

INDIAN RAILWAYS



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PROCEDURE OF NEW WAGON DESIGN APPROVALS

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PROCEDURE OF NEW WAGON DESIGN APPROVALS

1 General

- 1.1** Design Proposer (DP) shall approach EDME/Freight in Railway Board to offer any new non-RDSO design wagon for Indian Railway (IR) network.
- 1.2** In case the wagon is found acceptable during initial scrutiny by Railway Board, DP shall be advised to approach Wagon Directorate of RDSO/Lucknow, for further necessary action as per procedure described hereinafter in this document.
- 1.3** Wagon Directorate/RDSO shall maintain a priority register for taking up the cases on 'first come first serve' basis.
- 1.4** The new wagon design shall be better than the existing designs and conform to the conditions of Track Loading Density (TLD), Pay to Tare ratio etc. as mentioned in Annexure A-1. IR may review and modify these conditions from time to time depending upon the requirement.
- 1.5** The new wagon design should be fit to run at a minimum speed of 100 kmph.
- 1.6** The commodities which these new wagons would be fit to carry shall be specified by DPs. If it is fit to carry all commodities except some specified products, it should be mentioned.
- 1.7** DPs may also propose design of match truck/brake van along with the wagon. Any proposal, which can obviate the requirement of reversing the brake vans would be welcome.
- 1.8** Evaluation of various types of new wagon designs shall be as per the broad guidelines and specification, as laid down by RDSO for BG system, and DP may offer design within this specification.
- 1.9** Any waiver/relaxation of this design approval procedure shall be given only by Mechanical Engg. (Freight) Dte. of the Railway Board.
- 1.10** DP shall give summary of information submitted, duly indexed, giving reference to the various clauses of this approval procedure.
- 1.11** Once conceptual design is found suitable for IR system, a MOU will be signed between RDSO and DP, broadly covering following points :
 - (i) Time frame for activities depending upon resources and work schedule on hand
 - (ii) Places of testing, inspection schedule and inspecting organization
 - (iii) Total cost of design approval/testing/inspection charges and time frame for payments to RDSO.
 - (iv) Other contract terms as may be required between the parties.

After signing the MOU, both the parties will start working as per time schedule.

- 1.12** In addition to the information submitted as per this approval procedure, RDSO may require additional details for processing the case. The DP shall submit such details to RDSO within 10 days of the receipt of request for such information.

- 1.13** All IRS components to be used in the proposed wagon design shall be procured from RDSO approved sources or from principal manufacturer (AAR/UIC approved sources), if any. RDSO shall ensure that adequate number of approved sources are available so that supply of components does not become a constraint.
- 1.14** All non-IRS components shall be procured from established sources, after taking approval from RDSO.
- 1.15** All safety related items e.g. lock, door operating mechanism, etc. shall be procured from sources approved by Internationally Recognized Institutions e.g. AAR/UIC, etc.

2 Definitions

- 2.1** `AAR` means Association of American Railroads.
- 2.2** `BG` means 1676 mm gauge, referred to as Broad Gauge.
- 2.3** `DP` means Design Proposer i.e. the party who is proposing new wagon design.
- 2.4** EDSW – Executive Director Standards (Wagon)/RDSO, officer-in-charge of Wagon Directorate of RDSO.
- 2.5** EDME(Freight) – Executive Director Mechanical Engineering (Freight) /Railway Board.
- 2.6** `IR` means Indian Railways.
- 2.7** `IRS` means Indian Railway Standard.
- 2.8** `MOU` means Memorandum of Understanding
- 2.9** `OEM` means Original Equipment Manufacturer
- 2.10** `RDSO` means the Research Designs and Standards Organisation, Ministry of Railways, Manak Nagar, Lucknow-226011, India. For the purpose of this document `RDSO`, wherever mentioned, implies Wagon Directorate of RDSO.
- 2.11** `TLD` means track loading density in tonnes/meter wagon length over coupler.
- 2.12** `UIC` means International Union of Railways

3 Qualifying Criteria

Proposals of only those DPs who fulfill the following criteria shall be considered for technical evaluation:

- 3.1** Should have well qualified mechanical design engineers, (minimum graduate), having experience of at least five(5) years in wagon designing.
OR
Should have technical support/collaboration for wagon design from an organization which has been carrying out such jobs for at least five years
- 3.2** DP *or their partners (in case of Joint Ventures)* should have designed wagons in past which are running successfully in a railway system.
- 3.3** Documentary evidence to be submitted to RDSO for clause no. 3.1 & 3.2.

