

1855927/2023/HEP-SWM20915

Tele / Fax : 91-0522-2465739/2465717

Telegram : 'RAILMANAK', Lucknow

Email dir.pemetro@gmail.com



भारत सरकार - रेल मंत्रालय
अनुसंधान अभिकल्प और मानक संगठन
लखनऊ - 226011

Government of India
Ministry of Railways
Research, Designs & Standards Organization,
LUCKNOW - 226011

24th June 2016

No. EL/6.7.50

Chief Electrical Engineer,

- Eastern Railway, Fairlie Place, Kolkata - 700 001
- Northern Railway, Baroda House, New Delhi-110 001
- Central Railway, Parcel office, CST, Mumbai CST - 400 001
- Western Railway, Churchgate, Mumbai - 400 020
- Southern Railway, Park Town, Chennai - 600 003
- East Central Railway, Dighi, Distt- Vashali, Hajipur, Bihar-844 101
- East Coast Railway, Bhuvneshwar Orissa-751 016
- North Central Railway, Subedarganj, Allahabad-211033
- North Eastern Railway, Gorakhpur -273 001
- North Western Railway, Jaipur 302006
- Northeast Frontier Railway, Maligaon, Guwahati - 781 001
- Western Central Railway, HQR's Office, Annexe Building, Indra market, Jabalpur (M.P.) - 482001
- South Eastern Railway, Garden Reach, Kolkata - 700 043
- South Central Railway, Nilayam, Secunderabad - 500 371
- South Western Railway, New zonal Hq. Office, First floor, west block, Hubli 580 020
- South East Central Railway, Bilaspur-495004
- Konkan Railway, Belapur Bhawan, Sector-11, Belapur, Mumbai - 400 614
- Rail Coach Factory, Kapurthala-144 602
- Integral Coach Factory, Chennai-600 038
- Modern Coach Factory, Lalganj, Raibareilly-229 120

मुख्य विद्युत इंजीनियर

- पूर्व रेलवे, फेयरली प्लेस, कोलकाता - 700 001
- उत्तर रेलवे, बड़ौदा हाउस, नई दिल्ली - 110 001
- मध्य रेलवे, मुंबई सी एस टी - 400 001
- पश्चिम रेलवे, चर्चगेट, मुंबई- 400 020
- दक्षिण रेलवे, पार्क टाउन, चेन्नई - 600 003
- पूर्व मध्य रेलवे, हाजीपुर दिघी, जिला वैशाली, बिहार - 844 101
- पूर्व तट रेलवे, बी-2, रेल विहार, चन्द्रशेखरपुरा, भुवनेश्वर, 751 023 (उडीसा)
- उत्तर मध्य रेलवे, हेडक्वाटर, ब्लाक ऐ, सुबेदारगंज, इलाहाबाद - 211 033
- पूर्वोत्तर रेलवे, गोरखपुर - 273 001
- उत्तर पश्चिम रेलवे, जयपुर - 302 006
- पूर्वोत्तर सीमान्त रेलवे, मालीगांव, गुवाहाटी - 781 011
- पश्चिम मध्य रेलवे, जबलपुर - 482 001
- दक्षिण पूर्व रेलवे, गार्डेन रीच, कोलकाता - 700 043
- दक्षिण मध्य रेलवे, 7 तल, रेल निलायम सिकंदराबाद - 500 071
- दक्षिण पश्चिम रेलवे, 4 तल, श्री लक्ष्मी नारायण काम्पलेक्स, स्टेशन रोड हुबली - 580 020
- दक्षिण पूर्व मध्य रेलवे, बिलासपुर - 495 004
- कोकण रेलवे, रायगंड भवन, 8 तल, बेलापुर भवन, सेक्टर 11, पी0बी0 45, नवी मुम्बई 400 614
- आर0 सी0 एफ0, कपुरथला, 144 602 (पंजाब)
- आई0सी0एफ0, पेरमबुर, चेन्नई-600 038
- मार्डन कोच फैक्टरी, लालगंज, रायबरेली-229120, उत्तर प्रदेश

Sub.: Revised Specification No. RDSO/PE/SPEC/AC/0009-2014 (Rev. 2) for VRLA batteries.

RDSO has revised the Specification No. RDSO Spec. No. RDSO/PE/SPEC/AC/0009-2008 (Rev. 1) with Amendment No.1 for VRLA batteries.

In view of the above, a copy of revised Specification No. RDSO/PE/SPEC/AC/0009-2014 (Rev. 2) for VRLA batteries is enclosed herewith for reference and necessary action at your end. It is further informed that copy of specification is being emailed also.

The revised specification No. RDSO/PE/SPEC/AC/0009-2014 (Rev. 2) for VRLA batteries is also being incorporated in the RDSO's approved vendor directory effective from 01.07.2016.

Yours Sincerely,

(लीला घर सिंह यादव)

निदेशक/पी.ई. एवं बैट्री

कृते महानिदेशक/पी.एस. एवं ई.एम.यू.

Copy for information please

सचिव विद्युत/जी,
रेलवे बोर्ड, रेल भवन,
रेल मंत्रालय, नयी दिल्ली - 110 001

Kind Attn. Sh. Vinayak Garg, DEE(G)

7/6



भारत सरकार
रेल मंत्रालय

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

अनुसंधान अभिकल्प एवं मानक संगठन
रेल मंत्रालय

RESEARCH DESIGNS AND STANDARDS ORGANISATION
MINISTRY OF RAILWAYS

110 वोल्ट ट्रेन लाइटिंग, वातानुकूलित एवं एल.एच.बी यानों के लिये वाल्व रेगुलेटेड लेड एसिड बैटरीज की
विशिष्टी

VALVE REGULATED LEAD ACID BATTERIES FOR 110V TRAIN-LIGHTING , AIR CONDITIONED
AND LHB COACHES

संख्या RDSO/PE/SPEC/AC/0009-2014 (Rev.2)
No. RDSO/PE/SPEC/AC/0009-2014 (Rev.2)

SN	Date of Revision/ amendment	Revision/Am endment	Page/ClauseNo.	Remarks
1.	<u>10.06.2009</u>	<u>Rev1,Amdt-1</u>	4 of 21 Cl. 3.1	2V 650Ah VRLA cell included
2.	<u>01.1.2012</u>	<u>Rev1, Amdt. No.2</u>	Cl. 0.4(b) Cl 1.1 & Cl. 3.1 5.4.2 5.5.4&5.5.5.	Monoblock change from 18 to 19 for 120Ah Voltage setting of RRU/ERRU revised & tray detail added for 120 Ah VRLA cell. Test with 2% voltage ripple & regulation added. Also, conductance test included Renewal & acceptance test clause revised. Annexure 'C' revised for Vibration test on one sample.
3	<u>11.02.2014</u>	<u>Rev.2</u>	4 of 21/Cl. 3.1 8 of 21 Cl.5.5.4.1 (b) & 5.5.5.2(a) 12 of 21 Cl. 5.11.8 14 of 21 Cl. 5.16.2 14 of 21 Cl. 5.17.2.1	6V & 12V module added for 1100Ah cell Clause revised Requirement of life cycle test unit increased from 20 unit Requirement of Gas recombination Efficiency revised Density of ABS container revised

APPROVED

Nasim
21.07.15

ED/PS & EMU

Prepared by: <i>S. S. E. Elect.</i>	Checked By: <i>Director/PE & Metro</i>
-------------------------------------	--

**SPECIFICATION FOR VALVE REGULATED LEAD ACID (VRLA) BATTERIES
FOR 110V TRAIN-LIGHTING, AIR CONDITIONED AND LHB COACHES**

0.0 FOREWORD:

0.1 In 110V train lighting system, 6V, 120Ah capacity LMLA and Valve Regulated Lead Acid (VRLA) Batteries are used. For air conditioned coaches, 525 Ah & 800 Ah capacity LMLA Batteries and 1100Ah capacity VRLA Batteries are used.

