



TECHNICAL SPECIFICATION

FOR

Self-propelled Multipurpose Utility Vehicle for Hauling
of Stringing Vehicle & other Electrification Vehicles

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ISSUED BY:

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**Self-propelled Multipurpose Utility Vehicle for Hauling
of Stringing Vehicle & other Electrification Vehicles**

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Chapter - I

1.0 GENERAL CONDITIONS

1.1

This specification covers the design, manufacture, supply, testing & commissioning of Self-propelled Multipurpose Utility Vehicle for hauling of stringing vehicle and other Electrification vehicles (hereafter called SPMUV) for operation on broad gauge (1676mm) electrified (25 kV a.c.) routes of Indian Railways. The SPMUV shall have driving 4-axes and shall be used for hauling of stringing vehicle & other Electrification vehicles. The SPMUV shall have the facility to be used as maintenance, inspection and mast erection also. The SPMUV shall use the power generated by the Diesel Engine through Hydraulic Transmission or 3 Phase AC/DC Electrical Transmission for propulsion and not the power from live OHE.

1.1.1 The Self-propelled Multipurpose Utility Vehicle shall have 4-axes and shall be used for hauling of stringing vehicle and other Electrification vehicles. It shall be capable for hauling two vehicles having gross load of about 120 t. The vehicle shall have one driving cab at one end, a swiveling platform and a crane with telescopic boom and lifting hook at suitable location. The swiveling platform and crane shall be utilized during attention /maintenance, adjustment of over head equipment and mast erection.

1.1.2 In case of difference between the specification and exhibited drawings, the tenderer shall get an immediate clarification from RDSO which shall be final authority for technical clarification.

1.2 CLIMATIC CONDITIONS

1.2.1 The power pack & electric of the SPMUV shall be in continuous operation under the following atmospheric and climatic conditions. The vehicle shall be suitable to perform satisfactorily in J & K area also.

1	Atmospheric Temperature	Metallic surface temperature under Sun: 75° C maximum and in
2	Humidity	100% saturation during rainy season.
3	Reference site conditions	i) Ambient Temp. : -10 °C to 50° C iii) iv)
4	Rain fall	Very heavy in certain areas. The SPMUV shall be able to negotiate water logged tracks at 10 kmph, with water
5	Atmosphere during	Extremely dusty and desert terrain in certain

		areas. The dust concentration in air may reach a high value of 1.6 mg/m ³ . In many iron ore and coalmine areas, the dust concentration is very high affecting the filter and air ventilation system.
6	Coastal area	SPMUV and its equipments shall be designed to work in coastal areas in humid and salt laden atmosphere with maximum. pH value of 8.5, sulphate of 7mg per liter, max. Concentration of chlorine 6 mg per liter and maximum conductivity of 130 micro Siemens/cm.
7	Vibration	The equipment, sub-system and their mounting arrangement shall be designed to withstand satisfactorily the vibration and shocks encountered in service as specified. High level of vibration and shocks. Accelerations over 500m/s ² have been recorded at axle box levels for long periods during run. Vibrations during wheel slips are of even higher magnitude.
8	Wind speed	High wind speed in certain areas, with wind pressure reaching 200kg/m ²

1.2.2 The equipment and their arrangement shall withstand satisfactorily, the vibration and shocks normally encountered in service which are as below:-

- | | |
|---------------------------------------|------|
| (a) Maximum vertical acceleration | 3.0g |
| (b) Maximum longitudinal acceleration | 5.0g |
| (c) Maximum train acceleration | 2.0 |
- (g-acceleration due to gravity)

1.2.3 THE INDIAN TRACK PARAMETERS

S.N.	Description	Specified Values
1.	Gauge	1676 mm Broad Gauge (BG)
2.	Maximum Gradient	1: 33 up gradients
3.	Minimum radius of curve	175 m. It should also be capable of negotiating i) a radius of 213m in case of 1 in 8-1/2 BG turnout with 6.4m over-riding switch. ii) 175 m radius in case of 1 in 8-1/2 scissors crossing. iii) The maximum super elevation of 165 mm shall be considered alongwith maximum

		radius of curve available over Indian Railway.
4.	Track Structure	90 R Rail with M+4 Sleeper density and 200 mm ballast cushion below sleepers of which at least 75 mm shall be clean and rest in caked up condition
5.	Permitted irregularities	<ul style="list-style-type: none"> • Gauges ± 6 mm • Unevenness on 3.6 m base - upto 15 mm. • Twist on 3.6 m base - upto 3.5 mm/m • Alignment on 7.2 m base - upto 7 m
6.	10-isolated peaks/km of track exceeding the above limits of irregularities are permitted.	
7.	Third report of criteria committee shall be considered for number of peak per Km.	

1.2.4 MAXIMUM MOVING DIMENSION

	Maximum moving Dimensions	Maximum moving dimensions shall conform to diagram 1D of Indian Railway Schedule of Dimension (SOD) 1676 mm gauge (BG) revised 2004 (With Latest Amendments) with the pantograph and platform in lock down condition. Infringements, if unavoidable and fully justified, may be considered, if within the limits shown in SOD 1676 mm gauge (BG) revised 2004.
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1.2.5 OHE PARAMETERS

S.N.	Description	Specified Values
1.	Contact Wire	107 mm ² Hard Drawn Grooved Copper Contact Wire as per RDSO Specification No. ETI/OHE/76 (6/97) with latest Amendments
2.	Catenary Wire (Messenger Wire)	65 mm ² (19/2.1 mm) Stranded Cd-Cu Catenary Wire as per RDSO Specification No. ETI/OHE/50 (6/97) with latest Amendments
3.	Height of Contact Wire	6000 mm
4.	Height of Catenary Wire	7500 mm
5.	Stagger	± 200 mm on tangent track ± 300 mm on curves

6.	Implantation	4750 mm at platforms 2360 mm to 3300 mm
7.	Mechanical Tension	Presently 2000 kgf and likely to increase up to 3500 kgf.
8.	Note: Provisions shall have to be kept for 150 mm ² Contact Wire and 125m ² catenary Wire	

1.3 Examination of the Tender Offer:

- 1.3.1 The tenderer is required to furnish clause by clause comments to this specification, either confirming acceptance of the clause or indicating deviation there from.
- 1.3.2 A comprehensive specification of the SPMUV as offered shall be submitted separately.
- 1.3.3 In the event a tenderer is unable to comply, either partially or fully, to any of the stipulations made in this specification, it must be brought to the notice of purchaser with full particulars of the deviations, technical details, cost implications and past service performance, etc.

1.4 Design Development:

- 1.4.1 The successful tenderer (hereafter called as contractor) shall develop the design based on the details given in this specification and sound engineering practices. The entire design & technical data along with calculations shall be submitted to RDSO for approval before commencing construction of SPMUV or placing orders on sub-contractors.
- 1.4.2 The design shall be based on S.I. Units.
- 1.4.3 From the information given in this specification and instructions of RDSO, the contractor shall prepare a full set of engineering drawings and submit the same to RDSO for approval.
- 1.4.4 When submitting drawings of a particular item, other details depending on it shall be shown in juxtaposition.
- 1.4.5 Material specifications, manufacturing tolerances and other details, which are necessary for manufacture for each component shall be indicated on the drawings.

1.5 Approval of Drawings:

- 1.5.1 "Approval" to the drawing means the approval to the general adoptability of the design features. RDSO shall not be responsible for the correctness of dimensions on the drawings, materials used, strength or performance of the components. The contractor shall be wholly and completely responsible for all these variables. The contractor, when submitting proposals or designs for approval of the RDSO, shall draw attention to any deviation or departure from the specification involved in his proposals or drawings.

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1.5.2 Drawing for approval shall be submitted in standard size(s) as per IS: 696 along with main calculation details in triplicate.

1.6 Prints:

1.6.1 Three sets of tracings of the RDSO approved drawings/ calculations and six sets of their prints shall be supplied by the successful contractor to the indenter. The tracings shall be on RTF of durable quality. Drawings shall be made on Auto CAD. Three soft copies on DVDs shall also be supplied to the indenter along with hard copies as mentioned above.

1.6.2 Each set of tracings shall form a complete set of working drawings, the first sheet being the index and the following sheets being arranged properly to show the various assemblies, sub- assemblies and components of complete works in the following sequence:-

- (a) Diagram sheets showing the overall dimensions of the equipment, weights and the relation of overall dimensions to the space in the SPMUV.
- (b) Lists of all parts grouped in to major assembly with details of numbers per set, weight, specification material and drawing reference against each item.
- (c) General arrangement drawings of complete equipment sets, Diagram of lubrication points, indicate type of lubricant, Subassembly arrangement, drawing in proper and logical sequence.
- (d) Detailed drawings: On detailed drawing sheets, each part shall be identified by an alphabetic letter and the list of all parts forming the sub-assembly shall be tabulated just above the title block on the same sheet giving details against each alphabetic letter.

1.7 Contractor's responsibility:

1.7.1 The contractor shall be entirely responsible for the execution of the contract strictly in accordance with the terms of this specification and the conditions of contract, notwithstanding any approval which RDSO or the Inspecting officer may have given:

- a. Of the detailed drawing prepared by the contractor.
- b. Of the sub-contractors for materials.
- c. Of other parts of the work involved by the contractor.
- d. Of the tests Carried out either by the contractor or by the RDSO or the Inspecting Officer.

1.8 Warrantee: shall be as per IRS standard conditions of contract.

1.9 Exhibited Drawings and standard Specifications:

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- 1.9.1 "Exhibited Drawings" means the drawings which are exhibited or provided by RDSO for the guidance of the contractor.
- 1.9.2 The exhibited drawings, illustrative of a range of standardized dimensions and fittings, are listed in Annexure -1. The design of the SPMUV must comply with the dimensions, and fittings included in the exhibited drawings as far as possible. Any deviation therefore shall be clearly mentioned in the form of a table on the drawing.
- 1.9.3 The exhibited drawings are not guaranteed to be free from discrepancies. The contractor while preparing the engineering drawings shall ensure that these are free from discrepancies. He shall also incorporate all modifications desired by the RDSO, subsequently, without prejudice to the date of delivery or contracted price, except as provided for under the conditions of contract.
- 1.9.4 To improve upon the performance, modifications and corrections are made in the specification and drawings from time to time. The contractor must, therefore, satisfy himself that the drawings being used by him are of the latest version. In case of any doubt, he must get it clarified from RDSO.
- 1.9.5 The Contractor shall procure at his own expense all the drawings and specifications required for the manufacture of the SPMUV.
- 1.9.6 Copies of drawing referred to in this specification and given in Annexure-1 may be obtained from RDSO on payment.
- 1.9.7 Indian Railways Standard (IRS) specifications and Schedules of Maximum Moving Dimensions may be obtained on payment from the Manager, Government of India Publications, Civil Lines, Delhi 110 006 (INDIA).
- 1.9.8 Indian Standard Specifications (ISS) are available from Bureau of Indian Standards, 9-Bahadur Shah Zafar Marg, Delhi 110 002.
- 1.10 Materials:
- 1.10.1 Materials used in the construction of the SPMUV shall comply with the relevant IRS specifications or Indian Standard Specifications. Where IRS or ISS do not exist for specific components, the contractor shall submit proposed material specification for approval of RDSO.
- 1.11 Service Engineers:
- 1.11.1 The Contractor shall arrange for the supervision of commissioning of the SPMUV immediately after their receipt at ultimate destination. He is also required to carry out joint check of the receipt of components regarding short shipment or transit damages.
- 1.11.2 The contractor shall ensure commissioning of the SPMUV within 30 days from the date of intimation by the consignee.
- 1.11.3 The performance of SPMUV shall be demonstrated by the contractor after its successful commissioning at the consignee's works.

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1.11.4 The contractor shall provide and ensure servicing facilities in India throughout the warranty period. After the warranty period is over, he shall, on call, give and service support for troubleshooting and for obtaining spare parts.

1.12 Training:

1.12.1 The Contractor shall arrange to provide training in operation & maintenance of the SPMUV at their manufacturing works for four persons for a period of five days free of cost. The charges for travel, boarding and lodging shall be borne by the Railways. Training material shall be given as per Annexure-8-D.

1.12.2 Technical experts of the manufacturer during commissioning of SPMUV shall also adequately train operators/ maintenance staff nominated by the consignee.

1.13 Service Manuals and Spare Parts Catalogues:

1.13.1 Detailed Maintenance & Service Manuals including the manual for trouble shooting & operational requirement for the driver and maintenance staff for the SPMUV shall be prepared and three copies supplied free of charge, per SPMUV, to the consignee. Before printing the final version of the manual, the draft of the Manuals shall be got approved from RDSO.

1.13.2 Three copies per SPMUV of Spare Parts Catalogues shall also be supplied to the consignee.

1.13.3 In addition, three copies each of the Maintenance/Service and troubleshooting manual along with "Spare Parts Catalogue" and list of must change items with periodicity shall be supplied to RDSO.

1.14 Electric Arc Welding:

1.14.1 Indian Railways Standard Code of Practice for Electrical Arc Welding shall be followed. If the contractor desires to follow any other code of practice, it shall first be submitted for approval of RDSO.

1.14.2 Welding symbols shall be in accordance to IS:813. Drawings on which such symbols appear, are to bear a note on the bottom left hand corner, "WELDING SYMBOLS AS PER IS:813".

1.14.3 Railway Initial Letters: Where parts are required to be marked with Railway initial letters, they shall be 'I.R'

1.15 Sublet Orders for Materials: Any subletting of orders for materials/work shall have prior approval of RDSO.

1.16 Spare Parts:

1.16.1 Unit exchange spare parts shall be indicated. However, final decision to buy these will rest with the purchaser.

1.16.2 The prices for these spares shall be quoted separately. These spares shall be for every set of 10 SPMUV or part thereof. The complete details such as part number and their quantity shall be clearly indicated against following items with the offer.

- | | | | |
|------|---|---|--------|
| i) | Flexible coupling/
Engine connection (complete) | - | 1 set |
| ii) | Traction Alternator alongwith
Power Rectifier | - | 1 set |
| iii) | Air compressor (complete) | - | 1 unit |
| iv) | Motorised Bogie (complete with
Traction Motors and Break Gear) | - | 1 set |
| v) | Battery charger for charging of
starter Batteries | - | 1 unit |
| vi) | Auxiliary Alternator | - | 1 set |

1.16.3 The tenderer shall be responsible to ensure subsequent availability of the spare parts for the normal life of the respective equipment.

1.17 Tools:

List of tools & special tools for maintenance and overhaul of SPMUV shall be supplied as per Annexure-8-A, 8-B by the Tenderer in accordance with Clause 6.1 of this specification. The cost of tools shall be included in the price of SPMUV. The successful Tenderer shall submit the drawings and specification of tools required for the maintenance of the SPMUV.

1.18 Testing Kit

1.18.1 The tenderer shall supply testing equipment with each SPMUV required for ensuring optimum performance and trouble-free service of the major equipments & accessories provided in the SPMUV (e.g. Diesel Engine, Traction Alternator, Traction Motor and other Equipments with accessories). The special tools shall be supplied as per annexure-8-C and the cost of special tools shall be included in the price of SPMUV.

1.18.2 The Tenderer shall also offer separately special jigs, tools and instruments, which shall essentially be required for maintenance of SPMUV.

1.18.3 The contractor shall demonstrate to the IR, the satisfactory functioning of the tools, jigs & instruments supplied by him. The Specification of testing equipments shall be provided by successful Tenderer.

1.19 Maintenance equipments

The tenderer shall supply the following maintenance equipment along with each SPMUV. The cost of maintenance equipment shall be included in the price of SPMUV.

- a) One hydraulic Jack of 5 t capacity,

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- b) One tifter 3t, Two tifter 1.5 t, (As per RDSO's Specification No. TI/SPC/OHE/TOOLPL/0990).
- c) Three pull-lift 0.75 t, Two pull-lift 1.5 t, One pull-lift 3t (As per RDSO's Specification No. TI/SPC/OHE/TOOLPL/1990).

1.20 Quality Assurance Plan

1.20.1 The contractor should possess valid ISO-9001:2000 certificate for his work's address, covering the items for which he is participating in the contract. The contractor shall formulate Quality Assurance program (QAP) detailing the methodology proposed to be followed to ensure a quality product. QAP shall cover quality assurance procedures and procedures to be followed during all stages of design, manufacture, testing and commissioning of the equipment. The Contractor shall define the role of each functional group in the organization for achieving the required quality of the product and submit a comprehensive document "Quality assurance manual" in accordance with IS 10201-1982 as the basic guideline. The preparation of necessary charts and proforma shall be to IS: 7200 (Part- III)-82.