4 Stages of New Wagon Design Approval

Various stages involved in approval of new wagon design by DP are as under:

- a) Stage I - Concept Design Approval
- b) Stage II - Detailed Design Approval
- c) Stage III - Prototype Manufacturing, Testing, Design Validation & Provisional Speed Certificate
- d) Stage IV - Oscillation Trial and issue of Final Speed Certificate
- e) Stage V - Introduction of new Wagons in Open Line

5.0 Details of Stages of New Wagon Design Approval

Details of stages of new wagon design approval are as under:-

5.1 Stage I- Concept Design Approval

5.1.1 On receipt of initial clearance from Board (as mentioned under Clause 1.3 above, DP shall submit following information to ED/Wagon/RDSO, for concept design approval by RDSO:-

- a) Basic design parameters as per **Annexure 'A'**
- b) General arrangement diagram
- c) Necessary drawing showing dimensions of the wagons w.r.t IR SOD-2004 or latest
- d) Type of Commodity and load distribution
- e) Design considerations like factor of safety, dynamic augment, fatigue allowance criteria (general or component specific)
- f) Fatigue life of components (other than IRS components) in Kms or in number of Years. Fatigue life of the wagon body design shall be assessed subject to the availability of details/information with IR.
- g) Suitability of loading/unloading methods and equipments for the existing facilities on IR system.
- h) Type of Material used in Wagon Construction
- i) Type of Wagon: General Purpose, Commodity Specific, Route Specific
- j) Precaution which should be taken for the complete cycle from loading to unloading to take care of the working conditions/problems in the proposed design.
- k) List of IRS components being used in the proposed wagon design
- l) List of non-IRS components being used in the proposed wagon design
- m) List of own design components being used in the proposed wagon design, along with a certificate/undertaking that these components are not copied from IRS/other designs, and that there is no violation of the relevant IPR of the land.

5.1.2 RDSO will check the suitability of the concept design with respect to IR standards including dimensional clearance and acceptance from Track/ Bridge etc. point of view within 30 days, excluding time taken by DP in submitting the required clarifications, if any. If the design is found to be unsuitable, the DP shall be given opportunity to present his case to RDSO, within 30 days of the issue of the same from RDSO. If the DP fails to

give satisfactory explanation of the deficiencies, then the proposed wagon design shall be summarily rejected.

5.2 Stage II- Detailed Design Approval

5.2.1 The DP shall submit its detailed proposal within two months of its concept design approval by RDSO mentioned in clause 5.1.2. Any delay shall result in loss of priority of the proposal.

5.2.2 Following information shall be submitted:

5.2.2.1 Information relating to the Wagon body & assemblies

a.) Wagon body

- i) Product structure plan, which shows how the key elements such as components, sub-assemblies & assemblies form the final product.
- ii) Design drawings of key elements which show the main principle of design accompanied by a short description & as far as necessary for understanding of the design.
- iii) Criteria for the selection of materials & methods for their evaluation. (if such materials are in use in other existing wagons, it should be mentioned.)
- iv) Details of various structural joints.
- v) Minimum use of riveting shall be made. The DP should submit details for justifying the requirement/necessity of riveting in the wagon design.

b.) Bogie, including its components e.g. axle bearing, wheel & axle, etc.

The selected bogie shall be IRS standard bogie as per RDSO specification.

c.) Brake system

The wagon shall be fitted with graduated release air brake system as per the latest RDSO specifications. The brake linkage can be under frame/body or bogie mounted arrangements.

d.) Coupler & draft gear

The proposed wagon designs shall be with RDSO approved standard coupler and draft gear to RDSO specification no. WD-66-BD-06 or compatible, as per standard AAR specifications.

e.) Loading and unloading systems

- i) Details of operation and fitment of loading and unloading systems on the proposed wagon design
- ii) The above-mentioned details to be given for each type of commodity to be transported by the proposed wagon.
- iii) Details of Manufacturer of the loading and unloading systems.

5.2.2.2 Information about design methods and calculations (not applicable for IRS components/design)

- a) Standards used for design and calculation
- b) Computer programs used for design & calculation

- c) Results of NUCARS analysis & input data (Track Input file for carrying out NUCARS analysis to be procured from RDSO). The present dynamic performance characteristics as laid down by the Criteria Committee are given in **Annexure 'B'**. These dynamic performance characteristics may be revised by RDSO in future.
- d) Input data along with their basis and supported calculation for NUCARS analysis shall be submitted by DP if so desired by RDSO as per **Annexure 'E'**.
- e) Results of FEM analysis for the wagon body for different load conditions, duly verified by reputed institutions like IITs, etc. shall have to be submitted by DP's entering in the field of wagon design. However, for the existing wagon designers, whose similar wagon designs are successfully running in other railways, 'third party' verification of their FEM analysis shall not be necessary.
- f) Details of computer program used for FEM analysis, boundary conditions, load conditions, etc. considered in the FEM analysis
- g) Validation report of the FEM analysis results, duly certified by reputed institutions like IITs, etc. shall have to be submitted, after prototype testing, by DP's entering in the field of wagon design. However, for the existing wagon designers, whose similar wagon designs are successfully running in other railways, 'third party' certification of their validation report of FEM analysis shall not be necessary.
- h) The DP has the option to follow the same design manuals, codes, software as is used by RDSO or he may follow some other code but convert /explain the design output to RDSO.

