INDIAN RAILWAYS

सत्यमेव जयते

TECHNICAL SPECIFICATION FOR MODERN WAGONS (MODERN OPEN WAGON & MODERN BRAKE VAN)

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Contents

DEFINITIONS

i. AAR means Association of American Rail Roads.

ii. BG means 1676 mm Gauge, Refer to as Broad Gauge.

iii. Established Standard means Standards used in other Railways.

iv. FEM means Finite Element Method.

v. GPSmeans Global Positioning System.

vi. IR means Indian Railways.

vii. IRNSS means Indian Regional Navigation Satellite System.

viii. IRS means Indian Railway Standard.

ix. IRSOD means Indian Railways Schedule of Dimensions 1676mm Gauge (BG) Revised, 2022 with all ACS.

x. IS means Indian Standard.

xi. CISA Company Independent Safety Assessor- An accredited body as per ISO/IEC 17065 with experience of certifying rolling stocks of operating/designed speed of 75 kmph or more, to be engaged by the Technology Partner.

xii. ISO means International Organization for Standardization.

xiii. Kmph means Kilometer per hour.

xiv. MMD means Maximum Moving Dimensions.

xv. OHE means Over Head Equipment.

xvi. Payload to Tare weight ratio derived by dividing the commodity carrying capacity (in tonnes) of the wagon by the tare weight (in tonnes)of the wagon, one of the indicators of design efficiency of the wagon.

xvii. 'Purchaser' means the President of the Republic of India.

xviii. Rake means Standard freight train of 636 meter length,(without brake van and locos) Comprising varying number of wagons depending upon the length of individual wagon(s).

xix. RB means Railway Board, Ministry of Railways.

xx. RDSO means Research Design and Standards Organization, Ministry of Railways, Lucknow-226 011, India-The R& D wing of Indian Railways.

xxi. Sub-Technology Partner/Sub-Vendor means any person, firm or company from whom the Technology Partner may obtain any material, assemblies, sub-assemblies, services or any other assistance to fulfill the requirements of this specification.

xxii. Technology Partner means the firm/company/organization/association submitting the offer for the said work for Indian Railways conforming to this specification.

xxiii. Brake Van- means Train Manager Wagon, which is also known as Guard wagon or Caboose, placed at rearmost of the train.

xxiv. UIC means Union International des Chemins de Fer (International Union of Railways).

xxv. Wagon(s)- wherever mentioned in this document shall means both Modern Open Wagon(s) and modern Brake Van(s), unless specifically mentioned.

Chapter 1: General Technical Requirements

1.1. General:

1.1.1. The Wagons 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 Indian Railway Network.

1.1.2. The environmental and service conditions, performance & technical requirements are specified in these Specifications and Standards.

1.1.3. The Wagons 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 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.

1.1.4. Due consideration shall be given at design stage to the corrosive nature of the commodity to be transported and the ambient conditions of high temperature and humidity prevalent in India, as specified in Clause 1.4 of this Schedule.

1.1.5. The Technology Partner shall demonstrate, to the satisfaction of the Government, that the Sub-systems proposed to be used in the wagons are based on proven technology and design.

1.1.6. The manufacture of the wagons 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.

1.1.7. The Technology Partner shall comply with the requirements specified in Chapter 4of this Schedule with regard to Design and Drawings. The Testing and Acceptance of the wagons shall be carried out in terms of the provisions of Chapter 5 of this Schedule.

1.1.8. Where practical and unless otherwise stated, all requirements in this Schedule shall apply together simultaneously.

1.1.9. The Technology Partner 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.

1.2. Reliability, Availability, Maintainability and Safety (RAMS):

1.2.1. The wagon shall be designed to ensure Guaranteed Reliability, Guaranteed Availability and high degree of safety in order to provide a dependable service.

1.2.2. The plan for Reliability, Availability, Maintainability and Safety conforming to EN: 50126/ IEC 62278 shall be in-built in the offered design of the wagon.

1.2.3. The system safety plan shall identify and list safety critical components and this list shall be updated periodically.

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

a) Degraded modes and emergency operations shall be considered as well as normal operations;

b) Safety risk assessment shall utilize more than one methodology to assess risks;

c) Safety risk assessment shall include the consideration of dependent failures, in particular the braking system, bogie suspension, etc.; and

1.2.5. Details of RAMS analysis shall be submitted by the Technology Partner at the design approval stage to CISA.

1.3. Track Parameters:

Gauge	Broad Gauge 1676 mm	
Sharpest curve to be negotiated	175meter (Horizontal) 2500 meter(vertical)	
Sharpest reverse curve to be negotiated	175-meter 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, tanθ) turnouts on pre-stressed concrete sleepers	
Maximum super elevation	185 mm	
Maximum cant deficiency	100 mm	
Maximum gradient	1:37	
Permitted track tolerances	The track shall be maintained to as per provisions of Indian Railways Permanent Way Manual, June-2020, containing track geometry standards under Para 522. However, the trials shall be done on track having parameter decided on the basis of prevailing track tolerances of Indian Railway based on EN: 14363 methodology.	
Gauge (Under floating Condition)	As mentioned in Para 525 of Indian Railway Permanent Way Manual (IRPWM) June-2020.	
	Straight Track	-6mm to +6mm
	Curved Track with more than 440m radius	-6mm to +15mm
	Curved Track with less than 440m radius	Upto +20mm

- *Speed on curve shall be decided on the basis of Indian Railways Permanent Way Manual, June –2020.*

1.4. Climatic and Environmental Conditions:

i.	Altitude	Up to 1800 m from mean sea level
ii.	Operating Temperature	-10^0C to 50^0C During dry weather, the atmosphere is likely to be dusty.
iii.	Humidity	Upto 100%

iv.	Rainfall	Very heavy in certain areas.
v.	Atmospheric conditions	Extremely dusty and desert terrain in certain areas. The dust concentration in air may reach a high value of 1.6mg/m3. In most of iron ore and coal mine areas, the dust concentration is very high
vi.	Solar Radiation	1 kW/m2
vii.	Coastal area	Humid and salt laden atmosphere with maximum pH value of 8.5, sulphate of 7mg per liter, maximum concentration of chlorine 6mg per liter and maximum conductivity of 130micro Siemens/cm.
viii.	Wind speed	High wind speed in certain areas, with wind pressure reaching 216 kg/m^2 as per IS:875-Part 3(2015)

1.5. Commodities to be carried in Modern Open Wagons:

1.5.1. All commodities, except those mentioned below, can be carried in the modern open wagons:

a) Salt (or any other equivalent or more corrosive material).

b) Hot Rolled and Cold Rolled Steel coils.

1.6. Loading process

1.6.1. Commodities can be loaded into wagon through any of following means:

a) By pay loaders.

b) By silos/hopper.

c) By any other mechanized means.

1.7. Unloading process

1.7.1. Commodities can be unloaded from the wagon through any of following means:

a) Bulk commodity through tipplers.

b) Steel products through cranes.

c) Other commodities- by any suitable mechanized means.

1.8. Boundary Conditions:

Details of Boundary conditions of Bridges, Signal and Overhead equipment's are given below:

1.8.1. Stipulation of Boundary Conditions of Bridge (Annexure-1)

1.8.2. Stipulation of Boundary Conditions of Signaling (Annexure-2)

1.8.3. Stipulation of Boundary Conditions of OHE (Annexure-3)

Chapter 2: Performance Requirements

2.1. Leading Parameters:

2.1.1. Modern Open Wagon- shall meet the following leading parameters:

S. No.	Parameter	Value
i.	Axle load	25 tonnes
ii.	Track Loading Density	9.33 t/m (maximum)
iii.	Pay load	81.25 tonnes (minimum)
iv.	Tare Weight	18.75 tonnes(maximum)
v.	Payload to Tare ratio	4.33 (minimum)
vi.	Rake throughput (in 636 m length)	4790 tonnes (minimum)
vii.	Volumetric Capacity (in cubic meter)	71
viii.	Volumetric Capacity of heap Loading(in cubic meter)	5.66
ix.	Total Volumetric Capacity (in cubic meter)	76.66
x.	Bogie	To meet dynamic performance characteristics requirements as per EN:14363-2016, with limits mentioned in Annexure-G
xi.	Speeds Potential (Loaded/Empty)in kmph	75/100
xii.	Yard Examination Periodicity	12,000km (minimum)
xiii.	Intermediate Overhaul	24 months (minimum)
xiv.	Periodic Overhaul	06 years (minimum)
xv.	Life	35 years (minimum)
xvi.	Tracking Devices	GPS and RFID to be provided in all wagons.

2.1.2. Modern Brake Van shall meet the following leading parameters:

S. No.	Parameter	Value
i.	Axle load	6.0 tonnes (indicative)
ii.	Track Loading Density	9.33 t/m (maximum)
iii.	Length	14.5 meters (maximum)
iv.	Speeds Potential in Kmph	100
v.	Bogie	To meet dynamic performance characteristics requirements as per EN: 14363-2016& EN-12299, with limits mentioned in Annexure-G.
vi.	Yard Examination Periodicity	12,000km (minimum)
vii.	Intermediate Overhaul	24 months (minimum)
viii.	Periodic Overhaul	06 years (minimum)
ix.	Life	35 years (minimum)
x.	Tracking Devices	GPS and RFID to be provided in all Brake Vans.

2.2. Maximum Moving Dimensions:

2.2.1. The maximum Permissible length of train without locomotive(s) and Modern Brake Van should not be more than 636m.

2.2.2. Parameters of the Modern Open Wagon and Modern Brake Van should comply with the provisions of IRSOD-2022 with all ACS (Annexure-A).

2.2.3. Kinematic Envelopes: 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.

2.2.4. Details of Kinematic envelop are given at Annexure- E

2.3. Curve negotiability

The Wagons should be able to negotiate 10 degree curve and 1: 8.5 turn-out of Indian Railways. Details are given at Annexure- D

2.4. Brake system performance:

The brake system should meet all the requirements mentioned in para 3.9.