0.2 The conventional LMLA Batteries have common problems of frequent topping up, cleaning, sulphation of terminal and leakages etc. To overcome these problems to a considerable low level, the VRLA Batteries have been developed. These are also known as sealed maintenance free (SMF) Batteries.

0.3 After gaining field experience on 110V coaches, fitted with these Valve Regulated Lead Acid (VRLA) Batteries for train lighting, air-conditioned coaches and interaction with the manufacturers and production units/Railways, this specification was revised to Rev-1 with the incorporation of 70 AH LHB Battery and subsequently amended as brought out in top sheet. The specification is again being revised to Rev-2 to enhance the life units of the Battery.

0.4 This specification covers the design development and manufacture of VRLA Batteries for 110V, TL&AC coaches as follows:-

Type of coaches	Rated Capacity 10 Hr rate 27°C	No. of monoblock	No. of sets/coach	No. of Battery box/set
SG/LHB non-AC coaches	120 Ah	19 monoblock Batteries of 6 Volt or 57 cell of 2 Volt	1set	Two/One
SG AC coaches	1100 Ah	56 Cell	1set	Two
SG AC coaches	650 Ah	56 Cell	2set	Two
LHB coaches	70 Ah	9 modules of 12 Volt	1set	One

0.5 The supplier shall furnish the information of performance as given in Annexure 'A' and 'B' as per the approved design while submitting the tenders

0.6 For preparation of the specification, the assistance has been taken from the following publications:-

SN	Specification
I.	RDSO Spec. No. RDSO/PE/SPEC/D/TL/0009-99 with Amendment No. 1&2
II.	IS : 266-1993 with latest amendment
III.	IS : 6848-1979 with latest amendment
IV.	IS : 1069-1993
V.	IS : 8320-2000
VI.	IS : 4905:1968 with latest amendment
VII.	IS : 1146 – 1981 with latest amendment
VIII.	IEC 61373 –2010
IX.	IS 191-2007

 Prepared by SSE/Elect.	 Checked By Director/PE & Metro
---	--

1.0 SCOPE:

1.1 This specification covers the design, manufacture, method of testing and other requirements of VRLA Batteries to be used for train lighting / air conditioning / LHB application on passenger coaches having 110 V system. For train lighting, 120 Ah Batteries shall be used in conjunction with brushless alternators with suitable rectifier cum regulators of 4.5 KW capacity with nominal setting of $128.5 \pm 0.5V$, at 19.0 Amp (half load) and 1500 rev/min. 500Ah to 1100Ah Batteries shall be used in conjunction with two number of brush less alternators with suitable rectifier cum regulators of 18/22.75/25 KW capacity with nominal setting of 129 V, at half load and 1500 rev/min.

1.1.1 For 12 V, 70 Ah Battery used for LHB coaches, the auxiliary power required for charging is supplied by a charger capable of charging Batteries at constant voltage mode as required by the Battery. The current limit for charging the Battery shall be 20 Amps with the voltage setting at $122.0 \pm 1.0V$.

1.2 If proper maintenance practices and its related guidelines are followed, the expected life of Battery is 5 years from the date of commissioning.

2.0 TERMINOLOGY:

2.1 For the purpose of this standard in addition to definitions given in IS: 8320-2000, the following shall also apply.

2.2 Valve Regulated lead acid Battery: - A Battery, which requires no topping up under normal working conditions and minimal maintenance during service life of the Battery. It has self-operating safety valve, which normally does not open out during service, regulates pressure of gases generated inside during charging hence this Battery is termed as VRLA Battery.

2.3 Type test: - Test carried out to prove conformity with the requirement of this specification. These are intended to prove the general quality and design of a given type of Battery.


2.4 Full Charge: - It means the current drawn by the cell/Battery is reduced to lowest value when it reaches to full state of charge and three consecutive hourly readings of current remain constant.

2.5 Acceptance Test: - Test carried out on samples selected from a lot for the purpose of verifying the acceptability of the lot.

2.5.1 Lot: - All Batteries of the same type, design and rating manufactured at the same factory during the same period using the same process and materials offered for inspection at one time shall constitute a lot.

2.6 Electrolyte: - Aqueous solution of sulphuric acid for ionic conduction and Electro-chemical reaction during passage of current through a cell.

2.7 Terminal Post (lug): -A post (lug) of a cell or Battery to which an external electrical circuit is connected.

 Prepared by SSE/Elect.	 Checked By Director/PE & Metro
---	---

1855927/2023/HEP-SWM20915

3.0 OVERALL DIMENSIONS AND MASSES:

- 3.1 The maximum dimensions and weight of each module/tray shall not exceed the values as given in Table-1 for respective capacities of cell/Batteries:

Table-1-MAXIMUM DIMENSIONS(mm) AND WEIGHTS(kg) OF MODULES/TRAY

S N	Capacity at 27° C	Rate of Discharge	Over all Length	Over all Height	Over all width	Weight * (Module)
1	70Ah (12V Monoblock)	10Hr	352	178	170	26.5
2	120Ah (24/30v)***	10Hr	660	500	475	165.0
3	500Ah (6v)	10Hr	550	220	600	200
4	800Ah (6v)	10Hr	700	210	630	350
5	1100Ah** (6V/8V/10V/12V)	10Hr	880/1095/ 1095/1125	640 (Height of total module)	695	270/360/ 425/530
6	650Ah** (16V) (24V)	10Hr	875 1125	640 (Height of total module)	695	430 620

* Efforts shall be made to minimize the weight to reduce the weight of the coach. For easy loading/unloading, it will be preferred that 24 V module for 650Ah is splitted in two parts.

**fixing hole centre distance shall be kept for Length=810/821/1066 mm and for Width=629/534 mm

***Fixing hole centre distance for length=565±5mm and for width=305±5mm shall be kept for 120 Ah Battery

NOTE: -

- No deviation in the above dimensions and weight shall normally be permitted.
- The design of cell modules/tray of different types namely 6V, 8V, 10V, 16V, 24V and 30V in two or three tier mounting arrangement shall be duly approved by RDSO. The approved design of these modules shall only be modified in consultation with RDSO with different mounting methods: -
 - In existing Battery boxes,
 - Directly in the under frame.
- Three or more cells shall be kept in M.S. tray / modules having outer wall minimum thickness of 2 mm for 120 Ah and 3 mm or above for 500Ah onwards capacity, with minimum 2 mm partition wall thickness. These shall have provision to bypass one or two cells or 6V monoblock in case of any defect. The 12V 70 Ah monoblock Batteries do not require any steel tray.
- These Battery modules/tray shall be able to retrofit into the existing Battery boxes provided in under frame of AC coaches without effecting major changes in the existing Battery box.
- First time, fitment report shall be obtained from ICF or RCF.

Prepared by SSE/Elect.	Checked By Director/PE & Metro
------------------------	--------------------------------

3.2 TERMINAL POST AND CONNECTOR:

3.2.1 Positive and Negative posts with copper / Brass insert shall be clearly and unambiguously identifiable. 1100 Ah cell shall be with four terminal designs.

3.2.2 The take off terminal (positive and negative) for connection with coach cable for a set shall be given one side. The tightening torque shall be $12 \pm 1 \text{ Nm}$.

3.3 The lug hole dia of cable shall suit to M8 size fasteners except 70 Ah Batteries for which M6 size stain less steel fasteners shall be used.

3.4 CABLE CONNECTOR:

3.4.1 The cable connectors of suitable size shall have lead coating on lugs to withstand any corrosive attack. The thickness of the lead coating shall not be less than 25 microns, the lead coating thickness shall be measured in accordance with Appendix- 'F' of IS: 6848-79 with Amendment No. 1, 2 & 3.

