

SN	Cause of Breach of Contract	Purchaser's rights
8.	<b>Liquidation:</b> if the Contractor being a company is wound up voluntarily or by the order of a Court or a Receiver, Liquidator or Manager on behalf of the Debenture—holders is appointed or circumstances shall have arisen which entitle the Court or Debenture—holders to appoint a Receiver, Liquidator or Manager, the Purchaser may consider it as a Breach of Contract.	Purchaser may terminate the Contract.
9.	Any violation of the provisions of the Contract under Clause 4.9 or Clause 4.10 by the Contractor may be considered by the Purchaser as a Breach of Contract.	Purchaser is entitled to take action as per Clause 4.9 and Clause 4.10.
10	(a) Failure of the Contractor to obtain a valid licence under the extant Labour Codes and Rules before the commencement of the Contract.  (b) Failure of the Contractor to continue to have such valid licence until the completion of the Contract.	Purchaser is entitled to take action as per Clause 2.7(f)(ii).
11	Contractor sub-lets or assigns or transfers the Contract or any part thereof without the previous consent in writing of the Purchaser.	Purchaser is entitled to take action as per Clause 4.3(c).

### 13. Termination of Contract:

(a) Upon the Contractor committing a breach of Contract and the Purchaser, having so decided, may terminate the contract, in whole or in part, with following actions:

- (i) Forfeit the Security Deposit in whole, even if the Contractor defaults in complying with part of the obligations under this Contract.
- (ii) Wherever Security Deposit has been exempted for any reason, levy damages on the Contractor, not by way of penalty, an amount equal to Security Deposit amount, as would have been applicable had the Contractor not been exempted from submission of Security Deposit. These damages shall be treated as recoveries outstanding against the Contractor and dealt with accordingly.

(b) Purchaser's right to terminate the Contract, in whole or in part, without any

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compensation to the Contractor, shall not:

- (i) pre-judice or affect the rights and remedies which have accrued and/or shall accrue to the Purchaser after such termination;
- (ii) affect the performance of the Contract to the extent not terminated unless otherwise instructed by the Purchaser,
- (iii) extinguish warranty obligations of the Contractor for the Goods already supplied, if any.

#### **14. Rights of Purchaser on defaults by Contractor**

Notwithstanding the rights of the Purchaser under the Contract, especially those mentioned in Clause 12 and Clause 13 above, additionally, the Purchaser shall be entitled to take recourse to any or all of the following actions:

- (a) Temporarily withhold payments due to the Contractor under this Contract, till recoveries due to invocation of other Contractual remedies are complete.
- (b) Record adverse performance of the Contractor for taking appropriate administrative action, including debarment.
- (c) Undertake Dispute Resolution and/ or litigation for the transgression of the law, tort, and loss, which are not addressable by the above means.

#### **15. Limitation of Liabilities:**

- (a) Except in cases of criminal negligence or wilful misconduct, the aggregate liability of the parties, whether under the Contract, in tort or otherwise, shall not exceed the total Contract Price (less payments already made in case of Purchaser), provided that this limitation shall not apply to the cost of repairing or replacing defective equipment/ work under Warranty/Guarantee Clause (Clause 10), or to any obligation of the Contractor to indemnify the Purchaser concerning IPR infringement.
- (b) Neither Party shall be liable to the other Party, whether in Contract, tort, or otherwise, for any indirect or consequential loss or damage, loss of use, loss of production, or loss of profits or interest costs, which the other Party may suffer in connection with the Contract, provided that this exclusion shall not apply to any obligation of the Contractor to pay liquidated damages to the Purchaser.

#### **16. Force Majeure:**

- (a) On the occurrence of any unforeseen event, beyond the control of either Party, directly interfering with the delivery of Goods arising during the currency of the Contract, such as war, hostilities, acts of the public enemy, civil commotion, sabotage, fires, floods, explosions, epidemics, quarantine restrictions, strikes, lockouts, or acts of God, the affected Party shall, within a week from the commencement thereof, notify the same in writing to the other Party with reasonable evidence thereof. Unless otherwise directed by the Purchaser in writing, the Contractor shall continue to perform its obligations under the Contract as far as reasonably practicable and shall seek all reasonable alternative means for performance not prevented by the Force Majeure event. If the force majeure

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condition(s) mentioned above be in force for 90 days or more at any time, either party shall have the option to terminate the Contract on expiry of 90 days of commencement of such force majeure by giving 14 days' notice to the other party in writing. In case of such termination, no damages shall be claimed by either party against the other, save and except those which had occurred under any other clause of this Contract before such termination.

- (b) Notwithstanding the remedial provisions contained elsewhere in the Contract, none of the Party shall seek any such remedies or damages for the delay and/ or failure of the other Party in fulfilling his obligations under the Contract if it is the result of an event of Force Majeure.

**17. Book Examination Clause:**

The Government reserves the right for 'Book Examination' as follows:

- (a) The Contractor shall whenever called upon and required to produce or cause to be produced, for examination by any Government Officer duly authorised in that behalf, any cost or other book of account, voucher, receipt, letter, memorandum, paper or writing or any copy of or extract from any such document. The Contractor shall also furnish information relating to the execution of this Contract or relevant for verifying or ascertaining the cost of executing this Contract to such Government Officer in such manner as may be required. The decision of such Government Officer on the question of relevancy of any document, information of return being final and binding on the parties. The obligation imposed by this clause is without prejudice to the Contractor's obligations under any other statute, rules or orders which shall be concurrently binding on the Contractor.
- (b) The Contractor shall, if the authorised Government Officer so requires (whether before or after the prices have been finally fixed), afford facilities to the Government Officer concerned to visit the Contractor's premises to examine the processes of production and estimate or ascertaining the cost of performance of Contract. The authorised Government Officer shall have power to examine all the relevant books of Contractor's Sub-Contractor, or any subsidiary or allied firm or company, if any portion of the Contract is entrusted or carried out by such entities.
- (c) If on such examination, it is established that the Contracted price is more than the actual cost-plus reasonable margin of profit, the Purchaser shall have the right to reduce the price and determine the amount to a reasonable level.
- (d) The Contractor or its agency is bound to allow examination of its books within 60 days from the date the notice is received by the Contractor or its agencies calling for the production of documents under sub-clause (a) above. In the event of the Contractor's or his agency's failure to do so, the Contract price would be reduced and determined according to the best judgment of the Purchaser, which would be final and binding on the Contractor and his agencies.

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#### **18. Payment of Taxes and Duties:**

- (a) The Contractor shall be fully responsible for all taxes, duties, fees, levies etc., incurred up to the point of delivery of the Goods to the Purchaser.
- (b) Goods and Services Tax (GST) shall be paid at the rate applicable or as assessed, provided the sale transaction is legally subject to such taxes and is payable according to the terms of the Contract, subject to the following conditions:
  - (i) Payment of GST to the Contractor shall be made only upon submission of a GST-compliant bill/ invoice by the Contractor. It shall be the entire and sole responsibility of the Contractor to ensure that the invoice must include the correct and appropriate HSN code and applicable GST rate.
  - (ii) The delivery must be recorded in the name, location, and GSTIN of the Consignee, and the location of the Office of the Purchaser shall have no impact on invoicing.
  - (iii) Purchaser shall not pay a higher GST rate, if leviable, due to any misclassification of HSN number or incorrect GST rate incorporated in the Contract due to Contractor's fault. If the Contractor invoices Goods with a GST rate or HSN number differing from those specified in the Contract, payment shall be made as per invoiced GST rate or the GST rate incorporated in the Contract, whichever is lower. In case GST rate invoiced is higher than the one incorporated in Contract, the Contractor shall be required to adjust his basic price to the extent required by the higher GST rate as per invoice to match the all-inclusive price mentioned in the Contract.
- (c) **Statutory Variation Clause:**  
Unless otherwise stated in the Contract, statutory variation (fresh imposition and/ or variation) in applicable GST rate or other taxes and duties mentioned in the Contract shall be borne by the Purchaser, for statutory variations occurring after the date of submission of the tender, as per the conditions of the Contract, including amendments if any. However, GST rate amendments shall be considered for the quoted HSN code only, against documentary evidence, provided such an increase in GST rates is after the tender submission date and shall not be applicable for any misquotation of the HSN number or GST rate by the Contractor. The Purchaser is not liable for any claim from the Contractor on account of fresh imposition and/ or increase (including statutory increase) of GST, customs duty, or other duties on raw materials and/ or components used directly in the manufacture of the Contracted Goods taking place during the pendency of the Contract- unless such liability is expressly agreed to in terms of the Contract.

#### **19. Deleted.**

#### **20. Code of Integrity: Misdemeanours and Penalties:**

**20.1** Parties to the Contract shall not indulge in following prohibited practices, either directly or indirectly, at any stage during the execution of Contract:

- (a) "Corrupt practice"- making offer, solicitation or acceptance of a bribe, reward or



gift or any material benefit, in exchange for an unfair advantage or an inducement or reward for performing or refraining from performing any act related to execution of the Contract, or any other Contract with the Purchaser or the Government. This also applies to actions intended to show favour or disfavour towards any person in relation to the Contract.

Additionally, if the Contractor, or anyone employed or acting on his behalf (with or without the Contractor's knowledge), breaches this condition or commits any offense under Chapter XII of the Bharatiya Nyaya Sanhita, 2023 (as amended) or the Prevention of Corruption Act, 1988 (as amended), or any other law enacted for the prevention of corruption by public servants, the Purchaser shall have the right to terminate the Contract, as well as any other Contracts with the Contractor, and take further actions as outlined below.

- (b) "Fraudulent practice"- Any act of omission or misrepresentation that may mislead or attempt to mislead so that financial or other benefits may be obtained or an obligation avoided during execution of the Contract.
- (c) "Coercive practice" — any act of inflicting harm or threatening to harm persons or their property to affect the execution of a Contract.
- (d) "Undue Advantage" - improper use of information obtained by the Contractor from the Purchaser with an intent to gain an unfair advantage in execution of the Contract or for personal gain.
- (e) "Obstructive Practice" — Any action that materially impede Purchaser investigation into allegations of one or more of the above mentioned prohibited practices either by deliberately destroying, falsifying, altering; or by concealing of evidence material to the investigation; or by making false statements to investigators and/ or by coercive practices mentioned above, to prevent it from disclosing its knowledge of matters relevant to the investigation or from pursuing the investigation; or by impeding the Purchaser's rights of audit or access to information.

#### **20.2 Obligations for Proactive Disclosures in case of Conflict of Interest:**

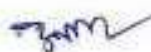
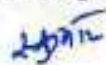
"Conflict of Interest"- Any personal, financial, or business relationship between the Contractor and any personnel of the Purchaser who are involved, either directly or indirectly, in the execution of the Contract.

Contractor is obliged under the Code of Integrity to suo-motu proactively declare any conflict of interest (coming under the definition mentioned above - pre-existing or as and as soon as these arise at any stage) in execution of the Contract. Failure to do so shall amount to a violation of Code of Integrity.

#### **20.3 Misdemeanours:**

The following actions shall be regarded as misdemeanours—if a Contractor, either directly or indirectly, engages in such behaviour at any stage during the execution of the Contract:

- (a) Violates the Code of Integrity;



- (b) Convicted of an offence under the Prevention of Corruption Act, 1988 (as amended) or under the erstwhile Indian Penal Code, 1860 (as amended) or under the Bharatiya Nyaya Sanhita, 2023 (as amended) or any other law for the time being in force for causing any loss of life or property or causing a threat to public health as part of the execution of a public procurement Contract;
- (c) Employs a government servant who has been dismissed or removed due to corruption;
- (d) Employs a non-official convicted of an offense involving corruption or abetment of such an offense, in a position where they could corrupt government servants;
- (e) Employs a government officer within one year of his retirement who has had business dealings with the Contractor in an official capacity before retirement.
- (f) Is determined by the Government to have doubtful loyalty to the country or national security consideration.

#### **20.4 Penalties for Misdemeanours:**

Without prejudice to and in addition to the rights of the Purchaser to other remedies as per the Contract, If the Purchaser concludes that a Contractor directly or through an agent has committed a misdemeanour in executing a Contract, the Purchaser shall be entitled, and it shall be lawful on his part to take appropriate measures, including the following:

- (a) Termination of the Contract, utilizing all remedies prescribed therein;
- (b) Forfeiture or Encashment of any Security Deposit associated with the Contract and
- (c) Recovery of any payments made by the Purchaser, including advance payments, along with interest at the prevailing Repo Rate (declared from time to time by RBI) prevailing on the date of such termination of the Contract.
- (d) In addition to the above penalties, the Purchaser shall be entitled and it shall be lawful for him to:
  - (1) File information against such bidder/ Contractor or any of its successors, with the Competition Commission of India for further processing, in case of anti-competitive practices;
  - (2) Initiate proceedings in a court of law against Contractor or any of its successors, under the Prevention of Corruption Act, 1988 (as amended) or under the Bharatiya Nyaya Sanhita, 2023 (as amended) or any other law for transgression not addressable by other remedies listed in this sub-clause.
  - (3) Remove Contractor or any of its successors from the list of registered/approved suppliers for a period not exceeding two years. Suppliers removed from the list of registered/approved vendors or their

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related entities may be allowed to apply afresh for registration only after the expiry of the period of removal.

- (4) Debar the Contractor from participation in future to Purchaser's procurements without prejudice to legal rights and remedies. Debarment shall automatically extend to all the allied firms of the debarred firm.

**20.5** Any dispute or difference in respect of the interpretation, effect, application, or recoverable amount under the aforementioned clauses by the Purchaser from the Contractor shall be decided by the Purchaser, whose decision there on shall be final and binding on the Contractor.



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## Annexure-IX

### Manufacturing Unit & Maintenance Depots – Coordinating Officer Contact Details and Proposed Familiarisation Visit Schedule

S.No.	Site	Co-ordinating Officer & contact details	Date of site Visit
<b>Manufacturing Unit</b>			
1.	Railway Manufacturing Unit, Kazipet	Shri. C.R.Krishna Reddy EME/Plg/Hqrs South Central Railway Mob. No: 9701370498	
<b>Maintenance Depots</b>			
1.	MEMU Depot, Rajahmundry	Shri. Dadi Prasad ADEE/MCS/RJY South Coast Railway Mob. No: 9701373782	
2.	MEMU Depot, Khurda Road.	Shri. Soumya Kanti Das, DEE (MEMU) East Coast Railway Mob. No: 8455881310	
3.	MEMU Depot Jhajha	Shri.A.K.Maurya CESE, East Central Railway Mob. No: 9771425302	
4.	MEMU Depot Kanpur	Shri.Ritesh Lalwani DEE/MEMU/CNB Mob. No: 9236451365	
5.	MEMU Depot Vadodara	Shri. Arjun Shroff Sr.DEE/MEMU/BRC Western Railway Mob. No: 9724091309	





भारत सरकार  
रेल मंत्रालय

Government of India  
Ministry of Railways

## Specifications and Standards for 130 km/h New Generation Non-Air-Conditioned Intercity Trains

Specification No.: ICF MD SPEC-483, ISSUE STATUS-01, REV-00,  
April-2026

<b>NUVVULA SITA RAMA PRASAD</b> Digitally signed by NUVVULA SITA RAMA PRASAD Date: 2026.04.02 16:54:13 +05'30'	<b>CHIRAYIL RAMACHANDRAN HARISH</b> Digitally signed by CHIRAYIL RAMACHANDRAN HARISH Date: 2026.04.02 16:06:27 +05'30'	<b>VINAY KUMAR GARG</b> Digitally signed by VINAY KUMAR GARG Date: 2026.04.02 18:34:11 +05'30'	<b>MANISH THAPLYAL</b> Digitally signed by MANISH THAPLYAL Date: 2026.04.03 12:35:43 +05'30'
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### ABBREVIATIONS

The following abbreviations are used in these Specifications and Standards:

Abbreviation	Full Name
AAR	Association of American Railroad
AC	Alternating Current
AF	Audio Frequency
ASHRAE	American Society of Heating, Refrigeration and Air-conditioning Engineers
ADD	Automatic Dropping Device
ATP	Automatic Train Protection
AWS	Auxiliary Warning System
BG	Broad Gauge
BP	Brake Pipe
BPAC	Block proving by Axle Counter
BS	British Standards
CBC	Centre Buffer Coupler
CTC	Centralized Traffic Control
DC	Direct Current
EER	Energy Efficiency Ratio
EI	Electronic Interlocking
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EN	Euro Norm (European Standard)
EMU	Electrical Multiple Unit
EP	Electro Pneumatic
EOTT	End of Train Telemetry
ETBU	Emergency Talk Back Unit
ETCS	European Train Control System
FEA	Finite Element Analysis
FEM	Finite Element Method
FOIS	Freight Operations Information System
GPS	Global Positioning System
GSM	Global System for Mobile
GSM-R	Global System for Mobile – Railways



<b>Abbreviation</b>	<b>Full Name</b>
HL	Hazard Level as defined in EN 45545
HT	High Tension (Voltage) (according to Indian Electricity Rules)
HMI	Human Machine Interface as defined in EN 16186-3
IBH/IBS	Intermediate Block Hut/Station
IC	Integrated Circuit
IEC	International Electrotechnical Commission
IER	Indian Electricity Rules
IEEE	Institution of Electrical and Electronic IR/ IR Nominated Agencies
IGBT	Insulated Gate Bipolar Transistor
IR	Indian Railways
IRS	Indian Railway Standards
IRSEM	Indian Railways Signal Engineering Manual
IRSOD	Indian Railway Schedule of Dimensions
IS	Indian Standard
ISO	International Standards Organization
KAVACH	Indian Railway Train Collision Avoidance System (TCAS) to RDSO Specification No. RDSO/SPN/196/2020 Version 4.0 with all amendments or latest.
km/h	Kilometers per hour
LED	Light Emitting Diode
LTE	Long Term Evolution
MACLS	Multi Aspect Colour Light Signaling
MCB	Miniature Circuit Breaker
MMD	Maximum Moving Dimension
MR	Main Reservoir
NF	Norme Française (French Standard)
OEM	Original Equipment Manufacturer
OHE	Over Head Equipment
ORD	Over Reach Detection
ORE	Office for Research and Experiments
PA	Public Address
PCB	Printed Circuit Board
PI	Panel Interlocking

<b>Abbreviation</b>	<b>Full Name</b>
PIS	Passenger Information System
PRS	Passenger Reservation System
PWD	Persons with Disabilities
RAMS	Reliability, Availability, Maintainability and Safety
RDSO	Research Designs & Standards Organization, Manak Nagar Lucknow -226011
RMVU	Roof Mounted Ventilation Unit
SI	Système Internationale
SIL	Safety Integrity level as per IEC 61508
SDH	Synchronous Digital Hierarchy
SMC	Sheet Moulding Compound
STM	Synchronous Transport Module
TCMS	Train Control and Management System
TMS	Traffic Management System
TPWS	Train Protection and Warning System
TS	Train Superintendent
UHF	Ultra-High Frequency
UIC	Union Internationale des Chemins de Fer (International Union of Railways)
UL	Underwriters Laboratories
UTS	Unreserved Ticketing System
VHF	Very High Frequency
VCU	Vehicle Control Unit
VVVF	Variable Voltage Variable Frequency
WC	Water Closet (i.e. a flush toilet)

## Definitions and Interpretation

Unless the context otherwise requires, capitalized terms not defined in this Schedule shall have the same meaning ascribed to such terms in the Agreement. Capitalized terms which are not defined herein or in the Agreement, shall have the meaning ascribed to such terms in the applicable standards. The abbreviations used in this Schedule shall have the full form ascribed to them in the Glossary. For this Specifications and Standards for New Generation Non-AC Intercity Trains (the “Schedule”), the following words and expressions shall, unless repugnant to the context or meaning thereof, have the meaning hereinafter respectively assigned to them:

Term	Definition
Agreement	Procurement-cum-Maintenance Agreement for Non-AC New Generation Non-AC Intercity Trains
Nominated Agency	Agency Nominated by Purchaser for the purpose of carrying out Design Approvals, Tests, Trials etc. required as per the agreement. Such agency will act on behalf of purchaser and guide purchaser.
BG	Shall mean 1676 mm broad gauge used in IR
Car	Shall mean a passenger carrying rail vehicle, either powered or non-powered, built in conformity with the provisions of these Specifications and Standards
Driving Cab	Shall mean a cabin, segregated from the passenger area, and situated at both the ends of a Train, and includes the equipment and Sub-systems forming part thereof
Driving Car	Shall mean a Car having Driving Cab and positioned at either end of the Train
Human Machine Interface (HMI)	Shall mean the interface between the system or equipment and the human interfacing with that equipment
IP or Ingress Protection	Shall mean the degree of protection provided by enclosures in accordance with IEC 60529
Basic Unit	Shall mean a composite unit of four Cars comprising of Motor and Trailer Cars
End Basic Unit	Basic unit with Driving Car
KAVACH	Indian Railway Train Collision Avoidance System to RDSO Specification No. RDSO/SPN/196/2020 version 4.0 with all amendments or latest
Middle Basic Unit	Basic Unit without Driving Car but with shunting panel
Propulsion Equipment	Shall mean and include traction converters, traction motor, transformer, Auxiliary converters and electronics (hardware and software for propulsion system) and other electrical systems.
Rail Level	The plane which passes through the top of the cross-sectional center line of both running rails
Reliability	Shall mean a high degree of probability that an equipment or system can perform a required function under specified conditions for a specified period, in conformity with the operational parameters specified in the document.

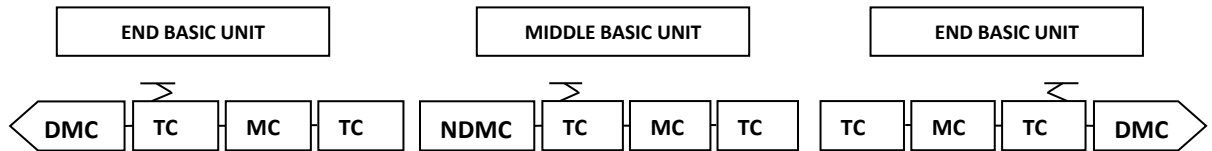


Rolling Stock	Shall refer to the fleet of rail borne cars with flanged wheels designed to operate on guiding rails, for carrying passengers. The words “Rolling Stock” and “Trains” as used in this Specifications and Standards are interchangeable;
SiC	Silicon Carbide based switching devices (MOSFET & DIODE)
Sub-system	Shall mean and include all equipment(s) forming part of such sub-system
TCMS	Train Control and Management System (TCMS) is a modular, scalable, secure, standard control and communication platform, which manages and controls the flow of information among various Sub-systems like Loco Pilot’s control, converters, doors, brakes, PIS, lighting, ventilation system etc. TCMS allows for efficient & reliable Train operation with in-built redundancy. It generates diagnostic messages useful in Train operation, troubleshooting, maintenance and communicates with the wayside control centers
Train	Shall mean a series of Cars hauled as a single unit by integral motors for transporting Users on the Railway Network.
Train/loco Pilot	Shall mean the person in the Driving Cab who is in control of the operation of the Train
Transmission and Suspension System	Shall mean system comprising traction gears, gear case, traction rod arrangements (if any), primary and secondary suspension springs and dampers with bogie frame
Others	Any capitalized term used herein not specifically defined shall have the meaning ascribed to such term in the Agreement
VDE	Verband der Elektrotechnik, Elektronik und Information stechnik. The VDE is the Association for Electrical, Electronic and Information Technologies and their related sciences, technologies and applications.
Vehicle	Shall mean and include powered and non-powered cars

## Chapter 1 - General Technical Requirements

### 1.1 General

- 1.1.1 The Trains shall conform to the technical requirements of design, development, manufacture, testing, commissioning and maintenance as per the Specifications and Standards set forth in this Schedule for operating on Railway Network.
- 1.1.2 The Train shall be Distributed Power type which shall have Driving Cabs on its both ends and shall be capable of running in either direction without the requirement for any change in its composition. Configuration shall be of 16 cars which shall be expandable to 20 cars and up to 24 cars and can be reducible to 12 cars. The orientation of the train configuration shall be preferably of 12 + 4 (i.e., 12 cars facing in one direction and 4 cars facing in opposite direction) which will be finalized during design stage. The percentage powering shall not less than 50%, to meet all the performance requirements of the specification. Each Middle Basic Unit shall be provided with a detachable handheld shunting unit panel, which shall facilitate movement of a single middle basic unit for the shunting purpose. The configuration of US EMU rakes being manufactured by IR is as under (12 cars formation as indicative reference):



**DMC+ TC+ MC+ TC+ NDMC+ TC+ MC+ TC + TC + MC+ TC + DMC**

- 1.1.3 The environmental and service conditions, performance & technical requirements are specified in these Specifications and Standards.
- 1.1.4 The design and manufacture of the Train and the various Sub-systems thereof shall be based on the requirements set out in these Specifications and Standards and in accordance with Good Industry Practice.
- 1.1.5 Due consideration shall be given at design stage to ambient conditions of dust, moisture, high temperature and vibrations prevalent in India, as specified in Clause 1.6 of this Schedule.
- 1.1.6 The Technology Partner shall comply with the requirements specified in Chapter 5 of this Schedule with regard to Design and Drawings. The Testing and Acceptance of the Trains shall be carried out by RDSO/IR Nominated Agency in terms of the provisions of Chapter 6 of this Schedule.
- 1.1.7 The Trains shall conform to the design requirements set out in this Schedule, which are the minimum prescribed. The Technology Partner shall be solely responsible for undertaking all the surveys, investigations and detailed designs with reference to different type of train working on various routes on Indian Railway in accordance with Good

Industry Practice and shall have no claim against the Government for any loss, damage, risks, costs, liabilities or obligations arising out of or in relation to such surveys, investigations and designs

- 1.1.8 Where practical and unless otherwise stated, all requirements in this Schedule shall apply together simultaneously.
- 1.1.9 The Bidder shall furnish clause-by-clause compliance on this technical specification. Clause by clause compliance to the specification shall only be considered for evaluation of offers. It shall be the responsibility of the Technology Partner to meet the specification as per the clause-by clause compliance.
- 1.1.10 The train should be fully vestibuled with wider gangways with full train interconnectivity for passengers.
- 1.1.11 Major Propulsion system e.g. Traction Converter, Aux. Converter, Main Transformer, etc. shall be underslung mounted.
- 1.1.12 All underslung mounted equipment shall have a positive mounting arrangement.
- 1.1.13 Underslung equipment Covers shall be so designed that in the event of failure of a locking device in service, covers shall remain captured and shall not infringe the Kinematic Envelope. Otherwise, cover retention catches shall be provided to prevent covers from accidentally falling off.
- 1.1.14 All under-floor-mounted rotating machinery shall be fitted with resilient mountings to eliminate transmission of mechanical vibrations to the car body.
- 1.1.15 Technology Partner shall submit technical details as per **Annexure IX** along with technical specification, functional specifications, block diagrams, schematic drawings, ratings, load calculation, simulation results for train performance, circuits, wiring diagrams, design of converter, inverter and other power & control equipment, weight balancing calculations, train control networking, protocols used and the software details for carrying out modifications as permissible. The loading of electronic equipment/components calculated under the ambient conditions as specified, RMVU design and component rating etc. shall be got approved. While the aspects covered, as above, are not exhaustive, the Supplier shall supply/furnish complete technical details with respect to their system and equipment design and to the satisfaction of IR at the time of design approval. The Technology Partner shall supply comprehensive electrical design documentation, including detailed schematic diagrams, wiring harness preparation charts, and 2D/3D layout drawings of all electrical equipment. Additionally, complete cable routing drawings with branch cable details up to end terminations—including terminal blocks and other electrical switchgear—shall be provided in 3D format, compatible with Capital (E-CAD) software or any other platform as advised by Indian Railways (IR) during design stage.

## 1.2 References to various Standards

1.2.1 The standards applicable and relevant to the complete Train and to the various Sub-systems and systems shall be:

- (i) IEC publications;
- (ii) EN;
- (iii) UIC;
- (iv) AAR;
- (v) IEEE;
- (vi) BS;
- (vii) RDSO specifications;
- (viii) ICF/RCF specifications;
- (ix) NF-F;
- (x) ORE;
- (xi) VDE;
- (xii) UL;
- (xiii) JIS
- (xiv) IS; and
- (xv) Any other standards referred to in this Schedule.

In the event of any contradiction in the aforesaid standards, the following standards shall have priority in the order listed:

- (i) Standards mentioned in these Specifications and Standards set forth herein;
- (ii) EN /IEC/UIC/AAR and
- (iii) IS.

For avoidance of any doubt, in case of any conflict between the requirements of these standards, the stipulations of Specifications and Standards in this Schedule shall have precedence.

1.2.2 The design of the Train and the Sub-systems and systems thereof shall comply with the standards specified at **Annexure-IV**. The temperature rise shall be measured according to the procedure stipulated by IEC and shall comply with the limits specified and the ambient conditions defined in the Specification. Specified temperature rise of equipment shall be calculated after taking into account at least 25% choking of air filters and radiator fins etc.

1.2.3 The latest version of the aforesaid standards, which have been published at least 60 (sixty) days prior to Bid Due Date shall be considered applicable.

### 1.2.4 Alternative Standards

The requirements listed in these Specifications and Standards are the minimum. The Technology Partner may adopt alternative internationally recognized codes, standards and specifications, if it can demonstrate to RDSO/Nominated Agency/Purchaser that such alternative is superior or more pertinent to the Train than the standards specified in these Specifications and Standards. The Technology Partner shall seek the prior approval of RDSO//Nominated Agency/Purchaser for any alternative standards proposed to be used.

### 1.3 Reliability, Availability, Maintainability and Safety (RAMS)

#### 1.3.1 General

The Technology Partner shall design the Train to ensure Guaranteed Reliability, Guaranteed Punctuality and high degree of safety in order to provide a dependable service. The optimization of the system with respect to reliability, availability, maintainability and safety shall form an integral element of these Specifications and Standards. The plan for reliability, availability, maintainability and safety shall conform to EN 50126/ IEC 61709/ IEC 62278. Reliability of electronic components shall conform to IEC 61709.

1.3.2 Technology Partner shall ensure to identify the components critical for safety that shall fall into safe operating mode in case of malfunctioning. The system safety plan shall identify and list safety critical components and this list shall be updated periodically.

1.3.3 Safety Assessment shall be carried out and shall include the following principles:

- i. Degraded modes and emergency operations shall be considered as well as normal operations;
- ii. Safety risk assessment shall utilize more than one methodology to assess risks; and
- iii. Safety risk assessment shall include the consideration of dependent failures, in particular the traction power, braking and control systems.

1.3.4 The scope of work shall also include Submission of final drawings, design calculations and other documents including operations and maintenance manuals;

#### 1.3.5 Troubleshooting Directory:

For quick guidance of Train operator and Maintenance staff, a summarized menu driven, user friendly Trouble Shooting Directory (TSD) shall be made available on HMI. The TSD shall have separate login modes for operators and maintainers. Extensive use of graphics shall be made in TSD for better understanding of the Train Operator. Details shall be decided during the design & revenue service period. Mobile app/Desktop app to be developed to display the faults and HMI screens for acknowledgement and diagnostic purposes. The TSD shall be editable by authorized maintenance personnel.

##### 1.3.5.1 Maintainer Mode

###### i) Highlighted FBD

The maintainer mode of TSD shall display detailed Functional Block Diagram (FBD) for the fault detection software logic wherein the relevant pathways of the logic diagram tree that triggered the fault shall be highlighted on the maintenance diagnostic tool software installed on the maintenance laptop.

###### ii) Input Output Signal State

The TSD shall also display the real-time states of the various input and output signals related to fault detection logic in tabular form.



**iii) Action Items**

Detailed action item text containing description of fault logic, possible failed device(s) info, troubleshooting instructions and corrective action as collapsible blocks of text shall be included on the TSD screen. This text shall be colour coded so as to indicate the most pertinent points for any particular failure.

**iv) Mode Switch**

It shall be possible to switch from maintainer mode to operator mode of TSD without logging out of TCMS maintainer mode but not vice-versa.

**1.3.5.2 Operator Mode**

**i) Graphics and Animations**

The operator mode of TSD must include graphics and animations that shall be developed corresponding to all the failed devices, all the failure cause identifications and all the proposed corrective actions for each of the faults. These graphics shall be submitted for review of IR/ IR Nominated agency and shall be promptly updated as per his decision.

The detailed proposal for the same shall be submitted during design phase and shall include a listing of all media files being provided in the TSD library.

**ii) Locational mapping**

The locational mapping of these graphic files with various train equipment and various fault codes shall also be submitted. The colour highlights and transition effects possible with the graphics shall also be made part of the proposal.

**1.3.5.3 Intelligent Analysis**

The TSD shall be smart enough to group together related faults (i.e. faults that have the same root cause) and provide guidance in a combined view for such faults. The various FBD logical pathways as requested above shall be distinguished in this case with different colours.

#### 1.4 Traction Power supply system

The power supply system adopted by the Government for operation of the trains is 25 kV, 50Hz single phase AC with following features:

Nominal supply voltage	25 kV (RMS), 50 Hz, single phase, AC
Normal variation in supply voltage	19 kV to 30 kV (RMS)
Voltage range for Train to operate in full compliance with these Specifications and Standards	22.5 kV to 29 kV
Occasional maximum voltage	30 kV (RMS)
Occasional minimum voltage	16.5 kV (RMS)
Normal variation in frequency	48.5 Hz to 51.5 Hz
Stagger of the contact wire	± 200mm on straight track Up to +300mm on curves
Normal contact wire height in mid span	5.5 m from Rail Level
Max. contact wire height	5.8 m from Rail Level (7.5 m in DFC for High Reach pantographs)
Min. contact wire height	4.54 m from Rail Level
Neutral sections	After around every 25 to 50 km Note: (i) Three types of Short Neutral Section of length 5.48 m, 9.5m & 14m are being used on IR. (ii) Overlap Type Neutral Section of 41m Length as per RDSO Drawing No. ETI/OHE/G/02161-Rev C is being used on IR.
Feeding zone for traction substation	There may be 3 - 4 block sections on each side fed by the traction substation.
Max. continuous OHE current rating	600 A.

**Note:**

- i) Pantograph bounce time- up to 45ms (limit of zero pressure contact) may also be considered.
- ii) It is to be noted that 'Minimum contact wire height of 4.54m from rail level' in para 1.4 is applicable to rolling stocks not higher than 4.27m with minimum electrical clearance of 250mm and track maintenance allowance of 20mm. For any rolling stock offered higher than 4.27 m, minimum static & dynamic clearance from contact wire & over line structure on the electrified route as per IRSOD (BG)-2022 with latest amendments/correction slips should be met. As few trains are envisaged to be operated under high rise OHE, parameters of High-rise OHE shall be considered to design the system duly maintaining electrical clearances as per IRSOD(BG) 2022 along with all amendments /correction slips.

- iii) The maximum current drawn by a 16-cars loaded Train to meet the performance requirements of this specification at 22.5 kV shall not exceed 540 A. It should be possible to run the train up to 24 cars formation with suitable parametric changes to take care that train current at 22.5 kV shall not exceed 600A. Regenerative braking system shall continue to operate when the supply voltage is in the range from 17kV to 30kV. Train operation shall be feasible at OHE voltage of 16.5 kV, may be with restricted power, however, the reduction in power below 22.5 kV should be proportional to reduction in voltage.

## 1.5 Track parameters

The track parameters of the Government shall be the following:

Gauge	Broad Gauge 1676 mm
Schedule of dimension	Indian Railways Schedule of Dimensions for Broad Gauge (1676 mm) Revised, 2022 with latest addendum and corrigendum slips
Sharpest curve to be negotiated	145.83 m radius(horizontal); 2500 m radius (vertical)
Sharpest reverse curve to be negotiated	145.83 m radius (horizontal) back to back with or without any straight portion in between
Sharpest turnout to be negotiated	6400 mm overriding switch (curved) BG (1673 mm) for 60 kg (UIC) or 52 kg rail for 1 in 8½ (crossing angle, tan $\theta$ ) turnouts on pre stressed concrete sleepers
Maximum super elevation	185 mm for design 165 mm for operation
Maximum cant deficiency	150 mm
Maximum gradient	1: 37
Permitted track tolerances	The track shall be maintained to as per provisions of Indian Railways Permanent Way Manual, 2024 (with latest amendment), containing track geometry standards under Para 522. Oscillation trials would be conducted on track having parameters decided on the basis of prevailing track tolerances of Indian Railway based on EN 14363:2016 methodology ( <b>Annexure-VII</b> ).

