

PART – I

GENERAL REQUIREMENTS

1. SCOPE OF THE SPECIFICATION

- 1.1 This specification covers the design, manufacture and supply, testing and commissioning of Two-Axle bogie type Broad Gauge (BG) High Speed Self Propelled Accident Relief Train (HS SPART) in completely assembled and furnished condition for operation at 160 km/h on BG section of 1676 mm gauge of Indian Railways. Tenderer shall quote separately for furnished equipments as shown in Supervisor van (DPC-I), Medical van (PC) and Tool Van (DPC-II).
- 1.2 The standard HS-SPART shall consist of three coaches - Air-Conditioned Supervisor van (DPC-I), Air-Conditioned Medical van (PC) and Tool Van (DPC-II) without Air-Conditioning shall be in accordance with RDSO drawing no. **CG – K 9148** placed at Annexure- I.
- 1.3 The specification has been prepared for general guidance of the manufacturer. Any deviation from specification intended to improve the performance, reliability and efficiency of the equipment as a whole or part thereof may be proposed for consideration. All such proposals shall, however, be accompanied with complete technical details and justification for proposed deviation.

1.4 GENERAL LAYOUT OF SPART

The layouts of BG HSSPART are enclosed herewith for the general guidance of the Contractor to prepare the key design for the proposed BG HS SPART. Deviation from these layouts may be proposed if it intends to improve the performance, utility and efficiency of the BG HS SPART as a whole or part.

- 1.4.1 **Supervisor van**, designated as Driving Power Car (DPC-I) with under slung power pack, shall be in accordance with RDSO drawing no. **CG – K 9149** placed at Annexure-II.
- 1.4.2 **Medical van**, designated as Power Car (PC) with under slung power pack, shall be in accordance with RDSO drawing no. **CG – K 9150** placed at Annexure-III.
- 1.4.3 **Tool van**, designated as Driving Power Car (DPC-II) with under slung power pack, shall be in accordance with RDSO drawing no. **CG – K 9151** placed at Annexure-IV.
- 1.5 This specification consists of seven parts as follows:
- Part I: General Requirement
 - Part II: Operating and Service Conditions
 - Part III: Mechanical Requirement
 - Part IV Power & Traction equipment, Control and Auxiliaries
 - Part V: Brake System
 - Part VI: Coach Lighting
 - Part VII: Testing and Inspection
- 1.6 The stock shall meet the operating requirements specified in **Part- II** of this specification, and shall be suitable for conditions of loading mentioned therein.
- 1.7 The contractor shall, in addition to observing and complying with this specification, be bound by the standard terms and conditions of contract for the construction, supply and delivery of coaches.

- 1.8 This specification is intended to include everything requisite to the construction of coaches, notwithstanding that everything required may not be mentioned herein, the Contractor shall ensure that the BG HS SPART coaches are complete in all respect and fit for operation.

2. QUALIFYING CRITERIA

Any firm / company wishing to participate in the tender should be an existing Rolling Stock manufacturer having adequate experience in design, manufacture, erection, testing and commissioning of Rolling stock. The company must have designed, manufactured and supplied at least 20 Self Propelled rail vehicles like Accident Relief Train / Diesel Multiple units in the last 3 calendar years. The tenderers must also have experience in manufacture or integration of such equipments like power pack, hydraulic transmission etc. The tenderer should indicate the details of engine and hydraulic transmission already in use for rail / traction application at similar maximum operating speed or higher. The tenderers must submit evidence of successful track record of manufacture/integration of equipments for traction system along with the offer.

3. GENERAL DESIGN REQUIREMENTS

- 3.1 The BG HS SPART shall incorporate all essential features necessary to yield high traffic use, low maintenance requirements, easy maintainability, high reliability in operation and high efficiency. The tenderer shall incorporate all the items required for proper functioning of the BG HS SPART in accordance with the current international practices.
- 3.2 The specification has been prepared for the general guidance of the Contractor to prepare the key design for the proposed BG HS SPART. Deviation from this specification may be proposed if it intends to improve the performance, utility and efficiency of the BG HS SPART as a whole or part thereof as options with separate prices. However, consideration of such deviations shall be at the discretion of the IR and shall be on the basis of merit. All such deviations shall be accompanied with complete technical details and justification for the proposed deviation.
- 3.3 The entire equipment shall be designed to ensure satisfactory and safe operation under the running conditions specified in **Part-II** and especially under sudden variations of load and pressure as may arise under working conditions due to faulty operation and short circuits.
- 3.4 The design shall also facilitate easy erection by means of suitable tools and equipment, inspection, maintenance and replacement of the various units comprising the equipment.
- 3.5 All working parts of the control and auxiliary circuit, specifically electronics and PCBs, shall be suitably covered to keep them free from moistures and dust. The protection level shall be furnished by the tenderer.
- 3.6 All equipment shall be adequately earthed, insulated, screened or enclosed. They shall be provided with essential interlocks and keys as may be adequate to ensure the protection of the equipment and the safety of those concerned with its operation and maintenance.
- 3.7 **Lubricants and Cooling oils:** Contractor shall study the currently available lubricants/cooling oils in India and employ them as far as possible. Full lubrication scheme and schedule for the BG HS-SPART shall be submitted. Wherein imported lubricants or cooling oil are used, Contractor shall study and furnish details of equivalent Indian lubricants/oil.
- 3.8 The process of design approval shall be facilitated by holding at least two specific higher level detailed design review meetings between representatives of Indian Railways and the contractor to ensure suitability of design and smooth progress of TOT. The first meeting

shall be held in the manufacturer's premises and the venue of second and subsequent meetings(if any) shall be decided mutually between IR and the contractor.

4. SCOPE OF SUPPLY

- 4.1 The supply of complete documentation including manufacturing drawings, design calculations and data, Maintenance Manuals, Operation Manuals, Circuit diagrams, Training Manuals, QA documentation , Key layout drawings etc.
- 4.2 Supply of lubricants and other consumables for the initial period of 12 months of commissioning and service. Supply & installation of material required for testing, commissioning and operation.
- 4.3 Supply of sets of special tools, commissioning & testing instruments etc. which shall be required at coach manufacturing unit at IR's workshop for carrying out major overhaul and at maintenance depot for regular maintenance of the BG HS-SPART coaches and the supply of spares so as to meet the three years maintenance requirements.
- 4.4 Contractor shall submit list of equipment and facilities required for maintenance and overhaul of BG HS SPART stock offered.
- 4.5 Software packages along with the suitable hardware & system support for scrutinizing the design calculations, equipment ratings, performance evaluation & making simulation studies etc. The package shall be complete in all respect so as to enable the RDSO to simulate all performance and operational related variables in India (RDSO).
- 4.6 In addition to the equipment and services specified in this specification, the Contractor shall supply all materials, cartage, tackle, plant, spare parts, special tools and appliances which may be necessary for the complete and efficient installation, testing and commissioning of the new units, even though such material or work may not be specifically mentioned in this specification. All such items shall be listed in the offer duly indicating their prices for invoice purpose. The Contractor shall also arrange all necessary technical supervision for the installation, testing and commissioning of the BG HS-SPART.
- 4.7 The Contractor shall give complete details of maintenance practices to be followed for maintaining coaches and all equipments, supplied against this specification

5. DEFINITIONS

Throughout this specification the term –

- 5.1 '**Purchaser**' means Railway Board on behalf of The President of Republic of India.
- 5.2 '**Inspecting Officer**' means the persons, firms or departments nominated by the Purchaser to inspect the work on his behalf and the deputies of the Inspecting Officer so nominated.
- 5.3 '**Contractor**' means the person, firm or company from whom the Purchaser may obtain any material or fittings to be used for the work.
- 5.4 '**Contract Drawings**' means the drawings, which are in **Annexure - I, II, III & IV** of this specification for the guidance of the Contractor.
- 5.5 '**RDSO**' means Research Designs & Standards Organisation, Lucknow.
- 5.6 '**Engineers**' means the RDSO, Ministry of Railways.

6. TRANSFER & USE OF TECHNICAL INFORMATION

- 6.1 Indian Railways shall reserve the right of exercising the option for transfer of technology for manufacture of coaches described in the specification. The transfer of technology shall include design know-how and manufacture of coaches. The scope of the transfer of technology is limited to the shell and bogies as defined in subsequent paras of this clause and Clause 7. However the tenderer should quote separately for T.O.T. of shell and bogie, and Indian Railway reserves the right of exercising the option for transfer of technology of only shell or bogie or both. In respect of all other items including couplers, power and hydraulic equipments, furnishings, air brake system etc., the drawings and specifications shall however, be furnished by the successful tenderer such that Indian Railways can source these items independently.
- 6.2 The Contractor shall indicate his technical terms and condition for transfer of technology to Indian Railways so as to enable manufacture of the coach offered against this specification at any nominated workshop of Indian Railways or in the public or private sector nominated by Indian Railways.
- 6.3 The successful tenderer shall also submit a list of his sub-Contractors to Indian Railways and shall be wholly responsible for transfer of technology for individual components, sub-assemblies/major assemblies built by the Contractor at his own works but obtained from sub-Contractors. This transfer of technology may also be done to any private or public sector company nominated by Indian Railways.
- 6.4 The terms and conditions for transfer of technology shall form a part of technical offer and shall be included in the envelope for technical offer except for commercial/financial terms.
- 6.5 The price, if any, for transfer of technology, manufacture and collaboration shall be payable in lump sum in the following manner: -
- i. 30% of the amount shall be payable after agreement is taken on record and delivery of all technical documents indicated in clause 7.1 of Part - I.
 - ii. 30% of the amount shall be payable after successful indigenisation of manufacture to the extent of 50% of the total value of the coach or after a period of 5 years after agreement is taken on record and delivery of all technical documents, whichever is earlier.
 - iii. 25% of the amount shall be payable after successful indigenisation of manufacture to the extent of 75% of the total value of the coach or after period of 7-1/2 years after agreement is taken on record and delivery of all technical documents, whichever is earlier.
 - iv. Balance 15% of the amount to be paid after successful completion of the collaboration agreement or after a period of 10 years after agreement is taken on record and delivery of all technical documents, whichever is later.
 - v. Submission of these terms and conditions are mandatory. Offers, which do not contain terms and conditions for transfer of technology, shall not be considered for evaluation.

7. SCOPE FOR TRANSFER OF TECHNOLOGY

- 7.1 The Contractor shall undertake to transfer complete technical know-how for design, manufacture and maintenance including: -

- i. Design calculations, material specifications, computer aided design packages utilised for development of design of coaches described in this specification.
- ii. Detailed key and manufacturing drawings, material and component specifications, type tests, batch analysis and routine tests for mechanical, electrical and thermal properties. The detailed drawings shall include dimensions, tolerance, surface finish, material specification of equipment/component and also details of jigs, fixtures and special tools required for manufacture of particular components.
- iii. Manufacturing process sheets including detailed components on special techniques for welding, forging or casting, heat treatment, assembly, etc. wherever applicable.
- iv. Detailed specifications for special machines, plant and tools etc. required for manufacture, inspection and testing of raw material, stage inspection and final inspection and testing, plant layout.
- v. Other technical clarifications and supplementary instructions as may be required for successful manufacture of coaches.
- vi. These documents shall include:
 - a. Contractor's address
 - b. Purchase specification including drawings and material specification
 - c. Details of type tests, routine tests and acceptance tests.
 - d. Details of test equipment needed for these tests and addresses of Contractors for such test equipment wherever available.
 - e. Maintenance manual including dimensional drawing for the item, if existing and available.
 - f. Contractor shall furnish authorization to its sub Contractors to quote directly against the IR's purchase queries.

7.2 The Contractor shall assist Indian Railways in developing sources/alternate material or materials, which are not readily available in India.

7.3 The Contractor shall arrange to train Indian Railways personnel in his premises or premises of his sub-Contractors in design, manufacture, quality control and inspection and maintenance of coaches. This training will be for 1000 man days or as may be decided based upon mutual agreement. The contractor shall depute qualified instructor for the training. It will cover the following trainings:

- .1 Training of Indian Railway Engineers in the manufacturer's design offices. The number of Engineers to be trained will be mutually decided before the contract is finalized.
- .2 Training of Indian Railway Engineers and Artisans in the works of the manufacturer and sub-contractors' Works
- .3 On the job training in solid models and drafting, specially related with re-engineering work if any.

It may be made amply clear that this training is in addition to the training specified in Clause 22.1.

7.4 The training will broadly cover the following aspects directly connected to the HS SPART:

- i. Design development of coaches and bogies with power pack and control system including CAD/FEM practices.