1.20.2 The tenderer whose bid is accepted, shall be required to submit a "Quality Assurance Manual" by giving details as to how the quality of specific product is proposed to be assured. Supply of the equipment shall commence only after "Quality Assurance Plan" has been approved by RDSO.

The above shall apply to the main contractor as well as sub-contractors.

1.21 Annual Maintenance Contract (AMC) :

1.20.1 The tenderer shall quote for AMC comprehensive of all equipments including Traction Motors, Alternators, Diesel Engine complete with transmission, Air Brake system with compressor unit, Control System and cooling system etc. The Annual Maintenance shall be applicable after warranty period for 5 years. The tenderer shall quote year wise rates of AMC detailing the various schedule enlisting the requirement of material/spare parts, consumables, technical expertise and services to be rendered by him after regular intervals. The AMC shall be comprehensive for all equipments for preventing as well as break down maintenance. The tenderer shall keep adequate spares in stock for regular schedule of AMC so that maintenance schedules are completed timely. AMC shall be all inclusive of replacement of parts if required either due to breakdown or wear.

The AMC cost shall be considered while evaluating the inter-se tender position. It shall be compulsory for the tenderer to quote for AMC.

1.20.2 In case of failure of any of the equipment covered under maintenance contract, it shall be repaired or replaced within reasonable time not exceeding 05 days from the day of reporting by the consignee. After this

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period of 05 days, penalty at the rate of Rs.5000 per day (flat) shall be imposed on the contractor for each day, or its part thereof.

1.20.3 The AMC agreement shall be entered with the Zonal Railways as per the accepted rate in the contract.

Chapter-II

2.1 DIMENSIONAL, OPERATING AND OTHER REQUIREMENTS FOR SPMUV

Para	Subject	Technical specification	
1	General	<p>The 8-Wheeler Self-propelled Multipurpose utility Vehicle shall have diesel electric transmission. However, the power and traction equipments shall be designed and manufactured to meet the requirement to start and haul the trailing load of two vehicles having total gross trailing load of not more than 120t.</p> <p>The general design of the SPMUV shall be as per standard industry practices, and fit for the purpose. It shall be manufactured with adequate running stability and suitable for use on Indian Railways. All standard materials shall be used to manufacture the SPMUV such that it is acceptable to the buyer. The SPMUV shall be manufactured so that it can be used for working under all weather conditions in India.</p>	
2	Purpose of use (applications)	<ul style="list-style-type: none"> • Each SPMUV shall work independently and shall be capable to haul the train formation in loaded condition at a speed of 80 kmph on level track. • Inspection, maintenance of OHE and mast erection. • Cantilever and OHE adjustment works. • It shall have one hydraulic swivelling and lifting platform. • It shall have a 30 tone meter crane with telescopic boom and lifting hook. 	
3	Vehicle parameters	Vehicle Type	8 -wheeler with two bogie
		Max Speed with trailing load	80 kmph
		Max Speed when running alone.	110 kmph
		Coupling and Buffer Arrangement.	Centre Buffer Transition with screw coupling conforming RDSO's Specification No. 56-BD 07 along with the side buffer arrangement to RDSO's Drawing Number SK-98145.
		Axle	Generally shall conform to RDSO's Drawing No. IRS R-43/92

Para	Subject	Technical specification	
		Maximum Axle load.	20.32 Tonne (The maximum axle load shall not exceed 20.32 tonne in any case and preferably shall be as less as possible)
		Wheels	Generally shall conform to RDSO's Drawing No. IRS R-19/93
		Wheel Profile	Generally shall conform to RDSO drawing No SK-91146
4	Elevating and Rotating Platform	Dimensions and Capacity	Length - 6000 mm (Approx.)
			Width - 1500 mm (Approx.)
			Maximum floor height - In lowered position-2600mm (Approx.) - In raised position -6000 mm (Approx.)
			Rotation $\pm 90^\circ$
			Capacity - (Persons with tools)- 1500 kg (Approx)
		Accessories	It shall be equipped with foldable railing of 1100 mm height with access gate and locking arrangement, anti skid flooring, a hydraulic rotating and lifting devices, removable guiding rollers for support of contact wire, mechanical locking device for fixing the platform on the lowered position, a detachable control panel and two search lights, four number flood lights, two electrical socket, pneumatic outlets etc. (Details to be submitted with offer)
		Control	The detachable Control Panel positioned inside platform includes controls and checks for – movements of the elevating platform (lifting, lowering, rotation), work creep speed, brake/brake release, automatic and emergency brake. It shall have provision to bring back the platform in travelling position in case of hydraulic failure, engine failure etc.
		Safety devices	i) Using of elevating platform is allowed only if the suspension on the rear axle is locked. ii) Using of elevating platform is allowed only if the pantograph is in the raised position. iii) Unlocking of suspension, travelling speed and lowering of pantograph are allowed

Para	Subject	Technical specification	
			only if the elevating platform is closed in travelling position.
5	Crane with lifting hook	Crane with telescopic boom and lifting hook	<ul style="list-style-type: none"> Crane with lifting hook shall be mounted at a suitable location on SPMUV as per IRS-37, EN13000, EN13001 and ISO 4305. All safety provision for ensuring safety of equipment and its sub system, the material, the surrounding, the operator, helper and any other Rail/Road user etc shall be provided.
		Lifting capacity	30 tonne metre (Approx.)
		Height in folded condition	Should not infringe MMD of Indian railways Schedule of Dimensions 1676 mm Gauge (BG), Revised 2004 (with latest revision), as per Para 4.7
		Outreach	Horizontal - 7.5 Meter (Approx) Vertical - 12.0 Meter (Approx)
		Stabilisers/ Outriggers	As per requirement shall be provided.
		Out Riggers	As per requirement shall be provided.
		Safety	<ul style="list-style-type: none"> The crane shall be equipped with an electronic safety load device, electro hydraulic levelling device, rubber mats, two working flood lights. It shall be fitted with one electric socket of 24 V, 10 Amp DC and two compressed air connections for operation of tools. Provision of over load and over outreach visual and audible devices for crane operator and in cabin operator Full load chart with slew angle and out reach along with crane stability calculations (in all condition of the crane) and drawings shall be submitted at the time of approval Crane hook and wire rope test certificate at 33% over load from any national or regional test house before the final test shall be produced. Overloading i.e. when the load being lifted shall exceeds 95% of the rated capacity at the radius; automatic-audio-visual warning shall be available. It shall also cut off the hoist operation if the load exceeds 105 % of the rated load at the radius. Between

Para	Subject	Technical specification	
			<p>98% and 105 % load of the rated capacity, the audio- visual warning pressure signals shall be continuous.</p> <ul style="list-style-type: none"> • Pressure relief valve, safety check valve (to protect sudden stoppage of any operation due to any reason), hose failure protection, cylinder protection etc. As applicable. • Proper safety arrangement for lifting, slewing, lowering and antifall devices for telescopic cylinders of the boom and for derricking cylinders shall be provided. • Machine shall have locking arrangement feature for load in any position. Lowering shall not be allowed by gravity in any case. • Provision of Locking valves to lock hydraulic rams in any case of failure of hydraulic system due to any reason. • Stability of machine in all operational position (loaded and unloaded condition, while moving, holding, lifting simultaneously or separately shall be ensured.
		Crane Controls	All the controls of the crane movement shall be fitted at a convenient place. One separate control desk for operation and control of emergency brake, movement of crane, stabilizer, lights etc.
		Crane fittings	<ul style="list-style-type: none"> • The crane shall be equipped with hydraulic extensions, Load hook, Hydraulic stabilizer jacks with outriggers, stabilizers pad, electro hydraulic height limiting device, adjacent track limitation device, electronic control of lifting capacity and range management system, earth bonding of all components and other accessories for safe operation of crane. • Lifting Hook- A standard forged hook with proper locking arrangement. The safe working load shall legibly stamped on a non-vital part of the hook, an authentic test certificate shall be supplied.
		Safety Devices of the Crane	i. Unlocking of suspension and lowering of Pantograph are allowed only if the Crane is in travelling position.

Para	Subject	Technical specification
		ii. The Crane can work simultaneously to the elevating platform, but the lifting capacity and the working area are automatically reduced to guarantee the Vehicle stability on all working conditions.
6	Pantograph	An electro pneumatically operated, insulated and an earthing pantograph fitted with a knife connector, suitable for 25 kV ac of reputed make. The knife connector located on the roof is actuated by means of an electro pneumatic device, coupled to the vehicle compressed air circuit. The earthing pantograph ensures perfect equipotential continuity between contact wire & rail

2.2 The SPMUV shall be an 8-wheeler vehicle. The disposition of equipment storage space shall be such as to ensure equal axle loads. Design shall be such as to afford easy inspection and maintenance.

2.3 Provision shall be made for the following in the SPMUV:

2.3.1 Driving Cab:

- (i) One driving cab shall be provided, at one end, with complete operating & driving control with dual dash boards to facilitate complete driving operation to drive the vehicle in either direction. Driver's seat shall be on the left side of each dash board. Adequate leg space shall be provided for the driver when he is seated. The general layout and arrangement of equipment in Driver's cab shall follow UIC CODEX 651 with respect to dimensions, safety features, furnishing, lighting, ventilation, noise level, field of view, driver's desk, seats etc. Spot lights shall be provided at suitable locations. The cab shall be ergonomically designed for better driving view in either direction of and comfort and also the various panels /equipment meant for Driver shall be so laid that they are easily readable and Driver is not required to move physically for any operation during run. All controls, brake handle, hand brake, Dead Man's device for horn and indication lamps/ meters shall be within easy access and view of the Driver.
- (ii) The SPMUV shall be equipped with inter-communication equipment between cab & working platform through hand free sets with their own battery.
- (iii) 2 numbers, 110 V sockets for hand signals in the cab.
- (iv) Head Light, Flasher lights search lights and marker lights at both ends of the cab. refer para 4.5.
- (v) OHE voltage sensing device in the cab.
- (vi) Full width single piece stone proof lookout glass shall be provided in the

end wall of Driver's compartment and these shall be glazed, clear, colorless polycarbonate to ICF spec no.ICF/MD/SPEC-159 (latest revision).

- (vii) Provision of wind screen wiper arm and blade assembly to be provided as per RDSO specification no.C-K306 (latest revision). Provision should be made for water spraying on wind screen to avoid any scratches on wind screen during wiping. The tenderer shall quote for electrically operated heavy duty wipers as an alternative option.
- (viii) Provision of mobile charging point to be made. The detail design and drawing shall be finalized at design approval stage.
- (ix) Arrangement for sitting of 6 persons to be made at suitable location in the Driving Cab.

2.3.4 The facilities to be provided in the SPMUV shall be as described briefly in the following Clauses.

2.3.4.1 Material Cabin: A small material cabin shall be provided adjoining driving cab having space and proper locking arrangement for the storage of costly equipment and fittings. The design shall be finalized at design approval stage.

Chapter - III

3.0 MECHANICAL DESIGN

3.1 Superstructure:

3.1.1 General: The SPMUV shall be of welded light weight construction, generally to maximum moving dimensions to diagram 1D of Indian Railways Schedule of Dimension 1676 mm gauge (BG) revised 2004 (SOD) with pantograph and platform in lowered condition. Infringements, if unavoidable and fully justified, may be considered, if within limits shown in the SOD. Weight of the SPMUV shall be kept as low as possible, without compromising with the strength. The structure shall withstand end load of 200 t (divided equally between the two buffers) applied in conjunction with full payload. Under such loading no permanent deformation should occur and stresses should remain below the yield point. The design shall be sufficiently rigid to withstand stresses imposed due to lifting with overhead or breakdown cranes or by jacks applied to the headstocks. The superstructure shall be designed as a tubular girder for the purpose of withstanding vertical loading, but the inner sheeting of the roof and walls shall not be stress-bearing members.

3.1.2 The under frame shall be designed to meet the following loads:

- i. A vertical load of 4 t/meter run uniformly distributed. The weight of the various equipment mounted in the SPMUV shall be considered as concentrated load and shall be simulated as such during load/strain testing.
- ii. A horizontal squeeze load of 100 t applied at each buffers.
- iii. A combination of loads specified at (i) & (ii).

3.1.3 The stresses estimated by an approved method shall not exceed 139.3 MPa (14.2 kgf /sq.mm) for members made from Steel to IS:2062 Fe 410CuWC and 221.7 Mpa (22.6Kgf/ sq.mm) for members made from corrosion resistant steel to IRS:M 41 for the uniformly distributed vertical load. Also for the squeeze load referred to above, the stress should not exceed 90% of the lower yield point or proportional limit of the material in the load carrying member of the shell and 95% of the lower yield point or proportional limit of the material in the end construction. The estimated vertical deflection of the shell at the center of the SPMUV shall also not exceed 10mm under any loading condition detailed at (i) to (iii) above.

Completed shell of prototype SPMUV shall be strain gauged for stress analysis under tare and loaded conditions with squeeze load. SPMUV shall be tested for leakage through roof and body sides and ends at the

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works of the manufacturer. To carry out this test, the manufacturer shall provide a test rig to the satisfaction of the inspecting authority.

3.1.4 **Side and End Wall:**

- (i) Material: The frame work shall be of low alloy high tensile corrosion resistant steel to IRS M-41 with latest revision/amendment.
- (ii) Side wall and pillars: The material of body pillar shall be IRS M-41. Pillars shall be continuous from sole bar to cant-rail, except below window openings, and shall be braced by longitudinal members between adjacent pillars. Bracing being designed to act as integral part of the exterior sheeting.
- (iii) The frame work shall be of low alloy high tensile corrosion resistant steel to IRS M-41 with latest revision.

3.1.5 **Body shell Structure:** The body shell including sheathing shall be of IRS: M 41 steel.

3.1.6 **Underframe:** The underframe material shall be of corrosion resistant structural steel to IRS: M 41 or copper bearing quality steel to IS: 2062 Cu WC, of welded integral structure. The under frame design shall be developed by the successful Tenderer keeping in mind the layout of SPMUV. The successful Tenderer shall submit under frame design to RDSO for approval at the time of design approval stage. They shall be assembled in jigs and fabricated by welding. Trough floor of 2.0 mm thick of steel to IRS: M 41 steel shall be provided in covered area.

3.1.7 **Headstocks:** These shall be of robust design suitable for coupling and buffing gear arrangements as detailed in this specification. Head stock material shall be IRS:M 41 steel.

3.1.8 **Draw gear members:** The members provided for carrying the trimmer casting shall be of strong and rigid construction capable of transmitting buffing forces specified in Clause - 3.1 under the most adverse operating conditions. They shall be braced together to the main sills in such a manner as to form, in conjunction with the flooring system between the transom and headstock a rigid assembly capable of withstanding all cross-racking forces, which may occur in service. The design shall, as far as possible, ensure that the load is applied symmetrically about the neutral axis of the longitudinal and is concentric to them.

3.1.9 **Draw & Buff Gear:** The SPMUV shall be provided with high tensile centre buffer transition coupler conforming to RDSO Specification No.56-BD-07 along with the side buffers arrangement to RDSO's Drawing No. SK-98145.

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The arrangement shall be such that shall be able to couple with existing BG rolling stock of Indian Railways.

- 3.1.10 **Lifting Pads:** The SPMUV body shall lend itself to repeated lifting in workshop by overhead cranes or jacks without risk or damage. Suitable lifting pads shall be provided and marked in a readily distinguishable manner on the body.
- 3.1.11 **Sole bar:** These shall be continuous members from headstock to headstock, adequately braced together to withstand the head on loading and cross racking forces and shall be capable to withstand jacking for the purpose of lifting the SPMUV. The sole bar shall be of corrosion resistant structural steel to IRS: M 41 Steel. The successful Tenderer shall submit the design/drawing of Sole Bar to RDSO for approval at the time of Design/Drawing approval stage.
- 3.1.12 **Body bolster:** These may be fabricated from pressed section and shall have suitable pads on which lifting slings may be placed. Body bolster shall be of copper bearing quality steel to IS:2062 Cu WC of welded integral structure.
- 3.1.13 **Floor bearers:** The design of floor bearers shall include robust main floor bearers placed transversely between the main sills and an adequate numbers of racking panels between the main sills and diagonal braces. The transverse floor bearers shall be so designed to carry the maximum super-imposed load under maximum load conditions as well as bracing between the main sills, and shall be flushed with the top faces of the main sills, and a suitable surface for the floor covering. The design shall generally ensure adequate drainage, so that corrosion is avoided, or is confined to parts, which can be readily renewed without affecting the main flooring members. Floor bearers shall be conforming to IRS: M 41 steel.
- 3.2 **Roof:**
- 3.2.1 The roof shall be designed to form a satisfactory chord to the superstructure considered as a girder, and to take a concentrated load of 6 men standing (450 kg), close together at any point. The structure shall consist generally of two main longitudinal members running from end to end of the SPMUV, braced at frequent intervals along their lower flanges, and rigidly connected to the arch bars, and to the grab pillars by rigid transverse members. At partition and semi bulkheads, the sills shall be attached to vertical pillars within or forming part of the partitions or semi-bulk-heads The roof top at both ends i.e. back & front ends shall be flat. Roof should be so designed that no water is accumulated in cavities to avoid the damage/rusting. Proper channels to be provided for easy exit of rain water. The construction

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through out shall be absolutely watertight and shall permit easy renewal of corroded sheets. The material of the roof shall be of IRS: M 41 steel sheet.

