled by a foot pedal in road mode and in Track mode.Electrical braking system will be acceptable.

10.3.6. Braking distances shall not exceed 2.5 meters on dry level track with

3 coupled railcars towing after the application of brake from a speed of 3 km/h.

10.3.7. The shunting vehicle shall be able to transfer among tracks and workshop floor by built-in in-railing mechanism. The in-railing procedure shall allow the driver to operate and monitor the in-railing process from driver seats on the paved tracks.

10.3.8. The vehicle shall have the provision of automatic flash light arrangement as indication for its every change of direction.

10.3.9. The machine shall have sufficient brake accumulator capacity or similar arrangement for additional braking support to avoid damages in case of failure of designated brake system while it moving with load.

10.4 Coupling

10.4.1 A suitable coupler shall be provided at both end of the shunting vehicle for coupling the railcars. A suitable to match Rolling stock couplers shall be provided on each side of the Battery Operated Road cum Rail Shunting Vehicle for coupling metro cars from both ends.

10.4.2 The coupler shall be designed for pulling, pushing rated loads.

10.4.3 Automatic Couplers height shall be adjustable by hydraulic mechanism, manually on both side (front and rear), after the shunter has stopped. It shall be possible to position the coupler head at the same height as that of car.

10.5 Shunting Vehicle Construction

10.5.1. The shunting vehicle shall be designed as compact as possible, especially in length, in order to facilitate travel on the ground.

10.5.2. The rail wheel size shall be such that operation of shunting vehicle under all conditions shall not result in any rail damage, corrugation, plastic deformation or any such effect.

10.5.3. The roof-mounted cabin shall have all around visibility made from 2-3 mm thick stainless steel. Cabin shall have sufficient inside height with suitable illumination. It shall have at least 2 lockable doors, safety glass and screen wipers. The cab itself shall have several grips for the operator to hold on.

10.5.4. Driver seats shall be provided on the Battery Operated Road cum Rail Shunting Vehicle. Driver seat with proven design facing forward,having 360 degree visibility and maneuverability will be acceptable..The driver seat shall be cushioned, preferably adjustable and with backrest angle adjustable.

10.5.5. The driver's desk design shall be such as to facilitate easy access from both sides of the Shunter.

10.5.6. The control shall be ergonomically designed and allow operation of the tractor in both direction of travel without need to twist or turn.

10.5.7 Headlights shall be provided on both the sides.

10.5.8. **Parking brake: electromechanical brake, applied automatically in case of power failure and standstill.**

10.5.9. Horn sound 70 dB or more shall be provided.

10.5.10. Emergency Stop push button shall be provided in all four corners of the vehicle.

10.5.11. Contractor shall provide the details of wheel profile to re-profile the wheel during design stage, in case of steel rail wheels.

10.5.12. Support areas for lifting the Battery Operated Road cum Rail Shunting Vehicle using screw jack shall be provided on both front & rear ends, near wheels.

10.5.13. The proposed rail wheels life of the Battery Operated Road cum Rail Shunting Vehicle shall not be less than 20 years. In case of rubber tyre wheels, contractor will be able to supply required number of rubber tyres for service life of 10 years upon request of NMRCL during these 10 years.

10.5.14. Special attention shall be drawn to the following points for the design and manufacture of the tractors:

- Operational safety,
- General ruggedness,
- accessibility to control of traction devices,
- 4 hoisting points/support areas on four corners for easy lifting of Shunter using E.O.T. crane / screw jacks,

10.6. Control Requirements

10.6.1. A control panel, all control gears and monitoring measures shall be provided at the driver seat for full operation of the Shunter.

10.6.2. A portable radio control unit shall be provided for operating the Battery Operated Road cum Rail Shunting Vehicle to tow and position the railcars in different lines of depots. The remote control shall be operable from a minimum distance of 200-250m.

10.6.3. The tractor shall be provided with remote control for remote operation of Shunter up to 3km/hr running on tracks.

10.6.4. Coupler height shall be adjustable by hydraulic mechanism standard manually at both side (front and rear), by remote optionally

10.6.5. The controls from the driver seat, portable radio control unit shall be interlocked to prohibit simultaneous operation commanded from more than one operator. Push buttons / switches used should be IP 55protection.

10.6.6. The vehicle / Shunter shall have the facility to monitor the rail position with the help of suitable display, while the vehicle moves on the rail without leaving driver seat.

10.6.7. The Battery Operated Road cum Rail Shunting Vehicle shall preferably have provision for regenerative braking system in the braking mode of the vehicle. The Battery Operated Road cum Rail Shunting Vehicle shall have the slip/ slide control to avoid the damage of wheels in case of low adhesion condition while moving on rails.

10.7. Battery and Battery Charger

10.7.1

An on-board charging station for battery recharging shall be provided on the tractor. Charger shall be compatible with the input supply voltage 360 to 440V, TPN (5 pin 3 P+N+E), 47.5 to 51.5 Hz. The contractor shall provide necessary cabling and connections to a power supply isolator provided by designated contractor in the depot. Recharging period of a fully discharged battery shall be less than 10 hours.

10.7.2

The vehicle shall be equipped with centralized water topping up facility.

10.7.3

Battery shall have sufficient capacity for travelling at least 40 Kms. under no-load condition or for travelling at least 9 Km under fully-loaded condition on single charging basis straight and flat track conditions. Battery shall have the life time up to 1500 charging cycles and shall be commercially available in India.

Details of the battery capacity, voltage, type etc shall be submitted in the offer.

10.7.4

The followings protection shall be included in the working of Battery Operated Road cum Rail Shunting Vehicle mentioned below:-

- Alarm/ indication for low battery voltage.
- Protection against low oil level in hydraulic system.
- Protection against over current of drive motor.
- Provision of auto parking brake.
- Provision of dead man switch.

- No traction with parking brakes on.

10.8 Earthing

Battery Operated Road cum Rail Shunting Vehicle body shall be electrically bonded to rail potential.

10.9: Technical alternative: Minor deviation in technical specification is permitted . However,minor deviation shall not affect SOD and performance parameter of machines.

10.10. RAMS (Reliability, Availability, Maintainability & Safety) Requirements:

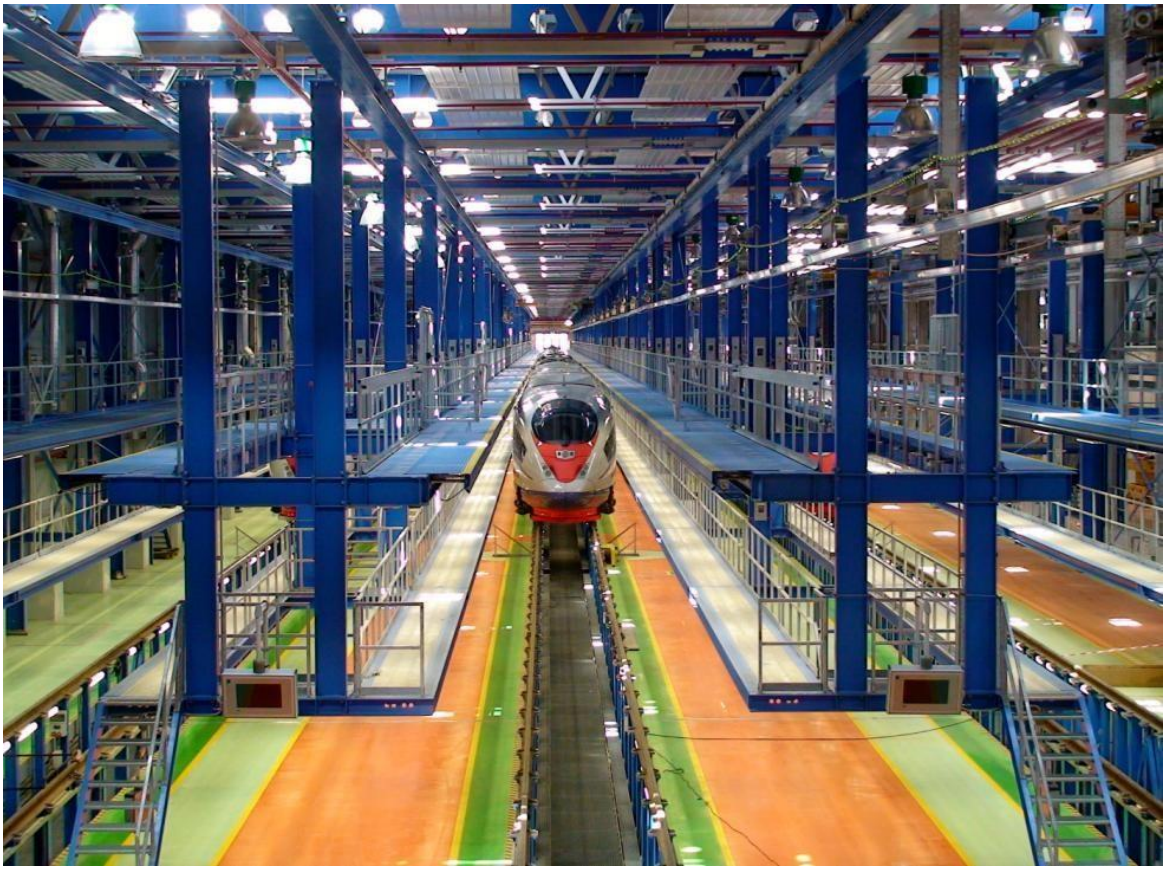
The Plant is expected to meet the RAMS target of 96% Availability, which will be calculated excluding the downtime planned for Preventive Maintenance Services. Standard Penalty will be applicable as per the Penalty Clause.

Note: The bidder shall submit the complete technical detail of offered M&P for technical evaluation.

Chapter-11

MULTI PURPOSE WORKING STAND (Item Code: NMRCLMNP010)

Equipment Name: MULTI PURPOSE WORKING STAND



Sample Image

Technical SPECIFICATIONS OF MULTI PURPOSE WORKING STAND AT NAGPUR METRO

CONTENTS:

GENERAL

The Multi Purpose Working Stand (MPWS) should be designed to enable maintenance operations on the roof, on the sides and on Under Floor components of rail cars. It consists of

- Roof Working Platform (RWP) with Train Driver Catwalk (TDC)
- Elevated Track

11. TECHNICAL DATA

11.1 Roof Working Platform (RWP) with train Driver Catwalk (TDC)

Length of RWP/TDC	Approx. 70 m
Width of platform	Approx. 1000 mm
Telescoping way of RWP platforms	Approx. 450 mm
Length of RWP/TDC-elements	5000 mm
Load capacity RAP/TDC	250 kg /m²
Operating voltage	400 V / 50 Hz
Control voltage	230 V / 24 V DC
Protection	IP 54
Working height of RWP	3605 mm T.O.R.
Working height of TDC	Approx. 1200 mm T.O.R.
Clearance between RWP/TDC	Train envelope
Load capacity stairways	2 persons a 85 kg plus 100 kg tools/spares

11.1.1 Overhead Catenary System

-Length of OCS 70 m

-Voltage 25 KV

- Foldable

- Include control system

DESCRIPTION OF COMPONENTS

11.2 Roof Working Platform (RWP) with train Driver Catwalk

11.2.1 Supporting Structure

The RWP/TDC is supported by welded steel construction hinged from the existing supporting structure of the building via head plates bolted to the structure beams. Holes into structure beams of building will be made during installation.

11.2.2 Platform Structure

Platform Structure developed hot dipped zinc coated corrugated steel profiles form the supporting structure of the RWP.
The profiles are bolted together with form pieces to grant easy fabrication and to ensure light design without any reduction in load capacity and deflection.
The steel structure as well as the telescopic part of the platform, movable towards the train, is covered by aluminium bulb plates.

11.2.3 Slide Railing

On each RWP, side rails are installed in the longitudinal direction (track direction) for the safety of the working personnel according to the presently valid European Regulations.

11.2.4 Movable Fall Down Protection at front and rear of RAP

The Fall Down Protection at the front and rear of the RWP is movable in longitudinal direction, suitable for each train set configuration and is swivelling to close the front and rear area between the two RWP sides (left and right).

11.2.5 Drive Unit

The Drive unit of each telescopic RWP-platform consists of a gear brake motor with drive shaft, pinion and toothed rack. The ends of the drive shaft are additionally supported by bearings.

11.2.6 Stair Cases

The RWP is reachable via a staircase placed directly at the side of the columns of the building structure .The direct place along the track has to be defined in cooperation with end-user

11.2.7 Crane

A crane with a capacity of two (2) metric tons including crane runway will be provided. The crane can be driven out on either end of the Multi Purpose Working Stand.

ELECTRIC COMPONENTS

11. 3 Description of Electrical Control System

Control system of the RWP will be activated by a key switch. The RWP system will be interlocked with the existing security system of the workshop including interlock to existing Overhead Catenary System (OCS). The telescopic platforms elements move out and in simultaneously. The end positions of the telescopic platforms are controlled by limit switches and interlocked with the access entrance doors. The telescopic platforms stop when a connecting block is activated or the telescopic platforms reach the limit switch.

Telescopic platforms touching the train will retract slightly for protection of the connecting blocks. The telescopic platforms (RWP) retract simultaneously and stop when the limit switch “fully retracted” is activated.

The door at the access side of the RWP will be released only if all telescopic elements are in contact with the train or if the limit switches “forward” are activated. The OCS can only be switched “ON” with all telescopic elements fully retracted, Movable Fall Down Protection at front and rear of the RAP in home position, door closed and the key switch in “off” position

11.4 Description of Key Exchange System

Interlocking with the workshop security system will be achieved by a Key Exchange System. Only when the OCS is switched off, the grounding key can be removed from the related control cabinet of the OCS. This key is the plugged into the key exchange system at the control cabinet of the RWP. The RWP can only be operated when the grounding key is plugged in and turned.

As soon as the drawers leave the “retracted” position the grounding key will be locked in the key exchange system.

When all drawers are fully extended or touching the rail car vehicle envelope, the cover of the employee keys will be unlocked and the employee keys released. Each

employee can now remove an employee key and enter the platform.