3.4.2 The cable used for connector shall be of elastomeric type with composition of class-6, table No.1 of RDSO approved make conforming to RDSO Specification No. Spec/E - 14/01 Part -I (Rev-II) -1993 or latest.

3.4.3 The voltage drop across the Battery / cell cable connectors used in the Battery bank shall be less than 15mV per connector at C10 rate. However efforts shall be made to minimise the voltage drop as low as possible.

3.4.4 Fire retardant, heat shrinkable transparent polyolefin sleeves shall be provided to cover the crimped joints. To prevent loose connection during service vibrations, good quality spring washers shall be used.

3.4.5 **NUTS, BOLTS AND WASHERS:** Nuts bolts and washers for connecting the cells shall be made of acid resistant stainless steel which does not require lead coating.

3.5 CONTAINER AND LID:

3.5.1 **PPCP CONTAINER:** The cells/Batteries shall be manufactured in PPCP/ABS (Acrylonitrile Butadiene Styrene) container.

3.5.1.1 Container shall have ribs on outer/inner surface and the lid shall have the ribs on inner / outer surface to ensure the adequate container strength with design margins. Ribs will have suitable radius of curvature.

3.5.1.2 The 70Ah container with lifting handle on container (instead of lid) and container for other rating shall have adequate strength and design margins to meet the actual field conditions / handling as prevalent over Indian Railways for which Battery manufacturers shall be wholly responsible notwithstanding the approval given by RDSO. The adequate measures shall also be taken by manufacturers to avoid more than 2% bulging of cells/ Batteries along shorter/longer sides of the cells / Battery without tray. Despite the above design measures taken by the manufacturers, if failures of cells / Batteries on account of the container / lid crack, are reported from the field, the manufacturers shall replace these cells / Batteries with new cells/Batteries free of cost within the warranty period. The design of container and lids shall generally conform to the following specifications for all types of Battery:

 Prepared by SSE/Elect.	 Checked By Director/PE & Metro
---	---

(1)	Material specification	PP-CP (Polypropylene Co-Polymer) FR V2 grade / ABS FRV2 grade
(2)	Outer wall thickness (Min.) of container without ribs.	3.0 mm (Minimum)
(3)	Partition wall thickness(min) (if used)	Mono block 12V, 70Ah -1.8mm & 6V,120Ah, 2.2 mm

- 3.6 **SEPERATOR:** The separators used shall be micro-porous glass or superior material having high acid absorption capabilities and shall be resistant to sulphuric acid with good insulating properties and very low resistance.
- 3.7 **ELECTROLYTE:** - It shall be prepared from Battery grade sulphuric acid conforming to IS 266-1993 with latest amendment.
- 3.8 **WATER:** - The water for electrolyte shall conform to IS: 1069 – 1993.
- 3.9 **SAFETY VALVE:** The safety valve shall be made from suitable rubber material. This shall be explosion resistant self-resealing & pressure regulating type. This safety valve shall be such that it cannot be opened without proper tool.
- 4.0 **SERVICE CONDITION:** The cells are required to work at ambient temperatures up to 55 Degree Centigrade and will be subjected to vibration and dust in service when installed in the Battery boxes suspended from the under frame of the coaches. The design and construction of cells shall be suitable to withstand the above service condition. The vibration level generally is 3g & 5g.
- 5.0 **RATING:**
- 5.1 **RATED CAPACITY:** - The rating assigned to the Battery shall be capacity (C10) in Ampere hour (after correction at 27 degree centigrade temperature) when the cell is discharged at 10 hr. rate to the end voltage of 1.75V per cell.
- 5.2 **DECLARED CAPACITY:** - Since the declared C10 capacity of Battery is generally higher than the rated C10 capacity, the manufacturer shall advice the declared C10 capacity of the cell
- 5.3 **OBTAINED CAPACITY:** - Obtained capacity is the capacity obtained during discharge of cell up to 1.75V at 10 hours rate of the rated capacity of cell. The variation between declared capacity and obtained capacity shall not be more than \pm 3 percent.
- 5.4 **TESTS AND PERFORMANCE:**
- 5.4.1 Classification of tests.
- 5.4.2 **Type Tests:** – The following shall constitute the type tests. All these tests shall be started after 3 cycles of charge / discharge at 10 hour rate. These tests shall be conducted at 20-32 degree centigrade unless and otherwise specifically mentioned. The test equipment shall be equipped with 2% or above voltage ripple and regulation.
- a) Capacity at 10 hrs rate as per Cl. 5.6 of this specification.
- b) Capacity at 5 hrs rate as per Cl. 5.7 of this specification.

Prepared by  S. S. E. Elect.	Checked By  Director/PE & Metro
---	--

1855927/2023/HEP-SWM20915

- c) Capacity at 3 hrs rate as per Cl. 5.8 of this specification.
- d) Watt-hour & Ampere-hour Efficiency test as per Cl. 5.9 of this specification
- e) Retention of charge and storage test as per clause 5.10 of this specification.
- f) Life test according to clause 5.11 of this specification. The number of life units shall be as per Clause 5.11.8. After completion of life cycle test the Battery shall be cut opened and examined to arrive at the reason for reduction in capacity.
- g) Recharge Capability test as per clause 5.12 of this spec.
- h) Loss of cell weight as per clause 5.13 of this specification.
- i) Equilibrium float current test as per clause 5.14 of this specification.
- j) Permissible discharge current as per clause 5.15 of this spec.
- k) Recombination efficiency test as per clause 5.16 of this spec.
- l) Material and component specification verification test as per clause 5.17 of this spec.
- m) Test on bolts & washers as per Clause 5.18
- n) Air pressure and leakage test as per clause 5.19 of this specification.
- o) Vibration test as per clause 5.20 of this specification.
- p) Internal resistance as per clause 5.21 of this specification
- q) Capacity (C10) at 0°C as per clause 5.22 of this specification
- r) Conductance measurement as per Cl.5.23.
- s) Checking of dimensions, mass, marking and workmanship as per clause 3.1 & 6.0 of this specification

5.5 SEQUENCE OF TYPE TESTS:- The Sequence of type tests and the number of samples required shall be in accordance with Annexure "C".

Note: The cell shall be covered by the type approval certificate from appropriate authority of RDSO. Separate type approval certificates shall cover significant variations in the design. The cell of new design shall be re prototype tested for which samples offered by the manufacturer shall be accepted.

5.5.1 If any of the samples fails in the relevant type test, the testing authority may call for fresh samples not exceeding twice the original number of cells tested in that particular test and subject them again to the test (s) in which failure occurred. If there is any failure in the retest(s) the sample type shall be considered as not having passed the requirements of this standard.

5.5.2 DURATION OF TYPE TEST:- Type test as per clause 5.4.2 shall be completed within six months (Maximum) from the date of starting the type test except storage test which shall be started within six months (max.)

5.5.3 INSPECTING AUTHORITY:- The type test as per clause 5.4.2 on cells shall be conducted by the representative of RDSO/Lucknow, India at the works of manufacturers for which all the test facilities shall be made available by the manufacturers at their cost.

5.5.4 RENEWAL OF TYPE TEST:- After successful prototype testing and fulfilling requirements of specification, initial approval given by RDSO shall be valid for maximum two / three years. Before expiry of validity manufacturer shall apply for

 Prepared by SSE/Elect.	 Checked By Director/PE & Metro
---	--

1855927/2023/HEP-SWM20915

renewal of type test approval six month in advance. The renewal/revalidation shall be done as per work instruction of RDSO and the samples shall be drawn from mass production at random. In case of unsatisfactory performance of cells in field, retype testing either part or full can also be done earlier at the discretion of the approving authority. During renewal following information shall be provided by the manufacturer along with other requirement as advised to manufacture. However, ISO guidelines for Vendor Approval shall prevail in case of any discrepancies.