- ii. Manufacturing technology and process engineering of the coaches and bogies with power pack and control system including design and manufacturing of Jigs/Fixtures/Tooling.
 - iii. Quality assurance systems, quality plans and inspection procedures including gauges.
 - iv. Maintenance engineering and repair practices for coach bodies and bogies including power pack and control system as far as available with Contractor.
 - v. The contractor shall endeavour to, where necessary, arrange to train IR personnel in the premises of his Contractors in design, manufacture, quality control and commissioning.
- 7.5 The Contractor shall depute qualified personnel from their unit to India, as necessary, to establish indigenous manufacture.
- 7.6 The Contractor shall ensure continuous transfer of updated design and manufacturing technology during the period of collaboration.
- 7.7 Collaboration agreement shall be for a period of 10 years. On expiry of this period, if Indian Railways are desirous of being technically associated with the Contractor for a further period, this shall be done through an agreement for such a period on terms mutually agreed upon. However, in case Indian Railways decide to manufacture coaches of the design covered by this collaboration agreement, after the collaboration period is over, Indian Railways shall have freedom to manufacture such coaches without any let or hindrance.
- 7.8 There shall be no binding on the purchaser to import any components or sub-assemblies only from/through the contractor.
- 7.9 Indian Railways shall have full right to export coaches of the design covered by the technology transfer agreement and manufactured at any nominated Works in India nominated for this purpose by Indian Railways without any let or hindrance during the period of collaboration agreement and the end of this agreement.
- 7.10 The technology transfer shall get under way immediately after the agreement is signed.
- 7.11 Software and Software tools developed by the contractor and required for the product for design and calculations and for development / changes in software shall be supplied by the contractor to IR.
- 7.12 The contractor shall supply information in respect of Standards used for the BG HS-SPART for the specifications of materials and tests included in the technical information.
- 7.13 The contractor shall make its best efforts for the procurement of spares by IR on a long term basis from different OEMs at reasonable prices.

8. CONTRACTUAL TERMS

- 8.1 To facilitate the examination of tender offer, the tenderer is required to offer comments clause by clause of this specification either confirming the acceptance of the clause and elaborating each details, where necessary, or indicating deviations there from. A comprehensive specification of the HS SPART offered shall also be submitted along with the above comments.
- 8.2 The contractor shall be entirely responsible for the execution of the contract strictly in accordance with the terms and conditions of the specification notwithstanding any approval which RDSO or the Inspecting Officer may have given: -

- i. of the detailed drawings prepared by the contractor,
- ii. of his Sub-contractors for materials, components and sub assemblies,
- iii. of other parts of the work involved in the contract,
- iv. of the tests carried out by the contractor / sub-contractor or RDSO or the Inspecting Officer.

9. CONTRACT DRAWINGS

- 9.1 Contract drawings in Annexure-I, II, III & IV of this specification give the general requirements for stock to be delivered.
- 9.2 The Contract drawings and other drawings provided by the Engineers are not guaranteed to be free from discrepancies and may be modified to suit the requirements of this specification, or as subsequently directed by the Engineers, without claim by the Contractor for extension of time or increase of price, except as provided for under the conditions of contract.
- 9.3 If, in any case, dimensions figured upon a drawing differ from those obtained by scaling the drawing; the former shall be taken as correct.
- 9.4 No modification to the contract and approved drawings shall be done except with the prior approval of the Engineers.
- 9.5 Where the tolerances have been indicated on drawings, the fittings shall be manufactured strictly within such tolerances. Where no particular tolerances have been indicated on the drawings, relevant International specification should be followed.

10. DESIGN DEVELOPMENT & APPROVAL OF DRAWINGS

- 10.1 The successful tenderer shall develop the design based on the details given in this specification and sound engineering practices. The entire design data shall be submitted in metric units with calculations to RDSO within 12 weeks from the date of placement of order. RDSO shall give remarks within 6 weeks and the firm shall submit the drawings for approval within next 6 weeks after incorporating the above corrections /modifications. Manufacture of prototype shall be started by the successful tenderer only after design “**approval**” is granted by Indian Railway.
- 10.2 The detailed calculations shall cover: -
- i. Hauling capacity calculation.
 - ii. Braking effort and EBD calculation on plane section and gradient with maximum load/without load.
 - iii. Calculation of centre of gravity of from rail level, details of weight transfer calculation, tractive effort versus speed curve.
 - iv. Load balancing calculations in longitudinal and lateral modes.
 - v. Life rating calculation of axle box bearings.
 - vi. Stress analysis of all major stress parts like body shell, bogie frame, suspension springs, axle, brake rigging including parking brake etc.
 - vii. Calculation for safety against derailment. Calculation for stability against wind force shall be supplied.
 - viii. Calculations for determining the spring and damper characteristics under tare and loaded condition.
 - ix. Crash-worthiness of the coach body.
 - x. Estimate of coach rolling resistance at various speeds.
 - xi. Vibration analysis of the carbody and the natural frequencies.
 - xii. Projected dynamic augment with the un-sprung masses as used and with IR track.

- 10.3 "Approval" to the drawings denotes general "acceptability" of the design features. Notwithstanding such an approval, the contractor will be wholly and completely responsible for the adequacy of the design of the BG HS-SPART offered. The contractor when submitting proposals on designs for approval of the RDSO shall draw specific attention to any deviation or departure from the specification involved in his proposals or drawings.
- 10.4 To facilitate filing of drawings in RDSO, it is essential that each drawing prepared for the manufacture/operation/maintenance shall be marked so that it can be identified. The contractor shall, therefore, ensure that all prints submitted are marked legibly at the right hand bottom corner. The following information is required in respect of each drawing submitted:
- .1 Contractor's drawing Number
 - .2 Contractor's name and date of submission
 - .3 Contract Number
 - .4 Nomenclature of the BG HS-SPART
 - .5 Description
- 10.5 The Contractor shall submit the complete material / technical specification of the components. The specification shall specifically be indicated on relevant drawings / documents.
- 10.6 The Contractor shall be responsible for carrying out improvements and modifications as may be considered necessary after tests and trials at his own expense on all the equipment supplied, provided such modifications/improvements are decided to be necessary for meeting the specified requirements of reliability, performance, safety etc. jointly between Contractor and RDSO.
- 10.7 For the purpose of technical decisions on improvements/modifications etc. on equipment, the final authority from the purchaser's side will be RDSO.

11. QUALITY ASSURANCE PLAN

- 11.1 The contractor shall formulate Quality Assurance Plan (QAP) detailing the methodology proposed to be followed to ensure quality product. QAP shall cover quality assurance procedures to be followed during all stages of design, planning, procurement, manufacture, testing, commissioning and servicing. The contractor shall define the role of each functional group in the organisation for achieving the required quality of the products and submit a comprehensive document of QAP.
- 11.2 Manufacture of BG HS-SPART shall commence only after "Quality Assurance Plan" is approved by the purchaser.
- 11.3 The above shall apply to contractor as well as sub- contractors.

12. MATERIALS

- 12.1 All materials used in the construction of the coach shall be of the specified quality and shall comply with the most recent issue of the relevant international standard specification.
- 12.2 The Contractor shall submit to the RDSO, a list showing the names of the Contractors of components, equipment and sub assemblies from whom they propose to obtain the materials and fittings for work under the Contract.

- 12.3 All castings shall be true to dimensions, homogeneous and free from defects and have their mating surface smooth and true to shape. Castings shall be properly annealed and subjected to radiography tests where required.
- 12.4 The use of aluminium and brass fittings for furnishing should be limited to the minimum extent in order to reduce pilferage. Specific approval shall be taken before using such material. Use of Aluminium in the under floor or in the load bearing areas shall not be desirable.
- 12.5 The material used shall be subject to the Contractor's corresponding QA procedures. It shall be ensured that material of the requisite quality is used throughout the execution of the work.
- 12.6 All the materials to be used for interiors, panelling, furnishing, lighting, ventilation etc. must comply with requirement for fire prevention, protection of staff in case of fire and from fire - side effect according to international standards.
- 12.7 At the same time no materials are permitted within passenger compartments, which contain asbestos, toxic material or that may splinter or will create sharp edges when broken.
- 12.8 The type and make of the equipment once finalised during design stage shall not be permitted to be changed during the contract unless agreed by the purchaser and RDSO in writing in view of reliability and availability.

13. EXECUTION OF WORK

- 13.1 The coaches shall be manufactured throughout in the best style of coach work and construction and shall conform to the best standards of the trade.
- 13.2 All components and sub-assemblies shall be interchangeable in whole and / or in part.
- 13.3 Sheets and plates shall be carefully straightened and flattened by stretching or by pressure. Plates shall be sheared when quite cold and their edges evenly finished. Welded components or members shall be correctly matched and accurate levels and clearances shall be ensured to result in perfect welds.

14. WELDING

- 14.1 All welding procedures shall be documented by the Contractor. Approval of the welding procedure shall be as per BS EN ISO 15614-1 (latest version): Specification of Approval Testing of Welding Procedures, or equivalent.
- 14.2 Approval of the welder shall be as per BS EN 287-1 (latest version): Specification for Approval Testing of Welders Working to Approved Welding Procedures, or equivalent.
- 14.3 Arc welding shall be performed by the MIG process and in all cases complete and adequate fusion with the base material shall be ensured. The side wall and end wall sheet are welded with spot welding.
- 14.4 Engineers or Inspector reserves the right to verify the quality of welds, particularly in critically stressed areas, by appropriate non-destructive testing methods (NDT).

15. CORROSION

- 15.1 Protection of materials against all types of corrosion shall be appropriate for the environment of India and the operating conditions of the coaches.

- 15.2 Corrosion protection methods for metallic components and equipment cases shall be submitted. Where feasible, such corrosion protection measures shall not require to be repeated throughout the life of the vehicle.

16. FASTENERS

- 16.1 Screw threads shall be of ISO metric sizes.
- 16.2 ISO Metric fine threads shall be used in applications where the fastener is subjected to alternating transverse loads. In other cases, the coarse series of threads shall generally be used, except where precluded by size. The use of studs shall be avoided wherever possible.
- 16.3 Normally, screw threads smaller than M5 size shall not be used. Screw and bolt heads shall be of hexagonal form on all M5 and larger screws. Screws smaller than M10 shall be of high tensile material.
- 16.4 Fixings shall be locked adequately to prevent loosening in service. Fixings shall withstand any shock loads the equipment is likely to encounter.
- 16.5 In critical areas the locking of all nuts, bolts and fixings shall be of a positive form, which prevents mechanical rotation of the nut relative to the bolt, irrespective of source vibration.
- 16.6 Stainless steel parts shall be secured by stainless steel screws or fasteners except in locations where high tensile strength is needed.
- 16.7 Whenever possible tapped holes shall be drilled and tapped to the full thickness of the material. Blind holes shall be used only where this is unavoidable. All such blind holes shall provide at least 3mm clearance between the end of the screws and the bottom of the tapped hole.
- 16.8 Tapped holes shall be provided with suitable thread inserts where necessary and shall always be used in aluminium or copper.
- 16.9 The use of loose nuts and bolts will only be accepted where it is possible for staff to easily reach both parts of the fixing simultaneously.
- 16.10 Fixings for covers which may have to be removed for maintenance, shall be captive.
- 16.11 Items of electrical equipment shall be fitted to panels so that all fixings can be made from the front only, except where specified otherwise.
- 16.12 All steel fasteners used in electrical equipment shall be either galvanised or cadmium plated.
- 16.13 Tenderer shall submit details if there are any variations from what have been laid down in different sub-clauses of this clause.

17. INSPECTION

- 17.1 The whole of the materials, or fittings used for works covered by the specification shall be subject to inspection by the Inspecting Officer, and shall be to his entire satisfaction.
- 17.2 The Inspecting Officer shall have the power to:

- (a) Adopt any means he may think advisable to satisfy himself that the materials or fittings specified are actually used throughout the construction.
 - (b) Take samples for such tests, as he may consider necessary by an approved metallurgist selected by him, whose report shall be final and binding on the Contractors.
 - (c) Visit at any reasonable time the Contractor's works to inspect the progress and quality of the work and the Contractor shall provide free of charge all equipment, labours, gauges, etc. required by him for this purpose.
 - (d) To reject any material or fittings that do not conform to the relevant specification or good practice, same shall be marked in a distinguishable manner, and shall be disposed of as may be directed by Inspecting Officer. The Contractors without extra charge shall replace such rejected parts.
- 17.3 Tests of materials and fittings shall be as far as possible carried out at the works of the makers of the materials or fittings. The Contractor shall provide such additional materials or fittings as may be required or arrange for test pieces to be incorporated in forging and castings as required by the Inspecting Officer and for their removal in his presence for test purposes. All tests in the works of the Contractor and their sub-contractors, independent tests shall be carried out free of cost by the Purchaser or the Contractor irrespective of whether the tests show that the material is/is not to specification.
- 17.4 No work shall be dispatched or packed until it has been passed by the Inspecting Officer, but such passing shall in no way exonerate the Contractor from their obligation in respect of quality and performance of the coaches.
- 17.5 In the event of dispute between the Inspecting Officer and the Contractor, the decision of the Engineer shall be final and binding.