Indian Railways Permanent Way Manual 2024 (with latest amendment) & its latest amendments specify the maximum cant deficiency as 150 mm. Speed on curve shall be decided on the basis of Indian Railways Permanent Way Manual, 2024 (with latest amendment). In case of cant deficiency of more than 150 mm, if the rolling stock is able to negotiate on curves within parameters of safety and also the forces assessed on track are within limit, the Rolling Stock would be acceptable. However, such a case would require sanction of the Railway Board.

## 1.6 Climatic and Environmental Conditions

1.6.1 The climatic and environmental conditions prevailing in India are the following:

Atmospheric Temperature	Minimum temperature: - 10°C Maximum temperature: 50°C Maximum touch temperature of metallic surface under the Sun: 75°C and in shade: 55°C
Humidity	100% saturation during rainy season
Solar radiation	1 kW/m <sup>2</sup>
Altitude	1776 m above mean sea level
Rainfall	Very heavy and continuous rainfall in certain areas (up to 2500 mm during rainy season)
Atmospheric conditions	Extremely dusty and desert terrain in certain areas. The dust concentration in air may reach a high value of 1.6 mg/m <sup>3</sup> . In many iron ore and coal mine areas, the dust concentration is very high affecting the filter and air ventilation system
Coastal area	Humid and salt laden atmosphere. The equipment shall function in accordance with this Specification when subjected continuously to a humid and salt laden atmosphere with maximum pH value as per IEC 60571, sulphate content of 7 mg per liter, maximum concentration of chlorine 6 mg per liters and maximum conductivity of 130 micro-Siemens / cm.
Vibration	The vibration and shock levels recorded on various Sub-systems in existing Trains of IR are generally more than the limits given in IEC 61373 particularly at axle box, and traction motor. Accelerations over 50 g have been recorded at axle box levels during run. Vibrations during wheel slips are of even higher magnitude. High levels of vibrations above 30 g have been measured at traction motor on IR's Trains, which increase up to 50 g with worn gear- pinion. Because of track irregularities, level of shocks and vibrations to which traction motors are exposed are far more than actually given in IEC for Traction Motor (TM) mounting arrangement. Technology Partner to carry out instrumented trials if considered desirable on existing stock for measurement of shocks and vibrations at design stage. The suspension system and the mounting arrangement of underslung / bogie mounted equipment shall be so designed that the equipment performance is not adversely affected due to such high vibrations and shocks.

Wind speed	High wind speed in certain areas, with wind pressure reaching 216 kg/m <sup>2</sup> .
Flood level	<p>The Train shall function in accordance with these Specifications and Standards in the event of flooding up to 203 mm above Rail Level as follows:</p> <ul style="list-style-type: none"> <li>• In the event of flooding at any level below Rail Level, the Train shall operate in full compliance with these Specifications and Standards.</li> <li>• In the event of flooding at a height between Rail Level and 203 mm above Rail Level, the Train shall operate in full compliance with these Specifications and Standards with the exception that it is permissible to restrict the operation of the Train to a maximum of 8 km/h.</li> </ul> <p>Allowance is to be made in addition for increase in the height of water level due to the “bow wave” effect of the Train passing through the water.</p>
Flood Proofing of the under-slung Equipment	<p>The traction gear and other equipment viz power converter-inverter, auxiliary converter, main transformer, Battery Box shall be water-proof to a standing depth of 650 mm (from Rail level under fully wheel worn condition) and Main Compressor, Air dryer, Traction Motors shall be water-proof to a standing depth of 400 mm (from Rail level under fully wheel worn condition)</p> <p>Waterproofing test shall be conducted on Traction &amp; Auxiliary Converter, main transformer, main compressor, battery box and other equipment to ensure ingress protection on this equipment by dipping them up to a height specified as above in stationary water for 24 hours. After immersion and normal drying (removal of free water, drainage and wiping of exterior surfaces only, without opening enclosures or replacing parts), the equipment shall be energised and successfully complete full functional tests at rated voltage and load. There shall be no water ingress in the area protected for compliance of the specified performance of the equipment and equipment shall function normal after the test. Traction Motor with gearbox shall be tested for waterproofing as defined in <b>clause 3.9.15.1</b> Axle box assembly including seals and housing shall be verified for water tightness in accordance with EN 12082-1:2025. All the other equipment mounted in the underframe shall be so designed that in case of flooding as above, it shall be possible to put them back into service with minor overhaul, cleaning etc. Other underslung equipment shall have IP protection as mentioned in <b>clause 3.1.9</b> and <b>3.1.10</b>. In case of flood levels more than the mentioned above, the equipment shall not be damaged, and it should be possible to rejuvenate the equipment without any adverse effect on their performance and it shall be possible to recover the Rake to full functionality after water recedes. In case flooding is up to the levels mentioned in this clause, it shall be possible to energize the Rake and move it to the New Maintenance Depot/Car shed on self-power. The Technology Partner shall collect the flood level data of Mumbai Suburban system during design stage.</p>

**Note:** In developing the detailed design, the Technology Partner shall acquaint himself and take note of the environmental operating conditions prevailing on IR especially during heavy monsoon, track flooding conditions, saline, humid and dusty atmosphere etc.



## 1.7 Signal and Telecommunications

- 1.7.1 The tracks over which the Trains shall work may be equipped with Semaphore/Multi Aspect Colour Light Signalling. The train detection may be through DC Track Circuit / Audio Frequency Track Circuit / Axle Counter. Block working may be Absolute Block system / Automatic Block system. Important minimum Signalling features of various standards of Interlocking prevailing in Indian Railways are stipulated in Para 7.131 of IRSEM Part I. The telecommunication system includes OFC, Quad cable, mobile train radio communication. However, to know the prevailing signalling & telecommunication system in the offered section, Technology Partner is expected to visit the section.
- 1.7.2 The Technology Partner shall make provision for full interface of control system with ATP system like KAVACH/TPWS/AWS/ETCS (procured by IR) and RTIS (Real Time Information System) in the offered section or provided in near future. Rolling stock shall have compatibility with the ATP system where- ever it is available in the section and interfaces as required. Technology Partner shall provide necessary space and mounting arrangements required for installation of ATP system and RTIS in the rolling stock. The Driver Machine Interface (DMI) shall be fitted towards the Loco Pilot side. The train will be commissioned with full installation of the KAVACH system. The procurement of the KAVACH system and RTIS will be done by IR.
- 1.7.3 CTC/TMS may be existing in the offered section or may be provided in near future.
- 1.7.4 EMI/EMC Compatibility of Rolling stock with signalling & telecom system provided in the offered section shall be tested as per EN-50238 or equivalent standards by accredited test agency/RDSO to ensure that the same are within specified limits.
- 1.7.5 The rake shall be certified for EN-50121 or equivalent standards for radiated EMI for which rolling stock shall be tested by accredited test agency and ensured that those are within specified limits.
- 1.7.6 The functioning and performance of existing signalling & telecom gears shall not get affected with the running of rolling stock. Rolling stock should not infringe with prevailing signalling & telecom gears in the section.
- 1.7.7 Wheel diameter and profile of rolling stock shall be as such that it is positively counted by axle counter.
- 1.7.8 RDSO specifications of various signal & telecom equipment are available on RDSO's website.
- 1.7.9 Telecommunication Cables based system
  - 1.7.9.1 Armoured Optical Fiber Cable (OFC) using mono-mode fibres in 1300 nm to 1550 nm band is laid along the track.
  - 1.7.9.2 Underground Railway Jelly Filled Quad Cable is laid along the track for providing telecom circuits.

1.7.10 Radio Communication based systems are working in IR in following frequency range given below:

SYSTEM	FREQUENCY RANGE
GSM-R	907.8 – 909.4 MHz (uplink) 952.8 – 954.4 MHz (dnlink)
LTE	713 - 718 MHz (uplink) 768 - 773 MHz (dnlink)
VHF-Walkie-Talkie	136-174 MHz
TETRA	380-400 MHz
MPT-27	330-360 MHz

SYSTEM	FREQUENCY RANGE	Remarks
MPT-27	330-360MHz	For Suburban Trains in Churchgate-Virar section of Western Railway for TMS
Digital Microwave	7125-7425MHz	Few may be existing
Locotrol /EOTT etc.	452-458MHz	Future system
Real Time Train Information System (a) Radio Frequency  (b)GSM/CDMA Frequency	2.4GHz  850/900/1800/ 1900/2100MHz	Future system

The train should be equipped with a compatible Cab radio in the section for mobile communication.

1.7.11 Train shall not affect normal working of Public Address system / Wi-Fi system / IP based video surveillance system / Passenger information systems provided on station platforms in the section.

1.7.12 IR is going for an advanced Train protection system in a gradual manner. It is likely to have following features:

- i) Kavach (RDSO specification RDSO/SPN/196/2020 version 4.0 with all amendments or latest may be referred for guidance).
- ii) The dimensions of the on-board equipment shall be finalized at design stage.

- iii) The Technology Partner shall coordinate with the OEM of KAVACH for suitable arrangement/interface for Brake interface arrangement and interface of track-side equipment. IR will facilitate the co-ordination between OEM and the Technology Partner.
- iv) Limit of Second Harmonic: The second harmonic current component 100 Hz & 83.33 Hz shall not exceed 8.5 A. The Technology Partner shall submit curves of harmonic currents vs load current per motor coach and per basic unit for rake configurations. These limits are over and above those given in Annexure V.

### 1.7.13 Cyber Security

- 1.7.13.1 The Technology Partner shall adopt and develop an information security framework, security plan and a thorough SDLC process that integrates risk management for protection against malicious and inadvertent manipulation of data transmitted over Train Control System to maintain the confidentiality, availability and/or integrity of Train Control System and wireless data transmission. This plan must be regularly reviewed, updated and accepted through a process of security certification, access control, gateway security, communications security, physical security. The manipulation may be caused by malicious activity like intrusion, hacking, phishing, wireless signal jamming, physical tampering, damaging critical communication cable or nodes; accident. The Technology Partner must demonstrate practically, the ability of the system to proactively detect, contain, eradicate and recover from a security breach.

The Technology Partner shall define procedures for assured operations and continuous monitoring of the security controls.

Relevant Standards for compliance: -

- a. ISO 27005
- b. IEC 62443
- c. TS 50701

Minimum Cyber Security measures such as, Backup and Disaster recovery, Antivirus, perimeter security devices (firewall, IPS/IDS, Proxy), Active Directory and Domain server, Encryption for data transmission and SAN storage server on a Centralized network as applicable. Also, shall cover Identity and Access Management, Application Security, threat and vulnerability management. For this purpose, Technology Partner shall engage a Cyber Security Consultant, who will recommend Cyber Security Guidelines complying the requirements of above standards.

- 1.7.13.2 The Technology Partner shall be required to engage with designated Cyber Security Consultant at the early stage of design development. The Technology Partner shall consider the inputs of Cyber Security Consultant into their design and develop their System Safety & Cyber Security Assurance Plan and submit to IR/ IR Nominated agency for approval. Cyber Security Consultant shall verify the implementation of the cyber security requirement as per international standards IEC62443, TS50701, ISO 27005 etc.
- 1.7.13.3 The Technology Partner shall be fully responsible for compliance with Cyber security standards and implementation of their System Safety & Cyber Security Assurance
- 1.7.13.4 **Cyber Security Assurance:**  
Notwithstanding the cyber security requirement defined elsewhere, the design of the RS system should comply with relevant clauses of ISO 27005, IEC62443 and TS50701, while designing and implementing the cybersecurity solution for the RS system. The RS Technology Partner has to ensure non-interference of security functionalities from safety. The RS Technology Partner shall define procedures for assured operations and continuous monitoring of the security controls. The Technology Partner must ensure a non-intrusive, passive, real time continuous monitoring of the Rolling Stock Control network (TCMS, PA/PIS and passenger Wi-fi networks) has no negative impact on the operation of the system. The system should be capable of understanding the railway protocols, asset types in real time in the rolling stock network. The RS Technology Partner has to ensure next-generation threat detection to safeguard the operational network and from emerging cyber threats and ensure regulatory compliance.

**Major security objectives should include the following:**

1. Restricting logical access to the network and network activity Restricting physical access to the network and devices.
2. Restricting unauthorized modification of data.
3. Detecting security events and incidents.
4. Maintaining functionality during adverse conditions and restoring the system after an incident.
5. Restricting hacking, phishing, malware, DOS attack etc.

The Technology Partner shall be fully responsible for compliance with Cyber security standards and implementation of their System Safety & Cyber Security Assurance Plan. Any cost associated with implementation of Cyber security guidelines shall be deemed to be included in the bid proposal.

## 1.8 Passenger Capacity and Payload

1.8.1 The 12/16/20/24 cars Non-AC Intercity train set shall have minimum number of passengers as follows at 8 passengers/m<sup>2</sup> capacity:

Formation	Sitting	standing	Total
12 Cars	1128	2862	3990
16 Cars	1512	3850	5362
20 Cars	1896	4838	6734
24 Cars	2280	5826	8106

1.8.2 In the driving cab, space shall be provided for carrying diagnostic tools required for online attention of the train.

1.8.3 The capacity indicated above is the minimum and the Company shall endeavor to optimize the space available in each Car for increasing the same in terms of sitting/Standing Passenger Capacity.

1.8.4 The Technology Partner shall design all types of cars for payloads as per UIC 566/EN 12663 (Category-P1) such that the axle load of each Car is within the maximum axle load limitation specified in this Schedule.

1.8.5 Weight of 60 kg per passenger shall be considered per passenger for arriving at gross weight of Train and standing capacity is calculated based on 8 passengers/m<sup>2</sup> of free space excluding the space between the seats.

1.8.6 The length of the coach shall be guided by IRSOD 2022 with latest amendments.

1.8.7 The weight distribution shall also take in account the compliance to UIC 566, EN 12663.

1.8.8 The notional leading particulars of the driving cars and non-driving cars are set out in the following Table

<b>Maximum axle load</b>	<b>20.32 Tonne</b> (including all tolerances as per applicable Standards)
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### 1.8.9 Station Platforms

Indian Railways has platforms of various heights indicated below:

(i)	Height above rail level for high passenger platforms	840mm maximum 760mm minimum
(ii)	Maximum Height above rail level for medium level passenger platform	455mm

**Note:**

- (a) Platforms may be flush with rail level.
- (b) The height for Mumbai suburban passenger platform and Pune suburban passenger platform may be in the range of 840mm-900mm.
- (c) The Cars shall have suitable safe and comfortable arrangement to allow users to board and alight from the train at stations having platform heights mentioned above.

1.8.10 The Cars shall have the provision for ground-level maintenance access for critical & safety items, passenger emergency evacuation and fire / rescue access to the Car interior.

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## Chapter 2 -Performance Requirements

### 2.1 Parameters of Train

The performance requirements of the Train shall be governed according to the following leading parameters:

S. No.	Description	Values/parameters
1.	Limiting profile of Car	Maximum moving dimensions 1D (EDO/T-2202) in reference to Indian Railways Schedule of Dimensions 1676mm gauge (BG) Revised 2022 with latest amendments (Annexure-I)
2.	Schedule of Dimensions	Indian Railway Schedule of Dimensions 1676 mm gauge (BG) Revised 2022 with latest amendments.
3.	Maximum axle load	Should Not Exceed 20.32 Ton. For track structure limitations in IR, Assessment Criteria limits at Annexure VII shall be applicable.

#### Notes:

- 2.1.1 For any infringement with Indian Railway Schedule of Dimensions 1676 mm gauge (BG) Revised 2022 with latest amendments, Technology Partner shall establish by technical analysis that such infringement shall not have any effect on safety of train & fixed infrastructure. Necessary decision for condonation of infringement may be considered by Indian Railways as per laid down procedure & extant rules.
- 2.1.2 Under fully worn wheels and fully loaded condition of the coach, the minimum clearance of bogie mounted equipment including IV coupler from rail level shall be more than prescribed in (IRSOD 2022) under worst conditions. The minimum clearance for the body mounted underslung equipment shall be 215 mm under tare condition with fully worn wheels.

### 2.2 Maximum Speed

Trains shall be designed to operate at a maximum service speed of 130 km/h. The train shall be designed so that the train can operate safely at a maximum speed of 145 km/h during testing.

### 2.3 Test and Trials

Tests and Trials of the Trains shall be conducted in terms of the provisions of chapter 6 of this document.

## 2.4 Kinematic Envelopes

- 2.4.1 The Kinematic envelope represents the maximum dynamic displacement of a Vehicle outline from track centre line and from rail level. This is an envelope comprising:
- (a) Rolling Stock profile.
  - (b) Track and Vehicle tolerances.
  - (c) Allowances for curvature and super elevation.
  - (d) Dynamic effects.
- 2.4.2 The Kinematic envelope of the Train shall be calculated in accordance with UIC505 series for Indian Railways infrastructure condition as per IRSOD. Track effects to be considered for working out the kinematic profile are:
- (a) Rail wear (Vertical and Lateral),
  - (b) Lateral track movement - (separately for straight track and for curved track),
  - (c) Cant on curves,
  - (d) Track tolerances,
  - (e) Horizontal curvature effects:
    - i. End throw; and
    - ii. Middle throw,
  - (f) Any other effect of track influencing kinematic profile.
- 2.4.3 These values depend on track curve, Car length and Bogie Centres which needs to be developed as part of the design by the Technology Partner. Vehicle effects to be considered for working out the kinematic profile are:
- (a) Tolerance of Vehicle dimensions,
  - (b) Surging and lurch (including the effect of wheel and undergear wear),
  - (c) Tilting due to super elevation and can't deficiency during operation.
  - (d) Vehicle roll,
  - (e) Vehicle bounce,
  - (f) Pantograph profile, dynamic effect like oscillation & sway of pantograph, electrical clearance, and
  - (g) Any other change having the implication of additional movement of Rolling Stock.
- 2.4.4 Other dynamic effects are:
- (a) Deviation due to wind loading (wind speed of 100 km/h on the main line and 70 km/h on the platform be considered for the kinematic envelope calculation of the vehicle),
  - (b) Unequal loading of Vehicles.

## 2.5 Traction Performance

- 2.5.1 All the requirements specified shall be achieved when the Train is loaded as per EN12663 / EN 15663 for the whole service range of wheel diameter.
- 2.5.2 All the requirements specified shall be achieved when the overhead line voltage is as per **Clause 1.4** of these Specifications and Standards.

- 2.5.3 Train shall be capable of accelerating to a speed of 130 km/h from 0 km/h in a maximum of 100 seconds on level track. For the purpose of this clause, a minimum train length of 16 Cars rake shall be considered. Time to achieve Maximum Operational Speed with one Basic Unit isolated is 165 sec.
- 2.5.4 Train shall be capable of achieving a minimum an average acceleration of  $0.7 \text{ m/s}^2$  for speed up to 40 km/h, subject to the requirements with respect to jerk rate specified in **Clause 2.7** of these Specification and Standards.
- 2.5.5 Train shall be capable of achieving a minimum residual acceleration of  $0.1 \text{ m/s}^2$  at the speed of 130 km/h.
- 2.5.6 Average Service braking rate from Maximum speed to standstill for fully loaded (AW4) train:  $0.9 \text{ m/s}^2$
- 2.5.7 Average Emergency braking rate for fully loaded train: from 130 km/h to 0 km/h (AW4) is  $1.1 \text{ m/s}^2$
- 2.5.8 **Train Resistance:** The Technology Partner shall furnish the formulae along with justification and reference, which have been used to determine Train resistance and guaranteed performance as per these Specification and Standards. All measures shall be taken to reduce the train's resistance to motion to reduce Energy consumption of the train. The front and rear ends of the train (Driving Cab/Nose) shall feature an aerodynamically optimized profile designed to minimize the pressure drag coefficient and vehicle energy consumption. Measures shall be considered to minimize turbulent airflow in the bogie, roof and gangway areas, thereby reducing the overall train resistance. The selected bidder shall perform a comprehensive CFD study to demonstrate the aerodynamic efficiency of the proposed design. The CFD report to include Pressure Contours & Velocity Streamlines, Drag Coefficient, Cross-Wind Stability. The bidder shall provide the calculated Davis Equation constants for the rake and the same shall be verified/established during the vehicle test/trials.
- 2.5.9 Technology Partner shall submit the RMS current values of traction motor and temperature rise of propulsion equipment for a 16 Cars rake operation for repeated all-out cycles of 6 km with a dwell time of 30 sec up to stabilization of temperatures of all propulsion equipment. The R.M.S. (Root mean square) loading of the traction motor with regenerative braking in use for all out running as mentioned herein shall not exceed the continuous rating of the traction motor. This should also be done with 1 basic unit isolated condition (only for submission of simulation together with temperature rise and validation on combined test bed)
- 2.5.10 The continuous rating of the traction converter, traction motor & the traction transformer shall be based on the criteria specified in **Clause no. 2.5.9**. The rating of equipment shall be demonstrated by thermal simulation and measurement during combined system testing as well as vehicle testing in the field. The procedure adopted for calculation of propulsion equipment ratings including the boundary conditions shall be submitted.

- 2.5.11 Actual gross weight of the train achieved incorporating the full loading of passengers as given in this specification for 16 cars train shall be taken for simulation and performance trials.

The fully loaded 16-cars rake with one basic unit isolated and already running continuously at sectional speed (up to maximum service speed and train is to run continuously on all out cycle of 6 km till thermal stabilization) shall be capable of starting on a gradient of 1 in 37 and clear the section of 10 km with speed up to 60 km/h. The temperature rise of the traction motor and other propulsion equipment shall be within thermal rating of the respective equipment. The one-hour rating of the Traction Motor shall be submitted. Average line voltage during the period shall be taken as 22.5 kV AC under traction. The time, in which the section will be cleared and speed attainable shall be furnished by the Technology Partner. Technology Partner shall submit simulation results for the propulsion equipment temperature rise under the above conditions as per **Annexure-X**

- 2.5.12 Wheel Diameters: The Technology Partner shall adopt optimal Wheel diameter for fulfilling the performance requirement in line with best industry practices. Train performance calculations shall be based on half worn wheels except where otherwise stated.

- 2.5.13 Power system fluctuations within the specified voltage range or feed extensions shall not cause propulsion system shutdown leading to jerks in the train.

- 2.5.14 Maximum Operational speed:

- a. In Inflated Condition of Air Spring - 130 km/h
- b. In Deflated Condition of Air Spring - Minimum 60 km/h(Configurable)

## 2.6 Brake System Performance

- 2.6.1 All the requirements specified in this Clause shall be achieved when the Train load is as specified in this Specification and Standards.

- 2.6.2 Train shall achieve an average deceleration of  $0.9 \text{ m/s}^2$  during full-service braking following the jerk limit as specified.

- 2.6.3 Train shall achieve a uniform full-service braking across the whole speed range from 0 to 130km/h. The full-service brake shall not achieve deceleration of greater than  $1.1 \text{ m/s}^2$  at any speed.

- 2.6.4 Train shall be fitted with an emergency brake which can bring the Train to standstill in less than 650 m when the train is travelling at 130km/h.

- 2.6.5 Specified brake performance shall also be achieved in case of failure of regenerative braking

## 2.7 Jerk Limit

- 2.7.1 Under all normal operating conditions, the rate of change of the Train acceleration or deceleration shall be less than  $0.7 \text{ m/s}^3$ . Failure of the jerk limiting system shall not limit braking effort. Emergency brake applications and any associated ramp down of tractive effort shall not be jerk limited. Reduction of tractive effort due to a power interruption (including passing through neutral sections) need not be jerk limited.



## 2.8 Ride Index

Rolling stock shall also be evaluated for Mean Ride Comfort by Standard method as per EN 12299 for rolling stocks. Acceptable Mean Comfort Index shall be less than 3.0.

## 2.9 Regenerated Energy

The regenerated energy for all out running (full traction up to maximum service speed followed by full service braking up to standstill) shall not be less than 35% of the energy consumed during powering at the specified voltage in **Clause 1.4** of this Specification. Acceleration and braking rates shall be as defined in **Clause 2.5 & 2.6** of this Specification and full auxiliary load shall be taken into account except emergency load. Duty cycle of compressors shall be taken as 100% during the test. The net energy consumed or regenerated at the pantograph shall be used for calculating percentage regeneration energy.

## 2.10 Train Weight

- 2.10.1 The Cars shall comply with all applicable strength and testing requirements, and shall minimize weight to the extent possible. In the selection of the type and thickness of material to be used, the Company shall be guided by the desire to obtain the maximum strength and reliability with the minimum weight which is obtainable at reasonable cost. The Company shall base its structural design on the specific loads, deflections and properties of structural sections called for in these Specification and Standards. For structures not specifically covered, the Company shall base its design on its experience, subject to successful stress analysis and structural testing. The structure and equipment supplied shall resist these loads, including fatigue loads, with sufficient factors of safety. The equipment shall be so designed such that the total overall axle load of each Car, fitted with necessary equipment & other accessories and laden as specified in **Clause 1.8** of these Specification and Standards, does not exceed 20.32 tonnes.
- 2.10.2 Axle load limitation shall be taken into account while finalizing and designing the equipment layout giving due consideration to weight unbalancing during tare and payload as specified in **Clause 1.8** of these Specification and Standards.
- 2.10.3 Maximum Tare weight of the train shall not exceed 838T for 16 cars. Tare weight shall mean complete train with all required accessories to run including car bodies, bogies, propulsion equipment, filled in water tanks etc. (excluding passenger load).

## 2.11 Power Factor

Train shall at all times achieve a minimum power factor of 0.98 as measured at the pantograph. The measurement of power factor shall be governed by EN 50388.

## 2.12 Efficiency

- 2.12.1 The peak efficiency of traction system consisting of traction transformer, traction converter (line side converter and drive side inverter) and traction motor shall not be less than 88% at one operating point in the maximum power zone of the driving operation characteristics under loading conditions specified in **clause 1.8** with a line voltage as per **clause 1.4**. The efficiency of the traction system shall be calculated duly taking into

account the energy consumed by the associated cooling equipment viz. blowers, pumps etc. of transformer, traction converter, traction motor etc. Efficiencies by running at constant speeds of 45, 110, 130 km/h shall also be measured and recorded. The measurement of the efficiency shall be performed on the combined test bed with full complement of equipment and shall be governed by IEC 61377.

2.12.2 The efficiency of the complete auxiliary converter system including sine filter shall not be less than 94% at full load. The complete system shall also include input inductors and output transformers (if any). The measurement of the efficiency shall be governed by IEC61287. Further the efficiency shall also be validated during vehicle type test.

2.12.3 Efficiency of the traction equipment shall be calculated taking into account energy consumed by auxiliary supplies (e.g., for cooling equipment – fans, pumps etc.)

## **2.13 Coupling within Train**

It shall be possible to attach a locomotive fitted with AAR-E/H type coupler having buffer/CBC height as per IRSOD 2022 with latest amendment with the coupler of Driving Car for clearing block section and movement of Non-AC Intercity train. If the couplings between coaches within the train are of different type, rescue couplers shall be provided. It shall be possible to fit these rescue couplers with the couplers of the coaches so that they can be attached to Locomotives of Indian Railways so as to haul the coaches in exigencies. Each train shall be supplied with two rescue couplers. One such Draw Hook used for MEMUs and EMUs running on Indian Railways is given in Annexure –III just for reference.

## **2.14 Environmental Noise Standards**

### **2.14.1 General**

The noise levels emitted from the Train shall be as low as possible and the Train shall be designed to prevent drumming, rattles or vibrations throughout the design life of the Vehicles. All noise levels specified below are in decibels referred to 20 micro-Pascal as measured with “A” weighting network of standard type 1 sound level meter with time weighting F. Exterior and individual systems and equipment noise measurements are to be made in accordance with ISO 3095, and interior noise measurements are to be made in accordance with ISO Standard 3381

### **2.14.2 Limits of Interior Noise**

The noise level inside the Cars (passenger areas) shall not exceed 68 dB(A) when stationary and shall not exceed 75 dB(A) at maximum service speed with all auxiliary equipment operating at its greatest noise output. The measurement shall be done as per ISO 3381. The noise level inside the Driving Cab shall not exceed 75 dB(A) at maximum service speed with all auxiliary equipment operating at its greatest noise output.

Note: The noise level in areas other than passenger area (vestibules, toilets etc.) shall conform to internationally acceptable norms / standards.

#### 2.14.3 Limits of Stationary Noise

The limiting value for noise emission of the Cars shall be 68 dB(A) at a distance of 7.5 m from the centerline of the track, 1.2m and 3.5m above the upper surface of the rails. The measurement shall be done in accordance with the standard EN ISO3095.

#### 2.14.4 Limits of Starting Noise

The limiting value for noise emission of the Cars shall be  $L_{pAFmax} \leq 82$  dB(A) at a distance of 7.5m from the centre line of the track, 1.2m and 3.5m above the upper surface of the rails. The measurement shall be done in accordance with the standard EN ISO 3095.

#### 2.14.5 Limits of Passing - by Noise

The limiting value for noise emission of the Cars shall be  $L_{pAeq,Tp} \leq 81$  dBA at a distance of 7.5 m from the centre line of the track, 1.2 m and 3.5 m above the upper surface of the rails. The passing – by noise shall be measured at 80 km/h and at maximum service speed. The value to be compared with the above limits is greater of the measured value at 80 km/h and the measured value at maximum service speed but referred to 80 km/h by following equation:

$$L_{pAeqTp}(80km/h) = L_{pAeqTp}(v) - 30 \cdot \log(v/80)$$

Where

$$L_{pAeqTp}(v) = \text{Measured value at maximum service speed}$$

$$v = \text{Maximum service speed}$$

The measurement shall be carried out in accordance with the standard EN ISO 3095.

### 2.15 Electromagnetic Compatibility Requirements

All components on the Cars shall be designed and constructed to fulfil the requirements of EN 50121-3-2. The complete Train shall meet requirements of standard EN 50121-3-1.

### 2.16 Fire Protection

- 2.16.1 The fire protection on Train shall be designed and constructed in accordance with EN45545. The applicable Hazard level will be HL3 for Trains with sitting Cars.
- 2.16.2 The train shall be designed to prevent fire propagation through the use of fire barriers in the floor, ends and fire-resistant equipment housings. The vehicle floor shall have fire barrier characteristics of min E30 and I15 as per EN45545 part 3 (latest editions)
- 2.16.3 The Technology Partner shall furnish the relevant data, fire load calculations, certifications etc. of the items considered in fire load calculations separately for Above & Below the floor level. The calculations and validation shall conform to the standard adopted by the Technology Partner for fire strategy.
- 2.16.4 At least two fire extinguishers of the dry powder type as per RCF spec. MDTs 45970 Rev.6 or (latest) or better system shall be installed in each car, readily accessible and flush mounted on panel diagonally.

## **2.17 General safety requirements:**

The Train shall present a safe, hazard-free environment to users, crew members and the general public. Passage through the Cars shall be easy and safe. Adequate handholds shall be provided throughout the Car. Users and crew shall not be exposed to tripping hazards, exposed electrical voltage, toxic materials or similar hazards. Normal and emergency equipment and controls which the users or crew may operate, shall be clearly identified, and operating procedures shall be presented in both text and graphic formats. Passenger emergency signs shall also be embossed in Braille raised typeface.

## **2.18 Adhesion Limit**

The equipment shall be so designed that the coefficient of adhesion requirement does not exceed 20% during powering and regenerative braking and under all requirements of performance as specified in these Specifications and Standards. The coefficient of adhesion requirement shall not exceed 12% in case of only pneumatic brake application.

## **2.19 Design Life**

The Train shall be designed for a life of 30years. The Train shall be designed so as to minimize the risks posed by obsolescence.

## **2.20 Maintenance**

- 2.20.1 The Rakes shall operate with minimum attention and without requiring replacement of components other than consumable parts (to be proposed by the Technology Partner and accepted by the IR/ IR Nominated agency) between the specified inspection/overhaul periods, under the specified operating conditions.
- 2.20.2 Design shall be modular to minimize down time following failures of equipment and components. Provision for mechanical handling devices shall be provided for any single piece of equipment weighing more than 35kg and all such items shall be identified during the Design Review. Equipment cover shall be provided with secure, visible, latching arrangement facilitating easy inspection from the side of rakes.
- 2.20.3 All underframe & roof mounted equipment which cannot be handled manually shall be configured such that it can be removed and replaced from track level using forklift trucks/lift tables/others without disturbing any other equipment. All such items, which may be required to be accessed and worked upon (including operation) in the event of any unusual occurrence online shall be such mounted that it shall be very easily accessible to the train operator from platform/track level.
- 2.20.4 If any equipment mounted above the ceiling requires the use of lifting equipment for its removal or refitting, this shall be readily achievable without the risk of damage to the vehicle interior/exterior.
- 2.20.5 Lubrication points shall be easily accessible.
- 2.20.6 On-vehicle test, equipment shall be used on a vehicle to discriminate between a fault on the main equipment and a fault on the control electronic equipment. Should the electronic equipment be found to be faulty, the equipment shall enable fault finding to be carried out at module level. Off vehicle test equipment shall be used in the depot/repair Centre. This equipment shall allow fault finding down to the smallest replaceable item of equipment.

- 2.20.7 The basic unit shall have equipment cases and modules that are connected to the main vehicle wiring via connectors which are proven in equivalent service duties to achieve high reliability and are easily removable in the event of equipment replacement.

The unit shall have provision for the isolation and where applicable, earthing of all electrical sub-systems to facilitate safe and systematic maintenance and fault diagnosis. It shall be possible to move the Basic Unit for maintenance purposes.

- 2.20.8 Interfaces of all equipment shall be provided with plug-in connectors with suitable locking arrangement for easy and quick replacement. It shall be physically impossible for plug and socket connections and that on safety-critical circuits to be mismatched.

- 2.20.9 The basic unit shall have standard test points on pneumatic systems. There shall be unrestricted access to facilitate checks during routine maintenance and fault diagnosis.

- 2.20.10 Flood proofing requirement as specified shall be ensured after each overhaul during the maintenance.

**2.20.11 Maintenance schedule:**

Technology Partner shall submit the basic maintenance schedules of the proposed Train. Minimum interval between two maintenance schedules in the depot for the train should be based on international standards/norms. Average running distance of a rake may be considered as 1000 kilometers per day.

The maintenance program prepared by Technology Partner shall have the following objectives:

- Enhancement of availability
- Minimization of maintenance costs
- Minimization of coach downtime/MTTS (meantime to restore serviceability)

## **2.21 Vibration**

- 2.21.1 The measured vibration on any portion of the car floors, walls, ceiling panels, stanchions, handholds and seat frames etc. shall be as per IEC 61373 when all equipment in the Rake are operating at their nominal capacity. Ride quality vibration measurements shall be carried out in accordance with ISO 2631-1 (1997), ISO 2631-4(2001) or with EN 12299 and UIC 518/EN 14363.

- 2.21.2 Shock and Vibration test as per IEC 61373 or other relevant standard(s).

- 2.21.3 The root mean square (RMS) (acceleration) vibration level measured on any part of the car floors, walls, ceiling panels, stanchions, handholds, or seat frames shall not exceed  $0.315 \text{ m/s}^2$ .