Only when all employee keys are returned and the cover is closed, the drawers of RWP can be returned to the "retracted" position. As soon as the drawers leave the working position of RWP, the cover of the employee keys will be locked.

When the drawers are in the "retracted" position, the grounding key of the OCS is released and can be returned to the control cabinet of OCS.The retractable OCS will be provided by other contractor.

11.5 Electrical Device

- Gear motor for telescopic platforms (RWP)
- Limit switches "backward" (RWP)
- Limit switches "forward"
- Connecting block
- Limit switch for fall protection in parking position
- Limit switches for the doors
- Master Control Cabinet (MCC)

11.6 REGULATION

The Multi Purpose Working Stand (MPWS) is designed in compliance with the presently valid European regulations for prevention of accidents.

11.7: Technical alternative: Minor deviation in technical specification is permitted . However,minor deviation shall not affect SOD and performance parameter of machines.

11.8 RAMS (Reliability, Availability, Maintainability & Safety) Requirements:

The Plant is expected to meet the RAMS target of 96% Availability, which will be calculated excluding the downtime planned for Preventive Maintenance Services. Standard Penalty will be applicable as per the Penalty Clause.

Note: The bidder shall submit the complete technical detail of offered M&P for technical evaluation.

NAGPUR METRO RAIL PROJECT

PART 2: WORKS REQUIREMENTS
SECTION VII-C: Reference Documents / Drawings (SOD, GAD etc.)

June 2016

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NAGPUR METRO RAIL CORPORATION LIMITED

(A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF MAHARASHTRA)

SCHEDULE

OF

DIMENSIONS

FOR

STANDARD GAUGE
(1435 Mm)
(25 KV AC OHE TRACTION)

NOVEMBER 2015

NAGPUR METRO RAIL CORPORATION LIMITED
28/2, Anand Nagar, C.K Naidu Road, Civil Lines
Nagpur -440001
INDIA

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SCHEDULE OF DIMENSIONS

STANDARD GAUGE (1435 mm)

PREAMBLE

Nagpur Metro rail has adopted Standard Gauge with 25 kV AC OHE Traction System. The Schedule of Dimensions has been prepared based on following factors: -

1. The Kinematic Envelope and other infringements have been calculated for the 2900 mm wide and 4200 mm high Rolling Stock, based on the Kinematic Envelope calculations. The track and vehicle maintenance shall conform to the clearances indicated therein during the period that these Rolling Stocks are in operation.

2. Track shall be maintained to the tolerances taken for calculation of Kinematic Envelope.

3. The clearances are based on assumption that windows are sealed and doors are closed during movement / operation.

4. The Structure Gauge indicated in the SoD shall not be violated under any circumstances except for platform coping.

5. The Kinematic Envelope(s) indicated in the SoD shall not be violated under any circumstances.

6. The Vehicle Kinematic Envelope for 40 kmph shall be applied only within the confines of stations. At all other locations, the Kinematic Envelope corresponding to 90 kmph vehicle speed with 100 kmph side wind speed shall be used for determining the Structure Gauge and Electrical clearances. The maximum speed for passenger operation shall be 80 kmph.

7. Maximum operating speed at platform shall be 40 kmph and Kinematic Envelope will not be infringed under any circumstances.

8. This SoD is applicable for Ballastless track on mainline and ballasted/ballastless track in Depots.

9. For evacuation of passengers, in case of emergency, including in cases of derailment of the end coaches, emergency doors provided at both ends (front & rear) of the train shall be used for evacuation. The emergency doors will open and rest between or onto the track plinth and the space available between the track plinths shall be used as walkway. The evacuation will be done under the supervision of train operator and/or station staff.

INTRODUCTION

The dimensions given in this Schedule of Dimensions are to be observed in all works on 1435 mm gauge (STANDARD GAUGE), unless prior sanction has been obtained from the Railway Board through the Commissioner of Metro Railway Safety to execute works, which infringe this Schedule of Dimensions.

This Schedule of Dimensions is applicable to Elevated and At-Grade sections of Nagpur Metro Rail, which shall be with 25 kV AC Traction system and Over Head current collection. The Rolling Stock shall be 2900 mm wide and 4200 mm high (maximum with pantograph in locked down condition or without pantograph) with sealed windows and doors closed while in motion.

Elevated Systems shall be on Viaduct. Elevated section shall have suitably designed Ballastless (DFF) Track. At-Grade system and the Depot area may have either Ballasted Track or Ballastless Track.

The Schedule of Dimensions (SoD) has been divided into five chapters as under

Chapter-I	----------	General
Chapter-II	----------	Stations
Chapter-III	----------	Rolling Stock
Chapter-IV	----------	Electric Traction
Chapter-V	----------	Platform Screen Door

CHAPTER-I

GENERAL

1.1 SPACING OF TRACKS

1.1.1 Minimum distance, centre to centre of tracks without any structure between tracks for tangent (straight) track:

a) Elevated Sections 3650 mm

b) At-Grade sections 3650 mm

Note: See Para-1.8 and Appendix-1 for minimum track centers on curves.

1.2 CURVES

1.2.1 Minimum radius of curves (horizontal)

i) On main running lines

Elevated and At-Grade Sections 120 m

ii) Depot and other non-passenger Lines 100 m

iii) At passenger platforms 1000 m

1.2.2 **Check Rail / Restraining Rail**

Check Rail / Restraining Rail shall be provided on curves on main line with a radius of 190 m or less. Check rail/Restraining rail shall not be mandatory for curves in depots, yards and non-passenger lines like pocket track, depot entry lines, etc., where speed is less than 25 kmph. The clearance between check rail/restraining rail and running rail shall be suitably decided by metro.

1.2. Minimum radius of vertical curve 1500 m

3

1.2.4 Cant and Cant Deficiency

a) Maximum Cant on curves 125 mm

b) Maximum Cant Deficiency 100 mm

1.3 GRADIENTS

1.3.1 The maximum grade (compensated) shall be 4%.

Note:

(i) There will be no change of gradient in transition portion of curves.

(ii) The gradient will be compensated for curvature at the rate of 0.04% per degree of curve.

1.3.2 Maximum permissible gradient on turnouts

(i)	On Ballasted Track	0.25%
(ii)	On Blallastless Track	2.5%

Note:

(i) There shall be no change of grade on and within 15 m of any turnout on ballastless track. Similarly, there shall be no change of grade on and within 30 m of any turnout on ballasted track.

(ii) In case of turnouts on gradient, there shall be no horizontal curve on and within 15 m of any turnout on ballastless track and 30 m of any turnout on ballasted track.

1.4 BUILDINGS AND STRUCTURES

1.4.1 Minimum horizontal distance from centre of track to any structure (except at passenger platform) for heights above rail level on level/constant grade tangent track shall be as under: -

Elevated and At-Grade Sections

Height from rail level	Horizontal distance from C.L. of track
i. Up to 65 mm	1465 mm
ii. 65 mm to 200 mm	1465 mm increasing to 1640 mm
iii. 200 mm to 305 mm	1640 mm
iv. 305 mm to 930 mm	1640 mm increasing to 1735 mm
v. 930 mm to 1095 mm	1735 mm increasing to1740 mm
vi. 1095 mm to 3310 mm	1740 mm increasing to 1825 mm
vii. 3310 mm to 3860 mm	1825 mm decreasing to 1495 mm
viii. 3860 mm to 6200 mm	1495 mm

Also refer to Figure No. NMSG-2

Note:

i) Extra allowance shall be provided for curves as laid down at Para-1.7.

ii) The term „structure" covers any item including light ones like ladders, isolated posts, cables etc. erected alongside the track except for passenger platform.

iii) Minimum lateral clearance for OHE masts for tangent track on the viaduct shall be 2150 mm from centre line of nearest track. iv) Minimum lateral clearance for OHE masts for tangent track at-grade and depot shall be 1950 mm from centre line of nearest track.

iv) For passenger platform, refer to Para-2.2.1 to 2.2.3 of Chapter-II.

1.5 KINEMATIC ENVELOPE

For the Kinematic Envelope for level or constant grade tangent track, refer to:

a) Figure No. NMSG-1 for At-Grade and Elevated Sections.

b) Figure No. NMSG-1A for At-Grade and Elevated sections at passenger platform.

Note:

Extra Allowance shall be provided for curves as laid down at Para-1.7

1.6 STRUCTURE GAUGE

Elevated and At-Grade Sections

The Structure Gauge (Fixed Structure Line) has been arrived at by allowing minimum clearance of 150 mm to Kinematic Envelope and minimum electrical clearance of 270 mm from 25 kV live parts conforming to the stipulations in chapter-IV of this SoD.

Refer to Figure No. NMSG-2 for Structure Gauge for outside stations on level or constant grade tangent track.

Note:

Extra allowance shall be provided for curves as laid down at Para-1.7

1.7 EXTRA CLEARANCES ON CURVES

Following are the extra allowances considered for curves.

Abbreviations used in Para-1.7:

C is the distance between centres of bogies in metres,
C_1 is the coach (vehicle) length in metres,
R is the radius of curve in metres, **Ca** is the Cant applied in mm, **h** is the height from rail level in mm and **g** is the distance between centres of rails in mm

1.7.1 INSIDE OF CURVE

A. Curvature effect

i) Mid throw at the center of the vehicle = V (in mm) =$125xC^2/R$ ii) Allowance due to gauge widening on curves

For values of items (i) and (ii) above, refer to Appendix-2

Note:

Lateral shift of 26 mm due to nosing is included in Kinematic Envelope for tangent track (and as a result, included in Structure Gauge also) shall be subtracted from the total extra allowance worked out as at Para-1.7.1(A)-i &ii

above for inside of a curve in case the value of mid throw (V) is equal to or greater than 26 mm. In case the value of mid throw (V) is less than 26 mm, the curvature effect shall be due to widening of the gauge only. (The Mid throw minus 26 mm shall be taken as zero).

B. Clearance for Cant

Elevated and At-Grade Sections

The lean „L" due to Cant at any point at height „h" above rail level is given by:

$$L = Ca \times h/g \text{ (all in mm)}$$

For values of Structure Gauge (E_1) for inside of a curve with cant effect only, (as shown in Figure No. NMSG-3A), refer to Appendix-3A for At-Grade and Elevated Sections.

C. Clearance for vertical curve (vertical throw)

Vertical Throw V_1 and V_2 (in mm) for vertical curve shall be calculated as under:

V_1 (with vehicle centre in sag or vehicle end on summit)

$$= 125xC^2/R$$

V_2 (with vehicle centre on summit or vehicle end in sag)

$$= (125xC_1^2 /R)-(125xC^2 /R)$$

For values of vertical throw V_1 & V_2 due to vertical curves of different radii, refer to NMSG-4.

1.7.2 OUTSIDE OF CURVE A.

Curvature effect

i) End throw at the end of vehicle = Vo (in mm)

$$= [125xC_1^2 /R]-[125xC^2 /R]$$

ii) Allowance due to gauge widening on curves iii)

Additional nosing due to gauge widening on curves

The values of items (i) to (iii) are shown in Appendix-2

B. Clearance for Cant

Elevated, and At-Grade sections

The lean „L" due to Cant at any point at height „h" above rail level is given by:

$$L = (-) Ca \times h/g \text{ (all in mm)}$$

-ve sign indicates relief due to cant or reduction in clearance required.

Note:

Full relief for lean due to cant (Ca) is to be taken into account only for calculation of track spacing without any structure between tracks. In case there is a structure adjacent to track, relief for lean is to be taken into account only if the cant provided is greater than 50 mm and shall be limited to a value = (Ca - 50) x h/g.

For values of Structure Gauge (F_1) on outside of curve with Cant effect only (as shown in Figure No. NMSG-3A), refer to Appendix-3A for Elevated and At-Grade Sections.

C. Clearance for vertical curve (Vertical throw)

The provisions at Para-1.7.1 (C) above shall be applicable in this case also.

For values of vertical throws V_1 & V_2 due to vertical curves of different radii, refer to NMSG-4.

1.8 MINIMUM TRACK SPACING ON CURVES

Elevated and At-Grade Sections

The worst case will be when the end of a bogie carriage on the inner track is opposite the centre of a similar carriage on the outer track.

1.8.1 Without any structure between tracks

The minimum track spacing on curves without any structure between tracks shall be the sum of the following:

i) (**E** + **F**),
ii) **T_1** (Extra lateral allowance due to curvature on inside of curve
iii) **T_2** (Extra lateral allowance due to curvature on outside of
iv) curve Minimum clearance between adjacent Kinematic Envelopes stipulated is as under:-
300 mm for Elevated and At-Grade Sections.

Where,

„**E**" is the distance from vertical axis of centre line of canted track to canted Kinematic Envelope on inside of curve at a height „h" (from rail level) for a given cant (Figure No. NMSG-3) and

„**F**" is the distance from vertical axis of centre line of canted track to canted Kinematic Envelope on outside of curve at a height „h" (from rail level) for a given cant (Figure No. NMSG-3).

Notes:

i) The value of „**F**", calculated from the formula at Figure No. NMSG-3 includes full relief due to Cant.

ii) The sum of '**E**' and '**F**' for same height (which are with Cant effect only) shall be the maximum of values calculated for various heights from rail level.

For values of **E**, **F**, $\mathbf{T_1}$ and $\mathbf{T_2}$, refer to the Appendices as shown below:

SECTIONS	**For E & F**	**For T_1 &T_2**
Elevated and At-Grade	1. 3 for 90 kmph KE 2. 3i for 40 kmph KE	2

1.8.2 With a structure between adjacent tracks

The minimum track spacing on curves with a structure between tracks shall be the sum of the following:

i) ($\mathbf{E_1}$ +$\mathbf{T_1}$) Minimum clearance to the structure from centre line of track on inside of curve (for outer track)

ii) ($\mathbf{F_1}$ +$\mathbf{T_2}$) Minimum clearance to the structure from centre line of track on outside of curve (for inner track)

iii) Width of structure between adjacent tracks (measured across the tracks).