18. PROTOTYPE TRAIN

- 18.1 The Contractor shall, after design "approval" first manufacture one prototype rake (consisting of three units) as per the specification and offer the same for inspection .
- 18.2 The prototype shall be inspected and tested for validation by RDSO or any other Indian Railway representative at the works of the manufacturer. After successful completion of tests and inspection at manufacturer's works, clearance for despatch shall be given. Then only the prototype shall be dispatched and offered for oscillation trial.
- 18.3 Oscillation test to prove the riding and stability performance of the cars shall be conducted as per Clause 2.3 of Part-VII on Indian Railway track.
- 18.4 Series manufacture shall not be proceeded with, until prototype has been approved by the IR, after successful oscillation trial. The prototype, after trials and RDSO clearance, will undergo field trials for four months. Contractor shall not proceed with any proposed modification arising out of prototype test unless it is approved by RDSO.

During the prototype tests / trials or during the warranty period, if any problems are thrown up or feedback information is obtained, which warrants a re-check of the design/ manufacture/ quality of the equipment and components, action will be taken as may be necessary by the Contractor to carry out the required investigations and to incorporate the improvements considered most appropriate to reach compliance with the specification & to ensure specified reliability and performance without any extra costs to the Purchaser. Such

improvements will be carried out in all HS SPART and will be validated for a period as per stipulations enumerated in the bid document.

- 18.5 Modifications mutually agreed to and complying with the specification, will be incorporated by the Contractor at his own cost in the HS SPART in a manner approved by the RDSO. Drawings incorporating the modifications as found necessary as a result of test and trial will be submitted to RDSO for approval before carrying out the modifications.
- 18.6 The Contractor shall further, notwithstanding any exercise by the Inspecting Officer of the power of superintendence, be responsible for the sufficiency of the packing, marking etc. of all imported parts of the work to ensure their delivery in India without damage.

19. **Special Tools for Maintenance**

- (i) The tenderer will also offer separately special jigs, tools and instruments which shall be essentially required for maintenance of mechanical, electrical / electronics and pneumatic equipment. Essential equipment and facilities required for attending local damage to the stainless steel structure, suspension and coach interiors etc. in case of accidental damages shall also be furnished. The tenderer shall explain the purpose/justification of the specialised equipment so offered. Tenderer shall add any other item, which shall be required during maintenance but not covered in the Schedule submitted by the purchasers. Tenderer shall submit the lists of such tools, instruments jigs etc. separately for IR's workshop carrying out major overhaul and for maintenance depot for carrying out regular maintenance and quote accordingly. The finalized lists of maintenance and additional tools shall be considered during commercial assessment of the bid.
- (ii) The Contractor shall demonstrate to the IR, the satisfactory functioning of the tools, jigs & instruments supplied vide the Clause 18.6 (i).

20. **SPECIAL OR PROPRIETARY FITTINGS**

All royalty charges for the use of special or proprietary fittings embodied in the construction of the coaches shall be borne by the Contractors. A list of components for which royalty is paid, together with the names of the firms and the royalty paid shall be furnished to the Engineers.

21. **PHOTOGRAPHS & DRAWINGS**

- 21.1 Colour photographs of various assemblies and sub-assemblies for newly built coaches shall be taken especially for the bogie, under frame, power pack and body in various stages of manufacture, and also for the parts, which cannot conveniently be photographed after assembly such as, body sidewall, end wall, roof framing, under-frame etc.
- 21.2 After completion, side end and three-quarter views of each coach shall be taken, including views of the interior furnishings.
- 21.3 The photographs shall be not less than 380 mm x 255 mm for the side views of the complete coach, or less than 255 mm x 200 mm for other views.
- 21.4 The soft copy on compact disc (CD) and three sets of prints of each shall be furnished to the Engineers, the prints being mounted on sheets to form complete set.
- 21.5 One set of final working drawings together with a set of photograph and CD print out shall be suitably bound and furnished to the Engineer.

22. TRAINING

22.1 The contractor shall provide training at the manufacturer's place for at least 500 man-days (or as may be decided mutually) for adequate number of Indian Railway personnel so that they acquire full knowledge of major assembly/sub-assembly used in HS SPART. The distribution of the number of trainees or batches may be decided on mutual discussion.

The training module shall be so designed that it shall be helpful in trouble-shooting, maintenance and operation of the HS SPART.

22.2 Besides the above, adequate number of maintenance and operating staff shall also be trained in the homing sheds during the commissioning of the HS SPART. For this the contractor shall depute qualified personnel(s) to impart the training.

22.3 Well trained and qualified instructors shall be deputed by the contractor for both the above mentioned trainings. TOT training shall be over and above this training, as per clause 7.3.

22.4 The training will broadly cover the following aspects directly connected to the HS SPART and will be processed as on job training:

- i. Details of coaches and bogies with power pack and control system and their maintenance together with details of Jigs/Fixtures/ Toolings.
- ii. Trouble shootings & Operation of SPART
- iii. Quality assurance systems, quality plans and inspection procedures including gauges.
- iv. Maintenance engineering and repair practices for coach bodies and bogies including power pack and control system as far as available with Contractor.
- v. The contractor shall endeavour to, where necessary, arrange to train IR personnel in the premises of his Contractors in design, manufacture, quality control and commissioning.

22.5 For trainings under TOT as mentioned in clause 6 as well as for the design review meeting and training mentioned in this clause, the following conditions shall apply

- i. The living costs of the IR personnel and the transportation cost shall be borne by IR. The accommodation and transportation between hotel and place of training will be provided by the Contractor.
- ii. The Contractor shall provide free of charge to IR personnel necessary information, working dress where needed, any safety glasses / equipment and supplies during the training period.
- iii. The Contractor shall designate qualified specialists to advice and train IR technical personnel and explain relevant aspects, related to product.
- iv. In case of illness or accident, the Contractor shall arrange for medical care in the best possible way, the cost of which shall be borne by IR.

23. SERVICE ENGINEERING

23.1 The Contractor shall provide, at his own expense, the services of competent engineers during the guarantee period and also during the first major overhaul of such nos. of HS SPART as may be agreed upon. The service engineers shall be available for testing/commissioning of the HS SPART, training of operating and maintenance staff. The service engineers shall also advise the Railways on maintenance, testing and operating facilities considered necessary for efficient performance of the HS SPART.

23.2 The contractor shall submit a proposal for AMC with quotation for major equipments for trouble free maintenance of HS SPART.

24. TESTING KIT

The contractor shall indicate testing equipment required for ensuring optimum performance and trouble free service of HS SPART as well as their major assemblies and sub-assemblies. The tenderer with complete quotations shall submit details of testing equipments.

25. SPARE PARTS

25.1 The tenderer shall submit a list of spare parts and special tools, both indigenous and imported, indicating the name and address of the manufacturers as detailed below:

List – A: Catalogue of unit spares, indigenous and imported, of the principal assemblies of the HS SPART such as the diesel engine, transmission, cardan shaft, axle drive, compressor, brake equipment etc. with price.

List – B: Recommended maintenance spares for two years initial requirements. The tenderer shall submit the list of such spare parts giving their detail description, source of supply, part number of the Contractor and price of each part.

25.2 The tenderer shall be responsible for ensuring subsequent availability of spare parts for efficient working of the respective equipments.

25.3 The tenderer shall also submit time bound plan/proposal for indigenous availability of imported components.

25.4 A spare part catalogue listing all components manufactured or purchased by the tenderer shall be prepared within 4 weeks of clearance of the prototype . The contractor shall furnish one copy of spare parts catalogue to RDSO and two copies to the consignee with free of cost.

26. COMMISSIONING OF THE HS SPART

26.1 The HS SPART shall not be dispatched or packed until the Inspecting Officer has passed it. Such passing shall in no way exonerate the contractor from obligation in respect of quality and performance of the equipment. In the event of dispute between the Inspecting Officer and the Contractor, the decision of the Purchaser shall be final and binding.

26.2 The consignee railways shall inform the Contractor after the HS SPART has reached at site. The HS SPART shall be commissioned by the Contractor within 4 weeks after intimation by the consignee. The consignee railways will issue a commissioning certificate after it has been successfully commissioned.

27. MAKER'S CERTIFICATE

Copies of Maker's certificate guaranteeing the performance of the HS SPART shall be submitted in duplicate along with the delivery of each set. Test certificates of major vendor items shall also be supplied along with each coach.

28. SERVICE CATALOGUES

28.1 Detailed operating manual, maintenance manual, standard schedules of examination and driver hand book shall be specifically prepared for the HS SPART and at least 3 copies each of the same shall be supplied free of charge per HS SPART to the consignee and three copies to RDSO. The draft contents of the manuals shall be submitted for approval to

RDSO within 4 weeks of clearance of the prototype. These documents shall also be supplied on compact disc (CD) compatible to MS-Office software.

The manual shall include chapters on:

- i. General characteristics
- ii. HS SPART design and its details including under frame design
- iii. Power equipment & details with mounting
- iv. Fuel, oil and cooling water circuit.
- v. Grease, oil chart with specification and quantity
- vi. Bogie design & suspension details
- vii. Wheel, Axle & axle set assembly with axle box bearing details
- viii. Brake rigging arrangement with schematic diagram of pneumatic circuit
- ix. Wiring diagram with complete illustration of components
- x. Controls and safety features & their test procedure, Special tools etc.

- 28.2 The manual shall include dis-assembly and assembly procedure with specific mention of any special tools required for carrying out the above work.
- 28.3 Manual shall include a separate chapter indicating the service and condemning/wear limits & tolerances for various assembly / sub-assembly, wherever applicable.
- 28.4 The manual shall contain a separate chapter pertaining to standard schedule of examination for complete HSSPART covering all equipments i.e. engine, transmission, cardan shaft, axle drive gear box, compressor, controls, brake system, suspension etc. for trouble free day to day maintenance.
- 28.5 The Driver's handbook shall contain technical data, operating instructions with suitable illustration & diagram and lubrication chart.

PART - II

OPERATING AND SERVICE CONDITIONS

1. GENERAL:

1.1 The HS SPART shall be a set of three self-propelled, lightweight, 8 wheeler rail car units with formation DPC+PC+DPC. However, details furnished therein are only indicative for the guidance of tenderer except those covered under Basic Data in Clause 2 of Part-II.

2. DETAILED OPERATING REQUIREMENTS AND OVERALL DIMENSIONS

2.1.1 The leading particulars of the Driving Power Cars (DPCs) & Power Car (PC) shall be as follows:

.1	Gauge	1676 mm
.2	Train formation	DPC+ PC+ DPC
.3	Maximum axle capacity	20.32 t
.4	Axle load (estimated)	17 t
.5	Pay load (estimated)	5 t
.6	Max. Operating speed (km/h)	160 km/h
.7	Max. Test speed (km/h)	175 km/h
.8	Brake System	Air brake
.9	Cattle guard	Yes (On both ends of DPCs)
.10	Profile of Driver's Cab	Aerodynamic

3. GAUGE AND MOVING DIMENSIONS

- 3.1 The coaches shall conform to Indian Railway BG Schedule of Dimension Revised 2004 (Latest Version).
- 3.2 The moving gauge of the HS SPART coaches shall be as per diagram no. 1D of Indian Railway BG Schedule of Dimension Revised 2004 (Latest Version).
- 3.3 Copy of Indian Railway BG Schedule of Dimension Revised 2004 (Latest Version) may be obtained on payment from The Director General / Track, RDSO, Manak Nagar, Lucknow (India) - 226011.

4. MAXIMUM CURVE AND GRADE

The coaches shall be capable of negotiating sharpest curves up to 175 m radius and steep grades as high as 1 in 37.

5. SERVICE CONDITIONS

5.1 The system should be in continuous operation during varying atmospheric and climatic conditions throughout the year. The equipment shall operate satisfactorily under the following climatic conditions:

Ambient temperature	:	-10 °C to 50 °C
Altitude	:	Sea level to 2500m
Max. Sun temperature	:	70° C
Relative humidity	:	10% to 100%

Rain fall: Very heavy in certain areas. The HS SPART shall be designed to permit its running at 10 km/h with water level of 200 mm above rail level.

During dry weather, the atmosphere is likely to be dusty.

6. PERFORMANCE REQUIREMENTS

The performance of coach shall be adjudged as per IR standing criteria for coaching stock given as under.