## **2.22 Fail Safe Design**

- 2.22.1 All equipment and systems, including software, affecting train safety and the safety of train crew and passengers, and/or identified as being “vital”, shall be designed according to the following principles (Couplers, door system, brakes, propulsion power removal, PEA shall be included, as a minimum.):

- 2.22.2 Only components having a high reliability and predictable failure modes and that have operated in similar service conditions in rolling stocks of Indian Railways/Metros shall be used.
- 2.22.3 Components must be utilized in such a manner that ensures that a restrictive, rather than a permissive condition will result from a component failure. (For example: brakes will apply, rather than release; train will decelerate, rather than accelerate.)
- 2.22.4 Circuits shall be designed such that when a normally energized electric circuit is interrupted or de-energized, it will cause the controlled function to assume its most restrictive condition. (Broken wires, damaged or dirty contacts, a relay failing to respond when energized, etc., shall not result in an unsafe condition.)
- 2.22.5 System safety equipment design must be such that any single independent component or subsystem failure results in a restrictive condition. Failures that are not independent, those failures which, in turn, always cause others, must be considered in combination as a single failure and must not cause a permissive condition
- 2.22.6 During the Design Review process, the technology Partner shall submit analyses for IR/IR Nominated agency's review and approval, which demonstrate compliance with these safety principles. These analyses shall address the following issues:
- i) Circuit design
  - ii) Hardware design (Failure Modes, Effect and Criticality Analysis)
  - iii) Electrical interference
  - iv) Software errors
  - v) System failures

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## Chapter 3 – Technical Requirements of Propulsion and Allied Systems

### 3.1 General

- 3.1.1 The Train shall be designed to ensure satisfactory and safe operation under the running conditions specified herein and especially under sudden variations of load and electric supply as may arise under working conditions due to faulty operation and short circuits.
- 3.1.2 The Train shall be used for short and medium distance services.
- 3.1.3 The design shall permit the operation of a Train with 12/16/20/24 cars configuration under loaded conditions with suitable parametric changes to take care of OHE limitations. All performance calculations/ evaluations shall be otherwise conducted on 16 cars train.
- 3.1.4 The design and arrangement of the Sub-systems and systems shall ensure that the performance requirements of the Train are achieved under the climatic and environmental conditions prevalent in India as specified in **Clause 1.6** of these Specification and Standards. The equipment, Sub-system and their mounting arrangement shall be designed to withstand satisfactorily the vibrations and shocks encountered in service and as specified in IEC 61373 except where specifically defined in these Specification and Standards.
- 3.1.5 There shall be provision of shunting mode switch in the Driving Cab of each End basic Unit. The speed of the Train shall be restricted by operation of this shunting mode switch. Shunting shall be possible in case the Train is separated in two or more parts (basic units). The speed shall be configurable and actions subsequent to exceeding the set speed shall be decided during the design stage.
- 3.1.6 Redundancy shall be built in with the design of the Sub-systems and systems in order to ensure reliability and availability. In the vital units of the power control circuit, where any defect/failure of a component would cause complete failure of Train's electrical system, suitable redundancy shall be provided preferably with automatic substitution features to avoid Train failure due to such defects.
- 3.1.7 There shall be provision of receiving shore supply of 415 V, 50 Hz, 3 phase supply, on Train, for testing during maintenance in the depot.
- 3.1.8 The Train, including all Sub-systems and equipment shall be of proven design i.e. the design of equipment, components etc. shall be based on sound, proven and reliable engineering practices with adequate satisfactory service experience meeting the requirements as specified. For the avoidance of doubt, the Government may require the Company to conduct such tests and trials as may be necessary to establish the reliability and efficiency of such technology and designs in accordance with the Good Industry Practice.

### 3.1.9 Ingress Protection

- 3.1.9.1 All equipment shall be suitably protected from dust and water. As a minimum, equipment shall be sealed to the standards stated below.
- 3.1.9.2 Under frame & externally mounted equipment: IP65 or higher if given in the governing specification (other than traction/ auxiliary converter/Traction Motor). Brake Chopper can be with IP 20 protection.
- 3.1.9.3 Equipment mounted inside the Car bodies: IP54
- 3.1.10 It may be necessary to protect some equipment to IP 67 in order to meet the requirements of **Clause 1.6** of these Specification and Standards.
- 3.1.11 There shall be provision of receiving shore supply of 415 V, 50 Hz, 3 phase supply, on Train, for testing during maintenance in the depot.

## 3.2 Environmental Protection

The materials likely to cause environmental damage during the manufacture, maintenance, operation and disposal of Train shall be avoided. The materials listed in this Clause are a minimum list of restricted material and the Technology Partner shall provide adequate evidence to the Government that all materials used shall not cause environmental damage. The material viz. asbestos; chlorofluorocarbons; polychlorinated biphenyls (PCBs); Exposed lead and paints containing lead; chromates; cadmium, except in nickel cadmium batteries; and cyanide shall not be used. Use & disposal of all material should be governed by norms set by the Government of India (Pollution Control Board).

## 3.3 Pantograph

- 3.3.1 The train shall work with all pantographs. Minimum distance between two pantographs should be as per EN 50367.
- 3.3.2 The profile of the pantograph in use in IR is as per drawing no. SKEL-3871 enclosed as Annexure – II for reference. Metallized carbon strip in accordance with RDSO's specification no. RDSO/2009/EL/SPEC/0097, Rev.1 or latest, or a superior alternative, shall be used on the pantograph. Number of trains with following options "a" and "b" will be advised during execution as per requirement. It shall be possible to retrofit high reach pantographs in place of normal pantographs whenever required.
  - (a) All pantographs will be high reach pantograph as per RDSO specification No. RDSO/2007/EL/SPEC/0054 (Rev.2).
  - (b) None of the pantographs will be high reach pantograph.
- 3.3.3 It shall be possible for each of these pantographs to be electrically disconnected from the roof equipment and earthed in case of damage.
- 3.3.4 The pantograph switch shall be provided in the Driver's cab for raising and lowering of all pantographs. The raising or lowering of the pantograph, with the Train in motion, shall not cause any unwanted disturbance to OHE. In the event of failure/damage of pantographs, it shall still be possible to work with other healthy pantographs of the Train.



3.3.5 The design of pantograph shall incorporate the following desired features:

- i) Efficient current collection at all speed with least sparking while traversing the OHE shall be ensured.
- ii) The maximum electrical resistance between current collector and power take-off should be limited to 2 milli ohms for normal pantograph and 10 milli ohms for high reach pantograph.
- iii) The pantograph shall have the feature to protect itself in case there is any panto entanglement with OHE.
- iv) Technology Partner shall conduct on line current collection test with GPS supported location recording system. The output report in soft copy shall be supplied for continuous / selective viewing of location having abnormal behavior and in hard copy with exception report of spark image, location wise report in excel/ word format for complete section selected for trial in Zonal Railway.
- v) In static condition, the pantograph shall exert upward force of  $7 \pm 1$  kg on OHE with tolerance as per IEC 60494-1. For running train Total contact force (Static Contact force and Aerodynamic force) shall be within boundaries defined in IEC-62486 Aero foils may be used for correction of the same.
- vi) The pantograph shall have an auto drop function to drop the pantograph automatically when excessive height is detected (ORD). The pantograph shall also have auto drop function in case of worn current strip or damaged pan head (ADD). Indication shall be provided to the driver when this function is operated.
- vii) Panto horns as well as panto strips shall be of proven design and shall be secured with Nord lock or equivalent suitable arrangement. The carbon strip shall be single piece carbon strip tested against EN 50405, glued with Epoxy phenol resin and arrangement for prevention of water ingress in support beam of carbon strip. V-type base support shall be preferred so as to ensure that strip remains fixed even if gluing ages.
- viii) The pan-head shall be designed preferably with pure carbon strips with a view to achieve minimum dynamic mass. The technology Partner shall furnish the expected frequency for replacement of strip in terms of kilometers earned by the car.
- ix) The electrical clearance between the live portion of the pantograph and the roof shall not be less than 290mm. The minimum mechanical clearance from fixed structures at any time should not be less than 100mm.
- x) The pantograph shall be a single arm, direct air operated type with two strip pan-head arrangement and compliant to IEC 60494. The creepage length of the insulators shall not be less than 900mm and shall be suitable for PD4 category and for unfavorable operating conditions of pollution (Ref EN50124).

- xi) Pneumatic pipe, other fittings and equipment provided on the pantograph frame shall be insulated from the frame to avoid any damage to pipes due to flow of fault current on account of earthing of the frame from any stray wire accidentally thrown by birds etc. on the roof. The insulation shall be suitable for 25kV AC system.
- xii) The pneumatic connection for roof to the pantograph shall be through an insulated air pipe suitable for 25kV.

### **3.4 Main Circuit Breaker and Earthing switch**

- 3.4.1 Each Pantograph Car shall be provided with a minimum of one main circuit breaker. Other Cars having traction transformers shall also be provided with main circuit breaker.
- 3.4.2 Roof mounted single bottle Vacuum Circuit breaker of proven and approved type shall be provided on a 25kV AC system. VCBs with earthing switch shall be provided. A suitable scheme for protection of 25 kV AC voltage system and HV cable to be adopted.

### **3.5 Lightning Arrestor**

Two metal oxide gapless lightning arrestors shall be provided on the roof of each Car fitted with a pantograph and/or traction transformer for protection against the line voltage transients caused by lightning and system switching. One lightning arrestor shall be connected to the high voltage circuit between the pantograph & the main circuit breaker and the other shall be connected to the high voltage circuit between the main circuit breaker and the transformer. These gapless lightning arrestors shall have discharge class-4 for primary and 3 for secondary.

### **3.6 Main Transformer**

- 3.6.1 The kVA rating of the transformer shall be specified at a line voltage of 22.5kV and shall be designed to deliver the power at a total current corresponding to the continuous rated traction motor currents after accounting for the efficiency & power factor of traction motor, traction converter, auxiliary converter for meeting the auxiliary load as specified in the specification.
- 3.6.2 The transformer shall be designed to conform to IEC: 60310 and the temperature rise limits on the windings and the oil shall correspond to IEC: 60310 limits minus 20°C under all conditions of operation.
- 3.6.3 The cooling agent for the transformer shall be K-class, biodegradable, arc resistant and shall have high flash point ( $> 250^{\circ}\text{C}$ ) & high fire point ( $> 300^{\circ}\text{C}$ ).
- 3.6.4 Heat detectors/LHD shall be provided on Transformer bushings and power couplers and low voltage/high voltage terminal boxes and to be linked to TCMS/Fire detection & control unit so that their status is monitored. The above information shall also be logged in TCMS.
- 3.6.5 The transformer shall be oil immersed to ensure the minimum acceptable standard for fire load. Forced air cooling may be adopted, if required. Means shall be provided for letting out the oil from the transformer through the floor to the underside of the train, in the event of any fault/electrical disturbance in the transformer causing oil to rush out. The fire load of the transformer shall be furnished as per **Clause 3.29**.

### **3.7 High Voltage Cable Assembly**

- 3.7.1 A suitably rated high voltage cable conforming to the external application for running on the roof under the ambient conditions as per the specification shall connect the VCB to the main transformer. The Technology Partner shall submit the cable layout schemes (preferably avoiding the passenger areas) during the design evaluation stage. All the safety measures must be listed along with the references of materials used by the Technology Partner.
- 3.7.2 This cable shall be suitably protected against insulation failure/ earth leakage and isolation through VCB shall be provided to avoid repeated tripping of feeding Traction substation.
- 3.7.3 A suitable scheme for protection of 25 kV AC voltage system including roof bus bar and HV cable to be adopted.

### **3.8 Power Traction Converter**

- 3.8.1 The four-quadrant power converter shall be IGBT or SiC device based with PWM control to ensure regeneration and the power factor to near unity. The voltage rating of IGBT/ SiC shall be chosen so that at least 25% margin is available after taking into consideration the DC link voltage and voltage jump on account of inductances and capacitances in the circuit. The wheel slip detection and correction system shall be an integral part of the control system of the power converters/inverter which shall capture any excessive acceleration, differential speeds between axles, over speed and any other parameter considered necessary to maximize adhesion and minimize wheel slipping / skidding.
- 3.8.2 There shall be Two Converters and Two Inverters in each motor Car feeding the traction motors with bogie-based control or Car based control.
- 3.8.3 The traction converter shall meet the requirements of IEC-61287 & the control electronics and PCBs shall conform to IEC-60571 including compliance to the optional tests. However, due to higher ambient temperature in India, the temperature for dry heat test shall be 80°C as against 70°C specified in IEC/EN. An extra performance check at 85 deg C shall also be carried out for 10 minutes over temperature value. LCD display units may be tested at 70°C. The vibration and shock tests and endurance tests shall be done as per IEC 61373 as per the requirements of design.
- 3.8.4 Gasket is preferred to have a life of minimum 6 years.
- 3.8.5 The converters in a train shall be controlled such that the harmonic currents in the track in the Kavach/ ATP.
- 3.8.6 The power converter - inverter shall be designed to cater the pantograph-bouncing phenomenon. Adequate compensation using suitable rating of DC link Capacitor shall be provided for the pantograph bounce time or short time line interruption cases. technology Partner shall submit the design calculations. Dry type capacitors (having self-healing property) are preferred to be used for DC link/harmonic filter/resonant circuits.
- 3.8.7 The box for the power converter - inverter shall be of stainless steel or Anodized/Painted Aluminium so as to avoid any corrosion in service on any account and the box shall last for the lifetime of the converter / inverter unit without needing any attention. The IP protection level of Converter box and that of aux. converter shall not be less than IP65. The connectors shall have IP67 protection.

3.8.8 The diagnostics features shall include but not limited to:

- i) The power converter-inverter shall use a control scheme that contains extensive self-diagnostic
- ii) The train operator from the cab shall be able to isolate any power converter / inverter.
- iii) Current drawn by each motor shall be measured and recorded if having group drive and sensor-less drive.
- iv) Protection scheme for propulsion system shall include but not limited to:
  - a) **Primary Circuit**
    - Over Current of Primary Circuit
    - Interphase short in secondary circuit
    - Interruption of catenary circuit
  - b) **Main Transformer**
    - Oil Flow Stop
    - Over Temperature of Main Transformer
    - Pressure Relief Valve
  - c) **Converter/Inverter**
    - Over Voltage of Primary Circuit
    - Low Voltage of Primary Circuit
    - Frequency Irregular
    - Waveform Irregular
    - Over Temperature of Power Unit
    - Over current of Secondary Circuit
    - Ground Fault
    - Low Voltage of DC Circuit
    - Over Voltage of DC Circuit
    - Over Voltage Thyristor/IGBT Failure
    - Wheel Slip / slide Tractive Effort Failure
    - Regenerative Effort Failure DM/RS/COR-OF/069
    - PWM Failure
    - Rotation Backward Detection
    - CPU Fault
    - Low Voltage of Control Power Source
    - Low Voltage of Gate Power Source
    - Low Voltage of DC 110 V Power Source
    - Calculated/Reference Speed Fault
    - Over current of Main Motor
    - Phase unbalance of motor current
    - Over Temperature of Main Motor
    - Traction Motor Current Unbalance in 4 motors
    - Fan Fault
    - Fault of Charging Circuit

The settings and calculations of above-mentioned protections shall be discussed during Pre – Final Design Stage. The settings and calculations of all diagnostics and protections functions shall be finalized during the Design Stage.

### 3.9 Traction Motor and Drive

- 3.9.1 Fully suspended Three phase high efficiency Asynchronous traction motor or Permanent Magnet Synchronous Motor shall be provided. Encapsulated design of traction motor will also be acceptable. The general design and manufacture of the motor shall be done to the standard IEC 60349-2/ 60349-4 in accordance with the modern traction practices.
- 3.9.2 In case of Permanent Magnet Synchronous Motor is chosen, SiC based traction Converter shall be used. All precautions shall be taken to avoid EMI/EMC with the existing signalling and telecommunication systems.
- 3.9.3 The traction motor shall preferably be self-ventilated. If installed, filters shall require cleaning no more frequent than once every two weeks. Sensor/sensor-less drive system for monitoring temperature and speed of traction motor to be adopted. However, failure of speed or temperature sensor(s) shall not lead to isolation of propulsion system.
- 3.9.4 The traction motors shall be designed for a life of thirty years with no need for major overhaul before 1.2 million kms or major maintenance schedule approved by Railways.
- 3.9.5 Insulation system
- i) The evaluation of the insulation system for thermal endurance shall be with fabricated test models by way of accelerated ageing tests based on the test programme drawn up in accordance with the norms specified in IEC: 60034-18.
  - ii) Evaluation of the insulation system shall be done according to IEC 60034-18. The temperature at which an extrapolated life of 20,000 hours is obtained shall be treated as the thermal endurance limit (Temperature Index) of the insulation system.
- 3.9.6 The designed L10 life of TM Bearing should be at least 2.5 million km.
- 3.9.7 Maximum temperature rise of traction motor winding shall be limited to  $T_i - 70^{\circ}\text{C}$ , considering 25% choking of filters. Thermal simulation of temperature rise in stator and rotor (if wound) with given duty cycle of the train operation shall be carried out to establish maximum temperature rise, which shall be within  $T_i - 70^{\circ}\text{C}$ . In case of cage rotor, temperature rise of cage rotor should not endanger any winding or any other parts like bearings etc. and the acceptable limit of temperature rise of cage rotor to be declared by propulsion Technology Partner.
- 3.9.8 In the event of a train getting immobilized on line due to mechanical problems like bearing seizure, gearbox or axle defect etc., suitable arrangement shall be provided like wheel skate or similar device to quickly and safely transfer the train to the Depot. Suitable jacking points shall be provided beneath the axle boxes for enabling the placement of wheel skate. At least one such equipment shall be provided in each Depot.
- 3.9.9 Where cables pass through holes in the traction motor frame, oil resistant resilient bushes suitably clamped shall be provided to prevent chafing of cables and to seal against the ingress of oil and water. The cables shall have sufficient freedom of movement to prevent stressing or fouling of other equipment during the full envelope movement of the bogie
- 3.9.10 The motor will be designed such that the “hot spot” temperature under conditions such as one hour, short-time and continuous rating of loading in any winding (stator and rotor) does not exceed the average temperature of that winding measured by resistance method by more than  $20^{\circ}\text{C}$ . For encapsulated design of traction motors lower limit of hot spot temperature can be accepted.
- 3.9.11 Type & Routine Tests on the traction motor shall be in accordance with IEC 60349-2 / 60349-4.

### 3.9.12 Traction Gear

All traction gears will be case hardened alloy steel of approved quality. Company shall submit proof of stability for gear tooth forming and total design, description of the gear tooth forming, provided materials, manufacturing and hardening procedures with corresponding specifications, Oil types and lubrication intervals.

### 3.9.13 Gear Case

Gear case shall be made of proven material and shall have sufficient mechanical strength so as not to get damaged due to hitting by ballast or any other foreign objects. The design of the gear case shall ensure minimum loss of lubricant during run. The oil circulation in the gear case should be independent of the lubrication of bearings for the traction motor. The Use of helicals for fastening purposes shall not be permissible.

### 3.9.14 Traction Motor Tests:

The traction motor shall be subjected to all the prototype & routine tests in line with IEC 60349-2 / 60349-4. Prototype tests shall include continuous temperature rise test, short time rating tests, characteristics tests, over speed, power factor, efficiency, dielectric & torque measurement tests.

### 3.9.15 Special tests on traction motor:

The following special tests on traction motor shall be carried out along with those specified in IEC 60349-2 / 60349-4: -

- a. Waterproofing tests: Waterproofing test will be conducted on Traction Motor along with Gear case (without bull gear, axle, roller bearing, sealing rings and other attached part) by dipping it up to a height equivalent to 400 mm from rail level (under fully wheel worn condition) in stationary water for 24 hours. The motor shall function normally after the test. Following test parameters shall be recorded:
  - i) Insulation resistance before immersion test
  - ii) Insulation resistance after immersion test
  - iii) Visual inspection regarding seepage of water inside traction motor
- b. Testing of insulation system as per IEC: 60034-18-31 at the relative humidity of 95-100% for a period of 48 hours and water immersion test for 30 minutes along with the voltage tests.
- c. Vibration test as per IEC 60349-2 / 60349-4.
- d. Traction motor bearing test for adequacy of sealing of lubricants
- e. The hot spot measurements shall be done during prototype tests on traction motor by embedding thermocouples in the stator winding.
- f. Measurement of waveforms of the motor converter voltage, motor converter current, motor torque & space vector flux under different ranges of operation during heat run & characteristics test on converter supply.

### 3.10 Auxiliary System

- 3.10.1 The auxiliary system shall consist of IGBT/SiC based (based on suitability, merit of design and proven design) auxiliary converters, auxiliary machines, blower-motors, compressor motors, oil / water pumps, battery charger, DC loads and associated protection system. The AC auxiliary system shall be galvanically isolated from the traction power system and the DC battery system. The Auxiliary Converter-Inverter shall provide power supply to all auxiliaries including ventilation blower motor, RMVU, air compressor, doors, light equipment, control units and low voltage loads. Auxiliary system design shall ensure that there is no surge/spike in the output voltage between phase to phase and with respect to earth. The common mode output voltage (vector sum of three phases) with respect to earth shall be as low as possible, say zero.
- 3.10.2 Each basic unit shall have an Auxiliary Power Supply System. The Auxiliary Power Supply System shall be designed in such a way that:
- In the event of failure of 75% Auxiliary Power Supply equipment of the 16-Cars Rake, the remaining healthy Auxiliary Power Supply equipment must be capable of supplying Auxiliary Power for all the loads (including Light, Fan, RMVU and Traction Auxiliary loads).
  - The above-mentioned design rules shall be fulfilled with a 16-Cars Rake. During the design stage the detailed auxiliary design concept shall be submitted for approval.
  - The changeover/load sharing shall be affected automatically and without any time delay through control electronics. Auxiliary converter shall be capable of catering the full auxiliary (100%) load at input voltage range between 19 kV to 30 kV AC and shall perform up to 17 kV OHE voltage at reduced output power. Reduction in output power will be gradual with the reduction of traction supply below the limit of 19kV. The auxiliary converter shall deliver at least 50% of the full rated capacity at 17 kV.
  - Headlight shall not extinguish while traversing the neutral section. However, control shall ensure that the battery does not get overloaded due to switching „ON“ of the headlight when overhead power is not available for a long period. The power supply to headlights will be 110 V DC with LED based head light as per RDSO specification No. RDSO/2017/EL/SPEC/0134 (latest) shall be used.
- 3.10.3 In addition to above, galvanically isolated 230 V AC, single phase supply of 1 kVA shall also be made available in the Driving Cabs to enable powering any small equipment when the Train is standing in the shed.
- 3.10.4 While traversing the neutral section, the lights shall work normally.
- 3.10.5 Auxiliary converters of rake shall be operated in synchronization for load sharing including RMVU through three phase 415V, 50 Hz bus line. Each Bus shall be capable of handling the auxiliary load of the complete rake. Auxiliary converters of rake shall be operated in synchronization for load sharing through three phase 415V, 50 Hz bus line. Input power factor of auxiliary converter-inverter shall be near unity under all load conditions for nominal operating range of OHE voltage of 22.5 kV to 27.5 kV. Under no condition it shall behave as capacitive and export reactive kVAR into the system and under no circumstances, Power Factor shall be below 0.9.

- 3.10.6 The temperature rise limits for auxiliary machines shall be reduced compared to IEC limits to take care of the higher ambient temperature specified. Only Insulation system of class 180°C or higher shall be adopted. The permitted maximum temperature rise for different classes will be  
Class 180: - 80°C  
Class 200: - 100°C
- 3.10.7 The three-output voltage shall be as follows:  
Output 1: 415V 50Hz 3φ 3 wire  
Output 2: 110V DC  
Output 3: 110V AC
- 3.10.8 The output of the auxiliary converter shall be sinusoidal. The output voltage shall be regulated within  $\pm 5\%$  of the nominal voltage and total harmonic disturbance shall be limited to 8% under all operating conditions. Phase-to-phase voltage imbalance shall be in accordance with EN 50533. The converter-inverter shall otherwise comply with the provisions of IEC 61287-1.
- 3.10.9 Margin of at least 5kVA per converter for possible increase of load in future shall be kept .
- 3.10.10 Staggered starting shall be provided between auxiliary power supplies on the Train to minimize start up loads
- 3.10.11 Protection and diagnostics

Protection scheme for Static Converter (auxiliary converter-inverter shall include but not limited to:

- Over current detector
- Over voltage detector
- Converter fault output
- Over temperature of semiconductor
- Single phase detector
- Inverter fault output
- AC over voltage detector
- AC low voltage detector
- AC overload current detector
- AC output short circuit current detector
- Control power supply failure
- Over voltage of inverter circuit
- Over current of inverter circuit
- Synchronous fault detector
- Starting failure
- Ground fault detector
- DC over voltage detector
- DC over current detector

The settings and calculations of above-mentioned protections shall be discussed during Pre – Final Design Stage. The settings and calculations of all diagnostics and protections functions shall be finalized during Design Stage.



- 3.10.12 The shore supply shall have sufficient capacity, rating and provision to enable maintenance personnel to test the electrical auxiliary equipment in three-cars unit. The shore supply connector of adequate capacity shall be provided at diametrically opposite convenient locations on either side of each unit. The details shall be finalized during design stage.
- 3.10.13 Internal 230V 50Hz 1 $\phi$  15A and 5A socket outlets (inside panel/cubicle) for charging emergency light, use of cleaning machines, vacuum cleaners, and other loads (minimum two per car and one in driving console) shall be provided in each car.
- 3.10.14 Preferably LED based lighting arrangement should be provided in the housing for maintenance purpose.
- 3.10.15 All auxiliary converter-inverters shall be identical, interchangeable and under frame mounted. All internal items of the equipment shall be easily accessible and detachable, with the converter-inverter “in situ”, to facilitate maintenance.
- 3.10.16 The Technology Partner shall provide suitable design and control measures to minimise energy consumption and exterior/interior noise when the rake is parked or stabled, including automatic reduction or shut-down of non-essential auxiliaries (including RMVU) and low-noise operation of any equipment required to remain in service during stabling.
- 3.10.17 The fault detection and isolation system for auxiliary converter and its associated loads shall be able to isolate the defective equipment without having any cascading effect of isolation of other equipment and the auxiliary converter itself.

### **3.11 Auxiliary Compressor Set:**

A 110 V DC battery operated auxiliary compressor (A proven 110V DC operated compressor (oil free) with Brushless DC motor/AC motor) set having adequate capacity, shall be provided in each unit for feeding the auxiliary air reservoir for operation of the pantograph and main circuit breaker during the preparation of the Train for service. Capacity of the auxiliary compressor shall not be less than 100 lpm / 1 h.p. Auxiliary compressor for pantograph shall be supplied as a module duly including - Aux. Compressor-1, safety valve -1, check valve -2, pressure switch -1, Air Filter -1, 35 L Reservoir -1, Isolating cocks-2. Any modification in the existing pneumatic Control circuit shall not Normally be preferred. However, if it becomes inevitable due to any design up-gradation of the equipment, it shall be the responsibility of the Technology Partner. It shall be possible to run the auxiliary compressor in manual mode without any adverse effect on the motor.

### **3.12 Battery and Battery Charger system along with Battery Box**

- 3.12.1 Low maintenance Explosion proof lithium-iron-phosphate batteries of adequate capacity [LFP or any other Lithium –ion battery with associated Battery Management System (BMS) in suitable series, parallel arrangement to take care of coach load and total system voltage of 110 V], shall be provided on each Basic Unit to feed the equipment for at least 2 hours in the event OHE supply is not available. Nominal voltage of the battery shall be 110 V. Battery system will be tested in general as per IEC 62928, IEC 62620 & IEC 62619.

- 3.12.2 BMS shall monitor the State of Charge (SOC), State of Health and ensure that the system operates in Safe operating Area (SOA). In case of abnormal rise in temperature of the cells, suitable warning shall be given through DDU.
- 3.12.3 The design and control of the battery shall ensure that the battery gets disconnected from non-essential loads when the battery gets discharged, however there shall be sufficient capacity left under all conditions to raise pantograph and to power voice recorder and flasher light. When auxiliary load is reconnected, the initial battery load shall not cause the battery output to oscillate.
- 3.12.4 The batteries shall be maintained at an adequate level of charge to satisfy the requirements of the following emergency loads for a duration of 2 hours after the loss of OHE power as given below:
- i. Ventilation in all Cars including Driving Cabs
  - ii. Communication system (CCTV, PIS and PA system)
  - iii. Head light and Emergency light including Flasher lights
  - iv. Diagonally opposite doors on either side
  - v. Train controls (full load)
  - vi. Fire detection system
  - vii. For the purpose of capacity calculations, a total of 15 Close-Open operations of door per hour shall be considered.
  - viii. Power requirements for maintaining power for Bio Toilets.
  - ix. Water raising pump.
  - x. Toilet emergency supply
  - xi. Door controls
  - xii. Electric horn
  - xiii. Driving console indicators, lighting and interlocking.
  - xiv. KAVACH/ATP equipment
- 3.12.5 There shall be provision in each basic unit for using the external power supply of 415 V, 50 Hz, 3-phase, Industrial 415V 50Hz 3 $\phi$  socket outlets with spring loaded covers, in a suitable enclosure with dust and water ingress protection, capable of accepting a shore supply shall be provided on each basic unit for testing of auxiliary machines, RMVU, Light and fans during maintenance in the depot and charging of battery. Each socket shall be accompanied by a red lamp, to warn of live sockets when a shore supply is plugged in. The control logic shall ensure that the Rake power-up is not possible when shore supply is applied to the Rake.
- 3.12.6 The battery shall be charged from the local static battery charger. The battery charger with automatic control shall be capable of providing a temperature compensated high rate boost charge and float charge compatible with the characteristic of the Li batteries.

### **3.12.7 Battery Box**

- a. The box for battery shall be such that to avoid any corrosion throughout the service life on any account and the box shall last for the lifetime of the cars. Within the battery box, the battery shall be mounted in roll out trays to allow for easy maintenance.
- b. The box interior / the roll out trays shall be lined with a non-flammable, electrolyte proof, insulating material of suitable thickness. The box shall be ventilated to preclude the possibility of built-up of any gas. Vibration proof automatic lock shall be provided to ensure absolutely no relative movement of the batteries inside the tray
- c. Battery box shall not deform/sag during lifetime of the cars.

### **3.13 Control Equipment**

- 3.13.1 All control equipment, relays and contactors shall be mounted on suitable panels placed in enclosures with IP54 protection and shall remain in the scope of supply of the Technology Partner including harnessing thereof. All cabinets/housings shall be made of corrosion free material and those mounted in underframe shall not require any painting. Electrical equipment installed in the underframe shall be protected by a housing made of stainless steel SS304 or anodized sea water proof aluminium or alternate material based on suitability for application. However, the housing shall be protected against ballast hitting as per the relevant international standards.
- 3.13.2 All vital contacts for operation of the Train shall be duplicated to provide redundancy.
- 3.13.3 Endurance tests, both mechanical and electrical, shall be in accordance with IEC60337. Suitable arc fault protection device has to be provided at the final circuit level.

### **3.14 Neutral Section Detection:**

In order to ensure VCB opening, a distance-based system for its operation during entry and exit of the Neutral section shall be provided based on the input from driver.

### **3.15 Wiring and Cabling**

- 3.15.1 The cables for wiring in the Train and equipment shall use high grade electrolytic copper stranded conductors tinned in accordance with Good Industry practices.
- 3.15.2 Electron beam, irradiated, thin walled, halogen free, low smoke and less toxic cables according to relevant international standards and the Good Industry Practice for rolling stock application, shall be used. The insulation/sheathing material shall be EPDM/EVA. At locations in the Train, where high temperatures are likely to be encountered, special cables shall be used. The Company shall submit details of cables conforming to EN 50264 for fire retardant, fire survival characteristics.
- 3.15.3 Cable layout shall be according to EN50343. To prevent damage of cables inside floor/roof/metallic trays and transition points (viz. saloon area to underframe/roof), it should be routed through conduits of stainless steel or better material. The end and start of conduit shall always be kept sufficiently above the floor level so that entry of water accumulated on floor after washing/cleaning shall be avoided in conduit and cable bunch.

- 3.15.4 All incoming and outgoing cable outlets shall be provided with cable fire barriers of intumescent material (at cable cleat) to prevent fire propagation through cable insulation. All cable runs in exposed locations, such as on the bogies or underframe and therefore potentially vulnerable to damage shall be in conduits of stainless steel or better material. Where such exposure is not a problem, cables shall be run in enclosed waterproof and dust-proof ducting.
- 3.15.5 No cable having a conductor size of less than 1.5 mm<sup>2</sup> shall be used except for multi core cables where 1.0 mm<sup>2</sup> cable is permitted. Smaller size cables for internal wiring of panels, control cubicles, consistent with the mechanical and electrical requirements, may be adopted.
- 3.15.6 A systematic cable transit management & sealing system shall be provided for protection of cables against cutting, damage, fire, vibration, pull tension, temperature variation, dust, water, humidity & rodents as well. Cable management Transit System must be fire resistant, smoke and gas tight, and the pressure/vibration shall not damage it or compromise its seal or security.
- 3.15.7 Sufficient spare Train line cables and contacts (at least 15 % and minimum 10 nos.) shall be provided for catering to future needs of the IR.
- 3.15.8 Fire survival cables according to EN 50200 shall be used for PA/PIS, Event recorder, ETBU circuit, Passenger Alarm, supply and other essential circuits of Fire detection system, CCTV, Brake system and Door system for their continued functioning to the extent possible in the event of fire. Survivable duration classification of PH30 (30 minutes) or higher shall be suitable.
- 3.15.9 EPDM type cable glands for sealing shall be provided; suitable EMC methodology shall be adopted.
- 3.15.10 IV coupler shall be protected against rain water ingress. Anti dangling devices shall be used to avoid rubbing of cables. Suitable dummies shall be provided for parking of the Coupler hoods once disconnected.
- 3.15.11 The insulation of all wires and cables including those used within equipment / subsystem shall be halogen-free flame- retardant and formulated to minimise generation of smoke, noxious emissions and corrosive fumes, in the case of overheating or fire in compliance with EN 45545 (Hazard level HL3) latest edition. All the cables and wires including electrical panels shall be suitably protected against entry and damage from rodents and red ants. However, Failure of train due to cable damage caused by rodents and red ants shall be on account of Technology Partner.
- 3.15.12 The maximum short circuit temperature shall not exceed 250°C.
- 3.15.13 The minimum cross-sectional area of control cables for connections between equipment shall preferably be 1.5 mm<sup>2</sup>.

### **3.16 Interior Lighting and Fans**

- 3.16.1 Lights and fans shall be fed by the auxiliary power supply system. The guaranteed life of the LEDs with their control system and optics/luminary shall not be less than 60000 burning hours. The specified illumination level shall be met till at the end of the life of 60,000 hours when the illumination is not less than 70% of their original illumination level. Smart lighting system to be adopted and the colour of the LEDs shall be cool day-white (temperature 6000-7000 K) during the day time and warm white (temperature

2700–3500 K) during night with automatic or programmable switching based on time or ambient conditions. LED shall be certified for LM80. Separately protected lighting circuits shall be used, such that in the event of tripping of one circuit, the others should provide evenly distributed lighting throughout the Car. The Photo biological safety report of minimum RG1 shall be submitted by the LED manufacturer.

- 3.16.2 All lights and fans shall be powered with 110 V DC supply and fans shall be powered with 110 V AC/DC supply.
- 3.16.3 Illumination within the saloon with LED luminaries shall be designed so as to ensure that the desired maximum illumination level is achieved with LEDs operating at less than 50% of its rated capacity.
- 3.16.4 During commissioning and subsequently, it may be desirable to adjust the lux level to 200 in the saloon at a height of 1.5 m above floor level along the entire length of the Car. With the exception of the illumination level, lighting shall be of similar or equivalent performance to EN 13272 – “Railway Application – Electrical Lighting for Rolling Stock in Public Transport Systems” as applicable to urban rail transport systems. Uniformity level as per EN 13272 shall be achieved.
- 3.16.5 At least 50% of lights, evenly distributed over the Car area, shall remain energized and provide sufficient light for safety of passengers, in the event of a OHE failure. Light and Fan control shall be provided from both the driving cabs.
- 3.16.6 For lighting the interior of the Car, suitable lamps with colour rendering index Ra as per EN 13272 shall be used. Ra shall be calculated as specified in the paper by Nickerson and Jerome in 1965, republished by the CIE in 1995.
- 3.16.7 Electricity Act 2003: Relevant provisions stipulated in the Electricity Act 2023 shall strictly be followed in the interest of safety of passengers/staff as well as for equipment / instruments provided in the Cars.
- 3.16.8 It shall be possible to isolate 50% lights of the rake from the driver’s cab when the Train is stabled in yards or shed.
- 3.16.9 Emergency lights (at least 8 nos. per coach) shall be provided in each coach to be fed by battery through inverters in case of total failure of auxiliary supplies. In case of battery reset, availability of emergency lights shall be ensured from direct battery supply.
- 3.16.10 Lighting on the driver’s console shall not be less than 60 lux measured at the console. The cab shall be provided with ceiling lights designed to provide 100 lux at 1 metre above floor level.
- 3.16.11 Two numbers of BLDC fans and 2 nos. Cab LED light shall be provided in each driver’s cab.
- 3.16.12 The fan shall be designed for minimum delivery of 85 m<sup>3</sup>/minute under the worst conditions. The number and type of fans shall be decided on the basis of the ventilation requirements. Fans should be water jet washable, with sealed bearing & without any need of painting. Fan switches shall be flame retardant conforming to category V0, as per UL 94 suitable for traction duty application. Endurance test to be conducted at rated load for 1,20,000 operations.
- 3.16.13 Flush-type disaster/emergency light shall be provided with health/status indication on the electrical cabinet.