Where,

$\mathbf{E_1}$ is the horizontal distance from vertical axis of centre line of track to canted Structure Gauge on inside of curve for a given cant, (Ref Fig no: NMSG-3A)

$\mathbf{F_1}$ is the horizontal distance from vertical axis of centre line of track to canted Structure Gauge on outside of curve for a given cant, (Ref Fig no: NMSG-3A)

$\mathbf{T_1}$ is extra lateral allowance due to curvature on inside of curve and

$\mathbf{T_2}$ is extra lateral allowance due to curvature on outside of curve.

Notes:

(i) The values of „$\mathbf{E_1}$**'** and „$\mathbf{F_1}$**'** for a given cant Ca, shall each be the maximum of values at different heights of structure from rail level. In case the cant provided is greater than 50 mm on inner track**,** the value of $\mathbf{F_1}$ shall be for the cant of (Ca-50) mm**.** In case the cant provided is 50 mm or less on inner track, the value of F_1 shall be for ZERO cant.

(ii) Minimum track spacing, so worked out with a structure between the adjacent tracks shall not be less than that calculated as per Para 1.8.1 for tracks without any structure between adjacent tracks.

For values of **E_1**, **F_1**, **T_1** and **T_2**, refer to the Appendices as shown below:

SECTIONS	**For E_1 & F1**	**For T_1 &T_2**
Elevated and At-Grade	1. 3A for Structure Gauge corresponding to 90 kmph KE. 2. 3Ai for Structure Gauge corresponding to 40 kmph KE.	2

1.9 DERAILMENT GUARD

(a) Derailment Guard shall be provided on inside/outside of running rail on viaduct and At-Grade section at locations specified by Metro Railway.

(b) Lateral Clearance between the running rail and the derailment guard shall be 250 ± 40 mm. It shall not be lower than 25 mm below the top of running rail and shall be clear of the rail fastenings to permit installation, replacement and maintenance.

1.10 SPECIAL OPERATING CONDITIONS: (COMMON FOR ELEVATED AND AT-GRADE SECTIONS)

1.10.1 Scheduled maintenance of permanent way will be performed outside service hours only.

1.10.2 All the passenger coaches will be provided with sealed windows including the cab, to prevent limbs and heads of passengers projecting outside the train. The passenger coaches will be provided with automatic remote controlled double leaf doors with their control from drivers cab. Until all doors are proved closed, it should not be possible to start the train. Likewise until the train has come to the stop, it should not be possible to energize the door opening circuits.

1.10.3 Since minimum clearance with fully worn wheel and under fully loaded condition from rail level for bogie mounted equipment is 75 mm, the coaches with the clearance less than 75 mm will not run on Metro Railway network.

1.10.4 The way side signaling, wherever provided, in addition to ATP, on temporary or permanent basis, will be so located that proper visibility to the driver is ensured. No workmen / Equipment are allowed between vehicle and structure gauge during operation of trains.

1.10.5 The corridor when fully functional will not have way side signaling as train protection will be by ATP. However in the initial period, till cab signaling system is fully commissioned, there will be way-side signaling which should be so located near the masts so that the proper visibility to the driver is ensured considering the alignment.

1.10.6 The evacuation of passengers in case of emergency in mid-section shall be done from front & rear emergency doors of the train. Space available between the track plinths shall be used as the walkway. The evacuation will be done under the supervision of train operator and/or station staff.

1.11 Additional Operating Condition for Elevated and At-Grade Sections.

1.11.1 In case of At-Grade sections, the track may be passing through populated areas and there are chances of trespass. Considering this fact, to prevent the people‟s and animals‟ access to the track, the sections will be robustly fenced.

1.11.2 The speed of trains shall be restricted to 30 kmph on platform when wind speed is more than 70 kmph but less than 100 kmph. When wind speed exceeds 100 kmph, the train movement shall be halted, preferably at platforms. Stationary trains shall not be started till wind speed reduces below 100 kmph.

1.11.3 As the track will be open to the climate, temperature variation will take place in the track, frequent cab inspection will be done during extreme winter and summer.

CHAPTER - II

STATIONS

2.1 SPACING OF TRACKS AT STATIONS

Minimum spacing of tracks at station on straight and on curve of radius of 1000 m and flatter, without any structure between tracks

Elevated & At-Grade stations 3650 mm

2.2 PLATFORMS

2.2.1 Maximum horizontal distance from centre of track to face of passenger platform coping

(i) For Elevated/At-Grade section 1525 mm

2.2.2 Minimum horizontal distance from centre of track to face of passenger platform coping

(i) For Elevated/At-Grade section 1520 mm

Notes:

a) Platform faces shall be flared away smoothly from the centre line of the track at either end for a distance of 1500 mm beyond passenger area so as to give from centre of track a dimension:

- 1590 ± 5 for At grade and Elevated Stations

b) For additional clearance for platforms on curves, refer to Para-2.7

c) The track access gates at the end of platform up to a height of one meter from top of platform shall not infringe the Kinematic Envelope.

2.2.3 Height above rail level for passenger platform:

	Maximum	Minimum
(a) Ballasted Track	1085 mm	1075 mm
(b) Ballastless Track (DFF)	1095 mm	1085 mm

2.2.4 (i) Minimum horizontal distance of any isolated structure on passenger platform from the edge of coping. 2500 mm a

ii) Minimum horizontal distance of any continuous structure on passenger platform from the edge of coping. 3000 mm a

Notes:

a) The structure on the platform is treated as isolated if the length along the platform length is 2000 mm or less. Any structure having a length exceeding 2000 mm is treated as continuous structure. The clocks/mirrors/CCTV screens etc shall not be considered structures and shall be located at a minimum horizontal distance of 1000 mm from platform edge/coping with minimum height of 2000 mm from top of platform.

b) There shall be no cant in passenger platform lines

2.2.5 For Structure Gauge at stations at Elevated Stations and At-Grade, refer to figure no NMSG-5 & NMSG-6.

2.3 GRADIENTS

2.3.1 Track gradient in Stations Gradient of track in station platform length shall be as under:

(a) Maximum gradient 1 in 400

(b) Desirable Level

Note: i) There shall be no change of grade/vertical curve within station platform track.

ii) There shall be no change of gradient within 30 m of any points or crossings on Ballasted track. In the case of Ballastless track, there shall be no change of grade/ vertical curve on the turnout.

2.4 INTERLOCKING AND SIGNAL GEAR

Maximum height above rail level of any part of interlocking or signal gear on either side of centre of track subject to the restrictions embodied in Note below shall be as under:

At-Grade and Elevated Stations

- From C.L. of track to 1330 mm — 25 mm
- From 1330 mm to 1465 mm — 25 mm increasing to 65 mm
- From 1465 mm to 1640 mm — 65 mm increasing to 200 mm

Note:

Except for check rails on curves, ordinary and diamond crossings or wing rails and point rails of crossings leading to snag dead ends, or such parts of signalling gear as are required to be actuated by the wheels, no gear or track fittings shall project above rail level for a distance of 229 mm outside and 140 mm inside the gauge face of the rails.

2.5 POINTS & CROSSINGS

2.5.1 Maximum clearance of check rail opposite nose of crossing 44 mm

2.5.2 Minimum clearance of check rail opposite nose of crossing 41 mm

2.5.3 Minimum clearance between switch rail and stock rail at heel 52 mm of switch

2.5.4 Maximum clearance of wing rail at nose of crossing 44 mm

2.5.5 Minimum clearance of wing rail at nose of crossing. 41 mm

2.5.6 Minimum clearance between toe of open switch and stock rail. 160 mm

2.5.7 Minimum radius of curvature for slip points, turnouts and 140 m crossovers.

2.5.8 On main lines, the turnouts and diamond Crossings shall be of the following types

a) 1 in 9 type turnout 190 m radius

b) 1 in 7 type turnout 190 m radius (Desirable)

140 m radius (Exceptional circumstances)

c) Scissors cross-over of 1 in 9 type consisting of 4 acute turnouts of 1 in 9 and 1 diamond crossing.

d) Scissors cross-over of 1 in 7 type consisting of 4 acute turnouts of 1 in 7 and 1 diamond crossing.

2.5.9 On depot lines, non-passenger lines like pocket track, depot entry lines etc, the turnouts and diamond Crossings shall be of the following types:

a) 1 in 7 type turnout 140 m radius

b) Scissors cross-over of 1 in 7 type consisting of 4 acute turnouts of 1 in 7 and 1 diamond crossing.

c) 1 in 7 derailing switches/ 1 in 7 type symmetrical split turnout.

2.5.10 Diamond crossings not to be flatter than 1 in 6.

Note:

a) The above restrictions shall not apply to moveable diamond crossings.

b) Switches and crossings shall not be located on transition curves & vertical curves.

b) There must be no change of super elevation (of outer over inner rail) between points 18 m outside toe of switch rail and nose of crossings respectively, except in the case of special crossing leading to snag dead- ends or under circumstances as provided for in item 2.6 below.

2.5.11 inimum length of tongue rail 9000 mm

2.5.12 inimum track spacing for 1 in 7 scissors crossover 4500 mm

2.5.13 inimum track spacing for 1 in 9 scissors crossover 4500 mm

2.6 SUPER-ELEVATIONS AND SPEED AT STATIONS ON CURVES WITH TURNOUTS OF CONTRARY AND SIMILAR FLEXURE.

2.6.1 Main Line:

Subject to the permissible run through speed based on the standard of interlocking, the equilibrium super-elevation, calculated for the speed of the fastest train may be reduced by a maximum amount of 100 mm without reducing speed on the main line.

2.6.2 Turnouts:

i) Curves of contrary flexure

The equilibrium super-elevation (**s**) in mm should be = $(1510/127)*(V^2 / R)$

Where,

R = Radius of turnout in meters and V is speed on turnout in Kmph.

The permissible negative super-elevation on the turnout (which is also the actual super-elevation of the main line) may then be = (100 – **s**) mm.

ii) Curves of similar flexure

The question of reduction or otherwise of super-elevation on the main line must necessarily be determined by the administration concerned. In the case of a reverse curve close behind the crossing of a turnout, the super-elevation may be run out at the maximum of 1 mm in 400 mm.

2.7 ADDITIONAL CLEARANCE FOR PLATFORMS ON CURVES

The additional clearance for platforms on curves shall be provided as shown at Appendix-4 **Note:**

As the minimum radius of curve for stations is 1000 m, there will be no super elevation and gauge widening on passenger platform lines.

CHAPTER-III

ROLLING STOCK

3.1 PASSENGER ELECTRIC MULTIPLE UNITS

3.1.1 (a) Maximum Length of the coach body 21940 mm (including end fairings)

(b) Maximum width of the vehicle 2900 mm

(c) Height of the coach body 4200 mm (maximum with pantograph in locked down condition)

3.1.2 Distance between bogie centres 14850± 250 mm

3.1.3 Kinematic Envelope for level tangent track

a. For At-Grade and Elevated Sections except for passenger platform. Figure No. NMSG-1

b. For At-Grade and Elevated Sections at NMSG-1A passenger platform. Figure No.

3.1.4 Minimum clearance above rail level under dynamic condition of fully loaded vehicle under worst condition** for bogie and axle mounted equipment. 75 mm

3.1.5 Minimum clearance above rail level under dynamic condition of fully loaded vehicle under worst condition*** for body mounted equipment. 102 mm

**The “worst condition” means it is with deflection of primary suspension and maximum tread wear.

***The “worst condition” means it is with deflection of primary suspension and, deflated air spring and maximum tread wear.

3.1.6 Wheel

a) Maximum wheel gauge back to back distance 1360 mm

b) Minimum wheel gauge back to back distance 1358 mm

3.1.7 a) Maximum diameter on the tread (measured at 70 mm from wheel gauge face) 860 mm

b) Minimum diameter on the tread (measured at 70 mm from wheel gauge face) 780 mm

3.1.8 a) Minimum projection for flange of new wheel (measured at 70 mm from wheel gauge face) 28 mm

b) Maximum projection for flange of worn wheel (measured at 70 mm from wheel gauge face) 36 mm

3.1.9 a) Maximum thickness of flange of wheel measured from wheel gauge face at 18 mm from outer edge of flange. 32.5 mm

b) Minimum thickness of flange of wheel measured from wheel gauge face at 18 mm from outer edge of flange. 22 mm

a) Minimum width of wheel 135 mm ± 1mm

3.1.11 Incline of tread 1 in 20

3.1.12 Floor Height

a) Maximum height above rail level for floor of any unloaded vehicle 1130 mm

b) Minimum height above rail level for floor of fully loaded normal vehicle 1100 mm

3.1.13 a) Maximum height of centre coupler above rail level for unloaded vehicle 815 mm

b) Minimum height of centre coupler above rail level for fully loaded vehicle 740 mm

3.1.14 Maximum length over couplers 22600 mm

3.1.15 Length of rigid wheel base for single bogie 2200 to 2600 mm

3.1.16 Maximum distance between any two adjacent axles 12900 mm

3.2 LOCOMOTIVES AND ENGINEERING SERVICE VEHICLES

Other items of rolling stock, viz shunting locomotives, OHE maintenance and inspection cars, emergency re-railing vans, track machines, etc., used on Nagpur Metro System (where these cars would be plying) will conform with the Kinematic Envelope of the Passenger Electric Multiple Units as shown in Figure No NMSG - 1 for Elevated & At-Grade sections and Figure No NMSG-1A for Elevated & At-Grade sections at platforms.

CHAPTER-IV

OVERHEAD ELECTRIC TRACTION 25 kV/AC 50 CYCLES PER SECOND

Note: Special precautions must be taken to maintain following clearances:

4.1 ELECTRICAL CLEARANCES FOR AT-GRADE AND ELEVATED SECTIONS

4.1.1 Minimum vertical distance between any live bare conductor (overhead equipment or pantograph) and any earthed structure or other bodies (rolling stock, over bridges, signal gantries etc.)