5.2.2.3 **Technical data for the wagon regarding C.G., Weight distribution, curve negotiability, throw over at head stock, etc. to be submitted as per the enclosed Annexure 'C'.**

5.2.2.4 **Information about maintenance and examination of proposed Wagon Design:-**

- a) Maintenance standards including clearances and tolerances at various locations & permissible limits of wear for train examination in open line, periodic overhaul (POH), routine overhaul (ROH) etc.
- b) Inspection procedure and periodicity of various inspection schedules in detail including the gauging practices to be followed for train examination in open line, periodic overhaul (POH), routine overhaul (ROH) etc
- c) Maintenance procedures in detail
- d) Machinery and equipment required for maintenance
- e) Gauges, jigs & fixtures required for maintenance
- f) Space requirement for maintenance activity

5.2.2.5 **Information about testing:-**

- a) Test standard: The proposed Test Scheme for the proposed wagon design shall conform to the 'Service Worthiness Tests And Analyses', as recommended in Chapter-11 of AAR specification M-1001, latest issue.
- b) However, where this is not being followed, the following details/information shall be furnished by the DP :

- i) Complete test schedule for wagon & components
 - ii) The test schedule should reflect material, components, sub – assemblies, assemblies & the finished product and will distinguish between:
 - o Type acceptance tests, Production Tests & Quality Check Tests
 - o Test on first article or on further wagons with test sequence
 - o Location of test site i.e. contractors works, etc
 - iii) Tests description, procedures and documentation of tests
 - iv) Details of Test equipments required
 - v) Format of recording various test results
- 5.2.3 RDSO will scrutinize the information submitted and indicate changes, if needed. Clarification/modifications, if asked for by RDSO, shall be submitted to RDSO within 30 days of receipt of the same. Any delay shall result in loss of priority of the proposal.
- 5.2.4 RDSO will communicate its approval of the detailed design in three months, excluding time taken by DP in submitting the required clarifications, as per clause 5.2.3 if any.
- 5.2.5 The DP should complete manufacturing of the prototype wagon and arrange facilities for testing of the prototype wagon within 1 year of the approval of detailed design. In case of failure, RDSO shall have to reschedule the subsequent activities. For any delay thereof, the responsibility shall lie with the DP.

5.3 Stage III - Prototype Manufacturing, Testing and design Validation & Provisional Speed Certificate

- a) All the fabrication & the workmanship shall meet the requirements of Chapter-V of AAR specification M-1001 (Section-C, Part-II), latest issue, and any such instructions as issued by RDSO.
- b) The surface preparation and painting shall be as per AAR specification M 1001 (Sec. C Part-II), latest issue, and any such instructions as issued by RDSO.
- c) Inspection of the wagon during its manufacturing shall be conducted by RDSO. For facilitating this, the DP shall provide :
 - (i) Assembly drawings for sub-assemblies, assemblies and the final product. These will be accompanied by quality requirements, test and inspection requirements
 - (ii) Information about quality Control which includes Quality Assurance Plan & Welding Procedure System/joints preparation details
- d) The various testing to examine correctness of design & evaluate the safety requirements will be conducted under supervision of wagon directorate of RDSO at the places where facilities exist (RDSO, TTCI or manufacturer's place) and all costs will be borne by the DP.
- e) The DP shall submit testing and design validation for the Prototype Wagon which would be completed in 30 days.
- f) Subject to the successful completion of testing and design validation, oscillation trial will be conducted.
- g) RDSO will issue following speed certificates for conducting oscillation trial:
 - a) Provisional speed certificate for movement of wagon at restricted speed

- b) Speed certificate for conducting oscillation trials

5.4 Stage IV- Oscillation Trial and issue of Final Speed Certificate

- a) The DP shall make the prototype wagon available at the place nominated by RDSO for conducting Oscillation trials, within 15 days of the issue of Speed Certificate mentioned in clause 3.3 f(a).
- b) Oscillation trials of the prototype wagon shall be conducted to confirm that the design will exhibit running characteristics as per the limits specified by Criteria Committee.
- c) After successful completion of Oscillation trials, RDSO will issue final speed certificate.
- d) The process of oscillation trials and obtaining CRS sanction shall normally be completed within 2-1/2 months. However, actual time period may be more depending on the work schedule of oscillograph car & time taken by Zonal Railways in obtaining CRS sanction.
- e) Issue of Final Speed Certificate shall be done within 10 days of receipt of oscillation trial report.

5.5 Stage V - Introduction of new Wagons in Open Line

- a) After issue of Final Speed Certificate, provisional approval will be given by the Railway Board for a mutually agreed number of wagons to be manufactured along with required number of brake vans.
- b) The DP has to start the field trial of the wagons within one year of Railway Board's approval as per clause a) above. Otherwise, the approval of wagon design shall lapse and the DP will be required to submit application to EDME/Freight in Railway Board for its renewal.
- c) Regular inspection of the wagons and its components shall be done by RDSO or agency nominated by EDS(W)/RDSO.
- d) After manufacturing of sufficient number of wagons, trials to determine braking distance & coupler force shall be conducted in the following cases, if required, depending on the availability of results for similar wagons :-
 - i. For wagons having axle load of more than 22.9 t and or
 - ii. Having more than 58 wagons in a rake
- e) Final approval for unrestricted use will be given after observing field performance of minimum 2 rakes for 2 lac kms/rake which should normally be completed in a period of about two years. In this time, the maintenance regime, which has been advised by the DP, shall be appropriately fine-tuned /modified, on the basis of the available field data. However, permission of Railway Board for manufacturing/ operating additional such wagons, may be sought after these wagons have demonstrated trouble –free service for at least 50,000 kms.
- f) Further, should any design modification be required to be made in any part of the equipment at any time, it will be advised to the DP, who will ensure its compliance for the existing wagons and new wagons, under manufacture.