- 3.16.14 All LED lighting fixtures and associated components shall comply with HL3 requirements of EN 45545 (Fire protection on railway vehicles).
- 3.16.15 For all other parameters and testing as per RDSO specification RDSO/PE/SPEC/TL/0091 -2026 (Rev2) shall generally be followed. Any deviation shall be permitted with prior approval of RDSO/IR Nominated agency
- 3.16.16 **Circuit Protection:** Technology Partner shall ensure that traction circuits shall be protected in accordance with the requirements of IEC 60077 - 'Railway Applications Electric Equipment for Rolling Stock'.

### 3.17 Master cum Brake Controller

- 3.17.1 A combined master cum brake controller, integrated into a single unit shall be provided in each Driving Cab. The master cum brake controller shall be designed so that the electrical/dynamic/ regenerative brake is applied by pulling the handle towards the Loco Pilot and traction is given by pulling the handle away from the Loco Pilot. The master cum brake controller shall be of step less type. The master controller shall be provided with a dead man's device which shall have to be activated manually and consciously by the driver. In case the driver gets incapacitated and the "dead man" device is released, the emergency brakes shall apply through direct opening to the atmosphere.
- 3.17.2 Master cum brake controller to be operational only after operation of Driving Cab activation switch. Only authorized persons having necessary keys / handles shall be able to operate the master cum brake controller. The key switch, reverser switch and traction/braking lever shall be interlocked. Only one Driving Cab shall be activated in the Train at a time.

### 3.18 APC and Vigilance Control Device

- 3.18.1 APC receiver compatible with existing track magnets shall be provided.
- 3.18.2 There shall be provision of Vigilance control device (VCD) including acknowledgement generally confirming to RDSO Specification No. RDSO /2008 /EL /SPEC /0025 (Rev.6) -2019 (latest).

### 3.19 Instruments and Gauges

- 3.19.1 The following information shall be made available to the Loco Pilot:
- i) Pressure in the main reservoir pipe
  - ii) Pressure in the brake cylinders
  - iii) Pressure in the brake pipe
  - iv) Indication of air flow in the brake pipe.
  - v) OHE line voltage;
  - vi) Battery voltage;
  - vii) Tractive/braking efforts;
  - viii) Train speed with Analog & digital display

Items marked above shall be continually displayed to the Loco Pilot via gauges with good visibility in daylight / night conditions. Status indication shall be provided on HMI for Lights, ventilation, brake system, PA & PIS, Auxiliary supply system, Speed, VCB open & closed, pantograph raised/down, compressors, MR/BP pressure of both Driving Cabs, condition of suspension systems, condition of axle bearings and brake cylinder pressures

of all Cars etc. Graphical representation for status of different Sub-system viz. brake system, auxiliary supply, PA & PIS, TCMS and propulsion & control system shall be provided on HMI.

### **3.20 Head Light, Flasher, Marker and Tail Lights**

#### **3.20.1 Headlights and Auxiliary Headlights:**

- a. Each Driving Cars shall be provided with twin beam LED headlights and two auxiliary head light.
- b. The headlight units shall be pre-focused, capable of giving minimum 4.8 lux at a distance of 305 meters. The beam spread shall be symmetrical and angle of beam shall not be less than 7 degrees.
- c. Arrangements shall be provided for dimming and dipping the headlight output when required. The headlight shall be provided in suitable waterproof enclosures conforming to IP 65 or better.
- d. LED Head light and Aux. head light shall confirm to RDSO specification No. RDSO/2017/EL/SPEC/0134 (LATEST)
- e. The headlights and taillights shall not get switched off while passing through neutral section

#### **3.20.2 Flasher Lights**

- a. Two flasher lights, one at each end of the Train, shall be provided. It shall be designed to provide  $40 \pm 5$  flashes per minute. It shall emit sufficiently bright amber-yellow light with a dominant wavelength of 590-595 nm to be visible at a distance of 2 km in clear daylight and not be affected by sunlight glare. The lux measured in axial direction shall not be less than 500 lux at 1 m and 55 lux at 3 m. The flasher lights shall be provided in suitable waterproof enclosures conforming to IP 65 or better. These shall work on battery supply. The flasher light shall work in the neutral section also.
- b. Facility for monitoring and positive confirmation whether flasher light is lit or not shall be provided in the form of audio-visual indication in Loco Pilot cabs.
- c. The working of the flasher lights shall be so integrated with the Train brake system that in the event of Train parting, flasher light shall get automatically turned on and any tractive effort on the Train shall be disabled until acknowledged by the Loco Pilot.
- d. This light shall be switched ON by the train operator in case of emergency and shall not be switched OFF even while negotiating neutral sections.
- e. Flasher light when lit and flashing shall be able to attract attention at a distance of 300m under clear sunny daylight

### 3.20.3 Marker Lights cum Tail Lights

- a. Two twin array marker lights with suitable waterproof enclosures conforming to IP 65 or better and window toughened front glass.
- b. Each twin array marker light shall provide one white and one red array. Red array marker light shall be considered as tail light.
- c. The clear visibility of tail light in clear daylight shall not be less than 2.0 kilometers along the longitudinal axis confirming to RDSO spec. No. ELRS/SPEC/PR/0022 (latest).
- d. The marker cum Tail lamp shall conform to RDSO spec. ELRS/SPEC/PR/0022 (latest). The functionality of Tail light may be realized through Marker lights in the rear of the train.
- e. The taillights shall be sufficiently large and bright.

### 3.20.4 Signal Exchange Light:

Flashing LED lamp (Green and RED) at outside of the driver's cab for exchange of signal between driver/guard and the station master during train operation shall be provided with following features:

- Light conforming to RDSO specification No. ELRS/SPEC/PR/0022 latest version
- Light shall be visible from >500 m in a clear day and >1km in clear night
- Frequency of flashing 55-65 per minute.
- IP 66 protection.

## 3.21 Train Control and Management System (TCMS)

- 3.21.1 TCMS shall integrate the task of fault diagnostics and display the same in addition to its control task. It shall be capable of real time monitoring of the status of all the vital equipment continuously and occurrence of faults. It shall also take appropriate protective action and shut down the equipment whenever necessary.
- 3.21.2 TCMS shall have a diagnostics facility, with non-volatile memory, to store all the relevant diagnostic data. On occurrence of each fault, fault information on equipment parameters, GPS location of Train, background data with time stamp shall be captured and stored with a view to enable proper fault analysis. There shall be a facility to capture post trigger and pre-trigger background information. The fault display to Loco Pilot shall also accompany the standard trouble shooting instructions in simple language. The diagnostic system shall be able to identify and log the faults of the Train and such data shall be stored for the duration of the storage for the memory shall be considered as per **Annexure-VIII**. The diagnostic system shall be able to identify the faults occurring due to defects in the Train and incorrect operation by the Crew.
- 3.21.3 The Train shall be provided with remote diagnostic and tracking equipment. The equipment shall be based on GPS and LTE/5G/6G technologies. This equipment shall perform the function of tracking of the Train and also communicate with the Train diagnostic system and parameters of the events referred in this specification as per **clause no. 3.30** and pass on this information to the central server. It shall be possible to remotely send and obtain the information stored in the diagnostic memory of the computer system, for troubleshooting/ diagnosis with the aim of facilitating and speeding up the maintenance process of the Train. Configuring the server and cost of access during warranty and maintenance period shall be in the scope of supplier for 2 different geographical locations.



- 3.21.4 The electronics used on the Train shall conform to IEC 60571/EN50155, IEC 60068, EN 50121, IEC 60721-2-5 and IEC 61373. All electronic equipment shall be designed to function correctly when the Train has been standing stationary in full sunlight at the maximum ambient air temperature (refer to **Clause 1.6** of this Specifications).
- 3.21.5 As a minimum, electronic equipment shall be designed to operate at internal cubicle air temperatures of 70°C under these conditions. Features of self-check and calibration shall be incorporated in the design.
- 3.21.6 The TCMS shall be interfaced with the brake system. The Automatic flasher operation (in case of Train parting) and dead man /Vigilance control functionality shall also be implemented.
- 3.21.7 The TCMS shall provide on-line, context sensitive trouble shooting assistance to the Loco Pilot in case of any fault, through the HMI display. The fault display to Loco Pilot shall also accompany the standard trouble shooting instructions in simple English language.
- 3.21.8 There should be a Rescue Drive Mode (RDM) with restricted speed in case of failure of Train wide communication.
- 3.21.9 The entire functions essential for the Train operation shall have redundancy to avoid any single point of failure. Adequate redundancy in the system design of TCMS, as permissible vide the standard adopted, shall be ensured. A complete schematic of the scheme with the redundancies shall be submitted by the Technology Partner. Critical signals for train operation on hard wires shall be redundant. Details shall be finalized at design approval stage. As a minimum, following shall be included:
- (i) All Driver desk interfaces to TCMS including signal bells shall be fully redundant;
  - (ii) There shall be no single point of failure in safety loops like Emergency stop, Emergency Brake, cab occupation, door related safety loops and door operation etc., which can cause immobility of the Train;
  - (iii) There shall be two physically independent ethernet based (100 Base TX or 1000 Base TX or Better) bus systems on following Ethernet topologies supported by EN/IEC61375-3-4 and EN/IEC 61375-2-5 on Train as well as Basic Unit; For Ethernet Topologies, Ethernet Consist Network with linear type (parallel network) with dual homing topology / ladder-type with dual homing topology/ ring-type with dual homing topology (compliant with EN/IEC 61375-3-4) and EN/IEC 61375-2-5) shall be provided. All the End Devices shall support dual-homing connections to the network via physically independent ports or shall have redundancy in end devices, if having single port connection, to increase system reliability and availability.
  - (iv) A single point failure of any individual equipment/component/board/communication link etc. shall not affect data acquisition or cause any adverse performance impact on train performance of train or loss of data. For critical subsystems where performance cannot be managed at train level redundancy, there shall be provision of receiving input through redundant means i.e. either by redundant physical inputs or by communication and physical input. The control of passenger amenities and safety functions shall be redundant;

- (v) Availability of the Basic Unit even in case Auxiliary Converter(s) of that Basic Unit is (are) not available.
- (vi) A Single point downloading of faults/events/data in all TCMS segments, Door Control Unit, PIS, PSSS, HVAC etc. shall be possible separately for TCMS and comfort networks through:
  - a. At depot level both physical port/wi-fi network (provided by Technology Partner.)
  - b. During the journey; TCMS, Door Control Unit, HVAC etc (non-comfort networks like PIS/PSSS) through 5G/6G network.
- (vii) Uploading of all types of software/program/data shall be done at depot/shed/stabling level for which physical port can be used.
- (viii) The uploading of software and downloading of data for PIS and PSSS shall be done at depot/shed/stabling level for which physical port can be used.

3.21.10 For control functions integrated in the TCMS, the requirements of EN 50126 and EN 50716 shall be applied. In particular, the risks associated with the integration of any control function shall be assessed and the design of the TCMS (SIL level according to EN 50716) shall reflect the level of risk identified.

3.21.11 The functionalities indicated as under (but not limited to) shall be minimum SIL2 Compliant for below defined vital and safety related control & monitoring functions:

- a. Emergency brake
- b. Standstill detection
- c. Speed control
- d. Roll back detection
- e. Speed indication
- f. Traction release
- g. Smoke and Fire detection.
- h. Deadman Function
- i. Automatic plug/sliding door control
- j. ETBU communication
- k. ATP/KAVACH interface

At all levels including but not limited to hardware, software and control functionality etc. Any change in SIL level shall be subject to the hazard analysis and acceptance or otherwise of the same by the IR/ IR Nominated agency, whose decision shall be final and binding. The final list of monitoring & control functions shall be detailed during stage

3.21.12 Independent safety audit or safety assessment by an accredited agency shall be done for above functionalities for validation and certification of SIL-2 levels according to prevailing EN standards and international practices.

3.21.13 Acceleration and speed shall be clamped to a selectable value while opting for 'shunting' operation. The shunting operation shall be selectable and shall be recorded. For clamping the speed, provision of a separate push button shall also be made on the Driver desk to limit the speed to 15 km/h (configurable parameter).

- 3.21.14 It shall be possible to read and record the energy consumption and regeneration figures for a particular time period for the individual basic unit and for the complete rake, along with train no., the name of the driver, date, time, distance, journey details etc. as fed through suitable electronic device in the driver's cab, details to be worked out during design stage. These figures shall be available readily on the driver's display panel as and when required and shall be retrieved through laptop.
- 3.21.15 The Technology Partner shall submit the values of parameters, list of fault messages, their environmental data, hierarchy of fault display, fault categorization, trouble shooting of each fault by way of graphical representation on HMI etc.
- 3.21.16 In the event of removal of any Basic Unit from the Train or addition of a basic unit to the train, it shall be possible to automatically configure the modified train formation in TCMS.
- 3.21.17 It shall be possible to selectively operate the circuit breakers or pantographs, if so required by the driver. Sequential operation of VCB as desired shall be ensured.
- 3.21.18 Synchronized time stamping of TCMS and PIS and interface of PIS with TCMS shall be adopted.
- 3.21.19 TCMS shall not allow the traction (provision of traction cut-off) with indication to motorman in case the system identifies that 50% or more bogies are in pneumatic brake isolated condition.
- 3.21.20 It shall not be possible to override the traction block. Further, it shall be ensured that proportional reduction speed after detection of EP brake isolation from maximum speed to set speed is achieved through automatic application of brake without intervention of driver.

**3.21.21 Fault Diagnostic Features**

**a. Self-check and calibration**

TCMS shall perform the task of fault diagnostics, in addition to performing the control/monitoring tasks. The design shall consider the train as a complete system and diagnostic capability incorporated in the system shall detect any node or line section failure rapidly to ensure no impairment of normal control and monitoring functions. The technology Partner shall submit proposed scheme and fault detection logic for IR/ IR Nominated agency's review and approval.

- (i) The fault diagnostic functionality of TCMS shall include, but not be limited to, the following features:
- (ii) Continuously monitor the status and determine health of all connected equipment and subsystems,
- (iii) Detect and log events and fault occurrences,
- (iv) Perform fault analysis and initiate appropriate failure management actions, including isolating or shutting down affected equipment wherever necessary.
- (v) Present alarms & conditions/guidance to the train operator.

**b. Fault Info Display:**

Real-time diagnostic information shall be made accessible on the train VDU to assist the operator to operate the train safely, quickly, efficiently, and to rectify resettable faults or failures.

**c. Fault Levels:**

The scheme proposed shall differentiate between faults which are not potentially life threatening (e.g. RMVU failure) and other system faults which could be life threatening (e.g. failure of the brake system).

The faults/events shall be at three or more levels with 'Level 1' events displayed on HMI with buzzer, 'Level 2' events displayed on HMI without buzzer and 'Level 3' being events recorded in the memory.

**d. Auto-upgradation of Frequent Faults:**

Provision shall exist to temporarily upgrade the level of the fault/event automatically in case of its being experienced for predetermined number of times (settable by the authorized maintenance personnel) in pre-determined time period (settable by the authorized maintenance personnel). Detailed proposal for the same shall be submitted for IR/ IR Nominated agency's review and approval.

### **3.21.22 User-Friendly Train Status Visualization Dashboard**

The system shall provide a user-friendly dashboard for real-time visualization of train status, accessible through both web and mobile platforms. The dashboard shall be designed with an intuitive interface to enable easy understanding and quick decision-making by users. Key features shall include:

- Real-time display of train status, including location, speed, etc
- Graphical visualization (Trains, maps, charts, and indicators) for enhanced situational awareness
- Responsive design, ensuring seamless usability across desktops, tablets, and smartphones
- Customizable views and filters to allow users to track specific trains, routes.
- Color-coded alerts and notifications for failures, faults, disruptions, or critical safety events.
- Minimal navigation complexity, enabling users to access key information within few clicks/taps

The dashboard shall prioritize clarity, performance, and accessibility to ensure effective monitoring by both technical and non-technical users.

### **3.22 Speed Indicating and Recording Equipment**

The Train shall be provided with GPS synced speed indicating-cum-recording equipment in each cab. The equipment shall also incorporate the feature of indicating and recording kilometers travelled by the Train. The capacity of the memory shall be such that it retains most recent data of at least 45 days' service period. The speedometer shall have programmable output modules which will be for automatic emergency brake application.

### **3.23 Loco Pilot's Cab and Display**

- 3.23.1 Driver's Cab shall be designed in accordance with EN 16186-1- 'Railway applications - Driver's cab: Visibility, layout, access', EN 16186-2- 'Railway applications -Driver's cab: Integration of screens, controls and indicators' and EN 16186-3- 'Railway applications - Driver's cab Design of displays. The HMI shall provide distinct screens for different functionality or subsystems. Capacitive-touch screen-based HMI or better of appropriate size shall be provided as approved by the Engineer. The display screen shall be of colour organic LED (OLED) type or LCD with backlit LED, high resolution, suitable for use in rugged railcar environment. HMI shall be equipped with brightness, sharpness, intensity, and contrast controls etc. HMI shall be capable to handle efficiently high volume of data without glitches.
- 3.23.2 The interface with the Loco/Train Pilot shall be simple considering the average level of proficiency of drivers in handling electronic devices. There shall be provision for standby display in case of failure of main Driver Display Unit (DDU). Alternate Display in the form of CCTV display, etc.
- 3.23.3 The display shall be designed to provide full guidance and assistance to the Loco/Train Pilot about the action to be taken in case of a fault. Selection of display medium shall take into account high ambient temperature and lighting conditions.
- 3.23.4 The system shall provide foolproof safety against unauthorized persons driving the train.
- 3.23.5 **Speed Sensor Redundancy:**  
Adequate redundancy shall be built in for correct train speed measurements in case of failure of any of the speed sensor. System shall also counter check the speed recorded by the ATP/ATO. For this purpose, the technology Partner shall suitably interface with Signaling technology Partner.
- 3.23.6 **VDU Screens Design**  
The screen layout including the selection of default screen, abbreviations etc. shall be reviewed and approved by the IR/ IR Nominated agency.
- 3.23.7 **CCTV Display Redundancy**  
Full redundancy shall be available between VDU of TCMS and CCTV. In case of failure of TCMS VDU, full functionality of TCMS VDU shall be available in CCTV VDU and vice versa. CCTV images can be displayed on the TCMS VDU on demand or event generated. The TCMS VDU shall have provision of displaying multiple screens as per the requirements.
- 3.23.8 The layout of the equipment on driver desk, including screen of HMI display shall be finalized during design approval stage to maintain uniformity with cab arrangement of a similar project of IR so that the cab layout remains same from driver's point of view to the extent feasible. Based on the approved layout, a mock-up of the complete driver's cab shall be made at purchaser premises/ nominated place to finalize the finer details and freeze the design. The design shall give an aesthetic look and the equipment shall be furnished in colour coordination. Fitment of various equipment on the panel shall be with proper finishing and proper IP protection against moisture and dust. Technology Partner

shall submit the design in 3-D model for cab layout.

### **3.24 Safety Measures**

- 3.24.1 Standard protective systems shall be provided, in accordance with the Good Industry Practice, for protection of the electrical equipment against abnormal currents, excessive voltages etc., with indicating facilities, so as to ensure safe and correct operations.
- 3.24.2 All exterior components including under-slung equipment shall be attached with use of secondary restraints, redundant fixings or secondary latches as appropriate to ensure that no single point failure shall cause equipment to either physically detach or protrude out of gauge.
- 3.24.3 Provision for protective earthing against electrical hazard shall be in line with EN 50153: Railway applications - Rolling stock - Protective provisions relating to electrical hazards. All electrical equipment shall be provided with essential interlocks & keys as may be adequate to ensure the protection of the equipment and the safety of those concerned with its operation and maintenance.
- 3.24.4 The design of the protection scheme shall be based on EN 50153 latest edition.
- 3.24.5 In case of any loose connection which may result into overheating of incoming wires then in such scenario protection shall be so designed that it shall be able to isolate the equipment without any major fire or overheating of the sub system or its cases. This protection scheme shall be independent of the overload protection & shall be capable of acting much before the load current reaches to its set tripping level.
- 3.24.6 An earth fault detection system shall be proposed by the technology Partner for review.
- 3.24.7 All electrical circuits shall be fully insulated from the superstructure on both the positive and negative sides and the super-structure shall not be used as any portion of an earth return circuit.
- 3.24.8 All electrical and electronic equipment shall be protected against surge or transient voltages caused by switching (internal or external to the Rolling Stock).
- 3.24.9 Driver PCBs for all LED lights shall not have electrolytic capacitor.

### **3.25 Electrical Fire safety**

- 3.25.1 The design of equipment shall incorporate all measures to prevent fire, and will be such that should any fire take place, the effects shall be minimized and no spread of fire should take place. Materials that are not fire retardant shall not be used. Cables which are fire retardant, low smoke, halogen free, less toxic according to relevant international and industrial applications for rolling stock shall be used.
- 3.25.2 All electrical circuits including 110 V DC shall be fully insulated from the super structure on both the positive and negative sides and the super-structure shall not be used as a part of any earth return circuit.
- 3.25.3 Relevant provisions stipulated in Central Electricity Authority (Measures related to Safety and Electric Supply) Regulations, 2023, shall be followed in the interest of safety of passenger/staff as well as for equipment / instruments provided in the Cars.
- 3.25.4 A manually operated two-position earthing switch shall be provided. Operation of the switch shall enable earthing of the power circuit of the Train and allow attention to the high voltage equipment by releasing interlocked keys from a box fitted to the earthing switch.

- 3.25.5 A discharging and an isolation switch shall be provided by the Technology Partner to facilitate the maintenance personnel with a simple means of isolating the traction equipment, discharging all high voltage capacitors to a safe voltage of 50 volt and earthing all high voltage equipment.
- 3.25.6 The inter-vehicular couplers for high-tension connections between equipment, if used, shall be proven. Such couplers shall be designed to cater for abnormal conditions such as vandalism activities. Details of the coupling arrangement shall be furnished. To ensure safety of personnel, it shall be ensured that coupling/ uncoupling power couplers shall be possible only in de-energized conditions.
- 3.25.7 Suitable danger/warning sign to warn the maintenance staff and commuters for the presence of hazardous electrical equipment shall be provided.
- 3.25.8 **Fire prevention measures for equipment design**
- a) Materials used in the manufacture of equipment/system shall be selected to reduce the heat load, rate of heat release, propensity to ignite, rate of flame spread, smoke emission, toxicity of combustion gases and shall comply with EN 45545 with hazard level HL-3.
  - b) All safety features in design, construction and materials used shall conform to the best safety standards and shall in particular prevent fires in Train in accordance with Good Industry Practice.

### 3.26 Automatic Fire Detection with Alarm System:

Very Early Smoke Detection Apparatus (VESDA) shall be used. A reliable automatic fire detection and alarm system (with SIL 2 compliant system as per EN 50716 and 50129 with certificate of independent safety audit or safety assessment by an accredited assessment body) shall be provided in the train covering the following areas:

- a) **Passenger area including lavatories:** Sampling points of aspiration system generally confirming to RDSO/2008/CG-04(latest), covering all areas including electrical cabinet area along with point type smoke/ smoke cum heat detectors, one in each lavatory and min 04 no in passenger area.
- b) **Traction converter, auxiliary converter, Battery box etc. - Linear Heat Detector (LHD) cables (UL or EN approved).**
- c) **On Board Electrical cabinets**– Point type smoke cum heat detectors with sampling points of aspiration detection system.
- d) In addition, RDSO approved fire detection and suppression system for electrical cabinets, traction converter, auxiliary converter, Battery box with adequate quantity for the enclosure targeted. The requirement of suppression system for all electrical cubicles, traction and auxiliary converter and battery box is over and above the requirements of EN 45545.
- e) Heat detectors/LHD sensors on low voltage/high voltage terminal boxes linked to TCMS/Fire detection & control unit so that their status is monitored. The above information shall also be logged in TCMS.

- f) Temperature/Heat sensor/LHD shall be provided in proximity of switching devices as well to ensure redundancy in the equipment enclosure/cabinet and shall be linked to TCMS/Fire Detection & Control Unit so that their status is monitored.

Smoke /Fire detection system compliant to ARGE Guide line Part 1“Fire detection in railway vehicles” shall be deployed. These standards may be referred for details of Smoke/Fire detection time, Positioning and commissioning of the system etc. The system to be capable of detecting smoke / fire along with its location at incipient stage of fire.

The sensitivity and location of detectors have to fulfil requirements of ARGE Guideline -Part 1 “Fire detection in railway vehicles”. False Alarm Immunity with dust discrimination algorithm and insect screen shall be provided. Airflow compensation algorithm shall be incorporated wherever applicable as per governing EN spec.

The number of smoke/heat detectors, LHD and their exact location may vary and shall be finalized during the design stage. Decision of the IR/ IR Nominated agency shall be final and binding

Prototype approval to ensure the compliance of the system to ARGE guidelines will be arranged by the Technology Partner and will be witnessed by any accredited assessor for these systems in presence of consignee/RDSO.

On detection of a possible smoke / fire by means of Smoke/Fire detectors, the system shall have different levels of response (at-least two i.e., warning and alarm) to be finalized at design stage. System indications must be promptly available to drivers via TCMS pop-up messages who shall then take necessary action to minimize the spread of fire. There should be a provision for isolation/ bypass of faulty detectors to avoid any inconvenience in train operations. The Smoke/Fire Detection system shall interface with TCMS in a redundant manner. Issues related to interface of smoke/fire detection system with TCMS shall be finalized at detailed design stage. All the major events (alarms, faults etc.) to be recorded in the detection system and should be retrievable on the maintenance terminal for analyzing any issue. The System shall be designed for self-diagnostic to any failure/trouble within The System i.e. wiring break within the system, discontinuity in the circuit etc. The Technology Partner/OEM shall provide necessary diagnostic tools (software, hardware etc.) in order to identify failures immediately.

### **3.27 Power Sockets**

- 3.27.1 2 Nos. of Charging stations one at each end of the coach with suitable combination of 3-pin and Type-C USB Charging ports and with international standard safety features shall be provided inside the coaches for charging batteries of portable electronic devices, mobiles or for powering a laptop computer.
- 3.27.2 Each charging station shall have minimum of 6 combinations of 3pin and type-C charging ports
- 3.27.3 A power socket to supply to battery charging of train from external supply source also needs to be provided.



### 3.28 Disaster Management Light

Separate self-contained Flush type disaster management LED type Emergency light units, with indication on the Electrical cubicle, 4 nos. in each Car having inbuilt primary/rechargeable battery (to provide backup of 12 hours) shall be provided. These lights shall be automatically switched ON in the event of non-availability of battery supply due to parting of Cars or derailment of Train.

### 3.29 Fire Loading

All the electrical material to be provided in Car shall have fire retardant properties and shall meet the requirement of EN 45545 -HL3 standard. Calculation of total fire load shall be calculated and submitted as per relevant international norms.

### 3.30 Event Recorder

3.30.1 The event recorder (Train data recorder) shall monitor and record identified critical events so that data is available for analysis to determine the probable cause of accident, incident or operational irregularities. There shall be minimum of one event recorder per rake with redundant train control interface and it shall be designed to provide an intelligence-based recording of the following parameters against the time axis (time interval shall be decided by recorder itself, whenever there is a change in the respective parameter). The minimum recording of parameters shall be as per EN/IEC 62625 latest. Event Recorder shall have one crash protected memory (not less than 8 GB) and one data logging memory (flash memory) (not less than 32 GB) for recording of data. The duration of the storage for the memory shall be considered as per **Annexure-VIII**.

The following (not limited to below mentioned) parameters shall be recorded:

- a. Speed in Kmph;
- b. OHE voltage;
- c. OHE current;
- d. Tractive/braking effort & master controller position;
- e. Battery voltage;
- f. Brake pipe & main reservoir pressure;
- g. Brake cylinder pressure
- h. Cab1 /cab2 activated cab and ICS on/off;
- i. Pantograph up/down position;
- j. Status of main circuit breaker i.e. open/close;
- k. Mode of operation i.e. traction mode/braking mode;
- l. Direction of travel i.e. forward/reverse with respect to activated cab;
- m. Head light status on/off;
- n. Flasher light status on/off;
- o. Horn & bell code status on/off;
- p. Status of penalty brake application (application of the vigilance system);
- q. Status of brake controller and emergency brake by Guard;
- r. GPS location
- s. Wiper on/off
- t. Operation of passenger alarm and ETBU
- u. Status of brake application (Service/Emergency) brake by TPWS/KAVACH/ATP
- v. Isolated Bogies/coaches
- w. Time of day and date

- x. Driver Identification
- y. Train/ Vehicle Identification
- z. Condition of air spring
- aa. Isolated Bogie/coaches
- bb. Occurrence of slip/slide
- cc. Event related to Door System (e.g. open/close status)
- dd. Stuck Door Information
- ee. Fire or Smoke details
- ff. Event related to Fire Detection System
- gg. Operation by the driver/train crew of passenger door controls where available.  
Source of door opening demand, status of door interlocks and side where possible.
- hh. Isolation/override by the driver/train crew of systems relevant to
- ii. Safety functions (e.g. control wheel slide, tilt control system)
- jj. Operation and driver override of passenger alarm system and fire detection system.
- kk. Operation, isolation/override of and driver response to onboard warning and protection systems such as TPWS/ATP/KAVACH, in cab signalling system, trip cocks and train control and monitoring system (TCMS)
- ll. Status and operation of cab radio systems
- mm. Status of interlock between doors and traction
- nn. Emergency bell / passenger alarm activation; and
- oo. OBCMS data
- pp. any other parameter considered necessary

The event recorder shall be designed to:

- i) Permit rapid extraction and analysis of data for monitoring of Driver or Train.
- ii) Assist retrieval of data after an incident or accident; and
- iii) mitigate the effects on recorded data of foreseeable impact or derailment.

The event recorder shall be designed and constructed to ensure the integrity of the recorded data and the ability to extract data following an incident. Provision shall be made for voice and video recording also. The event recorder shall be designed and tested in accordance with a recognized international standard such as the UK Railway Group Standard GM/RT2472 and EN/IEC 62625 latest. The equipment shall be configured to permit rapid extraction and analysis of data; assist retrieval of data after an incident or accident; and mitigate the effects on recorded data of foreseeable impact or derailment. The sharing of memory between data and audio/ video shall be finalized during design stage.

- 3.30.2 The data recorded should be capable of indefinite retention. All data should be date and time stamped. The duration of the storage for the memory shall be considered as per **Annexure-VIII**.
- 3.30.3 The Recorder shall be fully protected against illegal tempering, shall maintain its structural integrity and integrity/retrieval of data/device during accident. Further details shall be decided during design. All data to be recorded as mentioned in **Annexure-VIII** as a minimum.

### **3.31 Ventilation (Roof Mounted Ventilating Unit)**

- 3.31.1 Ventilation shall broadly conform to ICF specification no. ICF/Elec./0161(latest revision). The interface of the electrical equipment with the system shall be done.
- 3.31.2 It shall be the responsibility of the Technology Partner to ensure the ventilation level as desired. ASHRAE standard shall be referred for any clarification.
- 3.31.3 The coach ventilation arrangements shall be so designed that in the event of failure of forced ventilation; there is still a reasonable level of comfort to passengers not necessitating withdrawal of coach till destination.
- 3.31.4 Bidder shall furnish detailed calculation and design philosophy adopted and reason thereof. The energy consumption of the arrangement shall also be furnished. Suitable test procedure shall be furnished by the Technology Partner during design stage to validate the ventilation design.
- 3.31.5 For forced ventilation, fresh & filtered air will be introduced into the cars via longitudinally arranged diffusers situated in the ceiling. The Technology Partner shall furnish detailed design drawings of the duct arrangement at the time of design approval stage.
- 3.31.6 Superstructure shall be provided with ducting arrangement for discharge / exhaust of air. It shall be ensured that water does not enter in such arrangement during rains or car washing. Complete duct for the forced ventilation system shall be provided in the prototype unit only for measurement of air flow in actual conditions. Special care shall be taken to ensure that there is no ingress of water at the worst conditions, when there is heavy rain striking at 45-degree opposite to the movement of the train running at 130 kmph. This shall be verified by simulating on the mock-up at equipment manufacturer's works.
- 3.31.7 Suitable mechanism to adjust the air flow/speed of the ventilators, depending upon rush hours and seasonal requirements, shall be provided. Load weigh signal shall be used for adjustment of the ventilation in suitable steps. Alternative provision shall also be provided with the driver, which may be actuated if so desired during exigencies. The loading pattern may vary during 24 hours due to change in traffic pattern.

### **3.32 Driving cab Air conditioning**

- 3.32.1 The Technology Partner shall provide an Air Conditioning Unit suitable for Roof Mounted design in the Driving Cabs generally conforming to RDSO specification No. RDSO/2007/EL/SPEC/0055 (latest revision).
- 3.32.2 The air conditioning system in the Driving Cabs shall be designed to achieve the specified performance with four people (inclusive of the Train Operator) in the Driving Cab as per the outside dry summer condition and inside temperature of 25 °C (dry bulb) and 40% RH.

3.32.3 The air conditioning and heating system shall maintain temperature as follows:

<b>Summer</b>	Dry bulb	Wet bulb	% RH
Outside (Dry summer)	51°C	25°C	-
Outside (wet summer)	40°C	28°C	-
Inside (dry & wet)	20 to 25°C	-	40-60
<b>Winter</b>			
Outside	-4°C	-	-
Inside	(17-21) °C	-	-

3.32.4 In addition to the air conditioning system, provision of two fans shall also be made.

3.32.5 Temperature indicators shall also be provided in the Driving Cab.

### 3.33 Passenger information system (PIS)

#### 3.33.1 General

- i) The Passenger Information System shall include a 4k high resolution multi-colour graphic display, suitable for the remote displaying of moving messages, in multilingual (regional language(s) and English and/or Hindi), on board the train, in the passenger area. The colour of multilingual (regional language(s) and English and/or Hindi) character shall be approved by the IR/ IR Nominated agency. Emergency announcements may be displayed in red.

At-least 4 number of OLED/ LCD with backlit LED programmable displays (size shall be decided based on mounting location and shall use fully available mounting space), preferably at the draught screen & ceilings with adequate protection from vandalism etc. shall be provided in each saloon (location and size will also be reviewed further and shall be decided during mock-up review). These displays shall be used for messages/ advertisements (incl. video) etc. which shall be downloadable from one end of the car/unit and/or from the cab. Provision shall be made for remote downloading as well. Provision shall be made to install an equal number of OLED/ LCD with backlit LED displays in future by simply connecting it to the system. Size and location of provisional displays shall be decided during the design stage. Any wiring etc. if needed, shall be provided. It shall be possible to interface and commission such screens at these locations later on.

All displays shall be commercially available and shall work on open/commercial protocols. The colour combination of the display content should be such that these may be distinguished by colour blind people.

- ii) There shall be a Destination and/or train number Indicator behind the operator cab's wind screen. The destination indicator shall be capable of displaying two lines of multilingual messages. The top line shall display characters in regional language(s)/Hindi of at least 90 mm height while the second line shall display Hindi and/or English characters of at least 45 mm height with yellow LEDs. Inclusion of any other language and its display if required shall be decided during the design stage The Contractor shall submit a proposal for IR/ IR Nominated agency's review.
- iii) There shall be an External Side Destination Indicator on each side [capable of displaying multilingual (regional language(s) and English and Hindi) of cars, at an appropriate location close to the midpoint of the vehicle but beyond the sweep of the

passenger saloon doors. Details of the displays shall be decided during the design stage. The destination Indicator shall display the destination name to the passengers standing on the platform. It shall be capable of displaying the requisite information in a single line alternating between Regional/ Hindi and English language(s). The device shall be flush mounted with the exterior of the car bodies. The display shall automatically change as per short loop operation as the case may be. The location of external displays shall be finalized during the design stage in order to get a clear view of displays by passengers on the platform.