2.5. Dynamic performance

2.5.1. Modern Open Wagon and Modern Brake Van shall meet the dynamic performance requirements as per EN: 14363-2016, with limits as mentioned in Annexure-G.

2.5.2. Ride Index of Modern Brake Van: In addition, Modern Brake Van 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 3.5.

2.6. Maintenance Schedule

The Technology Partner shall submit the maintenance schedules of the proposed Wagons. Minimum interval between two maintenance schedules for the Wagons should meet the criteria given in para 2.1 above.

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

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

Chapter 3: Technical Requirements of Wagons and components

3.1. Design, Manufacturing and Testing of Wagons

3.1.1. The Technology Partner shall develop:

a) Design of 25t axle load capacity Modern Open Wagon conforming to IRSOD-2022 with all ACS **(Annexure-A).** The wagon should meet the leading parameters given in clause 2.1.1 of this specification.

b) Design of Modern Brake Van conforming to IRSOD-2022 with all ACS **(Annexure-A).** The Modern Brake Van design should be compatible with the Modern Open Wagons. The Brake Van should meet the leading parameters given in clause 2.1.2 of this specification.

3.1.2. Two prototypes each of Modern Open Wagon and Modern Brake Van shall be manufactured by the Technology Partner after approval of detail design of Modern Open Wagon and Modern Brake Van.

3.1.3. The wagons shall be subjected to stage inspection, final inspection, static test, Oscillation trial and field trial.

3.1.4. The wagons shall be subjected to Oscillation trials as per EN: 14363-2016and Modern Brake Van as per EN: 12299 for mean ride comfort (in addition to EN: 14363-2016) and it should successfully qualify the trial at the specified speed as per the criteria given at Annexure-G.

3.1.5. After successful completion of above tests, two rakes of Modern Open Wagons along with Modern Brake Vans shall be manufactured and subjected to field trial for 50,000 kms.

3.2. General

3.2.1. All critical components/assemblies (Bogie, Wheelset, Bearings, Coupler & Draft gear, Brake system etc.) being used in the wagons should be well proven. For establishing provenness, at least 2,500 nos. of each critical components/assemblies should have worked for at least six years in one of the Railway Systems, which can be having track gauge different from IR (1676 mm).

3.2.2. Compatibility of operation of the wagon by locos currently available on IR, both from the point of view of coupling and application/release of brakes, has to be mandatorily ensured.

3.2.3. Design of other interfacing parts/components of Wagons like loading /unloading mechanism should be user friendly and no special skill should generally be required for their operation.

3.2.4. Unloading of bulk material (coal, iron ore, etc.) shall normally be done on tipplers. Hence, doors shall normally not be used for unloading. However, two optimum size doors, one each placed on diagonally opposite side of wagon, for cleaning and maintenance purpose shall be provided.

3.2.5. Calculation of Fatigue life of Wagon and its various components in Kms. or in number of years, to be done as per AAR section-C Part–II Chapter 7 or any other AAR/UIC or any other established standards.

3.2.6. Technology Partner should visit some of the areas (loading and unloading points, yards, portion of track, etc.) on which the proposed Wagons are intended to be operated & maintained to get familiarized with the prevailing field conditions, which may be taken into account while designing the wagon.

3.2.7. Various Standards proposed to be followed for design, manufacturing, inspection; testing, operation and maintenance of Wagons shall be AAR/UIC or any other established standard.

3.3. Wagon Body:

3.3.1. Wagon body shall be designed as per AAR/UIC or any other established standards.

3.3.2. The wagon body shall be able to withstand the vertical and lateral forces which arise due to loading commodity (applicable for Modern Open Wagon), longitudinal draft and Buff force arising due to train operation, forces due to tippling operation and forces due to loading/unloading by other mechanized means etc.

3.3.3. The Under-frame shall be able to withstand the compressive end forces and impact forces arising due to loose-shunting.

3.3.4. The wagon shall be used for transportation of coal (having high Sulphur contents), mineral ores and other similar commodities. This should be duly taken into account while designing the wagon.

3.4. Global Navigation Satellite System (GNSS or better known as GPS)

3.4.1. Shall conform to CRIS specification for self-powered fixed GPS devises for freight stock tracking and tracing over Indian Railways.

3.5. Tags for Identification of Wagons (RFID)

3.5.1. Shall conform to CRIS specification of Tags for use for identification of vehicles on Indian Railways "No-2016/CRIS/NDLS-ITPI/WS-C/POLICY/RFID/0101/PT-1" (V4,1) or Latest.

3.5.2. Shall conform to CRIS Guideline for using data of RFID Tags OF Indian Railways "2019/CRIS/NDLS-ITPI/RFID/POLICY/0151/PT-2" (V4,1) or Latest.

3.5.3. Indicative Schematic drawing of Tag is enclosed as Annexure-I.

3.6. Modern Brake Van

3.6.1. Shall conform to leading parameters given in clause 2.1.2 of this specification.

3.6.2. The design shall be well within the IRSOD-2022 with all ACS and compatible with the Modern Open Wagon design.

3.6.3. Shall have proper heat and noise insulation (noise level<85 dBA) for affording comfortable ambience to the Train Manager (TM).

3.6.4. Shall have provisions for applying emergency brake and hand brakes.

3.6.5. Shall have provision of laterally projected windows (having shutters and glass) at both sides to facilitate TM to visualize the train from inside the modern brake van.

3.6.6. Shall have provision of two windows diagonally opposite at End walls, in front of both windows provision of table, cushioned chair in the TM cabin.

3.6.7. Shall have provision of locking arrangement of the TM cabin.

3.6.8. TM cabin shall have proper sealing arrangement so to prevent undue ingress of winds/water.

3.6.9. Shall have provision of Fan, Light and charging point in the TM cabin-all solar powered with power back-up upto 24 hrs.

3.6.10. Shall have provision of separate Bio-toilet with necessary amenities in the TM cabin.

3.6.11. Open Floor space with safety railings to be provided on Both End of TM cabin.

3.7. Bogie:

3.7.1. The bogie shall be of proven design and shall meet the dynamic performance characteristics requirements as per EN: 14363-2016, with limits mentioned in Annexure-G for both modern open wagons and modern brake van. Modern brake van shall also meet the Mean Comfort Index as per EN 12299 (in addition to EN: 14363-2016).

3.7.2. The structural design of the bogie frame and its components to conform to AAR, UIC or any other established standard for 25 t axle load for Modern Open Wagon and 6t axle load for Modern Brake Van.

3.7.3. Testing of the bogie frame shall be done in accordance with AAR, UIC or any other established standard.

3.7.4. Design of Suspension Elements (Metallic/ Non-metallic elements including rubber metal bonded items, Coil Springs, friction wedges etc.) to comply AAR, UIC or any other established standards.

3.7.5. All bogie parameter shall comply with the provisions of IRSOD-2022 with all ACS.

3.7.6. The bogie and its components should give satisfactory performance as per para 2.1 during service.

3.7.7. Any of the existing bogie design of Indian Railways shall not be used. Minor changes in suspension system, basic design parameters and components shall not be treated as new design. In this regard the decision of government shall be final and binding on the parties.

3.8. Wheel Disc, Axles, Wheel set & Roller Bearings

3.8.1. Axles to be designed in accordance with AAR/UIC or any other established standard.

3.8.2. Wheel disc to be designed in accordance with AAR/UIC or any other established standard.

3.8.3. Wheel sets to be in conformance with AAR/UIC or any other established standard.

3.8.4. Worn Wheel, wheel profile as per RDSO Drawing no. WD-88201 (attached as Annexure-J) shall be provided on all wheels.

3.8.5. Design validation of wheels and axles shall be required to be carried out to validate the design as per AAR/UIC or any other established standards.

3.8.6. Roller bearings to conform to AAR/UIC or any other established standard. Roller bearing selected shall be suitable for the axle loads prescribed in this specification. Roller bearing shall be grease lubricated & sealed.

3.9. Brake System

3.9.1. Twin pipe graduated release air brake system to be provided. Air brake system shall comprise of Brake Pipe & Feed Pipe / Main Air Reservoir Pipe (MARP) running through out all the wagons. On IR, Feed Pipe (FP) Pressure = 6.0 ±0.1Kg/cm^2 and Brake Pipe (BP) pressure=5.0 ±0.1Kg/cm^2.

3.9.2. Brake system shall conform to the requirement of UIC-540 "BRAKES- Air brakes for Freight Trains and Passenger Trains".

3.9.3. Necessary provision for automatic change over in brake rigging to suit working in empty and loaded condition of Modern Open Wagons to be made.

3.9.4. Adequate safety arrangements to prevent falling-off of brake equipment's/brake rigging on the track, in the event of failure of any component, shall be provided.

3.9.5. Emergency Braking Distance (EBD) of the freight train consisting of Modern Open Wagons and Brake Van:

a) Shall not be more than 750m on level track and 1000m falling gradient of 1:100, in both dry and wet conditions, in loaded condition at a speed of 75 Kmph.

b) Shall not be more than 750m on level track and 850mfalling gradient of 1:100, in both dry and wet conditions, at a speed of 100 Kmph in empty condition.

c) EBD Calculations to be done as per UIC 544-1.

d) EBD shall be calculated and measured considering 85% Brake power.

3.9.6. Parking Brake (Hand brake)- shall be designed to hold wagons on the gradient of 1 in 37 for unlimited time.

3.9.7. Design of the brake system and its interconnections shall be fail-safe. In the event of failure of any brake equipment, brakes shall be automatically applied.

3.10. Coupler and Draft Gear:

3.10.1. Coupler and Draft Gear shall be as per AAR/UIC or any other established standard.

3.10.2. The coupler shall be compatible with Existing IR freight stock having E/F type coupler.

3.10.3. The coupler should have anti-climbing feature.

3.10.4. The coupler should have positive locking arrangement to avoid incidental opening of coupler.

3.11. Painting and Marking:

3.11.1. PU/Equivalent or superior paint to be used, so as to protect the wagon from corrosion and other weathering effects.