- 6.1 The value of acceleration recorded as near as possible to the bogie center pivot shall be limited to 0.30g both in vertical and lateral direction. A peak value upto 0.35 g may be permitted provided the records do not indicate a resonant tendency in the region of peak values.
- 6.2 Sperling's Ride Index shall not be greater than 3.0. The formula for calculating Sperling's Ride Index is given below:

$$\text{RIDE INDEX} = 0.896 \sqrt[10]{(b^3/f)*\phi(f)}$$

Where b = mean acceleration in cm/sec²

f = frequency in Hz

$\phi(f)$ = a correction factor allowing for the effect of frequencies and is

0.325 f² for vertical ride index (frequency from 1 to 3 Hz)

0.80 f² for lateral ride index (frequency from 1 to 3 Hz)

- 6.3 A general indication of stable riding characteristic as evidenced by the movement of bogies on straight and curve track and by acceleration reading and instantaneous wheel load variations /spring deflections.

7. RELIABILITY

- 7.1 In addition to meeting the performance requirements, the coach shall incorporate high standards of reliability to ensure that operating cost and operation performance are optimized.
- 7.2 The Contractor shall provide the achieved quantitative reliability data of major subsystems expressed in Mean Time between Failures (MTBF) and / or Mean Distance between Failures (MDBF), based on operation of proven coaches for a minimum of 3 years and 450,000 kilometres per coach in revenue service and inline with relevant IECs, for purchasers and IR's evaluation. The MTBF shall be submitted for the ambient temperatures of 45⁰C, 50⁰ C, 55⁰C and at the temperature expected inside the engine compartments as per tenderer's calculation.

8. FIRE PERFORMANCE

8.1 General

- (i) Each train shall be designed to minimise the risk of a fire starting, as far as is practically possible.
- (ii) Materials used in the construction of each train shall be selected to reduce to the maximum extent practical the heat load, rate of heat release, propensity to ignite, rate of flame spread, smoke emission and toxicity of combustion gases.
- (iii) The train shall be designed to prevent fire propagation through the use of fire barriers in the floor, and in walls at the sides and ends and fire resistant equipment housings. Flammable materials shall be well contained and protected.

- (iv) The Contractor shall comply BS 6853 – 1999 Category II or any other equivalent/superior international standard for fire safety plan as applicable to the HS SPART stock. Whichever standard is selected for meeting the fire safety, the standard shall be decided and a copy shall be furnished to RDSO .The plan shall also include the tests to be completed and shall be submitted for review by the IR.

- (v) The plan shall include the Standards to be followed and the tests to be completed and shall be submitted for review by the Purchaser.

PART - III

MECHANICAL REQUIREMENTS

1. CARBODY

- 1.1 Each rake consisting of 3 car units and shall be completely equipped for independent two way operation with driver's cab at each end. The rake shall perform identically in both forward and reverse direction.
- 1.2 The car body and attached equipment shall be designed to provide for adequate clearance between car body and bogies for worst case operating conditions, except for any stops attached to the car body for limiting bogie movement or for bogie lifting during maintenance. Worst case conditions may result from horizontal and vertical curves, tracks super elevation, worn wheels, maximum load, roll, yaw, lateral motion, and suspension system failures.
- 1.3 The structure of the car body including shell should be suitable for severe loading condition and have a design life of at least 35 years in the services under loaded conditions with no fatigue or permanent deformation failure.
- 1.4 The body shell shall be of integral lightweight construction consisting of separate assembly groups for under frame, sidewalls, roof and end walls, joined together to form a tubular structure. These assembly groups shall be made from the rolled sections or pressed plates and plain sheets which are suitable for welding. The car body shall be made by spot / resistance welding as suitable and internationally acceptable welding procedure for austenitic stainless steel to be used in the manufacture of car .The car body structure shall be designed to make effective use of metal in providing the required strength and stiffness. Portions of the roof, side frame, and under-frame shall be designed to form a girder to carry the longitudinal and vertical shear, and bending loads resulting from the specified vertical loads. In selecting the type and thickness of material to be used, the Contractor's design shall optimize strength, durability, and weight.
- 1.5 The coach structure shall be designed so as to withstand the load specified for the material used in accordance with International specification.
- 1.6 Modern aesthetic design will be adopted for the driving end of DPC. Use of fibre moulded sheets or any other similar material for the purpose of giving modern aesthetic design shall be avoided as far as possible.
- 1.7 The welding procedure adopted for building the body shall be of international class and no weld spots etc. should be visible. No visible fastener head shall be permitted. Welding shall cause minimum surface indentation, shall not cause permanent discolouration and shall be arranged in uniform pattern. Detailed weld procedure shall be submitted.

2. MATERIALS

- 2.1 The car body structure, including sheathing and underframe shall be constructed of light weight, high tensile austenitic stainless steel. All stainless structure which is in public view shall be AISI 301LN (low carbon, with nitrogen) or SUS301L (with Nitrogen) or better with a brush finish. Stainless steel sheathing on the sidewall shall be flat while the stainless steel sheathing on the roof may be flat or corrugated. In case corrugations are provided on the roof, the depth shall not be greater than 1/2 inch (12.7 mm) .The corrugations shall not trap moisture.

- 2.2 Based on the consideration of strength and workability for different structural members of coaches, different types of Austenitic stainless steel as permissible for the coach manufacturing can be used. As such complete coach including underframe of the coach shall be of Austenitic stainless steel. This shall include the floor and any other sheet material used to cover the floor members.
- 2.3 The selection of stainless steel shall ensure that there are no inter granular corrosion cracking and stress corrosion cracking. Tenderer shall confirm this with complete manufacturing and welding procedure/standards adopted and proof of its sustained successful working under loaded conditions as specified.
- 2.4 The weight of the coaches shall be kept as low as possible consistent with adequate strength to meet the loading without exceeding stresses and deflections specified values for the coach structure.
- 2.5 Contractor shall also study local availability of Austenitic stainless steel being used for coach building with Steel Authority of India and any other indigenous source and indicate if the available steel is suitable for HS SPART manufacture.

3. CONSTRUCTION

3.1 General

The manufacturer shall ensure interchangeability of components and uniformity of structure throughout the fleet for the purpose, a sufficient number of jigs, fixtures, and templates shall be used. Such parts of the bodies as underframes, side frames, end frames, and roofs shall be built on jigs. Interchangeability of all equipments, hangers on all cars without the use of shims or elongated holes shall be ensured.

Welding shall be used to assemble the car body structure. Resistance welding shall be used for attaching the sheath to the frame. Stiffeners shall be attached to the sheathing by resistance welding. The remainder of the car body structure shall be constructed by fusion welding or resistance welding. All weld patterns shall be identical on all cars.

Resistance welding may be used for attaching the hangers and brackets to car frame in sub-assembly for subsequent attachment of equipment or the brackets, supports, pipe hangers, conduit supports and other attachments which are not part of the car body structure may be attached to the structure with mechanical fasteners. Suitable reinforcement of the car framing members in subassembly shall be done to accept attachments during assembly. As far as possible, the holes for attachments shall be in the webs of framing members rather than in the flanges. At such locations where the attachment is made to a flange, suitable bulkheads shall be provided in the member at the location of the attachment to assist in transferring the load into the web. Gussets are to be of full height.

Where dissimilar metals are joined, they shall be protected against bimetallic /electrolytic corrosion. Tenderer shall corroborate the reason for using the dissimilar materials at such specific locations.

Adequate drainage shall be provided in all body-structure members, and elsewhere as necessary to preclude water entrapment. Enclosed structural cavities shall be vented to prevent accumulation of condensate. In areas where water might be ingested, corrosion-resistant drain pans and drain lines shall be provided and shall be arranged to divert the discharge clear of all equipment and structure. Means shall be provided to prevent clogging of drain lines and drain holes. Any enclosed structural cavities of the steel

members shall be treated with a rust-inhibiting coating. Interior floor should be capable of being washed with hose pipe. There should be no location where water may stagnate.

3.2 Structural Connections

Connections consisting of a primary structural member that resists the end sill, coupler, primary collision posts, secondary collision posts, bogie-to-car body connection, or bolster anchor bracket, loads shall be designed so that the ultimate strength of the connection exceeds the ultimate strength of the weakest member joined. All other structural connections shall be designed to withstand the worst-case normal loading specified.

Intermittent fillet welds on members under tension are not permissible. Similarly plug or slot welds on tension members are prohibited. Intermittent groove welds are prohibited. Stud welding to car body structure shall not be permitted. Stud welding to non-load carrying stiffeners and secondary structure is permitted.

As far as possible self tapping screws shall not be used for structural connections. With the exception of attachment points of floor panels, interior panels and trim, there shall be no tapped holes in car structure. Tapping plates may be used. Tapping plates shall be designed to the same strength standards as the equivalent nut.

All holes for mechanical fasteners shall be clean and free of burrs. The Contractor shall devise a method of removing the burrs on the far (blind) side of a blind hole, and a method for its inspection.

3.3 Surface Finish and Flatness

The finish shall be approved by the IR. All exterior non-corrugated surfaces shall be free of ripples and buckling. The surfaces of flanges and webs of all structural members shall be straight and flat, and free of ripples, buckling, dents, gashes and other surface imperfections.

The maximum acceptable variation from a straight line for car body exterior surfaces and surfaces of flanges and webs of all structural members shall be maximum 1.0 mm over a length of 1000 mm and in similar proportion for other lengths when measured on unpainted body shell.

4. REQUIREMENTS FOR STRENGTH OF CAR BODY

4.1 The mechanical strength of the car body structure shall comply with the requirements of UIC - 566 and shall be compatible in respect of Crashworthiness.

4.2 The carbody, and any equipment mounted on, beneath or within it shall be designed to withstand the fatigue loads that the car body structure will encounter in service during its design life. The fatigue life assessment of body structure shall be carried out using recognised techniques and shall be submitted by the Contractor for review by the IR's representative.

4.3 Stress analysis of the coach structure shall be done by Finite Element Method using a recognised computer programme such as NASTRAN, ANSYS or similar and shall be submitted for scrutiny and approval during design stage.

4.4 Crashworthiness Analysis

i) In order to assess the energy absorbing properties of the structure, a crash energy absorption computer analysis and simulation of the vehicle shall be performed. The

analysis shall be based on the assumption that one vehicle impacts a fixed barrier. A report of the analysis shall be prepared and submitted during design. Test results, if available for the similar designs shall be submitted with the analysis. Criteria for agreement shall be included in the test results, if submitted as above. However, actual crash test need not be carried out. The car body shall be constructed so as to confine structural damage to localize areas during minor collision.

- ii) For any portion of the proposed design which is based on a service-proven vehicle with energy absorption capabilities that are the same as specified and that have been verified by analysis and test, the Contractor may provide data from previous test and crashworthiness analyses as needed to satisfy equivalent portions of these requirements. The Contractors shall submit a detailed technical proposal and crashworthy analysis to specify the following (a, b, c, d & e) in respect of the fully loaded vehicle. The detailed proposal shall also specify the measures taken in the design to achieve the above objective and the proposals verification to satisfy the effectiveness of the design. The report shall show that structural members and the car body satisfy the crashworthiness requirements of the specification. The report shall demonstrate that the crushing of the car body is stable.
 - a) The maximum collision speed at which there is no structural damage to the car body and the coupler. The primary source of energy absorption shall be incorporated within the unit end coupler. At this collision speed the impact energy shall be absorbed within the recoverable stroke of the coupler resilient element and the motion of the vehicle shall be arrested without any structural damage of the vehicle.
 - b) The collision speed up to which the anti climber protection provided on the vehicle head stock shall remain fully engaged and operational.
 - c) The maximum speed at which the cab structural collapse features deform completely, without damage of the car body.
 - d) The maximum speed upto which the energy of impact is absorbed by progressive deformation of end structure.
 - e) The maximum speed upto which end structural deformation limited to the portion of the structure which is outboard of the bogie bolsters. There shall be no deformation between the bolsters.

4.5 Stress Analysis

General

- i) The Contractor shall submit a stress analysis of the car body structure and equipment supports for equipment weighing over 90kilograms. Stress analyses for supports for items weighing less than 90 kilograms may be requested for review at the discretion of IR. The stress analysis shall be used to design the car structure to meet the requirements of this Specification and to obtain the light-weight car consistent with requirements. Structural tests shall be performed to confirm the adequacy of the design and the accuracy of the analysis.
- ii) For any portion of the proposed design which is based on a service-proven vehicle, the Contractor may provide data from previous tests, historical data from operations, or stress analyses as required to satisfy the corresponding portion of these requirements.

4.6 **Structural Design Loads**

- i) For each joint design, the static stress at maximum axle load of car body load shall be less than the stress that determines the allowable fatigue stress range. This stress range must be within the design fatigue stress range (fatigue limit) obtained for non-redundant or redundant structures as applicable.
- ii) The dynamic factor shall be determined by the Contractor but shall not be less than ± 30 percent. The fatigue design shall be based on applied and allowable fatigue stress ranges at 10 million cycles.