1. Any deviations from bill of material and QAP approved by RDSO earlier.
2. Implementation confirmation of modifications issued by RDSO, if any.
3. Addition / Deletion of Machinery and Plant.
4. Supply orders executed by the manufacturer in last 3 years. Following details should be covered for last 3 year supply.
 - a) PO No. / Date
 - b) Consignee and date of supply
 - c) Quantity
 - d) Rate (inclusive of all taxes)
 - e) Warranty failures reported (nature of failure and action taken).

5.5.4.1 Following tests as per clause shall be carried out on seven samples at any Government lab having data logging facility or at manufacturer's premises for renewal of approval. All cost of testing shall be borne by manufacturer:

- a) Ah and Wh Efficiency test as per clause 5.9
- b) *C3 capacity discharge test as per clause 5.8
- c) Equilibrium float current as per clause 5.14.
- d) Recombination efficiency test as per clause 5.16
- e) Internal resistance as per clause 5.21
- f) Conductance measurement as per Cl.5.23.

*C3 discharge test shall not vary more than ± 4 % from the value obtained during prototype testing subject to minimum 72% of C10 obtained (at 27°C) during the first C10 capacity discharge test (a). For above tests seven samples shall be picked up from any production lot at random. It shall be checked for dimension, mass, marking/workmanship and components verifications. RDSO representative shall witness the above tests or seal the sample for testing in govt. test house. The full report of testing shall be submitted to RDSO for evaluation as per specification. After successful completion of above renewal, type approval shall be reissued.

5.5.5 ACCEPTANCE TESTS:

5.5.5.1 The acceptance tests shall be conducted by RDSO or RITES/ Consignee as per this clause. Manufacturers shall submit in-house C-5 discharge test results along with Open Circuit Voltage after recharge along with the inspection call.

5.5.5.2 The following tests shall be conducted as acceptance tests.

- a. Capacity at 5 hrs rate according to clause 5.7 of this specification. The Capacity obtained shall not have variation of more than ± 4 percent of the C5 capacity obtained (Average capacity at 27°C during prototype testing) subject to minimum capacity 83% of obtained C10 capacity at 27°C. The weight of formed cell shall not vary more

Prepared by SSE/Elect.	Checked By Director/PE & Metro
------------------------	--------------------------------

than ± 3.5 percent of the average weight obtained during prototype testing. In one lot weight of formed cells shall not vary more than $\pm 3\%$.

- b. Checking of dimensions, mass, markings and workmanship as per clause 3.1 & 6.0
- c. Valve test open/closed as per clause 5.17.5 except 12V, 70 Ah Batteries.

5.5.6 **SAMPLING SCHEME AND CRITERIA FOR ACCEPTANCE:** A recommended sampling scheme and criteria for the acceptance of the lot for various lot sizes is given in Appendix "D"

5.6 **TEST FOR CAPACITY AT 10 HRS. RATE:**

5.6.1 After standing on open circuit condition for not less than 12 hrs. and not more than 24 hrs. from the completion of a full charge, the cell shall be discharged through a suitable resistance at constant current $I = 0.1 \times C10$ amperes, and the discharge shall be stopped when the closed circuit voltage across the Battery terminals falls to 1.75 volts per cell.

5.6.2 At this rate of discharge, hourly voltage readings shall be taken until the cell voltage approaches 1.90 volts per cell after which the readings shall be taken every 15 minutes until the voltage falls to 1.75V / Cell.

5.6.3 The capacity in Ampere-hour shall be obtained by multiplying the discharge current by the total time of discharge in hours and the product so obtained shall be corrected to temperature of 27 °C by the following formula.

$$\text{The capacity at } 27^{\circ}\text{C} = \frac{CT}{1+K(t-27)} \text{ Ah}$$

Where CT is the capacity observed at t degree centigrade. K is correction factor 0.0043; t is the average of hourly room temperature in degree centigrade.

5.6.4 The capacity on the first discharge the Batteries or cells shall give within ± 3 percent of declared capacity.

5.6.5 The Battery shall be charged at the normal charging rate immediately after the discharge within 15 hrs. The charging of VRLA Batteries may be carried out for test purpose using constant potential charging method or constant current charging method as recommended by the manufacturer.

5.7 **TEST FOR CAPACITY AT 5 HRS RATE:**

5.7.1 After standing on open circuit condition for not less than 12 hrs. and not more than 24 hrs. from the completion of a full charge, the cell shall be discharged through a suitable resistance at constant current $I = 0.2 \times C5$ amperes, Where $C5 = 0.83 \times C10$ and the discharge shall be stopped when the closed circuit voltage across the terminals falls to 1.75 Volts/ cell.

5.7.2 At this rate of discharge, hourly voltage readings shall be taken until the cell voltage approaches 1.90 volts per cell after which the readings shall be taken every 15 minutes until the voltage falls to 1.75V / Cell.

Prepared by SSE/Elect.

Checked By Director/PE & Metro

5.7.3 The capacity in ampere-hour shall be obtained by multiplying the discharge current by the total time of discharge in hours and the product so obtained shall be corrected to a temperature of 27°C by the formula referred in clause 5.6.3 using the values for correction factor K is 0.0084 for pasted plate.

5.7.4 Capacity at 5 hrs. rate shall not be less than 83% of obtained capacity.

5.7.4.1 The Battery shall be charged at the normal charging rate immediately after the discharge within 15 hrs.

5.8 TEST FOR CAPACITY AT 3 HR. RATE:

5.8.1 After standing on open circuit condition for not less than 12 hrs. and not more than 24 hrs. from the completion of a full charge, the cell shall be discharged through a suitable resistance at constant current $I = 0.33 \times C3$ amperes, Where $C3 = 0.72 \times C10$ and the discharge shall be stopped when the closed circuit voltage across the terminals falls to 1.70 volts per cell.

5.8.2 At this rate of discharge, hourly voltage readings shall be taken until the Battery voltage approaches 1.90 volts per cell after which the readings shall be taken every 15 minutes until the voltage falls to 1.70V/Cell.

5.8.3 The capacity in Ampere hour shall be obtained by multiplying the discharge current by the total time of discharge in hours and the product so obtained shall be corrected to a temperature of 27 deg. C by the formula referred in clause 5.6.3 using the value for correction factor k is 0.0091 for pasted plates.

5.8.4 The C3 Capacity shall not be less than 72% of obtained capacity.

5.8.5 The Battery shall be charged at the normal charging rate immediately after the discharge within 15 hrs.

5.9 WATT-HOUR AND AMPERE –HOUR EFFICIENCY TEST:

5.9.1 Ampere-hour efficiency: Full charged Battery shall be subjected to discharge at $I=0.1 \times C10$ Amp. to end voltage of 1.75V/cell. Careful measurements are made of ampere-hours delivered. On recharge, the same number of Ampere-hours is put back. The second discharge shall be made to the same end voltage as before. The efficiency of the Battery is then calculated as the ratio of the Ampere hours delivered during second discharge to the Ampere-hours put back on recharge.

5.9.2 Watt-hour efficiency: The watt-hour efficiency shall be calculated by multiplying the Ampere-hour efficiency by ratio of average discharge and recharge voltage. The values of discharge and recharge voltages shall be calculated from the log sheet for Ampere-hour efficiency.

5.9.3 Watt-hour and Ampere-hour efficiency when tested and calculated shall not be less than 84 percent and 96 percent respectively. During the test rest period of 12hrs to 24hrs shall be given between each charge/discharge.

5.9.4 Watt Hour and Ampere Hour efficiency shall be checked every six months by the manufacturer and record shall be kept. This must be mentioned in the QAP. Records shall be verified by RDSO.

