




| | | | |
|---|---------------------------------------|----------|------------------|
|  | BEML LIMITED BENGALURU | Doc. No. | FPIIC/TD/HSR0001 |
| | | Date | 18-11-2024 |
| | | Rev. No. | 01 |
| | | Page No. | 1/12 |

High-Speed Rail Project Scope of Work for Vehicle Design Verification consultancy

| | | | |
|-----------------|-------------|--------------------|---|
| Approved | 18-11-2024 | Mahanthesh. G M |  |
| Reviewed | 18-11-2024 | Krishna Prasad B N |  |
| Prepared | 18-11-2024 | Ram Krishna Rajput |  |
| | Date | Name | Signature |

| | | | |
|---|---|----------|------------------|
|  | Scope of Work for Vehicle Design Verification consultancy for High- Speed Rail Project | Doc. No. | FPIIC/TD/HSR0001 |
| | | Date | 18-11-2024 |
| | | Rev. No. | 01 |
| | | Page No. | 3/12 |

Table of Contents

| | |
|---|----|
| 1. Introduction | 4 |
| 2. Definitions | 4 |
| 3. Design Stages..... | 4 |
| 4. Qualification Criteria..... | 5 |
| 5. Scope of Work | 5 |
| 6. Time Lines | 7 |
| 7. Organization Structure | 7 |
| 8. Deliverables | 7 |
| 9. Time Schedule | 8 |
| 10.Details of Design Documents/Drawings (Ch. 6 of ICF/MD/SPEC-447)..... | 8 |
| 10.1.List of Designs and Drawings..... | 8 |
| 10.2.Other Designs | 9 |
| 10.3.Vehicle Dynamics Simulation | 11 |
| 11.IPR and Confidentiality | 12 |
| 12.Submittals | 12 |
| 13.Attachments | 12 |

| | | | |
|---|--|----------|------------------|
|  | Scope of Work for Vehicle Design Verification consultancy for High-Speed Rail Project | Doc. No. | FPIIC/TD/HSR0001 |
| | | Date | 18-11-2024 |
| | | Rev. No. | 01 |
| | | Page No. | 4/12 |

1. Introduction

This Technical Specification (TS) specifies the technical requirements for engaging design Verification agency/The consultancy to verify the high-speed Rolling Stock design & integration of all systems/ sub-systems conforming to the performance, quality and safety requirements mentioned in the Specifications and Standards (SS) i.e., ICF/MD/SPEC-447, for the train designed to operate at 249 kmph max. on Mumbai Ahmedabad High Speed Rail (MAHSR) corridor.

2. Definitions

The following definitions are applicable. Other capitalized terms (if any) shall mean the definitions as mentioned in the SS i.e., ICF/MD/SPEC-447.

- **"Employer"** means ICF-Chennai, its legal successors and assignees.
- **"Nominated Agency"** shall mean NHRCL and its representatives including an ISA (if any) deployed by NHRCL for the purpose of carrying out Design approvals, Tests, Trials etc.
- **"BEML"** means the contractor for Design, Development, Manufacture, Testing and Commissioning of Trains for the project.
- **"Consultancy "** means the Design Verification agency for verifying the Vehicle Design Documents/ Drawings submitted by BEML.
- **"Vehicle Design Documents/Drawings"** shall mean any and all of the documents developed by the contractor & vendors for the development of the Rolling Stock for ICF specifications no. ICF/MD/SPEC-447.
- **"Rolling Stock"** shall mean the train being developed to operate at a speed of 249 kmph and test speed at 280 kmph in compliance with Specifications and Standards i.e., ICF/MD/SPEC-447.

3. Design Stages

| Sl. No | Activity | Time Lines |
|--------|---|----------------|
| 1 | Concept Design of Rolling stock (CDR) | 4 months |
| 2 | Preliminary Design of Rolling stock (PDR) | CDR + 4 months |
| 3 | Detailed Design of Rolling stock (DDR) | PDR + 4 months |
| 4 | Total design time for Rolling Stock | 12 months |

| | | | |
|---|---|----------|------------------|
|  | Scope of Work for Vehicle Design Verification consultancy for High- Speed Rail Project | Doc. No. | FPIIC/TD/HSR0001 |
| | | Date | 18-11-2024 |
| | | Rev. No. | 01 |
| | | Page No. | 5/12 |

