TECHNICAL SPECIFICATION
FOR DEVELOPMENT OF HIGH SPEED BOGIE COMPATIBLE WITH
PASSENGER HHP (WDP4D) LOCOMOTIVES

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TECHNICAL SPECIFICATION FOR DEVELOPMENT OF HIGH SPEED BOGIE COMPATIBLE WITH PASSENGER HHP (WDP4D) LOCOMOTIVES

1.0 Foreword

RDSO is in the process of developing a high speed bogie (truck) for Broad Gauge Passenger HHP locomotive, which shall be able to serve up to an operating speed of 200 kmph. The bogie required to be equipped with:

i. Fully suspended traction motors

ii. A suitable drive gear system (gear box, all gears, coupling) either fully suspended or semi suspended.

iii. Disc brake

iv. Suitable Suspension system (springs & dampers)

v. Fabricated bogie frame

vi. Maintenance friendly equipments and systems

2.0 Scope

This specification describes the requirements for design, development, manufacture, supply, testing and commissioning of the bogie assembly (truck) which shall be able to serve a test speed up to 220 kmph and operating speed up to 200 Km/h.

Initially, 04 bogies will be procured and to be fitted under existing superstructure arrangement of WPD4D locomotive. After successful completion of oscillation trial and field performance on prototype locomotive, series implementation to be considered.

3.0 Salient features of Bogie (Truck)

The bogie design shall have following features:

i) Bogie offered by the firm shall be suitable to fit under WDP4D locomotives. The bogie shall be able to support approximately 79.5 t load of superstructure. The bogie presently used in WDP4D locomotive shown in Annexure –I and Maximum Moving Dimensions (MMD) is attached in Annexure –II.

ii) The bogie shall be of a proven design with fabricated bogie frame with a minimum service life of 25 years. The bogie assembly shall be designed for an axle load of 20.5 t.

iii) Measuring wheel or any other Internationally accepted means will required to be provided by supplier for lateral force measurement during oscillation trial of the prototype locomotive.

iv) The mechanical strength of the bogie frame shall comply with the requirements of UIC 615-4, UIC 515-4 for static test under exceptional loads and fatigue tests. The maximum stress developed under static load shall not exceed 85% of the yield strength of the material. The dynamic effects due to the inertia of the motors and transmission shall also be simulated along with traction and braking forces.

v) The bogie shall be attached to the locomotive car body in such a way as to permit lifting of car body and bogies as complete unit.

vi) The bogie shall be fitted with disc brake with parking brake facility. The EBD of locomotive shall be less than 1 km.

vii) Wheel and axle shall be provided by IR. However, supplier will suggest suitable wheel profile for high speed operation.

viii) The bogie shall be equipped with fully suspended Traction motor as specified in para 6.0.
The bogie shall be capable to operate without major scheduled maintenance for not less than 1,500,000 kms.

Equipments mounted on the Bogie frame as well as on Axle shall capable to withstand the following exceptional accelerations:

Bogie frame mounted equipments:
- a) Vertically - 5g
- b) Transversely - 5g
- c) Longitudinally - 5g

Axle mounted equipments:
- a) Vertically - 20g
- b) Transversely - 7g
- c) Longitudinally - 4g

4.0 Operating environmental conditions of locomotive

Atmospheric condition during hot weather is extremely dusty and desert terrain in certain areas. The bogie shall be designed to work in coastal area in humidity, salt laden and corrosive atmosphere.

Other environmental conditions shall be:
- Maximum temperature
  - Stabled Locomotive under sun: 70°C
  - On board Working loco under sun: 55°C
- Minimum temperature: -4°C
- Humidity: Up to 100% during rainy season.
- Altitude: Up to 1750 m above mean sea level.
- Rainfall: Very heavy in certain areas. The bogie shall be designed to permit locomotive running at 10 km/h in a flood water level of 102 mm above rail level.

5.0 Track Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Requirements</th>
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<tbody>
<tr>
<td>Gauge</td>
<td>Broad Gauge (BG) 1676 mm (nominal).</td>
</tr>
<tr>
<td>Track Structure</td>
<td>The track is to a standard of: 60 kg, 90 UTS rails on pre-stressed concrete sleepers, 1660 per km sleeper density, 300 mm depth of ballast cushion below the sleepers. Or 52 kg, 90 UTS rails on pre-stressed concrete sleepers, 1540 per km sleeper density, 250 mm depth of ballast cushion below the sleepers.</td>
</tr>
<tr>
<td>Sharpest curve &amp; turn out to be negotiated</td>
<td>174 m radius. The locomotive shall also be checked for passage in both directions over standard BG 1 in 8½ turnouts. Vogel’s layout or its internationally accepted equivalent for negotiability, throw over at headstock and coupler movement with details of clearances shall be prepared and supplied by the contractor. Maximum Super Elevation : 185 mm</td>
</tr>
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6.0 Compatibility of Traction motor with WDP4D loco control system/Traction Control System

The manufacturer of Traction motor should be experienced in manufacture of 3-phase AC transmission equipments for locomotive and evidence establishing adequate experience in manufacturing, testing, supply and after sale service for the same shall be furnished. Responsibility of compatibility of traction motor with WDP4D loco control system/Traction Control System (TCC) will lie fully on the tenderer. IR will facilitate co-operation of AC-AC system supplier for integration of Traction Motors.