6. Payment Norms

6.1 DP shall deposit payment in the following four stages:

- a) 1st payment of Rs. 20 lac (including non-refundable fee of Rs. 1 lac) at the time of re-submission to RDSO, after Railway Board's clearance, of new wagon design for concept design approval.
- b) 2nd payment of Rs. 20 lac at the time of submission of detailed wagon design for approval.
- c) 3rd payment of Rs. 40 lac at the time of submission of test reports[Para 5.3 (e)].
- d) Rs. 20 lac at the time of issue of speed certificate for oscillation trial.

Note: The above mentioned payment will be adjusted in final bill before issuing design approval/ certification.

6.2 RDSO has a rate structure, duly vetted by finance, for various types of consulting charges, design approval charges, trial charges including oscillation trial, inspection charges, testing charges etc. This rate structure is given in the **Annexure 'D'**, for guidance only.

6.3 At the time of evaluation of conceptual design, RDSO will also work out cost of design approval & testing charges accruing to RDSO, in consultation with associate finance.

6.4 For the use of IRS components like bogie, coupler, draft gear, etc, the DP will have to pay the prescribed design loan charges / royalty to RDSO.

7. Options of use of any wagon design by IR

7.1 After observing the field performance of the new wagon designs, IR shall have the option to procure and utilize any of the wagon designs, which suits its own requirement. Royalty or design loan charges (for non-IRS components) shall be paid by IR to the DP on the same terms & conditions, which are applicable for the use of IR designs by outside agencies. (As per MC/MISC/CS 87 Rev. 1 of Feb' 01).

7.2 Alternatively, IR and the DP may enter into an MOU, if acceptable to both parties, for joint ownership of the proposed wagon design. In this case IR will waive off all the approval and testing charges accruing to IR.

It also follows that if the Indian Railways buy these wagons for their own use, then neither of the parties will be entitled to charge any royalty/ Design loan charges

If the DP makes these wagons themselves, in that case it shall pay Royalty /DLC to IR for the standard parts used in the manufacture of these wagons such as Bogies/ Couplers etc. Such royalty/ Design loan charges will be estimated as per Railway Board's Policy.

If the DP loans the design to any third party, then the DLC charged by the DP from such manufacturer will be shared with IR as per the following guidelines:

- (i) For non – IRS components: in equal proportion between the DP and IR i.e. on 50:50 basis
- (ii) For IRS components: RDSO will get the full DLC, which will be estimated as per Railway Board's Policy.

8. Warranty

- 8.1 The DP shall be entirely responsible for the design, construction and the efficient performance of the wagon, notwithstanding any approval, which may have been given to the detailed drawings prepared by the DP or to the manufacture of materials or parts employed by the Supplier or to the test carried out by the Engineer.

9. IPR norms

- 9.1 The technical information submitted to RDSO under this design approval shall not be disclosed or published by RDSO to any third party, without the prior written consent of the DP. Similarly, DP shall not disclose or publish technical details of IRS design to any third party without prior approval of RDSO.
- 9.2 The DP shall confirm that the proposed wagon design is neither wholly nor partly, a copy of any of the wagon designs of any other firm/entity/railway. In case, the proposed wagon design is based partly or wholly on design of any other firm/entity/railway, the permission from that firm/entity/railway shall be furnished by the DP along with the concept design proposal.
- 9.3 In case any dispute regarding IPR arises, a committee of two Directors of RDSO, nominated by EDSW, shall examine the case and give its recommendation which will be reviewed by EDSW and submitted to Railway Board for final decision. Any further dispute shall be settled through legal remedies as provided in the Indian Acts related to Intellectual Property Rights.
- 9.4 If at any stage or any time in future, it comes to light that the proposed wagon design may be wholly or partly, copied from any of the existing/approved design of any other firm/entity/railway without its due permission, the DP shall be called upon to submit his explanation to the committee, as per clause 9.3, within 15 days of the receipt of such a notice from IR.
- 9.5 If at any stage, any IPR violation/infringement by DP is established with respect to the proposed wagon design, any approval granted to DP by IR shall stand withdrawn and IR will not accept any case of design approval from such DP for the next 10 years, from the date of withdrawal of approval. In addition, entire initial deposit or any remainder thereof, paid by the DP to RDSO, shall be forfeited.
- 9.6 RDSO shall not use any of the proprietary information, provided by DP, for any purpose other than the approval of the wagon design. Also, RDSO shall not use such information for design of a wagon.

10. Indemnity

- 10.1 The DP shall at all times indemnify the RDSO against all claims which may be made in respect of the new wagon design for infringement of any right protected by patent, registration of designs or trade mark . Provided always that in the event of any claim in respect of alleged breach of letters patent, registered designs or trade mark being made against the Purchaser, the RDSO shall notify the DP of the same and the DP shall, at his own expense, either settle any such dispute or conduct any litigation that may arise there from.