 Prepared by SSE/Elect.	 Checked By Director/PE & Metro
---	---

TEST FOR RETENTION OF CHARGE AND STORAGE TEST:

- 5.10.1 The object of this test is to determine the loss of capacity of a cell in open circuit during a specified period.
- 5.10.2 The cell shall be fully charged at the normal charging rate specified by the manufacturer and it shall then be subjected to two consecutive capacity test discharges in accordance with clause 5.6, the value of the initial capacity 'C' being calculated as the mean of the two results thus obtained.
- 5.10.3 After a complete recharge, the cell shall be stored for a period of 180 days (six months) at a temp. of $27 \pm 5^\circ\text{C}$.
- 5.10.4 After six months of storage the cell shall be discharged in accordance with clause 5.6. The value of the capacity measured after storage shall be denoted by C1.
- 5.10.5 After the discharge the cell shall be charged at the normal charging rate at C10 rate.
- 5.10.6 The loss of capacity 'S' expressed, as percentage shall be calculated by the formula.

$$S = \frac{C - C1}{C} \times 100$$

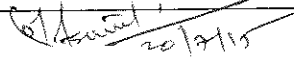
- 5.10.7 Requirement: The loss of capacity calculated as in 5.10.6 shall not be more than 10% over 180 days (six months) storage period.

5.11 LIFE TEST:

- 5.11.1 The life of Battery is defined by the number of life test units obtained under the following conditions.
- 5.11.2 The life test is carried out on at least two cells, which have satisfactorily passed the tests in accordance with clause 3.1, 5.6 and 6.0
- 5.11.3 **Original Test Capacity:**
- 5.11.3.1 The cells shall be kept in a water bath or suitable hot chamber and providing with chart recorder or life cycle tester which is maintained at $50 \pm 2^\circ\text{C}$. A minimum gap between the cells and the sides of water bath shall be 25mm. The cells shall be so immersed in vertical direction that the top of the cell is 25mm above water level in the tank.
- 5.11.3.2 After standing in open circuit for not less than 12 hours but not more than 24 hours from the completion of a full charge the Battery shall be discharge through a suitable resistance at a constant current $I = 0.10 \times C10$ Amp and discharge shall be completed when the closed circuit voltage across the Battery terminal falls to 1.75V per cell.
- 5.11.3.3 The capacity in Ah shall be obtained by multiplying the discharge current by the total time of discharge in hours. This capacity shall be called as original test capacity (OTC)
- 5.11.4 During these tests Battery shall be subjected to a series of discharges and charges continuously.

 Prepared by SSE/Elect.	 Checked By Director/PE & Metro
---	--

- 5.11.5 The discharge shall be for 4 hours or to 1.75V per cell at a current of 0.25 C10 Amp. This shall be followed by charge at a constant voltage of 2.3V per cell with a maximum current limit of 20 percent of the rated capacity for 20 hours. The charge and discharge cycle shall be carried out five times.
- 5.11.6 After above cycles of discharges and charges the Battery shall be kept on open circuit for 12 hours at $50 \pm 2^\circ\text{C}$. After this open circuit stand, they shall be test discharged at the rate of $I = 0.1 \times C10$ Amp. The discharge is continued to an end voltage of 1.75V per cell.
- 5.11.7 On completion of this discharge the Batteries shall be fully recharged. The combination of discharge and recharge cycles as described above together with 12 hours open circuit stand period, the test discharge and subsequent recharge shall be one unit of life test.
- 5.11.8 The Batteries shall be subjected to repeated test units described in clause 5.11.5, 5.11.6 and 5.11.7 until capacity measured in any test discharge falls to 80% of original test capacity (OTC) clause 5.11.3.3. The number of life units the Battery has yielded shall not be less than 24 units for 1100Ah & 650Ah VRLA Batteries and 22 units for others.
- 5.12 RECHARGE CAPABILITY TEST:**
- 5.12.1 The object of this test is to determine the recharge capability of the Battery after a specified period of storage at zero state of charge.
- 5.12.2 After standing on open circuit for not less than 12 hours and not more than 24 hours from completion of full charge, the Battery shall be discharged (as per Clause 5.6) through a suitable resistance at a constant current of $I = 0.1 \times C10$ amp. The discharge shall be stopped when the closed circuit voltage across the Battery terminals falls to 1.5V per cell.
- 5.12.3 After complete of discharge, the Battery (having 1.50V) shall be left on open circuit for a period of 7 days in fully discharge condition without disturbance at a temperature of $27 \pm 3^\circ\text{C}$.
- 5.12.4 After 7 days storage (the above cells having end voltage 1.50V), the Battery shall be charged at the normal charging rate immediately.
- 5.12.5 After standing on open circuit for not less than 12 hours but not more than 24 hours from the completion of a full charge, the Battery shall be discharged at a rate of $I = 0.1 \times C10$ Amp (as per Clause 5.6). The discharge is continued to an end voltage of 1.75V per cell.
- 5.12.6 Requirements: The obtained capacity shall not be less than 97% of initial capacity tested as per clause 5.12.2
- 5.13 LOSS OF CELL WEIGHT:** After fully charging the Battery it should be cleaned and dried. It should be weighed immediately but not exceeding one hour after drying with an accuracy of 0.05% or maximum least count of 50gm for the balance used. Then all vent-cum-filling plugs should be closed tightly and connected to constant voltage charger keeping the voltage 2.4 volt per cell, within the tolerance of $\pm 0.05\text{V}$, for 21 days in water bath or hot chamber at a temperature of $55 \pm 2^\circ\text{C}$. There-after cell is removed from circuit and dried. After this it is weighted accurately.

 Prepared by SSE/Elect.	 Checked By Director/PE & Metro
---	---

5.13.1 The cell weight loss shall not exceed 0.05gm/Ah/cell of the obtained capacity and between two cells/Batteries, variation shall not be more than 5% i.e. $\frac{[(\text{Max} - \text{Min})/\text{Max}] \times 100}{}$.

5.14 EQUILIBRIUM FLOAT CURRENT TEST: The Battery under test shall be kept in water bath at $55 \pm 2^\circ\text{C}$ and charging voltage shall be 2.4V per cell. The float current shall be measured and recorded. It shall not be more than 5mA/Ah of the rated capacity. This test shall be conducted during the initial three days (72hrs.) of the loss of cell weight test as per above clause 5.13.

5.15 TEST FOR PERMISSIBLE DISCHARGE CURRENT:

5.15.1 A fully charged Battery shall be used for test under either of the following conditions and checked by visual observation and measurement of voltage.

5.15.1.1 A fully charge Battery is allowed to rest for 12 to 24 hours at an ambient temp. of $27 \pm 3^\circ\text{C}$ and subjected to either of the following two discharges (a&b for 70Ah and c&d for other batteries):

- a) For 8 minute at a constant current of 3 C10 amps.
- or
- b) For 2 minute at a constant current of 6 C10 amps.
- c) For 1 minute at a constant current of 3 C10 amps.
- or
- d) For 5 seconds at a constant current of 6 C10 amps.

5.15.2 During the test there shall be no melting of the terminals or severance of electrical continuity and there shall be no deformation in the outside appearance of the Battery.

5.16 TEST FOR GAS RECOMBINATION EFFICIENCY:

5.16.1 Gas recombination efficiency is measured using a fully charged Battery after it has completed a C10 discharge successfully, with the following conditions:

- i) The test Battery is continuously charged for 96 hours at a constant current of 0.01 C10 Amps.
- ii) Within 1hr of completion of charge as specified in (i) charge continuously at a constant current of 0.005 C10 Amps.
- iii) Gases coming out of the Battery are fully collected in a glass-jar by displacement of water, a suitable arrangement for which shall be provided.
- iv) Time for gas collection: 1 hour (during charge as ii)
- v) Calculation of recombination efficiency;
From the measured volume of gas collected; volume of gas collected per cell under normal temperature and pressure condition is calculated as follows:
$$V_n = P/P_o \times 298/(t+273) \times V/Q \times 1/n$$

Where,

V_n = Normalized gas volume, ml/ah;

V = measured gas volume, ml;

P = measured ambient pressure, mm Hg;

Prepared by SSE/Elect.