3.11.2. Appropriate marking on the Wagons: Wagon Number (to be got allotted from Government), Wagon type (to be got allotted from Government), Owner Code (to be got allotted from Government), Carrying Capacity, tare weight, commodity loading marking, etc shall be provided.

3.11.3. Suitable pictograms explaining the working of interfacing components used in operation & important precautions to be provided at suitable locations.

3.11.4. Painting scheme and marking diagram shall be got approved from Government.

Chapter4: Evaluation of design

4.1. General:

4.1.1. The detailed design, simulations, manufacturing, testing, performance and other parameters of the proposed wagons offered by the Technology Partner shall be evaluated and certified by an CISA for compliance with standards/parameters used in the design.

4.2. Documents to be submitted along with the Concept Design:

Following drawings and details are required to be submitted by Technology Partner to Government, duly evaluated and certified by the CISA, along with the concept design.

4.2.1. Diagram drawing showing Front view, Top view and Side view of Modern Open Wagon and Modern Brake Van. The Side view shall be superimposed by MMD diagram no- 1D (EDO/T-2202). The diagram drawing shall also have all key dimension and parameters as mentioned in clause 2.1.1, 2.1.2 and Annexure-B1 & B2.

4.2.2. General Arrangement drawing detailing all major sub-assemblies and components.

4.2.3. Basic design parameters as per Annexure-B1 to B4.

4.2.4. Details of other features of the Modern Brake Van as mentioned in para 3.6

4.2.5. Details of Various Standards followed for design, manufacturing, inspection, testing, operation and maintenance of Modern Open Wagons& Brake Van, GPS& RFID with a copy of respective standard.

4.2.6. **Technical data:**

Technical data of both the wagons regarding weight distribution, curve negotiability, Kinematic Profile, throw over at head stock, etc. to be submitted as per the enclosed **Annexure 'C'**. Conditions for curve negotiability are given in **Annexure-'D'.** Condition for Kinematic Profile is given in **Annexure-'E'.**

4.2.7. Nominated Government representative(s) shall undertake a review of documents submitted by the Technology Partner and submit report to the parties within 4 (four) weeks from the date of receiving of such Designs and Drawings.

4.3. Documents to be submitted during Detail Design Stage

4.3.1. Detail design of the proposed wagons along with QAP duly evaluated and certified by the CISA shall be submitted by the successful Technology Partner (selected for the work) to the Government within 120 days of clearance approval of the concept design by the Government.

4.3.2. Nominated Government representative(s) shall undertake a review of the Detail Designs and submit a report to the Parties within 4 (four) weeks from the date of receiving of such Designs, drawings and other documents. It is further, agreed that any failure or omission of the Government to review and/ or comment hereunder shall not be construed or deemed as acceptance of any such design and drawings by the Government.

4.3.3. Pursuant to the design report or otherwise, the Technology Partner shall carryout such modification in the designs as may be necessary for conforming with the specifications and standards design of Wagons**:**

a. Design drawings of key elements which show the main principle of design accompanied by a short description & as far as necessary for understanding of the design.

b. Criteria for the selection of materials & methods for their evaluation. (If such materials are in use in other existing wagons, it should be mentioned.)

c. Details of various structural joints.

d. Conformance to the relevant standard mentioned in Chapter-3

e. Product structure plan, which shows how the key elements such as components, sub- assemblies & assemblies form the final product.

4.3.4. **Information about design methods and calculations:**

a. Computer programs used for design & calculation.

b. Details of computer program used for FEM analysis, boundary conditions, load conditions, etc. considered in the FEM analysis. Sample Load conditions are given in Annexure-'F'.

c. Results of FEM analysis for the wagon body for different load conditions for both the wagons.

d. Fatigue Analysis of wagon structure of both the wagons. Load environment data given in Chapter-VII of AAR, Section-C, Part-II to be used for fatigue analysis.

e. Precautions which should be taken for the complete cycle from loading to unloading to take care of the working conditions/problems in the proposed design of Modern Open Wagon.

4.3.5. **Design of Bogie, including its components e.g. wheel, axle, bearing, etc.**

a. Details and Diagram of bogies showing various components and their linkages.

b. Documents supporting conformance of the bogie and its various components to the relevant standards mentioned in Chapter-3

c. Details of computer program used for FEM analysis, boundary conditions, load conditions, standards, qualifying criteria etc. considered in the FEM analysis of Bogie frame and Bolster.

d. Results of FEM analysis of the Bogie frame and Bolster for different load conditions.

e. Details of running of same design of bogie in one of the Railway Systems and performance thereof.

f. Input data along with their basis and supported calculation for vehicle dynamic analysis shall be submitted by Technology partner.

4.3.6. **Vehicle Dynamic Simulation:**

a. 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.

b. All the parameters and values used in simulations shall be provided to enable Vehicle Modeling on NUCARS/ SIMPACK or any similar proven software including CG of wagons & bogie frame, mass moment of inertia (x,y,z), balancing of mass of the wagons and coefficient of damping both lateral and vertical directions etc.

c. 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 (for Brake Van), 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.

4.3.7. **Design of Brake system**

a. Air brake system overview, components and operation.

b. Brake schematic diagram.

c. Brake rigging diagram.

d. Brake power diagram.

e. Braking effort calculations.

f. EBD Calculation for both dry and wet conditions.

g. Parking Brake (Hand brake) arrangement and grade calculations.

h. Number, dimension and type of brake blocks.

i. Test Plan comprising of Test Matrix, Test Schedules and Test Procedures.

j. Documents supporting conformance to the relevant standards mentioned in Chapter-3

4.3.8. **Design of Coupler & Draft gear**

a. Details of Coupler and draft gear proposed.

b. Documents supporting conformance to the relevant standards mentioned in Chapter-3. Details of running of same design of coupler and draft gear in one of the Railway Systems and performance thereof.

4.3.9. **Painting & Marking**

a. Painting scheme & Marking diagram.

4.3.10. **Details of Loading and unloading systems**

a. Requirement of the loading/unloading systems in the wagon.

4.3.11. **Quality Assurance Plan (QAP):**

a. A detailed Quality Assurance Plan (QAP) for stage inspection and final inspection of prototype wagons shall be prepared by Technology Partner.

b. The QAP should include parameters to be checked, acceptance values, methodology to be used for checking, reference standards, frequency of inspection, etc.

c. QAP shall be got approved from CISA.

4.3.12. **Information about maintenance and examination of proposed Wagon Design:**

a. Proposed maintenance regime of the wagon and various standards proposed to be followed.

b. Details of various Maintenance Schedules, standards to be followed, activities to be carried out, dimensions to be checked, permissible limits of wear, etc. for yard examination and other major maintenance schedules.

c. Inspection procedure and periodicity of various inspection schedules in detail including the gauging practices to be followed for yard examination and other major maintenance schedules.

d. Maintenance procedures in detail.

e. Machinery and equipment required for maintenance.

f. Gauges, jigs & fixtures required for maintenance.

g. Space requirement for maintenance activity.

Chapter5: Test & Trials

5.1. General:

5.1.1. Prior to supply of two sample wagons that conform to the Specifications and Standards ("The prototype" wagons), 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 prototype comply in all respects with the specifications and Standards. The Technology Partner shall provide to the Nominated Government Representative(s) forthwith, a copy of the Technology Partner's report duly certified by CISA on each test containing the results of such test and the action, if any that it proposes to take for compliance with the Specifications and Standards.

5.1.2. The Technology partner shall, with at least 4 (four) weeks' notice to the Government, convey the date, schedule and detailed test plan that shall be conducted on the Prototype at the Manufacturing Unit and the Government shall have the right, but not the obligation, to nominate its representative to witness the tests. The Test Plan should indicate the tests to be conducted, procedure/method to be followed for tests, parameters to be measured, devices/instruments to be used, reference standards, frequency of inspection; and pass /fail criteria, etc. The test plan shall be got approved by CISA.

5.1.3. The Government's Representative shall make a report forthwith on the tests witnessed by it and provide a copy thereof to the Parties for review. The Technology Partner shall, prior to dispatch of the Prototype for delivery to the Government, procure that defects and deficiencies, if any, are rectified and the Prototype conforms to the Specifications and Standards.

5.1.4. In the event of failure of any Test specified in Clause 5.1.1, the Technology Partner shall rectify the defect and conduct repeat Tests, and the procedure specified in this Clause 5.1 shall apply mutatis mutandis to such repeat Tests.

5.2. Manufacturing and supply of two Prototype Wagons:

5.2.1. Manufacturing of two prototypes each of Modern Open Wagon and Modern Brake Van shall be undertaken by the Technology Partner.

5.2.2. First prototype of open wagon and that of brake van shall be supplied within a period of 12 months from the Appointed Date and 2nd prototype of open wagon and that of brake van within 60 (sixty) days of the date of delivery of the First prototype.

5.2.3. All the fabrication & the workmanship shall meet the requirements of standard(s) proposed to be followed by Technology Partner.

5.2.4. The surface preparation and painting shall be as per painting scheme developed by Technology Partner based on standard proposed to be used.

5.2.5. Stage and final Inspection of the modern open wagons and modern brake vans during manufacturing shall be conducted and certified by CISA, as per approved QAP.

5.2.6. Final prototypes of open wagons and brake vans shall be inspected by authorized representative(s) of government, for better appreciation and comments, if any, for the consideration of Technology Partner. During this inspection, a detailed presentation on the prototype of open wagons and brake vans shall also be given by Technology Partner. The Government's Representative(s) shall make a report forthwith on the inspection undertaken by it and provide a copy thereof to the Parties for review

5.2.7. Subsequently, Prototype shall be offered to Nominated Government Representative(s) for testing and trials on Railway network.