A proven insulation system shall be employed in the construction of traction motor windings having class of insulation not less than 200°C. Both side bearings i.e. drive end and non drive end, shall be grease lubricated. The Speed sensors shall be Jacquet/Noris/AJB/Krauss Mafei and temperature sensors shall be PT 100 type, preferably. Vibration and noise level in traction motor shall be in accordance with IEC-60349-2.

a) The traction motor shall compatible with the following characteristics:
   i) Max voltage phase to phase at Traction Motor: At 8th Notch around approximately 2000V.
   ii) Max current per phase per motor: At 8th Notch around 270 amps rms.
   iii) Range of frequency in which the IGBT operates: 1 to 120 Hz variable.

b) Important particulars of WDP4D Alternator:
   i) Maximum voltage (DC link) : 2600 V DC
   ii) Maximum continuous current : 1250 A DC
   iii) Maximum speed : 950 rpm
   iv) Number per locomotive : One

c) Tractive effort Vs speed characteristics of WDP4D locomotive is attached in Annexure-III.

7.0 Design Review Meeting

A design review meeting shall be held at the manufacturer premises to discuss the constructional and design details and integrability aspects including operation and maintenance of the complete bogie in the Indian Railway locomotive. In the meeting, a suitable test plan, including scope, for prototype and routine inspection, and in service performance shall be finalized. The meeting which will involve detailed design discussion together with the study of integrability aspects, will be atleast for 5 working days.

<table>
<thead>
<tr>
<th>Permissible Track Tolerances</th>
<th>B.G. Main Lines (Other than C&amp;M 1 Vol. 1)</th>
<th>B.G. High Speed Route (C&amp;M 1 Vol. 1)</th>
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<tr>
<td>Unevenness (3.6 m base)</td>
<td>&lt; 15 mm</td>
<td>&lt;10 mm</td>
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<tr>
<td>Twist (3.6 m base)</td>
<td>&lt; 2.78 mm / meter</td>
<td>&lt;2.08 mm / meter</td>
</tr>
<tr>
<td>Gauge Variation</td>
<td>&lt; ± 6 mm</td>
<td>&lt; ± 3 mm</td>
</tr>
<tr>
<td>Alignment (Versine on 7.2 m Chord)</td>
<td>&lt; 5 mm</td>
<td>&lt; 5 mm</td>
</tr>
<tr>
<td>Gauge Widening</td>
<td>Up to + 10mm</td>
<td></td>
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8.0 Development of Prototype Bogie

8.1 The firm shall first make one prototype bogie after design accepted by RDSO, and do prototype bench testing as per the mutually agreed upon test scheme prepared according to relevant international norms. During prototype testing, adjustments and alterations as required shall have to be done by the firm.

8.2 The supplier shall acquaint himself about the layout of the bogies, the reliability, maintenance and operation related issues being experienced by the Railways.

8.3 It shall be the responsibility of supplier to get the prototype bogie assembled/ fitted at IR premises in the nominated locomotive under their own supervision. Necessary assistance of man power and machine & tools for non-specialized works shall be provided by IR, free of cost.

9.0 Bogie qualification (Inspection & Testing)

9.1 The prototype inspection shall be carried out in accordance with the finalized test plan between RDSO and supplier in accordance with relevant international standards for individual items. The manufacturer shall preferably have in-house testing rig and arrangement for complete bogie. The product shall conform to the designed parameters with respect to its application, efficiency and effectiveness. Prototype inspection shall be done in the manufacturers premises.

9.2 The complete bogie shall be type tested at manufacturers premises in the presence of RDSO officials.

9.3 After successful bench test, two bogies will be fitted in a locomotive and put under service after completion of oscillation trials. Evaluation shall be based on oscillation trial results conducted at speeds 180, 200 & 220 kmph.

9.4 Oscillation trial of locomotive fitted with this bogie shall be conducted in four configurations, viz., instrumented bogie leading and trailing with original and condemning wheel profile. The following criteria will be adopted for clearing the stock for regular operations:

   a) The lateral/transverse forces lasting more than 2 meters shall not exceed 4 tonnes, when measured at the wheel axle box level.

   b) Evaluation shall also be done in terms of ride index which shall not be greater than 4. The preferred value is 3.75.

   c) A derailment coefficient should be worked out in the form of the ratio between the lateral force (Hy) and the wheel load (Q) continuously over a period of 1/20th second and the value of Hy/Q shall not exceed 1.

   d) The value of acceleration recorded as near as possible to the bogie pivot, shall be limited to 0.3 g both in vertical and lateral mode. A peak value upto 0.35g may be permitted, if the records do not indicate a resonant tendency in the region of the peak value.

   e) A general indication of stable running characteristic of the locomotives as evidenced by the movement of the bogie on straight and curved track and by the acceleration reading and instantaneous wheel load variation/ spring deflections.