4. Qualification Criteria


- 1) The consultancy shall be any Design verification agency / Indian entity having MOU/Tie-Up/ Consortium / Partnership with a competent Global Design/ Technical Firm provided such that Global Design / Technical Firm is having Design verification experience in complete Rolling Stock/Trains (Mechanical, Electrical, Signalling, Operations) for operating speed of 250 kmph and above. Supporting documents shall be submitted in tender submission stage.
- 2) The consultancy shall at least have experience of 3 projects in the past 10 years of verifying the design of Rolling Stock designed for 250 kmph and above. Supporting documents/satisfactory certificates from Rolling stock manufacturers or high-speed train operators shall be submitted in the tender submission stage.
- 3) The consultancy shall have proven track record to verify the Rolling Stock design & integration of all Sub-systems / systems conforming to the performance, quality and safety requirements.
- 4) Personnel engaged in design verification should have at least 15 years of relevant experience in Rolling Stock design verification and shall have executed at least one (01) high speed rail project of 250 kmph and above in the same role being proposed for this assignment. Accordingly, certified CV/ experience details of team members of design verification agency shall be submitted as documentary evidence in the tender submission stage.
- 5) The consultancy shall have experience as “Shadow Operator” i.e., along with design verification expertise, shall also have high speed train operation and maintenance expertise and relevant certificates shall be submitted as a documentary proof in the tender submission stage.

5. Scope of Work

- 1) The consultancy shall verify the Rolling stock design & integration of all sub-systems/systems conforming to the performance, quality and safety requirements as envisaged in SS i.e., ICF/MD/SPEC-447 and applicable standards.
- 2) The consultancy shall submit a design conformation report and detailed analysis on conformity of Car body Structure, Bogie Design, Brake System, Pantograph and Electric Propulsion systems, and all subsystems and complete train.

| | | | |
|---|--|----------|------------------|
|  | Scope of Work for Vehicle Design Verification consultancy for High-Speed Rail Project | Doc. No. | FPIIC/TD/HSR0001 |
| | | Date | 18-11-2024 |
| | | Rev. No. | 01 |
| | | Page No. | 6/12 |

- 3) The consultancy shall verify all the Vehicle Design Documents/ Drawings received from BEML to ensure that they are in complete compliance, on a clause-by-clause basis, to the Contract Specifications during the tenure of the consultancy.
- 4) The design verification of the Vehicle Design Documents/ Drawings in the respective Design Stages will be considered as complete only once the consultancy has provided a "Design Verification Certificate" stating that the Vehicle Design Documents/ Drawings meet the requirements of SS and adequacy of the design to operate the train at 249 kmph.
- 5) It may be possible that despite of a Vehicle Design Document/ Drawings verification have been completed as above, the accepted Vehicle Design Document/ Drawings is required to be re-performed due to changes in the accepted design documents/drawings by BEML. In such cases, consultancy shall verify the design documents/ drawings submitted by BEML incorporating such changes.
- 6) Every Vehicle Design Document/ Drawing shall be reviewed and verified. The time period for completion of the review and verification will be as per the clause 6 of this TS from date of submission of design documents to consultancy.
- 7) Besides the work relating to design document verification as stated above, consultancy may be required to support BEML during progress review meetings between BEML and ICF/ NHRCL by attending design meetings/ project review meetings (either physically or virtually) by design experts/ competent authority of consultancy.
- 8) The Vehicle Design Documents/ Drawings will consist of technical descriptions and drawings of the various sub-systems/ aggregates, design calculations, type test specifications/ procedures, type test reports, and related documents complying with the Standards and Specifications and also Quality control/process documents.
- 9) The consultancy shall be the technical guard for the project, through a specialized technical consultancy providing support to the BEML from the elaboration of the terms of reference and tendering of the studies involved, to the Verification of the results obtained by the system/sub-system suppliers, making observations and recommendations for improvement for them, highlighting the transparency and firmness in these technical recommendations.
- 10) The design verification activities shall conform to the latest editions (as on 30th Sep,

| | | | |
|---|--|----------|------------------|
|  | Scope of Work for Vehicle Design Verification consultancy for High-Speed Rail Project | Doc. No. | FPIIC/TD/HSR0001 |
| | | Date | 18-11-2024 |
| | | Rev. No. | 01 |
| | | Page No. | 7/12 |

2024) of standards or as brought out in ICF/MD/SPEC447 specification (Annexure-1).

- 11) BEML will bring out the applicable/ referred standards in each of the design documents. BEML will not provide any copy of the referred standards in the documents to the consultancy for the purpose of verification the Vehicle Design Documents/ Drawings and the consultancy shall arrange for the same by their own. And any other applicable standard referred to, by the consultancy during the verification shall be submitted to BEML by the consultancy. It may be noted that the rights of the standards lie with consultancy.