3.2.2 **Roof Ventilators:** Roof ventilators shall be provided as per the ICF Drawing No WL.RRM4-7-3-401 with latest alteration shall be used. The ventilator shall not violate the schedule of dimensions & drawings to be got approved from RDSO.

3.2.3 **Air Space:** The air space between the outer and inner sheeting of the roof shall be suitably ventilated as also the air space inside walls and end walls. Attachments may pass through the air space as required, but must be designed, so that they do not cause sections to form sealed chambers or lodgments for condensed moisture. The successful Tenderer shall submit the design/drawing to RDSO at the time of design/drawing approval stage.

3.3 **Windows:**

Lift type window made of powder coated aluminum to ICF drawing No EMU/4C/ASR-5-4-402 with latest alteration with fixed type poly carbonate louver on top and movable glass window at the bottom.

3.3.1 All window and door glasses shall be of laminated plate glass set in sun heat resistant synthetic rubber section.

3.3.2 All window openings shall be true to dimensions square and of uniform width. The window opening shall not at any point exceed 2mm over or under the specified dimensions and shall not be out of square by more than 2mm.

3.3.3 The windowsills of the body side windows shall have an outward slope of approximately 5°.

3.3.4 The body side windows shall have two shutters, one louver on the outside and a glass on the inside.

3.3.5 The glass used for windows/shutters shall be of safety laminated quality to IS: 2553, weighing not less than 9.76 kg/m². Gravity safety latches of approved design shall be provided at two intermediate positions to arrest the glass and louver shutters from falling down. The shutters should be balanced by balancers of suitable Design.

3.3.6 The louver shutters shall be provided with shoot bolt type safety latches to secure the shutters firmly in closed and open position.

3.4 **Doors:**

- 3.4.1 All door openings shall be true to specified dimensions and perfectly square. The openings shall be tested for size and squareness with templates so that doors open and close freely and when closed shall be reasonably weather proof and dust proof.
- 3.4.2 Hinged doors provided on the side walls for entry of drivers from outside of the SPMUV shall be of inward opening type and will give an opening of 750 mm approx.
- 3.4.3 Single leaf inward opening hinged or sliding doors with locking arrangement shall be provided in driver's compartment for entry in the corridor and shall have a clear opening of 550 mm.
- 3.4.4 Other doors on sidewalls shall preferably be of sliding type with a clear opening of 1300 mm. The door leaves shall slide on roller bearing carriers suspended from top rail and shall work in retaining guides on the doorsills. Each leaf shall have a window opening. Since the tenderer is expected to develop layout, location of doors may be decided in the most suitable manner.
- 3.4.5 Latches shall be fitted on all doors so as to secure them from inside in the closed position.
- 3.4.6 **Door locks:** All doors shall be fitted with reliable locks to be operated from outside and inside as well as for external padlocking shall also be provided on all doors opening out of the SPMUV.
- 3.4.7 **Door Footsteps:** The door footsteps assembly shall be of mild steel chequered plate of 6.0 mm thick edges shall be protected with metallic treads. Any other suitable arrangement shall also be considered.
- 3.4.8 **Door handholds:** Door hand holds of chromium plated steel tube, with malleable cast iron brackets shall be provided on either side of all body side doors and shall be so fitted as to clear the side walls sufficiently to prevent injury to knuckles. Hand holds shall also be within the SPMUV profile.

3.5 **BOGIES:**

- 3.5.1 General Design: SPMUV shall have two 4-Wheeled Bogies of robust welded design suitable for taking brake gear, suspension etc. and capable of withstanding the maximum static and dynamic stresses under its full load condition. The weight of the Bogie shall be as low as possible, consistent with strength and robustness. The bogie frame

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shall be of copper bearing steel plates to IS 2062 Fe 410 Cu WC and shall be fabricated by welding.

- 3.6.2 Bogie suspension Design shall be coil steel suspension in primary and secondary stage. The Bogie Design shall be as per ICF Drawing No. AC/DC/M/ASR-0-0-001 with latest Alteration.

The manufacturer of SPMUV car shall purchase bogie frame along with its accessories from the approved vendors of Indian Railways

3.6 **WHEEL, AXLES AND AXLE BOXES**

- 3.6.1 Wheel and axle dimensions shall meet the requirements of Indian Railways Schedule of Dimensions 1676 mm gauge-(BG) revised 2004.

- 3.6.2 Wheel assembly shall be of 952 mm diameter and shall be provided with roller bearings No 22328 C/C3. The wheels of SPMUV shall be solid forged wheels to RDSO drawing No SK-K4004 with latest alteration. All wheels sets shall be machined to take a speedometer drive.

- 3.6.3 Axles shall be to IRS-R43/92 stress calculations/FEM of wheel and axles shall be submitted. The calculations shall be done as per ARR/UIC specification.

- 3.6.4 The wheel profile shall be to RDSO sketch No 91146 with latest alteration.

- 3.6.5 40% dynamic augmentation of the vertical journal load will be used in calculating the axle stress in addition to vertical and horizontal forces and moments.

- 3.6.6 All wheel and gear seats and traction motor suspension bearing journals are required to be cold rolled together with stress relieving groves machined in the axle, between wheel seat and gear seat and between the wheel and traction motor suspension bearing journal of the axles.

- 3.6.7 Facilities for oil injection for removal of wheel shall necessarily be provided.

- 3.6.8 Standard axle boxes shall be used. Roller bearings will be grease lubricated and of type which have given satisfactory performance/service on railway stock. Special attention shall be paid to sealing arrangement of the ends of axle, to prevent ingress of water, dirt and loss of lubricants. This aspect requires special attention as the axle box may remain sub-merged in flood water during heavy rains. The sealing arrangement shall ensure that axle box will not need special maintenance even if it is submerged in water. The

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design of labyrinth will be such as to prevent the ingress of dust in to or outflow of grease from axle boxes.

- 3.6.9 One of the axle box and cover (not the leading one) shall house speedometer generator with suitable adopter. SPMUV shall be taken to provide special protection arrangement for the generator and cable connection against flying ballast and any other extraneous objects. The connection shall preferably be taken from the top of the axle box.
- 3.6.10 Complete working drawing of the axle box, guide arrangement with bearing and its components shall be submitted for approval along with maintenance instructions
- 3.6.11 The axle box body shall preferably be of cast steel.
- 3.6.12 The contractor will be required to provide recommended lubricants which should have been proven in similar railway service of the axle bearings.
- 3.6.13 An alternative lubricant, manufactured in India shall also be identified by the contractor in conjunction with the bearing manufacturer, and the lubricants manufacturing industry.
- 3.6.14 Design calculation for the powered axle shall be submitted for approval of RDSO.

3.7 **Brake System:**

- 3.7.1 The SPMUV shall be fitted with graduated release air brakes. The brake system shall be of UIC approved type and shall meet all UIC requirements. It shall have the following distinct positions.
- i) Release Position
 - ii) Minimum reduction position.
 - iii) Full service position.
 - iv) Emergency position.

Note Panel mounted air brake system of approved make conforming to Specification. No. MP-0.01.00.19 (Rev-01), June'2010 as approved by RDSO should be provided in order to achieve high reliability, low weight, better sensitivity and easy maintainability.

- 3.8.2 **Brake Blocks:** The composition 'K' type non-asbestos brake blocks to RDSO Specification No. C-9508 with latest revision/amendment shall be used. Brake rigging shall be as per ICF drawing No. EMU/M-3-2-064 with latest alteration shall be provided to prevent the brake blocks riding down the wheel tapers.

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- 3.8.3 The Emergency Braking Distance (EBD) for fully loaded (20.32x4=81.28 t) SPMUV from maximum speed of 110 km/h to zero shall not be more than 800 meter on flat section. The Tenderer shall also submit calculation for EBD on 1 in 33 down gradient.
- 3.8.4 It is proposed to use the SPMUV for hauling two wagons weighing 60t each in gross load condition [see Item-11 (vii & ix) of table at Clause 2.12(vii). The manufacturer shall indicate the Emergency Braking Distance that can be obtained with above loaded wagons in the rear in un-braked state.
- 3.8.5 The SPMUV shall be provided with the following additional brake requirements:
- i) A D-1 Emergency Brake valve in both driving cab on extreme right hand side for emergency brake application.
 - ii) Stand-by brakes, in case of failure of distributor valve or any component in the main brake system. This shall be decided at the design approval stage.
 - iii) Parking brake to RDSO Specification No. CK 408 (latest revision) capable of holding fully loaded with 120 t trailing load of two loaded bogie Flat Wagons in un-Braked state on 1 in 33 down gradient under wet condition.
 - iv) Flexible Hose connection shall conform to SAE 100R1
- 3.8.6 Application of any type of brake provided on the SPMUV shall result in simultaneous cutting of the power to the driving axles. Interlock for this arrangement may be included in governor system for safety precaution.
- 3.8.7 The brake rigging arrangements shall be light and as simple as possible with minimum number of levers and fulcrum points permitting easy access to brake blocks and other wearing parts. Composite brake block shall only be used as per the standard approved drawing.
- 3.8.8 Brake system shall be provided with automatic slack adjuster built into the brake cylinder.
- 3.8.9 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.
- 3.8.10 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 brake blocks and literature on brake equipments proposed along with offer and get the brake system approved from RDSO before manufacture of the prototype.
- 3.8.11 Air dryer of approved make conforming to Specification No.MP-0.01.00.09 (Rev-05), March' 2011 shall be provided. (In line with latest equipment on EMU/DEMU).
- 3.8.12 Main air 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). Cut off cock may be provided at inlet of auto drain valve.

- 3.8.13 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.
- 3.8.14 The supplier shall get the brake schematic approved by the RDSO.
- 3.8.15 Stand-alone VCD of approved make conforming to spec No MP-0.34.00.04 (Rev.04) Dec 2008 shall be provided.
- 3.8.16 Brake system shall be such that in dead condition of 8WDETW can be hauled by another air brake stock.

3.9 **Piping & Pipe fittings:**

- 3.9.2 Seamless stainless steel pipe bright annealed to ASTM A 269 Gr. 304, which can be bent cold shall be used. The layout of piping shall be designed to keep all pipes, especially the brake cylinder pipes, as short and straight as possible Bends should be used throughout, but where elbows have to be used; they shall be of round type. Where the pipes itself are bent, their internal area shall be maintained uniformly.
- 3.9.3 Double ferrule pipe fitting consisting of body, front ferrule, back ferrule and nut shall provided. The body and nut shall be of carbon steel of ASTM A-108 Grade -II with electro cobalt zinc plating with chromic passivation. The front ferrule and back ferrule shall be made from stainless steel to ASTM A276 TP 316 SS and conforming to ICF Specification No. ICF/MD/SPEC-166 with latest revision/amendment.
- 3.9.4 All pipes shall be adequately clamped to the frame assembly. Compreg to RDSO Specification No. C-9407- type II shall be used for clamp.
- 3.9.5 Pipes, ducts and conduits shall conform to an identification colour scheme with polyurethane paint as per RDSO's Specification, which shall be approved by RDSO.
- 3.9.6 Chart showing the colours for identification of pipes shall be displayed in cab at a prominent place where it is likely to be needed for reference.
- 3.10 **Interior furnishing:** The SPMUV shall be furnished with light weight fire retardant material. The material used for finishing and furnishing shall be suitable for use under Indian climatic conditions and shall be as for as possible fire proof, non-hygroscopic and vermin and rot proof. The furnishing shall be as agreed between the contractor and RDSO. It may be noted that Indian Railways are presently using 3 mm decorative/resin bonded thermo- setting Laminated plastic sheets of approved shades,

possessing resistance to spread of flame as indicated in para 5.16 of IS:2046. With a view to retarding the spread of fire, the continuity of LP sheets shall be broken by the provision of suitable metal barriers. The laminated plastic sheets conforming to STR No. C-K-514 (Latest Revision) may be used for thermosetting resin bonded Laminated Sheet for.

3.11 **Ceiling and paneling:** The ceiling in compartments shall be of minimum 2 mm thick NFTC to RDSO Specification No. C-K 511 (Latest Revision). The ceiling material shall be IRSM-41 where ever required.

3.12 **Flooring Construction:** Floor of the vehicle shall be as per ICF Drg. No. EMU/MASR-41-001 with latest alteration. The opening in the flooring for passage of pipes and cables through the floor shall be so constructed as to prevent any seepage of the oil. In addition to give effective protection against the spread of fire originating beneath the body.

3.13 **Extra Fitting:**

- (i) Door steps shall be provided at all body side doors.
- (ii) Continuous water wriggles from one end of the SPMUV to the other shall be provided.
- (iii) Tail lamp bracket to IRS Drawing No.C.BF-113 shall be fitted at each end of the shell.
- (iv) Rain water channels of suitable design over the doors & windows way shall be provided.
- (v) Tenderers may note that the SPMUV may be washed mechanically. Tenderers may also note that the exterior of the SPMUV may be washed in automatic washing plants. Exterior of the SPMUV shall be designed keeping this in view.

3.14 **Cattle Guard:** Detachable type cattle guards shall be provided under each buffer beam. The cattle guard shall be fitted with adjustable rail guards so as to maintain the minimum free space above the rails under all conditions (see item 7 of clause 2.0).Cattle guard shall be as per RCF Drawing No. EM26108 with Latest Revision.

3.15 **Insulation:** An insulation layer of suitable thickness of non-asbestos material shall be provided inside the shell. End walls and sidewalls shall be provided with suitable anti-drumming and anti-corrosive compound. Underside of the under frame over the engine area shall be properly insulated to minimize heat transfer to the compartment. The material used

for insulation shall be non-inflammable type. All other parts shall be provided with anti-corrosive compound.

- 3.16 **Noise Suppression:** The tenderers shall indicate noise suppression features incorporated in the design. Maximum noise level should not exceed 75 dB inside the cab.
- 3.17 **Trap Doors:** Suitable trap doors shall be provided on the flooring for attention of underslung equipments, during service. The design of trap door shall be such that it can be conveniently lifted when attention to equipment is required but strong enough to withstand normal passenger loading. The trap door shall remain in level to the floor of the SPMUV.
- 3.18 **Anti-pilferage measures:** While securing compartment fittings, anti-pilferage measures shall be incorporated.
- 3.19 **Fire extinguishers and first aid equipment:** Four fire extinguishers CO₂ type of 5 kg capacity shall be provided, one each in both the cabs and two in workmen's lobby. Space shall be provided for keeping a first aid box and one stretcher.
- 3.20 **Corrosion protection:**
- i) Sheets and plates (other than Stainless Steel) used for SPMUV construction shall be suitably treated against corrosion before fabrication.
 - ii) Sub-assemblies shall be treated against corrosion as per UIC Code 842-5 after they are manufactured.
 - iii) SPMUV shall be treated after fabrication as per UIC Code 842-5.
 - iv) In addition to above, the design shall be such as to minimize the incidence of corrosion. Indian Railways experience is that most corrosion takes place due to seepage of water from the floor and window openings.
 - v) The tenderer may suggest any better corrosion protection system that he may have adopted with success in SPMUVs manufactured by him.
 - vi) The Tenderer shall note that SPMUV floors are washed regularly at certain time intervals. Hence the floor construction should be such that it does not permit water to seep through the floor and cause corrosion to trough floor and under frame members.
 - vii) Tenderers may note that Indian Railway have noticed heavy corrosion on under the lavatories. As such, corrosion resistant steel shall be used for construction of floor and adjacent members under lavatories and the neighboring bays.