	Condition	For Flexible OHE
(i)	Long duration (Static)	250 mm
(ii)	Short Duration (Dynamic)	200 mm

Note:

A minimum vertical distance of 270 mm shall normally be provided between rolling stock and contact wire to allow for a 20 mm temporary raising of the tracks during maintenance. Wherever the allowance required for track maintenance exceeds 20 mm, the vertical distance between rolling stock and contact wire shall correspondingly be increased.

4.1.2 Minimum lateral distance between any bare live conductor (overhead equipment or pantograph) and any earthed structure or other bodies (rolling stock, over bridges, signal gantries etc.)

	Condition	For Flexible OHE
(i)	Long duration (Static)	250 mm
(ii)	Short Duration (Dynamic)	200 mm

4.1.3 Height of contact wire: Minimum height from rail level to the underside of live Conductor wire

i) In the open, Under bridges and other special locations…….. 4800 mm

ii) At level crossings …….. 5500 mm

iii) In running and carriage sheds where staff may be expected to work on the roof of rolling stock. …….. 5200 mm **Note:**

a) The normal height from rail level to the underside of contact wire is 5000 mm

b) On curves, all vertical distances specified in items 4.1.3 above, shall be measured above level of the inner rail, increased by half the super-elevation.

4.1.4 Maximum variation of the live conductor wire on either side of the centre line of the track under static conditions:

i) On straight …….. ±200mm

ii) On Curves …….. ±300mm

Note:

These limits would not apply to special locations like insulated overlaps and out of run wires.

4.1.5 Maximum width of pantograph collector:

The Kinematic Envelope with the size of Pantograph adopted shall be within the Kinematic Envelope shown at Figure No. NMSG-1.

CHAPTER-V

PLATFORM SCREEN DOOR

5.1 PLATFORM SCREEN DOOR SETTING OUT DIMENSIONS

Minimum Platform screen door width	2000 mm
Minimum Platform screen door height	2150 mm
Maximum Platform screen door threshold offset from track centerline – straight track	1520 mm
Minimum Platform screen door panel offset from track centerline – straight track	1525 mm
Minimum Platform screen door header offset from track centerline	1520 mm
Station Platform height – finished architectural level	1090±5mm
Minimum horizontal distance of any structure on a passenger platform from the edge of coping	2500 mm

Note:

(a) Assumed plus/minus 300 mm stopping accuracy.

(b) Platform screen door at stations on curves shall be considered separately taking into account the additional clearance as per Appendix-4.

(c) Platform screen doors are designated as railway operational structures. Therefore, platform screen doors may infringe the Structure Gauge, but does not infringe the kinematic envelope and having minimum clearance of 10 mm from kinematic envelope to platform screen door (refer NMSG-7)

(d) The deflector attached to the bottom of the sliding door shall be designed in order not to protrude beyond the door threshold.

Appendix-1

PERMISSIBLE SPEED, CANT AND MINIMUM TRACK SPACING ON CURVES.

ELEVATED AND AT-GRADE SECTIONS

RADIUS OF CURVE (m)	CANT mm	MAXIMUM PERMISSIBLE SPEED kmph	MINIMUM DISTANCE BETWEEN ADJACENT TRACKS See note (a) mm
3000 or more	15	80	3650
2800	15	80	3650
2400	20	80	3650
2000	20	80	3650
1600	25	80	3650
1500	30	80	3650
1200	35	80	3650
1000	40	80	3700
800	55	80	3700
600	70	80	3750
500	90	80	3750
450	95	75	3750
400	105	75	3800
350	110	70	3800
300	110	65	3850
200	110	50	3900
175	110	50	3900
150	110	45	3900
150*	0	30	4000
120	110	40	4000
120*	0	30	4000

Notes:

(a) The track spacing shown in the table above is without any column/structure between two tracks and is with equal cant for both outer and inner tracks.

b) Track spacing shown in Table above is not applicable to stations which should be calculated depending on specific requirement.

c) Figures for any intermediate radius of curvature may be obtained by adopting the value for sharper curve.

d) Cant provided is limited to desirable value of 125 mm.

e) Maximum cant deficiency is 100 mm

f) Maximum permissible speed shown in above is calculated with maximum super-elevation of 110 mm and maximum cant deficiency of 85 mm.

g) The above table gives the max permissible speed for different curvatures. However, the cant to be provided depends on the speed attainable on any speed restrictions etc. The speed attainable should be determined through „speed simulation".

h) Spacing between tracks = E+F+T1+T2+300 mm (clearance between adjacent Kinematic Envelopes).
Where,

E& F refers to Fig. NMSG-3, T1 & T2 refers to Appendix-2
T1 = Extra lateral allowance due to curvature inside of curve.
T2 = Extra lateral allowance due to curvature outside of curve.
* Curves to be provided in depots

Appendix-2

EXTRA HORIZONTAL CLEARANCE ON CURVES

(CURVATURE EFFECT)

INSIDE OF CURVE

REFERENCE: PARA 1.7.1

RADIUS OF CURVE	MID-THROW (28500/R)	NOSING INCLUDED IN K.E/ STRUCTURE GAUGE FOR TANGENT TRACK	EXTRA GAUGE TOLERANCE ON CURVES	EXTRA HORIZONTAL CLEARANCE ON CURVE	REMARKS
(m)	(mm)	(mm)	(mm)	(mm)	
(R)	**(V)**	**(N)**	**(G)**	**(T_1)**	
120	237.5	26.0	9.0	221	(G) EXTRA GAUGE TOLERANCE ON CURVES SHARPER THAN 1000 m RADIUS: 9 mm FOR CURVES WITH RADII SHARPER THAN 500 m AND 5 mm FOR CURVES WITH RADII OF 500 m TO LESS THAN 1000 m.
150	190.0	26.0	9.0	173	
175	162.9	26.0	9.0	146	
200	142.5	26.0	9.0	126	
250	114.0	26.0	9.0	97	
300	95.0	26.0	9.0	78	
350	81.4	26.0	9.0	64	
400	71.3	26.0	9.0	54	
450	63.3	26.0	9.0	46	
500	57.0	26.0	5.0	36	
600	47.5	26.0	5.0	27	
700	40.7	26.0	5.0	20	
800	35.6	26.0	5.0	15	
900	31.7	26.0	5.0	11	
1000	28.5	26.0	0.0	3	**T_1=V-N+G for V EQUAL TO OR GREATER THAN (N) AND T1= G for V < (N)**
1200	23.8	26.0	0.0	0	
1500	19.0	26.0	0.0	0	
1600	17.8	26.0	0.0	0	
2000	14.3	26.0	0.0	0	
2400	11.9	26.0	0.0	0	
2800	10.2	26.0	0.0	0	
3000 or more	9.5	26.0	0.0	0	

Note:
Mid throw (in mm) V = (125 x C^2) /R= 28500/R
Where 'C' is the distance between bogie centers=14.850+0.250=15.100m OR 14.85 - 0.250=14.600 m The worst case will be with C=15.100 m R is the radius of curve in metres.

Mid throw (in mm) V = (125 x C^2) /R= 28500/R

OUTSIDE OF CURVE

REFERENCE: PARA 1.7.2

RADIUS OF CURVE	END-THROW (33525/R)	EXTRA GAUGE TOLERANCE ON CURVES	EXTRA NOSING DUE TO EXTRA GAUGE TOLERANCE	EXTRA HORIZONTAL CLEARANCE ON CURVE	REMARKS
(m)	(mm)	(mm)	(mm)	(mm)	
(R)	**(Vo)**	**(G)**	**(EN)**	**(T_2)**	
120	279.4	9.0	2.3	291	(G) EXTRA GAUGE TOLERANCE ON CURVES SHARPER THAN 1000 m RADIUS: 9 mm FOR CURVES WITH RADII SHARPER THAN 500 m AND 5 mm FOR CURVES WITH RADII OF 500 m TO LESS THAN 1000 m.
150	223.5	9.0	2.3	235	
175	191.6	9.0	2.3	203	
200	167.6	9.0	2.3	179	
250	134.1	9.0	2.3	145	
300	111.8	9.0	2.3	123	
350	95.8	9.0	2.3	107	
400	83.8	9.0	2.3	95	
450	74.5	9.0	2.3	86	
500	67.1	5.0	1.3	73	
600	55.9	5.0	1.3	62	
700	47.9	5.0	1.3	54	
800	41.9	5.0	1.3	48	
900	37.3	5.0	1.3	44	
1000	33.5	0.0	0.0	34	T_2=Vo+G+EN EN=Gx0.251986301
1200	27.9	0.0	0.0	28	
1500	22.4	0.0	0.0	22	
1600	21.0	0.0	0.0	21	
2000	16.8	0.0	0.0	17	
2400	14.0	0.0	0.0	14	
2800	12.0	0.0	0.0	12	
3000 or more	11.2	0.0	0.0	11	

Note:

End Throw (in mm) Vo= (125 x C_1^2) /R - (125xC^2)/R = 33525/R

Where 'C' is the distance between bogie centers = 14.850+0.250=15.100m OR 14.850-.250=14.600 m

Worst case will be with C=14.600 m

'C_1' is length of coach in meters = 21.940 m and

'R' is radius of curve in meters.

APPENDIX-3
NAGPUR METRO
CANT EFFECT ON KINEMATIC ENVELOPE-HORIZONTAL (VEHICLE SPEED - 90 kmph)
AT-GRADE AND ELEVATED SECTIONS
REF: PARA 1.8.1

Height above rail level measured perpendicular to plane of track →	h=	938			h=	997			h=	1130			h=	2876			h=	3296			h=	4014			h=	4866			h=	5018		
Distance from center line of track to K.E for tangent track. →	ab=	1582			ab=	1584			ab=	1590			ab=	1658			ab=	1658			ab=	1225			ab=	1220			ab=	880		
Cant	Angle α	Sin α	cos α	tan α	E	F	H_1	H_2	E	F	H_1	H_2	E	F	H_1	H_2	E	F	H_1	H_2	E	F	H_1	H_2	E	F	H_1	H_2	E	F	H_1	H_2	E	F	H_1	H_2
125	4.748	0.083	0.997	0.08	1654	1499	1128	866	1661	1496	1187	925	1678	1491	1320	1057	1890	1414	3066	2791	1925	1379	3484	3210	1553	889	4164	3961	1619	813	5013	4811	1292	462	5136	4990
120	4.558	0.079	0.997	0.08	1652	1502	1121	869	1658	1500	1180	928	1675	1495	1313	1060	1881	1424	3059	2795	1915	1391	3477	3214	1540	902	4159	3964	1603	829	5008	4814	1276	478	5132	4992
115	4.368	0.076	0.997	0.08	1649	1506	1113	872	1655	1503	1172	931	1671	1499	1305	1063	1872	1434	3051	2799	1904	1402	3470	3218	1527	916	4153	3967	1587	846	5002	4816	1260	495	5128	4994
110	4.178	0.073	0.997	0.07	1646	1509	1106	875	1652	1507	1165	934	1668	1503	1298	1066	1863	1444	3044	2803	1894	1413	3463	3221	1514	929	4148	3969	1571	862	4997	4819	1243	512	5124	4996
105	3.987	0.070	0.998	0.07	1643	1513	1098	878	1649	1511	1157	937	1665	1508	1290	1069	1854	1454	3037	2806	1883	1425	3456	3225	1501	943	4142	3972	1555	879	4992	4822	1227	529	5120	4997
100	3.797	0.066	0.998	0.07	1641	1516	1091	881	1647	1514	1150	940	1661	1512	1283	1072	1845	1464	3029	2810	1873	1436	3449	3229	1488	956	4136	3974	1540	895	4986	4825	1210	546	5115	4999
95	3.607	0.063	0.998	0.06	1638	1520	1083	884	1644	1518	1142	943	1658	1516	1275	1075	1836	1474	3022	2813	1862	1447	3441	3233	1475	970	4131	3976	1524	911	4981	4827	1194	563	5111	5000
90	3.417	0.060	0.998	0.06	1635	1523	1076	887	1641	1522	1135	946	1655	1520	1268	1078	1826	1484	3015	2817	1852	1459	3434	3236	1462	984	4125	3979	1508	928	4975	4830	1178	579	5107	5002
85	3.227	0.056	0.998	0.06	1632	1527	1068	890	1638	1525	1127	949	1651	1524	1260	1081	1817	1493	3007	2821	1841	1470	3427	3240	1449	997	4119	3981	1492	944	4969	4832	1161	596	5102	5003
80	3.037	0.053	0.999	0.05	1629	1530	1060	893	1635	1529	1120	952	1648	1528	1253	1084	1808	1503	3000	2824	1830	1481	3419	3244	1436	1011	4113	3983	1476	960	4964	4835	1145	613	5098	5004
75	2.847	0.050	0.999	0.05	1627	1533	1053	896	1632	1533	1112	955	1644	1532	1245	1087	1799	1513	2992	2828	1820	1492	3412	3247	1423	1024	4107	3986	1460	977	4958	4837	1128	630	5093	5006
70	2.657	0.046	0.999	0.05	1624	1537	1045	899	1629	1536	1104	957	1641	1536	1237	1090	1790	1523	2985	2831	1809	1503	3404	3251	1410	1038	4101	3988	1444	993	4952	4839	1112	646	5088	5007
65	2.467	0.043	0.999	0.04	1621	1540	1038	902	1625	1540	1097	960	1637	1540	1230	1093	1780	1533	2977	2834	1798	1515	3397	3254	1397	1051	4096	3990	1428	1009	4947	4841	1095	663	5084	5008
60	2.277	0.040	0.999	0.04	1618	1543	1030	904	1622	1543	1089	963	1634	1544	1222	1096	1771	1542	2970	2838	1788	1526	3389	3258	1384	1065	4090	3992	1412	1026	4941	4844	1079	680	5079	5009
55	2.087	0.036	0.999	0.04	1615	1547	1023	907	1619	1547	1082	966	1630	1548	1215	1099	1762	1552	2962	2841	1777	1537	3382	3261	1370	1078	4083	3994	1396	1042	4935	4846	1062	697	5074	5010
50	1.898	0.033	0.999	0.03	1612	1550	1015	910	1616	1550	1074	969	1627	1552	1207	1102	1752	1562	2954	2845	1766	1548	3374	3264	1357	1091	4077	3996	1380	1058	4929	4848	1046	713	5069	5011
45	1.708	0.030	1.000	0.03	1609	1553	1007	913	1613	1554	1066	972	1623	1556	1199	1105	1743	1572	2947	2848	1755	1559	3366	3268	1344	1105	4071	3998	1364	1074	4923	4850	1029	730	5064	5012
40	1.518	0.026	1.000	0.03	1606	1557	1000	916	1610	1557	1059	975	1619	1560	1192	1107	1734	1581	2939	2851	1745	1570	3359	3271	1331	1118	4065	4000	1348	1091	4917	4852	1013	747	5060	5013
35	1.328	0.023	1.000	0.02	1603	1560	992	919	1607	1560	1051	978	1616	1563	1184	1110	1724	1591	2931	2854	1734	1581	3351	3274	1318	1132	4059	4002	1332	1107	4910	4854	996	763	5055	5014
30	1.138	0.020	1.000	0.02	1600	1563	984	921	1603	1564	1043	980	1612	1567	1176	1113	1715	1601	2923	2857	1723	1592	3343	3277	1305	1145	4053	4004	1316	1123	4904	4856	980	780	5049	5015
25	0.949	0.017	1.000	0.02	1597	1566	977	924	1600	1567	1036	983	1608	1571	1169	1116	1705	1610	2916	2861	1712	1603	3335	3281	1291	1158	4046	4006	1300	1139	4898	4858	963	797	5044	5015
20	0.759	0.013	1.000	0.01	1594	1569	969	927	1597	1571	1028	986	1605	1575	1161	1119	1696	1620	2908	2864	1702	1614	3328	3284	1278	1172	4040	4007	1284	1155	4892	4859	946	813	5039	5016
15	0.569	0.010	1.000	0.01	1591	1573	961	930	1594	1574	1020	989	1601	1579	1153	1122	1686	1629	2900	2867	1691	1625	3320	3287	1265	1185	4033	4009	1268	1172	4885	4861	930	830	5034	5017
10	0.379	0.007	1.000	0.01	1588	1576	953	933	1591	1577	1012	991	1597	1582	1146	1124	1677	1639	2892	2870	1680	1636	3312	3290	1252	1198	4027	4011	1252	1188	4879	4863	913	847	5029	5017
5	0.190	0.003	1.000	0	1585	1579	946	935	1587	1581	1005	994	1594	1586	1138	1127	1668	1648	2884	2873	1669	1647	3304	3293	1238	1212	4021	4012	1236	1204	4873	4864	897	863	5023	5018
0	0.000	0.000	1.000	0	1582	1582	938	938	1584	1584	997	997	1590	1590	1130	1130	1658	1658	2876	2876	1658	1658	3296	3296	1225	1225	4014	4014	1220	1220	4866	4866	880	880	5018	5018