4.7 **Floor Load**

The vehicle floor shall be designed to a uniformly distributed payload plus interior equipment, such as seats, interior liners, equipments and equipments boxes etc.

4.8 **Roof Load**

All parts of the roof structure and sheets, equipment covers, roof walkway, screens and other guards shall have sufficient strength to withstand, without permanent deformation, the load imposed by maintenance personnel carrying tools and equipment while working on the roof.

4.9 **Jacking Pads**

There shall be a minimum of four jack pads on each side sill. One jack pad shall be located under each primary side collision post. Another set of jack pads shall be located at the bolster to permit jacking the car with IR standard floor jacks so that the bogie can be rolled from under the car without removing any equipment or structure. The bottom of all jack pads shall have a non-skid surface to provide frictional resistance against incidental horizontal loading between the jack pad and jack head.

4.10 **Lifting Pads**

There shall be lifting pads located at the bottom of the side sills between the bolsters. These pads shall be designed for lifting the car with both bogies attached using overhead crane with lift hooks available in IR's maintenance depot /workshop. The car shall be capable of being lifted with four jacks, one at each quadrant of the car body in any combination.

4.11 **Jacking and Hoisting Loads**

Coach body shall lend itself to repeated lifting in workshops by overhead cranes or jacks without risk of damage. Suitable lifting pads shall be provided and marked in a distinguished manner on the coach body. The design shall be sufficiently rigid to withstand stresses imposed by lifting with overhead or break-down cranes used by the IR.

Each car body jack pad and its supporting structure shall have a load factor of two, based upon supporting vehicle weight. The vertical load on each jack shall be combined with a horizontal load of 10 percent of the vertical load applied in any horizontal direction. Under this loading condition, there shall be no permanent deformation of any car body structure.

The same load factors as above shall apply for lifting pads.

The car body with bogies attached, shall be capable of being lifted with four jacks, one at each quadrant of the car body either under the primary side collision post or bolsters, in any combination, without permanent deformation of any car body structure.

4.12 **Equipment Loads**

All supports shall be fatigue-resistant throughout the designed life of the car. Structural connections in equipment supports shall be subject to the requirements specified. In particular, equipment support fastenings shall be designed so that in no case shall either the strength of a fastener, or the shearing of the fasteners through the base material, be the limit of the carrying capacity of a member.

5.00 **Underfloor Equipment Supports**

- 5.01 Underfloor equipment weighing more than 90kg shall be supported directly by the side sills, body sills, or by transverse floor beams or longitudinal supports between transverse floor beams. All equipment shall be mounted with at least four supports, unless otherwise approved by IR. Dissimilar metals shall not be allowed at connections. Connection components shall not require disassembly, for maintenance, or for removal and replacement of equipment. Equipment requiring removal and replacement for other than accident damage shall be supported so that both bolts and nuts are easily accessible. Equipment supported on resilient mounts shall essentially be provided with safety straps or other devices for support in case of mount failure. The underfloor mounted equipment shall be provided with additional safety arrangement and shall be retained within clearance envelope after loss of any point of support. Equipment mounted on resilient mounts shall be designed to achieve positive retention above the clearance line in case a mount fails. No equipment weighing more than 10kg shall be supported by threaded fasteners in tension or shear. No equipment shall be supported by bolts in holes tapped in the car structure. However, it is permissible to use tapping plates in accordance with the requirements specified.

Equipment or equipment supports shall neither contribute to nor detract from the controlled crushing of the structure as required.

5.02 **Corrosion Protection**

A corrosion-resistant coating, as specified and if required, shall be applied to the entire underframe and the inside of side and end sheets. A corrosion resistant coating is not required on stainless steel members except for sound deadening as may be necessary to meet the noise limits specified. Protection against corrosion and painting of coaches shall be as per UIC 842-5.

6. **ROOF AND FLOOR CONSTRUCTION**

- 6.1 Roof Structure: Equipment mounted under the roof suspended from the roof structure shall be bolted to the framing members. The framing members shall be reinforced in sub-assembly to accept the equipment load.
- 6.2 The Contractor shall ensure the adequate water drainage from the roof such that no water is discharged into the vicinity of doorways. Rain gutters shall be provided over windows and doors. Roof equipment arrangement design shall not permit accumulation of water.
- 6.3 **Floor construction:** The floor shall be constructed so that all applicable noise, vibration, strength and fire endurance rating requirement are met. It shall provide high resistance to fire and to noise generated beneath the vehicle. A hard wearing non-slip fire retardant floor covering will be provided.

- 6.4 The floor panels shall meet the fire resistance requirements. The floor design shall allow the floor covering to be removed without damage to the floor sub structure.
- 6.5 The floor deck shall be designed to withstand the dead load plus passengers load. The floor deck shall be flame retardant and moisture proof.
- 6.6 Specific measure shall be taken to insulate the floor against the noise generated by suspension, wheel and braking etc.
- 6.7 The floor construction shall be such that it does not permit water to seep through the floor and cause corrosion to floor / underframe component. Indian Railways experience is that most of the corrosion take place due to seepage of water through the floor and through the window opening and door opening. The non-skid floor structure shall be designed so as to minimize the life cycle cost of the floor over its designed value.
- 6.8 The floor covering shall have high abrasion resistance, water proof and sealed, resistant to staining and shall be easily cleaned using conventional floor cleaning methods and suitable cleaning agent. The sub-floor shall be insulated for anti-drumming and noise suspension.
- 6.9 The openings in the flooring for the passage for pipes and cables shall be constructed as to prevent any seepage of the oil and in addition give effective protection against the spread of any fire originating beneath the body.

7. VENTILATION

Air-Conditioning shall be provided at suitable location for ensuring adequate comfort to the occupants in Supervisor van (DPC -I) and Medical van (PC). Contractor shall submit complete air-conditioning details including power supply arrangement etc. and shall be finalized before manufacture. Roof ventilators shall be provided on Tool van (DPC -II) at suitable locations.

8. VESTIBULES

The non-driving ends of DPCs and both ends of PC shall be provided with UIC type vestibules. The end walls design shall be such as to permit fixing of vestibules.

9. DOORS

- 9.1 Door shall be provided as shown in layouts. The body side doors of Supervisor van (DPC-I) and Medical van (PC) should be of a design that ensure proper sealing against water & dust ingress on the run for air-conditioning.
- 9.2 The body side doors shall also be provided with carriage door lock suitable for locking / unlocking with standard square key both from inside and outside.
- 9.3 Door hand holds shall not project outside the coach profile.
- 9.4 The door sill shall be constructed from or equipped with slip proof profile with excellent wear resistance and drainage effect for rain water.

10. WINDOWS

Body Side Double sealed glass windows shall be provided on Medical Van (PC) and Supervisor Van (DPC-I) and Body Side windows with louver shutters and glass shutters shall be provided on Tool Van (DPC-II) as shown in layouts.

11. INTERIOR FINISH & FURNISHINGS

- 11.1 The contractor shall propose world-class vehicle interiors, which incorporate a modern aesthetic approach with considerations to optimize human comfort, safety and security as well as to minimize noise in the coaches.
- 11.2 External paneling, including the under surface of the car roof and all interior surfaces of the car body side panels shall be coated with suitable anti-drumming compound, except where corrugated materials are used. The body side and roof outer skin shall have a suitable thickness of approved acoustic insulating material bonded to their interior surfaces.
- 11.3 The design of interior fittings shall be safe under all conditions of occupants and luggage impact during emergency braking and buffing under fully loaded conditions.
- 11.4 All non-metallic materials shall satisfy the requirements of toxicity, flammability and smoke emission limitations etc. as per BS 6853 or superior International standard.
- 11.5 All interior surfaces must be finished with good blending and good slow ageing properties to provide a pleasant, high quality interior and for ease of cleaning and maintenance.
- 11.6 All internal panels surfaces shall be smooth finished with modern low flammability, low smoke emission and low toxicity materials. All internal panels shall be resistant to graffiti, scuffing, vandalism and cleaning agents. Rounded corners or covings shall be provided wherever mutually perpendicular flat plane surfaces abut. Metal kicking strips of 150mm depth with radiused covering are required on all exposed vertical surfaces above floor level.
- 11.7 As far as possible, fastening devices, fixings and securing screws shall not be visible from within the coaches.
- 11.8 Gaps between all interior-lining panels, seat, shell etc. shall be minimized. The effects of the thermal expansion shall be taken into account and all unsealed gaps shall not exceed 1mm in depth where feasible. Suitable cushioning at panel joints shall be provided to suppress noise.
- 11.9 Equipment cupboard for housing equipment, for which access from the coach is necessary, may be provided at the car body ends.
- 11.10 Materials used shall comply with the relevant IS specifications. Where IS or BIS specifications do not exist, the contractor shall submit relevant specification for proposed material for approval. The contractor shall submit the test procedure of proposed material for approval.
- 11.11 The interiors and the furnishing material shall be warranted for manufacturing defects, breakage, discolouration, cracks etc. 6 years from date of commissioning.
- 11.12 3-D model drawings complete in all respect shall be submitted for approval of the interior-furnishing scheme.

12. BOGIE

General design:

- 12.1 Each coach shall have two 4-wheel bogies of fabricated, robust and welded frame design suitable for taking load from brake gear, suspension etc. and capable of withstanding the maximum static and dynamic stresses under loaded conditions and under the speed etc.,.

values as specified in clause 2.1.1 of part – II. The static and dynamic loads imposed by gear drive and transmission of power has to be taken into account and provision for the same, as per the operational requirements, shall be there in the bogie design.

- 12.2 The bogie shall be provided with two stage suspension with coil / rubber suspension in primary stage and air suspension in secondary stage with requisite damping in both vertical, lateral and if required in yawing modes also so as to ensure comfort and safety requirements. Calculations for determining the spring characteristics and damping value in various modes will be submitted by the Contractor.
- 12.3 It shall be constructed to continue in service, under normal operating conditions for at least its designed life of 35 years, assuming normal wear and tear, and maintenance. During that period, there shall be no major rebuild, repair or strengthening of any bogie structural members.
- 12.4 The design shall provide means for easy compensation for wheel wear and loss of height in the bogie resulting from other causes.
- 12.5 The axle yaw stiffness, and the rotational resistance of the complete bogie shall be such that lateral flange forces generated when negotiating the track alignments for the route specified are not so high to lead to excessive rail wear and wheel flange wear, but shall be sufficient to obviate bogie or wheel set hunting.
- 12.6 The weight of the bogie shall be as low as possible consistent with strength and robustness. The bogie shall be capable of negotiating curves of 10^0 and ruling gradient as high as 1 in 37.
- 12.7 The natural frequencies of vibration of the vehicle body when fully fitted and equipped, shall be separated sufficiently from the suspension frequencies so as to avoid the occurrence of undesirable responses at any speed, vehicle loading or suspension condition. Additionally, the suspension shall not excite the body to an extent that the desired ride criteria are not attained.
- 12.8 **Bogie Strength:** The mechanical strength including fatigue test of the bogie frame shall comply with the requirement of UIC 615 - 4 and UIC 515 - 4 and the requirements of the specification.

13. RUNNING GEAR

- 13.1 The material for powered axles shall be to IRS: R-43/92. The material for non-powered axles shall be to IRS: R-16/95 and forged steel wheel to IRS: R-19/93 Pt. II. Suitable axle box and roller bearings shall be provided so as to ensure safe and reliable running during train operations.
- 13.2 Roller bearings shall have minimum life rating of 650000 kms when computed as per methodology given in ISO 281/1. Lubrication of the roller bearings shall be in accordance with the recommendations of the manufacturers.
- 13.3 The powered axle shall be designed in accordance with DIN EN 13104 and non-powered axle shall be designed to DIN EN 13103 & calculation submitted along with input data.
- 13.4 The wheels shall be designed in accordance with UIC 510 – 5(0) and FEM calculation submitted along with input data.

14. EXTERIOR AND INTERIOR COLOUR SCHEME

Exterior and Interior colour scheme of HS SPART coaches shall be got approved by RDSO/Railway board.

15. CATTLE GUARD

Cattle guard shall be provided at the driving ends of each unit .The cattle guard shall have enough strength so as not to collapse on line in case of collision with stray animals like cows etc. In any case, damage to the system shall be minimum and it shall be ensured that the train service is not adversely affected. It shall be so designed that it shall reduce likelihood of vehicle roll over by reducing surfaces which can trap object, and should also present an integral look to the vehicle besides providing high level of safety.