Conditions Applicable to New Wagon Designs Proposed for IR Network

I. Up to 22.9t axle load –

TLD	: 8.355 t/m (maximum)
Pay to tare ratio	: i) More than 4.0 for open wagon :(ii) More than 3.75 for covered/hopper wagon :(iii) More than 3.0 for flat wagon :(iv) More than 2.5 for tank wagon :(v) More than 3.0 for any other wagon for bulk commodity :(vi) for commodity specific wagon, shall be decided on case to case basis

II. More than 22.9t axle load and upto 25 t axle load –

TLD	: 9.33 t/m (maximum)
Pay to tare ratio	: (i) More than 4.5 for open wagon :(ii) More than 4.0 for covered/hopper wagon :(iii) More than 3.5 for flat wagon :(iv) More than 3.0 for tank wagon :(v) More than 3.5 for any other wagon for bulk commodity :(vi) for commodity specific wagon, shall be decided on case to case basis

III. Proposed design shall conform to requirements of IR SOD-2004 or latest, issued by Railway Board

**BASIC DESIGN PARAMETERS OF PROPOSED WAGON DESIGN TO BE
SUBMITTED FOR CONCEPT DESIGN APPROVAL**

PARAMETER	DETAILS
A. General	
1. Axle Load (in tonnes)	
2. TLD (in tonnes/meter)	
3. Tare weight of complete wagon (in tonnes)	
4. Payload of a wagon (in tonnes)	
5. Payload to tare weight ratio	
6. Numbers of wagon in 626 meter length	
7. Payload of rake in 626 meter length (in tonnes)	
8. Height of C.G. in empty and loaded conditions for commodities proposed to be loaded (in millimeters)	
9. Commodity for which wagon is designed	
10. Other commodities, which may be carried in the wagon	
B. Overall Dimensions (in millimeters)	
1. Length over coupler faces	
2. Inside Length	
3. Length between bogie centers	
4. Length over head stock	
5. Coupler height over level Track from rail level	
6. Overall width	
7. Inside width	
8. Floor height from rail level	
9. Inside height	
10. Volumetric Capacity (in cubic meter)	
11. Volumetric Capacity of heap Loading(in cubic meter)	
12. Total Volumetric Capacity (in cubic meter)	

Note: Maximum center of gravity in the IR system is not defined. However, wagons with a maximum center of gravity of 3139mm are running in the system i.e. double stack container operation.

Annexure-B

DESIRED DYNAMIC PERFORMANCE CHARACTERISTICS OF WAGON

Simulated performance of the proposed wagon design shall satisfy the prevailing acceptance criteria at a speed of 110 kmph. Only those proposals whose performance values have been found within acceptable limits, **as per the current report of ‘The Standing Criteria Committee for evolving criteria for assessment of stability of Rolling Stock on Indian Railways’**, will be considered for further evaluation

In future, whenever track friendly bogie is developed, the criteria adopted for the track friendly bogie shall be followed.

Annexure C

TECHNICAL DATA OF THE PROPOSED WAGON DESIGN

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

1. Weight & center of gravity of each component and also CG of the equipment installed on the wagon body
2. Weight distribution indicating lateral & longitudinal unbalance,
3. Balancing calculation for the wagon
4. Method of adjustment of wheel /axle load
5. Calculation of unsprung mass
6. Vogel's layout for 10 degree curve and for 1 in 8.5 turnout for bogie negotiability
7. Throw-over at head-stock/wagon and coupler movements together with details of clearance.
8. Estimation of flange forces on curves and turnouts
9. Stress analysis of all major stress bearing parts of the under frame under static & dynamic conditions
10. Calculation for energy absorption
11. Projected dynamic augment with the unsprung masses as used with the IR track
12. Stability calculation
13. Vibration analysis of the wagon body and the natural frequencies.

Note: Except for Sl. 1, AAR limits shall be acceptable.

Annexure-D

RATE STRUCTURE FOR WAGON DESIGN APPROVAL

- A. The costs of the various tests conducted at RDSO lab are given below. These costs are indicative only and subject to revision:-

S. No.	Description of tests	*Cost of Testing in Rs.
1	Elastomeric pads (1.5 lac cycles @ 2 Hz on each of 2 pads)	2,19,291/-
2	Elastomeric pads (5 lac cycles @ 2 Hz on each of 2 pads)	3,75,618/-
3	Elastomeric pads (10 lac cycles @ 2 Hz on each of 2 pads or 05 lac cycles @ 2 Hz on each of 4 pads)	6,10,107/-
4	Shock Absorber (16 lac cycles @ 1.67 Hz)	6,53,531/-
5	Helical Springs (20 lac cycles @ 2 Hz on 1 spring)	5,84,053/-
6	Helical Springs (20 lac cycles @ 2 Hz on 2 spring)	10,53,032/-
7	Wagon Side Bearer Pads (10 lac cycles @ 2 Hz on 1 pads)	3,47,392/-
8	Wagon Side Bearer Pads (10 lac cycles @ 2 Hz on each of 2 pads)	5,81,882/-
9	High capacity Rubber Buffer Spring /raft Gear Rubber Buffer Spring (10000 lac cycles @ 0.5 Hz on 1 spring)	52,543/-
10	Bogie Frame(6 million cycles @ 3-4 Hz with 50 strain gauge locations)	58,55,120/-
11	Bogie Frame(8 million cycles @ 3-4 Hz with 50 strain gauge locations)	63,76,208/-
12	Bogie Frame(10 million cycles @3-4 Hz with 50 strain gauge locations)	69,23,350/-