5.2.8. In the event that the Technology Partner fails to deliver the Prototype within the period specified in Clause 11.3.1, the Government may recover from the Technology Partner an amount equal to 0.5 % (zero point five per cent) of the wagon Price as Damages for each and every week, or part thereof, by which the delivery of the Prototype is delayed; provided that such Damages shall not exceed 10% (ten per cent) of the wagon Price.

5.3. Static testing of Prototype of Modern Open Wagon and Modern Brake Van:

5.3.1. Static Test Scheme for the wagon shall conform to the AAR, UIC or any other established standards. It should include:

5.3.2. Complete test schedule for wagon & components.

5.3.3. The test schedule should reflect material, components, sub-assemblies, assemblies & the finished product and will distinguish between:

a. Type acceptance tests, Production Tests & Quality Check Tests.

b. Test on first article or on further wagons with test sequence.

c. Location of test site i.e. Technology Partner's works, etc.

5.3.4. Tests description, procedures and documentation of tests.

5.3.5. Details of Test equipment's required.

5.3.6. Format of recording various test results.

5.4. Information for Static Testing:

For facilitating static testing, the Technology Partner shall provide:

5.4.1. Assembly drawings for sub-assemblies, assemblies and the final product. These will be accompanied by quality requirements, test and inspection requirements.

5.4.2. Information about quality Control which includes Quality Assurance Plan &Welding Procedure System/joints preparation details.

5.5. Tests for guidance:

5.5.1. Dimensional check, welding check and marking & painting as per check sheets prepared by Technology Partner and approved by CISA.

5.5.2. Static Load test in empty, loaded, over loaded (25% more), overloaded in 18 hrs at tangent and at 10 degree curve by putting simulated payload to examine the structural rigidity of the design as per AAR, UIC or any other AAR, UIC or any other established standards.

5.5.3. Squeeze load test conducted by applying compressive load and combination vertical and compressive end load on the wagon only as per AAR, UIC or any other established standards.

5.5.4. Shower test for modern Brake Van.

5.6. Bogie Test:

5.6.1. **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 or AAR, UIC or any other established standard as applicable. General conditions mentioned in EN 13749/UIC 515-4/UIC 615-4 or AAR, UIC or any other established standard 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 characters shall be made with the detailed explanation.

5.6.2. Bogie Rotational Resistance (X Factor) Test: The bogies rotational resistance (X factor) test under shall be carried out at the Technology Partner's works/ suitable location/laboratory under tare and loaded conditions as detailed in EN: 14363 or AAR/UIC or any other established standards. 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 $\Delta Q/Qo$ and the bogie rotational factor X.

5.6.3. **Bogie suspension Elements:**

a) Coil spring: Type testing as per EN: 13298, AAR/UIC or any other established standardsalong with endurance testing.

b) Rubber suspension/guiding elements including rubber metal bounded items: The rubber suspension/guiding including rubber metal bounded items/ components shall comply and type tested as per requirements of EN: 13913, AAR/UIC or any other established standards.

5.6.4. **Wheel, Axle & Bearings:**

Type testing as per AAR/UIC or any other established standards mentioned for wheel, axle and bearing in this specification for Indian Railway Track conditions.

5.7. Dynamic testing (oscillation trials)

5.7.1. For determining that each Prototype conforms to Specifications and Standards, the Government shall, within 120 (one hundred and twenty) days of the delivery of the Prototype, conduct, or cause to be conducted, on the Government's railway lines, the Tests specified in this specification.

5.7.2. In the event of failure of any Test specified in Clause 5.7.1, the Technology Partner shall rectify the defect and present the Prototype for repeat Tests, and the procedure specified in this Clause 5.7 shall apply mutatis mutandis to such Tests.

5.7.3. Based on satisfactory simulation results, the Prototype wagons shall be subjected to trials and evaluation. Dynamic testing shall be carried out on second prototype of modern open wagon and modern brake van duly complying with the EN: 14363-2016 and in addition, for modern brake van as per EN: 12299 for measuring mean comfort index.

5.7.4. 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.

5.7.5. Indian Railway Track Geometric Quality parameters are given at **Annexure-H.**

5.7.6. The acceptance limits are given in **Annexure-G**.

5.7.7. Modern Brake Van 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 4.0. 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 EN:14363:2016) shall be decided based on IR track conditions as per EN:14363:2016 methodology.

5.7.8. For clarity, it is reiterated that EN: 14363 are 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 are mentioned in this document, it shall be read in this context.

5.7.9. Government shall keep the Technology Partner apprised, on the planned dates for undertaking dynamic testing of prototype modern open wagon and modern brake van.

5.7.10. The Parties agree that the Tests pursuant to Clauses 5.7.1 and 5.7.2, as the case may be, shall be conducted at the cost and expense of the Government. However, instrumented measuring wheelsets or any other specialized equipment shall be supplied by the technology partner at its cost.

5.7.11. In the event the Technology Partner is not satisfied with the Tests conducted by the Government, it may cause such Tests to be carried out by an independent agency and submit the results thereof to the Government. The Parties expressly agree that if the Government does not accept the results of such independent agency, the Dispute Resolution Procedure shall apply. However cost of such tests shall be borne by technology partner.

5.7.12. The Parties expressly agree that either Party shall notify the other Party of the date, time and place of Tests so as to afford sufficient opportunity to the other Party to witness the Tests.

5.7.13. The Parties expressly agree that conducting of Tests by the Government shall not relieve or absolve the Technology Partner of its obligations and liabilities under this Agreement in any manner whatsoever.

5.8. Brake test:

5.8.1. Brake shall be tested to meet the requirements as per UIC-547.

5.9. Acceptance of Prototype

5.9.1. The Government shall, no later than 30 (thirty) days after successful completion of the Tests, communicate its acceptance of the Prototype to the Technology Partner.

5.9.2. Prior to accepting the delivery of Prototype, the Government may inspect the Prototype in accordance with the provisions of Clause 5.2.

5.9.3. The Parties expressly agree that acceptance of the prototype by the Government shall not relieve or absolve the Technology Partner of its obligations and liabilities under this Agreement in any manner whatsoever.

5.10. Field Service testing and trial of 2 rakes:

5.10.1. After issue of acceptance by the Government, Technology Partner can start manufacturing of offered designs of open wagons and brake vans. Inspection of these wagons shall be undertaken by CISA as per relevant specifications given in this specification and standard/parameters proposed by the Technology Partner. An inspection certificate shall also be issued by CISA, after successful completion of inspection. Government may, at its discretion, nominate its representative to carry out an inspection, both stage and final, of the manufactured wagons.

5.10.2. Field service trials for two rakes of open wagons along with brake vans, till it earns 50,000 Km, shall be done to assess the efficacy of the design.In service and final inspection of these two rakes shall be undertaken by CISA as per relevant specifications and standard/parameters proposed by the Technology partner. An Inspection certificate shall also be issued by CISA, after successful completion of final inspection. Government may, at its discretion, nominate its representative to carry out an inspection, both in-service and final, of these two trial rakes..

5.10.3. Technology Partner shall prepare detailed check-sheet covering all the main parameters and the acceptance criteria for the key parts/components. The check-sheet should be approved by CISA before commencement of the field trials

5.10.4. Performance of following key components shall be mandatorily assessed in the field trial:

S.N.	Name of part
1)	Bogie complete (including side bearer, suspension, EM pads, bolster and side frame castings and C.P. TOP)
2)	Wheel set including Bearing
3)	Brake system (Brake cylinder, DV, Reservoir, empty load devices, Brake shoe etc.)
4)	Brake rigging (Brake leverage, empty load device, slack adjuster, control rod, pull rod etc.)
5)	Hand brake
6)	Coupler

S.N.	Name of part
7)	Draft gear
8)	Lashing and securing arrangements
9)	Doors
10)	Under-frame members
11)	Body/super structure
12)	Welding/fastening
13)	General conditions i.e. abnormal wear, corrosion, sagging, abrasion, crack, breakages
14)	GPS
15)	RFID

5.10.5. Any improvement in the design/manufacturing which may be required, after the field service trials, shall be undertaken by the Technology Partner, in all the wagons, both in-service, under manufacturing and to be manufactured.

5.11. Special trials:

5.11.1. Special trials like Emergency braking distance/Coupler force/controllability, as mentioned in specifications given in this specification, shall be undertaken on one rake by CISA. All necessary facilities for these special trials shall be made available by Technology Partner to CISA, at its own cost. However, oscillograph car shall be provided by IR, free of cost. The other modalities of such trials shall be jointly worked out by the Technology Partner and the Government.

5.11.2. Charges for hauling the test train on railway track in India during special trials and movement of test train to nominated test site shall be borne by IR.

5.11.3. Government will issue necessary authorization for such special trials, including obtaining sanction of concerned Zonal Railway(s). Government may, at its discretion, nominate its representative to witness the special trials.

5.11.4. Results of such special trials, duly certified by CISA, shall be submitted to the Government for review and issue of directions, if any, which will be promptly complied with by the Technology Partner.

5.11.5. EBD trials shall be conducted on level track and 1 in 100 down gradient at speed of 60Kmph and 75Kmph in loaded condition and 90 and 100Kmph in empty condition. A series of 3 trials shall be conducted in each condition to establish the consistency of braking distances and its variation with theoretical calculations. Variation beyond ±15% would need to be explained provided the conditions of clause 3.9.5 are met. The brake force shall be measured through load sensors before the start of trials in stationary condition.

5.11.6. Acceptance criteria for EBD shall be at 75 Kmph in loaded and 100 Kmph in empty, against the values specified (with given tolerance) in this specification. However, EBD shall also be conducted at 60 Kmph in loaded and 90 Kmph in empty for assessing the braking behavior. Reference EBD values at these speeds (60 Kmph in loaded and 90 Kmph in empty) shall be specified by the Technology Partner.

5.12. Intellectual Property Rights:-

5.12.1. All the design drawings, documents related with wagon design, manufacturing, testing, quality assurance, etc. arising out of this project, shall be the exclusive property of IR.