3.21 Information to be submitted by the tenderer

- (a) The following information shall be furnished by the tenderer along with the offer:
- (i) Transverse cross section of the proposed SPMUV along with principal dimensions so as to illustrate the general construction of the shell. Also superimposed upon this should be the schedule of dimensions as embodied in the Indian Railways Schedule of dimensions –1676 mm gauge, revised 2004. Infringements, if any, should be accurately defined in the sketch.
 - (ii) A "Section" view of the plan of the, showing the layout of the major equipments along with principal dimensions.
 - (iii) Side elevation of the proposed SPMUV.
 - (iv) A "Sectional" side elevation of the SPMUV underframe showing the disposition of the major equipments on the underframe.
 - (v) To demonstrate his capability for designing SPMUV body, the tenderer shall submit a set of actual calculations pertaining to SPMUV structure for any bogie vehicle, designed by him in the past . These shall be submitted alongwith his tender offer.
 - (vi) The schematics of the brake pneumatic alongwith the internal schematics of the valves proposed to be used shall be furnished alongwith the tender. The schematics shall be accompanied with a write up on sequence of events during application, release and emergency.
 - (vii) Type of compressor and its capacity shall be indicated along with tender. This will be accompanied with a technical justification for the compressor capacity selected.
 - (viii) Estimated weight of the SPMUV structure shall be furnished alongwith the tender. Also weights of principal assemblies mounted on the SPMUV structure shall also be furnished.
- (b) The other relevant information but not limited to following shall be furnished at design approval stage by the successful tenderer.
- (i) A representative sectional view of the SPMUV floor, illustrating the floor construction. The specifications of the materials used in its construction should be identified.
 - (ii) Furnishing material intended to be used by the tenderers-specifications should be identified.
 - (iii) Insulating material proposed by the manufacturer specifications should be identified.
 - (iv) Ceiling material proposed to be used by the manufacturer specifications should be identified.
 - (v) Principal features of noise suppression shall be identified and submitted.
 - (vi) Principal features showing adequate fire redundancy shall be identified and submitted.

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(vii) Tentative brake rigging diagram alongwith details of brake cylinder and slack adjuster proposed to be used shall be submitted.

(viii) In case parking brakes are proposed the features of the proposed parking brake actuator, its type and the schematics shall be furnished.

3.22 The guaranteed technical particulars of the SPMUV shall be submitted as per Annexure-7.

Chapter - IV

ELECTRICAL EQUIPMENTS

- 4.0 **Illumination:** Driving Cab & Storage space shall be provided with level of Illumination of at least 30 Lux at the working plane level (1m above the floor level).The lighting shall be provided with 18 W, 600 mm x 26 mm double capped Fluorescent tube lights with wire mesh guard along with its fittings and Electronic Lamp ballast as per RDSO Specification No. RDSO/PE/SPEC/ TL/0011-2000 (Rev.1) with the latest revision shall be used.
- 4.1 Driving cab and workshop shall be provided with two, 110V, 300 mm sweep fans conforming to IS: 6680.
- 4.2 **BATTERY:** Lead Acid maintenance free storage battery of capacity as mentioned at Clause no.5.3.2.20 of Chapter-V, conforming to IS: 6848-1972 shall be provided in under slung Battery boxes. The Battery fuses shall be located close to the battery terminals.
- 4.2.1 Terminals for charging the batteries from external charging equipment shall also be provided. The location of the batteries shall be such that there is no danger of their getting damaged due to tools and equipment inadvertently falling on them. If the cells are packed in two rows in the battery box, a hylam sheet shall separate the two rows.
- 4.3 **Alternator for charging batteries of DG sets:**
An engine mounted alternator with rectifier and regulating equipment of suitable capacity for charging of 24 V DC 290 Ah battery shall be provided. The output of the generator shall cater for battery charging for diesel engine starting (battery voltage 24V). The maximum power demand will be required when the SPMUV is stationary and with engine running at low idling speed.
- 4.4 Battery charger for charging batteries of 110 V of 120 Ah capacity Lead acid maintenance free storage battery of capacity as mentioned at Clause No.5.3.2.20. The battery charger shall be from RDSO's approved vendors complying to the RDSO's Specification No. RDSO/PE/SPEC/AC/0008 (Rev.2) with latest alteration.
- 4.5 A 10 kVA, 3-phase, 415V, low noise Diesel Generating set for power supply to lifting platform and machines in workshop shall be provided with SPMUV. The Gen set shall be mounted on anti-vibration mounting to reduce the vibrations.
- 4.6 A skid mounted portable Diesel Generator similar to Honda make (petrol start kerosene run or petrol start petrol run) of 3 kVA (minimum), 240V, 50 Hz alongwith transformer shall be provided to meet 150 Amps light weight IGBT based welding machine load and other auxiliary load of search lights (2x250 watts), emergency light and for other such purposes. Design of transformer shall be decided at design approval stage.

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4.7 **Circuitry**

- 4.7.1 The load shall be suitably distributed based on standard practice.
- 4.7.2 Electrical equipment such as switches, lamp holders and other items shall conform to the following latest Specifications:
 IS:6965: Switches for use in Railway stock.
 IS:1258: Bayonet lamp holders.
 IS:1293: Three pin plug and socket outlets.
 IRS: EA-199: For ceiling light fittings like CFL within transparent enclosure.

4.8 **Power for head lights, tail lights etc.**

- 4.8.1 Following lights shall be worked on the alternator/ rectifier provided with diesel engine. This is to ensure that failure in the other lighting system does not affect the mobility of the SPMUV.
- 4.8.2 **Twin beam Head light:** Twin Beam head lights shall be provided at both ends. The head light shall conform to RDSO's Specification No ELRS/SPEC/PR/0024 (Rev-1) Oct. 2004. The operating voltage of head light shall be 24 V DC. 24 V DC supply for twin beam head light shall be taken from 110/24 DC-DC convertor. DC-DC Convertor shall be as per RDSO's Specification No. ELRS/SPEC/DC-DC Convertor/0021, Rev.1
- 4.8.3 **Tail light:** Tail lamp (Red aspect) of LED type 24 V 15 W as per RDSO's Specification No. RDSO/PE/SPEC/TL/0119-2000 (with latest revision) shall be provided at each end to comply with General & Subsidiary Rules of Indian Railways.
- 4.8.4 **Flasher light:** One flasher light each of LED type as per RDSO's Specification No ELRS/ SPEC/LFL/0017 (Rev-1) Sept,2004 shall be provided on the roof at either end of the SPMUV.
- 4.8.5 **Marker Light:** Marker light of LED type (Red aspect) as per RDSO's Specification No ELRS/SPEC/PR/0022 (Rev-1) Oct. 2004 shall be provided on either end of the SPMUV.
- 4.8.6 **Search Light:** SPMUV shall be provided with two 250 Watts search lights with Metal Halide lamps, one on each end, for inspection of the OHE while on the run. Searchlights shall provide a high intensity illuminating beam and capable of swiveling on universal joint type supports. Design details shall be finalized at the time of design approval stage.
- 4.8.7 **Wiring-**All Electrical wiring in the SPMUV wagon shall be done with e-beam cables conforming to RDSO's Specification No ELRS/SPEC/ELC/0019 Rev.-1 dated 06.07.2010 with latest amendment.

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- 4.8.8 **Horns:** The SPMUV shall be fitted with two horns at the roof with different tones on both sides. Horns shall be operated on compressed air. These shall be operated by a hand switch provided within the access of the Driver. Horn cover to RDSO Drawing No. CG-K5056.
- 4.8.9 **SPEED INDICATOR/ RECORDER:** Speed Indicator and Recording Equipment of 0 -160 km/h range shall conform to RDSO's Specification No.MP-0.3700-07 (Rev.03) of April'2003. The cab of SPMUV shall have one recorder-cum-indicator and one speed indicator.
- 4.8.10 **Cab Heaters:** Both the cabs shall be provided with electrical heaters to keep cab environment warm during winter season. The power supply to heater shall be given from the auxiliary alternators as specified.
- 4.8.11 **Flood lights:** Four flood lights giving diffused light of 75 watts shall be provided with each SPMUV. Detailed design of it shall be finalized at the design approval stage.
- 4.8.12 **Emergency push-buttons (Mushroom Type):** Five emergency push-buttons shall be fitted on the chassis sides and one on the roof. When activated, they provoke:-
(i) Idling of the engine & removal of excitation of alternator.
(ii) Stop of elevating platform.
(iii) Braking of the vehicle.
- 4.8.13 **Earthing Arrangement of SPMUV:**
- All metallic parts of SPMUV including the working platform, shell structure & bogie shall be integrated electrically to ensure proper earthing of SPMUV through wheels to Rail. The body of the lifting motor, control panels, swiveling motor at platform, crane and other electrical equipment shall be connected to the earth. Traction motor shall be provided with earth brush. The schematic diagram of earthing arrangement to be provided for the SPMUV & equipment in it shall be submitted by the successful tenderer for approval of RDSO.

Chapter – V

5.0 POWER EQUIPMENT & CONTROL

5.1 The different speeds of the twin-power pack from idle to maximum speed and the corresponding power developed should be so selected that all the conditions mentioned in **Clause - 2.1 of Chapter-II** can be satisfactorily met. However the number of speeds and power levels chosen should not be less than 8 (herein after referred to as notch positions) in addition to the idle position. The performance of the power pack shall be optimum in each notch position in addition to being able to meet the traction load and demand by the auxiliaries.

5.2 Detailed calculations shall be submitted alongwith tender indicating the power demand by the traction motors for different conditions and the demand on the power pack. These calculations shall indicate whether adequate reserve power has been provided for Characteristic curves for the Traction Alternator & Rectifier indicating the performance for different notch positions should be furnished. These curves, inter-alia, should indicate speed, BHP, power consumption by auxiliaries, excitation voltage and a.c. and d.c. currents. These characteristics should clearly indicate the extent of matching or mismatching of power.

5.3 DIESEL ENGINE AND TRANSMISSION SYSTEM

5.3.1 The SPMUV will have two independent diesel electric transmission systems, each comprising a diesel engine, an alternator along with its power rectifier, two traction motors mounted on each bogie, auxiliary alternators with their rectifier-cum regulator units, engine and traction controls, synchronised for operation from a common master controller from the driving cab(s). In case of failure of one of the transmission systems, provision shall be made so that the same can be isolated and the SPMUV can still work at reduced power from the healthy transmission.

5.3.2 Diesel Engine

5.3.2.1 Two independent under-slung naturally aspirated, turbo-charged and after cooled Diesel Engines of proven design of Cummins make NTA-855R or similar other reputed make suitable for 8-Wheeler Diesel Electric SPMUV, complete with all accessories, suitable for traction service under the climatic and operating conditions obtained in India, shall be provided. The continuous traction rating of each engine shall be 340 hp (approximately) or higher at 1800 rpm after due de-rating for environmental temperature of 55⁰C. It shall be battery started. Specific Fuel Consumption (SFC) shall be low. Robust construction, low maintenance and satisfactory record of past

performance are of paramount importance. Tenderer shall furnish full particulars of the engine with the offer. Adequate allowance shall be made in the power of the diesel engine for the de-rating under most adverse climatic conditions stated in Clause-1.2 of Chapter-I of this specification. Successful tender shall give detailed calculations for engine's suitability and its rating.

- 5.3.2.2 The supplier shall indicate the total horse power required for the auxiliaries with the break up power for each of the auxiliary machines at rated output.
- 5.3.2.3 The tenderer shall indicate the net horse power available for input to traction under the conditions mentioned under para-1.2 of Chapter - I of this specification.
- 5.3.2.4 The idling speed of the diesel engine shall be such so as to match the requirement of various auxiliary machines driven by the engine.
- 5.3.2.5 The Diesel Engine shall work satisfactorily with fuel oil to Indian Standard Specification No.1460-grade A, but shall also be able to function in a trouble free manner even with Grade B fuel oil to the same Specification.
- 5.3.2.6 Suitable hand priming pump shall be provided to avoid air lock in the fuel system.
- 5.3.2.7 The engine shall be provided with suitable end on mounting arrangement to SAE-O dimensions for coupling with and driving the traction alternator. The mounting and coupling arrangement shall be of adequate capacity to withstand high deflection and torque (at starting, stopping and due to misfiring of cylinders) so that no damage is caused to the alternator and engine components in service.
- 5.3.2.8 The drive gear for driving compressor, auxiliary alternator and electric fan drive for the radiator shall also be in the scope of supply of the tenderer.
- 5.3.2.9 Detailed torsional vibration analysis of the complete 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.
- 5.3.2.10 Air inlet to the engine shall be from inside the SPMUV with proper ducting arrangement from the filters.
- 5.3.2.11 Piping from the air cleaner to the turbo-driven air handling unit shall be in the scope of supply.

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- 5.3.2.12 The exhaust pipe shall not leave carbon soot on important assemblies like traction motors, axle drive etc. The exhaust pipe shall be taken horizontally and located under floor avoiding the position near footsteps of the vehicle with adequate insulation to withstand 700°C and to avoid.
- 5.3.2.13 Filters shall be of adequate air flow capacity/filtering efficiency to ensure satisfactory performance under dusty environment.
- 5.3.2.14 The tenderer shall submit graphs showing the BMEP/engine output torque and SFC at all notch positions from idling speed to rated speed.
- 5.3.2.15 Lube oil consumption at rated output as a percentage of the fuel oil consumption should also be indicated.
- 5.3.2.16 The tenderer shall furnish a copy of the 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 done in the presence of RDSO's representative. In case engine is already type tested and found satisfactory then routine test report is to be submitted for all the engines by the firm to the purchaser. RDSO may like to conduct acceptance test, if required.
- 5.3.2.17 Fuel tank of at least 700 liters capacity indicating SPMUV wagon's operating time with 700 liter fuel oil to be given.
- 5.3.2.18 The noise level in the driver's cabin with the doors and windows in closed condition shall be less than 75 db (A) and in the inside of the SPMUV shall not exceed 80 db (A) at maximum output and speed of the engine.
- 5.3.2.19 The exhaust emission shall be below the limit laid down in UIC/ORE No. B13/RP22/E Clause-4 of the entire engine range of operation from idle to full power and shall be measured as per UIC/ORE/B13/RP21E. The exhaust opacity shall not exceed 20 as measured by Hartridge smoke Meter or equivalent scale under all conditions including acceleration of the engine. A suitable catalytic converter shall be connected in exhaust pipe to limit the emission.
- 5.3.2.20 The tenderer shall supply the complete system including engine starter and battery chargers. Batteries shall be of following ratings:-
- (i) 24 V, 290 Ah batteries of RDSO's approved make for Engine cranking.
 - (ii) 110 V, 120Ah battery of RDSO's approved make for Control and auxiliary circuits.

- 5.3.2.21 Suitable anti-vibration mountings for the engine, alternator, auxiliary alternator, and compressor shall be used. The anti-vibration mountings (AVMs) shall be of approved make. The type and number of AVMs offered shall be specified. To meet the vibration limit, any increased numbers if required shall be to the contractors account. The deflection characteristics of the AVMs shall be submitted.
- 5.3.2.22 Drawings for the suspension brackets shall be got approved by RDSO before manufacture/ supply.
- 5.3.2.23 All threaded fasteners shall be of RDSO approved make.
- 5.3.2.24 The engine manufacturer shall provide necessary safety devices to protect the engine against hot engine, low lube oil pressure, engine over speed and low water levels etc. two high water temperature thermostats with 5^oC difference in setting shall be provided.
- 5.3.2.25 List of all accessories that are offered with the diesel engine, clearly indicating those mounted on the engine and those supplied loose shall be furnished by the tenderers.
- 5.3.2.26 Electrically operated gauges for the various indication requirements and fault indication lamps shall be provided in each driving cab.
- 5.3.2.27 The stopping of the engine shall be by de-energising a fuel solenoid valve.
- 5.3.2.28 The initial fill of lube oil for the engine as recommended by the engine manufacturer shall be in the tenderer's scope of supply.
- 5.3.2.29 The tenderer shall submit along with the offer, complete engine data as per Annexure - 3, as applicable to the Engine offered.

5.4 **COOLING EQUIPMENT**

- 5.4.1 The Cooling Equipment shall be guaranteed to work efficiently under the climatic conditions specified in para-1.2 of Chapter- I of the specification. The radiator and fan shall be of adequate capacity with 30% choked condition of the radiator used. Air flow required for the radiator fan shall be at least 15% more than that actually required to make up for any reduction in air flow due to train movement. The limiting ambient capability of the cooling system shall be minimum 55 ^o C with 30 % choked condition
- 5.4.2 The complete technical details of the radiator and its fan shall be furnished.
- 5.4.3 Two independent sets of cooling equipment (i.e roof mounted radiator, hydraulic tank, hydraulic oil cooler and water pipes) shall be provided. The individual radiator will take care of the cooling requirements of respective engines and the hydraulic cooler.