REFER TO FIGURE NMSG-3

$E=[ab+(h \times \tan\alpha)] \times \cos\alpha$

$F=[Ab-(h \times \tan\alpha)] \times \cos\alpha$

$H_1=(Ca/2)+(h / \cos\alpha)+(Ab-h \times \tan\alpha)\times\sin\alpha$

$H_2=(Ca/2)+(h/ \cos\alpha)-(ab+h \times \tan\alpha)\times\sin\alpha$

ab=Ab=Distance from center line of vehicle to K.E for Tangent track at height 'h' from rail level

ac=Distance from center line of canted tack to K.E for Tangent track at height 'h' from rail level.

bc=hxtanα=Lateral increment due to cant(measured along the line parallel to line joining top of rails.

APPENDIX-3i

NAGPUR METRO

CANT EFFECT ON KINEMATIC ENVELOPE-HORIZONTAL (VEHICLE SPEED- 40 kmph)

AT-GRADE AND ELEVATED SECTIONS

REF: PARA 1.8.1

Height above rail level measured perpendicular to plane of track →					h=	944			h=	1066			h=	1133			h=	2874			h=	3296			h=	4014			h=	4866			h=	5018		
Distance from center line of track to K.E for tangent track. →					ab=	1516			ab=	1516			ab=	1516			ab=	1581			ab=	1580			ab=	1225			ab=	1220			ab=	880		
Cant	Angle α	Sin α	cos α	tan α	E	F	H_1	H_2	E	F	H_1	H_2	E	F	H_1	H_2	E	F	H_1	H_2	E	F	H_1	H_2	E	F	H_1	H_2	E	F	H_1	H_2	E	F	H_1	H_2
125	4.748	0.083	0.997	0.08	1589	1433	1129	878	1599	1423	1250	999	1605	1417	1317	1066	1813	1338	3058	2796	1847	1302	3478	3216	1553	889	4164	3961	1619	813	5013	4811	1292	462	5136	4990
120	4.558	0.079	0.997	0.08	1586	1436	1121	881	1596	1426	1243	1002	1601	1421	1310	1069	1804	1348	3051	2799	1837	1313	3471	3220	1540	902	4159	3964	1603	829	5008	4814	1276	478	5132	4992
115	4.368	0.076	0.997	0.08	1583	1440	1114	883	1593	1430	1236	1005	1598	1425	1303	1072	1795	1358	3044	2803	1826	1324	3464	3224	1527	916	4153	3967	1587	846	5002	4816	1260	495	5128	4994
110	4.178	0.073	0.997	0.07	1581	1443	1107	886	1590	1434	1229	1008	1595	1429	1295	1075	1786	1367	3037	2806	1816	1336	3457	3227	1514	929	4148	3969	1571	862	4997	4819	1243	512	5124	4996
105	3.987	0.070	0.998	0.07	1578	1447	1100	889	1586	1438	1221	1011	1591	1434	1288	1077	1777	1377	3029	2810	1805	1347	3450	3231	1501	943	4142	3972	1555	879	4992	4822	1227	529	5120	4997
100	3.797	0.066	0.998	0.07	1575	1450	1092	892	1583	1442	1214	1013	1588	1438	1281	1080	1768	1387	3022	2813	1795	1358	3443	3234	1488	956	4136	3974	1540	895	4986	4825	1210	546	5115	4999
95	3.607	0.063	0.998	0.06	1572	1454	1085	894	1580	1446	1207	1016	1584	1442	1274	1083	1759	1397	3015	2816	1784	1370	3436	3238	1475	970	4131	3976	1524	911	4981	4827	1194	563	5111	5000
90	3.417	0.060	0.998	0.06	1570	1457	1078	897	1577	1450	1199	1019	1581	1446	1266	1086	1749	1407	3008	2820	1774	1381	3429	3241	1462	984	4125	3979	1508	928	4975	4830	1178	579	5107	5002
85	3.227	0.056	0.998	0.06	1567	1460	1070	900	1574	1454	1192	1021	1577	1450	1259	1088	1740	1417	3001	2823	1763	1392	3422	3244	1449	997	4119	3981	1492	944	4969	4832	1161	596	5102	5003
80	3.037	0.053	0.999	0.05	1564	1464	1063	902	1570	1457	1185	1024	1574	1454	1252	1091	1731	1427	2994	2826	1752	1403	3415	3248	1436	1011	4113	3983	1476	960	4964	4835	1145	613	5098	5004
75	2.847	0.050	0.999	0.05	1561	1467	1056	905	1567	1461	1177	1027	1570	1458	1244	1094	1722	1436	2986	2829	1742	1414	3408	3251	1423	1024	4107	3986	1460	977	4958	4837	1128	630	5093	5006
70	2.657	0.046	0.999	0.05	1558	1471	1048	908	1564	1465	1170	1030	1567	1462	1237	1097	1713	1446	2979	2833	1731	1426	3401	3254	1410	1038	4101	3988	1444	993	4952	4839	1112	646	5088	5007
65	2.467	0.043	0.999	0.04	1555	1474	1041	910	1560	1469	1163	1032	1563	1466	1230	1099	1703	1456	2972	2836	1720	1437	3393	3257	1397	1051	4096	3990	1428	1009	4947	4841	1095	663	5084	5008
60	2.277	0.040	0.999	0.04	1552	1477	1033	913	1557	1472	1155	1035	1560	1470	1222	1102	1694	1466	2965	2839	1710	1448	3386	3261	1384	1065	4090	3992	1412	1026	4941	4844	1079	680	5079	5009
55	2.087	0.036	0.999	0.04	1549	1481	1026	916	1554	1476	1148	1038	1556	1474	1215	1105	1685	1475	2957	2842	1699	1459	3379	3264	1370	1078	4083	3994	1396	1042	4935	4846	1062	697	5074	5010
50	1.898	0.033	0.999	0.03	1546	1484	1019	918	1550	1480	1141	1040	1553	1478	1208	1107	1675	1485	2950	2845	1688	1470	3372	3267	1357	1091	4077	3996	1380	1058	4929	4848	1046	713	5069	5011
45	1.708	0.030	1.000	0.03	1543	1487	1011	921	1547	1484	1133	1043	1549	1482	1200	1110	1666	1495	2942	2848	1678	1481	3364	3270	1344	1105	4071	3998	1364	1074	4923	4850	1029	730	5064	5012
40	1.518	0.026	1.000	0.03	1540	1490	1004	924	1544	1487	1126	1045	1545	1485	1193	1112	1657	1504	2935	2851	1667	1492	3357	3273	1331	1118	4065	4000	1348	1091	4917	4852	1013	747	5060	5013
35	1.328	0.023	1.000	0.02	1537	1494	996	926	1540	1491	1118	1048	1542	1489	1185	1115	1647	1514	2927	2854	1656	1503	3349	3276	1318	1132	4059	4002	1332	1107	4910	4854	996	763	5055	5014
30	1.138	0.020	1.000	0.02	1534	1497	989	929	1537	1495	1111	1051	1538	1493	1178	1118	1638	1524	2920	2857	1645	1514	3342	3279	1305	1145	4053	4004	1316	1123	4904	4856	980	780	5049	5015
25	0.949	0.017	1.000	0.02	1531	1500	981	931	1533	1498	1103	1053	1535	1497	1170	1120	1628	1533	2912	2860	1634	1525	3334	3282	1291	1158	4046	4006	1300	1139	4898	4858	963	797	5044	5015
20	0.759	0.013	1.000	0.01	1528	1503	974	934	1530	1502	1096	1056	1531	1501	1163	1123	1619	1543	2905	2863	1624	1536	3327	3285	1278	1172	4040	4007	1284	1155	4892	4859	946	813	5039	5016
15	0.569	0.010	1.000	0.01	1525	1507	967	936	1527	1505	1089	1058	1527	1505	1156	1125	1609	1552	2897	2866	1613	1547	3319	3288	1265	1185	4033	4009	1268	1172	4885	4861	930	830	5034	5017
10	0.379	0.007	1.000	0.01	1522	1510	959	939	1523	1509	1081	1061	1523	1508	1148	1128	1600	1562	2889	2868	1602	1558	3311	3290	1252	1198	4027	4011	1252	1188	4879	4863	913	847	5029	5017
5	0.190	0.003	1.000	0	1519	1513	952	941	1520	1512	1074	1063	1520	1512	1141	1130	1591	1571	2882	2871	1591	1569	3304	3293	1238	1212	4021	4012	1236	1204	4873	4864	897	863	5023	5018
0	0.000	0.000	1.000	0	1516	1516	944	944	1516	1516	1066	1066	1516	1516	1133	1133	1581	1581	2874	2874	1580	1580	3296	3296	1225	1225	4014	4014	1220	1220	4866	4866	880	880	5018	5018

REFER TO FIGURE NMSG-3

E=[ab+(h x tan α)] x cos α

F=[Ab- (h x tan α)] x cos α

H_1=(Ca/2)+(h / cos α)+(Ab-h x tan α)xsin α

H_2=(Ca/2)+(h/ cos α)-(ab+h x tan α)xsin α

ab=Ab=Distance from center line of vehicle to K.E for Tangent track at height 'h' from rail level

ac=Distance from center line of canted tack to K.E for Tangent track at height 'h' from rail level.

bc=hxtanα=Lateral increment due to cant(measured along the line parallel to line joining top of rails.