Checked By Director/PE & Metro

1855927/2023/HEP-SWM20915

Po = Normal atmosphere pressure, 760 mm Hg;

T = Ambient temperature in degree centigrade;

Q = Ah of electricity passed during gas collection;

n = Number of cell from which gas is simultaneously collected.

Gas recombination efficiency is then calculated as:

Recombination efficiency (percent) = $(1 - V_n/684) \times 100$

5.16.2 Gas recombination efficiency shall be 95% or more.

5.17 MATERIAL AND COMPONENTS VERIFICATION TEST:

5.17.1 The cell shall be examined in the dismantled condition to see that the manufacturing is in the approved outline and assembly drawing and various components are conforming to the specification as declared by the manufacturer.

5.17.2 **CONTAINER & LID:** Containers shall conform the following tests as per clause 7 of IS: 1146-81.

- i) Verification of constructional requirements
- ii) Verification of marking and packing
- iii) High voltage test
- iv) Drop ball test*
- v) Plastic yield test
- vi) Acid resistance test
- vii) Izod impact test

*For drop ball test, the height at which container get crack shall not be less than 1000 mm (minimum single value)

5.17.2.1 The density of the material shall be 0.95 ± 0.04 grams/cc for PPCP and 1.13 ± 0.04 grams/cc for ABS at 25° C

5.17.3 **CHECKING OF ALLOY:** Firms shall furnish reports of alloy composition (spine & grid) checked by optical emission spectrometry (O.E.S.) or atomic absorption spectrometer (AAS).

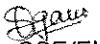
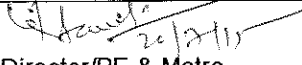
5.17.4 SEPARATORS:

5.17.4.1 The uncompressed separator, electrolyte (Sp.Gr.1.250) absorption of the separator shall be at least 5gram of electrolyte (Sp.Gr.1.250) / gram of separators material.

5.17.4.2 The uncompressed separator sample from the separator box shall be cut to make it into one piece with the size of 1 inch width and 25 inches length.

5.17.4.3 The minimum electrolyte (Sp.Gr.1.250) content at 5 inches height from electrolyte level of the container shall be at least 5 gram of electrolyte/gram of separator. The electrolyte (Sp.Gr.1.250) shall conform to IS: 266-1993 latest editions and the temperature of the electrolyte shall be within $27 \pm 3^\circ\text{C}$

5.17.4.5 The weight of electrolyte content/gram of separator shall be 75% Min. of the value obtained at 5 inch when checked at a height of 18 inch from the height of 5 inches.

 Prepared by SSE/Elect.	 Checked By Director/PE & Metro
---	---

1855927/2023/HEP-SWM20915

5.17.4.5 The total wicking height shall not be less than 25 inches in 6 hours

5.17.5 SAFETY VALVE:

5.17.5.1 The safety valve shall be explosion proof.

5.17.5.2 The vent shall release excess pressure between 2 and 7 PSI and shall reseal before the pressure drops to atmospheric pressure. Manufacturers shall declare open/closing pressure of one particular vent seal with in the tolerance of $\pm 8\%$ in PSI when tested repeatedly for 5 times. The variation between two vent seals for closing/opening pressure shall also not be more than $15\% \left[\frac{\text{Max} - \text{Min}}{\text{Max}} \times 100 \right]$ tolerance limit. Opening and closing pressure setting shall not overlap.

5.17.5.3 **SAFETY VALVE OPERATION:** In the safety valve function test, either valves themselves or valves as components of the Battery are tested by gradually increasing air pressure and the safety valve pressure is measured when valve opens, similarly, gradually reducing air pressure from the level of pressure that has caused the valves to open, the pressure when the valve is closed, is measured and shall pass the clause 5.17.5.2.

5.18 NUTS, BOLTS AND WASHERS: Nut, bolts and washers shall be stainless steel and shall be resistant to sulphuric acid.

5.18.2 Bolts and washers shall be tested by immersing in 1.300 Sp.gr. of sulphuric acid for not less than 72hrs; the acid shall be cleared at the end of this period. There shall not be any visible effect on the nuts, bolts & washers.

5.19 AIR PRESSURE TEST: This test shall be carried out on all cells and Batteries before filling acid to ensure the sealing strength and to check leakage in the cells.

5.19.1 To check the leakage and sealing strength in cell, compressed air at the pressure of 7 psi shall be applied for 1 minute. The cell lid shall not show any visible sign of movement due to the air pressure and drop in pressure due to leakage. To detect the leakage, cell shall be immersed in water bath.

Note: The air pressure test shall be done on 100% cells of PPCP/ABS at the pressure at 5-6 psi during production for 20 seconds.

5.19.2 Any cell failing this test shall be rejected for further assembly.

5.20 VIBRATION TEST: The cell shall be subjected to vibration and shock testing as per IEC 61373 - 2010.

- a) Random vibration test as per clause 8 Table-1, category 1 Class B
- b) Simulated long life test as per clause 9, Table-2, category 1 Class B
- c) Shock test as per clause 10, Table-3, category 1 Class B

5.20.1 There shall be no leakage of electrolyte. C10 capacity test also shall be carried out prior to commencing and on completion of above tests. RDSO representative shall witness the capacity tests and it should be within 3% of capacity obtained.

5.20.2 If the testing facility is not available in house, manufacturer can carried out the test at any approved Govt. laboratory.

 Prepared by SSE/Elect.	 Checked By Director/PE & Metro
---	--

5.21

INTERNAL RESISTANCE OF CELLS:- After charging and rest not exceeding 24 hour, the cell shall be discharged for one hour at 10 hr rate. The test shall be continued by increasing the discharge current to approximately equal to 75% of rated capacity i.e. $A1=0.75 \times C10$ and after an interval not exceeding 5 minutes, the current shall be decreased to 25% of rated capacity i.e. $A2=0.25 \times C10$. The current $A1$ and $A2$ in amperes and the corresponding cell terminal voltage $V1$ and $V2$ in volts shall be measured. Accuracy of instruments used shall be 0.001V and 0.1Amp. The internal resistance in milli ohm of the cell shall be calculated by applying following formula.

$$R = \frac{V2 - V1}{A1 - A2} \times 1000 \text{ Milliohm}$$

- 5.21.1 The variation in internal resistance of two cells shall not be more than 10% $\left[\frac{\text{Max} - \text{Min}}{\text{Max}} \times 100\right]$. For 12V 70Ah Batteries, the internal resistance of Batteries shall not be more than 8 milli-ohm and variation between two Batteries not exceed 10% $\left[\frac{\text{Max} - \text{Min}}{\text{Max}} \times 100\right]$.

- 5.22 **CAPACITY AT 0°C:** - The fully charged cell shall be stored for 12 to 24 hour at the temperature of $0 \pm 1^\circ\text{C}$. The cell then shall be discharged maintaining same temperature by current $I=0.1 \times C10$ Amp. to a cut off voltage of 1.75V. The amp-hour capacity of cell shall be measured. The capacity shall not be less than 70% of obtained capacity.

- 5.23 **CONDUCTANCE MEASUREMENT OF CELL:** The conductance of all Batteries/cells shall be measured with conductance meter and value shall be recorded. The variation between the Batteries/cells shall not exceed 10% with respect to maximum conductance value $\left[\frac{\text{Max} - \text{Min}}{\text{Max}} \times 100\right]$.