16. EXTERIOR FITTINGS & FINISHING

16.1 Foot-steps shall be provided at all body side doors. A wearing plate shall be provided on all top footsteps. Distance between the adjacent foot-steps should approximate be 200mm.

16.2 Boards and number plates with mounting brackets shall be provided on both sides of the coach.

16.3 Door hand hold arrangement shall be provided in all doorways.

17. MARKING:

Coach shall be marked generally to a marking scheme, which shall be got approved from RDSO.

18. COUPLER

18.1 Schaku semi permanent couplers shall be provided at ends of coaches except the driving ends of DPC-I and DPC-II, which shall be provided with hooks.

18.2 The couplers shall allow coupled coaches to negotiate curves of 10⁰.

18.3 It shall be possible for Indian Railway to employ a separate power unit to move the HS-SPART.

19. SEATS & BERTHS

Seats & Berths shall be ergonomically designed. All seats & Berths and backrests shall be cushioned with fire retardant non-toxic material to BS - 6853 or superior International standard. The seats shall be firmly fixed to the frame, which shall be robust enough to stand overload. Underseat supports shall be constructed and located to allow for clearance, provide easy access to the floor below the seat for cleaning and washing.

20. DRIVER'S CABS

20.1 Driver's cab shall be air-conditioned & with aerodynamic profile and shall include all the necessary equipments required. Contractor shall submit complete air-conditioning details including power supply arrangement etc. and shall be finalized before manufacture.

20.2 Microphone for PA system of suitable wattage with facility to store 3 CDs at a time with appropriate tone and volume control. PA shall be able to work from the power supply system provided in the HS SPART.

20.3 Driver's cab and driver's seat should be ergonomically designed and should afford easy visibility and access to controls/gauges.

- 20.4 Half slider opening side window shall be fitted in the driver's cab.
- 20.5 A sliding door between the driver's cabin and Tool van / Supervisor van compartment with the provision of locking from inside shall be provided.
- 20.6 Distribution fuse board and switches for the lights of Tool van / Supervisor van / Medical van area shall be located in driver's cabin.
- 20.7 Electric bell communication between the driver and Tool van / Supervisor van / Medical van shall be provided, with switches at suitable locations in the compartment.
- 20.8 Layout of driver's control desk and other equipment in the driver's cabin shall be submitted for approval.
- 20.9 HS SPART shall have single piece stone proof look out glass for the drivers cab.
- 20.10 Provision of clip pad for caution orders, walky-talky and tumbler holder arrangement shall be made in drivers cab.
- 20.11 Fire retardant paneling similar in colour scheme and material being offered by the tenderer for the interior of the coach shall be used in drivers cab.
- 20.12 A footrest shall be provided in front of driver's seat.
- 20.13 The cab shall be adequately insulated against noise, vibration, heat and ingress of water and dust.
- 20.14 Step-irons to Drivers' compartments: Steel step-irons shall be provided below the entrance to each driver's compartment, and shall be so located as to provide a convenient foot-hold without infringement of maximum moving dimensions diagram 1D of BG IR SOD revised 2004 (latest revision).
- 20.15 The general layout and arrangement of equipment in drivers cab shall follow UIC – 651 OR (latest version) with respect to dimensions, safety features, furnishing, lighting, ventilation, noise level, field of view, drivers desk and seats. Spot light shall be provided at suitable locations.
- 20.16 The panels and driver seat shall be so placed relatively that driver gets best forward view. Access to the cab will be from either side of the cab by means of doors which shall be of sliding type flushing with the side wall when closed.
- 20.17 Each cab shall be provided with the following:
- (a) Two pneumatic motor driven wind screen wipers with emergency manual control.
 - (b) Two fans for crew
 - (c) Two fire extinguishers and one first aid box.
 - (d) One signal exchange device between driver- guard and driving cab & emergency cab shall be decided during design stage
 - (e) Two dual tone heavy duty pneumatic horns
 - (f) Communication arrangement between driver & guard
 - (g) A suitable Display Unit for displaying status of engine parameters shall be provided. The speed and Brake Pipe pressure should be prominently displayed.

20.18 Cab Floor

The cab floor shall be clear of all discontinuities, and shall not incorporate access panels to underfloor mounted equipment, junction boxes and cable ducts. It shall be possible to undertake water washing of the cab floor without damage to the floor or equipment.

20.19 Cab Lighting

The cab shall be provided with ceiling lights, providing 200 lux at 1 m above floor level. It shall be operated automatically by the opening of either cab door, and extinguished manually from within the cab.

ELASTOMERS

21.1 All elastomeric parts shall be of neoprene, unless otherwise required, the elastomer shall be compounded and cured to perform satisfactorily in the temperature range specified in this specification. The elastomers shall have high resistance to ultraviolet radiation, weather, washing fluids used by IR, salt deposits and the longest possible life consistent with the other characteristics specified. All elastomeric parts shall be resistant to Ozone, oxidation, heat, oil, grease, salts and acids. The resilient mounts shall be of natural rubber. Synthetic rubber compounds may be substituted for natural rubber only when approved for a specific application.

21.2 **Life expectancy:** For all parts made by vulcanising an elastomer to metal a service life of six years should be obtained when parts are used in normal service. All rubber parts shall be compounded to be resistant to abrasion, grease and oil.

22. JERK LIMIT

Under all normal operating conditions, the rate of change of coach acceleration or deceleration shall not be more than 0.75 m/s^3 . Failure of the jerk limiting system shall not limit braking effort. Emergency brake applications and any associated ramp out of propulsion shall not be jerk limited.

PART - IV**POWER & TRACTION EQUIPMENT, CONTROLS AND AUXILIARIES****1. GENERAL**

- 1.1 The HS SPART shall consist of two Driving Power Cars (DPCs) and one non-driving Power Car (PC).
- 1.2 The gross power shall not be less than 2000 hp under standard UIC condition, and shall be sufficient enough to meet the operating requirements with acceleration reserve of 6 %, and ageing reserve of 5 %. This power should be derived from three equally distributed independent power units installed on two DPCs, and one PC, each consisting of a fuel efficient diesel engine transmitting power to the wheels through hydrodynamic transmissions, cardan shaft & axle drive gearbox.
- 1.3 It shall be possible to operate the HS SPART with Single / Two / Three Power packs. There shall be provision to switch-off any power pack as per operational requirement.
- 1.4 The equipment shall incorporate features to ensure high availability of HS SPART, low maintenance requirements and high reliability in operation and excellent transmission efficiency.
- 1.5 Easy access for inspection and maintenance requiring minimum attention shall be given special consideration in the design of the power equipments and the layout of HS SPART.
- 1.6 The engine and transmission systems shall be electronically controlled.
- 1.7 **Scope of Supply:** Scope of supply of equipment/systems to be provided in 3-coach HS SPART shall be as under: -

S. No.	Item Description	Qty/ SPART
.1	Fuel efficient diesel engine capable of producing a combined total power not less than 2000 hp (under standard UIC condition.) with mounting pads & brackets, associated equipment and controls, Eliminator filtration system, Engine driven alternator for charging battery for engine cranking, Electric motor driven Cooling equipment complete with radiator, Fuel pipes and Fittings.	3
.2	Hydrodynamic transmission of proven design in rail traction application, with mounting pads & brackets, associated equipment and controls.	3
.3	Proven axle drive gearbox of suitable gear ratio for 175 km/h, powered axle & torque arm complete.	3
.4	Cardan shaft of proven make for drive between transmission and axle drive.	3
.5	Electrical motor driven air compressor.	2
.6	Engine driven alternator of adequate capacity.	3
.7	Controls & instrumentation for SPART (1 set for each DPC)	2 set
.8	Battery: a. 24 V, 290 Ah for engine starting b. 110 V, 120Ah for controls	3 set 1 set
.9	DA set of adequate capacity	2 nos.
.10	Speed recorder cum indicator in one DPC & speed indicator in other DPC	1 set

- 1.8 The manufacturer may decide upon any other item, which is essential for manufacture of HS SPART and not included in the above scope.
- 1.9 The power equipment and their mounting arrangements shall be of robust design for traction duty and shall withstand the vibration and shocks normally encountered in service to UIC codes. Skid mounted power equipment shall be preferred. The installation drawings of power equipment shall be submitted by the supplier.
2. **DIESEL ENGINE:**
 - 2.1 The gross hp requirement is estimated at minimum 2000 hp under standard UIC condition. This power shall be derived from three equally distributed independent power units installed on two DPCs and one PC, consisting of fuel efficient diesel engine. The tenderer shall indicate the horsepower of engine under site conditions as per UIC condition. The tenderer shall supply engine driven alternator of adequate capacity as standard accessory for charging battery for engine cranking. The main auxiliaries like compressor drive for cooling equipment etc. shall be electrically driven. The Contractor shall however, indicate the total horsepower required for auxiliary, if any, with break-up power requirements for each of the auxiliary machines at rated output.
 - 2.2 The tractive effort available at various speeds under adverse climatic conditions shall not be, under any circumstances, inferior to RDSO graph no. G.DP – 1179 placed at Annexure - V. Supplier shall submit TE Vs speed curve with matching calculation and superimpose RDSO curve to compare performance.
 - 2.3 If notch control is provided, the tenderer shall submit notch wise engine rpm and power. The tenderer shall also submit graphs showing the BMEP / Engine output torque and SFC at all notch levels.
 - 2.4 Air intake with filters, ducts and exhaust arrangement shall be compatible with engine system.
 - 2.5 Filters for engine air intake shall be of adequate airflow capacity and shall be provided with restriction indicator to ensure satisfactory performance under dusty environment.
 - 2.6 The exhaust and silencer arrangement of engine shall be properly routed for emission. The exhaust pipe shall be horizontal and located under floor avoiding the position near entrance to the car.
 - 2.7 The diesel engine shall work satisfactorily with fuel oil to Indian Standard Specification No. 1460 (2005).
 - 2.8 The exhaust emission of diesel engine shall follow the UIC - I (UIC - 624, 1st edition, April'2002) standards or better. In case emission standard is different from UIC - I, then the tenderer shall clearly spell out the emission standard of the engine being offered.
 - 2.9 The fuel tank of adequate capacity, about 2000 litre for each DPC/PC shall be provided.
 - 2.10 The detailed torsional vibration analysis of the complete dynamic system under normal engine working as well as under conditions of one cylinder misfiring for the complete operating range including 10% over speed shall be furnished.
 - 2.11 The tenderer shall furnish a copy of **Type Test report of the Engine** by a Statutory Body in support of their claim regarding performance, reliability and specific fuel consumption. In case the engine offered is not Type tested earlier, the testing shall be carried out in the

presence of RDSO or its authorized representative. In case engine is type tested, it shall be routine tested in the presence of RDSO or its authorized representative.

3. COOLING EQUIPMENT

- 3.1 The cooling equipment shall be guaranteed to work efficiently. Apart from meeting the requirements of diesel engine, the cooling equipment shall be required to dissipate heat of transmission oil so that maximum temperature of transmission oil at any time under continuous full load working shall not exceed 110° Celsius.
- 3.2 Radiator of adequate capacity for cooling the water, lubricating oil and transmission oil, shall be provided. The cooling system shall be with excess capacity of 30% towards choking. The heat dissipating requirement of the transmission oil shall be heat equivalent of 30% of the maximum horsepower input to the transmission under most adverse site conditions.
- 3.3 The cooling system shall be adequately pressurized and vented to avoid all possibilities of cavitations.
- 3.4 The maximum operating water temperature shall normally not exceed 90° Celsius.
- 3.5 The electric motor driven radiator fan shall be provided.
- 3.6 Installation drawings for the radiator and fan with details of fan drive and mounting arrangement shall be supplied by the tenderer.
- 3.7 The cooling system shall be effective and efficient in both directions of running of the SPART.
- 3.8 The following technical information about the cooling equipment shall be furnished:
 - .1 Cooling requirements for all sources of heat (with break up).
 - .2 Heat dissipation characteristics of the radiator (including lube oil cooler) and its resistance characteristic.
 - .3 Radiator fan characteristics showing the air flow vs. total head at different fan speeds.
 - .4 Cooling system matching calculations.
 - .5 Schematic cooling circuit diagram showing water, oil and air flow through each equipment.

4. TRANSMISSION SYSTEM

4.1 Hydraulic Transmission:

- 4.1.1 Energy efficient hydrodynamic transmission proven on rail traction application shall be used. The combined tractive effort available at various speeds under adverse climatic conditions shall not be inferior to RDSO graph no. **G.DP – 1179** placed at Annexure - V. Supplier shall submit Tractive Effort Vs Speed curve with matching calculation.
- 4.1.2 Offered transmission shall not call for any special attention during towing of HS SPART due to power equipment failure.
- 4.1.3 Special care shall be taken to ensure reliable and efficient performance of the transmission without developing a temperature beyond the safe permitted limit during full load operation. It shall be insensitive towards vibrations and thermal or mechanical overloads. The system shall not call for any special care on the part of the driver to protect the transmission from damage under any circumstances.