APPENDIX-3A

NAGPUR METRO

CANT EFFECT ON STRUCTURE GAUGE (CORRESPONDING TO 90 kmph KE)-HORIZONTAL AT-GRADE AND ELEVATED SECTIONS

REFERENCE: PARA 1.8.2

ALL FIGURES ARE IN mm

Height above rail level measured perpendicular to plane of track →					h=	305			h=	930			h=	3310			h=	3775			h=	6200		
Distance from center line of track to Structure Gauge for tangent track. →					ab=	1640			ab=	1735			ab=	1825			ab=	1546			ab=	1546		
Cant	Angle α Degrees	Sin α	cos α	tan α	E_1	F_1	H_1	H_2	E_1	F_1	H_1	H_2	E_1	F_1	H_1	H_2	E_1	F_1	H_1	H_2	E_1	F_1	H_1	H_2
125	4.748	0.083	0.997	0.08	1660	1609	502	231	1806	1652	1133	846	2093	1545	3512	3210	1853	1228	3953	3697	2054	1027	6369	6113
120	4.558	0.079	0.997	0.08	1659	1611	494	234	1803	1656	1125	849	2082	1556	3505	3214	1841	1241	3946	3700	2034	1048	6363	6118
115	4.368	0.076	0.997	0.08	1658	1612	487	237	1801	1659	1117	853	2072	1568	3497	3219	1829	1254	3939	3704	2014	1069	6357	6122
110	4.178	0.073	0.997	0.07	1658	1613	479	240	1798	1663	1109	856	2061	1579	3489	3223	1817	1267	3933	3707	1994	1090	6351	6126
105	3.987	0.070	0.998	0.07	1657	1615	471	243	1795	1666	1101	860	2051	1590	3481	3228	1805	1280	3926	3711	1973	1111	6345	6130
100	3.797	0.066	0.998	0.07	1657	1616	463	246	1793	1670	1093	863	2040	1602	3474	3232	1793	1293	3919	3714	1953	1132	6339	6134
95	3.607	0.063	0.998	0.06	1656	1618	455	249	1790	1673	1085	867	2030	1613	3466	3236	1780	1305	3912	3718	1933	1153	6332	6138
90	3.417	0.060	0.998	0.06	1655	1619	447	252	1787	1676	1077	870	2019	1624	3458	3240	1768	1318	3905	3721	1913	1174	6326	6142
85	3.227	0.056	0.998	0.06	1655	1620	439	255	1785	1680	1069	873	2008	1636	3450	3245	1756	1331	3899	3724	1893	1195	6320	6146
80	3.037	0.053	0.999	0.05	1654	1622	431	258	1782	1683	1061	877	1998	1647	3442	3249	1744	1344	3892	3728	1872	1215	6313	6149
75	2.847	0.050	0.999	0.05	1653	1623	424	261	1779	1687	1053	880	1987	1658	3434	3253	1732	1357	3885	3731	1852	1236	6307	6153
70	2.657	0.046	0.999	0.05	1652	1624	416	264	1776	1690	1044	884	1976	1670	3426	3257	1719	1369	3878	3734	1832	1257	6300	6157
65	2.467	0.043	0.999	0.04	1652	1625	408	267	1773	1693	1036	887	1966	1681	3418	3261	1707	1382	3871	3737	1811	1278	6293	6160
60	2.277	0.040	0.999	0.04	1651	1627	400	270	1771	1697	1028	890	1955	1692	3410	3265	1695	1395	3863	3741	1791	1298	6287	6164
55	2.087	0.036	0.999	0.04	1650	1628	392	273	1768	1700	1020	894	1944	1703	3402	3269	1682	1407	3856	3744	1771	1319	6280	6167
50	1.898	0.033	0.999	0.03	1649	1629	384	276	1765	1703	1012	897	1934	1714	3394	3273	1670	1420	3849	3747	1750	1340	6273	6170
45	1.708	0.030	1.000	0.03	1648	1630	376	278	1762	1707	1004	900	1923	1726	3385	3277	1658	1433	3842	3750	1730	1361	6266	6174
40	1.518	0.026	1.000	0.03	1648	1631	368	281	1759	1710	996	904	1912	1737	3377	3280	1645	1445	3835	3753	1710	1381	6259	6177
35	1.328	0.023	1.000	0.02	1647	1632	360	284	1756	1713	987	907	1901	1748	3369	3284	1633	1458	3827	3756	1689	1402	6252	6180
30	1.138	0.020	1.000	0.02	1646	1634	353	287	1753	1716	979	910	1890	1759	3361	3288	1621	1471	3820	3759	1669	1423	6244	6183
25	0.949	0.017	1.000	0.02	1645	1635	345	290	1750	1719	971	914	1880	1770	3352	3292	1608	1483	3813	3761	1648	1443	6237	6186
20	0.759	0.013	1.000	0.01	1644	1636	337	293	1747	1723	963	917	1869	1781	3344	3296	1596	1496	3805	3764	1628	1464	6230	6189
15	0.569	0.010	1.000	0.01	1643	1637	329	296	1744	1726	955	920	1858	1792	3335	3299	1583	1508	3798	3767	1608	1484	6223	6192
10	0.379	0.007	1.000	0.01	1642	1638	321	299	1741	1729	946	923	1847	1803	3327	3303	1571	1521	3790	3770	1587	1505	6215	6195
5	0.190	0.003	1.000	0	1641	1639	313	302	1738	1732	938	927	1836	1814	3319	3306	1558	1533	3783	3772	1567	1525	6208	6197
0	0.000	0.000	1.000	0	1640	1640	305	305	1735	1735	930	930	1825	1825	3310	3310	1546	1546	3775	3775	1546	1546	6200	6200

REFER TO FIGURE: NMSG-3A

$E_1=[ab+(h \times \tan \alpha)] \times \cos \alpha$

$F_1=[Ab-(h \times \tan \alpha)] \times \cos \alpha$

$H_1=(Ca/2)+(h / \cos \alpha)+(Ab-h \times \tan \alpha) \times \sin \alpha$

$H_2=(Ca/2)+(h/ \cos \alpha)-(ab+h \times \tan \alpha) \times \sin \alpha$

ab=Ab=Distance from center line of vehicle to Structure gauge for Tangent track at height 'h' from rail level

ac=Distance from center line of canted tack to Structure Gauge for Tangent track at height 'h' from rail level.

bc=hxtanα=Lateral increment due to cant (measured along the line parallel to line joining top of rails).

APPENDIX-3Ai

NAGPUR METRO

CANT EFFECT ON STRUCTURE GAUGE (CORRESPONDING TO 40 kmph KE)-HORIZONTAL

AT-GRADE AND ELEVATED SECTIONS

ALL FIGURES ARE IN mm

Height above rail level measured perpendicular to plane of track →						h=	305			h=	1133			h=	932			h=	3310			h=	3775			h=	6200		
Distance from center line of track to Structure Gauge for tangent track. →						ab=	1569			ab=	1666			ab=	1666			ab=	1730			ab=	1545			ab=	1545		
Cant	Angle α Degrees	Sin α	Angle α (RADIANS)	cos α	tan α	E_1	F_1	H_1	H_2	E_1	F_1	H_1	H_2	E_1	F_1	H_1	H_2	E_1	F_1	H_1	H_2	E_1	F_1	H_1	H_2	E_1	F_1	H_1	H_2
125	4.748	0.083	0.083	0.997	0.08	1589	1538	496	237	1754	1566	1330	1054	1737	1583	1129	853	1998	1450	3504	3218	1852	1227	3952	3697	2053	1026	6369	6113
120	4.558	0.079	0.080	0.997	0.08	1588	1540	489	239	1751	1571	1322	1057	1735	1587	1121	857	1988	1461	3497	3222	1840	1240	3946	3700	2033	1047	6363	6118
115	4.368	0.076	0.076	0.997	0.08	1588	1541	481	242	1747	1575	1314	1060	1732	1590	1114	860	1977	1473	3490	3226	1828	1253	3939	3704	2013	1068	6357	6122
110	4.178	0.073	0.073	0.997	0.07	1587	1543	473	245	1744	1579	1306	1064	1729	1594	1106	863	1967	1484	3482	3230	1816	1266	3933	3707	1993	1089	6351	6126
105	3.987	0.070	0.070	0.998	0.07	1586	1544	466	248	1741	1583	1299	1067	1727	1597	1098	866	1956	1496	3475	3234	1804	1279	3926	3711	1972	1110	6345	6130
100	3.797	0.066	0.066	0.998	0.07	1586	1545	458	250	1737	1587	1291	1070	1724	1601	1090	870	1945	1507	3467	3238	1792	1292	3919	3714	1952	1131	6339	6134
95	3.607	0.063	0.063	0.998	0.06	1585	1547	451	253	1734	1591	1283	1073	1721	1604	1082	873	1935	1518	3460	3242	1779	1304	3912	3718	1932	1152	6332	6138
90	3.417	0.060	0.060	0.998	0.06	1584	1548	443	256	1731	1596	1275	1077	1719	1607	1075	876	1924	1530	3452	3246	1767	1317	3905	3721	1912	1173	6326	6142
85	3.227	0.056	0.056	0.998	0.06	1584	1549	435	259	1727	1600	1267	1080	1716	1611	1067	879	1914	1541	3445	3250	1755	1330	3898	3725	1892	1194	6320	6146
80	3.037	0.053	0.053	0.999	0.05	1583	1551	428	261	1724	1604	1260	1083	1713	1614	1059	882	1903	1552	3437	3254	1743	1343	3892	3728	1871	1214	6313	6149
75	2.847	0.050	0.050	0.999	0.05	1582	1552	420	264	1720	1608	1252	1086	1710	1618	1051	886	1892	1563	3429	3257	1731	1356	3885	3731	1851	1235	6307	6153
70	2.657	0.046	0.046	0.999	0.05	1581	1553	412	267	1717	1612	1244	1090	1707	1621	1043	889	1882	1575	3422	3261	1718	1368	3878	3734	1831	1256	6300	6157
65	2.467	0.043	0.043	0.999	0.04	1581	1554	405	270	1713	1616	1236	1093	1705	1624	1035	892	1871	1586	3414	3265	1706	1381	3871	3737	1810	1277	6293	6160
60	2.277	0.040	0.040	0.999	0.04	1580	1556	397	272	1710	1620	1228	1096	1702	1628	1027	895	1860	1597	3406	3269	1694	1394	3863	3741	1790	1297	6286	6164
55	2.087	0.036	0.036	0.999	0.04	1579	1557	389	275	1706	1624	1220	1099	1699	1631	1020	898	1849	1608	3398	3272	1681	1406	3856	3744	1770	1318	6280	6167
50	1.898	0.033	0.033	0.999	0.03	1578	1558	382	278	1703	1628	1213	1102	1696	1634	1012	901	1839	1619	3390	3276	1669	1419	3849	3747	1749	1339	6273	6170
45	1.708	0.030	0.030	1.000	0.03	1577	1559	374	281	1699	1631	1205	1105	1693	1637	1004	904	1828	1631	3383	3279	1657	1432	3842	3750	1729	1360	6266	6174
40	1.518	0.026	0.026	1.000	0.03	1577	1560	366	283	1695	1635	1197	1108	1690	1641	996	908	1817	1642	3375	3283	1644	1444	3835	3753	1709	1380	6259	6177
35	1.328	0.023	0.023	1.000	0.02	1576	1562	359	286	1692	1639	1189	1112	1687	1644	988	911	1806	1653	3367	3287	1632	1457	3827	3756	1688	1401	6252	6180
30	1.138	0.020	0.020	1.000	0.02	1575	1563	351	289	1688	1643	1181	1115	1684	1647	980	914	1795	1664	3359	3290	1620	1470	3820	3759	1668	1422	6244	6183
25	0.949	0.017	0.017	1.000	0.02	1574	1564	343	291	1685	1647	1173	1118	1681	1650	972	917	1785	1675	3351	3293	1607	1482	3813	3761	1647	1442	6237	6186
20	0.759	0.013	0.013	1.000	0.01	1573	1565	336	294	1681	1651	1165	1121	1678	1654	964	920	1774	1686	3343	3297	1595	1495	3805	3764	1627	1463	6230	6189
15	0.569	0.010	0.010	1.000	0.01	1572	1566	328	297	1677	1655	1157	1124	1675	1657	956	923	1763	1697	3335	3300	1582	1507	3798	3767	1607	1483	6223	6192
10	0.379	0.007	0.007	1.000	0.01	1571	1567	320	300	1673	1658	1149	1127	1672	1660	948	926	1752	1708	3326	3303	1570	1520	3790	3770	1586	1504	6215	6195
5	0.190	0.003	0.003	1.000	0	1570	1568	313	302	1670	1662	1141	1130	1669	1663	940	929	1741	1719	3318	3307	1557	1532	3783	3772	1566	1524	6208	6197
0	0.000	0.000	0.000	1.000	0	1569	1569	305	305	1666	1666	1133	1133	1666	1666	932	932	1730	1730	3310	3310	1545	1545	3775	3775	1545	1545	6200	6200

REFER TO FIGURE: NMSG-3A

E_1=[ab+(h x tan α)] x cos α

F_1=[Ab- (h x tan α)] x cos α

H_1=(Ca/2)+(h / cos α)+(Ab-h x tan α)xsin α

H_2=(Ca/2)+(h/ cos α)-(ab+h x tan α)xsin α

ab=Ab=Distance from center line of vehicle to Structure gauge for Tangent track at height 'h' from rail level

ac=Distance from center line of canted tack to Structure Gauge for Tangent track at height 'h' from rail level.

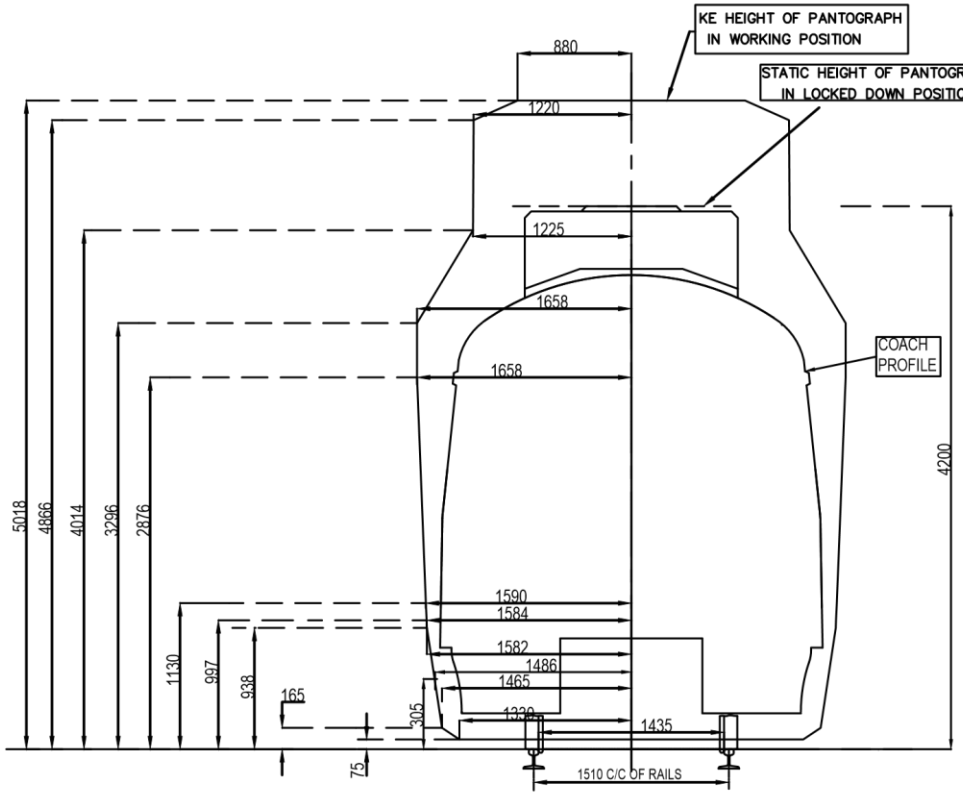
bc=hxtanα=Lateral increment due to cant (measured along the line parallel to line joining top of rails).