- 5.4.4 The maximum operating water temperature shall normally not exceed 95°C. There should be provision of alarm and shut off at higher temperature.
- 5.4.5 The radiator shall be roof mounted either with proven electric fan drive system or hydraulic fan drive arrangement which shall have thermostatic control to regulate the fan speed depending upon the water temperature shall be provided. Complete technical details of the radiator and its type of fan & drive shall be furnished to RDSO. The most suitable and reliable design and type of fan & drive shall be selected at the design approval stage. If there is any cost differential for electric driven radiator cooling fan and hydraulic driven radiator cooling fan shall be clearly indicated by the tenderer.
- 5.4.6 Suitable water raising apparatus, using mono block pumps for topping up the water in the radiator shall be in the scope of supply. A stainless steel tank for the radiator of not less than 100 litres capacity shall also be provided.
- 5.4.7 The installation drawings of the radiator and fan with details of fan drive shall be supplied by the tenderer.
- 5.4.8 Cooling Proving trials shall be carried out in a test bed at the firm's premises (OEM) to prove the adequacy of the cooling system comprising of radiator and hydraulic oil cooler for the prototype in the presence of RDSO's representative. The procedure for such testing shall be submitted and got approved from RDSO.
- 5.4.9 The following calculations in support of offered cooling system shall be submitted:
- Cooling requirement for all sources of heat (with break up)
 - Heat dissipation characteristics of the radiator and its resistance characteristics.
 - Radiator fan characteristics showing the air flow Vs total heat at different speeds.
 - Cooling system-matching calculations.
 - Schematic cooling circuit diagram showing water, oil and air flow through each equipment.
- 5.4.10 The tenderer shall submit drawing for mounting details of radiator assembly, fan drive arrangement and ensure that these fit completely within the overall dimensions of SPMUV and shall be got approved by RDSO.

5.4.11 Compressor

5.4.11.1 Two engine driven air-cooled compressors (one with each engine) of adequate capacity and complete with all accessory suitable for continuous operation at a nominal maximum pressure of 8 kg/sq.cm shall be offered. The capacity of the air compressor shall not be less than 10 cfm at engine low idling speed. The essential accessories as under shall also be in the tenderer's scope of supply:

- i) Suitable after cooler.
- ii) The compressor shall be provided with suitable governor to cut in and cut out at 7 kg/cm² and 8 kg/cm² respectively and a safety valve set at 8.5kg/cm².

- Note:**
- i) The compressor capacity and expected power consumption shall be specified at low idle and max operating speed of the engine.
 - ii) The compressor offered shall be of proven capability in Railway Rolling stock application.

5.5 Engine Control

- 5.5.1 The engine shall be electronically controlled using suitable and proven ECUs.
- 5.5.2 The engine control system should return the engine to idling (no traction load) position in case of emergency brake application.
- 5.5.3 Electronic Governing system for engine control (LCC) as well as main traction alternator excitation control shall be provided.
- 5.5.4 Tenderers shall indicate notch wise speed and power of the engine offered.

5.6 TRANSMISSION SYSTEM

Three phase a.c./d.c. transmission system shall be used. The tenderer shall furnish full technical details as per Annexure -4 for the transmission system offered. Tenderer shall submit block diagram of power circuit for approval of RDSO.

5.7 Alternator

- 5.7.1 A three phase variable speed self-ventilated, self-excited, brushless and under slung traction alternator shall be provided (two Alternators per SPMUV). The Alternator shall either be end on mounted or connected to the engine through a flexible coupling. The alternator shall have a load regulation system that shall ensure optimum utilisation of the installed

power of the diesel engine at all notch positions. Each Traction Alternator shall have power output of 230 KW (approximately).

- 5.7.2 The Alternators offered shall be with Single Bearing, which will be self lubricating type ball bearings.
- 5.7.3 The winding of the traction alternator for both stator and rotor shall be with Class H (180°C). Insulation withstanding the dusty working conditions without deterioration of electrical and other properties. The tenderer shall give details of the insulation scheme, proposed to be used for approval by RDSO. Filters if felt necessary by the alternator manufacturer shall be provided at the alternator intake. The filter shall be of dry fire retardant type. Details shall be indicated in the tender. It is, however, preferable not to use filters. One hour rating of Traction Alternator shall be 10 percent higher of continuous rating. Field proven Traction Alternator suitable to SPMUV shall be offered by successful tenderer.
- 5.7.4 The alternator shall have a rating adequate to meet the full specified traction load under the prescribed site conditions, besides capability to meet the higher starting load and sustained and momentary over loads. Each Traction Alternator shall has power output of 230 KW (approximately).

NOTE: The tenderer shall clearly specify.

- i) The VI characteristics of the Traction Alternator in d.c. at full load.
- ii) The continuous rating near the top of the VI curve (higher voltage, low current) and near the bottom of the VI curve (higher current, low voltage) at 1800 rpm and the corresponding one hour ratings.
- iii) Overload capability as a percentage of the full load and deviations.
- iv) Short circuit capability and deviations thereof.

5.7.5 External cables

- 5.7.5.1 For connecting the alternator with the rest of the associated traction equipment, the thin walled e-beam cables as per RDSO approved specification No ELRS/SPEC/ ELC/0019(Rev.1) with latest amendment shall be provided. However, the cable sizes and the voltage grade for the power and control cables shall be given by the manufacturer.
- 5.7.5.2 The Cables from traction alternator to power rectifier should be suitable for carrying out current of 800A (rms).
- 5.7.5.3 The location of terminal box shall be on the periphery of Traction Alternator. Suitable cutaway with a cover plate having cable entry holes with suitable cable glands/ grommets to permit entry of insulated cables as selected above, shall be provided. The internal and external cable terminations shall be on a terminal board made of fiber glass SMC or better material, suitably mounted inside the alternator terminal box. The galvanized/ cadmium coated MS terminal studs of adequate size shall be

located across each other without criss-crossing and they shall be suitable for crimped terminations connected palm to palm. The head of the terminal studs (preferably hexagonal) shall be embedded on the rear side of the terminal board and shall be further secured on top by a nut. For securing cable lugs, nuts, locknuts, flat and spring washers shall be provided. Adequate number of crimping sockets suitable for recommended size and number of output cables shall be supplied along with the alternator. The Crimping sockets shall be of Dowell's make only.

NOTE: The Terminal box location, internal and overall arrangement and dimensions shall have prior approval of RDSO.

5.7.5.4 The alternator housing shall be of fabricated steel construction designed to withstand high torsional stresses, shocks and vibrations. The minimum ground clearance in half worn wheel wear condition under tare weight shall not be less than 230 mm.

5.7.5.5 The provisions shall be made for driving the auxiliary alternator and Air Compressor through a common shaft extension from Diesel Engine through V-Belts and pulley on the extended shaft of the Diesel Engine. Pulley of C-section to IS: 3142 shall have a suitable PCD to be approved during design approval stage. The material of pulley shall steel forged conforming to IS: 2004 Gr.III. The pulley shall be push-fit with suitable securing arrangement.

5.7.6 **TESTS:**

5.7.6.1 Type, routine and acceptance tests on the alternator if required, shall be performed in accordance with IEC 60-349.

5.7.6.2 The type test procedure for prototype power pack (engine plus alternator) testing shall be submitted and got approved from RDSO. Type testing of prototype power pack shall be carried out in the presence of RDSO's representative. If already type testing is done for the power pack, routine/acceptance tests shall be done in the presence of RDSO's representative after getting the procedure approved from RDSO by the contractor.

NOTE:-

- (i) The temperature rise for the windings allowed by IEC:60-349 shall be reduced by 30 °C to allow for higher ambient temperatures.
- (ii) The characteristics curves as applicable to the traction alternator shall be submitted, duly indicating therein, the selected locations corresponding to the different notch positions.
- (iii) The successful tenderer shall submit the bearing life and shaft calculations and get them approved before offering the alternator for inspection.
- (iv) The Tenderer shall clearly indicate the rating, weight, current, voltage and power and also dimensional details.

- (v) The excitation system adopted shall be explained in detail giving all relevant characteristics for different notch positions of the engine and their matching with engine characteristics.
- (vi) The detailed calculations for arriving at the alternator rating to meet the specified requirements shall be furnished.
- (vii) Any special item (for e.g. Screened cables) required for any signal/control feed between engine, alternator and electronic governor shall be in the scope of supply.

5.7.6.3 **Auxiliary Drive:** An auxiliary drive of adequate capacity shall be provided to meet all the auxiliary loads of SPMUV. The drive shall be suitable for minimum of 8 kW auxiliary alternator.

5.7.6.4 **Power Rectifier:** Each alternator power output shall be rectified by a full wave 3 phase silicon diode bridge rectifier (two rectifiers per SPMUV). The rectifiers shall be suitable for under slung forced cooled and well protected. The technical constructional requirements along with testing as given in Annexure-5 shall be complied with. The output of bridge shall be connected to suitable filter chock if considered necessary. The design should adequately to take care of the service conditions of the Traction Motors.

5.7.6.5 Power Rectifier should have power loss not more than 400 Watt. It should be able to work in N-1 condition. This indication "Rectifier fuse blown off" should be available on driver desk.

5.7.6.6 The OGA drawings shall be got approved prior to manufacture and supply against each contract.

5.8 TRACTION MOTOR

5.8.1 Four axles hung, nose suspended and self-ventilated DC series Traction Motors of proven design and approved by RDSO two on each Bogie, shall be provided on the SPMUV. The Armature coils shall be formed of polyimide (kapton) covered copper conductors and suitably impregnated. TIG/MIG welding shall be used for the commutator. The technical/ constructional requirements as given in Annexure - 6 shall be complied with the traction motor of similar design and construction with proven performance in traction application on IR will be preferred. Traction motors shall be 4601 BX type of M/s. BHEL or TM 2141 A of M/s CGL type or similar proven design with taper roller suspension bearings. Class of insulation of TM shall be "H class" (180 °C Class). Output of each Traction Motor shall be 115 KW (Approximately).

5.8.2 **Motor rating:** The one hour rating of traction motor shall be of 97% excitation and continuous rating shall be adequate to give the required performance. The motor will be provided with 3% permanent ohmic field shunting.

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5.8.3 The temperature rise for the windings allowed by IEC-60349 shall be reduced by 30°C to allow for higher ambient temperatures.

5.8.4 **Motor Suspension & Axle Drive:** The Traction Motor shall be nose suspended with taper roller bearing arrangement. Each traction motor shall drive one axle of its motor bogie through a single reduction gear drive enclosed in a rigid and water tight gear case firmly secured to prevent damage by movement and vibration under the most severe operating condition but easily removable for attention to the gear.

5.8.5 The Traction Motor shall be designed to comply with the operating requirements stipulated in chapter-II without exceeding the temperature rise limit.

5.8.6 The lubricants to be used for the suspension bearings and the gear case shall be specified by the manufacturer.

5.8.7 The gear wheels and pinion shall be as per RDSO's Specification No.C-K-303 with latest revision.

5.8.8 The single reduction gear with gear ratio 20:91 shall be provided.

5.8.9 The traction motor should be a complete assembly including gears, pinions, gear case, nose suspension rubber sandwich, taper roller suspension bearings, dust guard and axle shield, earth brush etc. Adequate length of the Traction Motor cables shall be brought out from the motor for termination in the under frame mounted cable connection box with provision for connecting the cables from the coach. Provision of a well covered terminal box on the traction motor such that the connection between the traction motors and the junction box is made through separate cables shall be preferred. The design of suspension shall ensure no leakage or ingress of gear case compound in the roller bearing under any circumstances.

5.8.10 Motor Contactor

Motor contactor of BHEL make or similar proven make, duly type tested and approved by RDSO/ICF/CLW, one contactor for each motor, suitable for operation in combination with overload relays, for opening the traction motor circuit in overload and under fault conditions shall be provided. These contactors shall be located in dust-proof cubicle mounted on the underframe in such a way as to prevent all risk and damage to other apparatus from arcs formed by their operation.

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- 5.8.11** Traction motor contactors, reversers, protective relays and other control gears shall be as specified in Annexure-6 They shall be housed in box and dust proof enclosures to be mounted in the underframe, however, alternate location may also be considered subject to clearance of the offered layout by RDSO.
- 5.8.12** The Motor contactor shall open the circuit, they protect automatically on overload and shall be capable of clearing the resultant arcs under all conditions of overload.
- 5.8.13** Bearings: The Armature shall be mounted on anti-friction roller bearing of RDSO approved make. The inner race shall have adequate interference for the duty.
- 5.8.14** All motor contactor on SPMUV shall be suitable for remote operation from any driving cab through the traction motor overload 'reset' switch. The motor contactors shall be of electro-pneumatic type of RDSO/ICF/CLW approved make or similar proven make duly type tested and approved by RDSO/ICF/CLW shall be provided with blow out coils and arcing horns, etc to brake the current without detriment to their working parts or adjacent equipment. All contact trip, interlocks, pins and plungers etc. shall be easily accessible for maintenance.
- 5.8.15** The Tenderer shall submit the following characteristic and performance curves:
- i) Speed Vs Tractive Effort
 - ii) Current Vs Speed
 - iii) Tractive Effort Vs Current
- 5.8.16** Suspension Bearing: Taper roller suspension Bearings from RDSO's approved source shall be provided. Material composition and properties of plain sleeve bearings shall be as laid down in RDSO's Drawing No. RDSO/PE/SK/EMU/0052-2003 Rev.0.
- 5.8.17** First four (04) Traction Motors of first prototype 8 wheeler SPMUV shall be type tested by RDSO accordance with IEC-60349. Routine and acceptance tests if required on the traction motors, shall also be performed in accordance with IEC-60349.
- 5.8.18** The Traction Motor's thermal capability shall be adequate to meet the operational requirement of lowest road speed (i.e. 5 kmph) for 90 minutes. A special test shall be carried out at the time of type test to establish/confirm this aspect. For this purpose, at an output equal to one fourth of the calculated power required for the lowest road speed and the

corresponding cooling available, the temperature rise shall not exceed the limit prescribed above.

5.9 AUXILIARY ALTERNATOR WITH RECTIFIER-REGULATOR

Two auxiliary self-cooled, brushless pulley driven alternators of RDSO's approved make, one with each engine shall be provided in the SPMUV with suitable regulating equipment and Battery Charger to supply 122 V d.c. \pm 5% regulated voltage from idle speed to max. Speed of the engine for meeting the following loads:-

- i. Battery charging (110 volts, 120 Ah batteries) provided on the SPMUV- 10 amps.
- ii. Lights and fans load of the SPMUV-25 amps.
- iii. Flood Lights
- iv. Search lights
- v. Control system 10 amps.
- vi. Twin beam head light of 250 watts, 110 V d.c. as specified in Chapter-IV of this specification.
- vii. Power required for forced cooling motor for rectifier shall be of 1 kW approximately.
- viii. Cab Heater load one each of 1 kW in both the cab.
- ix. The alternator shall have a rating of minimum 8 kW (Electrical load requirement shall be got approved from RDSO)

5.9.1 The insulation of the alternator shall be class "F" or better and the same shall not be affected by the Engine area environment, which may have traces of Diesel and Lube oil fumes.

5.9.2 Mounting: Suitable base frame and mounting arrangement shall be supplied alongwith the auxiliary alternator. The base frame shall have suitable belt tensioning provision. The base frame drawing shall be got approved by RDSO before manufacture. Driving and driven pulley dimensions, pulley groove details, material specification, box dimensions etc. Shall be furnished in a drawing and got approved.

NOTE: Alternatively, companion alternator made as an integral part of the main alternator may also be offered.

5.10 Rectifier-Regulator:

5.10.1 The rectifier-regulating equipment will be under frame mounted. The crimping sockets shall be of Dowell's make only. The rectifier regulator box shall have an openable front cover, which shall be capable of being closed and locked in position by suitable hinged bolts of M12 size and wing nuts.

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- 5.10.2 The Rectifier-Regulator box shall be of protection level IP: 65 (Completely protected against dust and jet of water from all directions).
- 5.10.3 The Rectifier-Regulator box shall be Electro-galvanised and painted gray.
- 5.10.4 The Regulator shall have provision of potentiometers for current and voltage setting for adjustment depending upon the service conditions.
- 5.10.5 The overall efficiency of the alternator alongwith its Rectifier-Regulator shall not be less than 70%.
- 5.10.6 The Rectifier-Regulator shall conform to IEC: 60-571.
- 5.10.7 Details of the equipment shall be as per Annexure- 5.

5.11 **TESTING:**

The following tests shall constitute type tests which are to be carried out at the manufacturer's works to ensure compliance of the specifications.