5.12.2. IR shall have the exclusive transferable right to manufacture/get manufactured, from third party(ies), wagons arising out of this project for use in India, Asia and Africa . This includes the right to use all drawings, specifications, and technical information etc necessary for the purchase of the relevant components from suppliers of these components.

5.12.3. For manufacture/get manufactured wagons arising out this project for use in other parts of the world (other than those mentioned in clause 5.12.2 above), can be done by IR and/or Contractor on mutually agreed terms.

5.12.4. IR shall have the right to make/get manufactured dies, jigs and fixtures, core, mould, pattern etc., in accordance with the wagon design developed.

5.12.5. IR shall also have the right to incorporate any technological improvements in these wagons.

5.12.6. IR shall have the right to operate and maintain the wagons.

Annexure-A: Indian Railway Schedule of Dimensions

IRSOD means Indian Railways Schedule of Dimensions 1676mm Gauge (BG) Revised, 2022with all Advance Correction Slips.

Copy of the IRSOD and Advance Correction Slips are available at Railway Board website. These may also be collected from RDSO.

Annexure-B: Basic Design Parameters

B1- Modern Open Wagon

	PARAMETER	DETAILS
1.	**General**	
1.1.	Axle Load (in tonnes)	
1.2.	TLD (in tonnes/meter)	
1.3.	Tare weight of complete wagon (in tonnes)	
1.4.	Payload of a wagon (in tonnes)	
1.5.	Payload to Tare Weight ratio	
1.6.	Numbers of wagon in 636 meter length	
1.7.	Payload of rake in 636 meter length (in tonnes)	
1.8.	Height of C.G. in loaded condition for lightest commodity proposed to be loaded (in millimeters)	
1.9.	Height of C.G. in empty condition (in millimeters)	
2.	**Overall Dimensions (in millimeters)**	
2.1.	Length over coupler faces	
2.2.	Inside Length	
2.3.	Length between bogie centers	
2.4.	Length over head stock	
2.5.	Coupler height over level Track from rail level	
2.6.	Overall width	
2.7.	Inside width	
2.8.	Overall height	
2.9.	Floor height from rail level	
2.10.	Inside height	
2.11.	Wheel Diameter	
2.12.	Wheel Base	
2.13.	Volumetric Capacity (in cubic meter)	
2.14.	Volumetric Capacity of heap Loading(in cubic meter)	
2.15.	Total Volumetric Capacity (in cubic meter)	

B2: Modern Brake Van

	PARAMETER	DETAILS
1.	**General**	
1.1.	Axle Load (in tonnes)	
1.2.	TLD (in tonnes/meter)	
1.3.	Weight (in tonnes)	
2.	**Overall Dimensions (in millimeters)**	
2.1.	Length over coupler faces	
2.2.	Inside Length	
2.3.	Length between bogie centers	
2.4.	Length over head stock	
2.5.	Coupler height over level Track from rail level	
2.6.	Overall width	
2.7.	Inside width	
2.8.	Overall height	
2.9.	Floor height from rail level	
2.10.	Inside height	
2.11.	Wheel Base	
2.12.	Wheel diameter	

B3- GPS

	PARAMETER	**DETAILS**
1.	Weight (in grams)	
1.1.	System of Powering	
1.2.	**System of determining location**	

B4- RFID

	PARAMETER	**DETAILS**
1.	Weight (in grams)	

Annexure-C: Technical Data

Following technical data of proposed wagon design shall be submitted:-

a. Weight calculation.

b. Calculation of unsprung mass.

c. Vogel's layout for 10 degree curve and for 1 in 8.5 turnout for bogie negotiability.

d. Kinematic Profile of the wagon.

e. Throw-over at head-stock/wagon and coupler movements together with details of clearance.

f. Estimation of flange forces on curves and turnouts.

g. Projected dynamic augment with the unsprung masses as used with the IR track.

h. Stability calculation.

i. Fatigue life and its criteria.

j. FEM load cases and boundary conditions.

Annexure-D: Curve Negotiability

1. Curve negotiability shall be verified in following conditions:

    (i) On curves having a radius of 175m
    (ii) 8:1/2 turnout

2. Lateral clearances/tolerances as per Indian Railway track to be used.
   The maximum Gauge clearance and alignment error to be taken as 35 mm for IR track.

3. Lateral clearance of Rolling stock shall be as per proposed design of Rolling stock.

4. Following documents may be referred for calculating curve negotiability:
    (i) AAR-M-1001
    (ii) UIC-505

5. Technology Partner may also select some other equivalent standard for calculating the curve negotiability.

Annexure-E: Kinematic Profile

1. The Kinematic Profile of proposed wagons shall be developed for Indian Railways infrastructure condition as per IRSOD in following conditions:

    a) Tangent Track
    b) Curve Track (175m radius)

2. Following may be considered for developing the Kinematic Profile.

    (i) Lateral movement of wagon due to various clearances between wagon parts: As per wagon design

    (ii) Tilting of wagon due to suspension deflection: As per suspension design considering one side suspension in Home condition.

    (iii) Track effects:

    a) Lateral track movement - (Gauge clearance) : 15 mm
    b) Track cross level variation: 55 mm
    c) Track alignment error: 20 mm
    d) Horizontal curvature effects:
    e) End throw:
    f) Middle throw; and
    g) Any other effect of track influencing kinematic profile.

3. Following documents may be referred for developing the Kinematic Profile:
    (i) AAR-M-1001
    (ii) UIC-505

4. Technology Partner may also select some other international standard for calculating the curve negotiability.

Annexure-F: Load cases and Boundary Conditions for FEM

Load Cases	Description	Value	Acceptable Criteria
Load Case – 1	Buff load (Horizontal compressive force at Back stop location on both ends of wagon)+ Gravity load	Buff load= 'x' t Gravity =weight of the structure	Shall be decided by CISA
Load Case – 2	Buff load + Gravity load + Pay load	Pay load= 'y' t	
Load Case – 3	Buff load + Gravity load + Pay load (with dynamic augment of 40%) + lateral force (horizontal force due to payload with 40% dynamic augment) on side wall and end wall.	Buff load= 'x' t Pay load= 'y'*1.4 Lateral force= 'z' t (on each side wall) Lateral force on end wall	
Load Case – 4	Draft load (Horizontal tensile force at striker casting location on both ends of wagon) + Gravity load	Draft load= 'x/2' t Gravity =weight of the structure	
Load Case – 5	Draft load + Gravity load + Pay load (vertical uniform loading on floor area)	Pay load= 'y' t	
Load Case – 6	Draft load Gravity load + Pay load (with dynamic augment of 40%) + lateral force (horizontal force due to payload with 40% dynamic augment) on side wall and end wall	Draft load= 'x/2' t Pay load= 'y'*1.4 Lateral force= 'z' t (on each side wall) Lateral force on end wall	
Load Case – 7	Compressive load on side walls due to tippler	Side wall load =Due to tippler	
Load Case – 8	Coupler Jacking load		

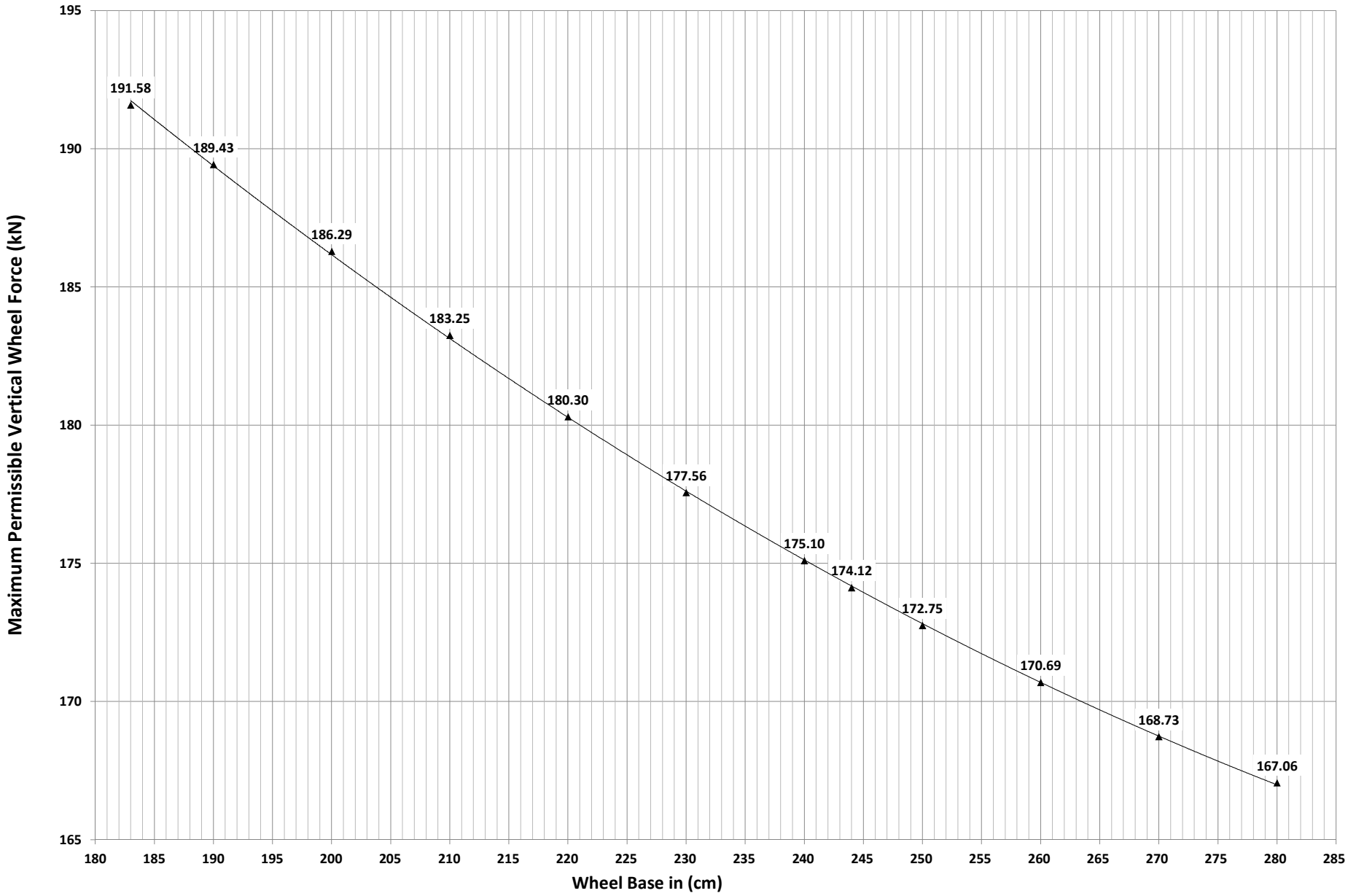
Note:

1. Presently IR is taking value of 'x' as 250t for 22.9t axle load wagons.
2. Technology Partner or CISA may also select some other international standard/ criteria for FEA analysis.