5.24 TEST EQUIPMENTS:

- 5.24.1 The voltmeters, Ammeters, Thermometers and hydrometers required for tests specified in this standard shall meet the requirements given in 11.2 of IS: 8320-2000. Where digital meters are used, the meter shall be capable of displaying up to two decimals in the range 0 to 99V and one decimal in 100 and above volts range. The digital meters shall be capable of displaying at least up to two decimal values.

- 5.24.2 All prototype tests shall be conducted by the computerized control Battery charging /discharging equipment with 2% or above voltage ripple & regulation and shall have monitoring & recording system of test parameters. Manually testing is not permitted. Life cycle testing is to be carried out through fully computerized control with continuous logging facility of time, voltage (minimum 6 channels), current, temperature, Ah, Wh, Mode and cycle step.

- 5.24.3 The rest period before discharge shall be 12 to 24 hour, however in unavoidable circumstances if rest period exceeds to 24 hour, additional freshening charge shall be given before conducting the discharge test.

6.0 MARKING AND PACKING:

- 6.1 Either the shorter or longer side of each of module, shall have the following details marked on it:

a) Manufacturers name or trademark embossed on container lid.

 Prepared by SSE/Elect.	 Checked By Director/PE & Metro
---	---

- b) Manufacturers name; trademark and place of manufacturing and.
- c) Rating at 10hr. discharge rate.

Note: STICKER not permitted on steel modules.

- 6.1.1 The year and month (e.g. April 07 can be shown as 04/07) of manufacturer shall be hot punched of letter size not less than 6 mm on the lid. Marking shall also be done by acid proof paint on shorter side of containers and steel modules. Code wise date shall not be accepted.
- 6.1.1.1 Manufacturer name or trademark and rating of Battery will be impressed or embossed on the container or on lid in cells/Batteries if marking is not possible to be embossed on container
- 6.1.2 Manufacturer shall be responsible for safe transportation of Battery. Battery should be delivered in good condition to consignee at his depot/workshop. If there is any damage manufacturer shall replace the Battery free of cost.
- 7.0 **MANUAL OF INSTRUCTIONS:** The manufacturer shall supply one copy of instructions manual for routine maintenance and attention required during service, with every batch of Batteries supplied to the each consignee. Effort shall be made by firm to minimize maintenance by design improvement with intimation to RDSO. The instruction manual shall comply with RDSO's SMIs.
- 8.0 **WARRANTY:** The manufacturer shall declare the expected life under testing condition in type test offer as well as while submitting the technical details to RDSO.
- 8.1 The manufacturer shall replace all the failed cells with new cells of same design / type within the warranty period free of cost as per the term and conditions of the purchase order or the contract.
- 9.0 **STANDARDIZATION:** For 2V 1100Ah cells Battery box has been standardized to suit all make of Battery. The Battery shall be accommodated in 28+28 configuration in two-Battery box in M.S module/tray. Battery box cradle shall be as per RDSO Drg. No. SK -K 0037 Alt.3 (or latest).
- 10.0 **DRAWING:**
- 10.1 The manufacturer shall supply one set of drawing in A4/A3 size listed as below for approval while offering the cell / mono-bloc for type testing. Soft copy of part drawing with 3D view shall also be submitted.
 - a) Cell/monoblock drawing with dimensions of front, top and side view
 - b) Part drawings showing different sections with dimensions of front, top and side view.
 - i) Container
 - ii) Terminal post (Positive and Negative).
 - iii) Container lid.
 - iv) Pole (+Ve & -Ve).
 - v) Plates (+Ve & -Ve groups assembly).
 - vi) Separator.
 - vii) Inter cell/unit and end cell cable & connector.

Prepared by SSE/Elect.

Checked By Director/PE & Metro

11.0 RELIABILITY:

- 11.1 RDSO approval means the approval of general design features. Notwithstanding the approval, manufacturer is wholly and completely responsible for performance, life and reliability of Battery during service.
- 11.2 After the prototype approval no designs change shall be undertaken by manufacturer on prototype cell/Batteries without prior approval of RDSO, failing to which the approval may be withdrawn by RDSO at any time
- 11.3 If considered necessary RDSO may undertake re-testing of some or all prototype tests as per this specification at any time to ensure proper effective quality control being exercised by the manufacturer at different stage of manufacturing.
- 11.4 RDSO may, also undertake some special tests for concerned manufacturers to validate the design changes for which all the necessary testing equipment etc. shall be arranged by the manufacturer free of cost.
- 11.5 Manufacture shall be responsible for reliable performance and life of cells/Batteries in the field.

12.0 DESIGN DOCUMENTS AND INSTRUCTIONS MANUAL:

- a) One set of drawing as per clause 10.0 of the specification before offering for type tests.
- b) In house test result as per annexure 'A' and 'B' shall be sent to RDSO before offering for type test. After completion of tests following documents in bound booklet should be submitted in duplicate.
- c) After completion of prototype test manufacturer shall submit two copy of following documents in bound form for approval. One copy duly approved shall be returned to manufacturer.
- Bill of Material
 - Design details
 - ISO Certificate with letter of issuing authority
 - Drawings
 - Prototype test result
 - Quality assurance inspection plan.
 - Maintenance manual.
- d) Maintenance manual and QAP in soft and hard copy should be submitted in advance for approval.
- e) Alternative superior designs can be considered provided necessary technical justification with benefits is furnished for scrutiny.

13.0 IN-FRINGEMENT OF PATENT RIGHTS: Following undertaking to be signed and submitted by vendor during registration of item:

"Indian Railways/ RDSO shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, use of similar components

 Prepared by SSE/Elect.	 Checked By Director/PE & Metro
---	---

1855927/2023/HEP-SWM20915

in the design & development of this item and any other factor not mentioned herein which may cause such a dispute. The entire responsibility to settle any such dispute/matters lies with the manufacturer/supplier.

Details/design/documents given by them are not infringing any IPR and they are responsible in absolute and full measure instead of Railways for any such violation. Data, specifications and other IP as generated out of interaction with Railway shall not be unilaterally used without the consent of RDSO and right of Railways/RDSO on such IP is acceptable to them".

14.0 OTHER REQUIREMENTS: The firm shall have valid ISO-9000 Certification from a reputed Certifying Agency regarding compliance to establishment of the Quality Systems for ensuring quality product by its effective implementation during various stages of manufacturing from raw materials process controls, testing, quality checks to finish product.

15.0 AFTER SALES SERVICE:

15.1 The manufacture shall make necessary arrangements for closely monitoring the performance of cells through periodical (preferably once in three months during the warranty period) visits to the location where they have been installed for observations and interaction with the operating and maintenance personnel of the Indian Railways. Arrangements shall also be made by the successful tenderer for emergency, stand by spare parts being kept readily available to meet exigencies warranty replacement so as to keep the cell in service with least down time.

15.2 The successful tenderer shall respond promptly to any call given by Indian Railways for any assistance by way of attending to failures. Investigation into the cause of failure includes tests to be done and for such other items with a view to see that the equipment serves the purpose for which it is intended. Technical guidance to ensure proper operation and maintenance of the equipment shall be constantly rendered.