- iv) The Destination Indicators and/or Train number shall be able to be set via the route setting control. The route setting control shall also be possible through the TCMS.
- v) The Train Number/Destination Indicators and external side destination indicators shall have a view angle of not less than 120 degrees in the horizontal plane and shall be legible under direct sunlight, artificial light and darkness from a minimum distance of 20m. Light sensors shall be equipped to vary the intensity of the LEDs based on the level of ambient light.
- vi) The Destination Indicators /Train Number Indicators and External Side Destination Indicators display shall use high intensity full colour RGB LED matrix capable of minimum sustained brightness of minimum 5000 cd/m<sup>2</sup> under direct sun light conditions. The system shall have auto brightness adjustment to the ambient condition using light sensor to ensure optimal legibility during day and night times. The external display shall be a minimum of 32x192 pixels LED matrix at maximum 5 mm pitch, with provision to display at least two rows of alphanumeric characters simultaneously with a minimum character height of 16 LEDs. Higher densities may also be proposed to improve character rendering. The necessary adaptation of given parameters shall be finalized at design stage
- vii) Size and location of The Train Number/Destination Indicators and external side destination indicators indicator shall be optimized as much as possible with reference to mounting location. Details shall be submitted for review by the IR/ IR Nominated agency.
- viii) Location & size of all the displays shall be reviewed during mock-up review.

### 3.33.2 Programmable Digital Route Maps (DRM):

At least 4 nos. of programmable coloured OLED or LCD with LED back-lit based route maps (size shall be decided based on mounting location and shall use fully available mounting space) for the respective lines shall be provided above saloon door, gangway ends, ceilings etc. (location and size will also be reviewed further and shall be decided during mock-up review). These displays shall have following provisions as minimum. Details shall be decided during design:

- a. Display of destination station, present station, approaching station, distance for reaching next stations, real time clock and door indications etc. Necessary interface shall be ensured by the Contractor.
- b. Route-map of respective lines in different colours, point of inter-change or any other important information, flashing of emergency messages, important train messages, videos, GIF etc., scrolling of routes, adding/ expunging of stations, selectable display of route.

- c. The size of the letter on OLED or LCD with LED backlit displays panel and resolution shall be programmable and have adequate clarity and visibility for a seating passenger. Further details shall be decided during design.
  - d. Direction of movement of displays, positioning of destination station on DRM shall match with the geographical direction of destination station/train direction.
  - e. The station names shall be displayed in multi-languages (Regional/Hindi, Hindi/English) alternatively.
  - f. DRM display size has to be much longer to give comfortable view of the complete line(s) and additional information as already described above.
  - g. Door indication on DRM shall be discussed during the design stage and is likely to be different on each DRM due to its mounting location. Details shall be submitted for review by the IR/ IR Nominated agency.
  - h. Routes map, arrows, lines etc. shall be dynamically updated based on the train location.
  - i. Provision shall also be made to install equal number of LCD with LED backlit display in future by the Employer by simply connecting it to the system. Size and location of the provisional displays shall be decided during design. Detail specification shall be drawn, and screens shall get approved during design. Additional changes if required during design shall be incorporated during design.
  - j. Programming of all displays including DRM shall be ensured by the Contractor. Full facilities including any hardware/software tools for programming the displays and system shall be supplied to each Depot. Employer's IR/ IR Nominated agencies shall be fully trained to programme, edit and interface the display panels with the system.
- 3.33.3 The external displays shall have adequate brightness which shall have auto adjustment with the outside ambient light. Programmable split screens of all Displays (LCD with LED backlit) capable of displaying different messages, advertisements (including videos) etc. in each split shall be provided. Full details shall be submitted for review by the IR/ IR Nominated agency. Size & location of all the displays shall be optimized as much as possible with reference to the mounting location. Details shall be submitted for review and approval by the IR/ IR Nominated agency.
- 3.33.4 Layout of fully programmable displays shall be discussed during the design. Any requirement for the decision on layout shall be suitable taken care by the RS contractor. Displays & system shall be capable for displaying live videos like news, TV channels, sports etc. full details shall be discussed during the design.
- 3.33.5 There shall be no limitations on assigning different files (including video, gif etc.) on the programmable display split screens.
- 3.33.6 The location and number of all type of display units shall be proposed by the Contractor taking into consideration the need for all-round good visibility by passengers within the saloon seating arrangement/platform. The Contractor shall submit proposal, including diagrammatic representation of the angle of visibility of the display units. Details of the available sizes of displays and mounting locations shall be discussed during design stage.

3.33.7 Simulation/3-D CATIA view along with blind spot for the same shall be submitted for review by the IR/ IR Nominated agency. The contractor shall propose suitably to increase or change of location of this display to cater the above required for IR/ IR Nominated agency's review & finalization.

#### 3.33.8 Voice Communication System

- i. The Train shall provide a public address (PA) facility so that Loco Pilot /Guard can make announcements to the passengers from Driving / non-Driving Cab. The public address intercom system shall have the Train Driver-Guard and Train Driver/Guard – Passenger communication. Emergency buttons and talk back phones shall be located near all the doors and gangways.
- ii. If more than one emergency device has been operated, each demand shall be independently acknowledged, and alarms shall be stored, displayed and answered sequentially. Provision shall be there for voice recording of the conversations with GPS stamping.
- iii. The communication between Train Driver-Guard shall be in full duplex mode and multiplexed with suitable measures to prevent acoustic feedback. The priorities of different functions of the public address system shall be defined.
- iv. In case of failure of one unit of PA system or a passenger communication unit in one Car, there shall not be failure of the whole system. All the communication and control cables shall be conforming to international standards for fire survival characteristics suitable for the Train services so that full functionality for passenger communication is maintained.
- v. The number, positioning and output of each loudspeaker and power amplifier shall be designed such that an even sound coverage in all areas of the passenger Cars is achieved. The loudspeaker should be separated into two groups and each audio line should be supplied by its own amplifier. Ambient Noise Measurement (ANM) device to be used to get Adjustable PAPIS volume
- vi. An automatic recorder shall be provided to record all automatic announcements made by PA system in saloon, manual announcements through MOP/AOP in saloon, announcements made by OCC in saloon (train), conversation between cab to cab and conversation between passenger (recorded PEA wise with time stamp & train no. & rake ID) & train operator when Passenger emergency alarm is activated in MP3 format or any other superior format. It shall be possible to download the recorded data without using any special tool/equipment directly from the recorder. The recorder shall have expandable memory to store the data for at least three days in revenue service.”

#### 3.33.9 Operation of Passenger Information and Automatic Announcement System

Passenger-oriented services (information/entertainment) (in visual and audio) shall be capable of being originated from the train operator's cab. The system shall also be capable of making pre-recorded announcements (both audio and visual) by manual triggering from the main communications panel.

Apart from the manual system, messages shall operate automatically for the route from the TCMS information. Messages and announcements shall be triggered based on distance travelled and door operations. Manual override shall be provided to allow for station skipping. The train operator shall be able to override the automatic system and select messages to be broadcasted randomly. All activation criteria shall be submitted for review

by the IR/ IR Nominated agency. In case of system degradation, the train operator shall be able to make manual announcements through a microphone from the cab.

### **3.34 Video Surveillance System (VSS)**

Video Surveillance System shall comprise of an IP based close circuit television (CCTV) network, surveillance cameras and other accessories as per RDSO Telecom Directorate Specification no. RDSO/SPN/TC/106/2022 (Version No. 3.1 or Latest). Layout attached with tender document shall be followed.

### **3.35 On-train Public Address System**

- 3.35.1 The microphone to be used for public address / announcements from Cab and OCC should have high dynamic noise cancelling feature
- 3.35.2 Power amplifiers are required for the PA system and shall be provided in each car. Each power amplifier shall feed 50% of the speakers in the same car and 50% in the adjoining car, to ensure that in the event of a single power amplifier failure;
- 3.35.3 The sound pressure level when measured at a height of 1.5m above the floor shall not vary by more than 3dB along the entire length of the car.
- 3.35.4 Adequate number of exterior speakers in order to warn/aware the passengers/commuters while boarding/de-boarding shall also be provided.
- 3.35.5 The PA system shall exhibit no oscillation, acoustical feedback or other instabilities at any combination of input level, gain or speaker volume control settings under all test and operational conditions.

### **3.36 Passenger Alarm Signal Apparatus**

- 3.36.1 The coaches shall be equipped with an audio/visual passenger alarm system. Minimum 04 special extra-large size alarm pushbuttons shall be provided per Car for easy identification and access for the passengers. Each Car shall be provided with the following:
  - a. Flush mounted alarm push mechanism with integrated LEDs to indicate the system is activated,
  - b. LED based Alarm indicator on both external sides of the coach.
  - c. Minimum 2 Alarm indication reset shall be provided at suitable locations inside the Coach for easy access and resetting by authorized persons using reset key.
- 3.36.2 The activation of the alarm shall be displayed in both driving cabs by hooter and indication. Further, the Car(s) where the alarm was activated & the location shall be indicated on driver's display. The alarm buzzer in the cab shall be resettable by the driver or guard. In the event of alarm activation, the guard and driver shall have the possibility to activate the CCTV screen of the related camera with single button operation.
- 3.36.3 Passenger Alarm Signal (PAS) Equipment shall be in accordance with para 1 of EN 16334
- 3.36.4 All Users shall be able to contact the Loco Pilot/Guard/TS by activating the emergency alarm push button to stop the Train and receive assistance. The effect on the Train of an activated alarm signal may vary, depending on the location of the Train and the lines on which it is travelling. Generally, the effects on the Train of an activated alarm signal are:
  - a. Event (Activated alarm signal) occurring within the station area (for example, due to a person being pinned between the doors or between the platform and the Train):



immediate halt of the Train at platform. Event occurring outside the station area (for example, fire or passenger becoming unwell): transmission of the activated alarm signal to the Train Pilot in order to inform him that an incident has occurred in the Train and to ensure that the Train is brought to a halt by the Loco Pilot in a place which is suitable for assistance to be rendered (away from tunnel, gallery or bridge).

- b. The passenger shall receive confirmation that the activation of the alarm signal has been noted within the Train.

3.36.5 **Emergency Talk-Back Unit [ETBU]:** 4 No.s of ETBU (on two physically independent channels) shall be provided in cars. Once pressed/operated, it shall be possible for the passenger to communicate with the Train Driver / Guard. If more than one emergency device has been operated, each demand shall be independently acknowledged. Provision shall be there for voice recording of the conversations with GPS stamping for the duration of the storage for the memory shall be considered as per **Annexure-VIII** in the Event recorder described in **clause 3.30**. Functionality in ETBU to be in accordance with Clause 1.2.4 of UIC 543. ETBU sound level shall be adjustable to Min 80 dB at 1m distance.

3.36.6 The CCTV camera of the coach shall focus on the ETBU area during the conversation. A small LCD display at the passenger end shall communicate the status of his request in case of multiple operation of ETBUs.

3.36.7 As per EN 16334, PAS should have a resetting device.

### 3.37 Recording Features:

#### 3.37.1 TCMS Memory Capacity Limit

For the functionalities specified in these specifications, not more than 70% of the provided memory capacity shall be utilized. Further all the memories used in TCMS shall be expandable further as required by the Employer/IR/ IR Nominated agency.

3.37.2 **Event Recorder Capacity:** The recorder shall have the provision of recording at least 200 signals of the data which should be easily retrievable either by directly connecting the Window based PC or/and the storage media shall be removable type. The recording shall be on a non-volatile memory capable of retaining the recorded data with time stamp and location as mentioned in **Annexure-VIII** as a minimum.

### 3.38 On Board Condition Monitoring System (OBCMS):

OBCMS with remote diagnostics: For status of RMVU (including Motor tripping), Bearing's health, spring, Fire Detection System, Door operation, water level Indicators, Toilet odour monitoring and wheel flattening shall be provided. The details shall be integrated with the DDU along with alert messages.

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## **Chapter 4 – Car body, Bogie, Brake system**

### **4.1 Wheel, Axles Roller Bearings**

- 4.1.1 Axles shall be designed in accordance with BS EN 13103-1:2017 or latest.
- 4.1.2 Wheels shall be in accordance with EN 13262 – “Railway Applications – Wheel Sets and Bogies – Wheels – Product Requirements” and EN13979-1+A2 – “Railway Applications – Wheel Sets and Bogies – Monobloc Wheels – Technical Approval Procedure – Part 1.
- 4.1.3 Wheel sets shall be in accordance with EN13260 – “Railway Applications – Wheel Sets and Bogies – Wheel Sets – Product Requirements” or other equivalent internationally recognized standard.
- 4.1.4 Axles shall be in accordance with EN13261 – “Railway Applications – Wheel Sets and Bogies – Axles – Product Requirements.
- 4.1.5 Components including wheels, secured to the axle by interference fit shall be designed to remain secure over appropriate temperature ranges in accordance with the Good Industry Practice.
- 4.1.6 Design validation of wheels and axles shall be required to be carried out to validate the design. Latest versions of EN standards as mentioned in this clause should be used.
- 4.1.7 Sealed Cartridge Tapered Roller Axle Bearings with L10 life  $\geq 3$  million km shall be conforming to EN 12080:2022.
- 4.1.8 A proven Wheel Flange Lubrication system in leading wheels shall be provided. The target interval between bogie overhauls shall be not less than 1.2 million kilometers of service operation.
- 4.1.9 The final verification of individual axle load shall be conducted on a fully loaded rake through weighment. The Technology Partner shall demonstrate that axle loads are within 20.32 Tons limit under uniform passenger load distribution considering all tolerances.

### **4.2 Bogie Design**

- 4.2.1 The bogies shall provide the required riding comfort. Bogie design & validation shall generally conform to EN15827. The bogies shall be of the two axles bolster less type, incorporating a proven primary suspension system
- 4.2.2 The structural design of the bogie frame shall conform to EN 13749:2011 – “Railway Applications – Method of Specifying Structural Requirements of Bogie Frame” or equivalent standard, category B-I, but with payload as specified in **Clause 1.8** of these Specifications and Standards
- 4.2.3 Testing of the bogie frame shall be in accordance with Annexes F and G of BS EN 13749:2011– “Railway Applications – Method of Specifying Structural Requirements of Bogie Frame”.

- 4.2.4 The bogie shall have Air Spring in secondary suspension and coil springs in primary suspension. Design of Suspension Elements will comply to following standards: -
- i) Air spring as per EN 13597.
  - ii) Rubber suspension/guiding elements including rubber metal bonded items as per EN 13913.
  - iii) Hot coiled cylindrical springs (with fire retardant paint; compliant to EN 45545-2, HL-2) as per EN ISO 2162-2, EN 13298, EN 13906-1, EN 10089
  - iv) Any other suspension element as per relevant standards.
- 4.2.5 No component of bogie shall infringe with the minimum clearance of 91 mm (accordance with MMD to 1D of IRSOD (BG), Revised 2022 or latest) from Rail Level with fully worn wheels and with maximum permissible load (stops under contact in primary & secondary suspension and suspension in failed mode).
- 4.2.6 Rolling Stock shall be designed with its curve negotiating design capability with minimum 150 mm cant deficiency for operation. Designer shall technically establish maximum possible cant deficiency potential in rolling stock design by way of calculations / dynamic simulations. As performance of rolling stock during on-track trials shall also be dependent on track structure & irregularities and Indian Railways has experience of rolling stock operation up to 150 mm cant deficiency only, mandatory assessment of the rolling stock shall be done for 150 mm cant deficiency during operation. However, to utilize full potential of design, further trials to assess maximum cant deficiency which can be permitted on Indian Railways track network will also be done by Indian Railways.
- 4.2.7 Adequate corrosion protection shall be provided. A corrosion protection plan with methodology for the bogie shall be submitted. This shall comprise of paint protection system of external surfaces. The internal areas of the frame shall be completely sealed to avoid moisture ingress after the internal surfaces are protected from corrosion by suitable corrosion resistance substance or any other alternative measure. The corrosion protection plan shall be submitted and got approved during detail design. Bogie frame shall be painted with corrosion resistant paints tested for 15,000 hrs salt spray testing.
- 4.2.8 All fasteners shall be with All Metal Prevailing Torque Nuts. All fasteners for bogie mounted equipment or components shall be positively locked. Use of self-locking Nuts alone shall not be acceptable. However, self-locking nuts with lock washers would be acceptable.
- 4.2.9 The Bogie items such as Primary Helical springs, Dampers, Rubber to metal bonded items, Castings and Forging items shall be painted with a paint scheme such that salt spray test of minimum 1500 hrs. shall be ensured.
- 4.2.10 IR based on successful trials on designs of Bogie received against this specification, may standardize one of the designs for future procurements. Perpetual rights shall be accorded by the Technology Partner to Indian Railways to use design of Bogie and its technical documentation to manufacture or get manufactured and maintain or get maintained Bogies by IR for use in India as well as for exports. Design of Bogie received can also be modified by IR to adapt for fitment of other makes of propulsion system.
- 4.2.11 The bogie shall be either Conventional type with in/out board bearing or Articulated type bogie
- 4.2.12 The Paint system for bogie and its components shall be such a way that it provides superior corrosion resistance and shall be compliant to EN 45545 HL3 with respect to fire standards. The Environmental factors shall be taken into due consideration.

### 4.3 Draw and Buffing Gear

- 4.3.1 It shall be possible to attach a locomotive fitted with AAR-E/H type coupler having buffer/CBC height as per IRSOD 2022 with latest amendment with the coupler of Driving Cars for clearing block section and movement of Intercity Train. If the couplings between coaches within the train are of different types, rescue couplers shall be provided. It shall be possible to fit these rescue couplers with the couplers of the coaches so that they can be attached to Locomotives of Indian Railways so as to haul the coaches in exigencies. Each train shall be supplied with two rescue couplers. One such Draw Hook used for MEMUs and EMUs running on Indian Railways is given in Annexure –III just for reference.
- 4.3.2 Pneumatic connectors shall be provided separately in order to connect Main reservoir and brake pipe connections manually.
- 4.3.3 Front couplers of the first and last coaches shall be of AAR E/H type and shall conform to RDSO Specification No. RDSO/2011/CG-03 (latest revision). Couplers between basic units shall be semi-automatic type and shall conform to RDSO Specification No. RDSO/2017/CG-07 (latest revision) and couplers within the basic unit shall be of semi-permanent type. The coupler and draft-gear shall, in conjunction with the inter-car gangway, be capable of gathering, engaging and coupling units for Rake formation up to 24 Cars on all track conditions detailed in this specification. Coupling shall be achieved with the most adverse mismatch of car heights, caused by wheel wear, passenger loading, air spring deflection, and service tolerances.
- 4.3.4 The coupler shall be equipped with an integral self-centering device to prevent the coupler from swinging transversely when uncoupled.
- 4.3.5 Couplers shall have the shear-off functionality to prevent the damage to car body structure and deformation tube for absorbing crash energy to prevent the damage to car body structure in addition to other crash energy absorbing equipment/ structure provided in cars required for meeting crashworthiness as per EN 15227.
- 4.3.6 Anti-climbing arrangements including energy absorbing features between the cars shall be provided.
- 4.3.7 The coupler shall provide adequate support to the wider gangway with passengers @ 8 pax/m<sup>2</sup>.
- 4.3.8 The speed of the train shall be 9 km/h during coupling.
- 4.3.9 Each rake of coupler shall be supplied with 2 nos of Rescue couplers.
- 4.3.10 Rescue coupler shall be designed in such a way that it shall haul the rake of 24 fully loaded cars at a speed of 30 km/h on the gradient of 1:37.
- 4.3.11 Rescue coupler shall be designed in such a way that it can be handled by 1-2 persons during operation.
- 4.3.12 The Semi Permanent and Semi-Automatic couplers of all the different makes shall be interoperable with each other. TSI certification for semi-automatic coupler shall be submitted by the OEM.
- 4.3.13 Rescue couplers supplied by OEM shall be interoperable with all the makes of couplers

#### 4.4 Compressed Air System

4.4.1 The compressed air system shall ensure delivery of the compressed air complying with the air quality class specified in ISO-8573.

##### 4.4.2 Compressor

- (i) Compressor shall be oil free and suitable for rolling stock applications in dusty and humid climate, with motor of adequate capacity shall be provided for each unit so as to meet the total compressed air requirement under all operating conditions such as but not limited to brake system, control system, air suspension spring, horns etc.
- (ii) The motor compressor unit shall be under slung, resiliently mounted with the under frame to minimize the levels of vibrations transmitted to the Train body.
- (iii) The motor shall be a 3-phase AC motor suitable for working from the 3-phase output of the Auxiliary converter or independent inverter as the case may be.
- (iv) System design shall be such that the average duty cycle of any compressor without electrical braking is not below 30% and does not exceed 80%. The run time and duty cycle of each compressor shall be recorded through TCMS for maintenance schedule point of view.
- (v) **Compressor mounting:** Vibration limit in standstill condition at Floor level to be specified. Validation of Mounting and vibration study shall be carried out by Third Party agency like ARAI.
- (vi) Brake system shall be modular and all Pipes shall be properly secured.
- (vii) In the event of total failure of electric brakes and one air compressor on a fully loaded sixteen-cars train, the remaining air compressor on the train shall have sufficient capacity to enable the train to remain in service for at least four (4) hours. An “intelligent air compressor management” (with option of forced start) shall be provided to ensure that both the compressors on a sixteen-cars train are operated during fill-up and all the compressors in the train are operated alternatively thereafter, to avoid moisture condensation in the compressor due to low duty cycle.
- (viii) The drive motor shall conform to the requirement of IEC 60349-2 and the temperature rise of the windings of the motor shall be limited to temperature index of the insulation minus 70° C. The motor shall have at least IP55 protection.
- (ix) The compressor shall be designed to achieve a minimum of 12000 hours of running time between overhauls. Routine maintenance shall not be required at a frequency more than once per year.
- (x) Correct functioning and running hours of compressors shall be monitored and recorded by TCMS.

##### 4.4.3 Air Dryer

- i) The air delivered to the pneumatic system shall be clean and dry, free from water vapor, oil and particles and shall conform to the air quality specified in ISO 8573. An air dryer and filtration unit proven on rolling stock application suitable for extremely hot, humid and dusty conditions prevailing in IR, shall be provided.

- ii) The grade of filtration at rated pressure shall be minimally as follows:
  - (i) Particles removal down to: : 1 micron
  - (ii) Liquid water removal :> 95%
  - (iii) Dew point depression at 10kg/cm<sup>2</sup> : minimum 25°C.

The technology Partner shall advise the percentage relative humidity of outlet air. However, the relative humidity at the outlet of the air dryer shall not be more than 35%. Air dryer design shall ensure that under all ambient conditions prevailing in IR, no condensation takes place.

- iii) A proven regenerative type of air dryer using desiccant and of a suitable capacity shall be provided between the air compressor and the main reservoir. The air dryer shall be preceded by an automatic drain valve, which collects and discharges the bulk of the moisture in the compressed air, before it enters the air dryer. The air dryer shall have IP65 protection.
- iv) Suitable means of dust separation, along with an automatic drain valve prior to the air dryer shall be provided. An inter-cooler and after-cooler of liberal capacity shall be supplied to ensure efficient operation of the air dryer. A humidity indicator showing the condition of the outlet air through change of colour shall be provided. Full technical details of the proposed air dryer shall be furnished by the technology Partner for review by the IR/ IR Nominated agency. Interval for replacement of desiccant in the dryer unit shall be furnished.
- v) All failures of the air dryer shall be displayed in the TCMS.

#### 4.4.4 Air Reservoirs

Main reservoirs of adequate capacity, made of corrosion resistant material, shall be provided with provision of adequate safety arrangements.

### 4.5 Pipe System

- 4.5.1 A main reservoir pipe shall run continuously throughout the train.
- 4.5.2 All piping shall be of stainless-steel conforming to the requirements of SUS 316L to JIS G3459 or equivalent with flare less bite type double compression fittings generally conforming to the requirements of DIN 2353.
- 4.5.3 Sharp bends shall be avoided, and standard connections shall be used as far as possible. All pipelines shall be suitably colour coded. The proposed colour coding shall be reviewed during the Underframe Equipment Layout Mock-up review.
- 4.5.4 All branches from the main reservoir pipe or control system shall be fed via self-locking cocks (coloured according to the corresponding pipe colour) with or without vent and electrical switches as appropriate. Magnet valves, reducing valves, check valves, silencer and drain plugs etc. shall be incorporated as required. The switches shall be protected against dust and water
- 4.5.5 Quick release coupling test points made of stainless steel, with blanking plugs shall be provided. They shall be located in easily accessible positions.
- 4.5.6 Flexible hoses shall be kept to a minimum and be proven in EMU service. Burst hose protection shall be provided to increase the integrity of the air supply system against rupturing of inter-car flexible hoses. Armoured hoses are preferred to be provided in the flexible connections in the parking brake piping.

- 4.5.7 Foreign matter shall be removed from all pipes prior to installation.
- 4.5.8 All pipes shall be installed by means of clamps with integral, moulded vibration damping inserts to prevent any rattling in service. Clamps shall not be welded to the pipe.
- 4.5.9 Where piping pass through holes in the floor, structure member etc. it shall be rigidly clamped immediately adjacent to the hole to prevent contact to the edge of the hole.
- 4.5.10 In the event of leakage from the Pneumatic circuit/system, it shall be possible to isolate the effected part of the circuit by train operator (and reach up to destination station. Isolation arrangement shall be simple and shall not require more than square key normally carried by Train Operator. Contractor shall submit detail plan during design for engineer's approval. The isolation arrangement shall preferably be in the saloon and shall be secured and monitored alternatively the isolation arrangement may be through magnet valves.

#### 4.6 Horns

Dual tone pneumatic horns shall be provided facing outwards at each end of the Train. The horns shall be of sufficient size and power to be distinctly audible at a distance of 1 (one) kilometre from the Train. The two horns shall have different tones but shall be in harmony with each other when blown together.

#### 4.7 Driving Cabs

- 4.7.1 Aerodynamic Driving Cab with suitable nose cone shall be provided in Driving Cars at each end of the Train with provision for adequate forward visibility. Driving Cabs shall be adequately reinforced and connected with the main under frame at the cab ends. The Driving Cab shall be adequately insulated against noise, vibration, heat, ingress of water and dust. The Nosecone should give a streamlined look to the train and shall be part of the mock-up.
- 4.7.2 **Cattle Guard (obstacle deflector)** as in **clause 4.11.**
- 4.7.3 Driving Cab shall be designed in accordance with BS EN 16186-1- 'Railway applications - Driver's cab: Visibility, layout, access', EN 16186-2- 'Railway applications -Driver's cab: Integration of screens, controls and indicators and BS EN 16186-3- 'Railway applications - Driver's cab Design of displays. Window openings to allow Loco Pilot to look back shall be provided on each side of the Driving Cab.
- 4.7.4 The Driving Cab shall be ergonomically designed for convenience and to minimize fatigue of the Loco Pilot. Ergonomic and human aspects of the cab design shall be compatible with Indian Anthropometric Dimensions. The visibility diagram shall be in accordance with UIC 651. For any contradiction with BS EN 16186-1 in this regard for visibility, UIC 651 shall prevail.
- 4.7.5 The driving position shall be on the left side of the Driving Cab and the brake handles shall be located on the left-hand side of the Loco Pilot in the running direction. The relative positions of Driving Cab equipment shall be similar to those available on IR's present 3-Phase electric locomotives and EMUs.
- 4.7.6 Electric motor driven wind screen wipers system and their component should be tested as per RDSO specification C-K306, IS 7827 part-I, IS 7827 part-II, IS 14141. Manual emergency operation shall also to be provided. The Windscreen shall be constructed of toughened, laminated safety glass, and shall comply with the requirements of UIC 651, IS 2553 (Part-1 and 2), EN 15152, and UIC 566. The inner and outer surfaces of the windscreens shall be scratch resistant.

- 4.7.7 Driver desk shall be designed to protect against any failure due to spillage of liquid over it. Provision shall be made for placing fog safe device in driver desk.
- 4.7.8 Vigilance Control Device (VCD): VCD shall be provided in Driving Cab for monitoring alertness of the Loco Pilot through multi-resetting system which resets by specified normal operational activities of the Loco Pilot and also by acknowledgement of the vigilance check by pressing a pedal switch provided for this purpose. Absence of the normal driving functions and acknowledgement at specified interval of one minute shall cause audiovisual warning. If audiovisual warning is not acknowledged for  $16 \pm 4$  seconds, it shall result into emergency brake application.
- 4.7.9 **Train Operator's Seat:**
- The train operator's seat (2 No.s per cab) shall be sturdy, cushioned, non-slippery, ergonomically designed with back/lumber support using non-flammable materials and filling, and fully adjustable in the longitudinal and vertical directions.
- Adjustable footrest shall be provided for train operator. The seat and footrest shall be harmonized and shall be suitable for anthropology of Indians to ensure comfortable seating for Train Operator.
- 4.7.10 There shall be cab side door on both sides of the cab. The grab handle provided to enter the cab shall be brush finish with sufficient hand clearance.
- 4.7.11 An emergency equipment cupboard shall be provided at suitable location and equipped with first Aid box, safety equipment including fire extinguishers (5 Kg capacity) etc.
- 4.7.12 Suitable space/enclosure shall be provided in the cab for keeping train operator's kit, manuals and log books etc.

## 4.8 Car Body Structure

- 4.8.1 Common Car body structure shall be adopted for all types of cars. The car bodies shall be manufactured using Austenitic Stainless Steel / Aluminium and it shall be from the latest and best practiced Rolling Stock Application. (underframe may be partially stainless steel). The Car body shall be lightweight and corrosion resistant and rugged to withstand the tractive and braking effort as well as impact and accidental damage. The mechanical strength of Railcar body shall conform to EN 12663 (Category P1) and the design of Railcar body shall be compatible in respect of crashworthiness with EN 15227 (Category C1) standard;
- 4.8.2 The design of the coach body shall be such as to ensure that under fully loaded condition the maximum vertical deflection of the sole bar (at the center) shall be less than 1/1000 of the bogie center distance.
- 4.8.3 The exterior appearance of the car bodies with Austenitic Stainless Steel shall be smooth (not corrugated) such that the maximum variation from the required car profile, over any one-meter length, shall not exceed 1.5 mm in unpainted condition.



#### 4.8.4 Car body Material:

- i) Stainless steel of grade SUS301L to JIS G4305 or better shall be used. In case of Aluminium 6 series grade to be used.
  - ii) Complete cars including underframe of the cars shall be of Austenitic stainless steel except Headstock / body bolster which may be of Light Alloy High Tensile (LAHT) steel. Preventive measures to prevent galvanic corrosion at dissimilar metal contacts shall be ensured.
- 4.8.5 Exterior surface finish of Stainless-steel sheets used in the outer side and end walls shall be 2J as per BS EN 10088-2.
- 4.8.6 In the case of stainless-steel cladding materials below 6mm in thickness, the side and end wall sections and under frame shall be manufactured from rolled sections, folded or pressed plates, or plain sheets.
- 4.8.7 All welds including spots welds marks shall be pickled and passivated/ Treated with Suitable surface treatment with acceptable procedure to protect against any visible rusting/chemical deposits/blackening etc.
- 4.8.8 Non-stainless-steel surfaces below the floors of the car bodies shall be primed with epoxy coating and then finish painted with two coats of a Railway approved polyurethane paint or better.
- 4.8.9 The Car bodies shall be of an integral design, where under frame, sidewalls, end walls and roof shall be integrated so that the body structure contributes to strength of under frame and the unit as a whole behaves as a rigid tube in its ability to withstand loads. The longitudinal end of the car bodies shall incorporate an anti-telescopic feature.
- 4.8.10 The Technology Partner shall choose the suitable alloy as per the applicable EN specification and shall establish his proven and proposed manufacturing process and selection of extrusions. Where dissimilar materials are used, measures shall be provided to mitigate corrosion in the body due to electrolytic action.
- 4.8.11 Throughout the design life of 30 years, the Car bodies material shall not degrade or be etched by the environmental conditions that exists in Indian Coastal areas, the original appearance of the Cars does not deteriorate to the extent that it cannot be restored by normal washing. Technology Partner shall decide painting/finishing schedule accordingly.
- 4.8.12 It shall be ensured that the downward deflection of the cars in fully loaded condition shall be within the permitted deflection throughout the service life. Detailed calculations shall be submitted by the Technology Partner for the expected deflection. Tests for stresses etc. as well as other tests as per relevant standard for the method of construction deployed shall be carried out under specified loads.
- 4.8.13 The car bodies and any equipment mounted on beneath, on roofs or within it shall be designed to withstand the fatigue loads that the car body structures will encounter over the design lifetime. The fatigue life assessment of body structures shall be carried out according to the referenced standards under this specification and shall be submitted by the Technology Partner for review by the IR/ IR Nominated agency.
- 4.8.14 The car bodies shall be designed to have high thermal insulation to reduce the heat loss and heat transfer coefficient (K value) of car bodies excluding glazing/windows/gangway area shall be kept within  $1.6 \text{ W/m}^2$ .

- 4.8.15 The cars shall be completely watertight, without using any sealing compound, and be able to withstand rainwater protection test, as approved by the IR/ IR Nominated agency. simulating a train traveling at speed under severe climatic conditions of IR as well as passage through automatic wash plants. If considered unavoidable, only weld through sealants shall be provided. The external sealants shall not be exposed to direct sunlight.
- 4.8.16 The exterior colour schemes including Logo of the Cars shall be developed by the Technology Partner in consultation with the Government.
- 4.8.17 The design of the car exteriors shall generally be aesthetically pleasing and shall minimize the build-up of dirt. All measures shall be taken to reduce the train's resistance to motion to reduce Energy consumption of the train. Provision of underframe skirt, flushing of HVAC, aerodynamic car-body profile, etc. may be considered
- 4.8.18 Rainwater gutters shall be properly laid and guided so that water shall not fall on widows and electrical couplers

## **4.9 Crashworthiness**

- 4.9.1 The design and crash worthiness of the Car bodies shall meet EN 15227 (Category C1) - 'Railway application- Crashworthiness requirement of the railway vehicle body' standard collision scenarios using complete trainset method or reference train method (Annex D of EN 15227).
- 4.9.2 The Car structures and its supplemental energy absorption devices shall be designed to minimize accelerations transmitted to Users, by absorbing collision energy, whilst not permitting one vehicle to over-ride another, nor to telescope one into another. A suitable proven energy absorption feature with associated collapse and anti- climbing features shall be incorporated into the coupler/buffers or other structural members.
- 4.9.3 At high energy levels it shall ensure that collision energy is absorbed by progressive deformation of the Coupler structure, Anti Climber at driving car end as well as in between the cars and the vehicle end structure, thereby protecting the passengers and passenger area in the car. There shall be least deformation between the body bolsters.
- 4.9.4 Of particular concern is the driving cars front structure (Aerodynamic nose cone), which is required to protect the train operator, and vital control and communications equipment in the event of a collision. The Technology Partner shall design the driving vehicle and its cab structure in such a manner as to fulfil the requirements of EN 15227.

## **4.10 Appearance**

### **4.10.1 Painting and finishing**

- i) Finishing shall be carried out with a proven, scratch resistant paint (Polyurethane or better). The paint shall be compliant to EN 45545 HL3 with respect to Fire standards.
- ii) The colour scheme and style for both interior and exterior shall be submitted for approval at design stage duly considering the expression emanated by the vehicle body with colour scheme & its expressions.
- iii) The paint coating shall be tested in accordance with relevant latest international standards.
- iv) Anti-graffiti clear coating shall be provided on the finished surface of Cars.
- v) No part of the car bodies shall be left unpainted/exposed to the atmosphere.