Annexure-G: Desired Dynamic Performance Characteristics:

S.No.	Assessment Magnitude	Limits			Remarks
1	Sum of guiding lateral forces (ƹymax)	0.85(10+P_{FO}/3)KN P_{F0} – Axle load in KN			Safety parameters
2	De-railment Coefficient {(Y/Q)max}	0.8			
3		1.2 (In Transition)			
4	Moving rms of guiding forces (ƹyrms)	[0.85(10+P_{FO}/3)]/2 KN			Safety & Stability parameters
5	Quasi-static guiding force (Yqst)	66kN			Track Loading parameters
6	Quasi-static vertical wheel force (Qqst)	145kN P_{FO}<=225kN			
		155 kN 225 kN<P_{FO}<=250 kN			
7	Maximum vertical wheel force (Qmax)	Wheel base & Bogie centre	Proposed maximum Vertical Wheel force for IR	Typical Rolling Stock example	Limit of vertical wheel force for different rolling stock varies with varying wheel base & bogie centre. Graphs indicating Max. Vertical Wheel Force & wheel base for Bogie centre distance (652.4cms, 900cms& 100 cms) for 60 kg 90 UTS rail are enclosed as annexure A, B, C for general guidance. For bogie center between 1100 cm to 1490 cm, graph of bogie centre of 1100 cm has to be referred. Similarly for Bogie Centre between 900 cm to 1100 cm, graph of Bogie centre of 900 cm has to be referred. These graph 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 EN-14363:2016 provisions in this regard. These limits are based on 60 kg 90 UTS rail. For R260 and higher grade rails, EN limits shall be applicable.
		Wheel Base-185cm, Bogie Centre-1200cm	191 kN	WAG 9 H	
		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	Trainset	
		Wheel Base-280cm, Bogie Centre-1020cm	167 kN	WAP 5	
8	Mean Ride Comfort Index as per EN:12299	<3.5			For modern Brake Van

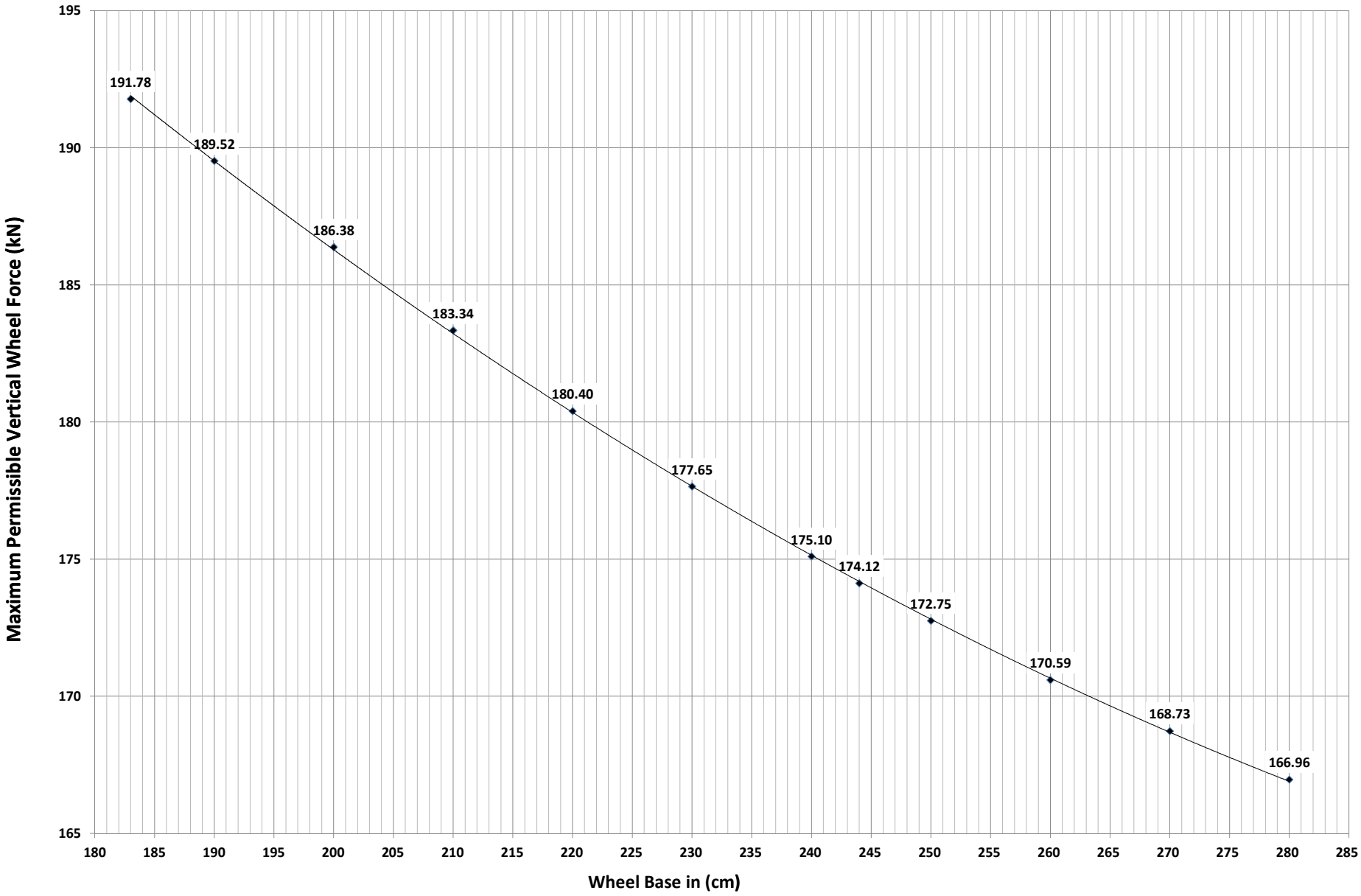
Maximum Permissible Vertical Wheel Force (Bogie Centre - 652.4 cm)



Note:

- Curve starts at wheel base of 183cm for bogie centre distance of 652.4 cm.
- Interpolated values should be taken as approximate only. Exact calculation to be done to find intermediate values and for other bogie centre .
- These values of permissible vertical wheel force are applicable for 60kg 90UTS rail subjected to residual rail stress value of 24.5 kg/mm^2 and thermal stress value of 10.03 kg/ mm^2.

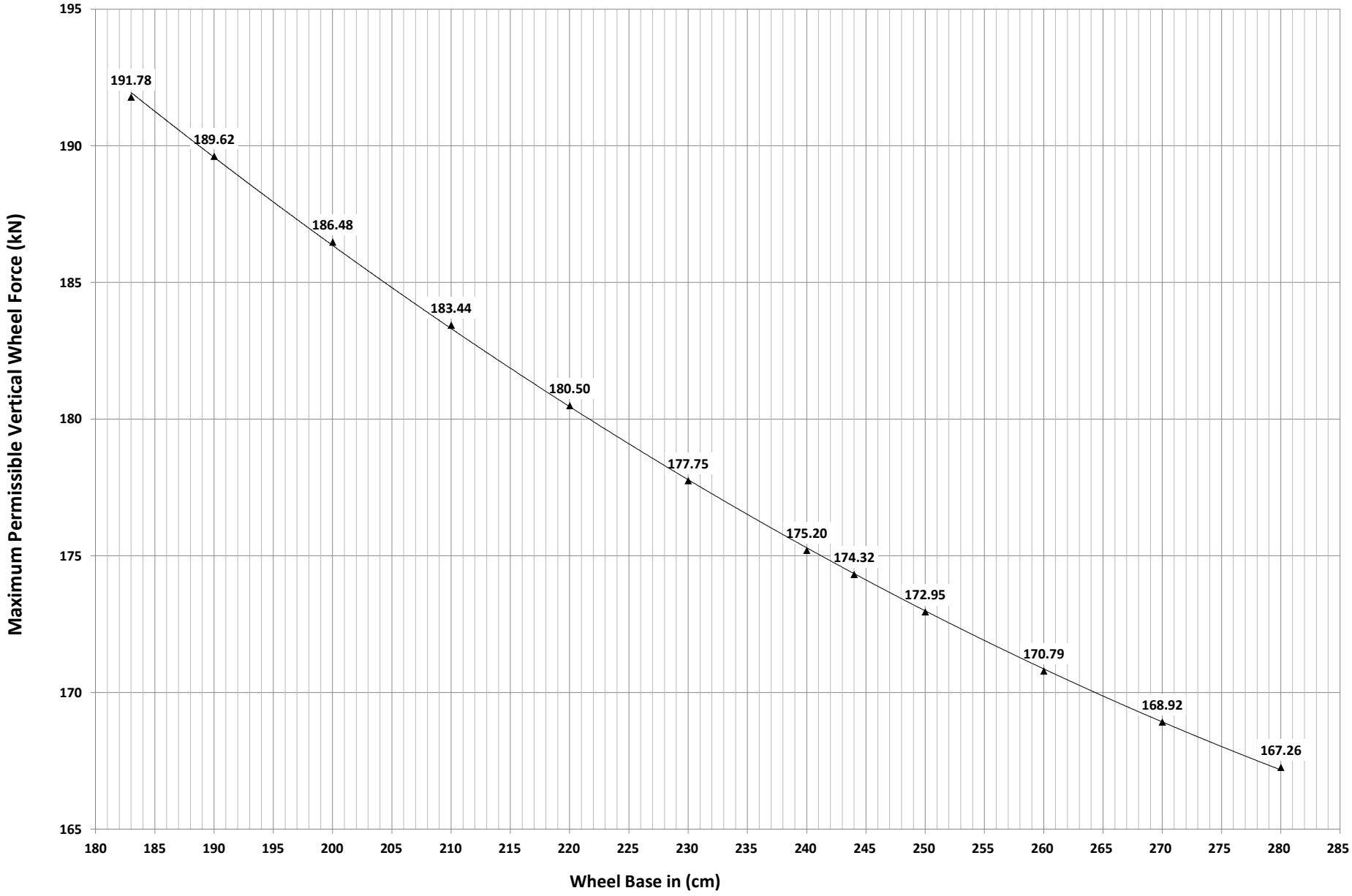
Maximum Permissible Vertical Wheel Force (Bogie Centre - 900 cm)