Appendix-4

Additional Clearance for Platforms on Curve

Elevated and At-Grade stations

Radius (metre)	Cant (mm)	Extra Clearance (mm)		Remarks
		Inside of curve	Outside of curve	
				1. Extra Clearance for curves:
3000	0	10	11	a) Inside of curve = Midthrow = $125C^2/R = 28500/R$ and C, Distance between bogie centres = 15.10m for the worst case and R is radius of curvature in metre.
2800	0	10	12	
2400	0	12	14	
2000	0	14	17	b) Outside of curve = Endthrow = $(125C_1^2/R) - (125C^2/R) = 33525/R$ where C_1, Length of the vehicle = 21.94m (including end fairings) and C, Distance between bogie centres = 14.60m for the worst case and R is radius of curvature in metre.
1800	0	16	19	
1600	0	18	21	
1500	0	19	22	
1200	0	24	28	2. Additional Sway has not been taken to reduce the extra clearance on curved platforms.
1000	0	29	34	



NOTES

1. ALL DIMENSIONS ARE IN mm
2. HORIZONTAL AND VERTICAL SHIFTS DUE TO CURVES, INCLUDING VERTICAL CURVES AND CANT SHALL BE EXTRA
3. KINEMATIC ENVELOPE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION
4. THE CONDUCTOR HEIGHT ABOVE RAIL LEVEL SHALL ALSO TAKE IN TO CONSIDERATION PRESCRIBED ELECTRICAL CLEARENCES BETWEEN ALL LIVE OVERHEAD EUIPMENT AND PANTOGRAPH / VEHICLE AND ALL PARTS THEREOF.
5. A TYRE OR ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR A DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE OF THE GAUGE FACE OF THE WHEEL.
6. KINEAMTIC ENVELOPE FRO 90 kmph VEHICLE SPEED AND SIDE WIND SPEED OF 100 kmph.

KINEMATIC ENVELOPE FOR 90 kmph
AT-GRADE AND ELEVATED SECTIONS
ON LEVEL OR CONSTANT GRADE TANGENT TRACK
EXCEPT FOR PASSENGER PLATFORM

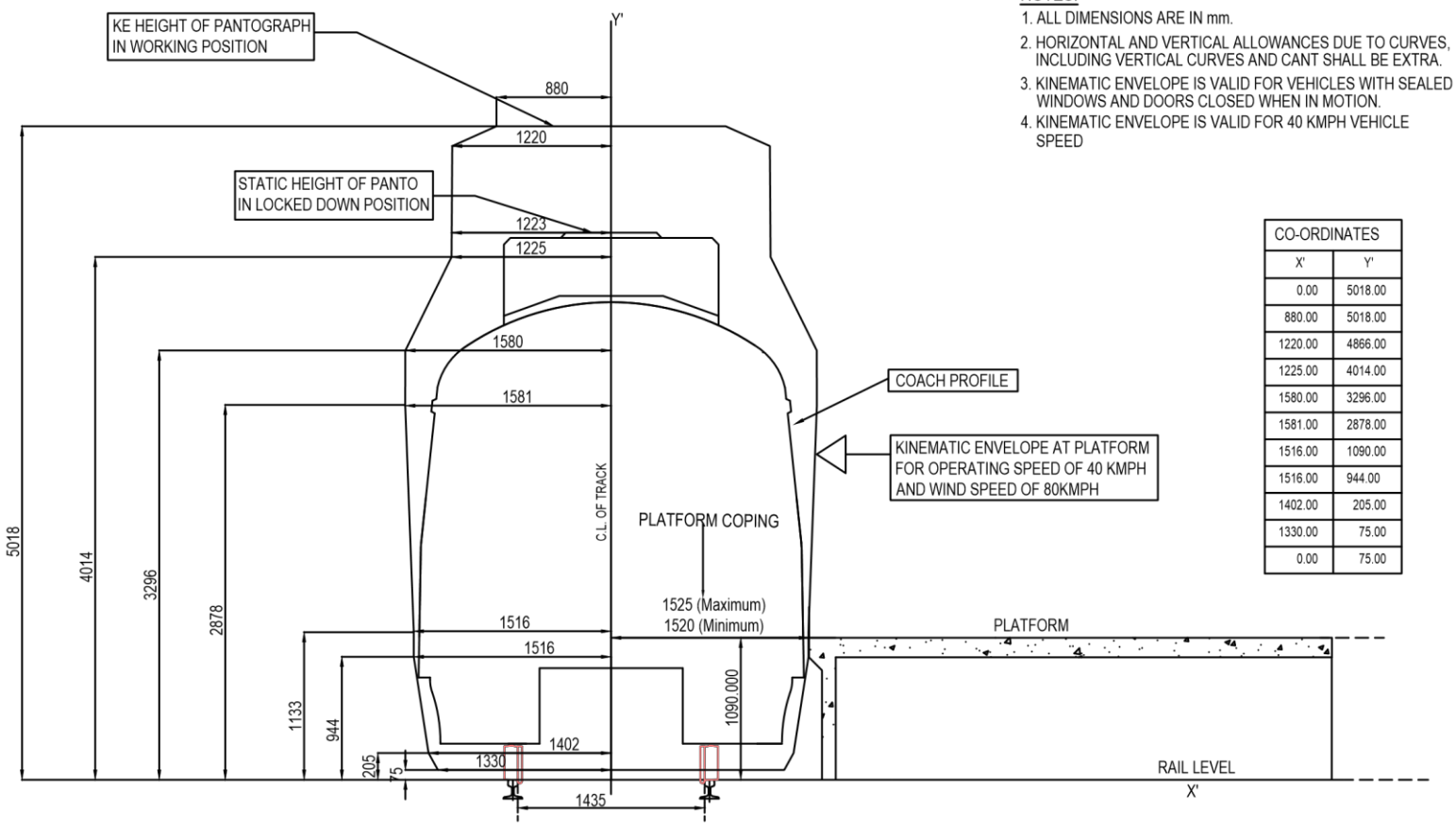
NAGPUR METRO RAIL CORPORATION LTD

STANDARD GAUGE
(1435 mm)
25 kV A.C.TRACTION

FIGURE No. NMSG-1

SCALE: NOT TO SCALE

REF: PARA 1.5, 3.1 & 3.2



NOTES:

1. ALL DIMENSIONS ARE IN mm.
2. HORIZONTAL AND VERTICAL ALLOWANCES DUE TO CURVES, INCLUDING VERTICAL CURVES AND CANT SHALL BE EXTRA.
3. KINEMATIC ENVELOPE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHEN IN MOTION.
4. KINEMATIC ENVELOPE IS VALID FOR 40 KMPH VEHICLE SPEED

CO-ORDINATES	
X'	Y'
0.00	5018.00
880.00	5018.00
1220.00	4866.00
1225.00	4014.00
1580.00	3296.00
1581.00	2878.00
1516.00	1090.00
1516.00	944.00
1402.00	205.00
1330.00	75.00
0.00	75.00

NAGPUR METRO RAIL CORPORATION LTD

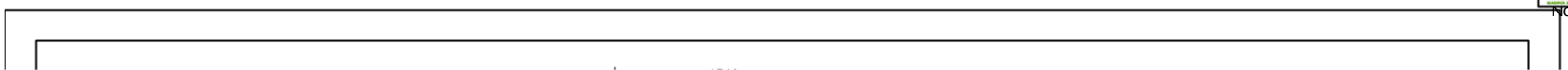
STANDARD GAUGE
(1435 mm)

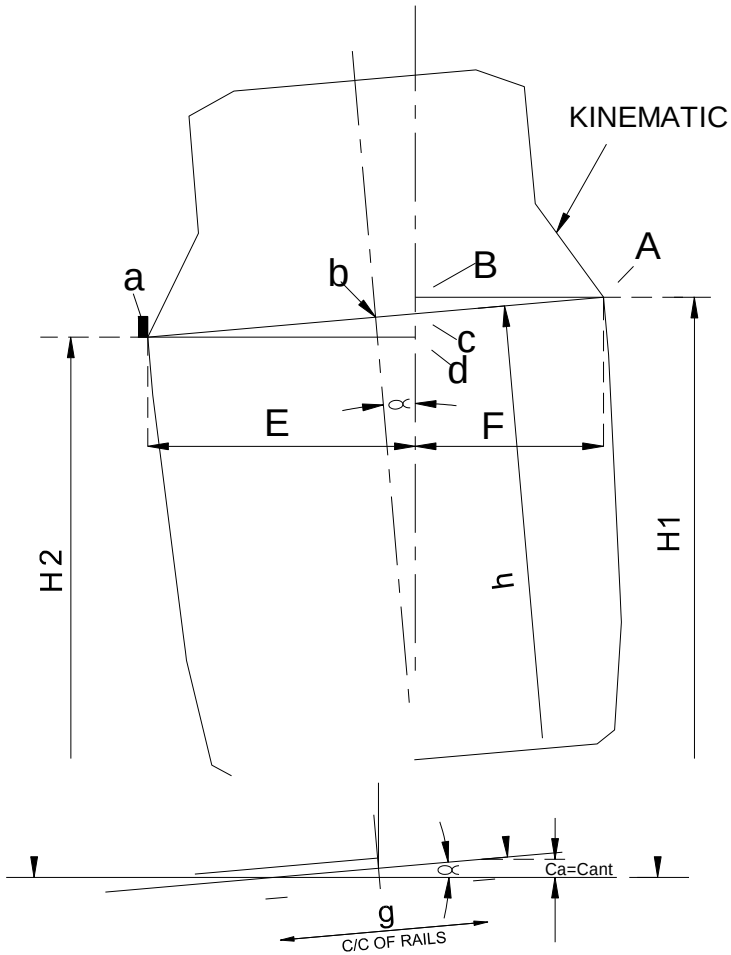
25 kV A.C.TRACTION

KINEMATIC ENVELOPE FOR 40 KMPH
AT GRADE AND ELEVATED SECTIONS
ON LEVEL OR CONSTANT GRADE TANGENT TRACK
AT PASSENGER PLATFORM

FIGURE NO. NMSG-1A

SCALE: NOT TO SCALE | REF: PARA 1.5, 3.1 & 3.2





ab=Ab= Distance from centerline of track to Kinematic Envelope for Tangent Track at height 'h' sin —— = cant/g g= 1510 mm

Ca = Cant applied

E =[ab+(h x tan —)] x cos

F =[Ab- (h x tan —)] x cos

H =(Ca/2)+(h/cos —)+(Ab-h x tan —) x sin

H =(Ca/2)+(h/cos —) - (ab+h x tan —) x sin

For values of E , F , H and H , refer to Appendix 3 for 90 kmph Kinematic Envelope and Appendix 3a for 40 kmph Kinematic Envelope.

NOTES:

KINEMATIC ENVELOPE FOR AT-GRADE/ELEVATED SECTIONS HAS BEEN SHOWN AS A TYPICAL FIGURE.

EFFECT OF CANT ON KINEMATIC ENVELOPE

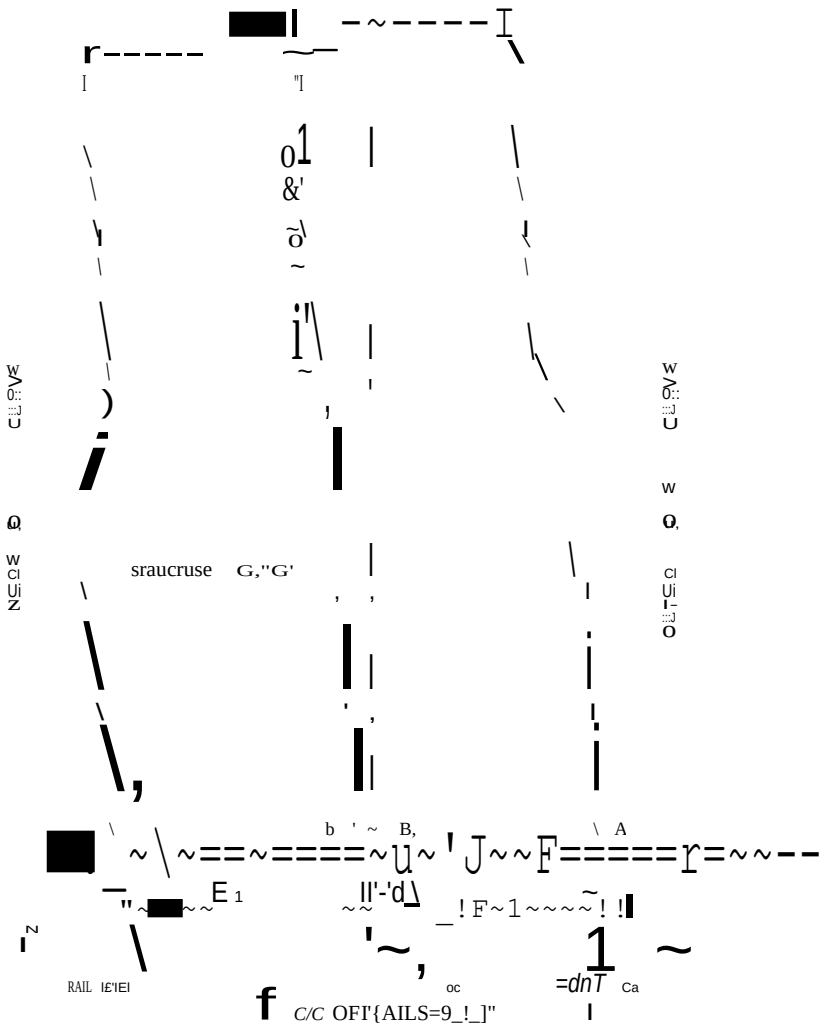
NAGPUR METRO RAIL CORPORATION LTD.