#### 4.10.2 Finish

- i) The surface finish of the Car bodies, Doors and other surfaces visible to Passengers shall present a high quality finish that delivers: a smooth and continuous surface free from protuberances, sharp edges, weld spatter or manufacturing marks; a ripple-free appearance when painted or covered in high gloss materials; panel joints on the exterior that are not visually misaligned to an observer with normal eyesight standing 1m from the joint; and no undulations on any exterior surfaces exceed 1.5 mm over 1m length, excluding Vehicle roof and under frame. The design of the car's exteriors shall be aesthetically pleasing, and shall minimize the buildup of dirt.
- ii) The Vehicle number shall be applied on both sides of each Vehicle, at both ends, both externally & internally. All signages, longitudinal colour band and branding image shall have the anti-graffiti property as per relevant international standard (NFF 31 112 or any other equivalent international standard). Safety and Emergency related signages shall be fluorescent type. Technology Partner shall prepare the detailed plan for signages and submit for approval.
- iii) Technology Partner shall submit the measures that will maintain the original appearance of the car's exteriors from undue deterioration, staining or streaking, including appropriate cleaners. Authority envisages usage of car's exteriors for advertising purpose. There shall be no damage to the car body exteriors throughout the lifetime by advertisements being pasted/applied on the car body exteriors. The technical design specifications of the exterior advertisements shall be submitted.

#### 4.11 Cattle Guard (obstacle deflector)

The Driving Cab end of the Train shall be provided with a rugged cattle guard that can withstand and sustain the collisions at the maximum service speed with animals weighing up to 600 kg without much damage and shall be strong enough and profiled to prevent the entry of animals under the Cars after impact. Nosecone cladding/structure shall be modular, so that in case of minor damages, the damage portion can be easily replaced.

#### 4.12 Emergency Ingress / Egress Locations

4.12.1 A location shall be marked on the roof of the Cars where emergency services may cut through to gain access to the interior of a Cars that has rolled on to its side. This space shall be clearly labelled to enable emergency services to immediately identify the appropriate space and cut lines. The location shall be adequate to enable a stretcher born patient to be removed from the Car. The region shall be hindrance free and easy to cut in view of safe and fast evacuation.

##### 4.12.2 Positioning of emergency exits-

The following rules shall apply with regard to providing number of emergency exits on each side of the Cars

- a) The distance to be covered between any seat and emergency exit must be less than 16m.
- b) The number of emergency exits per vehicle must be at least 2 for less than 40 users and at least 4 for more than 40 Users,
- c) The emergency exit must be provided an access space of at least 700 x 600 mm.
- d) The emergency exit must not be located in the deformable crumple zone designed to improve crashworthiness.

4.12.3 In an emergency, it must be possible to leave the Train in following ways:

- a) Through windows, by pushing out window or pane or by breaking the glass.
- b) Through the compartment doors, by rapid unmounting of the door or breaking the glass.
- c) Through the access doors, by pushing out pane or breaking the glass.

4.12.4 Windows fitted as emergency exits must be made of tempered or laminated glass. Where tampered glass is used, the Cars shall be equipped with hammers to break the glass.

4.12.5 Where laminated glass is used, evacuation shall be possible by:

- a) Either pushing out the pane.
- b) Using special laminated glass that can be broken with a hammer, requiring little time to get through.

#### **4.13 Car Roof and Roof Mounted equipment:**

- i) Incidences of stray wire being dropped by birds etc. are quite frequent. In many cases this has fallen on OCS and roof equipment mounted on the body. These resulted not only in interrupting train running and power supply system but also withdrawal of rakes from revenue service and also puncturing of roof sheets. To obviate these problems, suitable design arrangements for provision of suitable insulation (for 25 kV single phase) of all live parts on the roof (excluding pantograph pan) shall be provided and methodology shall be finalized during Pre-Final Design Stage with the approval of IR/ IR Nominated agency.
- ii) Roof design shall be such that there shall be no possibility of water stagnation at any part of the roof.
- iii) All live parts on the roof including Bus bars, Joints, Terminals, Conduits, Leads etc. shall be suitably insulated for 25kV AC Arrangements for insulation shall be finalized after approval from IR/ IR Nominated agency

#### **4.14 Interior Furnishing**

##### **4.14.1 General Consideration**

- i. The Cars interior shall be HL3 compliant and have resistance to fire and shall be designed in accordance with the directives of EN 45545 (part 1 to 7). The Cars interior furnishing material should have fire retardant properties confirming to European Standards EN 45545, part-2 (HL3).
- ii. The Technology Partner shall propose vehicle interior layout, which incorporates a modern aesthetic approach with considerations to optimize passenger comfort, safety and security as well as to minimize noise in the saloon.
- iii. Minimum passenger Saloon headroom shall be 2160mm.
- iv. It shall incorporate wide double leaf automatic sliding doors, transverse 3+3 seating arrangement, draught screens placed alongside the doors separating the seating area from the doors, grab-rails, LED lighting, air ventilating outlet grills, luggage racks, passenger information displays, public address loudspeakers, Passenger Saloon Surveillance System, Wi-Fi network, passenger alarm and egress devices.

- v. Adequate space just after each driving cab at both ends shall be provided to accommodate vendors similar to the vendor compartments provided in the existing EMU Rakes which are in service in Mumbai suburban system. A hard partition shall be provided in the cars to separate the earmarked space for vendors from rest of the car. Isolated air ventilation shall be provided to vendor compartment to avoid circulation of air with fish smell etc. to other parts of the car. Each vendor compartment shall have automatic doors at each side of the compartment.
- vi. The body side and roof outer skin shall have a suitable thickness of approved acoustic and thermal insulating material bonded to their interior surfaces.
- vii. The design of interior fittings shall be safe under all conditions of passenger impact, during emergency braking and buffing under empty to fully loaded condition.
- viii. All non-metallic materials shall satisfy the fire property requirements of flammability, toxicity, smoke emission limitations, flame spread and heat release etc. specified in EN45545 Part 1 to 7 latest editions or better equivalent international norms/standards applicable for rolling stock operating in similar conditions.
- ix. All interior surfaces must be finished with good blending and good slow ageing properties to provide a pleasant, high-quality interior and for ease of cleaning and maintenance. No material shall degrade or stain when exposed to food, drink, graffiti, or any cleaners used by the Maintenance Personnel. No material shall produce any odour that would be noticeable or irritating to passengers.
- x. All internal panel surfaces shall be smooth finished with modern low flammability, low smoke emission, anti-graffiti, and low toxicity materials. All internal panels shall be resistant to graffiti, scuffing, vandalism, and cleaning agents (properties of cleaning agent shall comply with the Anti-graffiti Protection Standard NFF 31-112). Rounded corners or covings shall be provided wherever mutually perpendicular flat plane surfaces abut. Metal sticking strips of 150mm depth with radiused coving are required on all exposed vertical surfaces above floor level.
- xi. All panels shall conform to ASTM D2563- level 1 and NFF01-281 standards. The colour shall not fade or discolour with time, or change due to rubbing. Vacuum infusion process with in mould heating, Non-Crimp Fabric with Phenolic or FR Grade Vinyl ester Resin (confirming to EN 45545-2), shall be used to get light weight panels having 60% or more fabric by volume.
- xii. Additives, fillers, monomers, catalysts, activators, pigments, fire retardants, and smoke inhibitors shall be added to the resin mixes to obtain finished products with the required strength requirements and the flammability requirements as mentioned in EN 45545 Part 2 (Hazard level HL3) latest editions. Antimony Trioxide shall not be used. Mineral filler shall not exceed 30 percent of the finished weight for any preformed matched die moulding process.
- xiii. To obtain desired colour with good surface finish, finished exposed gel-coated surfaces with a minimum gloss value of 85 when measured with a 60degree gloss-meter as per EN ISO 2813, high scratch resistance and anti-graffiti properties, gel coat with layer of surface tissue be used in the moulds. The gel coat shall have a minimum thickness of 0.4 mm and a maximum thickness of 0.75 mm. Painting of panels shall not be permitted unless specifically approved by the Engineer. Hand laying process shall not be acceptable, unless specifically approved by the Engineer.

- xiv. Alternatively, Contractor with the approval of Engineer may use Prepreg panels subjected to meeting the requirements of flammability, toxicity and smoke emission limitations etc. with suitable surface finish, scratch resistance and anti-graffiti properties.
- xv. Aluminium panels preferably with Aluminium extrusion having suitable thickness, adequately stiffened may be considered. The panel shall be provided with coatings following due processes and methodology used and proven in Indian Metro Rail Projects. The flatness of Aluminium side panels shall be controlled within 0.5 mm per 1m length. The panels shall have rubber packing on backside of the panel to prevent any bi-metallic corrosion. Contractor shall submit details of processes and raw materials proposed to be used in manufacturing of different panels such as side panels, driver's desk, ceiling panels, End ceiling panels, inspection cover panels, door coving panels, ceiling coving panels etc. for approval of the Engineer during design stage.
- xvi. Contractor must furnish details for different panels but not limited to properties such as Glass Content, Ultimate Tensile Strength, Tensile Modulus, Ultimate Flexural Strength, Flexural Modulus, Compression Strength, Compression Modulus and Impact Test complete with the test methods in compliance of relevant ISOs.
- xvii. Contractor shall also submit 200 mm x 250 mm samples of each proposed material, indicating material finishes.
- xviii. Gaps between all interior lining, panels kick strips, seat shell, etc. shall be kept to bare minimum say 1 to 2 mm. Suitable cushioning at panel joints shall be provided to suppress noise.
- xix. Advertising display areas, locations and its fixtures in interior zones of vehicle shall be provided.
- xx. The Technology Partner shall propose arrangements for digital screen panel with latest technology Dynamic Route Maps Indicator and normal/digital advertisement holders in the saloon that are unobtrusive and easy to maintain. Alternative and additional display systems may be proposed, which satisfy the above intentions.
- xxi. At least two fire extinguishers of the dry powder type of approximately 10 kg capacity or better system shall be installed in each saloon, readily accessible and flush mounted on panel diagonally.
- xxii. A dedicated and clearly marked space for at least one wheelchair along with necessary seats for Passengers with Disability (PWD) shall be earmarked in two Cars of the standard 16 cars rake. To maximize passenger seating capacity, the Technology Partner may install foldable (tip-up) seats in the designated area. These seats shall be designed for use by passengers whenever required. One additional space in 20 Cars Rake and two additional spaces in 24 Cars Rake shall be provided for PWD and wheel-chair in addition to that mentioned above for the standard rake. Grab rails and wheelchair clamps shall be provided in the space to secure and assist the mobility impaired persons.
- xxiii. In passenger saloon area, charging stations (110V AC and USB Type-C ports) shall be provided as mentioned in **Clause 3.27.1**. Location of these ports shall be finalized during design stage.

#### 4.14.2 Floor

- i. The floor covering shall be without steps, anti-slip, waterproofed and sealed, non-skid, resistant to wear and staining shall not trap dust, and shall be easily cleaned using conventional floor cleaning machines/methods and media. Adhesion between floor board and floor covering shall be appropriate and shall last for the lifetime of floor covering. There shall be no cases of floor covering peeling off from floor board.
- ii. The floor shall be designed to provide an effective fire barrier for a minimum of 30 minutes, and it shall be in compliance and validated as per EN45545 part 1 to 7 Latest editions. The sub-floor should be insulated for anti-drumming and noise suppression. Test reports shall be submitted. At all door openings, the floor shall make a water-tight connection. No opening in the subfloor is permitted.
- iii. The Technology Partner shall ensure even, uniform, and gapless joints. The flooring shall have high abrasion resistance as per ISO-4649 and shall be compliant with relevant EN/ISO standards.
- iv. The non-skid floor structure shall be of floating floor type. Composite Floor Boards/ Aluminium honeycomb sandwiched type floating floor with suitable noise, vibration and heat insulation, duly supported on rubber cones shall be used. The floor shall comprise of floor board, rubber cushion, glass wool insulation and floor covering subject to its conformance with EN45545 part 1 to 7 Latest editions to achieve low noise level inside the cars and less weight. Subject to submission of complete details and approval by the Engineer & for better noise attenuation level of the floor and conformance to EN45545 part 1 to 7 Latest editions.
- v. The floor, and its mounting structure, shall be designed to withstand specified loads that may be applied over the life in normal operation of the consist. The minimum thickness of the floor structure shall be 80 mm. There shall be no hatches in the floor or passenger areas. Floor hatches in driving console shall be avoided.
- vi. The floor design shall allow the floor covering to be removed without damage to the floor sub-structure.
- vii. The sub-floor should be insulated for anti-drumming and noise suppression.
- viii. Specific attention shall be paid to the design of complete floor system to eliminate floor swelling/ bulging or floor contraction for the lifetime of the vehicle.

#### 4.14.3 Draught Screens

Beside all passenger access body-side doorways, shall be provided a small longitudinal space, providing a “stand-back” position for passengers to maneuver themselves into position when nearing their station.

Beyond the stand back area and at the end of the adjacent seating area a draught screen shall be installed.

The draught screens shall be fitted with clear safety toughened glass, in such a way as to provide uninhibited hand holds to passengers.

## 4.15 Toilet System

- 4.15.1 The Car(s) shall include zero discharge toilet systems. Toilets shall be completely odour-free.
- 4.15.2 The Car(s) shall include environment friendly toilets (Bio digester/bio toilet) systems of a modular design, spacious, environment & user friendly and easily maintainable. The environment friendly toilet (Bio digester/bio toilet) shall treat the human waste by biological degradation (aerobic/anaerobic) and shall confirm the effluent discharge quality to the existing norms applicable by Central Pollution Board or any other authority applicable in India. One toilet per car shall be an Indian style toilet (squatting pan type with health faucet) and balance toilets shall be a western commode (WC) toilet with suitable seat and cover including health faucet.
- 4.15.3 Number of Toilets shall be minimum one per Driving coach and two per coach (for other coaches). In DTCs, the toilet shall be suitable for Persons with Restricted Mobility (PRM). Additionally, there shall be a toilet (WC) for crew in each driving coach.
- 4.15.4 The toilet shall be of Modular design
- 4.15.5 The Toilet shall be designed in such a way that it shall be cordoned off from Passenger area so water shall not seep inside the flooring in passenger area.
- 4.15.6 Following additional preferable features for toilets shall also be included:
- i) Automated toilet flushing when not flushed by the user.
  - ii) Toilet ready indications etc.
- 4.15.7 Interior furnishing and toilet fittings, water taps, toilet flushing should be conforming to standards already in best practice world over in high-speed Trains.
- 4.15.8 Toilets shall be provided with adequate slope and shower drains.
- 4.15.9 Pressurized flushing with all systems on board
- 4.15.10 Bio-retention tank
- 4.15.11 Toilets shall be easily cleanable.
- 4.15.12 Aluminium shall be used for sidewall of toilets. For flooring and roof, Stainless steel shall be used.
- 4.15.13 All toilets shall have adequate handles to make them passenger friendly.
- 4.15.14 Each toilet shall include the following equipment:
- i) Mirrors;
  - ii) Wash basin with water tap;
  - iii) Toilet paper dispenser (In Western style WC);
  - iv) Liquid soap dispenser
  - v) Waste container (Waste Bin)
  - vi) Coat hooks (Two);
  - vii) Lighting
  - viii) Circulation of fresh air
  - ix) Provision of toilet freshener liquid /tablets
  - x) Flush push button;
  - xi) Grab handle;



- xii) Water tap near WC and 01 bowl/ stainless steel mug for water with stand should be provided with anti-pilferage provision;
- xiii) Lavatory engaged / free indication light shall be provided at both ends inside the Cars at a convenient location, this light shall be generally visible throughout the Car.
- xiv) Suitable devices for extraction of foul air from toilet compartment shall be provided.

#### **4.15.15 Lavatory doors**

The strength of the lavatory doors shall be as per UIC566. The design of all parts and components of lavatory doors shall meet the fire prevention requirements of UIC sheet 564-2.

### **4.16 Water Tanks and Water Circulation**

- 4.16.1 Water tanks of defined capacity shall be provided. Coaches shall be provided with suitable water pumps for supply of water to lavatories in Cars. Each lavatory shall also be provided with one overhead water tank of minimum 30-liter capacity. Material selection for water tanks, piping and pipe fittings shall be protected against corrosion and shall be suitable for intended service life of the coaches.
- 4.16.2 Each coach shall be provided with water tanks of minimum 1800 L capacity. In Driving coach minimum 900 L capacity water tank shall be provided.
- 4.16.3 Mechanical strength of the water tanks and their suspension shall meet the requirement as per Para 2.1.4 of UIC566 or equivalent specification.

### **4.17 Passenger Seats**

Seats shall be ergonomically designed, aesthetically pleasing, durable, light weight, anti-slip, fire resistant, comfortable with low maintenance, scratch and vandalism proof. Design shall ensure comfort with lumbar support, Transverse 3+3 seating arrangement as per the existing seating arrangement of Mumbai Suburban system shall be provided. Together with colour scheme, all the details of seating including the layout shall be finalized during design stage. The Main Specifications of Seats are:

- i. Seats frame material (stainless steel or aluminium) shall satisfy the requirements of EN 45545. Cushioned seat structure to be used that offer high surface stiffness while remaining lightweight.
- ii. Behaviour of seats at static, fatigue, vibrations, impact stress shall be tested as per NFF 31-119 and indentation test shall as per ISO 2439. The indentation hardness shall be similar to industry standards. The indentation hardness and depth shall be measured first be tested initially and then at 80,000 cycle intervals. The natural frequency of the seat system (including seated passengers) shall be greater than 1.4 times the natural frequency of the Carbody natural bending frequency.
- iii. Seats and upholstery shall be easily cleanable, repairable, and changeable and will not be adversely affected by normal cleaning agents. The seat including backrest shall be cushioned and the material used shall be long lasting, dirt and wear resistant fabrics and shall not become readily soiled, impervious to water, paint, human waste, graffiti removers, wash plant solution, cleaning solution, food, and drink spills. Cushioned/Padded seat modules shall be removable to allow for quick replacement but shall be not removable by passengers during the journey.

- iv. Upholstery used shall be tested for various mechanical characteristics and colour fastness. The test scheme/standard used and criteria for acceptance shall be submitted for review and approval.
- v. There shall be a holding handle of suitable design on the aisle side of the seat backrest so that passenger standing in the aisle area can hold it for support during standing. Seat shall provide resistance to passenger movement longitudinally along the vehicle during acceleration and braking. The proposed seats should have been in use in suburban trains worldwide.

#### **4.18 Luggage Racks:**

Lightweight Luggage racks shall be provided in each car at 1800 mm above the floor level. Dimensions of the luggage rack shall be about 450mm width and minimum clear height of 300mm from the ceiling. Due care shall be taken in its design so as to avoid vibrations and injury to passengers. The luggage rack shall be validated according to UIC566. Details shall be decided at design

#### **4.19 Mock-up**

The Technology Partner shall make available for review by the purchaser, the mock-ups for all passenger and crew interface related items for each of the variants -

- i) Interior Panelling
- ii) Interior lights & Fan
- iii) RMVU with duct
- iv) Partitions
- v) Luggage racks
- vi) Seats
- vii) Hand holds
- viii) Modular toilets
- ix) Flooring
- x) Doors
- xi) Driver's cab
- xii) Driver's desk

One module of each coach variant shall be submitted with all original fittings planned intact as a mock-up. Digital model alone shall not be acceptable except for the roof layout. The mock-ups shall demonstrate, together with all the aesthetic design sessions supported by samples, design book, 3D virtual views etc., The mock-ups shall be constructed at the Technology Partner's facilities and shall be placed at location (within India) required by purchaser. The mock-up will be reviewed by a team of IR Personnel and based on the review; the Technology Partner shall carry out necessary modifications.

#### **4.20 Grab Poles and Grab Rails:**

- i. Aisle area between the seats and area in front of the saloon doors shall be used by standing passengers. Accordingly grab rail in accordance with UIC 566/EN 12663 shall be provided throughout the saloon.
- ii. The layouts shall be proposed by Technology Partner during design stage and shall be decided during mock up. Stainless steel grab handles with minimum five handles per meter

of grab rail shall be provided. Additional Stainless steel grab rails shall also be provided at the entrance (both sides) of each door and also near gangway as approved during Mock up review. Easy-to-grip grab rail shall be provided at suitable locations inside the cars with a focus on making it easier to grip from the perspective of passenger accessibility.

- iii. The grab poles and grab rails shall be of stainless steel and shall suffer no permanent deformation when subjected to loading conditions during service. The grab handles and grab rails shall be easily accessible by passengers included between 5th percentile of Indian female and 95th percentile of Indian adult male. Height of grab handles and grab rails in ladies' compartment shall be lower than that of normal compartment. Grab rail and stanchions in saloon area shall be brush finished.
- iv. The completely assembled grab handles shall be subjected to pull off and endurance test to measure the maximum load they can withstand.

## 4.21 Doors and Windows

### 4.21.1 Body Side Automatic Doors

- 1. Each Car shall have four (4) pairs of electrically operated, bi-parting sliding automatic doors with adequate provision for ventilation conforming to EN 14752:2025 or latest- 'Railway applications- Body side entrance system
- 2. The doors being provided on the Intercity Train shall have clear opening of minimum 1400 mm at full opening and there shall be two doors of each having minimum 1400 mm opening per side.
- 3. The strength of the sliding door shall be as per EN 14752:2025 or latest and the doors shall be able to resist the loads without deformation or damage. Provision shall be made for passengers to open Car doors to permit evacuation from a stopped Train in an emergency. There shall be an internal and external manual release mechanism on one door per side in each Car. It shall be possible to monitor the status of each door on the TCMS.
- 4. The passenger body side door shall fully close/open within 2.5 to 3.0 second from the initiation of close/open door command. Opening and closing time of the doors shall be adjustable in the range of 2 to 4.5 seconds.
- 5. Provision of finger protection to be offered on leading edge of door leaf to protect Passengers according to EN14752:2025 or latest. The end of the closing stroke (100mm) shall be damped or cushioned to reduce impact and minimize possible injury to passengers.
- 6. The Technology Partner shall ensure suitable provisions in the Door system to minimize the risk of Train dragging along a person or object trapped by the Train doors. Full details of **anti-drag system** along with recommended system in line with EN 14752:2025 or latest shall be submitted for review and approval.

**7. Obstacle Detection Mechanism:**

- a. When a non – elastic rod with a maximum rectangular cross section of 10 mm x 60 mm is trapped with its long edge vertically between the door leading edge and the frame of the door shall not be indicated as closed and locked. The requirement shall be verified at three positions, the bottom, the middle and the top of the door. If soft horizontal bottom rubbers are provided, this requirement applies from the bottom edge of the door leaf upwards above the rubber.
  - b. The maximum force exerted on an obstacle during final closing stroke shall comply EN 14752-2025 or latest, 5.2.1, 4.2.2.
  - c. The values specified shall be measured using a device and method as described in Annexure-D of EN 14752: 2025 or latest. Measurement on each door may not be required if the system provides constant performance.
  - d. An obstacle with maximum dimension of 2 x 60 mm flat withdrawn slowly in outward direction with a force. The obstacle removal force shall comply EN 14752-2025, 5.2.1.4.3.
  - e. The door at closing should detect a 10x60mm obstacle placed between door leaves at the bottom, mid height and top of the door leaves.
  - f. If obstacle is faced during closing, the automatic door shall reclose 3 times, this shall be adjustable.
    - i. While the doors are closing if an obstacle is detected, the doors will open 50 mm on either side, stay free for 1 sec, and try to close again.
    - ii. If the obstacle is still detected, the doors will reopen 50mm on either side, stay free for 1 sec, and try to close again.
    - iii. If the obstacle is still detected; the doors should reopen fully and stay free in fully open position and waiting for the next valid open/close command.
  - g. If obstacle is faced during opening, then door will move to close come in pause position and stay there unless again command has been not generated.
  - h. Door closed and obstruction sensing information shall be sent from each coach in the rake to TCMS.
  - i. The number of obstructions during opening or closing shall belogged by the door control system as an aid to diagnosing door system problems
8. The door mechanism shall have safety provision whereby the Train shall not start unless all doors have been closed and locked. An indication confirming that all doors are closed shall be provided in the Driving Cab.
9. Each door shall be provided with one emergency egress device and Bowden Cable inside the coach according to EN14752: 2025, 4.3.2. Emergency egress device shall be actuated by rotary switch. In an emergency, it must be possible to leave the Train through the compartment doors by operating the Emergency Egress Switch of the door and manually opening the door leaves. Also, 1 No. out of 2 doors on each side of a coach shall be provided with one emergency access device and Bowden Cable outside the coach according to EN 14752: 2025, 4.3.3. Emergency access device shall be actuated by key according to EN14752 Annex H.
10. A door opening & closing warning shall be provided by audible and flashing light indication. Door closure warning input to be given to External Door warning hooter prior to door close command. This shall be provided at the Centre of each door, both outside and inside, to indicate door status including isolated state. Indicator light of amber color be used at each door interior and one indicator dual light of amber and red

color be used at each door exterior for carrying out the following functions.

- a. Door warning: indicators warn by blinking. (amber).
- b. Door during closing: indicators are blinking. (amber)
- c. Door closed: indicators are not illuminated.
- d. Door during opening: indicators are blinking. (amber)
- e. Door opened: indicators are illuminated Continuous. (amber)
- f. Door in failure: indicators are illuminated Continuous. (amber)
- g. Door isolation: indicators are illuminated Continuous. (amber)
- h. EED/EAD operated: indicators are blinking. (amber)

11. A door close announcement through PA/PIS followed by a chime\ (scheme to be finalized during design stage) shall be triggered each time the “Door Close” button is pressed.

The chime shall warn the passengers inside the train as well as those on the platform about the door operation. It shall be possible for maintenance depot to adjust the volume of speakers easily as per the need. The door close chime shall continue to play till the Doors achieve locked position. Selection of the type and adjustment of volume of the chime shall be independent for external and internal. The adjustment of the volume of the chimes for internal shall be independent of the volume for announcements.

12. It shall be possible to monitor the status and faults of each door on the TCMS.
13. A microprocessor-based Door Controller Unit (DCU) shall control each pair of doors and shall be an integral part of door control assembly. The door controller unit shall communicate with TCMS. All events with respective time and date stamp in DCU shall be available for diagnostic purpose. These events shall also be available in TCMS for retrieving centrally from TCMS through the port available in the driving cab and/or remotely.
14. It shall be possible to modify/change the parameters or closure/opening logic of doors’ circuit and implement the same as required by IR based on their operational and maintenance requirements.
15. Doors shall be electrically operated from 110V DC. (nominal) supply through train line. The door operating mechanism shall be of a proven design in service. The door system shall continue to operate correctly with the car battery voltage supply range between 77V to 137.5 V DC.
16. Successful closing of doors should be confirmed by mechanical locking. Interlocks should prove the closed and locked position of door system and then application of traction power should be enabled.
17. No spurious electrical signals shall cause any door to be released or opened. There shall be no single point failure of equipment or wiring, or two-point failure with one failure undetected, which would cause a door to open without being commanded. The door controls shall be interlocked with the train’s zero speed circuitry so that the doors cannot be opened until the train is stopped.
18. The control architecture of body side door shall utilise the combination of hardware and software for reliable and robust control to avoid single point failure in the control on basic unit level and on train level.

19. It shall be the responsibility of the Supplier to jointly finalise the interface with the door supplier, which shall be facilitated by the Purchaser.
20. For opening the doors "Door Enable with Side Selection" command shall be given by the Driver / Guard to release the doors if the zero-speed signal is activated.
21. To minimize the risk of the train dragging a person or object trapped between the doors, an anti-drag feature is required. This feature shall detect small objects trapped in the door, as defined in EN 14752:2025 or latest and prevent the train from moving forward. The automatic door system shall have a static anti-drag system as described in the clause 5.2.1.5 of EN14752:2025 (latest)
22. The Automatic sliding door must be having both Static and Dynamic Anti drag feature as per EN 14752 :2025 or latest.
23. The PIS system provided shall be capable of automatically providing audio announcements that are triggered as part of the Exterior Door obstacle detection sequence. This message shall be audibly broadcast in the affected coach including Vestibule and a suitable visual indicator to be provided for indicating the status adjacent to the Exterior Door.
24. If an Exterior Door is locked out of service or does not operate correctly, the Unit shall provide visual information to Passengers and platform staff via local PIS displays.
25. The door system is required not to detect pulling forces of up to 150N applied on the test object from inside applied with an angle of 300, 900, 1500 in relation to the direction of motion.
26. To reduce potential tampering of the system by passengers the system shall not detect an object of diameter 15 mm with a spherical front of R15 mm pressed perpendicularly onto the inside surface of the rubber with a force of 150 N. The requirements shall be verified at the mid position of the door only.
27. Since automatic door is related to passenger safety, it is necessary that system should be highly reliable and shall have high value of MTBF. SIL-2 certificate required for door control unit shall be as per EN 50716 and EN 50129.

#### 4.21.2 Windows

Windows shall be provided with protection grill for safety and security. The windows shall have sliding glasses. Large window openings are preferred to permit standing passengers a wider view. In DMC/NDMC coaches ,3 nos. per coach and in TC coaches, 4 nos. per coach should be of emergency windows. The size of the windows shall be subject to review by the IR/ IR Nominated agency

#### 4.22 Inter-Car Gangways:

- 4.22.1 The cars shall have a gangway connecting to the adjoining cars excluding the Driving cab conforming to EN 16286- 'Railway applications-gangway systems between vehicles- Main applications. The gangway shall be completely weatherproof, draught proof and resist vandalism & noise. It shall be possible to Lock/Unlock the fully sealed gangway between the cars by operation of suitable lever and quick release mechanism. The lever

shall be concealed and be accessible only from outside/inside the train by maintenance staff, with suitable anti-tamper provisions. The attenuation of outside noise through the gangway shall not be less than 33 dBA. In case of separation of cars, the gangways shall have securing arrangement and shall not get damaged or de-shaped. The gangways shall be provided with both outer and inner fairings. The outer fairing shall be completely flush with the car body profile.

- 4.22.2 The headroom in the inter-car gangway area shall be at least 1900 mm, and the clear width of approximately 1400 mm. The inter-car gangway shall be maintained as nearly as possible at the same height as the rest of the car floor and at no point shall it exceed 20mm difference. Height changes shall be ramped so as not to cause inconvenience and slippage to passengers. Vertical gaps between the hinged moving tread-plates of the inter-car gangway and the general floor level of the cars shall not exceed 5mm.
- 4.22.3 The design of the floor shall be such that the relative movement between adjacent vehicle ends does not cause sliding floor plates to lift in such a way as could cause injury, in particular to sandal-clad or bare feet. Heat and sound insulation measure sufficient to meet internal noise levels of the car bodies shall be provided. Sealing of the gangway shall eliminate leakage of any water into the saloon area. Also, the water from saloon shall not go and collect below the gangway floor.
- 4.22.4 The PIS shall have two colour displays in each Vestibule. These displays shall have a minimum size of 500mm diagonal. Important route and journey information should be provided within the Vestibules to allow Passengers to continue to receive information whilst waiting to disembark or whilst moving through the Unit. These displays can also provide detailed door opening information specific to the Exterior Doorway.
- 4.22.5 Indian Anthropometric dimensions shall be referred to for ergonomic design. Certification from ARAI /ICAT required.
- 4.22.6 The inter-car gangway shall be HL3 compliant as per EN 45545.
- 4.22.7 Fully sealed Inter car Gangway shall be tested for following as per ICF/MD/Spec 369:
  - 1. Endurance test
  - 2. Rainwater Leak test
  - 3. Minimum Curve test
  - 4. Air Tightness test
  - 5. Load test
  - 6. Weight test
  - 7. Sound Insulation test

#### **4.23 Foot Step**

Foot Step shall be provided at all body side doors in all the Cars. The design of the foot step shall be skid free. These shall be designed so that it is possible to board the Train from the platforms. The design of Foot Step shall be such that the gap between the platforms and the Foot Step is minimal and ensure smooth movement of passengers between the platforms and the Trains.

The foot plate of the gangway shall be designed in such a way that there shall not be any lifting of Foot plate during articulation of Train.

#### **4.24 Braking Requirements and Brake Equipment**

- 4.24.1 The Train shall be fitted with indicating devices to provide indication to the Loco Pilot about brake system faults / train parting. In case of Train parting during run, flasher light shall be automatically switched 'on'
- 4.24.2 Emergency brake valve shall be provided on the right-hand side in Driving Cab near assistant Loco Pilot for direct opening of air brake pipe during emergency by the assistant Loco Pilot. During emergency brake application by emergency brake valve or through Loco Pilot's master controller automatic Train power cut off shall take place.
- 4.24.3 Emergency stop push-buttons shall be installed in each Driving Cab. Activation of the buttons shall apply the emergency brakes under all conditions, including from the inactive Driving Cabs. Activation of the emergency brake by any means shall result in the propulsion system being disabled in a safe critical manner by opening the main circuit breaker and lowering pantograph. The propulsion system shall not be re-enabled until the Train is at zero speed and the emergency condition has been reset.
- 4.24.4 Design of the brake system and its interconnections shall be fail-safe. In the event of failure of brake equipment and brake electronics, relevant to Train operational safety, brakes shall be automatically applied.
- 4.24.5 Roll Back protection shall be provided to ensure that the train moves only bare minimum standing on gradient with power on. The direction of wheel movement with respect to master controller position shall be compared and protection shall be applied in case of conflict.
- 4.24.6 If no. of bogies isolated is more than the minimum bogies required to achieve Guaranteed Emergency Brake Requirement (GEBR), then traction block shall be applied. However, it shall be possible to override the traction block and a speed restriction of 10 km/h (configurable) shall be applied. Speed restrictions shall be finalized during design stage. In case more than 50% bogies are isolated in a train, then the traction block shall be applied, and it shall not be possible to override the traction block.
- 4.24.7 There shall be provision to avoid/ protect Ballast hitting on the underslung brake equipment.

#### **4.25 Brake System**

- 4.25.1 The brake system shall be of proven design, which has worked successfully in long-distance high-speed passenger Trains.
- 4.25.2 There shall be Bogie Level redundancy in Brake control system as well as WSP control similar to Vande Bharat Trainset with two BECUs per car.
- 4.25.3 There shall be Wheel slide protection system with redundancy at Bogie level similar to Vande Bharat Trainset. Phonic wheel and speed sensor shall be provided in axles for monitoring of axle speeds for the purpose of Wheel slide protection.
- 4.25.4 There shall be Load Dependent or Load proportionate braking similar to Vande Bharat in all modes of Braking such as Auto Brake, Emergency Brake and EP brake.
- 4.25.5 All the valves, pipes, fittings, levelling valve, Installation lever shall be Stainless steel to avoid corrosion.
- 4.25.6 The OEM shall submit the Blending Logic of Regenerative and Friction Brake.



- 4.25.7 The brake system shall comprise the following types of brakes:
- (i) Electro-Pneumatic (EP/ EP assist) friction service brakes or more advanced version
  - (ii) Electric regenerative service brakes
  - (iii) Provision of smooth and continuous blending of EP and regenerative braking
  - (iv) Fail safe, electro pneumatic friction emergency brakes
  - (v) Fail safe, fully pneumatic (BP controlled) friction emergency brakes
  - (vi) Spring applied air-release parking brakes
  - (vii) Automatic Emergency Brakes
- 4.25.8 The braking system shall have provision for interface with ATP system depending on its availability.
- 4.25.9 The electrical regenerative braking system shall be the primary braking system of the Train. The braking system of the Train shall also ensure that when the electric brake is insufficient to provide the required braking effort, the necessary proportion of the air brake of the Train, superimposed on the electric brake, is applied (system also known as “brake blending”).
- 4.25.10 Air brake system comprising MR & BP shall run from end to end of the Train with two isolating cocks at either end of cars terminating outside. Locomotives on Indian Railways have pressure settings of  $5 \pm 0.1 \text{ Kg/cm}^2$  for BP  $8.5 \pm 0.1 \text{ Kg/cm}^2$  to  $10 \pm 0.1 \text{ Kg/cm}^2$  for MR.
- 4.25.11 In the event of critical failure of brake equipment of the train having bearing on safety of the train, brakes shall be automatically applied.

**4.25.12 Computerized Electro-Pneumatic (EP) Friction Braking**

The electrically operated pneumatic friction brake system shall be of proven design and capable of achieving all performance requirements mentioned in **Clause 2.6** of these Specifications and Standards without the aid of electric regenerative braking.