* *Excluding service tax*

- B. Ordinarily, the average cost for conducting oscillation trials is about Rs. 40 – 50 lac. However, the cost may increase, if different variations of the equipment are considered. Costs for the other field trials like EBD test, coupler force test, etc. will be in same range.
- C. Speed certificates shall be issued as per the prevailing rate.
- D. Costs incurred on the other activities related with wagon design approval procedure like conceptual design approval, detailed design approval & Speed certificate shall be calculated on the basis of man-hours utilized for this purpose. The man-hour rate will be as per the prevalent rate. (viz. the existing man hour rate is Rs 944/-)
- E. In case the proposed wagon design is not successful in the oscillation trials, efforts for resolving the problem, if possible, shall be undertaken by RDSO which may involve testing of new assemblies for suspension systems, etc. In such a case, any additional charges incurred in problem analysis, testing, etc. shall be payable by the DP.
- F. Inspection cost charged shall be as per the norms indicated in the RDSO's terms and consultancy conditions(MC/MISC/CS 87 Rev. 1 of Feb' 01 or latest)
- G. In addition, the DP will have to pay any other additional cost, which may be incurred in the design approval process.

Annexure-E

**DATA REQUIRED FOR COMPUTER MODELING OF
RAILWAY VEHICLES**

(Values of parameters are to be defined in units as indicated against the respective parameters. Unless otherwise specified, the units are Mega-gram for Mass and Mega-gram-meter- square for inertia, mm for length, radian for angle. Principle axes pass through the CG of the heavy body. Coordinate system for the required data as specified below is given in *Annexure-I* and method of specifying the body CG heights and suspension mid-point and heights are given in *Annexure – II*). The list given below is not exhaustive and if the bidders have used any data in addition to the list given below, same should be furnished.

1. Masses, Inertia and CG Heights

Masses and moment of inertia (I) of the car body, bolster, side frames and wheel/axle set about three principal axes passing through respective CGs as per following format.

1.1 CAR BODY

	Tare Load Condition	Gross Load Condition
Mass* (In Metric tonne)		
Moment of Inertia I_{XX} in Roll (in Mg-m ²)		
Moment of Inertia I_{YY} in Pitch (in Mg-m ²)		
Moment of Inertia I_{ZZ} in Yaw (in Mg-m ²)		

****Mass of car body = Tare Weight of wagon – 2 X (Weight of Bogies).***

1.2 Bolster:

Parameter	Value
Mass* (In Metric tonne)	
Moment of Inertia I_{XX} in Roll (in Mg-m ²)	
Moment of Inertia I_{YY} in Pitch (in Mg-m ²)	
Moment of Inertia I_{ZZ} in Yaw (in Mg-m ²)	

1.3 Side Frame:

Parameter	Value
Mass* * (In Metric tonne)	
Moment of Inertia I_{XX} in Roll (in Mg-m ²)	
Moment of Inertia I_{YY} in Pitch (in Mg-m ²)	
Moment of Inertia I_{ZZ} in Yaw (in Mg-m ²)	

**Mass = 1/12 Wt. Of bogie – (bolster Wt. + 2X Wt. Of wheel set with axle Boxes + Wt. Of 2 radial arms)

1.4 Wheel Set:

Item	Value
Mass [#] (In Metric tonne)	
Moment of Inertia I_{XX} in Roll (in Mg-m ²)	
Moment of Inertia I_{YY} in Pitch (in Mg-m ²)	
Moment of Inertia I_{ZZ} in Yaw (in Mg-m ²)	

Mass = Weight of { wheel and axle + two axle boxes + radial arm }

2. Center Pivot:

Parameter	Value
Type of pivot (Flat or Spherical)	
Diameter of pivot	
Radius of curvature (if spherical)	
Radial clearance (if flat)	

3. Side Bearer:

3.1	Parameter		Value
3.2	Lateral distance between side bearer centers on the same bolster	=	
3.3	Number of springs in each side bearer nest	=	
3.4	Pre-compression (displacement) of side bearer springs under tare	=	
3.5	Clearances (if any) of:		
3.5.1	Longitudinal/Lateral stoppers	=	
3.5.2	Vertical stoppers	=	

4. Space coordinates and connections

4.1 Space coordinates of CGs of all heavy bodies viz. Car body, bolster, side frames, wheel/ axle set with respect to mid point of lead axle at rail level under tare conditions under Body CGs: Location in tare, loaded and fully unloaded (released state of suspension) condition to be indicated as per following format.

(Please refer to Annexure – I and II for explanation)

Heavy Body	X	Y	Z		
			Z ₁ Under Fully un-loaded condition (all springs released)	Z ₂ Under Tare load condition	Z ₃ Under Gross load condition
Main Car body					
Leading Bolster					
Trailing Bolster					
Leading side-frame left					
Leading side-frame right					
Trailing side-frame left					
Trailing side-frame right					
Leading bogie leading axle					
Leading bogie trailing axle					
Trailing bogie leading axle					
Trailing bogie trailing axle					

4.2 Space coordinate of mid point of all connections between car body and bolster, bolster and side-frame, side frame and axle including primary and secondary suspensions, with respect to mid point of lead axle at rail level may please be tabulated for each connection under tare and fully loaded conditions.