- 4.1.4 Selection of suitable coupling between engine and transmission shall be the responsibility of the supplier in consultation with OEM.
- 4.1.5 The tenderer shall furnish a copy of **Type Test report of the Transmission** by a Statutory Body in support of their claim regarding performance and reliability. In case, the transmission offered is not type tested earlier, the testing shall be carried out in the presence of RDSO or its authorized representative. In case transmission is type tested, it shall be routine tested in the presence of RDSO or its authorized representative.
- 4.1.6 The contractor shall offer **combined power pack** i.e. engine along with hydraulic transmission on test bed for validation of matched set for prototype HS SPART.
- 4.1.7 The contractor shall be responsible for ensuring proper alignment of engine and transmission.
- 4.1.8 After mounting of the power equipment on the HS SPART, the contractor shall carry out stall test and running test to demonstrate the satisfactory performance of offered power equipment as per Clause 4.4. Contractor shall indicate the **stall rpm**.
- 4.1.9 The tenderer shall submit details of reversing mechanism if it is not integral part of transmission.

4.2 **Axle Drive Gear Box with Powered Axle**

- 4.2.1 Proven axle drive gear box of suitable gear ratio for 175 kmph, complete with powered axles & torque reaction arm shall be used. One axle drive shall power inner axle of one bogie of each car. The tenderer shall ensure that the offered power equipment is well matched with the axle drive and meets the performance requirements. Supplier will submit maximum torque capacity of axle drive at start.
- 4.2.2 The input flange of the axle drive shall be oil injection mounted.
- 4.2.3 The powered axle shall conform to IRS R- 43.
- 4.2.4 The tenderer shall furnish a copy of **Type Test report of the ADGB** by a Statutory Body in support of their claim regarding performance and reliability. In case the ADGB offered is not Type tested earlier, the testing shall be carried out in the presence of RDSO or its authorized representative. In case ADGB is type tested, it shall be routine tested in the presence of RDSO or its authorized representative.

4.3 **Cardan Shafts:**

- 4.3.1 The cardan shaft shall be of robust design and well proven in performance capability, suitable for transmitting rated horsepower and maximum torque encountered during operation. The tenderer shall furnish detailed technical data of the cardan shafts offered.
- 4.3.2 The resultant angularity of cardan shaft, when connected, shall be within 5⁰.
- 4.3.3 The tenderer shall submit along with his offer, complete technical data for complete power equipment offered as per Annexure-VIII.

4.4 **Performance Test:** The offered power equipment shall be subjected to performance test as detailed below:

- 4.4.1 Type test / routine test of:

- Diesel engine
- Transmission
- Axle drive gear box

4.4.2 Engine and transmission combined test on test bed.

4.4.3 After mounting of power equipment on SPART:

- Functional test
- Stall test
- Running test

The above tests shall be carried out in presence of RDSO representatives or authorized person as per Test Programme mutually agreed to, between the contractor and the Indian Railways.

5. Auxiliary DG set:

5.1 The Supervisor van and Tool van of HS SPART shall be provided with one auxiliary DA set of adequate capacity each, of which one will be standby.

5.2 The following anticipated electrical loads will be catered by the suitable auxiliary DG set:

S.No.	Description	Load (kW)
	AC-RMPU for MRV & supervisor van – 3 Nos.	45.0
	WRA pump – 2 Nos. (Only 1 works at a time)	0.746
	Fans – 0.84 kW per coach for 3 coaches	2.52
	Lights – 1.2 kW per coach for 3 coaches	3.6
	Cardiac Monitor	0.25
	Transport Ventilator	0.3
	Electric Coterie	1.0
	Pulse Accumulator	0.2
	Autoclave	2.0
	Water sterilizer	1.8
	Refrigerator	0.746
	Kitchen load	6.0
	Headlight – 2 Nos., Marker light, Tail light- 2 nos., Flasher light	1.0
	110V Battery Charger	1.0
	Air compressor electric motor driven	13.5
	Traction Engine cooling fan load @ 24 kW per powerpack	72.0
	DA set cooling fan load @ 8 kW per set	8.0
	Ventilation fan for Auxiliary DA set@ 5 kW per set	5.0

5.3 The Genset room shall be provided with adequate sound proofing to overcome noise pollution.

5.4 Both the gensets will be required to work at accident site and the controls shall be accordingly provided so that these can be worked as single or a combined unit.

5.5 Changeover switch of adequate rating and approved make between two 125 kVA Genset shall be provided in case one Genset is mal-functioning.

5.6 A suitable radiator for cooling of DA set shall be mounted on rooftop of the Supervisor van/Tool Van.

6 **ALTERNATOR:**

6.1 Engine driven alternator of adequate capacity for charging 24 V batteries shall be provided.

7 **BATTERY:**

7.1 **Starter Battery:** 24 V, 450 Ah, low maintenance Lead Acid storage batteries (min. 5 hrs. discharge rate) preferably conforming to RDSO/PE/SPEC/TL/0001-1998 (Rev-0) and of approved make shall be provided. Adequate fuse protection shall be given in positive and negative battery circuit. The battery shall cater to 3 cranking of engine at 10 seconds interval.

7.2 **Battery for controls (110V system):** 6V, 120 Ah x 18 nos. monobloc type VRLA batteries of approved make conforming to RDSO specification no. RDSO/PE/SPEC/AC/0009 - 2008 (Rev. 1) with Amendment no.1 or with latest amendment with charging facility at 110 V for controls in medical van shall be provided for light and controls.

7.3 Terminals for charging the batteries from an external source shall also be provided.

7.4 Plug socket terminals for charging the battery from external supply shall be provided.

8 **COMPRESSOR:**

8.1 Two numbers of electrical motor driven air compressor each of 1350 LPM FAD at 8 Kg /cm² to meet the requirements of braking shall be provided. OEM shall specify the correct grade of compressor oil suitable for operation of compressor under given climatic condition as per Clause 5 of Part-II. One compressor will act as standby.

9 **CONTROL AND INSTRUMENTATION:**

9.1 Adequate control equipment including gauges, instruments, and safety devices shall be provided for safe and satisfactory operation of the HS SPART. The equipment and controls shall be so arranged in the driving cab, that they facilitate easy access for operation and maintenance. Interlocks shall be provided such that HS SPART can be operated **from one DPC only at a time.**

9.2 Power On-Off indication for each powerpack shall be provided on control panel of each driving cab.

9.3 **Gauges, Instruments and Safety Devices :**

9.3.1 **Diesel Engine**

- .1 Engine starting switch/push button.
- .2 Engine throttle master controller
- .3 Lube oil pressure gauge
- .4 Lube oil temperature gauge
- .5 Cooling water temperature gauge
- .6 Battery charge/discharge Ammeter
- .7 Engine hour meter and engine speed indicator
- .8 Engine stop switch/push button
- .9 Emergency stop (Engine)
- .10 Glow type fuel level indicator
- .11 Radiator water level indicator

9.3.2 Transmission

- .1 Transmission oil temperature gauge
- .2 Transmission oil pressure gauge
- .3 Transmission clutch oil pressure gauge

9.3.3 Other Gauges

The HS SPART shall be provided with the following gauges pertaining to brake system. All the gauges should be LED type self-illuminated.

- .1 Main reservoir pressure gauge 4”
- .2 Brake cylinder pressure gauge 4”
- .3 Brake pipe pressure gauge 4”
- .4 Vehicle speed indicator cum recorder (in one DPC)
- .5 Vehicle speed indicator (in other DPC)

All gauges shall be of proven and reliable design. Graduations of the gauges shall be in metric units.

9.3.4 The following safety devices shall be provided :

- .1 Water temperature too high - Engine to idle
- .2 Transmission oil temperature high - Engine to idle
- .3 Low lube oil pressure - Engine to shut down
- .4 Engine speed too high - Engine to shut down
- .5 Radiator water level too low - Engine to shut down
- .6 Vigilance Control Device - Brake to apply, Engine to idle & Transmission to neutral

9.3.5 The following Audio -Visual Signals or Reference panel lights shall be provided in the driver's cab :

- .1 Lube oil temperature too high
- .2 Radiator water temperature too high
- .3 Engine lube oil pressure low.
- .4 Engine shut down by safety relay
- .5 Forward/ Reverse proving lamp.
- .6 Engine starting
- .7 Engine over speed
- .8 Battery charging / discharging

9.4 The control system shall have the provision for connecting the Deadman's device. When the device operates, the engine should come to idle and simultaneously the de-clutching of transmission should take place.

10.1 SPEED INDICATOR / RECORDER:

- 10.1 Speed indicating and recording equipment of 0 - 200 km/h range, shall consist of an axle box mounted opto-electronic speed sensor, one junction box, one speed indicator and one recorder cum indicator unit with micro controller containing FLASH EEPROM internal memory for calculating and recording the journey data. A portable FLASH memory card shall be used for external memory. The equipment shall conform to RDSO specification No.MP-0.3700-07 (Rev.05) of August '2008.

11. CABLES & OTHER ELECTRICAL FITTINGS:

- 11.1 Electron Beam Irradiated Power & control cables of standard metric sizes shall be provided as per RDSO Specification No. ELRS/SPEC/ELC/0019 (Data Sheet 2A and 2B) Rev.0. Terminal ends for control cables and wire shall conform to RDSO Specification No.MP-0.5200.04.
- 11.2 The Power car shall be equipped at both ends with standard headlights to RDSO specification for **Twin Beam Head Light** with 24 halogen lamps for electric, diesel electric and EMU no. ELRS/SPEC/PR/0024 (Rev-1), Sept'2004 and specification for DC-DC Converter for electric loco. /diesel electric loco No. ELRS/SPEC/DC-DC Converter/0021, (Rev-1), Sept'2004.
- 11.3 Aspect lights, cab lights/ conduits etc. shall be of proven type available indigenously.
- 11.4 The power car shall be provided with **Marker light** to RDSO specification for LED Marker light for electric loco/diesel electric loco No. ELRS/SPEC/ PR/0022, (Rev-1) October'2004.
- 11.5 The Power car shall be provided with **Flasher lights** to RDSO Spec. for LED based Flasher light units for electric loco/diesel hydraulic loco/EMU/DMU No. ELRS/SPEC/LFL/0017(Rev.1) of Sept'2004.
- 11.6 SPART shall be provided with red **LED blinking type Tail light 2 Nos.** at each end of car to RDSO specification no. RDSO/PE/SPEC/EMU/0063 with latest revision.

12. MAINTENANCE AND SPARES:

- 12.1 The tenderer shall submit quotation separately for Annual maintenance for the following equipment. The Railways will have right to accept or reject the offer for Annual Maintenance contract. The scope of proposed AMC is as under:

12.1.1 For traction power equipment:

- a) Diesel engine
- b) Transmission
- c) Drive system (Axle drive, cardan shaft etc.)
- d) Controls & safety items
- e) Cooling system equipment

12.1.2 For DA set

- a) Diesel engine
- b) Alternator
- c) Ventilation & Cooling system equipment
- d) Controls & safety items

12.2 Contractor shall be responsible for

- a) Carrying out the scheduled maintenance as per recommendation of OEM:
 - i) Routine maintenance (i.e. Filter cleaning/change, oil top up / change etc.)
 - ii) Periodic maintenance at fixed intervals or on the basis of hours of usage as recommended by OEM.
 - iii) Annual maintenance (i.e. Checking of condition of gears and other parts of transmission - Top overhaul / D check etc.)
 - iv) Major Overhaul

- b) Out of schedule maintenance, like attending to major failure, if any.
 - c) Provision of spares required for carrying out the above maintenance.
- 12.3 The contractor shall be responsible for trouble free working of the equipment. He shall also be responsible for ensuring subsequent availability of spares of respective equipments.
- 12.4 The offer shall include cost of each schedule/check. Equipment that will replace in each schedule shall also be clearly mentioned in the offer.
- 12.5 The maintenance contract will be valid for 7 years.
- 12.6 He shall also submit comprehensive list of minimum consumable and non-consumable spares required to be stored as emergency spares to meet the out of schedule requirements
- 12.7 The contractor shall be responsible for carrying out the schedules in time and use quality spares to ensure that the downtime of SPART is maintained below 10%.
- 12.8 The contractor shall ensure the reliability of spares used during routine or periodic maintenance. In case of premature failure of such components, it shall be the responsibility of the contractor to replace them free of cost.
- 12.9 In case of any failure that calls for out of schedule attention, the contractor will attend the same with utmost priority. If situation warrants, he shall carry out failure analysis of failed component and ensure that such failures are not repeated.
13. **WARRANTY / GUARANTEE:**
- 13.1 IRS conditions of contract – Para 3200 shall apply.
- 13.2 Apart from IRS conditions of contract – Para 3200, the following warranty / guarantee conditions shall also apply:
- The Contractor shall at his expense, replace any part of the equipment failing or proving unsatisfactory in service due to defective/faulty design, defective material or bad workmanship within a period of 24 months from the date of placement in service or 30 months from date of delivery whichever is earlier. The period of warranty shall stand extended by the time taken by the firm in replacing the defective component from the date of lodging of complaint by the user Railway. All aspects of workmanship and design shall be covered by this warranty. The Contractor shall immediately provide arrangement for rectification of failures reported under warranty.
- If any equipment of the system has undergone major design modifications during the warranty period, warranty period of the equipment may be extended as per mutual agreement between RDSO and Contractor.
14. **INFRINGEMENT OF PATENT RIGHTS:**
- Indian Railway shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, components used in design, development and manufacturing of complete system and any other factor, which may cause such dispute. The responsibility to settle any issue lies with the manufacturer.