- i) The friction braking system shall function as the ultimate braking system on the Train, acting as a backup during normal service braking and as the primary braking system during emergency stops and while stationary.
- ii) The friction brake shall be achieved by means of a pneumatic brake and shall be fully rated to meet, on its own, the full braking performance and shall be capable of sustaining the continuous full emergency braking requirement.
- iii) In the event of a failure of the regenerative brake, the friction brake shall be capable of carrying out two consecutive emergency brake applications from maximum speed to standstill of a rake in loaded condition. The rake shall be deemed to then accelerate at its maximum rate up to maximum speed after each stop.
- iv) The Cars shall be provided with disc brakes (in accordance with EN 14535-1 or EN 14535-2 as applicable).
- v) Brake pad shall conform to the requirements of UIC 541-3. Brake pad material shall not contaminate the track or rails leading to interfering with signaling system.
- vi) Adequate safety straps shall be provided below the moving components of brake rigging to prevent falling on the track in the event of failure of any component.

- vii) The braking system shall provide adequate safety against rolling back of the Train in case the Train is to be started on a rising gradient of 1 in 37.
- viii) Specific provision shall be made in the software to ensure that the Train while starting on the gradient, the roll back, if any, is nominal.
- ix) Minimum SIL levels at train level shall be complied for the brake system

Emergency brakes	SIL4
Service Brake	SIL2

#### 4.25.13 Electric regenerative Braking

The Train shall be designed so that the regenerative brake system is used to the maximum extent possible. Full utilization of the regenerative braking is envisaged in the 3-phase drive system such that regenerative braking is available over full range of speed to be blended/ interfaced with the existing EP brakes.

- i) If the re-generative braking becomes ineffective, the friction brakes shall immediately be applied to maintain the braking rate demanded by the Loco Pilot.
- ii) A smooth changeover between the re-generative brake and the friction brake shall be achieved. This smooth changeover shall be achieved even in the event of failure of the overhead line or when passing through neutral sections.
- iii) Electric regenerative brake fadeout shall not occur above 5 km/h.

#### 4.25.14 Emergency Braking

Emergency braking shall be applied as a consequence of break in emergency brake loop wire. The break can be caused by the Train operator intentionally or by opening of contacts of safety devices in the brake loop, provided in the design, to avoid unsafe conditions. Brake loops shall be redundant.

- i) Emergency brake is applied by friction brake system. Emergency braking distance as specified in **Clause 2.6.4** of these Specifications and Standards shall be achieved from 130 km/h to 0 km/h for all loading condition on level tangent track.
- ii) Two emergency brake push-buttons shall be installed in each Driving Cab in the Train. Activation of the buttons, including that of non-active Driving Cabs, shall apply the emergency brakes
- iii) Any device provided to allow the Loco Pilot to apply the brake in an emergency shall cause a emergency brake application. in the train.
- iv) Unintended parting of the Train shall result in an emergency brake application on both portions of the Train. An indication or message as required for the same should be provided.
- v) Wheel slide protection shall be available during emergency braking. Any failure in the wheel slide protection in emergency braking shall result in the application of full brake force and deactivation of the slide system.

- vi) Activation of the emergency brake by any means shall result in the propulsion system being disabled in a safe manner. The propulsion system shall not be re-enabled until the Train is at zero speed and the emergency condition has been reset.
- vii) The friction brake system shall be rated to, and have sufficient thermal capacity to safely complete two successive accelerations and emergency brake cycles, with no interval between each cycle on loaded Train. Each cycle shall comprise a full acceleration from standstill to 130 km/h followed by the application of emergency brake to standstill. On completion of the **two** cycles, the brake system shall show no abnormalities. The requirement shall be demonstrated during testing. Thereafter, the Train friction brake shall have sufficient thermal capacity to be able to complete its journey without regenerative brakes.

#### 4.25.15 Brake Control System

- i) All circuits and controls essential for braking equipment shall be a fail-safe with redundancy. A microprocessor-based brake control system shall be offered.
- ii) Adequate redundancy with provision of two independent Electronic Brake Control Unit for each car, so that either EBCU can take control of other bogie in the event of failure similar to IR Vande Bharat (Bogie level redundancy) to ensure that the brakes in the car do not become non-functional in case of failure of power supplies, isolation of traction equipment or failure of control electronics and pressure transducers etc. In case of isolation due to any defect, the brake system shall take adequate corrective action with least system isolation.
- iii) A Deadman device shall be incorporated into the Master Controller Handle. Activation of the same shall cause emergency brake application. Ergonomic Design of Master Controller shall ensure minimum strain on Train Operator's arm. Twist type Master Controller shall be preferred. Overall design shall specifically be got approved from IR/ IR Nominated agency.
- iv) The Brake control unit shall have provision for logging of selectable parameters/signals (by the Employer/IR/ IR Nominated agency) and faults with related data.
- v) The diagnostic tools for brake system shall include complete graphical & analytical tools, recording of events, data of brake system and interface signals etc. It will also have facility to add on the necessary signals as requires during fault investigations.

#### 4.25.16 Brake Operating Timing

The following maximum brake operating timing shall be achieved as per EN13452-1. The maximum time for a brake application from full application to 90% of full Brake Cylinder Pressure (BCP) and for brake release from full Brake Cylinder pressure to 10% shall not exceed the following:

- i) Service Brake Application : 2.0 seconds
- ii) Emergency Brake Application : 1.5 seconds (max.)
- iii) Service and Emergency Brake Release: 3.5 seconds

A malfunction of the EP friction brake affecting the braking rate or safety shall result in an emergency brake application. In case of single point failure, brake compensation shall take place to account for failure of brake on one bogie. This shall be achieved with minimal intervention of the Train operator.

#### 4.25.17 Brake Pipe (BP) controlled back-up system

- i) A brake pipe-controlled back-up brake system shall be provided in cars, allowing the brakes on each Car to be controlled by the pressure in the brake pipe, irrespective of the presence of electrical power on any Car.
- ii) The brake pipe pressure shall be controlled by means of a separate control unit ergonomically placed on the Loco Pilot's console and having three positions for application, charging and lap modes.
- iii) This system shall also be used to control brake system of dead train during rescue by a healthy train, transit of Cars and shunting operation.
- iv) During the operation of this mode, dynamic brakes shall be isolated and the pneumatic brake application shall be resorted.

#### 4.25.18 Parking Brake

- i) The parking brake shall apply when commanded by the driver/Train Operator or in case of cab deactivation. The parking brake shall also apply automatically in all circumstances where the service brake is no longer capable of holding the Train stationary. The parking brake shall be designed to hold a Train with payload as specified in **clause 1.8** of these Specifications and Standards, on the gradient of 1 in 37 in the wind condition for an unlimited time. Parking brakes shall be incorporated on 50% or more of brake actuators of each car. Parking brakes shall be capable of holding a fully loaded stationary train on a 1 in 37 gradient under all track conditions, indefinitely.
- ii) Parking brakes shall be applied in the event of loss of the main compressed air supply. The parking brakes shall be capable of release from within the Driving Cab when the compressed air supply is present. With no compressed air supply available, it shall be possible to release individual parking brake actuators manually from track level. Application of parking brakes shall also be controllable from the Driving Cab. Unintended parking brake application due to air leakage from parking brake line will be detected and displayed on Train Control & Management System (TCMS) as fault indication.
- iii) The design shall be such that the parking brakes will take effect prior to fade off holding brake and shall ensure that the combined brake effect of the pneumatic brake and parking brake is never less than the full brake effort of the parking brake alone.
- iv) Status of Train parking brake shall be displayed on the HMI.
- v) Parking brake control – The parking brake shall be applied and released by the use of an illuminated pushbutton(s). The parking brake shall be interlocked with the traction equipment to prevent the Loco Pilot taking traction with the parking brake applied. The system shall not permit application of parking brake when the Train speed is greater than 5 km/h.

#### **4.25.19 Auto-Emergency Brakes (AEB) system:**

- i) Auto-Emergency Brakes (AEB) refers to a special system of braking employed on ghat sections with steep gradients.
- ii) The AEB is enabled by means of a key which is specific to each train, Once AEB is enabled, the train speed is limited to a pre-set value; the brakes are applied immediately if the speed rises above the preset value. TCMS will monitor the speed based on the AEB activation which will activate emergency brake system. The EBR gets energized when the speed sensor detects that the train is moving faster than pre-set speed. (or other programmable speed limit)

#### **4.25.20 Wheel Slip-Slide Protection**

- i) Traction and brake control system shall be designed to eliminate, by means of a reduction of short duration in the traction or braking power, the excessive slipping or sliding of axles occurring during acceleration or deceleration, and to prevent locking of axles. In addition, the system shall make optimum use of the available adhesion between rail and wheel.
- ii) In the event of wheel slip, corrective action shall be taken by the wheel-slip protection subsystem in order to adjust the effort to the available wheel-rail adhesion. The slip shall be detected by evaluation of each axle speed and acceleration and compared with a calculated speed reference for the Train.
- iii) In the event of wheel slip/slide, adequate brake system effectiveness should be maintained.
- iv) Digital wheel slide protection with gradual slide correction shall be provided in all braking modes. The slide detection shall be performed per axle and the correction per axle level (in case of electro-dynamic braking) and axle level (in case of friction braking) similar to Vande Bharat. The correction of slide shall operate independently on each vehicle. Automatic wheel wear compensation shall be incorporated in the wheel slip/slide protection Sub-system.
- v) The sliding effect shall be maintained during a relevant period of time, in order to increase the available adhesion at the wheel-rail contact with permanent control, in minimizing the air consumption and optimizing the stopping distance.
- vi) The correction process for wheel slip/slide shall not cause infringements of the signalling compatibility requirements.
- vii) The performance of the wheel slide protection equipment shall satisfy the relevant requirements of UIC 541-05.
- viii) The wheel slide system shall detect the onset of slip/slide by either an axle deceleration exceeding a pre-set parameter, or detection of a difference between the relative speeds of the axles of any one axle of the bogie.
- ix) Wheel slip/slide indication shall be provided.

#### 4.25.21 Load Weighing System

Load weighing system shall be used for measurement of air spring pressure to limit the adhesion utilization, meet the requirements of acceleration, braking and detection of deflated air spring. The pneumatic signal for the load weighing system is to be provided by the Technology Partner. The load weighing compensation signals to the propulsion and braking systems shall be a continuous function available for all Cars weights up to full load. Adequate redundancy shall be provided in the load weighing system and failure shall be recorded in the diagnostic. If there is a failure of this system, the coach shall respond as if it was fully loaded. Air spring deflation indication shall be provided in the driver's cab including the information regarding Car, air spring position in Bogie, status messages etc. In order to ensure reliability of the scheme, adequate redundancy shall be considered to take care of the failure conditions. Separate weight sensor for each air spring in one bogie shall be provided to achieve redundancy at bogie level.

Air spring deflation indication system shall monitor the air spring pressure for each air spring, and in case of air spring deflation should not permit speed of the train beyond permitted value for such condition. Air spring failure indication alert should be provided in driver's cab with location details. Failure events of air springs should be logged.

#### 4.26 Facilities for Passengers with Restricted Mobility

- 4.26.1 The train should have Space for Wheel chair and Stretchers with PRM (Persons with Restricted Mobility) friendly toilets in selected coaches along with securing arrangement and ramp for loading and unloading End to End, duly facilitating entry and exit (relevant standard UIC 565-3) in each of the end Driving coaches. These coaches will have one toilet for differently abled persons and another toilet for other passengers. Each end driving trailer coach should have facility to accommodate two differently abled persons along with two attendants. The end driving coaches of the train should also be provided with suitable ramps to enable safe entrain/detrain of wheelchair.

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## Chapter 5 – Designs and Drawings

### 5.1 Designs and Drawings

5.1.1 The Technology Partner shall provide to RDSO/Nominated Agency:

- a) Designs and Drawings of the Prototypes, as specified in this Chapter-5.
- b) Reports of simulation of the safety, performance, running characteristics & ride index of the Train.
- c) Size & Format of Drawings

Drawing submitted shall be of full sizes as they are originally prepared. The dimensions, weight, capacity, etc. shall be in SI units unless otherwise agreed. If the drawing size is bigger than the standard paper size with the required scale, the scale of drawing can be discussed with purchaser/RDSO.

5.1.2 Supplier shall submit the basic details of their system design, weight particulars and its disposition, covering all major items viz. transformer, traction converter, auxiliary converter, traction motor, auxiliary machines, software specification, control electronics, compressor, TCMS communication protocols, display systems, RMVU, PA/PIS, CCTV, system expandability and any other aspect/equipment which is within the scope of supply of the Supplier. Supplier shall refer **Annexure IX** while submitting such details.

5.1.3 RDSO/Nominated Agency shall undertake a review of the Designs and Drawings and submit a report to the Technology Partner within 4 (four) weeks from the date of receiving the Designs and Drawings. It is agreed that any failure or omission of RDSO/Nominated Agency to review and/ or comment hereunder shall not be construed or deemed as acceptance of any such Designs and Drawings by RDSO/Nominated Agency.

Pursuant to the Design Report or otherwise, the Technology Partner shall carry out such modifications in the designs as may be necessary for conforming with the Specifications and Standards.

All Designs and Drawings shall be in English.

### 5.2 Additional designs and drawings

If the RDSO/Nominated Agency determines that for discharging its duties and functions under the Agreement, it requires any designs or drawings other than those listed in this Chapter-5, it may by notice require the Technology Partner to prepare and furnish such designs and drawings forthwith. However, RDSO/Nominated Agency/Purchaser shall endeavour to protect the Intellectual Property rights of the Technology Partner therein.

### 5.3 List of Drawings

The Technology Partner shall provide the Designs and Drawings of the following:

- 5.3.1 **New Generation Non-AC Intercity Train:** The Design shall include (a) Car profile; (b) tractive effort corresponding to continuous rated speed; (c) Design of car body shell and interiors.
- 5.3.2 **Weights:** The Design shall include the weight of the complete fully furnished Cars of each type along with weight breakup of all the equipment and sub-systems.

- 5.3.3 **Traction motor:** The Design shall include suspension arrangement & Overall General Arrangement Drawing of traction motor along with necessary calculations.
- 5.3.4 **Brake system and Parking Brake:** The Design shall include (a) functional description of complete system and individual components; (b) regenerative braking calculations including braking effort, brake blending and its speed range; (c) brake effort calculations, EP, Auto and regenerative brakes (d) parking brake calculations; (e) interfacing of service brake and parking brake; (f) braking curves for the Train; (g) braking distance calculations under gross load condition at maximum permissible operating speed at level track; (h) control system; (i) redundancy (j) operating time; (k) wheel slip-slide protection; (l) SIL level; (m) brake pipe controlled back-up system; and (n) emergency brake.
- 5.3.5 **Bogie including brake rigging and suspension:** The Design & drawings shall include (a) traction motor mounting arrangement if any; (b) un-sprung mass; (c) primary and secondary suspension; (d) bolster arrangement; (e) axle floating arrangement; (f) Bogie frame and major bogie components under static and dynamic loading conditions & strength calculations; (g) Vogel's layout/diagram or any other suitable calculation/drawing for 10° curve and 1 in 8½ turnout for negotiability of bogie; (h) throw over at head stock coupler; (i) movement of bogie parts with clearances; (j) estimation of flange forces on curves and turn outs; (k) kinematic/dynamic profile of vehicles for any infringement (l) design validation of components of bogie as per specification & applicable standard Structural reports (structural as well as dynamic validation). (m) For bogie-less design, necessary safety validation documents.
- 5.3.6 **Wheel Set:** The Design shall include (a) bearing and lubrication; (b) wheels, axles and roller bearings, including maximum stress under fatigue loading conditions and anticipated service life; (c) weight distribution indicating lateral and longitudinal balance; (d) method of adjustment of wheel and axle load; (e) diameter of wheels (in mm) when new and fully worn; (f) wheel profile as per Specification and Standards and (g) Design validation as per Specification and Standards
- 5.3.7 **End lighting:** The Design shall include the installation details of (a) headlight; (b) marker light; (c) tail light; and (d) flasher light.

## 5.4 Other Designs

The Technology Partner shall also provide the following Designs:

- (a) the strength of the under-frame as well as under-frame equipment under static and dynamic loading conditions using FEM;
- (b) projected stability and riding performance of the Train using mathematical modelling technique with parameters of suspension system and dimensions adopted for track standards;
- (c) stresses & FEA of under-frame, bogie frame / bolster, suspension springs, wheels, bearing, axles, other components and fatigue life of these components;
- (d) deflection calculations of under-frame under different loading conditions;
- (e) maximum moving dimension calculations;
- (f) calculations of harmonics and EMI/EMC parameters;
- (g) Crashworthiness shall be proved by submission of a detailed report having relevant calculations & crash simulations carried out with standard software;



- (h) Hazard identification, safety assessments and mitigations; The Hazard Analysis shall be carried out in accordance with EN50126 as the primary standard, or any other internationally accepted equivalent standard in areas not adequately addressed by the former standard.
- (i) calculations for tractive and braking effort versus speed curves showing balancing speed;
- (j) air supply by compressor and consumption of air by equipment;
- (k) Centre buffing force calculations;
- (l) calculations for safety against derailment, primary and secondary spring and damper characteristics under tare and loaded conditions, braking distance calculations with and without load on level and gradient section
- (m) Finite Element Modelling of Shell with standard computer software's shall be carried out for stress/deflection analysis of the car bodies.
- (n) System design documents and simulation for compliance of various performance parameters of train.
- (o) Design documents for compliance of electrical fire & train safety requirements.
- (p) Train configuration including distribution of propulsion equipment.
- (q) Document certifying the compliance of IER-1956 (as amended up to 25th November 2000) and Central Electricity Authority (Measures related to Safety and Electric Supply) Regulations, 2010.
- (r) Document for compliance of Disaster Management Light
- (s) Document for compliance of Event Recorder (Train Data Recorder).
- (t) Document for compliance of Video Surveillance System and Cab Recording Equipment.
- (u) Document for certifying the compliance of Horns.
- (v) Document for compliance of passenger amenities and safety items like PA/PIS, ETBU and Infotainment System etc.
- (w) Document for compliance of Coach and Cab lighting.
- (x) Document for certifying the compliance of Deadman Handle.
- (y) Document for certifying the compliance of Vigilance Control Device (VCD)

## **5.5 Vehicle Dynamics Simulation**

- 5.5.1 Technology Partner shall conduct vehicle dynamic simulations on the bogies and the results thereof shall conform to the performance requirements stipulated in the Specifications and Standards.
- (i) All the parameters and values used in simulations shall be provided to enable Vehicle Modelling on SIMPACK or any similar proven software including CG of coach & bogie frame, mass moment of inertia(x,y,z), balancing of mass of the coach and coefficient of damping both lateral and vertical directions etc.
  - (ii) Parameters as per EN 14363 on track having parameter decided on the basis of prevailing track tolerances of Indian Railway based on EN 14363:2016 methodology for first stage & dynamic performance assessment by simplified as well as normal method & other tests shall be evaluated including Mean Ride Comfort by Standard Method as per EN 12299, Bogie rotational resistance, wheel offloading on twisted track, safety & performance on twisted track, Wheel wear index, Bogie rotation, Curving capability and any tendency to hunt, Natural frequency of the suspension etc.

### 5.5.2 Derailment Safety and Stability

- (i) The design of the bogie, including the wheel profile, shall prevent the generation of high lateral to vertical force ratios on any wheel that could result in derailment under all track conditions defined in its specifications, and at all permitted Car speeds over the alignment, up to 10% above the maximum speed permitted, the L/V ratio shall not exceed values as per EN14363 Yard operation and deflated secondary suspension conditions shall also be considered.

Nadal's limit is the limiting L/V ratio for a single wheel and is defined as:

$$L = \tan(\delta) - \mu$$

$$V = 1 + \mu \tan(\delta)$$

Where:

L is the lateral force component exerted by the single wheel on the rail

V is the vertical force on a single wheel

$\delta$  is the flange angle of the wheel relative to the rail

$\mu$  is the wheel to rail coefficient of friction

Dynamic requirements shall be compliant with the specific Indian regulations and legislation.

- (ii) Calculations to confirm that the derailment quotient Y/Q is not exceeding values as per EN14363 Table-4 where Y & Q are the instantaneous lateral force on the wheel flange and the instantaneous vertical load on that wheel tread respectively under the most adverse conditions.

## 5.6 Drawings:

The Technology Partner shall also provide the following Drawings:

- (a) General layout of all equipment in the Car bodies including driving cab layout, driver's desk layout, driver's visibility diagram, Car lifting arrangement, location of jacking pads and bogie retention arrangement;
- (b) Diagram showing alignment of Cars on sharpest curve and 1 in 8½ turnout. This diagram shall also show that the profile of the Car bodies are within the moving dimensions including the extra clearance permitted on curves when the Cars are negotiating a sharp curve;
- (c) Arrangement of return current and earth brushes;
- (d) Lubrication diagram with lubricant brands and quantities;
- (e) Schematic diagram of power, control and auxiliary circuits;
- (f) Brake system diagram;
- (g) Layout of Train on curves including reverse curves showing coupler, gangway and interconnections between Cars;
- (h) Arrangement of draw and buffing gear, side buffer installation, draw gear, and connections at Train ends;
- (i) Maximum moving dimension drawing showing extreme cases including curve overthrows;
- (j) Earthing and bonding arrangements of all Cars

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## **Chapter 6 - Testing of Trains**

### **6.1 General**

- 6.1.1 Prior to offering a sample Train that conforms to the Specifications and Standards for testing by RDSO/Nominated Agency (“the Prototype”), the Technology Partner shall carry out, or cause to be carried out, at its own cost and expense, all Tests in accordance detailed in this specification and such other Tests that the Technology Partner may consider necessary to demonstrate that the Trains comply in all respects with the Specifications and Standards. The Technology Partner shall provide to the RDSO/Nominated Agency forthwith, a copy of the Technology Partner’s report on each test containing the results of each test and the action, if any that it proposes to take for compliance with the Specifications and Standards. Subsequently, Prototype shall be offered to RDSO/Nominated Agency for testing and trials on Railway network.
- 6.1.2 The individual prototype equipment, systems and sub- systems shall be type and routine tested in accordance with the relevant IEC/UIC/EN publications inclusive of the mandatory and optional tests along with the special tests as specified.
- 6.1.3 All type tests shall be conducted by Technology Partner or such other agency or person agreed by RDSO/Nominated Agency at the Technology Partner’s cost where ever performed in presence of and to the satisfaction of RDSO/Nominated Agency, who reserves the right to witness any or all of the tests. All tests and trials on rake level will be carried out on prototype rakes. Tests & trials already carried out on prototype rakes will generally not be repeated on another prototype rake. If considered necessary, instrumentation may also be required during service trials in addition to downloading of subsystem data for analysis. Detailed test plan will be finalized during design stage.
- 6.1.4 RDSO/Nominated Agency may waive some of these tests in case of equipment/ sub-assemblies where the manufacturer can establish to the satisfaction of RDSO that such tests have already been carried out earlier. In such a case, manufacturer shall submit complete test reports along with necessary certification.
- 6.1.5 Wherever any equipment, system, sub system is not specifically covered by an international recognized specification or test procedure, the tests which are acceptable to both to Technology Partner and to the IR’s representative shall be devised.
- 6.1.6 Without prejudice to any provisions of the contract, the purchaser reserves the right to witness any or all of the type tests and to require submission of any or all test specification and reports.
- 6.1.7 The Technology Partner shall arrange instrumentation and record speed, voltage, current, temperature rise of various equipment, energy consumption, tractive effort and other relevant parameter as necessary for ensuring compliance of the Specifications.
- 6.1.8 The temperature of the various parts of the electrical and control equipment shall be recorded during the Tests as per the standard procedure specified; The Technology Partner shall supervise and carry out the Tests at its works on combined test bed and also at the site and shall provide all equipment and consumables necessary for such Tests. Special measuring instruments shall also be provided by the Technology Partner.

- 6.1.9 The Technology Partner shall submit a detailed test plan for specified trials indicating the tests to be conducted, procedure/method to be followed for tests, parameters to be measured and devices/instruments to be used; and Pass/Fail criteria etc. for approval. Submitted test plans shall be as per IEC 61133 and after the approval from RDSO/Nominated Agency. After successful completion of the tests & trials and acceptance of the results, prototype rake will be cleared by RDSO/Nominated Agency for commercial services.

## **6.2 Mechanical Tests**

- 6.2.1 Validation of Designs of Bogie and testing of prototype Bogie including static load and fatigue tests as per relevant standards. Characteristic tests of various suspension items including rubber suspension elements will be submitted. Type testing reports for these suspension elements shall also be submitted.

### **6.2.2 Vehicle Body Shell:**

Car body strength Test shall be carried out and a lifting Test shall also be performed in accordance with UIC 566/ EN 12663 (Category P1) under simulated loads as a type test.

#### **a. Squeeze Test of shell:**

The shells of Cars of Trains including the end driving Cars shell shall be subjected to static vertical and squeeze load Test for the Prototype. Cars having different types of body shell will undergo the squeeze Test separately.

The superstructure shall be subjected to vertical loads and combination of vertical and squeeze load as specified in EN 12663/EN 15663. Tests shall be as per UIC 566/EN 12663 & EN 15663.

#### **b. Brake equipment – Type Test**

Following Tests shall be carried out on the Brake System:

- (i) Functional checks such as working stroke, slack adjuster operation and parking brake action.
- (ii) Recording of the relationship of brake pad force to cylinder pressure over the full working range.
- (iii) Plotting of brake force against pressure curves in all conditions of operation of brake cylinder and parking brake.
- (iv) Vibration test as defined in IEC 61373.
- (v) Air leakage test.

### **6.2.3 Brake Lining:**

The Technology Partner shall carry out testing of brake lining in respect of coefficient of friction with respect to the wheel disc/ brake disc under dry and wet conditions, maximum temperature attained during braking, rate of wear etc.

#### 6.2.4 Brake Control Equipment

Individual items of electro-pneumatic equipment shall be type tested as follows:

- (i) Mechanical Operation and Endurance as defined in IEC 60077
- (ii) Vibration and Shock as defined in IEC 61373.
- (iii) Air Tightness generally as in IEC 60529.
- (iv) Electrical Test, generally as in IEC 60077.
- (v) Characteristic Tests
- (vi) Each item of equipment having a pilot or transducing function shall be tested to confirm compliance with the Technology Partner's design data. Oscillograms shall be produced in support.

#### 6.2.5 Bogie Frame

##### a. FEA

- (i) The load test on bogie frame shall be conducted with the help of solid modelling and FE analysis using latest software package to evaluate the maximum stress at critical locations on the bogie/bogies.
- (ii) The test load (vertical, lateral and longitudinal load) required to be applied on bogies shall be calculated as per EN 13749 & load cases obtained through simulations.

##### b. Bogie Static & Fatigue Test

Static test, Fatigue test, Field test (Track test) on bogie frame & bolster as per EN 13749/UIC 515-4/UIC 615-4 as applicable. General conditions mentioned in EN 13749/UIC 515-4/UIC 615-4 & given examples of programs for static & fatigue tests will be adopted based on load cases obtained through simulations. Necessary changes for differences in bogie suspension or vehicle body characteristics shall be made with the detailed explanation.

##### c. Bogie Rotational Resistance (X Factor) Test

The bogies rotational resistance (X factor) test under inflated and deflated air spring conditions shall be carried out at the manufacturer's works/ suitable location/laboratory under tare and loaded conditions as detailed in EN14363. The rotational resistance shall neither cause excessive flange wear nor cause any possibility of flange climbing but shall be adequate to avoid bogie hunting on straight track. The Technology Partner shall show by analysis that no flange climbing occurs on any curve and moving at all possible speeds set using the wheel unloading factor  $\Delta Q/Q_0$  and the bogie rotational factor X.

##### d. Bogie Suspension Elements

- i. **Air spring:** - The suspension characteristics of air spring provided in the bogie shall be tested for its stiffness, loads v/s deflection, pressure v/s load characteristics, creep test, endurance test and damping characteristics in vertical and lateral mode under the different pre load conditions by the Technology Partner. EN 13597 is to be referred in this regard.

- ii. **Rubber suspension/guiding elements including rubber metal bonded items:**  
The rubber suspension/ guiding including rubber metal bonded items components shall comply & type tested as per the requirements of EN 13913.
- iii. **Hydraulic damper:** - All the hydraulic dampers provided in the suspension shall be tested for load v/s velocity at different frequencies and amplitude of oscillations. Tests shall also be conducted on the hydraulic damper for practical determination of effective stroke length and dynamic durability for maintenance free operation. Endurance testing will also be conducted as part of type test *according to EN-13802.*
- iv. **Coil springs:** Type testing as per EN 13298 along with endurance testing.
- e. **Wheel, Axle & Bearings**  
Type testing as per standards mentioned for wheel, axle & bearing in this specification for Indian Railways Track conditions.
- f. **Test for Air Spring Deflation Detection System:**  
Air spring deflation detection test shall be carried out through reduction in pressure inside the air spring. For this purpose, necessary instrumentation shall be arranged by Technology Partner.

#### 6.2.6 Oscillation trials (on prototype rake)

Oscillation Trials for determining Vehicle Dynamics, Derailment Safety and Stability:

- i) Based on satisfactory simulation results, the Prototype shall be subjected to trials and evaluation. Assessment of rolling stock (First stage at suitable location/rig & second stage – Dynamic performance assessment by normal method) shall be carried out as per EN 14363:2016 standard, on track having parameter decided on the basis of prevailing track tolerances of Indian Railway based on EN 14363:2016 methodology. The acceptance limits will be as per EN 14363:2016, subject to fulfilment of requirement as per **clause 2.1** of Chapter 2. First Stage Assessment of rolling stock as per EN 14363:2016 for Indian Railways track parameters shall be got done by the Technology Partner through any independent accredited agency and necessary reports submitted to RDSO/Nominated Agency for evaluation.
- ii) Dynamic Performance Assessment/ Oscillation Trials of rolling stock as per EN14363:2016 shall be conducted by RDSO/Nominated Agency. To perform trial, in compliance with 4th criterion, 2 nos. Instrumented Measuring Wheel-sets (IMWs) (to ensure one complete instrumented bogie) are required for EACH TYPE (variant) of bogies in the rake. The required Instrumented Measuring Wheel sets along with all compatible sensors, instrumentations, required software and data acquisition system for acquisition of data to EN14363 will be provided by the Technology Partner. Necessary raw data acquired during trials would be collected by RDSO/Nominated Agency after every trial run. Final analysis and evaluation would be done by RDSO/Nominated Agency. Kindly note that the oscillation trials, in this case, would involve fitting + taking runs with IMWs, successively for EACH Variant of Coach in the Rake.

- iii) Rolling stock shall also be evaluated for Mean Ride Comfort by Standard method as per EN 12299 for rolling stocks. Acceptable Mean Comfort Index shall be less than 3.0. Track condition for the purpose will be Indian Railways track maintained to standards prescribed in IRPWM and limits for various track parameters (TL90, TL50 etc. as mentioned in EN14363:2016) shall be decided based on IR track conditions as per EN14363:2016 methodology. Passenger comfort analysis as per EN 12299:2009 shall be got done by the Technology Partner through any independent accredited agency and necessary reports along with raw data shall be submitted to RDSO/Nominated Agency for evaluation.
- iv) Trials in fault modes like deflated air spring etc. shall also be conducted for safety & stability of train.
- v) For clarity, it is reiterated that EN 14363 is being adopted by Indian Railways for its BG network. Methodology for testing will be as per EN 14363 for IR track condition, tolerances, maintenance standard, structure etc., and test sections & zones will be selected accordingly. Wherever EN 14363 is mentioned in this document, it shall be read in this context. Please refer Annexure VII for Acceptance Limits for Dynamic Behavior of Testing Rolling Stock as per the methodology detailed in EN-14363.
- vi) Please refer Annexure VI for Indian Railway Track Geometric Quality parameters.
- vii) In case of non-readiness of Indian Railways for testing as per adopted EN 14363 for any reason, rolling stock safety assessment (Oscillation trials) shall be done as per Third Report of Standing Criteria Committee, rev.-1. Clarity in this regard shall be provided by purchaser, when bogie design is part of supply.
- viii) Trains shall be designed to operate on Indian Railways Broad Gauge track with a spacing of 1676 mm between the two running rails and tolerances as specified in IRPWM. For conducting oscillation trial on speed above 130 km/h, the trial shall be conducted with instrumented wheel for measurement of lateral force at rail-wheel level and instantaneous vertical wheel load.

#### **6.2.7 Braking Distance trial (on prototype rakes)**

After the completion of satisfactory oscillation trial, the braking distance trials shall be conducted by IR for the rake formation of 16 Cars rake. The rake formation shall be finally decided during design stage. The Technology Partner shall be associated with this test in respect of the items related to regenerative braking, brake blending and connected microprocessor controls.

#### **6.2.8 Tests on Parking brakes (on prototype rake)**

Parking brakes shall be tested by applying the parking brakes fully and air brake released under the specified conditions as defined in the specification.

#### **6.2.9 Coupler force trials (on prototype rake)**

The measurements shall be recorded in accordance with the test scheme approved by the RDSO/Nominated Agency in accordance with Good Industry Practice. The Purchase shall submit allowable coupler force in tensile and compressive mode of operation.

#### **6.2.10 Working out the actual Train resistance formula for the prototype rake.**

### **6.3 Electrical Tests**

6.3.1 Generally, test procedures shall be followed as per the latest IECs of Equipment/ Systems/Subsystems testing.

6.3.2 Test on sub system concerning passenger amenities and safety like, PA/PIS, ETBU, CCTV, Infotainment system, Coach and Cab Lighting, Head Light, Flasher Light, Tail Light, signal exchange light, Cab Recording etc. as per specification and relevant standards.

6.3.3 The individual sub-systems of the Prototype shall be tested in accordance with Good Industry Practice to determine their compliance with Specifications and Standards. Such Tests may include simulation validation, laboratory and field tests for validating the design of each sub-systems and optional tests in accordance with relevant standard specifications/IECs for various sub-systems. All equipment should be type and routine tested with relevant standards as detailed in specification &/or Annexure -IV of this specification.

#### **6.3.4 Type tests on electronic equipment and control electronics**

The electronic equipment and Control Electronics shall be tested as per IEC 60571/EN50155, IEC 60068, EN 50121, IEC 60721-2-5 and IEC 61373 including both compulsory and optional tests. Dry heat test, as specified in IEC 60571, shall be conducted for testing power and control electronic equipment at 80 degrees Celsius. LCD display units shall be tested at 70°C.

#### **6.3.5 Test on combined test bed**

The propulsion equipment shall be tested on the combined test bed at the manufacturer's works as per the stipulations of IEC 61377.

#### **6.3.6 Efficiency Test**

- a. The efficiency of the transformer, power converter line side converter and drive side inverter, auxiliary converter and traction motor shall be measured at full load during the prototype test. Efficiency at full load means efficiency computed from parameters measured at conditions corresponding to full load and governed by IEC 60310 for transformer, IEC 61287-1 for power converter and auxiliary converter and IEC 60349-2 / 60349-4 for traction motor.
- b. Along with 'mandatory' tests as described in the IECs, 'optional and investigative' tests shall also be conducted. Any other tests which become imperative due to the specific requirement of this specification and is categorically mentioned in this specification shall also be carried out.



#### 6.3.7 Complete Train:

Complete train shall be type & routine tested as per IEC 61133 and as per the test program agreed by RDSO/Nominated Agency. After erection, the complete equipment shall satisfactorily withstand the dielectric voltages as specified in the IEC specification.

##### a. Sequence Test:

Connection shall be made to the 25 kV AC overhead contact system and all parts of the control and main power circuit shall be tested out to ensure correct sequence of operation, all interlock cut-out switches shall then be tested, and the pantograph shall be tested to prove the speed of raising and lowering.

##### b. Interference Test:

Tests to determine the levels of interference with traction power supply, signal and telecommunication equipment and facilities to prove that these are within acceptable limits in accordance with the Specification. The Technology Partner shall provide a necessary complete set of calibrated equipment/instrumentation and technical guidance to verify such parameters, which are necessary for evaluation of the Trains.

##### c. Pacemaker Interference Test:

This shall include test to verify that any emissions from the equipment of Train do not adversely affect the pacemakers/ hearing aids that may be used by the passengers. Test shall be conducted as per EN 45502 and EN 50500.