The measurements shall be done by RDSO in accordance with RDSO’s report no. MT- 334.

10.0 Documentation, records and Suppliers responsibility

10.1 Certificates/Approvals of the product/ manufacturer:

   a) The manufacturer shall be certified for ISO 9001:2008 (the scope of the ISO Certification shall specifically cover the manufacturing / supply products involved in this tender). IRIS certification of the firm will be an additional advantage.

   b) Credentials/ Experience of manufacturer: The supplier shall provide reference of all those projects executed by them for various Railways during the last 5 years wherein they have used same/similar type of Bogie. Performance report of the same shall be submitted by the tenderer.
c) The tenderer shall also indicate the details of manufacturing facility & location and details of any local infrastructure and service support in India.

10.2 The supplier shall produce the details of interface between bogie and under frame, clearly showing the dimensions for the following components:
   a) Pivot pin arrangement
   b) Lifting connections between under frame & bogie
   c) Lateral and vertical stop
   d) Interface of suspension elements i.e. springs, lateral/yaw/roll dampers etc.

10.3 The supplier shall supply detailed installation and maintenance manual for proper installation of bogie in the locomotive. This manual shall also include details of preventive maintenance schedules. For this purpose, the supplier shall depute his Engineers/Supervisors to the purchaser's site for assistance during installation of the bogie in the locomotive.

10.4 The supplier shall associate himself during commissioning, testing and field trials of the bogie on the locomotive and depute a team of Engineers/Supervisors for this purpose.

10.5 The supplier shall submit following traction motor curves in motoring and braking operations:
   - RPM Vs Torque, Current Vs Torque, RPM Vs Current, PF Vs RPM and Voltage Vs RPM, RPM Vs DC Link Voltage, Speed Vs Efficiency, Speed Vs Slip, RPM Vs Effective Current, RPM Vs Peak Current.

10.6 The supplier shall recommend a list of spares required for satisfactory maintenance and operation of bogie for a period of five years. Probable source of supply of major items shall also be furnished.

10.7 The supplier shall supply the user's manual containing instructions for assembly/disassembly during maintenance. The instructions for inspection and troubleshooting shall be clearly given.

10.8 The failure per million kilometer causing road failure shall not exceed 0.0025 (1 failure in 400 million kilometer) Failure per million kilometer needing warranty replacement shall not exceed 0.023 (1 failure in 42.84 million kilometer).

10.9 The supplier shall arrange for training for minimum 7 working days in their premises on operation and maintenance aspects of the complete bogie being supplied by them. The training will be given for 10 persons. The Boarding, lodging and travel expenditures of the IR personnel, deputed for training will be borne by IR.

11.0 Deliverables and Scope of Supply

11.1 Supply & assembly of two bogies functionally working as per this specification

11.2 Satisfactory type testing report

11.3 Successful completion of oscillation trial in line shall be considered as one deliverable

11.4 Fatigue test report of bogie frame

11.5 Mechanical strength verification (FEA) report of the bogie frame

11.6 Maintenance manual and Schedule of Maintenance

11.7 Training as per para 10.9 of this specification

11.8 List of spare parts along with source of supply

11.9 Traction motor curves in motoring and braking operations as specified in para 10.5

12.0 Guarantee and Warranty

12.1 The supplier shall be responsible for any damage to equipment due to defective design, materials, workmanship up to a period of 24 months after commissioning or within 30 months from the date of supply, whichever is earlier. The supplier shall replace within seven days such equipment during the warranty period at his cost. The period of warranty shall be extendable in case of...
recurring problems attributable to defective design material or manufacturing. The supplier's liability in respect of any complaints defects and/or claim shall be limited to the furnishing and installation of replacement parts free of any charge. Further, if any design modification is required to be made in any part of the equipment, the period of 24 months shall commence from the date when the modified part is commissioned in service. If, during the guarantee period, the equipment is out of commission on contractors account the period of guarantee shall be extended by the period for which the equipment remains out of commission.

12.2 The supplier shall be responsible for carrying out all the modifications at his cost on any part of the equipment during the period of warranty required for satisfactory operation of the equipment as per technical specification. For any technical decision the final authority from the purchaser's side shall be RDSO.

12.3 All the replacements and repairs that the purchaser shall call upon the contractor to deliver or perform under this guarantee shall be delivered and performed by the contractor promptly and satisfactorily.
Annexure-I
**Annexure-III**

**Tractive Effort Vs Speed characteristics (AAR Condition)**

*4500 GHP WDP4D (Dual Cab) Diesel Electric Locomotive*

- One Traction Alternator type TA17
- Six Traction Motor type ITB 2525 or equivalent
- Gear ratio: 17:77, Wheel Dia.: 1054mm (Half Worn)
- Starting Tractive Effort: 400 KN.

![Graph showing tractive effort vs speed characteristics](image)