(Please refer to Annexure – I and II for explanation)

Important: Separate tables must be filled up and furnished for free condition, tare condition and gross load condition for relevant parameters

4.2.1	Height of center pivot from rail level	=	_____mm
4.2.2	Center pivot diameter	=	_____mm
4.2.3	Height of side bearer vertical connection	=	_____mm
4.2.4	Lateral distance between two secondary spring nests	=	_____mm
4.2.5	Vertical height of each secondary nest from rail level	=	_____mm
4.2.6	Height of elastomeric pad from rail level	=	_____mm
4.2.7	Height of spring plank (if present) from rail level	=	_____mm
4.2.8	Lateral distance of wheel/rail contact point	=	_____mm
4.2.9	Side bearer vertical stiffness per side bearer connection	=	_____MN/m

5.3 Connection Characteristics

5.3.1 Stiffness and damping characteristics of side-bearer between car body and bolster in vertical, lateral and longitudinal mode, for each nest may please be specified as under: -

I.	Vertical stiffness and damping characteristics of the secondary spring group as a hysteresis loop.		
II.	Vertical stiffness of spring nest / side bearer	=	_____ MN/m
III.	Vertical damping at side bearer level	=	_____ MN
IV.	Lateral stiffness of spring nest / side bearer	=	_____ MN/m
V.	Lateral damping at side bearer level	=	_____ MN
VI.	Side bearer yaw connection series type stiffness per bogie	=	_____ MN-m/radian
VII.	Yaw damping at side bearer per bogie	=	_____ MN-m
VIII.	Hysteresis loop of the primary suspension in vertical mode (if elastomeric pads are proposed)	=	Extension and compression loops
IX.	Stiffness characteristics of the primary suspension in lateral mode		
X.	Damping characteristics of the primary suspension in lateral mode		
XI.	Stiffness characteristics of the primary suspension in longitudinal mode		
XII.	Damping characteristics of the primary suspension in longitudinal mode		

5.3.2 Center Pivot characteristics

Yaw damping characteristics at center pivot (between car body and bolster).

- I. Under tare condition= _____ MN-m
- II. Under loaded condition = _____ MN-m

5.3.3 Primary Suspension details

	In Tare	In Loaded	Unit
Vertical stiffness of primary suspension at each axle box			MN/m
Lateral stiffness of primary suspension at each axle box			MN/m
Longitudinal stiffness of primary suspension at each axle box			MN/m
Vertical damping of primary suspension at each axle box			MN
Lateral damping of primary suspension at each axle box			MN
Longitudinal damping of primary suspension at each axle box			MN

Hysteresis loops in vertical, lateral and longitudinal modes may be provided for elastomeric pads. If the same has been modeled as a parallel pair, then force – deflection characteristics may be provided.

5.4 Secondary Suspension

- I. Secondary vertical springs hysteresis loop per group may be given.
- II. Additionally Hysteresis loop for load proportional damping should be specified.

	Tare	Loaded	Unit
Secondary vertical stiffness per group			MN/m
Secondary lateral stiffness per group			MN/m
Secondary longitudinal stiffness/group			MN/m
Secondary vertical damping/group			MN
Secondary lateral damping/ group			MN
Secondary longitudinal damping/ group			MN

5.5 Relative pitch and relative yaw characteristics (stiffness and damping) between the two side frames. If spring plank is additionally provided between the two side frames, then these characteristics should be provided for configuration with plank and without plank separately.

I.	Relative pitch stiffness	=	_____MN/m/bogie
II.	Relative pitch damping	=	_____MN
III.	Relative longitudinal stiffness	=	_____MN/m/bogie
IV.	Relative longitudinal damping	=	_____MN

- 5.6 a) Non-linear connection characteristics should be specified in the form of force-displacement/force-velocity graphs and additionally, Piecewise linear characteristics graphs in terms of load and deflection should be provided.
- b) When defining connections between two heavy bodies, the type of connection viz. series pair, parallel pair of spring and damper or a hysteresis should be clearly specified.
- c) Wheel rail contact geometry should be given in full details and with the full wheel–rail contact geometry table.

5.7 Degree of freedom of connection between two heavy bodies should be indicated as under:

	Heavy Body	Define each connection, its type (series pair/parallel pair/hysteresis, etc.) its degrees of freedom modeled
a.	Car body – bolster	
b.	Bolster – side-frame	
c.	Side-frame – axle	
d.	Wheel-set – rail	
e.	Side frame to side frame	

Location of mid-point of connection in tare and loaded condition must be indicated separately for tare condition and gross loaded condition.

(Please refer to Annexure – I and II for explanation)

6. Design Particulars:

6.1	Wheel diameter	=	_____mm
6.2	Wheel base	=	_____mm
6.3	Bogie center distance	=	_____mm
6.4	Tare weight of wagon	=	_____mm
6.5	Static deflection of car body CG Under tare load	=	_____mm
6.6	Static deflection of car body CG Under gross load	=	_____mm
6.7	Height of car body CG from rail level under fully released condition of primary and secondary vertical springs and side bearer.	=	_____mm
6.8	Height of CG of car body from rail level under tare condition.	=	_____mm
6.9	Height of CG of the car body of the fully loaded vehicle from rail level	=	_____mm

7. Clearances:

7.1	Lateral Gib clearance at axle box between side frame and axle boxes	=	± _____mm
7.2	Longitudinal Gib clearance at axle box between side frame and axle boxes	=	± _____mm
7.3	Lateral Gib clearance between bolster and side frame at secondary stage	=	± _____mm
7.4	Lateral clearance between body and bolster at center pivot for flat pivot	=	± _____mm
7.5	Any other clearances at bump/rebound stops provided as part of the suspension (please elaborate).	=	± _____mm