5.11.1 **Type Test:**

- i. Verification of dimensions of assemblies of alternator, rectifier and regulating equipment.
- ii. Temperature rise test at minimum speed for full output as well as the maximum speed without Air over the auxiliary Alternator and the rectifier regulator box.
- iii. Insulation resistance test.
- iv. High voltage test
- v. Load test
- vi. Mechanical over speed and induced voltage test.
- vii. Drooping voltage characteristics test.
- viii. Current limiting characteristics test.
- ix. Surge protection test.
- x. Measurement of stator and field resistance.
- xi. Water tightness test for rectifier – regulator.

- 5.11.2 **ROUTINE TESTS:** All tests other than those indicated at serial nos. ii, vii and ix of type tests mentioned above, shall be carried out.

- 5.12 **CONTROL AND INSTRUMENTATION:** The basic control scheme shall ensure matching of traction load with that of the diesel engine output preventing any overloading. The two power packs will independently feed two motors each (the motors fed from one power pack being on the same bogie). In case of failure of one power pack, it shall be possible to isolate the same, on line, by the driver, and the SPMUV shall continue to be worked with the healthy power pack, at reduced power.

- 5.12.1 Motor speed will be controlled by varying the applied voltage. The two Traction Motors fed from one power pack shall be connected in parallel.

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5.12.2 The tenderer shall furnish, along with schematic circuit diagrams, the power, auxiliary and control scheme proposed to be followed.

5.13 **Traction Control Gear:** General Design Consideration: Control gear for the motors and other switch gear shall comply with IEC:60-77 and shall be suitable for 110V D.C. supply.

5.13.1 The winding of all magnet coils shall be properly dried, impregnated, baked and moulded with epoxy resins.

5.13.2 All auxiliary machines operated on 110V D.C. supply shall be provided with adequately rated dc contactors.

5.13.3 All the contactors used for breaking dc current of value 10 A and above shall have properly designed arc chutes and blow out coils.

5.13.4 DC contactors shall be operated for one million operations during endurance test for an electrical endurance capability of 1 million operations at the rated voltage and current.

5.14 SCOPE OF CONTROL GEARS: Control gears which are in the scope of supply of the contractor shall comprise of all apparatus and connections necessary for the safe and efficient operation of the equipment and shall include the following.

5.14.1 The Control Gears shall include:

- i) Driver Desk
- ii) Control Cubicle-1
- iii) Control Cubicle-2
- iv) Motor Switch Group Cubicle
- v) Resistor Panel

5.14.2 Energizing and controlling Traction Alternator and main motor circuits and protecting these circuits from overload or short circuits.

5.14.3 Operating traction motor contactors, reversers, etc. By means of low voltage control circuits through any master controller and automatically regulating the same as required for operation.

5.14.4 Providing means for annunciation of different healthy and fault conditions, through necessary auxiliary contacts and LED indication lamps, for traction and brake circuits at the driving cab.

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- 5.14.5 Providing low tension supply of the main lighting circuits, ventilation equipments, charging the 120 Ah, 110 V battery and driving of the auxiliary machines.
- 5.14.6 Earthing in an approved manner, all equipment boxes and cases supporting or containing live parts and of the main traction motor and auxiliary machine circuits.
- 5.14.7 Protecting and isolating all auxiliary circuits by means of circuit breakers and by manually operated isolating switches or links and fuses.

5.15 CONTACTOR BOX(S)

- 5.15.1 All the power contactors of a power pack shall be housed and inter-connected through bus bar in a separate cubicle called "CONTACTOR BOX", which shall preferably be under slung however, alternate location may also be considered subject to clearance of the offered layout by RDSO and designed for IP-55 (hose proof) protection. For each SPMUV, two such boxes shall be supplied (one per power pack).
- 5.15.2 **REVERSER:** Electro pneumatically operated reverser of proven design of reputed make duly tested and approved by RDSO/ICF/CLW for changing the direction of rotation shall be provided in each motor circuit. These shall be mounted in cubicle on the underframe and shall be of robust design, remote controlled and suitably interlocked to ensure that no movement can take place while they carry current. Provision shall be made for hand operation, in emergency. The reverser contact shall have self-wiping action.
- 5.15.3 Mounting arrangement shall be finalized at design approval stage.

5.15.4 Motor Cut out Switch: Two four position rotary switches, of RDSO/ICF/CLW approved make, one for motor 1&3 and other for motor 2 & 4 shall be provided. The first switch will have position marked as 'normal', '1 out', '1 & 3 out' and '3 out'. The second switch shall have markings 'normal', '2 out', '2 and 4 out' and '4 out'. The switches shall have sufficient contacts to provide various facilities for control as required including the following.

- (i) To energise the shunt coils of the current limit Relay to reduce the drop out power current value suitably, if any motor is cut out.
- (ii) To prevent operation of 'motor switches trip' lights when motor have been deliberately cut out.
- (iii) To permit operation of the unit while CABR is tripped provided that a pair of motors has been cut out.

- (iv) To control feeds to the individual motor contactors, to isolate the contactors and cut the motors out of the circuit.
- (v) All pneumatic equipments used in the power circuit shall be able to perform satisfactorily at minimum pressure of 5.0 kg/cm².

5.15.5 RELAY PANEL:

5.15.6 Alternators:

Earth fault relay – for earth faults in the traction circuit.

5.15.7 Traction motor:

- (i) Overload relay/ over current protection-resetting type with reset in the Driver's cab - Contactor Box
- (ii) Earth fault relay -Control Panel-1
- (iii) Scheme for isolation of faulty motor: A scheme of isolation shall be provided individually for all the four traction motors to facilitate their isolation by the driver quickly. -Control Panel-1

5.15.8 All the control relays required for the system shall be supplied duly mounted on a panel, name-tagged, wired and properly terminated.

5.15.9 INSTRUMENTS AND SAFETY DEVICES:

5.15.9.1 The following instruments & safety devices shall be part of supply for safe and satisfactory operation of the SPMUV. The equipment and controls shall be arranged in both the driving cabs of the SPMUV so that the SPMUV can be worked from any one of the driving cabs. Interlocks shall be provided such that SPMUV can be operated from one cab only at a time. The driver should be able to start or shut down the engine from his cab.

5.15.9.2 Instruments:

5.15.9.3 Diesel Engines.

5.15.9.4 Switches, meters and gauges

- (i) Engine starting switch/ push buttons
- (ii) Lube oil pressure gauges
- (iii) Lube oil temperature gauges
- (iv) Cooling water temperature gauges
- (v) Battery charge/ discharge ammeter for 24 V battery.
- (vi) Engine hour meter and engine speed indicators
- (vii) Engine stop switch/push buttons
- (viii) Low cooling water level indicators
- (ix) Over speed devices
- (x) Emergency stop for engine by Borden wire

5.16 Safety Devices:

- a) Water temperature too high- engine to idle. However, driver shall be able to raise the engine speed during the operation of the hot water temperature switch.
- b) Low lube oil pressure - engine to shut down
- c) Engine over speed - engine to shut down
- d) Radiator water level low - engine to shut down
- e) Low Hydraulic oil level - engine to shut down

A. Traction Alternator:

- a) Control battery (110 V) Voltmeters.
- b) Control battery (110 V) Ammeter
- c) For protecting the source, earth fault relay shall be provided.
- d) Earth fault relay – for earth faults in the traction circuit

B. Rectifiers:

- a) Traction Ammeter - To indicate the current drawn from rectifiers.
- b) Voltmeters reading phase to phase voltage

C. Traction motor:

- (i) Overload relay/ over current protection-resetting type with reset in the Driver's cab.
- (ii) Earth fault relay.
- (iii) Scheme for isolation of faulty motor: A scheme of isolation shall be provided individually for all the four traction motors to facilitate their isolation by the driver quickly.

NOTE: Recommended settings for all the aforementioned relays shall be specified by the tenderer.

5.17 Control and Auxiliary Circuits: All circuits shall be protected by MCBs of appropriate ratings and type. Ratings of the MCBs to be provided shall be furnished by the tenderer.

5.17.1 All coils of contactors and relays shall be provided with suitably rated freewheeling diodes.

5.18 DRIVER'S CONTROL DESK.

5.18.1 The Driver's Desk complete in all respect with all the control gear items duly fitted, wired and terminated on a terminal board shall form the scope of supply of contractor.

5.18.2 DRIVER'S CONTROL SWITCH: The driver's control circuit shall be energized through the driver's control key. The inter-changeability provided shall be such that the key can be removed from the lock only when the switch is turned to off position and when the key has been removed, the switch cannot be turned to the ON position. The key shall be common for both drivers' key switches.

5.18.3 MASTER CONTROLLER :

- i) The number and arrangement of step shall be marked on the master controller.
- ii) Contacts and operating mechanism shall be easily accessible and of suitable design for railway service. All live portions and contacts, cables and terminal mountings within the master controller shall be kept well clear of exhaust from all pipe unions to, any pneumatic equipment.
- iii) The reversing drum operating boss shall be fenced in such a manner that the key can only be inserted and withdrawn when the drum is in the neutral/off position and the drum shall be mechanically interlocked so that it can only be placed in this position when the master controller handle is in the OFF position.
- iv) The master controller shall be fitted with a Dead Man's handle (depression type) designed to switch OFF power and apply brakes automatically whenever the driver releases his pressure on the handle, if it is in any but the OFF position and in the OFF position if the reverser key is in FORWARD or REVERSE positions. The Dead Man's handle mechanism shall be suitably enclosed to prevent interference with it or the insertion of any form of packing to wedge the handle down.
- v) Spare contacts provided to be paralleled to prevent the SPMUV from not responding in case of any bad contacts on any of the interlocks.

5.19 INDICATION LIGHTS :

- 5.19.1** The indications of LED type shall be provided in both driving cabs of the SPMUV as given in Clause – 5.20. Built in redundancy (with spare LED) should be there so that in case of failure of one LED the indication is available.
- 5.19.2** The "LED" indication provided in the SPMUV shall have illumination level of minimum 30 mcd High intensity type LED, capable of being seen even against Direct Sunlight. The arrangement of LED indication panel with LEDs connected with series resistor is NOT preferred.

5.19.3 The Driver's desk shall be fabricated preferably in single unit, however two parts can be considered at the time design drawing approval for ease of loading.

5.20 CONTROL PANEL

5.20.1 A suitably designed control panel shall be provided in the SPMUV for housing all the control accessories. The panel shall be so situated so as to provide easy access to all the components for their maintenance /service.

5.20.2 Adequate Control Equipment including gauges, instruments and cab safety devices shall be provided for safe and satisfactory operation of the SPMUV. The controls shall be so arranged in the driver's cab that it will be within easy reach of the driver from all drivers' position. All gauges shall be of proven, reliable design and of LED lit type. Graduations of all gauges shall be in metric unit. Following gauges shall be provided in the cab:-

- i) Diesel Engine lube oil pressure gauge.
- ii) Cooling water temperature gauge (Electronic)
- iii) Traction Motor load ammeter.
- iv) Air brake gauges.
- v) Battery charge and discharge ammeter.
- vi) Water level indicator (Electronic)
- vii) Speedo-meter.

The following audio-visual signals or reference panel lights shall be provided in the cab for operation of the SPMUV:

- i) Low lubricating oil pressure
- ii) Lube oil temperature too high
- iii) Radiator water temperature too high
- iv) Engine 1 ON
- v) Engine 2 ON
- vi) Engine shut-down
- vii) Wheel slip indication
- viii) Battery discharge indication
- ix) Aux. Gen failure indication
- x) Low idle rpm indication
- xi) Power ground
- xii) Cranking contactor welding indication
- xiii) Traction control supply ON
- xiv) Alternator 1 Excitation ON
- xv) Alternator 2 Excitation ON
- xvi) Alternator overload
- xvii) Alternator winding temp
- xviii) Alternator bearing temp

- xix) Engine 1 Trip
- xx) Engine 2 Trip
- xxi) Rectifier 1 fuse failure
- xxii) Rectifier 2 fuse failure
- xxiii) Rectifier 1 fan failure
- xxiv) Rectifier 2 fan failure
- xxv) Aux . Alternator failure.
- xxvi) Motor over load.
- xxvii) Motor Earth fault.
- xxviii) Parking Brake applied.
- xxix) Emergency Brake applied
- xxx) Drive function released.
- xxxi) Common annunciation.

The following safety devices, inter alia, shall be provided:

- i) Water temperature too high - Transmission cut off and engine returned to idle.
- ii) Low water in radiator-Power to transmission cut-off and engine shut down.
- iii) Low lube oil pressure- Power to transmission cut-off and engine shut down.
- iv) Engine speed too high (over speed trip)- Power to transmission cut-off and engine shut down
Adequate protection of an approved design shall be provided against electrical over loads and grounding.

5.21 **Surge suppression capacitors:**

Capacitors of suitable rating shall be wired in the control circuits to reduce the arcing at contacts of the relays to a minimum.

5.22 **Operating Keys and Locks:**

One set of operating keys of the approved design and dimensions having the following function shall be provided with each unit:-

- (i) Door lock key.
- (ii) Driver's control Switch key.
- (iii) Master controller locking key, (Reverser key)
- (iv) Any other control key offered as necessary.
- (v) Brake controller key.

Chapter – VI**MISCELLANEOUS:****6.0 Tools**

- 6.1 Each SPMUV shall be supplied with a complete kit of tools and testing equipment required by a driver in an emergency and for normal working of the SPMUV. These will be arranged in a tool box provided in a cab. These tools are listed in annexure 8-A & 8-B.
- 6.2 A list of tools to be provided for use in Maintenance Depot shall include tools necessary for maintenance and repair of SPMUV including specified equipment for auxiliary and ancillary equipment. The tenderer should list and quote for these tools. The rate shall however not be used for tender evaluation purpose. It shall not be mandatory for railways to buy these tools.
- 6.3 All special tools shall be listed and catalogued illustrating the method of application.
- 6.4 Maker's test certificate -Copies of maker's test certificates guaranteeing the performance of the equipment/accessories shall be supplied in duplicate alongwith the delivery of each SPMUV.

6.5 Weighment:

- 6.6 Each completed SPMUV shall be weighed 4 times successively and vertical load exerted by each wheel on the track shall be measured, with due regard as to the accuracy of the measuring equipment. The pre-weighment run shall be over a section of track containing difference of levels. No alteration or adjustment shall be made to the SPMUV after SPMUV passing or adjustment shall be made to the SPMUV after passing over this section of track and before weighment. The arithmetic mean of the values taken during 4 successive weighment shall be the value of measurements.
- 6.7 After weighment, a check shall be made to ensure the following:
- i) Total weight is within the nominal weight.
 - ii) Axle load is within +/- 2 % of the nominal axle load.
 - iii) The difference between the two wheel loads of any axle is not more than 4% of the axle load. First completed prototype SPMUV shall be subjected to squeeze test to ensure that it shall withstand a maximum end load of 200 t without any signs or permanent distortion. The test conditions is specified in clause-3.1.1

Chapter-VII

INSPECTION

- 7.1 The whole of the materials or fittings used for works covered by this specification shall be subjected for inspection by the Inspecting officer to be nominated by the purchaser and shall be to his entire satisfaction.
- 7.2 The Inspecting officer shall have the power to: -
- a. Adopt any means he may think advisable to satisfy himself that the materials for 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 and without previous notice the contractor's works to inspect the progress and quality of the work and the contractor shall provide free of charge all equipment and labour required by him for this purpose.
 - d. Reject any material or fittings that do not conform to the relevant specification or good practice, which shall be marked in a distinguishable manner, and shall be disposed off in such a manner as the Inspecting Officer directs. Such rejected parts shall be replaced by the contractor without extra charge.
- 7.3 Tests of materials and fittings shall as far as possible be carried out at the works of the maker's 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 forgings 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 contractors and their sub-Contractors shall be at the cost of the contractors.
- 7.4 No material shall be dispatched or packed until it has been passed by the Inspecting Officer. Such passing shall in no way exonerate the contractor from their obligation in respect of quality and performance of the SPMUV.
- 7.5 In the event of dispute between the Inspecting Officer and the Contractor, the decision of the purchaser shall be final and binding.

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7.6 **Radiographic testing of steel castings.**

7.6.1 All steel castings wherever used and welding joints shall be subjected to radiographic testing after manufacture / repair, to a suitable scheme/ standard suggested/ approved by RDSO.

7.7 One of the power bogies shall be subjected to exhaustive stationary tests at Contractor's works in the presence or RDSO representative. The tests on bogies shall include dynamic fatigue testing and strain measurement. The test shall be under simulated loading conditions to represent the service load. The body shell shall also be subjected to loads for validating the design calculations of shell. The contractor shall afford all facilities for conducting these tests at his cost.