Note:

- Curve starts at wheel base of 183cm for bogie centre distance of 900cm.
- Interpolated values should be taken as approximate only. Exact calculation to be done to find intermediate values and for other bogie centre .
- These values of permissible vertical wheel force are applicable for 60kg 90UTS rail subjected to residual rail stress value of 24.5 kg/mm^2 and thermal stress value of 10.03 kg/ mm^2.

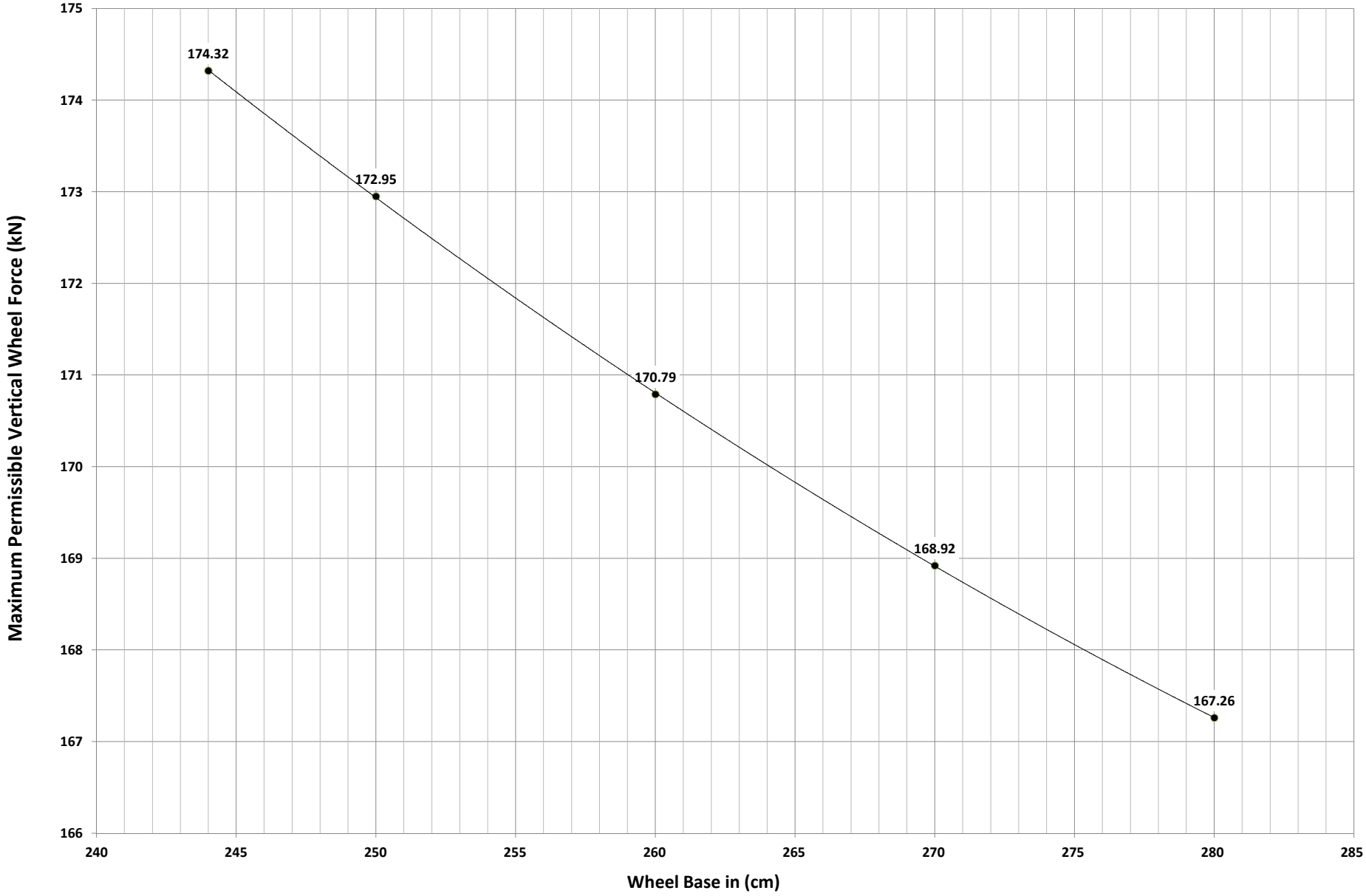
Maximum Permissible Vertical Wheel Force (Bogie Centre - 1100 cm)



Note:

- Curve starts at wheel base of 183cm for bogie centre distance of 1100 cm.
- Interpolated values should be taken as approximate only. Exact calculation to be done to find intermediate values and for other bogie centre .
- These values of permissible vertical wheel force are applicable for 60kg 90UTS rail subjected to residual rail stress value of 24.5 kg/mm^2 and thermal stress value of 10.03 kg/ mm^2.

Maximum Permissible Vertical Wheel Force (Bogie Centre - 1490 cm)



Note:

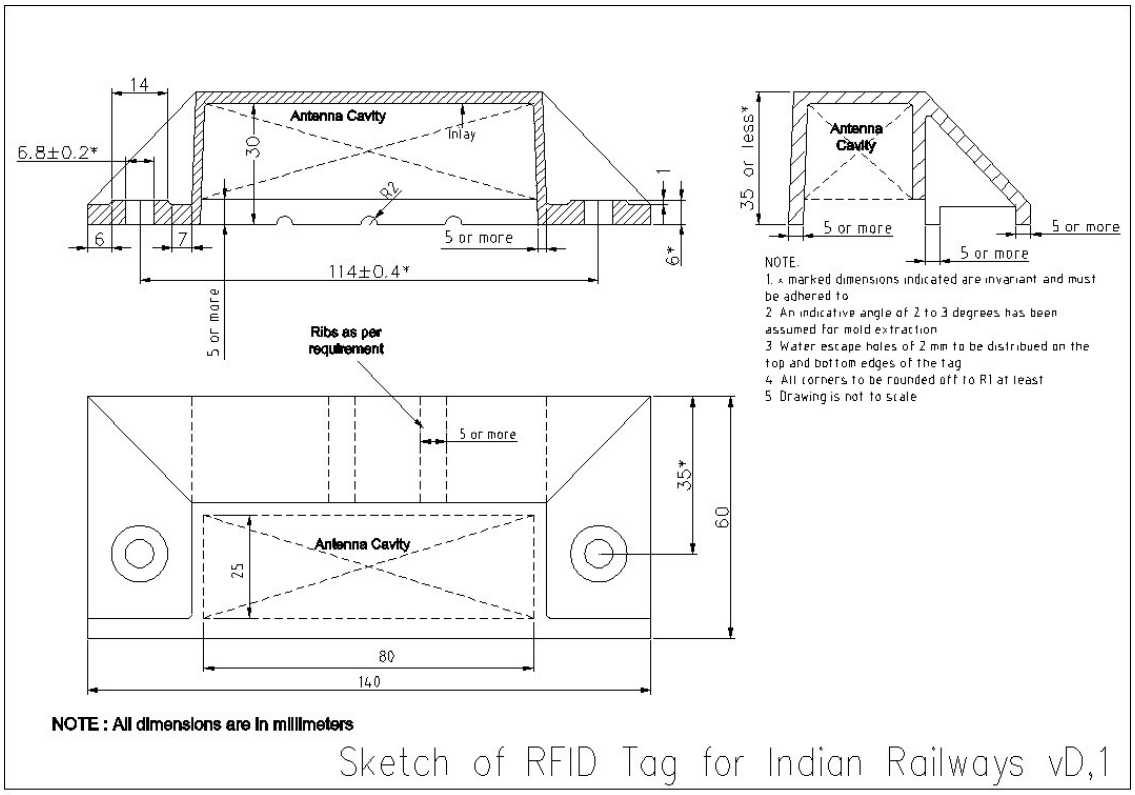
- Curve starts at wheel base of 244cm for bogie centre distance of 1490 cm.
- Interpolated values should be taken as approximate only. Exact calculation to be done to find intermediate values and for other bogie centre .
- These values of permissible vertical wheel force are applicable for 60kg 90UTS rail subjected to residual rail stress value of 24.5 kg/mm^2 and thermal stress value of 10.03 kg/ mm^2.