##### d. Vibration and Shock Values:

The equipment used in the cars shall conform to IEC61373 for shocks and vibrations as specified on the basis of the location and mounting of the equipment. The tests shall also cover Endurance tests included herein. The measured vibration on any portion of the car floor, walls, ceiling panels, stanchions, handholds or seat frames shall be less than  $0.315 \text{ m/s}^2$  when all equipment in the train are operating at their nominal capacity.

##### e. Service Tests

The prototype rakes fitted with the supplied equipment, shall be subjected to service trials. Service trials are intended to prove the satisfactory running performance of the supplied equipment and evaluate their reliability in service, ease of maintenance and operations. The performance of the equipment shall be assessed based on the experience gained during the service trials. Necessary modification as required and also as desired by the RDSO/Nominated Agency shall be implemented in the series production as well as on the prototype rakes.

### 6.4 Performance Test (On Prototype Rakes)

The Train performance with regard to the supplied equipment shall be demonstrated in test runs and shall meet the target figures given in Chapter 6.

#### 6.4.1 Test Runs:

- (i) Test runs shall be carried out on nominated sections of IR or any other sections on which the stock is to be operated with sufficient number of trains to ensure that the train equipment meets the operating conditions. The Technology Partner shall arrange instrumentation and record speed, voltage, current and temperature rise of various equipment, energy consumption, tractive effort and any other relevant parameter.

- (ii) The temperature of the various parts of the electrical equipment shall be recorded during the test as per the standard procedure specified. For further details refer Chapter 3.
- (iii) The Technology Partner shall supervise and carry out the above tests both at his works on combined test bed and also at the site and shall provide all equipment required for such tests and such special consumable stores as oil, grease etc., for the first filling and for trial runs. Special measuring instruments shall be provided by the Technology Partner.
- (iv) During the test's acceleration, deceleration, speed on straight level track and the energy consumption for a round trip shall be measured. In all cases, 16-Cars fully loaded train shall be tested.

#### 6.4.2 Energy Consumption

The Technology Partner shall measure the required values of energy Consumption for a 16-car, fully loaded rake in all out run, as mentioned in **clause no.2.9** and operation on the nominated section for all out running without coasting and as per time table halting at halt stations.

The validation of efficiency and energy consumption shall be done on the combined system test bed as per the IEC 61377 and 61133.

#### 6.4.3 Acceleration:

The acceleration will be calculated from the time taken to reach a speed of 40 km/h. The time taken shall be from the instant master controller is switched on to the instant speed of 40 km/h is touched. Tests will be conducted to confirm acceleration performance and jerk performance.

#### 6.4.4 Deceleration:

The deceleration test shall be taken after preliminary runs of the rake in order to bed the brake pads. The test shall be taken on dry rail and the average of three tests will be taken as the final figure for deceleration.

### 6.5 Commissioning of Trains at Maintenance depot:

- 6.5.1 Each rake shall be commissioned at maintenance depot of IR by the Technology Partner's staff before putting into commercial service. The Technology Partner shall be responsible for commissioning of two prototype rakes and all the series Train sets.
- 6.5.2 Two prototype rakes after the successful completion of all tests and trials and clearance of RDSO/Nominated Agency shall undergo service trials for six months or one lakh km whichever is earlier. Clearance for supply of propulsion equipment/Train (as applicable) for series rakes shall be given by Purchaser after successful service trials for six months or one lakh km as stated above of any of the prototype rakes. The supply of series rakes for the period of service trials can commence as agreed by the Technology Partner and purchaser. However ,during the prototype tests/service trials, if any problem arise or feedback is obtained, which warrants a re-check of the design/manufacture/quality of the equipment and components, action will be taken as may be necessary by the Technology Partner to carry out the required investigations and to incorporate the modification considered most appropriate to reach compliance with the specification without any extra

costs to the Purchaser and in a manner approved by the RDSO/Nominated Agency on equipment/components already supplied as well as those to be supplied later.

- 6.5.3 Two trains shall be instrumented with separate Power Quality measuring instruments, data acquisition systems and power analyser (with provision for permanent installation and necessary software/analysis tool) to measure, record and analyse the power quality. The measurement with these instruments shall include but not limited to Time, kW, kVAR, kVA, THD, TDD, Total Power Factor and Displacement Power Factor. Further details shall be finalized during design stage.
- 6.5.4 Technology Partner may also propose to measure the power quality parameters through TCMS. In such case, TCMS shall have the adequate capability of measurement and data acquisition to analyse higher order harmonics (up to 50th) and measure power quality parameters mentioned above with minimum accuracy of 0.1% and sampling rate of 100 kHz on real time as well as on recording basis. Hence, a suitable power analysis tool/software shall be built in TCMS to be available for all trains. However, this proposal shall be subjected to approval of the IR/ IR Nominated agency.

## **6.6 Routine Tests:**

### **6.6.1 Routine Tests on Trains**

All the routine tests specified for a Train in IEC 61133 shall be conducted at the manufacturer's land.

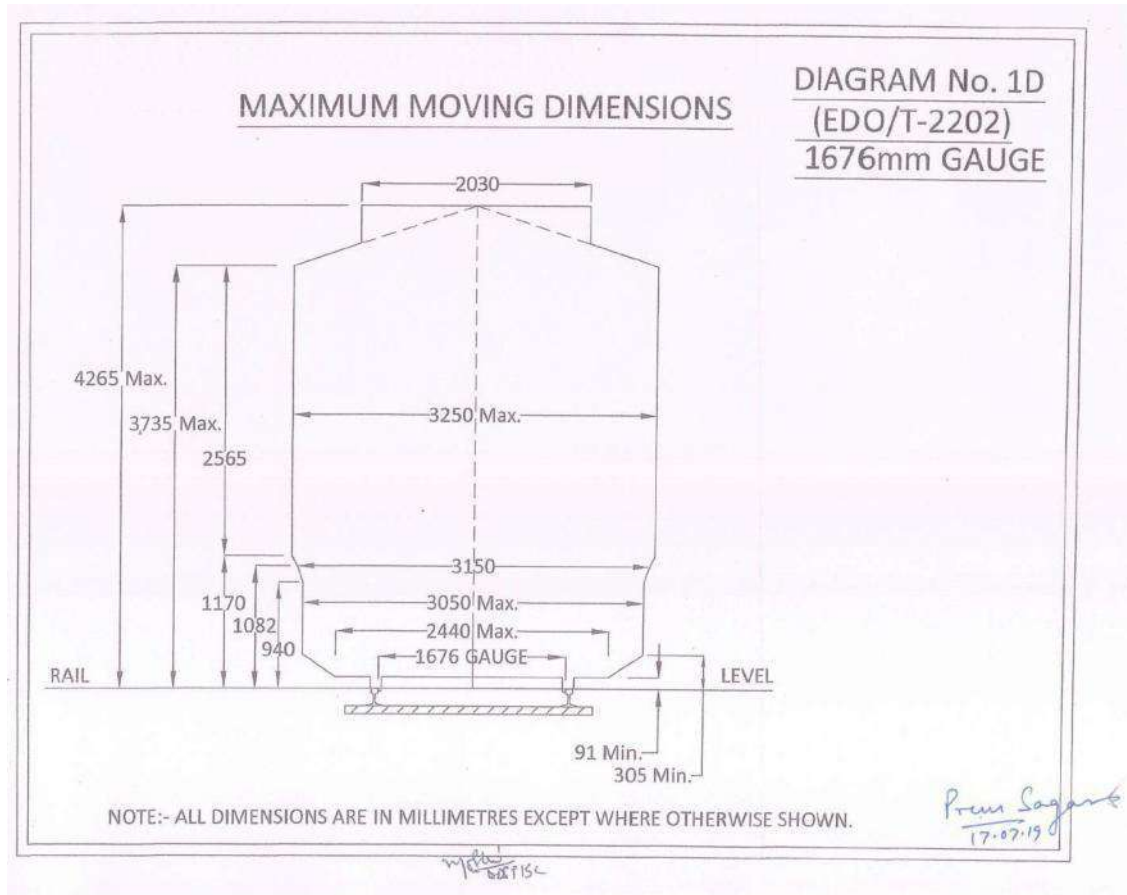
### **6.6.2 Routine Tests on Sub-systems**

- a. The individual sub-systems of the Trains shall be tested in accordance with Good Industry Practice to determine their compliance with Specifications and Standards.
  - b. The RDSO/Nominated Agency may, in its discretion, require the Technology Partner to furnish copies of the work test certificates (WTC) of any sub-system of the Train.
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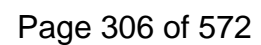
### **LIST of ANNEXURES**

<b>S. No</b>	<b>Annexure No.</b>	<b>Description</b>	<b>Reference Clause(s)</b>
1	ANNEXURE - I	Maximum Moving Dimensions of IR	2.1
2	ANNEXURE – II	Bow Profile of Panto Pan	3.3.2
3	ANNEXURE – III	Draw Hook with Collar	2.13, 4.3.1
4	ANNEXURE – IV	List of Specs	1.2.2
5	ANNEXURE – V	Limits of Interference Currents	1.7.12(iv)
6	ANNEXURE – VI	IR Track Geometric Quality parameters	6.2.5.vi
7	ANNEXURE – VII	Dynamic Behaviour Assessment using EN-14363 based methodology	1.5, 2.1, 6.2.5(v)
8	ANNEXURE – VIII	Record Duration for Memory	3.21.2, 3.30.3, 3.30.4,3.36.5,3.37.2
9	ANNEXURE – IX	Design Data, Calculations and Drawings	1.1.15, 5.1.2
10	ANNEXURE – X	Performance Simulations to be Submitted by the Supplier	2.5.11

**ANNEXURE-I: MAXIMUM MOVING DIMENSIONS OF IR**







#### ANNEXURE –IV: LIST OF SPECS

i.	Electric traction – rolling stock – test methods for electric and thermal /electric rolling stock on completion of construction and before entry into service	IEC 61133
ii.	Electronic equipment used on rail vehicles	IEC-61287
iii.	Specific rules concerning the electronic control part of converters	IEC-60571
iv.	Electric traction - electronic converter-fed alternating current motors	IEC 60349 –2
v.	<b><i>Electric traction – Rotating electrical machines for rail and road vehicles – Part 4: Permanent magnet synchronous electrical machines connected to an electronic converter</i></b>	<b><i>IEC 60349 –4</i></b>
vi.	Railway application – rolling stock – Part 1: Combined testing of inverter fed alternative current motors and their control system	IEC 61377-1
vii.	Guide for the evaluation and identification of insulation systems of electrical equipment	IEC 60505
viii.	Electric railway equipment-Train communication network	IEC 61375-1
ix.	Rotating electrical machines: Functional evaluation of insulation systems	IEC 60034-18
x.	Railway applications – electromagnetic compatibility – Part 3-2: rolling stock – apparatus	EN 50121-3-2/ IEC 62236-3-2
xi.	Railway applications – electromagnetic compatibility – Part 2: emission of the whole railway system to the outside world	EN 50121-2/ IEC 62236-2
xii.	Railway applications – compatibility between rolling stock and train detection system	EN 50238 IEC 62427
xiii.	Transformer and chokes	IEC 60310
xiv.	Transformer oil	BS 1481984
xv.	High voltage AC circuit breaker	IEC 60077-4
xvi.	Rules for pantograph of electric rolling stock	IEC: 60494-1
xvii.	Relays, contactors and switches	IS 3231, IEC 60947
xviii.	Cables	IEC 60228, IS 10810, EN 50264
xix.	Lightning arrestor	IEC 60099-4, IS 3070 Pt III
xx.	Railway applications – rolling stock equipment – shock and vibration test	IEC 61373
xxi.	Programming languages for PLC	IEC 61131
xxii.	Railway applications – electric equipment for rolling stock	IEC 60077
xxiii.	Electronic equipment used on rail vehicles	IEC 60571



xxiv.	Power converter installed on board rolling stock – Part 1: Characteristics and test methods	IEC 61287-1
xxv.	Power converter installed on board rolling stock– Part 2: Additional technical information	IEC 61287-2
xxvi.	Railway application – rolling stock protective provisions against electrical hazards	IEC 61991
xxvii.	Auxiliary machines	IEC 60034
xxviii.	Environmental testing	IEC 60068
xxix.	Batteries	Relevant IECs
xxx.	Degree of protection provided by enclosures	IEC 60529
xxxi.	Rules for installation of cabling	EN 50343
xxxii.	Railway applications, welding of railway vehicles and components. Inspection, testing and documentation (The Technology Partner shall, no later than the 5th(fifth) anniversary of the Appointed Date, demonstrate compliance to the EN 15085)	EN15085
xxxiii.	Schedule of Dimension	IR Schedule of dimension for Broad Gauge, revision 2022 with latest amendment
xxxiv.	Reliability of electronic component	IEC 61709
xxxv.	RAMS	EN 50126/ IEC 62278
xxxvi.	Metallized carbon strip for pantograph	RDSO's specification no. RDSO/2009/EL/SPEC/009 7 Rev. 1 or latest
xxxvii.	Track Geometry	Indian Railway Permanent Way Manual
xxxviii.	Railway applications —Current collection systems - Requirements for and validation of measurements of the dynamic interaction between pantograph and overhead contact line	BS EN 50317
xxxix.	Railway applications —Current collection systems — Validation of simulation of the dynamic interaction between pantograph and overhead contact line	BS EN 50318
xl.	Railway applications — Current collection systems — Technical criteria for the interaction between pantograph and overhead line (to achieve free access)	BS EN 50367
xli.	Aluminium and aluminium alloys - Extruded rod/bar tube and profiles - Part 2: Mechanical properties	EN 755-2
xl.ii.	Aluminium and Aluminium alloys - Sheet, strip and plate - Part 2: Mechanical properties	EN 485-2
xl.iii.	Tensional Strapping	EN 13891
xliv.	Railway Standard – Welding of railway vehicles and components	EN 15085

### ANNEXURE V -LIMITS OF INTERFERENCE CURRENTS

S.No.	Interference Current	Overall limit
1.	Psophometric current AC traction	10.0A
2.	DC components in AC mode	4.7A
3.	Second Harmonic Component 100 Hz & 83.33 Hz in AC Traction per basic unit	8.5 A
4.	1400Hz to 5000Hz	400mA
5.	More than 5000Hz upto 50000Hz	270mA
6.	50Hz components in DC mode	2.4A

Interference limit for Signal Equipment:

1. Limit of AFTC compatibility shall be demonstrated as per IEC62427/EN-50238 for used on Indian Railways.
  - i) M/s Siemens make AFTC (FTGS46/FTGS917/TCM100): Limits as defined Table A.3 of EN-50238-2:2015 as below.

Type	F <sub>0</sub> [Hz]	I <sub>0</sub> RMS[A]	ΔF3dB	ΔF20dB[Hz]	T[S]	T <sub>p</sub> [s]
FTGS46	4750	1	200	560	0.04	0.12
FTGS46	5250	1	206	570	0.04	0.12
FTGS46	5750	1	214	580	0.04	0.12
FTGS46	6250	1	220	590	0.04	0.12
FTGS 917	9500	0.33	360	900	0.04	0.12
FTGS 917	10500	0.33	380	920	0.04	0.12
FTGS 917	11500	0.33	400	950	0.04	0.12
FTGS 917	12500	0.33	425	1015	0.04	0.12
FTGS 917	13500	0.33	445	1100	0.04	0.12
FTGS 917	14500	0.33	470	1160	0.04	0.12
FTGS 917	15500	0.33	490	1195	0.04	0.12
FTGS 917	16500	0.33	510	1230	0.04	0.12

- ii) M/s Alstom make AFTC(DTC24): Limits as defined in Table A.9 (Digicode) of EN-50238-2:2015 as below.

Type	F <sub>0</sub> [Hz]	I <sub>0</sub> RMS[A]	ΔF3dB	ΔF20dB[Hz]	2*N[-]	T[S]
DTC24-2	2100	2.2	400	440	10	1
DTC24-2	2500	2.2	400	440	10	1
DTC24-2	2900	1.5	400	440	10	1
DTC24-2	3300	1.5	400	440	10	1
DTC24-2	3700	1.5	400	440	10	1
DTC24-2	4100	1.5	400	440	10	1
DTC24-2	4500	1.5	400	440	10	1
DTC24-2	4900	1.5	400	440	10	1

Type	F <sub>0</sub> [Hz]	ΔF[Hz]	I <sub>0</sub> RMS[A]	T[S]
All kind of UM71 equipped with RENUM receptor	1700	90	0.3	0.3
All kind of UM71 equipped with RENUM receptor	2000	90	0.3	0.3
All kind of UM71 equipped with RENUM receptor	2300	90	0.3	0.3
All kind of UM71 equipped with RENUM receptor	2600	90	0.3	0.3
UC9500	9500	100	0.3	0.3

iii) M/s Ansaldo make AFTC(UM-71): Limits as defined in TableA.13 of EN-50238-2:2015 as below.

iv) M/s Bombardier make AFTC (TI 21): Limits as per Table A.15 of EN-50238-2:2015 or latest & as per Table A.16 of CLS/TS 50238-2:2020 to be followed.

The compatibility plan to be made as perEN-50238 where limits of current generated by all Rolling stock should not be more than the above limit the current returning from each rolling stock towards TSS will go through the AFTC between present all rolling stock and TSS and will add up in worst case. The summation rule as per clause B.8.2 of EN-50238-2:2015 shall be used to work out the Max. Permissible current limit generated by one Rolling Stock. This shall be clearly defined in the Test Plan to be submitted to RDSO.

2. Axle Counter Compatibility as per EN50238: -

i) The measurement shall be done as per EN: 50238-3:2013 and EN-50592:2016. The following are the limits for different type of Axle counter used on Indian Railways as on date.

Axle counter make& model	Centre frequency tolerance range KHz	Filter curve 3 dB/20dB bandwidth KHz	Filter order using for evaluation	Magnetic field in X direction rms dBμA/m	Magnetic field in Y direction rms dBμA/m	Magnetic field in Z direction rms dBμA/m	Rail current UIC 60rms mA	Integration time T <sub>int</sub> ms
M/s Siemens make (ZP D 43, ZPD43I)	43.0±1.7	±0.02/±0.3	2	100	85	98	68	2
M/s Siemens make (ZP 43E)	43.0±1.0	±0.16/±1.2	4	100	83 to 90d	98	68	1
M/s Frauscher make (RSR180)	250±1.0	±5.0/±15	4	121	113.8	101.0	277.6	1.5
M/s Eldyne/Thales make (ZP30H, Zp30 C-NT, Zp30, Zp30K)	27.0-32.0	±0.12 /±0.45	4	114	94	101	220	4
M/s G. G. Tronics India Pvt. Ltd.		Limit shall be informed later.						
M/s Nippon Signal India Private								
M/s Medha Servo DrivesPvt.Ltd.								
M/s Central Electronics Ltd								
M/s Signal & Telecom Workshop								

3. As per EN-50238, the agency conducting the test shall preferably be certified to EN ISO/IEC 17025. The rake shall be certified for EN-50121 for radiated EMI.
4. The compatibility with Kavach equipment shall be covered. The rake shall be complied to EN- 50121 for Radiated EMI. The compatibility from the requirement of space to accommodate the existing Kavach equipment in Trainset etc. Shall also be covered.

## ANNEXURE VI: IR TRACK GEOMETRIC QUALITY PARAMETERS

Speed Band	Speed (KMPH)	UNEVENNESS				ALIGNMENT			
		TL90	TL70	TL50	QN3	TL90	TL70	TL50	QN3
I	>130	2.53	1.67	1.31	12.39	2.02	1.32	1.10	9.00
II	>110 & ≤ 130	3.61	2.39	1.79	15.00	2.39	1.66	1.32	9.67
III	>100 & ≤ 110	3.82	2.52	1.97	16.50	2.55	1.70	1.36	10.50
IV	≤ 100	4.00	2.83	2.25	19.40	2.55	1.78	1.42	11.08

**Note:** Above track geometric quality parameters have been calculated on the basis of measured track tolerances of Indian Railway so far, based on EN 14363:2016 methodology.

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## ANNEXURE-VII: DYNAMIC BEHAVIOUR ASSESSMENT USING EN-14363 BASED METHODOLOGY

*Minutes of Standards Criteria Committee Meeting (SCC) held on 24.04.2023*

### Dynamic Behaviour Assessment using EN-14363 based methodology

#### **BACKGROUND**

- As desired by Railway Board, RDSO is going to switchover to EN 14363:2016 based methodology for dynamic behavior assessment of rolling stocks on IR BG network.
- In this context, following meetings of Standing Criteria Committee (SCC)/RDSO on 05.09.2022 and 07.09.2022, RDSO had proposed, to Railway board, for approval, the acceptance limit for BG rolling stocks based on EN14363:2016 vide letter no.RM2/MCI/21 dated 22.09.2022.
- Railway Board has approved the acceptance limits for various stocks vide their letter no 2020/CE-II/TS/22.9 dated 31.01.2023
- Further to the above approval of Acceptance Limits by Railway Board, it is imperative that a comprehensive document detailing the procedure /requirements/references/ Acceptable Limits for dynamic performance assessment of Railway Vehicles as per EN-14363 Methodology is compiled & formally issued. With the above purpose, this document- "Dynamic Behavior Assessment using EN-14363 based methodology" has been compiled & is being finally issued.
- For simplicity & immediate reference this document shall be referred to as "Fourth Report of Standing Criterion Committee".

#### **Important Note:**

*These guidelines need to be read along with the Trial protocol manual (TPM no. Z53 .07.251 issue -06 May 2020) and Standard EN14363:2016.*


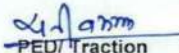
#### **1. Scope:**


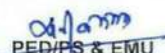
This document recommends that the assessment, as per this document, of dynamic behaviour of railway vehicle, be undertaken for Rail vehicles which are mandated by Policy Circular 6.

#### **2. The guidelines contained in this report are intended for**

- 2.1. **Vehicles:** All type of <sup>new</sup> railway vehicle (locomotives, passenger coaches, multiple units, trainset and Freight stock) to be operated on BG (nominal gauge- 1676mm); being vertical axle load upto 225KN for non-freight stock (except for locomotives) and 250KN for freight stock and for locomotives.
- 2.2. **Infrastructure:** Indian track infrastructure, considering its layout and as per provisions of 'Indian Railways Permanent Way Manual'.
- 2.3. **Wheel-rail interface:** The procedure includes the assessment of nominal new profile equivalent conicities and also high equivalent conicities to ensure safety against instability.

  
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2.4. **Operating conditions:** Assessment will be performed for specific combinations of admissible speed and admissible cant deficiency.

**3. Test Conditions**

3.1. **Vehicle Configurations:** - (Refer para 5.1 page 15 of TPM )

3.2. **Leading/Trailing running direction:** - . (Refer para 5.1.1 page 15 of TPM)

3.3. **Fault modes:** - (Refer para 5.1.2 page 15 of TPM)

3.4. **Loading conditions:** -(Refer para 5.1.3 page 15 of TPM) or as advised by concerned Design Directorate.

**4. Admissible Speed and Admissible cant deficiency –**

(Refer subpara 4 of Para 3 'Scope' and subpara 4.1 under Para 4 'Test unit parameters', page 13 & 14 of TPM)

**5. Requirements of Test zones, Test sections and Special Sections**

5.1. Test track comprises different test zones (Refer para 7.2 .3 page 24 of TPM and table 2 , page no. 44 of EN14363:2016)

5.2. Stability Test Zone is basically tangent track or Zone -1. Special requirements for stability test in context to equivalent conicity is tabulated in table 8.1 of TPM under para 8.0. page no.35 of TPM.

**6. Track Quality:**

Track quality parameters consists TL90, TL70, TL50 & QN3 for unevenness and alignment and would be advised / provided by TMM Dte for IR network .(Refer para 5.3 page 15 of TPM)

**7. Test Methods:**

Normal Measuring Method (with Multi -Dimensional analysis) of dynamic performance assessment as per EN14363:2016 shall be used.

**Normal Measuring Method:**

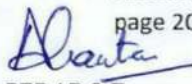

**a. Measured Quantities & Instrumentation:**

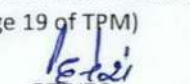
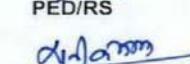
(Refer Table 6.1 page 18 of TPM).


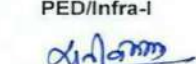
**b. Assessment Magnitudes:**

The Foreword (Refer para 7.1, page 21 of TPM) may be referred to for General description regarding dynamic behaviour assessment.

Assessment magnitudes are derived from measurement quantities (Refer Table no. 6.2 page 20 of TPM & para 6.3 , page 19 of TPM)

  
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**b.1 Sum of guiding forces left and right wheel ( $\Sigma Y$ ):**

(Refer para 6.3.1, page 19 of TPM)

**b.2 Derailment coefficient ( $Y/Q$ ):**

(Refer para 6.3.2, page 19 TPM)

**b.3 Track loading forces Y and Q:**

(Refer para 6.3.3, page 19 of TPM)

**b.4 Sum of guiding forces left and right wheel, rms value ( $\Sigma Y_{rms}$ ):**

(Refer para 6.3.4, page 19 of TPM)

**b.5 Running conditions Speed (V), angular velocity (Gyro) and Unbalanced lateral acceleration ( $A_{nc}$ ):**

(Refer para 6.3.5, page 20 of TPM)

**c. Assessment Method:**

c.1 For the calculation of the maximum estimated values, the confidence intervals, as specified must be applied. (Refer para 7.4.1, page 27 of TPM, issue 06).

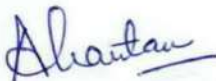
c.2 For characteristics values, its grouping in context to safety and track loading are mentioned in para 7.3.3.1 and 7.3.3.2, page 27 of TPM issue 06.

c.3 The **Multi-dimensional method**, (Refer table no 7.12 under para 7.4.4, page 29-30 of TPM) shall be used for Assessment Magnitudes with respect to their Influencing parameters (Refer table no 7.13 under para 7.5, page 31-32 of TPM) in their respective zones of assessment.

c.4 **Evaluation of test results in transition curves:** (Refer para 7.9, page 34 of TPM)

c.5 **Re-Calculation of ( $Y/Q$ )<sub>a,max,rec</sub>:**

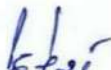
(Refer para 7.6.3.2.5 ,page no. 65 of EN14363:2016 and para 3.1 ,page no.124 of TPM).



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### 7.1 Acceptance Limit values:

Maximum Estimated values should be within the below tabulated acceptance limits

Assessment Magnitude	Limit values as approved by Railway Board			Remarks
Sum of guiding lateral forces ( $\Sigma Y_{max}$ )	0.85(10+ $P_{FO}$ /3) KN Where, $P_{FO}$ – Axle load in KN			Safety Parameter
Derailment coefficient ( $Y/Q$ ) <sub>max</sub>	0.8			Safety Parameter
	1.2 (in transition)			
Moving rms of guiding forces ( $\Sigma Y_{rms}$ )	[0.85(10+ $P_{FO}$ /3)]/2 KN			Safety & Stability Parameter
Quasi- Static guiding forces ( $Y_{qst}$ )	66 KN			Track Loading Parameter
Quasi- static vertical wheel force ( $Q_{qst}$ )	145 KN if $P_{FO} \leq 225$ KN			Track Loading Parameter
	155 KN if $225 \text{KN} < P_{FO} \leq 250$ KN			
Maximum Vertical Wheel force ( $Q_{max}$ )	Wheel base & Bogie centre	Maximum Vertical wheel force for IR	Typical Rolling stock example	Limit of vertical wheel forces for different rolling stock varies with varying wheel base & bogie centre. Graph indicating Max. Vertical wheel force & wheel base for bogie centre distance (652.4cm, 900cm & 1100cm) for 60 kg 90UTS rail, are enclosed as annexure A, B & C for general guidance. For bogie centre between 1100cm to 1490cm, graph of bogie centre 1100cm has to be referred. Similarly for Bogie centre between 900cm to 1100cm, graph of bogie centre of 900cms has to be
	Wheel Base- 185cm Bogie centre- 1200cm	191 KN	WAG9H	
	Wheel Base- 200cm Bogie centre - 652.4cm	186 KN	Freight stock including BOXNM2, BOXNS	
	Wheel Base- 256cm Bogie centre - 1490cm	170 KN	LHB coach	
	Wheel Base- 270cm Bogie centre - 1490cm	168 KN	Train set	
	Wheel Base-	167 KN	WAP5	

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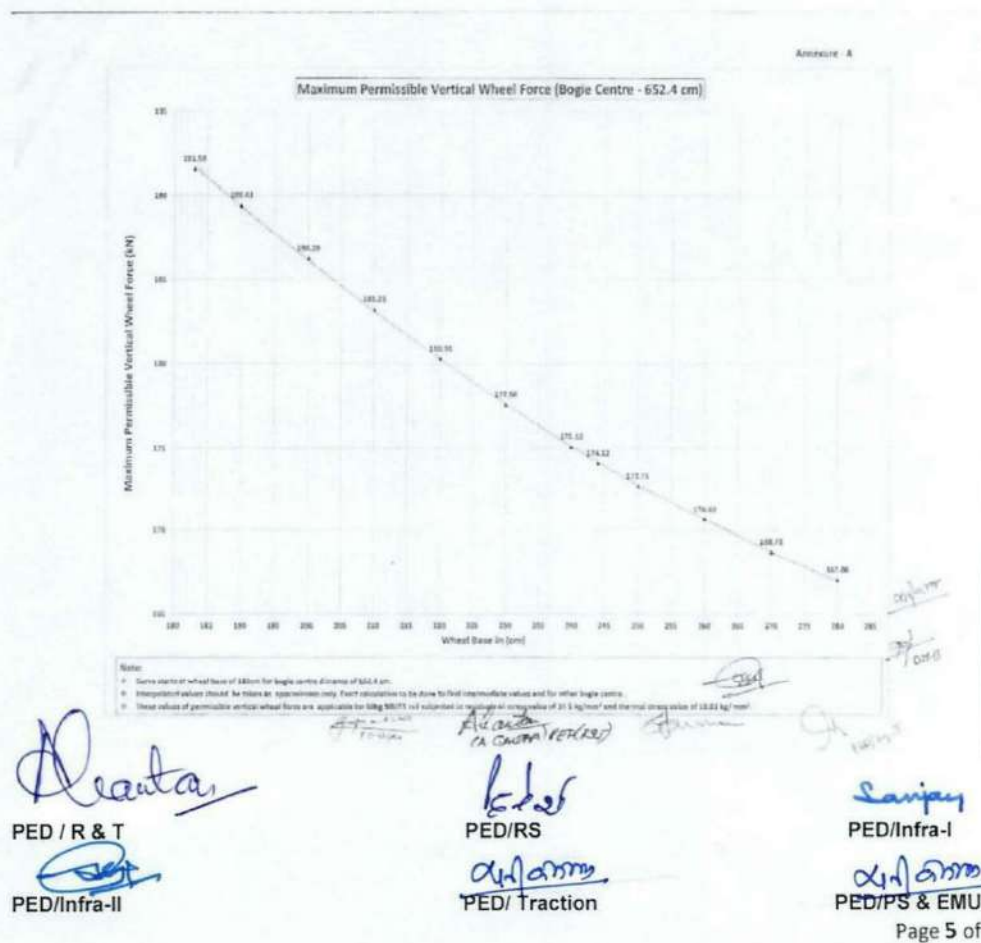
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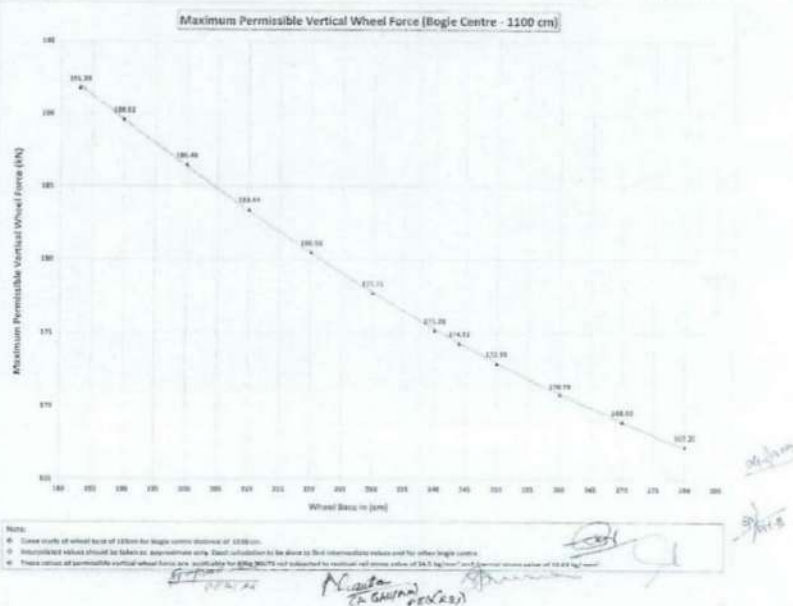
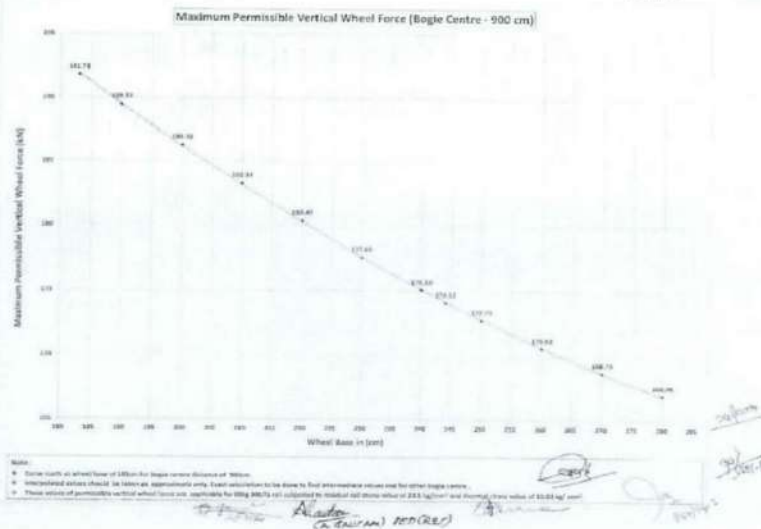
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	280cm Bogie centre - 1020cm			referred. These graphs will be applicable for two axle bogie. For other wheel arrangement separate analysis will be required to be done. Permissible vertical wheel force shall be lower of values as per above graph and EN14363:2016 provision in this regard. These limits are based on 60 Kg 90UTS rail. For R260 and higher grade rails, EN limits shall be applicable.
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**8. Other Pertinent Issues:**

8.1 RDSO(Testing Directorate) presently has 06 sets of IWS (one set each of LHB , BOXN (1000 mm Dia) , BOXNS (840 mm dia) , WAP5 , WAG9H loco and Train 18 (Ver-I). Since IWS, is an imperative requirement as per the Normal measuring method of EN-14363, availability of IWS with Testing Dte or through contract means shall be checked and confirmed before undertaking Dynamic behavior assessment as per EN-14363 methodology.

If relevant IWS with accessories are not available with Testing Directorate, then IWS should be arranged by Testing Directorate in consultation with Design Directorate for concerned RS before undertaking trial based on EN standard.

8.2 The EN-14363 based dynamic behavior assessment has particular requirements of Test Stretches & should ideally be undertaken on the Dedicated Test Track (DTT). In case trials are to be conducted on IR revenue track the following conditions/facilities would need to be ensured

a) Conditions of Zone -1, 2, 3, 4 , special conditions, equivalent conicity for stability and zone-1, recalculation norms and Track quality parameters etc. over nominated test track as mentioned in table 2 of EN 14363:2016.

b) Test-Section should be preferably at one location of IR network.

c) It shall be kept in mind that nominated test section is close to a RS maintenance line / ROH depot or loco shed to facilitate fitment of IWS of relevant rolling stocks and its attention during trial ( in case of abnormalities in signals of IWS or other issues).

8.3 The first Stage assessment trial (safety against derailment) as per EN-14363, shall be conducted over the available twist-curve track (method -1) in the DTT.

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## Extract of relevant Clauses/Pages of Trial

### Protocol Manual (TPM) referred-to in the Fourth Report of Standing Criterion Committee