7.8 **Acceptance tests.**

Besides the checking and testing carried out during manufacture and before dispatch of the SPMUV to India it shall be subjected to the following tests before final acceptance.

7.9 **Performance capability tests.**

The SPMUV shall be subjected to tests to establish its performance based on the supply by the tenderer against the specification. The contractor shall at his own expense provide the services of competent Engineers/Supervisors and supporting staff during the performance capability tests of the prototype.

7.10 **Riding quality tests.**

7.10.1 The riding quality tests shall be conducted at a speed which is 10% higher than the maximum specified operating speed, i.e. 120 kmph on a section of mainline track over which there are no temporary speed restrictions and which is considered by the railway as being in a generally run down condition for main line standards but without speed restrictions. The tests shall be conducted from a reasonably low speed, which is considered safe by the Indian Railways, upwards in steps of 10-15 km/h to establish the performance at the specified speeds. Test shall be conducted as per RDSO's conventional DAS method as mentioned in MT-334.

7.10.2 Emergency Braking Distance (EBD) and Haulage Capability Test shall also be conducted.

7.10.3 The following shall be the track standards of the test section:

(i) **Track structure:**

90R rail with M+4 sleeper density and 200mm ballast cushion below sleeper, of which at least 75mm shall be clean and rest in caked up condition.

(ii) Permitted irregularities:

The Criteria approved by "Standing Criteria Committee" for selection of Test Stretches for Oscillation Trials on BG routes of IR shall be considered.

Ten isolated peaks/km of track exceeding the limits of irregularity are permitted.

7.11 Acceptance Criteria:

7.11.1 The dynamic augment at maximum speed of 110 km/h plus 10% shall preferably be within 50% at rail level. The lateral forces at maximum speed will be within 4-t per axle. The vertical acceleration shall not exceed 0.3 g both in vertical and lateral modes in tare and loaded conditions. The sparring ride index shall not exceed four. The derailment co-efficient shall not exceed one or latest as laid down by RDSO at the time of inspection/oscillation trial.

ANNEXURE - 1

LIST OF EXHIBITED DRAWINGS

Sl.No	Drawing No.	Description	Clause Ref.
1.	Diagram ID 1676 mm gauge (BG) of IR schedule of dimension	Maximum moving dimension.	2.2.6
2.	RDSO/SK.No.98145	Side buffer arrangement	3.1.9
3.	C/BF/113	Tail lamp bracket.	3.14 (iii)
4.	W/WL-1660	Wheel	3.21.2
5.	RDSO Spec. No.56-BD-07	Centre Buffer Transition Coupler	3.1.9
6.	as per ICF Drawing No. AC/DC/M/ASR-0-0-001 with latest Alteration	Bogie design	3.6.2
7.	RDSO Drawing No. SK-K4004	Wheels	3.7.2
8.	ICF Drawing No. EMU/M-3-2-064 (Latest)	Brake Rigging	3.8.2
9.	RCF Drawing No.EM.26108 (Latest)	Cattle Guard	3.15
10.	RDSO sketch No 91146 with latest alteration	The wheel profile.	3.7.4

ANNEXURE - 2**LIST OF DRAWINGS & THEIR STANDARD NOMANCLATURE**

List of Drawings to be submitted to RDSO for approval before undertaking manufacture of prototype SPMUV.

SN Drawing/Documents to be submitted to RDSO for approval

1. Layout of SPMUV
2. Suspension arrangement.
3. Helical coil spring
4. Load v/s deflection diagram of helical coil spring
5. Suspension calculation
6. Enlarged View of Driver's window
7. Normal Visibility diagram of Driver
8. Cooling circuit diagram
9. Axle Box Guide arrangement
10. Brake rigging assembly
11. Schematic Diagram of Brake system
12. Emergency Braking Distance calculation
13. Wheel and axle (non powered)
14. Wheel Diameter 952 (machined)
15. Shell arrangement
16. Side wall assembly (Right)
17. End wall (Right)
18. Roof Assembly
19. Transverse cross section
20. Vogel Diagram
21. Alignment of SPMUV
22. Power pack arrangement
23. Under frame arrangement
24. Trammeling diagram
25. SPMUV lifting arrangement
26. Under frame calculation
27. Loading Diagram
28. Roof Equipment layout
29. Estimated weight of the SPMUV structure and weight of principal assembly mounted on the SPMUV
30. Strength calculation of cross member of under frame
31. Un sprung mass SPMUV
32. Balancing calculation
33. Power pack arrangement
34. Axle (powered)/ Motorized Bogie.
35. Axle drive Gear box assembly
36. Fuel Tank
37. Enlarged view of drivers window

38. Ant pilferage measure
39. Checking of squareness of door and end wall
40. Measurement of deflection of underframe
41. Measurement of distortions of doorways along the length of SPMUV
42. Measurement of distortions of shell across width at door way
43. Drawing showing location of strain gauges on the under frame.
44. Speed v/s tractive effort characteristics of SPMUV
45. The block diagram showing power circuit.

ANNEXURE-3

The following details pertaining to electrical equipment shall be submitted by the tenderer :

- I. Diesel Engine
 1. Exact description and model of the engine
 2. Rated output under UIC site conditions
 3. Site Conditions
 - Ambient Temperature 55 °C
 - Altitude above mean sea level 1000 m
 - Relative humidity above 40%
 4. Rated speed at continuous rating
 5. Type of cycle (two/four stroke)
 6. Method of pressure charging
 - Pressure ratio of compressor at the rated output
 - Single stage/two stage
 - No. of turbochargers used
 - Make and model of turbocharger
 7. Type of exhaust system
 - Constant pressure/pulse type/multi pulse type
 8. Method of cooling the charge air
 9. Type of combustion chamber
 10. Fuel injection equipment
 - Type of injection system
 - Diameter of pump plunger
 - Nozzle opening pressure
 - Maximum duration of injection in degrees of crank
 11. Number, arrangement and angle of cylinder.
 12. Cylinder bore
 13. Piston stroke
 14. Cubic capacity/cylinder
 15. Compression ratio
 16. Firing order
 17. Mean piston speed at rated speed
 18. Brake mean effective pressure
 19. Maximum combustion pressure at no load at minimum idling speed
 20. Compression pressure at rated output
 21. Minimum no-load idling speed – whether a low idle feature is provided on the engine
 22. Minimum no load speed under steady conditions
 23. Speed ranges which should not be used continuously
 24. Break away torque when the cooling water temperature is 5 °C

25. Minimum firing speed when the cooling water temperature is 5⁰C or at the lowest possible temperature of air intake air in rev/minute.
26. Torque resistance to the firing speed required to turn the engine when the cooling water temperature is 5 ⁰C at the lowest temperature of intake air.
27. Piston
 - i. Type of Piston used – whether single piece or composite
 - ii. No. of piston rings used.
 - iii. configuration of the rings
 - iv. whether all the rings are located above the gudgeon pin
 - v. method of cooling required for the piston
 - vi. oil flow rate and temperature of oil at the piston outlet
28. Cooling system
 - i. Single/double cooling circuit
 - ii. Whether cooling system is pressurized
 - iii. Coolant temperature at outlet from the engine
 - iv. Heat absorbed by the cooling water at the rated output
 - v. Rate of flow of water
 - vi. Inter cooler coolant temperature at entry to the cooler
 - vii. Treatment recommended for water
29. Lube Oil System
 - i. Temperature of cooling oil with the indication of the point of measurement
 - ii. Maximum permissible temperature of cooling oil
 - iii. Heat absorbed by the cooling oil at rated output
 - iv. Swamp capacity
 - v. Quantity required to commission
 - vi. Brand of oil recommended
30. Consumption of lubricating oil at the rated output in litres/hour and as a percentage of fuel consumption.
31. Total capacity of lubricating oil pump (s) at the rated output speed in litres/min
32. Lubricating oil pressure at rated speed on entering the engine and at the normal operating temperature
33. Maximum pressure of charge air in the intake manifold at the rated output.
34. Maximum pressure of gases at the turbo inlet at the rated output
35. Maximum speed of the turbocharger at rated output
36. Maximum permissible speed of the turbocharger.
37. Temperature of exhaust gases at turbo inlet at the rated output under UIC and site conditions.
38. Maximum permissible temperature for which the turbocharger components have been designed
39. Heat balance of the engine

40. Weight of the engine complete with all items excluding water and lubricating oil.
41. Weight of water contained in the engine
42. Weight of oil contained in the engine
43. Weight of major components to be handled during maintenance
 - i. Turbocharger
 - ii. Inlet cooler
 - iii. Crank case bare
 - iv. Crank shaft
 - v. Piston and connecting rod
 - vi. Cylinder liner
 - vii. Cylinder head
44. Specific fuel consumption with the tolerance band under UIC and site conditions – indicate the lower heating value of the fuel used in arriving at the specific fuel consumption figures
45. Fuel oil consumption at idle in litres/hour
46. Requirement of fuel specification or any other restriction on the use of fuel with different sulphur contents
47. Number of such engines used in rail traction and the period since the engines have been in service and their performance
48. Safety devices provided on the engine
 - i. Over speed
 - ii. low lube oil pressure
 - iii. overload
 - iv. high exhaust temperature
 - v. high intake temperature
 - vi. any other
49. Specification of lube oil suitable for engine
50. Method of starting
51. Governor
 - i. Make and type
 - ii. Full load speed and drop characteristics
 - iii. Torque required at the output shaft
52. Estimated period between top and major overhauls
53. periodicity of overhauling the following critical components
 - i. Turbocharger
 - ii. Piston and piston rings
 - iii. Cylinder liner
 - iv. Air and exhaust valves
 - v. Fuel pump
 - vi. Injector/Nozzle assembly
 - vii. Main bearings
 - viii. Connecting rod bearings
54. Whether the diesel engine is suitable for satisfactory sustained operation under :

- i. Site conditions mentioned in para 2
 - ii. Dusty environment
 - iii. Frequent starting and stopping of diesel engine
 - iv. Average load factor 60%
55. Inlet and exhaust valve timings
56. Special design features of diesel engine highlighting the measures which have been taken to achieve :
- i. Low specific fuel oil consumption
 - ii. Low lubricating oil consumption
 - iii. Low idling fuel oil consumption
 - iv. High reliability
- Maximum availability
 - Reduced level of thermal and mechanical loading of critical components
57. General arrangement and dimensional details.
58. Characteristic curves of diesel engine under UIC and site conditions-
- i) Curves for torque, output and specific fuel consumption expressed and guaranteed without upper tolerance for different settings of the injector pump, i.e.
 - Setting at which the engine develops the rated output at its rated speed.
 - Setting at which the engine develops $\frac{3}{4}$ of the rated output at its rated speed.
 - Setting at which the engine develops $\frac{1}{2}$ of the rated output at its rated speed.
 - Setting at which the engine develops $\frac{1}{4}$ of the rated output at its rated speed.
 - ii) The torque speed curve which the manufacturer considers to be the maximum torque that should be used for rail traction. This should cover the range from idling speed to the point corresponding to the international rated output at the rated speed.
 - iii) The curve of fuel consumption for no-load running, commencing from the minimum idling speed, expressed in litre/h

ANNEXURE -4**TRANSMISSION SYSTEM PARTICULAR****I Alternator**

1. Description Make & type
2. Drive – Details of arrangement of bearings and coupling
3. Classification – No. poles, number of phases and phase connections
4. Maximum permissible speed –
Max. voltage a.c.
D.C. (i.e. rectified)
Max. current a.c..
5. Rating -
 - i) One hour rating – Voltage, current, output & speed
 - ii) Continuous rating –
 - (a) High voltage
 - (b) Low voltage
6. Class and type of insulation
 - a) Stator
 - b) Rotor
7. Temperature rise
 - a) Rotor winding
 - b) Stator winding
8. Resistance at 25 °C
 - a) Rotor winding
 - b) Stator winding
9. Synchronous impedance at max. frequency and load
10. Stator details
 - a) Overall dimensions
 - b) No. and size of slots
 - c) Winding
 - i) Type
 - ii) Conductor size and material
 - iii) Turns per coil
 - iv) Pitch
11.
 - a) Rotor-type, No. of poles, length, bore, size and air gap
 - b) Details of rotating armature exciter and rectifier assembly
12. Bearing:
 - a) Single or double
 - b) Type-sealed or open
 - c) Grease-type, capacity and time interval for re-greasing
 - d) Bearing life and shaft size calculations.
13. Mountings – Details of mounting arrangement.
14. Coupling-Type and details
15. Cooling
Calculations of cooling capacity

16. Weight
 - a) Complete unit with accessories
 - b) Alternator only
 - c) Rotor (with fan if any)
17. Characteristic curves
 - a) Natural curves
 - b) V-I curves (Notch wise)
 - c) Efficiency vs. current
18. Tests : Results of –
 - a) Type test
 - i) Temp. rise test and its calculation
 - ii) Rating
 - iii) Characteristic curves
 - b) Routine test
 - i) Temperature Rise Test
 - ii) Over speed Test
 - iii) Dielectric Test
19. Tractive Efforts vs. Road Speed curve along with Alternator Rectifier Current vs. Voltage curve showing method of calculations.

II Auxiliary Alternator with Rectifier – Regulator

1. Make
2. Model
3. Continuous & short time rating and details of voltage and current regulation
4. Bearing life and shaft size calculations.
5. Weight

III Traction Motor

- 1.1 Type
 1. V - volts
 2. I - Amps
 3. N – rpm
 4. S – km/h
 5. N max/N
 6. N shaft
 7. N max

1.2 Armature

1. Diameter.
2. Length
3. Air ducts – surface
- section

4. No. of slots.
 5. Conductor size.
 6. Conductor area.
 7. A) Continuous..... for amps
1 Hour for amps
 8. Continuous A/sq.mm for A
1 Hour..... A/sq. mm for A
 9. A) Continuous
1 Hour
 10. ADNL 10^{-9} at cont FF
..... at 1 hr rating
..... at S max.
 11. B (B/A) at cont FF
..... at 1 hr rating
..... at S max.
 12. S maxkm/h
 13. N max rpm
 14. Wheel dia (half worn)
 15. Gear Ratio (New)
 16. Suspension
 17. Armature bearing – commutator end
- pinion end
 18. Turns/coil
 19. Type of winding
 20. Coil Throw
 21. Length mean turn
 22. Resistance at 110°C
 23. Inductance at 30 cps.
 24. Weight of copper (kg)
 25. Tooth volume
 26. Core volume
 27. Arm. Turns/pole
 28. Arm. At/pole - FF
 29. Arm. Core int.dia
 30. Net core depth
 31. Arm. Steel tech. spec.
 32. Banding material
 33. No. of bands cc
 34. Band width.
 35. S (cont) M/s rpm km/h
- 1.3 Main poles

1. Insulation
2. Number
3. External D Internal D
4. Number of turns per pole.
 - Frame end
 - Arm end
5. Conductor dimension – Frame end
 - Arm end
6. Current density - Frame end
 - Armature end.
7. Length of mean turn - Frame end
 - Armature End

8. Resistance at 110°C
9. Inductance at 50 cps
10. Radial gap length- Tip
 - Centre
 - Mean
 - Eff

11. Field At
 - @ FF
 - Arm. AT
12. Pole Arc.
13. Total fringe
14. Eff. Pole arc
15. Eff gap area
16. Pole flux density.
17. Pole copper weight.
18. Pole steel tech spec.
19. Yoke steel tech. spec.

- 1.4 Commutation poles
 1. Insulation
 2. Number
 3. External D Internal D
 4. Number of turns per pole – Frame end
 - Arm end
 5. Conductor dimensions - Frame end
 - Arm end
 6. Current density - Frame end
 - Arm end
 7. Length of mean turn - Frame end
 - Arm end

- 8. Resistance at 110° c
- 9. Inductance at 50 cps
- 10. Radial gap length
 - Tip
 - Centre
 - Mean
 - Eff
- 11. Int. Pole flux density
- 12. Copper weight
- 13. Pole steel tech. spec.