Annexure-H: IR Track Geometric Quality parameters

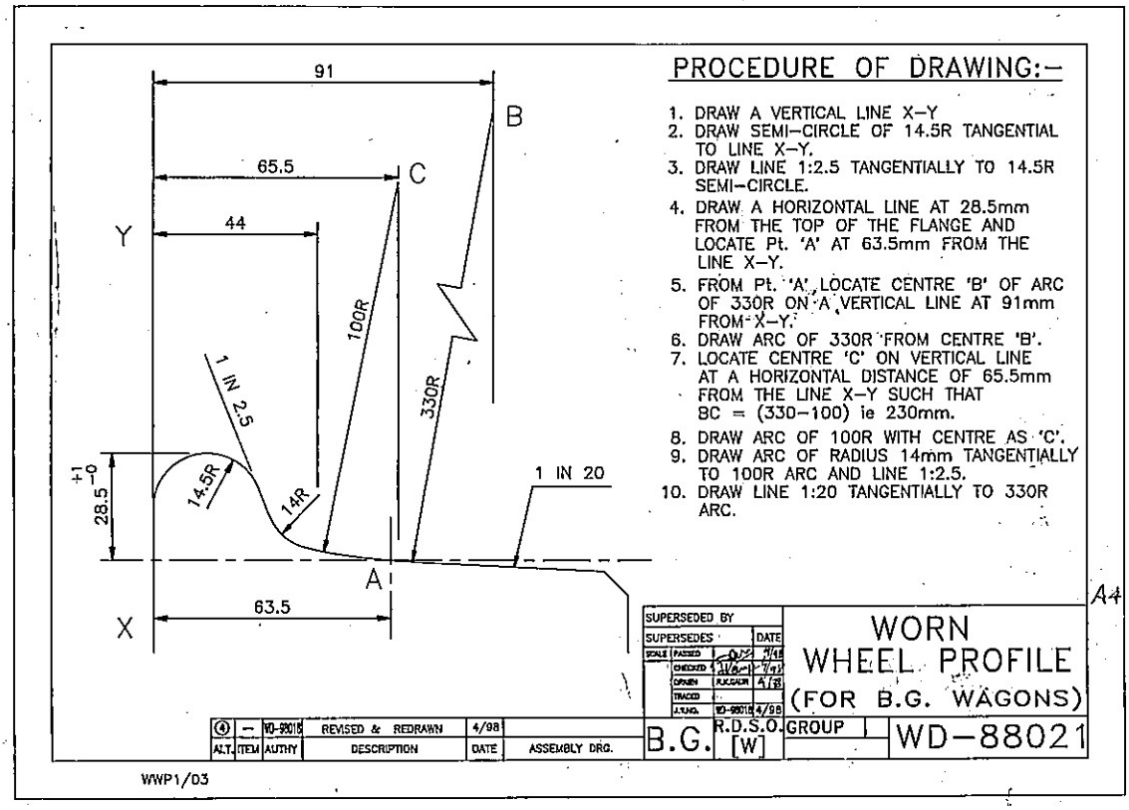
Speed Band	Speed (KMPH)	UNEVENNESS				ALIGNMENT			
		TL90	TL70	TL50	QN3	TL90	TL70	TL50	QN3
SB-I	>130	2.45	1.65	1.30	12.14	1.89	1.23	0.99	8.81
SB-II	>110 &<=130	2.83	2.00	1.57	13.08	2.10	1.43	1.15	8.99
SB-III	>100 &<=110	3.73	2.45	1.90	16.59	2.52	1.63	1.29	10.64
SB-IV	<=100	3.74	2.53	1.97	18.26	2.65	1.72	1.36	12.18

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.

Annexure-I: Indicative Schematic drawing



Annexure-J: Worn WheelProfile

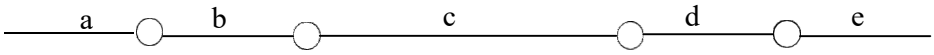


Annexure-1: Stipulation of Boundary Conditions of Bridge

1. The bridges on IR have been designed for BGML (1926), RBG (1975), MBG (1987), CC+8+2 (not a Standard loading), HM Loading (2000), 25t (2008). Bridges older than 1926 have been designed for maximum axle load less than that in BGML. Thus loads on bridges have been increased on five occasions in about 100 years. Further, there is a demand for interoperability of rolling stocks designed for DFC on IR network also. This may call for even higher loading (32.5t) at subsequent stages.
2. Broadly loads considered in bridge design are Dead load, Live loads, Seismic loads, windloads, etc. Dead load is weight of the bridge. Seismic loads and Wind loads are broadly guided by BIS Codes. Live load is train load. Thus, Loads and Rolling Stock parameters of concern are-
   a) Seismic Loads - Provisions of BIS Codes and IRS Codes are followed.
   b) Wind Loads - Provisions of BIS Codes are followed.
   c) Train loads - Axle loads, spacing of axles, Tractive and Braking forces, Trailing Load Density, Impact loads.
   d) Rolling Stock Parameters - Height of center of gravity of wagons, suspension characteristics, CDA, etc.
3. IRS Bridge Rules specify the loads for design of super-structure and sub-structure of bridges and for assessment of the strength of existing bridges. IRS Bridge Rule specifies Equivalent uniformly distributed load (EUDL), Coefficient of Dynamic augments(CDA) values and longitudinal forces for Broad Gauge Standard Loadings (BGML)-1926, Revised Broad gauge loading (RBG)-1976,Modified Broad gauge loading (MBG)-1987 and 25t-2008 loading. The loads specified therein shall be taken into consideration in calculating the strength of all bridges. For checking the adequacy of Existing Bridges for higher Bridge Loading Standards/higher axle loads, the Bending Moments and shear Forces shall be calculated on the basis of EUDLs specified for different Loading Standards. In case it is found inadequate, calculation shall be done on the basis of actual train axle loads with the help of software "Moving Load" issued by RDSO. Para 2.5.3(b) of IRS bridge rule specifies the CG height should be upto 1830 mm for BG stocks.
4. Para 28 of The Railway opening for Public carriage of passenger rule, 2000 specifies that "No new type of engine or rolling stock which would cause stresses exceeding those specified in the IRS Bridge Rules, 1964, or the Standard Codes of Practice, or in the absence of any such reference, the design criteria approved by the Central Government for existing structures or excessive stresses in track shall be ordered until the sanction of the Central Government has been received through the Commissioner for doing so."
5. To avoid unsuitability of bridges during its lifespan, broad parameters of Rolling stock design must be kept within limits of Maximum axle load, trailing load density, axle spacing, height of center of gravity of rolling stocks, tractive & braking forces, and limits of impact loads.

For optimal utilization of existing RDSO standard span Bridge infrastructure over IR BG network for standard loading following boundary parameters may be used in design of wagons:-

Wagon Axle configuration:



Where:-

a: Distance between one end CBC to centre of first wheel

b: Spacing between center of first wheel to center of second wheel

c: Distance between center of second wheel to center of third wheel

d: Spacing between center of third wheel to center of fourth wheel

e: Distance between center of last wheel (fourth wheel) to other end CBC

The boundary parameters for Wagon design are defined by considering most restrictive existing Motive Power unit (double headed WDG6G) with limiting maximum tractive effort by30.5t.Any future restrictive locomotive (increase in axle load and/or change in axle configuration on lower side) may call for speed restriction or prohibition on bridges. Maximum Braking force at Rail level should not exceed 10% of axle load of Wagon.

Values of a,b,c,d& e for different speed and axle load should be as below:

(i) 25t axle load wagon for 60kmph operation.

CG height	**a**	**b**	**c**	**d**	**e**	**Total length**
Upto1830mm	≥1.5m	≥2m	≥5.10m	≥2m	≥1.5m	≥12.10m
1830-2000mm	≥1.5m	≥2m	≥5.25m	≥2m	≥1.5m	≥12.25m
2000-2100mm	≥1.5m	≥2m	≥5.35m	≥2m	≥1.5m	≥12.35m

Note: Any deviation in above parameters in design of wagon may call for speed restriction or prohibition on bridges.

(ii) 25t axle load wagon for75kmph operation.

CG height	**a**	**b**	**c**	**d**	**e**	**Total length**
Upto1830mm	≥1.5m	≥2m	≥5.47m	≥2m	≥1.5m	≥12.47m
1830-2000mm	≥1.5m	≥2m	≥5.65m	≥2m	≥1.5m	≥12.65m
2000-2100mm	≥1.5m	≥2m	≥5.8m	≥2m	≥1.5m	≥12.80m

Note: Any deviation in above parameters in design of wagon may call for speed restriction or prohibition on bridges.

Annexure-2: Stipulation of Boundary Conditions of Signaling

1. Provisions of GR, SR, IRSOD, SEM & all extant instructions issued from time to time as applicable shall be complied with.
2. While running through a station yard, speed of the Rolling stock shall be restricted to the maximum permissible speed as per standard of interlocking provided at the station or any other speed restriction whichever is severe.
3. In case of wagons having EBD of more than 1 Km and provision of second distant signal in absolute block working territory/4 Aspect signalling in automatic block working territory (as laid down in para 7.1.13 (b) & 7.1.15 of IRSEM) is not available then a suitable speed restriction shall be imposed to bring EBD within 1 kms.
4. In case electromagnetic compatibility (EMI/EMC) test with S&T equipment is required due to design of wagon, then same may be ensured before introduction of normal running of the said rolling stock.

Annexure-3: Stipulation of Boundary Conditions of OHE

For Boundary condition of OHE for operation of Wagons, following Paras of IRSOD (BG)-Revised,2022should be referred:

1. Chapter V-A Electric Traction 25KV AC, 50 Cycles of Schedule-I regarding Electrical Clearances, Minimum height of Contact wire, Stagger of contact wire, Maximum Pantograph width.
2. Chapter V-B Electric Traction 25KV AC, 50 Cycles with High Rise OHE of Schedule-I regarding Minimum height of Contact wire, Minimum Height of Overhead Structure, Clearances for power line crossings & Maximum Pantograph width.
3. Appendix for Extra clearances on curves & Appendix A to Chapter V-A for Clearances required for 25 KV single pace A.C. Electric Traction.
4. Para 7 & 8 of Schedule-I, Chapter I regarding Minimum Horizontal distance from center of Track to any structure.
5. Para 10 of Schedule-I, Chapter I regarding Height of Road over Bridge and Foot Over Bridge.
6. Para 11 of Schedule-I, Chapter I regarding Clearances for Power line crossing including telephone line crossing of Railway Tracks.