8. Spring design details:

Spring details of all the springs used at various levels viz. Primary, secondary springs (inner, outer, snubber) side bearer springs etc. with following particulars: -

(Separate table may please be made for each spring)

8.1	Free height	=	_____mm
8.2	Home height	=	_____mm
8.3	Mean coil diameter	=	_____mm
8.4	Pitch circle diameter	=	_____mm
8.5	Number of turns (effective)	=	_____
8.6	Wire diameter	=	_____mm

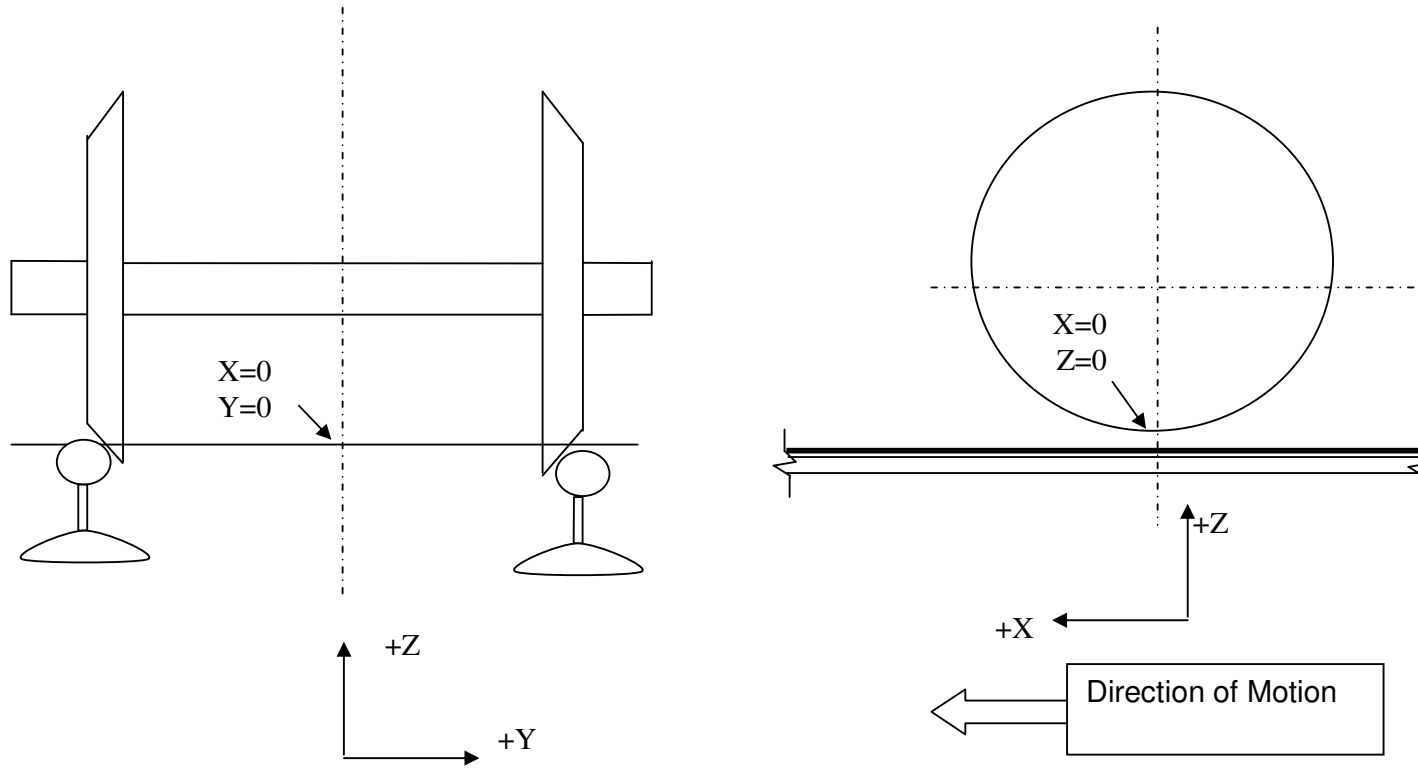
8.7	Stiffness	=	_____ Kg/mm
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9. If the bogie has radial steering mechanism, following data may be furnished.
- I) Inter-axial shear stiffness = _____ MN/m
 - II) Inter-axial bending stiffness = _____ MN/m/Radian

Details of the calculations of the above two values may also please be provided.

10. Drawing & Sketches:
- 10.1 Detailed design drawings of Bogie may please be furnished.
 - 10.2 Drawing of the side bearer with housing may please be furnished.
 - 10.3 Co-efficient of friction may please be specified at:
 - a) Side bearer
 - b) Center Pivot
 - c) Wedge block at secondary suspension
 - 10.4 A paragraph bringing out the salient features of the suspension should be provided along with sketch/drawing of suspension arrangement.
 - 10.6 Data in any system / unit of measurement other than the mentioned are not acceptable.

Coordinate system for specifying the vehicle's geometry to create the mathematical model for doing its theoretical assessment



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Specifying Center of Gravity height for two stage suspension

Annexure – II