6. Time Lines

- 1) The consultancy shall complete the design verification activities of Vehicle Design Documents/ Drawings as per following timelines:

| Particulars | First Verification | Second Verification |
|--------------------------|--------------------|---------------------|
| Concept Design (CDR) | 10 Working Days | 7 Working Days |
| Preliminary Design (PDR) | 10 Working Days | 7 Working Days |
| Detail Design (DDR) | 10 Working Days | 7 Working Days |

7. Organization Structure

The consultancy shall submit the proposed detailed organization structure of the design team for design verification activities for efficient and timely submission and clearance of the design documents by the Nominated Agency.

The representatives of the consultancy shall be stationed in India during the tenure of the consultancy for design interaction with ICF/ NHRCL and at BEML, Bengaluru for efficient and timely submission and clearance of Design documents.

8. Deliverables

The verification of each Vehicle Design Documents/ Drawings shall be accompanied with the following deliverables: -

- i) Open Issue List (OIL) document with review/ verification results and comments, if there are any issue in the Vehicle Design Documents/ Drawings.
- ii) The Compliance matrix reflecting the clause-by-clause compliance with the Standards and Specifications and applicable/ referred Standards along with comments, if any.

| | | | |
|---|---|----------|------------------|
|  | Scope of Work for Vehicle Design Verification consultancy for High- Speed Rail Project | Doc. No. | FPIIC/TD/HSR0001 |
| | | Date | 18-11-2024 |
| | | Rev. No. | 01 |
| | | Page No. | 8/12 |

- iii) If no comments are provided or no observations are specified by consultancy, the consultancy shall provide a 'Design Verification Certificate' for the Vehicle Design Documents/ Drawings submitted for verification stating that the document/ design has been verified and such verified document/ design meets the Standards and Specifications with exceptions (if any) and the design is adequate to operate at speed of 249 kmph.

9. Time Schedule

- 1) The contract key dates for the design and development activities based on LoA are as below and shall be adhered to:
- a) Completion of Design Verification of Conceptual Design : 14th Mar, 2025
 - b) Completion of Design Verification of Preliminary design : 30th July, 2025
 - c) Completion of Design Verification of Detailed design : 15th Nov, 2025

The above contractual key dates are to be consider as "dates of completion" which may vary.

10. Details of Design Documents/Drawings (Ch. 6 of ICF/MD/SPEC-447)

- 1) The consultancy shall review and verify the below documents/ drawings as minimum.
- 2) The consultancy may propose the additional design documents/ drawings which may be prerequisite for functional or operational requirements of high-speed trains.
- 3) The list of documents/ drawings may increase during details design or based on the Nominated Agency (NHSRCL) review, comments and recommendations.
- 4) The consultancy shall verify any such additional documents/ drawings/ reports without any additional cost and within the timelines specified at clause 6 of this TS.

10.1. List of Designs and Drawings

The consultancy will be provided with following Designs and drawings for verifications:

- (i) Train: (a) Car profile; (b) tractive effort corresponding to continuous rated speed; (c) Design of Car body shell and interiors.
- (ii) Weight: The weight of the complete fully furnished Car of each type along with weight breakup of all the equipment and sub-systems.

| | | | |
|---|---|----------|------------------|
|  | Scope of Work for Vehicle Design Verification consultancy for High- Speed Rail Project | Doc. No. | FPIIC/TD/HSR0001 |
| | | Date | 18-11-2024 |
| | | Rev. No. | 01 |
| | | Page No. | 9/12 |

- (iii) Traction motor: The suspension arrangement & overall General Arrangement Drawing of traction motor along with necessary calculations.
- (iv) Brake system and Parking Brake: 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 for the Train; (g) braking distance calculations under gross load condition at maximum permissible operating speed at level track; (h) control system; (i) redundancy (k) operating times; (l) wheel slip/slide protection; (m) SIL level; (n) brake pipe controlled back-up system; and (o) emergency brake.
- (v) Bogie including brake rigging and suspension: Shall include (a) traction motor mounting arrangement if any; (b) unsprung 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) deleted (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).
- (vi) Wheel Set: (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; (d) parking brake calculations; (e) interfacing of service brake and parking brake; (f) braking curves (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
- (vii) End lighting: The installation details of (a) headlight; (b) marker light; (c) taillight; and (d) flasher light.

10.2. Other Designs

The consultancy will be provided with following Designs for verifications.