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PART – V

BRAKE SYSTEM

1. Brake System

- 1.1 The HS SPART shall be provided with twin pipe graduated release air brake system. It shall be of UIC approved type and shall meet all UIC requirements. It shall have the following distinct positions:
 - i) Release and running positions
 - ii) Minimum reduction position
 - iii) Full application position
 - iv) Emergency position
- 1.2 The emergency braking distance (EBD) for HS SPART with the maximum speed of 160 km/h shall be substantially less than 1000 m.
- 1.3 The HS SPART shall be provided with the following additional brake requirements:
 - i) One Emergency brake valve in each driving cab on extreme right hand side.
 - ii) Stand-by brakes (SA-9), in case of failure of distributor valve or any component in the main brake system.
 - (iii) Stand-alone VCD of approved make conforming to Spec. No. MP-0.34.00.04 (Rev-03), Aug'2006 should be provided.
- 1.4 Application of any type of brake provided on the HS SPART shall result in simultaneous cutting of the power to the driving axles.
- 1.5 The brake rigging arrangements shall be light and as simple as possible with minimum number of levers and fulcrum points permitting easy access to Disc brakes and other wearing parts.
- 1.6 Brake system shall be provided with automatic slack adjuster built into the brake cylinder.
- 1.7 Adequate safety straps shall be provided below the moving components of the brake rigging and other components to prevent falling on the track in the event of failure of any component.
- 1.8 Parking brake to RDSO spec CK 408 (latest revision) capable of holding fully loaded on steep down gradient under wet condition shall be provided. The Parking brake should be adequate to hold the 3-Car unit under loaded condition stationary on 1 in 37 grade.
- 1.9 The supplier shall submit details of brake system covering brake schematic diagram, working principle, brake power diagram calculation for EBD, number, dimension and type of Disc brakes and literature on brake equipments proposed along with offer and get the brake system approved from RDSO before manufacture of the prototype.
- 1.10 Air dryer of approved make conforming to Spec. No. MP-0.01.00.06 (Rev-03), March'2007 should be provided.
- 1.11 Main reservoirs of adequate capacity shall be provided. In addition, a separate braking reservoir and a non-return valve be provided for braking only. Suitable drain valves/cocks shall be provided to drain off the condensate in the reservoir (s). An automatic drain valve shall be provided where feasible in addition to manually operated drain valves/cocks.
- 1.12 The tenderer shall be required to supply the detailed drawings, specifications and testing procedure for rubber components/parts of all the valves/cocks used in the brake system

and shall guarantees for satisfactory working of the components at least for 24 months from the date of supply and 18 months from the date of commissioning. The supplier shall also get the brake schematic approved by the RDSO.

2. PARKING BRAKE

2.1 Provision of the Parking brake shall be made in either of the driving coaches.

3.0 EMERGENCY ALARM COMMUNICATION

3.1 The consist shall be provided with emergency alarm communication system.

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PART - VI

COACH LIGHTING

1.0 GENERAL

- 1.1 This covers the requirements of lighting equipment to be installed in the HSSPART. Lights and fans shall be as per layouts mentioned in Annexure – I of this specification.
- 1.2 One belt driven auxiliary generator provided on each DPC shall meet the power supply of lights & fans for all 3 coaches and 110 V battery charging to the HSSPART. Battery pack shall be provided on each DPC for power supply to lights and fans during engine shut down position.

2.0 WIRING

- 2.1 The code of practice for wiring as per EL/TL/48 shall be generally followed. Each driving cab shall be provided with a control panel with controlling switches for lighting and fan circuits. Suitable indication lamps shall be provided to indicate the working of the generator and ON/OFF positions of various feeders. The configuration of coupler wires shall be such as to meet the above requirements. The controls of lights and fans shall be possible from any of the driving cabs.

3.0 INTER CAB COUPLERS

- 3.1 Power and trailer coaches shall be connected to each other by means of suitable electrical power couplers and socket arrangements so that the control of lights , fans etc in all the coaches of the unit is possible from any driving cab. Each end wall of the coach shall have a socket on one side and coupler plug on other side so as to permit flexibility in operation.

4.0 LIGHT FITTINGS

- 4.1 Centralized light fittings with MCB protection at end wall shall be provided as per ICF modified light fittings arrangement.

5.0 FANS

- 5.1 Brush less d.c (BLDC) fixed type of fans of 400 mm sweep shall be provided. Each fan shall be controlled by its own switch. The fan base shall be insulated from the coach body and the coach wiring shall be terminated to 2-way connectors supplied with the fan and fixed on the ceiling.

6.0 LIGHTS

- 6.1 **Interior:** Fluorescent fittings shall be used for lighting the compartment as shown in layout drawing of Supervisor van, Medical van and Tool van.
- 6.2 **Exterior:** External light fittings will work on 110 V DC. 15W incandescent lamps to IS: 897 shall be fitted at locations as shown in the coach layout drawings of this specification. The coach wiring shall be terminated on 2-way connectors to IRS Drg. No.E101/M/B and the connection to the light fitting shall be given from 2-way connectors using flexible wires.
- 6.3 All the lights shall be grouped into L- I and L- II circuits, which shall consist of essential and non-essential lights respectively. 50% of the compartment lights and doorway lights shall be wired as essential lights and all the other lights as non-essential lights.

- 6.4 One electrical socket on either side of the power car shall be provided to facilitate the use of portable inspection lamp for the examination of under frame equipment.
- 6.5 Provision of sockets for charging mobile/cell phone and Laptop shall be provided in all DPC and TC.

7.0 **SWITCHES**

- 7.1 Modular switches for the control of compartment fans shall be located on the body sidewall pillars between windows in the respective bays. All light points shall be wired without individual switch. A separate switch shall be provided in the driver's cab for control of headlights.

8.0 **TEST CERTIFICATES**

- 8.1 Electrical test shall be carried out on each coach in accordance with EL/L/48. One copy of test certificate after counter signature by Inspecting Engineer shall be made available to the Railway to which the coach is allotted.

9. **MARKINGS**

- 9.1 At either end panel underneath the coupler socket, following shall be stenciled.

*Junction box provided inside. *

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PART - VII

TESTING & INSPECTION

1. DIESEL HYDRAULIC TRACTION SYSTEM

- 1.1 The various tests of equipments of diesel hydraulic traction system shall be conducted as per clause 4.4 of Chapter-IV.
- 1.2 The testing shall be carried out as per Test Programme mutually agreed between manufacturer and RDSO.
- 1.3 The Contractor shall submit detailed type and routine test programs to RDSO for approval. Tests shall be carried out as per mutually agreed test program and the total cost shall be borne by the manufacturer.
- 1.4 All facilities for carrying out the prototype test should be made available by the firm. After successful type test and fitment on the HS SPART, the equipment will be again tested on SPART for their combined performance evaluation.
- 1.5 All the modifications required due to defects noticed or design improvements found necessary as a result of the test / trial shall be carried out by the tenderer in the least possible time. Total cost of such modifications/design changes shall be borne by the manufacturer.
- 1.6 Type tests will be performed on one prototype unit, however, routine tests shall be carried out on each equipment.
- 1.7 If mutually agreed between manufacturer and RDSO, witnessing of routine tests may be waived for sets manufactured after the prototype. The routine tests of equipments, for which witnessing has been waived, shall be accepted after successful scrutiny of test results submitted to RDSO.
- 1.8 To obtain additional information regarding performance and functionality of any equipment or sub-system, investigation tests may be specially requested by RDSO.
- 1.10 **Instrumentation**
 - (a) All the instruments used for testing should be duly calibrated. The calibration certificates are to be shown to RDSO representative(s) on demand.
 - (b) Before starting test all the specified limit for parameters to be recorded during test shall be submitted by the contractor.

2. MECHANICAL TEST ON PROTOTYPE COACHES/UNITS/RAKES

The following tests shall be conducted only on the first (prototype) coach, unit or rake as the case may be:

2.1 SQUEEZE TEST OF SHELL

- 2.1.1 This test shall be done at the contractor's premises and shall be witnessed by the IR's representative if so desired by the IR.
- 2.1.2 The first DPC and PC coach superstructure shall be regarded as structural test prototype and shall be subjected to static vertical and squeeze (head on) loads tests.

- 2.1.3 The main members of the underframe, sidewalls end walls and roof shall be strain gauged. The location of the strain gauges shall be determined in consultation with the contractor at the design stage based on the result of the Finite Element Analysis.
- 2.1.4 The superstructure shall be subjected to vertical loads and combination of vertical and squeeze load as specified in UIC-566 and the stresses at specified locations, the deflection and body spread shall be recorded.
- 2.1.5 The stresses so recorded shall normally not exceed $2/3^{\text{rd}}$ of the yield strength of the material in case of vertical load alone and shall not exceed 90% of the yield strength in case of application of combination of vertical and squeeze loads. However the acceptance criteria for all the parameters recorded in this test as well as the detailed test scheme shall be finalized at the design stage in consultation with the contractor.

2.2 Tare Weights

- 2.2.1 The Contractor shall take the tare weights of coaches forming any or all the subsequent units, which shall be reported to the Engineers as for the first unit.
- 2.2.2 **Clearances:** The first unit to be completed shall be placed on level straight track, and the coupler heights, spring heights, bogie clearances; and other clearances shall be checked under tare and loaded conditions. The unit shall under these load conditions; pass through a structure representing the moving gauge to diagram as shown in Annexure -VIII.

2.2.3 Tests on Maximum Curves

- 2.2.3.1 The first unit to be completed shall be loaded to test load conditions specified in UIC-566 and run on curved track having a angle of 10° , with no gauge widening, when the following conditions should obtain:
- 2.2.3.2 There shall be no fouling of parts due to the throw over of the bogies, and due to the movement of the coupling gear between the coaches.
- 2.2.3.3 While the unit is on this curve, the brakes shall work efficiently and reliably.
- 2.2.3.4 Tests on HS SPART at site: To ensure that the brake and control equipments are reliable and efficient when operated from the driving compartments at each end of HS SPART.

2.3 OSCILLATION TRIALS

- 2.3.1 The Oscillation Trials shall be conducted on the prototype unit to assess its riding and stability characteristics. The Trials shall be conducted in India in association with the contractor.
- 2.3.2 The trials shall be conducted upto a maximum test speed of 175 Km/h on level tangent track:
- In tare and loaded condition
 - With new and worn wheel profile
- 2.3.3 The trials shall be conducted on selected test stretches consisting of straight station yard and curve sections as per the acceptance criteria given in Clause 6 of Part - II of this specification.

2.4 BRAKING DISTANCE TRIALS

2.4.1 The Braking Distance trials shall be conducted on the first rake as decided during detailed design stage.

2.4.2 The trials shall consist of

- Stationery Trials
- Running Trials

2.4.3 The Stationery Trials shall consist of measurement of various brake system parameters like initial charging time, application time, release time etc.

2.4.4 The Running Trials shall consist of measurement of braking distances under different operating conditions in both tare and loaded mode.

2.4.5 The test scheme for these trials shall be finalized at the design stage.

2.5 Tests on Parking Brakes:

The parking brake will be tested as follows: The 3 -coach train, under tare condition, will be brought to stop on the steepest gradient by application of air brake. The parking brake of the train shall be applied fully and the air brakes released. Under these conditions, the parking brakes shall be capable of holding the train stationary on the gradient. Test results shall be recorded for wet rail conditions.

2.6 The Dynamometer car tests shall be conducted on the prototype rake to ascertain starting and rolling resistance of the cars and to prove tractive effort versus speed characteristics and dynamic braking effort versus speed characteristics of the cars. The detailed test scheme shall be finalized during design stage.

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