1.5 Equalisers (commutator end)

- 1. Total number
- 2. Copper weight

1.6 Ventilation

- 1. Number of fans
- 2. Flow m³/min (at continuous speed)
- 3. N rpm 1.35 N max (overspeed)

1.7 Commutator and brushes

- 1. Useful diameter
- 2. Useful length
- 3. No. Of commutator bars.
- 4. Bar pitch
- 5. Average bar/brush
- 6. Voltage between segments
- 7. Reactance voltage
- 8. Insulation thickness between bars.
- 9. Number of brush arms
- 10. Brush/arm
- 11. Brush/size
- 12. Quality
- 13. Current density
 - For Amps (cont)
 - For Amps (1Hr.)
 - For Amps (start)
- 14. S (cont) m/s rpms
- 15. S (1hr) m/s rpms
- 16. S (max) m/s km/h
- 17. Type of commutator construction

1.8 Weight

- 1.Motor without gearing kg N
- 2.Armature without pinionkg N
- CONT 1 Hr
- kg Nkg N
- 3.Wt/kw
- 4.Wt/hp
- 5.Pinion (kg)
- 6.Gear wheel (kg)
- 7.Gear case (kg)
- 8.Frame (kg)
- 9.Total weight (kg)

1.9 Losses and Efficiency

1 Hour Continuous

- 1.I² R(ARM)
- 2.I² F (Series)
- 3.Core
- 4.Brush drop
- 5.Brush friction
- 6.Bearing F and W

1.10 Magnetic Circuit

1. 1 hr rating values

<u>Magnetic</u>	<u>FF Leakage</u>
Area length	B AT
Tooth	
Core	
Pole	
Yoke	
Gap	
Total AT	

2.0 Gears and pinions

- 1. Type of gearing
- 2. Module
- 3. Grade of steel used for pinions and gears
- 4. Particulars of heat treatment
- 5. Kilometerage guarantee for bull gears

6. Kilometrage guarantee for pinions
7. Material and type of construction for gear case.

IV. Power Rectifier

1. Diode – Make & type
2. No. of parallel paths & no. Of diodes /path
3. Overall dimensions of rectifier unit
4. Ratings
 - a) Current Rating
 - max. Cont. (direct) forward current
 - b) Thermal Rating
 - Max. & Min. Operating junction temp
 - Max. & Min. Storage temperature
5. Resistance
 - a) Forward
 - b) Reverse
6. Details of damping circuit
 - a) Resistance value & circuit
 - b) Capacitance value & connection
7. Bus bar arrangement
8. Weight
9. Mounting arrangement
10. Characteristic curves
 - a) Voltage vs. Current
 - b) Power dissipation as a function of reference point temperature
11. Semi-conductor fuses
 - a) Make
 - b) Fusing characteristics
 - c) $I^2 t$ characteristic

ANNEXURE-5**POWER RECTIFIER SPECIFICATION****1.0 Technical requirements including the design features.**

1.1 The rectifier unit shall comprise of three phase full wave bridges using silicon diodes. It shall preferably consist of three separate bridges connected in parallel on the input and output side.

1.2 Device Rating

1.2.1 The current rating of the devices shall be such that even under one bridge (n-1) failure condition the rectifier, with two remaining effective three phase bridges shall be capable of meeting the full Tractive power duty/duty cycles and abnormal conditions including short circuit.

1.2.2 An unbalance of 20% shall be considered in the sharing of the load between the bridges, for design purposes, though, in actual testing the unbalance shall be limited to 10% only.

1.2.3 The diodes shall have a PIV rating of not less than 3000 V or not less than 2.8 times the maximum crest working voltage whichever is higher.

1.2.4 Characteristics curves of the diodes indicating power loss, forward voltage drop, slope resistance, thermal resistance characteristics and characteristics curves of the fuse shall be submitted in A4 size.

1.2.5 The permissible junction and case temperature for the device shall be declared.

1.2.6 Diodes in the cubicle shall belong to one FVD group while they shall be in three consecutive FVD groups for all the units to be supplied. FVD shall have a band width of 50 milli-volts at the full rated diode current.

1.2.7 The semiconductor device junction temperature shall be calculated for (n-1) condition operation at rated permissible current for three duty cycles after temperature stabilisation in heat run test at a current value equal to the one hour rating of the traction motors.

For this purpose, RMS value of the starting current over the notching up duration for 1 minute followed by RMS value of the steady state one hour rating current for eight minutes, followed by zero current for thirty seconds will form one cycle. At the end of three such successive cycles the junction temperature shall be computed. There shall be enough margin.

- 1.2.8 The devices shall meet all the requirements as per IS:7788.
- 1.2.9 The use of capsule type diodes are acceptable.
- 1.3 Snubber and Damping Networks
- 1.3.1 Each diode shall be provided with RC network to overcome the hole storage effect.
- 1.3.2 RC damping networks shall be provided to protect against switching surges expected. Supporting calculations shall be furnished.
- 1.3.3 The resistors and capacitors for the RC network shall be respectively of silicon coated, non-bursting type suitable for traction duty duly approved by RDSO.
- 1.3.4 Resistances – Silicon coated, non-inductive, wire wound resistors and stud mounting type with lug terminals shall be used. The wattage ratings shall be three times the calculated maximum wattage in the circuit under worst loading and high ambient conditions.
- 1.3.4 Capacitors – shall be of non- bursting type. The clearance and creepage distance between the live terminals and also the body shall comply with table 5 of IS-7788. The maximum working voltage across any capacitor shall not exceed 50% of the rated repetitive voltage. In the case of hole storage capacitors the voltage rating shall not to be less than PIV rating of the semiconductor device. The capacitors shall be designed for operation at 85 °C. The capacitors will be of GE make. Use of indigenous make shall have the prior approval of RDSO.
- 1.4 **Fuses**
- 1.4.1 The diodes shall be protected by semi-conductor fuses whose selection shall be supported by the calculation to ensure their matching with the diodes. $I^2 t$ values for the diode shall be more than the $I^2 t$ for the fuse. Diode and fuse characteristics shall be furnished along with the tender. The fuse selection shall withstand the short circuit current expected.
- Note:** The expected short circuit current/impedance with duration shall be specified.
- 1.4.2 The semiconductor fuses used for the diode protection shall be of approved makes. Fuses of la Ferraz, Bussman or English Electric make only are approved at present.
- 1.4.3 Since the rectifier unit consists of multi-bridges connected in parallel, signaling fuses, associated suitable relays and micro switches shall be

provided to given an indication in case of single bridge failure and to trip the load on the alternator in case of double bridge failure.

1.5 Constructional Features

1.5.1 The tenderer shall submit details of the overall dimensions of the rectifier along with the offer.

1.5.2 The cubicle as well as internal sub-assemblies shall be interchangeable from one unit to the other.

1.5.2.1 The cubicle shall be of cold rolled steel metal sheet with strong frame work suitable for underframe mounting to withstand shocks and vibrations encountered in service run with a maximum speed of 105 kmph. This shall be protected against damages due to ballast hitting. The minimum thickness of panels shall be 12.0mm and may be increased as panel width increases as mentioned below.

<u>Maximum Panel Widht</u>	<u>Thickness</u>
Upto 750 mm	2.0 mm
> 750mm but < 1500 mm	2.5 mm
>1500 mm but < 2000 mm	3.2 mm

1.5.2.3 The cubicle shall be provided with two numbers of earthing bosses with M12x20 tapped hole on each side. The bosses shall have 5 mm thick copper/brass plate brazed.

1.5.3 Easily interchangeable inspection doors with locking arrangement shall be provided to facilitate easy access to vital parts like fuses, diodes etc.

1.5.4 Withdrawable bridge racks consisting of diodes, fuses and associated components shall be provided on rails for withdrawing during maintenance.

1.5.5 The equipment layout shall provide easy accessibility for maintenance.

1.5.6 Suitable ventilating louvers shall be provided for air outlet.

1.5.7 The devices with heat sink shall be mounted of FRP (SMC)/ Epoxy panels of adequate thickness (not less than 10mm) with hand holds for easy removal and insertion in position.

1.5.7.1 Heat sinks shall be of extruded constructions. The sand casted or gravity die casted are not acceptable. SPMUV shall be taken to have proper surface finish and surface flatness. Current collection through heat sink

shall be avoided. In case it is not possible, the heat sink device mounting surface and the current collection contact area shall be treated to prevent electro corrosion and bimetallic action.

1.5.7.2 Recommended optimum pressures for mounting the devices on the heat sink shall be furnished. Suitable thermal compound having low thermal resistance shall be used to fill up the void between the mating surfaces of heat sink and device. The same shall seal the joint against moisture.

Note : Transient thermal impedance characteristics curves of the heat sink at different cooling air rate shall be submitted for approval.

1.5.8 Blower shall be mounted as an independent unit connected suitably to the duct with adequate resistance to reduce vibrations. Blower Motor shall be easily accessible for maintenance.

1.5.9 The unit shall be painted with two coats of red oxide followed by two coats of white stove enamel on inside and aircraft grey on outside to IS-5:1961.

1.5.10 Fasteners used in the cubicle shall be of minimum M6 and screws of M10 and above shall be of high tensile strength.

1.5.10.1 Studs of the terminal board shall have adequate current rating with minimum size not less than M6 and shall be coated with cadmium plating. The method of connections shall be such that the current should not pass through the studs. Number of connections per stud shall be limited to two. The insulating boards shall be fire retarding FRP sheet moulding type. They shall pass the fire retardant test as per specification IS - 2046. Separate terminal board shall be provided for different voltages. Positive and negative terminals shall be separately located. All the terminal studs shall be legibly identified with their circuit numbers.

1.5.11 The bus sizes on the a.c. & d.c. sides shall be such that the final temperature when corrected to 47°C ambient is not more than 100 °C copper bus bar must be tin plated after bending/drilling the required holes, with thickness of plating not less than 8 microns.

1.5.11.1 The bus bars used shall be of high conductivity electrolytic copper as per IS:613 with current density not exceeding 4 A/mm². The bus bar shall have colour code with red, yellow and blue on the a.c. side and brown and black respectively for positives and negatives on the d.c. side. Bus bars supports shall be made with insulators and be identified by engraving the respective circuit numbers with contrast colour paint applied on the engraved marking.

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- 1.5.12 All the cable wire ends shall be terminated with suitable sockets using proper dies and tools.
- 1.5.13 Cables – All the cables/wires shall be multi-strand flexible insulated cables conforming to E/14-01/parts I,II and III. PTFE insulated cables of adequate voltage rating and size shall be used for inter-connection snubber circuits and signaling fuses.
- 1.5.14 All the wires shall be numbered with cables ferrules of approved design on both ends of the cables.
- 1.5.15 Wiring layout- The quality of workmanship and layout of wiring shall be of high standard to ensure long life. The following guidelines shall be kept in view.
- a) Complete separation of low, medium and high voltages.
 - b) Separation temporarily and permanently energised cables with separate bunching.
 - c) Avoiding of sharp bends.
 - d) Provision of grommets for cables entries.
 - e) Supporting of cable bunches with insulated supports using nylon ties.

2.0 Tests

- 2.1 Type tests on silicone diodes – At least ten diodes shall be subjected to type tests as per IS-7788 in the presence of RDSO Inspecting Official sufficiently in advance to avoid delay of prototype testing of the rectifier unit.
- 2.2 Routine tests on each diode shall be conducted as per IS-7788 and the results recorded by the manufacturer. 10% of the lot offered selected at random shall be subjected to routine tests in the presence of inspecting official of RDSO.

2.3 Type test on Rectifier assembly:

- 2.3.1 Temperature rise test – with normal ventilation, the rectifier shall be subjected to the duty cycle expected on the traction motors with the temperature maintained at 47°C and until steady temperature is obtained. The temperature stabilisation can be deemed when three successive readings taken at 15 minutes intervals do not vary by more than 0.5°C. The maximum diode junction temperature arrived shall be less than the permissible junction temperature as declared by the diode manufacturer

after the duty cycles as described in clause 1.2.7 of Annexure-5. The temperature rise test shall be conducted both for n and $(n-1)$ bridge conditions.

- 2.3.2 Heat run test with $(n-1)$ parallel paths will be conducted on first prototype and afterwards the test may be conducted corresponding to normal duty cycle with all bridges in operation.
- 2.3.3 Fuse blade temperature and bus temperature shall not exceed 100 deg. C for $(n-1)$ parallel paths.
- 2.3.4 Instruments used for type testing shall be of 0.5 class accuracy and shall have been calibrated within 6 months from the date of testing.
- 2.3.5 Power losses measured for the diodes shall not exceed 10% of the declared value.

3. **Guarantee:**

The diodes of the main Rectifier shall be guaranteed for satisfactory working for a period of five years from the date of commissioning.

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ANNEXURE - 6

DESIGN OF TRACTION MOTORS AND SWITCH GEARS

- 1.0 Number and arrangement of motors
- 1.1 Each SPMUV shall be fitted with four numbers of DC series traction motors, two on each bogie. The motors shall be axle hung nose suspended type and shall be series wound, working on the pulsating current. The motors shall be designed to comply with the conditions stipulated in IEC-60349. The temperature rise allowed by IEC shall be reduced by 30 Deg. C, to allow for higher ambient temperatures. All motors shall be permanently connected in parallel.
- 1.2 The motor shall be designed to comply with the operating requirements specified with exceeding the temperature-rise limits.
- 1.3 The motors shall be so designed that severe damage will be avoided in case of transients such as fluctuations of the voltage, switching surges. The traction motor circuit shall comprise all the protective devices which will prevent any damage to them due to transients. The general design and maintenance of the motors shall be of the highest standard in accordance with the modern traction practices. The particulars of the motors shall be furnished as per Annexure - 4.
- 1.4 The motor contactor shall be of Electro-pneumatic type with blow out coils and arcing horns etc. to break the current without detriment to their working parts or adjacent equipment. All contact tips, interlocks, pins and plungers shall be easily assessable for maintenance. The motor contactor shall be capable to open the circuit on overload and under fault condition.

ANNEXURE -7

PARTICULARS TO BE SUPPLIED FOR THE SPMUV

The following data shall be supplied for the SPMUV along with the tender offer:

1	Length of the SPMUV over head stock.	...mm
2	Total wheel rigid base...mm	
3	Height of SPMUV floor (under tare)	...mm
4	Distance between bogie centers.	
5	Distance between side buffers	...mm
6	Height of buffers when wheels are:	
	(i) new	...mm
	(ii) fully worn out.	. mm
7	Maximum height of the SPMUV with wheels in new condition.	...mm
8	Maximum height of the cab at corners with wheels in new condition.	...mm
9	Maximum width of the SPMUV.	...mm
10	Minimum height above rail level of any component with the SPMUV wheels in maximum worn conditions.	...mm
11	Reduction in the above height in the event of spring rigging failure.	...mm
12	Diameter of wheels over tread	... mm (new) ... mm (worn out)
13	Axle load.	...t (max.) .t (min.)
14	Total weight of the SPMUV.	
	- in fully loaded condition	...t
	- in empty condition	...t
15	Maximum speed of the SPMUV.	
	- attached to a train	...km/h
	- Self-propelled	...km/h
16	Maximum tractive effort at rail	...kg
17	Maximum continuous tractive effort	...kg
18	Maximum speed of operation at maximum continuous tractive effort.	...km/h
19	(a) Fuel oil consumption at 75% of rated output of the diesel engine.	...litre/
	(b) Lubricating oil consumption at 75% of rated output of the diesel engine.	...litre/h

Annexure-8-A

List of tools for maintenance work and repair of minor fault

Sl.No.	Tool description	Make	Quantity
1	Box spanner set 10-34 mm		1 set
2	Ring Spanner 6-33 mm		1 set
3	Double end spanner set 6-36 mm		1 set
4	Grease gun		1
5	Torque wrench EVT 2000@		1
6	Pipe wrench 18"		1
7	Hammer 2 Lbs		1
8	Screw Driver 6"		1
9	Screw Driver 12"		1
10	Chisel 6"		1
11	Cutting plier		1
12	L N key set 3 to 17		1 set
13*	Emergency Spares		1 Kit
*Emergency Spares: consists of Fuses, Control Panel lamps, MCBs and Critical Hoses.			
Make to be indicated in the column			

Annexure-8-B

Testing Kit for SPMUV.

Sl.No.	Tool description	Make	Quantity(Nos)
1	Injector adjustment Kit		1
2	Vacuum gauge 90-30 inch of Hg)		1
3	Pressure Gauge(0-30 PSI)		1
4	Hand tachometer(0-3000 RPM)		1
5	Dial gauge (Least Count=0.001")		1
6	Magnetic gauge		1
7	Megger 500 V		1
8	Multi Meter (DC Range: 400 mV AC Range: 400mV-750 V) Resistance: 400- ohm to 400 Mega ohms)		1
Make to be indicated in the column			

Annexure-8-C

Special tools

Sl.No.	Tool description	Make	Quantity
1	Axle Box Hydraulic Bearing puller		1

Annexure-8-D

Training material in Hindi and English with each SPMUV.

Sl.No.	Tool description	Quantity
1	Training notes/ Write up with diagrams	2 Nos
2	Slides/Wall charts	2 Nos