- (i) The strength of the under-frame as well as under-frame equipment under static and dynamic loading conditions using FEM.

| | | | |
|---|---|----------|------------------|
|  | Scope of Work for Vehicle Design Verification consultancy for High- Speed Rail Project | Doc. No. | FPIIC/TD/HSR0001 |
| | | Date | 18-11-2024 |
| | | Rev. No. | 01 |
| | | Page No. | 10/12 |

- (ii) The carbody strength, fatigue life estimation under static and aerodynamic dynamic loading conditions using CFD and FEM.
- (iii) Projected stability and riding performance of the Train using mathematical modelling technique with parameters of suspension system and dimensions adopted for track standards.
- (iv) Stresses & FEA of under-frame, bogie frame / bolster, suspension springs, wheels, bearing, axles, other components and fatigue life of these components.
- (v) Deflection calculations of under-frame under different loading conditions.
- (vi) Maximum moving dimension calculations.
- (vii) Calculations of harmonics and EMI/EMC parameters.
- (viii) Crashworthiness detailed report having relevant calculations & crash simulations carried out with standard software.
- (ix) Hazard identification, safety assessments and mitigations.
- (x) Calculations for tractive and braking effort versus speed curves showing balancing speed.
- (xi) Air consumption calculation of healthy and partially cutout air supply by compressor and consumption of air by equipment with acceptable air loss.
- (xii) Centre buffing force calculations.
- (xiii) 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.
- (xiv) Finite Element Modelling of Car shell with standard computer software's for stress/deflection analysis of the car body.
- (xv) System design documents and simulation for compliance of various performance parameters of Train.
- (xvi) Design documents for compliance of electrical fire & Train safety requirements.
- (xvii) Train configuration including distribution of propulsion equipment.
- (xviii) 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.
- (xix) Document for compliance of Disaster Management Light(t) Document for compliance of Train Data Recorder (TDR).
- (xx) Document for certifying the compliance of minimum fresh air quantities under different conditions.

| | | | |
|---|---|----------|------------------|
|  | Scope of Work for Vehicle Design Verification consultancy for High- Speed Rail Project | Doc. No. | FPIIC/TD/HSR0001 |
| | | Date | 18-11-2024 |
| | | Rev. No. | 01 |
| | | Page No. | 11/12 |

- (xxi) Document for compliance of Passenger Car Surveillance System and Cab Recording Equipment.
- (xxii) Document for certifying the compliance of Horns.
- (xxiii) Document for certifying the compliance of Vigilance Control Device (VCD).
- (xxiv) Document for compliance of passenger amenities and safety items like PA/PIS, ETB and Infotainment System etc.
- (xxv) Document for compliance of Car and Cab lighting.
- (xxvi) Aerodynamically shaped nosed design and simulation document.

10.3. Vehicle Dynamics Simulation

The consultancy will be provided with following simulations/drawings for verifications.

- (i) Vehicle dynamic simulations on the bogies and the results
- (ii) Derailment Safety and Stability
- (iii) Simulations / calculations for establishing maximum possible cant deficiency potential in rolling stock design.
- (iv) Drawings:
 - a) General layout of all equipment in the Car body 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 Car on sharpest curve and sharpest turnout. This diagram shall also show that the profile of the Car body is within the moving dimensions including the extra clearance permitted on curves when the Car is 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) Air Supply and 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.

| | | | |
|---|---|----------|------------------|
|  | Scope of Work for Vehicle Design Verification consultancy for High- Speed Rail Project | Doc. No. | FPIIC/TD/HSR0001 |
| | | Date | 18-11-2024 |
| | | Rev. No. | 01 |
| | | Page No. | 12/12 |

- j) Earthing and bonding arrangements of all Cars.

11. IPR and Confidentiality

- 1) The consultancy shall agree and abide to treat confidentiality of all documents, information, data and knowledge assimilated during the execution of the design verification of this contract. The consultancy is required to sign a Non-Disclosure Agreement with BEML.
- 2) The IPR of the Vehicle Design Documents/ Drawings generated for the Standards and Specifications i.e., ICF/MD/SPEC-447 shall lie solely with ICF and BEML. The design documents and parts there of shall not be shared or transferred in full or partial to any third party in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without prior written permission of ICF and BEML.

12. Submittals

The consultancy shall submit the following as a minimum, along with the technical offer.

- 1) Complete Technical offer for scope of work
- 2) Supporting documents for Qualification Criteria compliance
- 3) Clause-by- Clause compliance for
 - a) Technical Specification (this document)
 - b) ICF MD SPEC-447, ISSUE status-01, Rev. Draft dt. 05.09.2024.
 - c) Amendment to ICF/MD/SPEC-447 issued by NHSRCL, document No. NHSRCL-CO/MA/RS/01/IHSRS/2434/.1/OHQ16980 dtd. 20.09.2024.

13. Attachments

- 1) ICF MD SPEC-447, ISSUE status-01, Rev. Draft dt. 05.09.2024.
- 2) Amendments to ICF/MD/SPEC-447 issued by NHSRCL, document No. NHSRCL-CO/MA/RS/01/IHSRS/2434/.1/OHQ16980 dtd. 20.09.2024.

-----END OF DOCUMENT-----