STANDARD GAUGE
(1435 mm)
25 kV A.C.TRACTION

FIGURE No. NMSG-3

SCALE: NOT TO SCALE

REF: PARA 1.8.1



ab=Ab= Distance from centerline of track to Structure Gauge for Tangent Track at height 'h'

sin oc ~ canVg

g~ 1510 mm

Ca ~ Cant applied

E1 =Iab+] h x tanee I] x cos a:

F ı ~[Ab- (h x tan a: l) x cos a:

HF(Ca/2)+(h/cosoc)+(Ab-h x tanoc) x sin oc

H2~(Ca/2)+(h/cos oc) - (ab+h x tan oc) x sinoc

For values of E,. F ~ H 1and H 2, refer to Appendix 3A.

NOTES:

STRUCTURE GAUGE FOR AT-GRADE/ELEVATED SECTION HAS BEEN SHOWN AS A TYPICAL FIGURE.

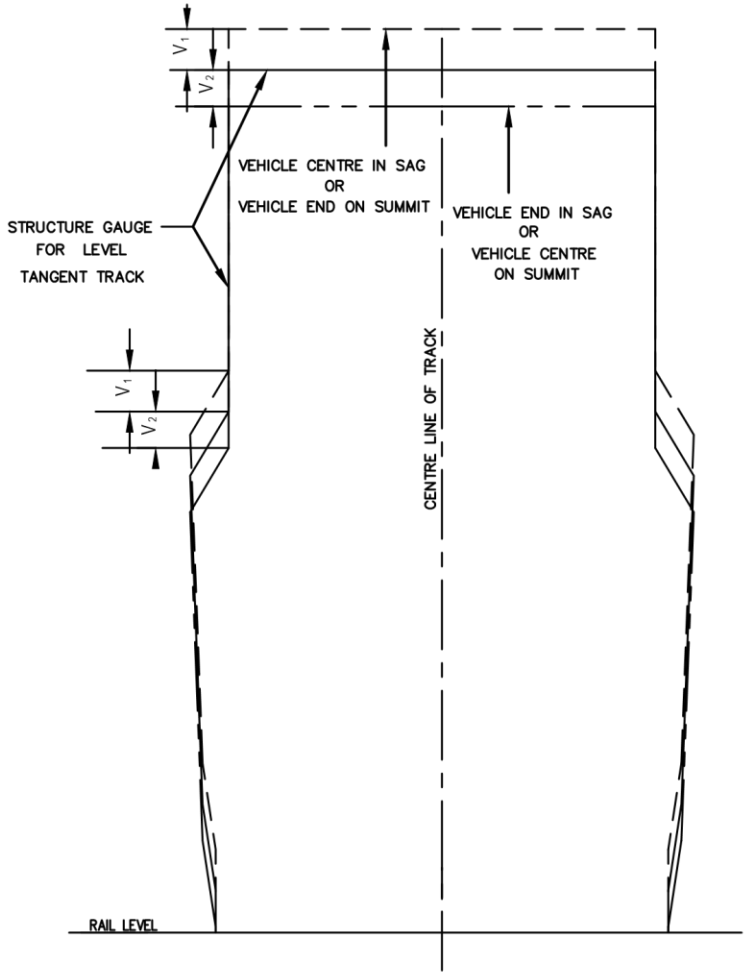
EFFECT OF CANT
ON
STRUCTURE GAUGE

NAGPUR METRO RAIL CORPORATION LTD.

STANDARD GAUGE
(1435 mm)
25 kV A.C.TRACTION

FIGURE No. NMSG-3A

SCALE: NOT TO SCALE | REF: PARA 1.7.1, 1.7.2&1.8.2



VERTICAL THROW

RADIUS OF VERTICAL CURVE metres	V_1 mm	V_2 mm
1500	19	22
1600	18	21
1700	17	20
1800	16	19
1900	15	18
2000	14	17
2100	14	16
2200	13	15
2300	12	15
2400	12	14
2500	11	14
2600	11	13
2700	11	12
2800	10	12
2900	10	12
3000	10	11

NOTE:

THE FIGURE IS TYPICAL AND WILL APPLY TO ELEVATED AND AT-GRADE SECTIONS.

EFFECT OF VETRTICAL CURVE ON STRUCTURE GAUGE

NAGPUR METRO RAIL CORPORATION LTD.

STANDARD GAUGE
(1435 mm)
25 kV A.C.TRACTION

FIGURE No. NMSG-4

SCALE: NOT TO SCALE

REF: PARA 1.7.1(C) & 1.7.2(C)

RADIUS= 14325 mm. (THIS WILL VARY WITH TRACK SPACING AND OHE STRUCTURE).

3645 3645

FIXED STRUCTURE LINE
(STRUCTURE GAUGE)

MINIMUM *GIG* OF TRACKS =3650
(WITHOUT ANY STRUCTURE)

NOTES:

1. ALL DIMENSIONS ARE IN mm.
2. ALLOWANCE FOR CURVE/CANT SHALL BE EXTRA. HOWEVER THE TRACK CENTRES AT STATION WILL NOT INCREASE WITH CURVES OF RADIUS OF 1000 M AND ABOVE.
3. STRUCTURE GAUGE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION
4. OHE IS SUSPENDED FROM CEILING BY DROP ARM.
5. IN THE STATION AREAS A REDUCED KE AS SHOWN IN THIS FIGURE SHALL BE APPLICABLE SUCH THAT THE KE IS CLEAR OF THE PLATFORM COPING AND ACCORDINGLY THE MAXIMUM SPEED THAT CAN BE PERMITTED IN THE STATION AREAS SHALL BE DETERMINED

NAGPUR METRO RAIL CORPORATION LTO

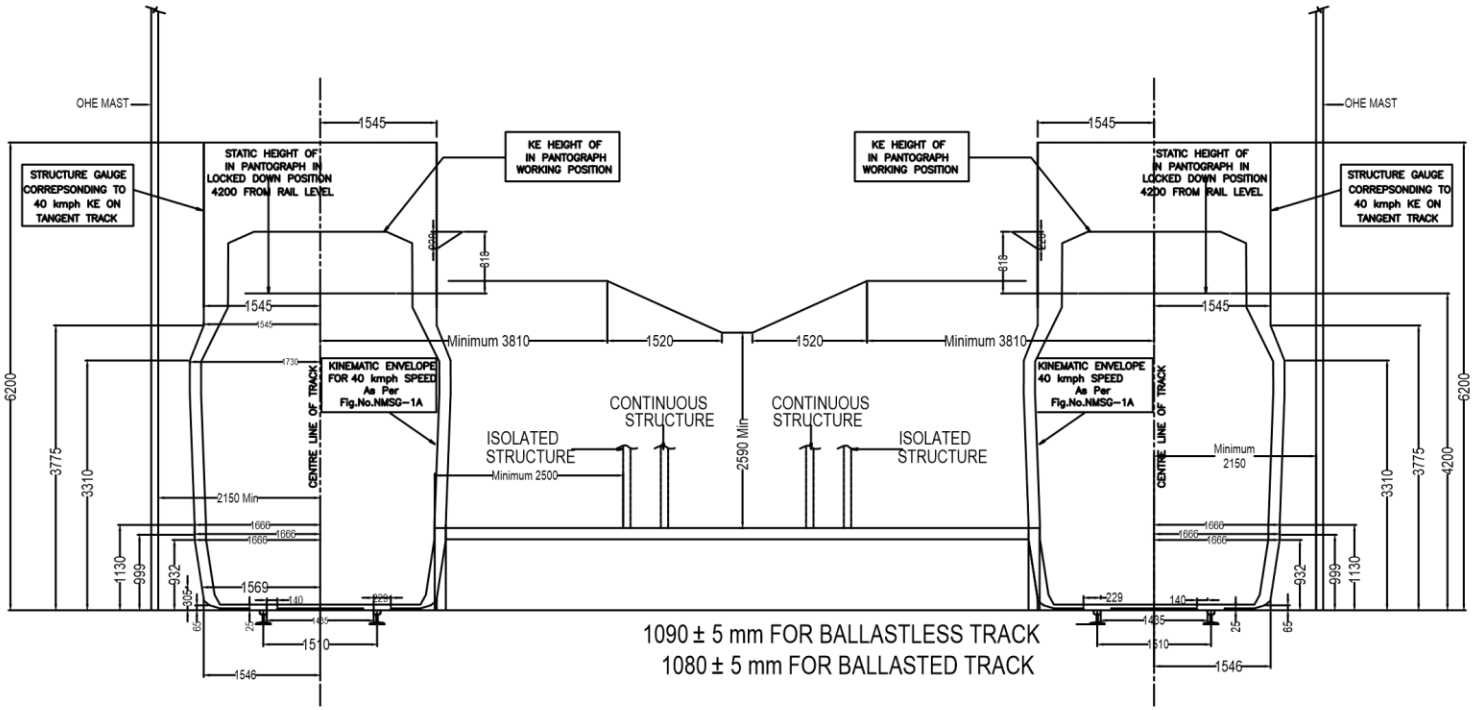
STANDARD GAUGE
(1435 mm)

25 kV A.C.TRACTION

STRUCTURE GAUGE AT
ELEVATED/AT-GRADE STATION
WITH SIDE PLATFORMS
LEVEL OR CONSTANT GRADE TANGENT TRACK

FIGURE NO. NMSG-5

SCALE: NOT TO SCALE REF: PARA 2.2.5



TYPICAL FOR 8.0 m WIDE ISLAND PLATFORM.

NOTES :

a) All Dimensions are in mm.
b) Allowance for curve shall be extra.
c) Structure gauge is valid for vehicles with sealed windows and doors closed while in motion.
d) Distance of platform coping from center of track as per the Para-2.2

STRUCTURE GAUGE AT ELEVATED STATION
WITH ISLAND PLATFORM
ON LEVEL OR CONSTANT GRADE TANGENT TRACK

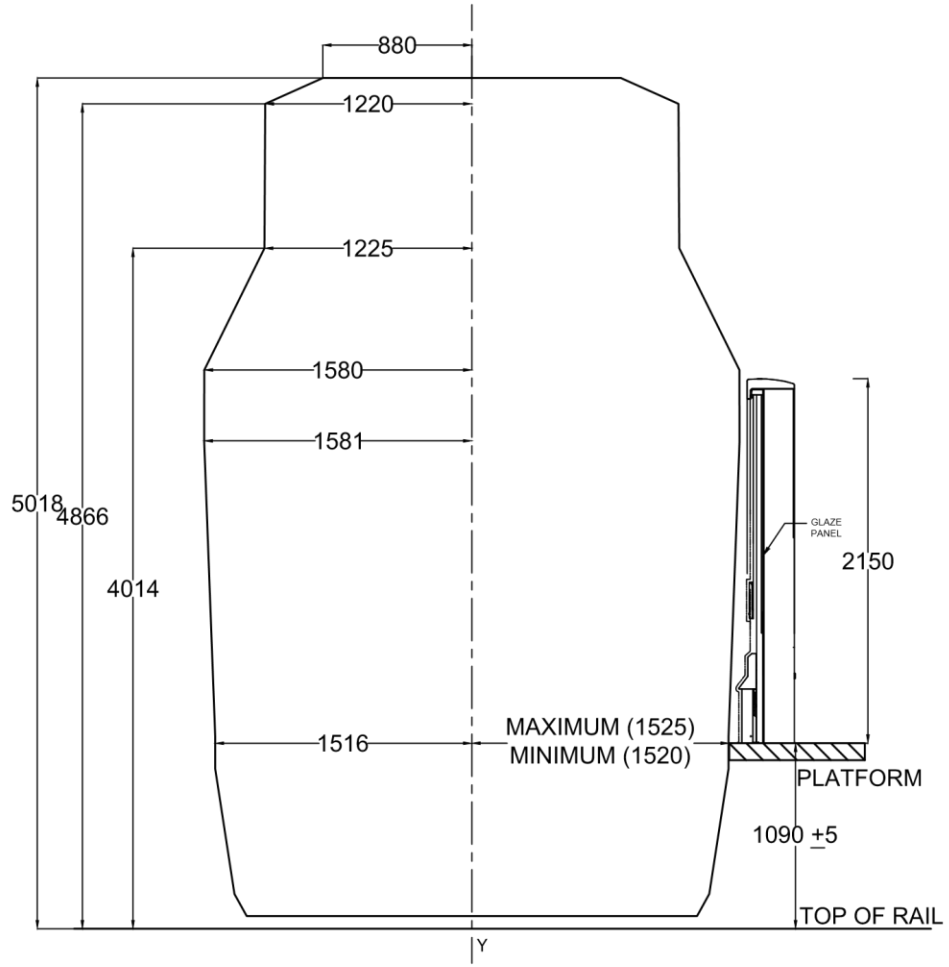
NAGPUR METRO RAIL CORPORATION LTD

STANDARD GAUGE
(1435mm)
25 kV A.C. TRACTION

FIGURE NO NMSG - 6

SCALE: NOT TO SCALE

REFER PARA 2.2.5



NOTES:

1. ALL DIMENSION ARE IN mm.
2. HORIZONTAL ALLOWANCE DUE TO CURVES SHALL BE EXTRA
3. KINEMATIC ENVELOPE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHEN IN MOTION.
4. MINIMUM GAP OF 10 mm SHALL BE MAINTAINED BETWEEN KE AND PLATFORM GATE AT ANY POINT.

PLATFORM GATE ELEVATED/AT GRADE (PLATFORM) ON LEVEL OR CONSTANT GRADE TANGENT TRACK

NAGPUR METRO RAIL CORPORATION LTD.

STANDARD GAUGE
(1435 mm)
25 kV A.C. TRACTION

FIGURE No. NMSG - 7

SCALE: NOT TO SCALE

REF: PARA 5.1