 Prepared by SSE/Elect.	 Checked By Director/PE & Metro
---	--

SCHEDULE OF DESIGN PARTICULARS

The following particulars are required to be supplied by the manufacturer with the quotation:

SN	Description	Particulars to be filled in
1.	Make	
2.	Type of unit	
3.	Manufacturer's nomenclature	
4.	Overall dimensions of unit (length x width x height)	
5.	Mass per unit with acid	
6.	Cell container material	
7.	Type of positive plates	
8.	Type of negative plates	
9.	Separators	
10.	Quantity of electrolyte per cell (litres)	
11.	Sp.Gr.of electrolyte for initial filling at 27 degree centigrade	
12.	Material of terminal and inter-cell Connectors	
13.	Normal charging rate (Amps)	
14.	Internal resistance (Ohms)	

ANNEXURE 'B'

SCHEDULE OF PERFORMANCE

SN	Description	Particulars to be filled in
1	Following particulars reg. the type tests shall be supplied by the manufacturer along with the certificate against any quotation or tender	
2	RDSO type approval certificate No. with date and validity	
3	Amper-hour capacity (Actual)	
4	C10Ah	
5	C5Ah	
6	C3Ah	
7	Amper-hour efficiency	
8	Watt hour efficiency	
9	Storage and Retention of charge	
10	Life Units	
11	Recharge capability	
12	Loss of cell weightgm/Ah/cell	
13	Charge and discharge curves with voltage versus time for cell for discharge at 10 Hours rate and charge at normal rate.	
14	Safety valve open/closedPSI	
15	Equilibrium float current	
16	Internal resistance	
17	Conductance	
18	Capacity (C10) at 0 deg.C. %	
19	Recombination efficiency	

Prepared by SSE/Elect.

Checked By Director/PE & Metro

ANNEXURE 'C'

SAMPLE FOR TYPE TESTING

SN	TEST	SAMPLE NUMBER									
		1	2	3	4	5	6	7	8	9	10
1.	Checking of dimensions, mass, markings and workmanship	x	x	x	x	x	x	x	x	x	x
2.	Capacity at 10 hrs. rate	x	x	x	x	x	x	x	x		
3.	Material and component specification verification test										x
4.	Conductance	x	x	x	x	x	x	x	x		
5.	Air pressure									x	x
6.	Life			x	x						
7.	Watt hour and ampere hour efficiency					x	x				
8.	Capacity at 5 hr. rate					x	x				
9.	Capacity at 3 hr. rate					x	x				
10.	Storage and Retention of charge					x	x				
11.	Gas recombination efficiency	x	x								
12.	Capacity (C10) at 0 deg. C	x	x								
13.	Equilibrium float current	x	x								
14.	Loss of cell weight	x	x								
15.	Valve open/closed							x	x		
16.	Recharge capability							x	x		
17.	Vibration							x			
18.	Internal resistance									x	x
19.	Permissible discharge current									x	x

ANNEXURE 'D'

SAMPLING PROCEDURE FOR ACCEPTANCE TESTS

1. **LOT:** In the consignment, all the Batteries of the same rating manufactured from the same material under similar conditions of production shall be grouped together to constitute a lot. These Batteries in the sample shall be drawn from the lot at random. For the purpose of random selection, reference may be made to IS: 4905-1968 or latest.
2. **SAMPLE SIZE AND CRITERIA FOR CONFORMITY**
 - 2.1 The Acceptance tests shall be conducted on minimum two samples up to a maximum of 1 percent of each type in a lot, the samples being drawn at random by the purchasing or inspecting authority as specified in Appendix "G" of IS: 6848 with latest version or amendment.
 - 2.2 If any of the samples Batteries fail in any of the acceptance test, twice the original number of samples shall be taken and subjected to all the acceptance tests. If there is failure in re-test, the lot may be rejected.

XXXXX

 Prepared by SSE/Elect.	 Checked By Director/PE & Metro
---	--

SPECIFICATION NO.TI/SPC/OHE/8WDETC/0092 (02/09)

**GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS**



सत्यमेव जयते

TECHNICAL SPECIFICATION
FOR
8-WHEELER DIESEL ELECTRIC INSPECTION &
MAINTENANCE OHE CAR UNDERSLUNG TYPE
FOR
OPERATION ON BROAD GAUGE (1676 mm)

(August' 2015)

Issued by
RESEARCH DESIGNS & STANDARDS ORGANISATION
MANAK NAGAR, LUCKNOW-226011
(For Official use only)

SPECIFICATION NO.TI/SPC/OHE/8WDETC/0092(02/09)

Amendment Number	Date of Amendment	Total pages including annexure	Amendment/Revision
0	NA		First issue
Nil	02.05.2012	87	Revision-1

	PREPARED BY	CHECKED BY	APPROVED BY
SIGNATURE			
DATE			
DESIGNATION	SSE/TW	Dy. Director/TI	EDTI

COPY NUMBER

--	--

ISSUED BY

SIGNATURE.....

DATE.....

ISSUED TO

.....

NOTE: This specification is property of RDSO. No reproduction shall be done without permission from DG (TI), RDSO. This specification is not for general use.

Chapter - I**GENERAL CONDITIONS****1.1 Scope**

1.1.1 This specification covers the design, manufacture, and supply, testing & commissioning of self-propelled 8-Wheeler Inspection & Maintenance OHE car for operation on broad gauge (1676mm) electrified (25 kV a.c.) routes of Indian Railways. The 8-Wheeler Inspection & Maintenance OHE car is a self-propelled 4-axle vehicle and is used for periodical inspection, patrolling and maintenance of traction overhead equipment (OHE). It shall also be used for attending to sites of break down, restoration and damaged OHE etc. It is also required to erect small lengths of catenary and contact wire by way of repairs of damaged OHE. The 8-Wheeler Inspection & Maintenance OHE car uses the power generated by the Diesel Alternator set provided in the OHE car for propulsion and not the power from live OHE.

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

1.2 CLIMATIC CONDITIONS

1.2.1 The power pack & electrics of the OHE car shall be in continuous operation under the following atmospheric and climatic conditions: -

1	Atmospheric temperature	Metallic surface temperature under Sun: 75° C max. and in shade: 55 °C max. Minimum temperature: - 10°C (Also snow fall in certain areas during winter season).
2	Humidity	100% saturation during rainy season.
3	Reference site conditions	i) Ambient Temp. : 50° C ii) Humidity: 100% iii) Altitude: 1000m above mean sea level.
4	Rain fall	(i) Ranging from 1750 mm to 6250 mm. (ii) Number of rainy days/annum 120
5	Atmosphere during hot weather	Extremely dusty and desert terrain in certain areas. The dust concentration in air may reach as high as 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	OHE car 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

		<p>arrangement shall be designed to withstand satisfactorily the vibration and shocks encountered in service as specified in clause 1.2.2.</p> <p>High level of 50 g vibration and shocks. Accelerations over 500 m/s² have been recorded at axle box levels for long periods during run. Vibrations during wheel slips are of even higher magnitude.</p>
8	Wind speed	High wind speed in certain areas, with wind pressure reaching 200kg/m ²

1.2.2 The equipments 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 | 2.0g |
- [g: Acceleration Gravity]

1.2.3 The OHE car shall be able to negotiate water logged tracks at 10 kmph, with water level of 102 mm above the rail top, for which the Equipment shall be suitably designed.

1.2.4 The OHE car and its principal assemblies shall be designed and manufactured to give satisfactory performance in the tropical climate, having very dry & dusty regions in arid zones of the country, to humid coastal areas and extreme cold climate of the northern region..

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 OHE car 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 OHE car 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 detail, 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.

1.5.2 Drawing for approval shall be submitted in standard size (s) as per IS: 696 along with main calculation details in triplicate. List of drawings/calculations to be submitted to RDSO for approval before undertaking manufacture of prototype DETC are given in ANNEXURE-2. Any other drawings of which manufacturer desires to obtain approval of RDSO shall also be submitted to RDSO.

1.6 Prints:

1.6.1 One set of tracing, two sets of their prints & two DVD of the RDSO approved drawings/ calculations shall be supplied by the successful contractor with each tower wagon. The tracings shall be on RTF of durable quality. Drawings shall be made on Auto CAD. Two sets of tracing, two sets of prints and two copies of approved drawings & calculations along with 3 DVDs shall be supplied to RDSO.

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 show the overall dimensions of the equipment, weights and the relation of overall dimensions to the space in the OHE car.
- (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 indicating type of lubricant. Sub-assembly 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 OHE carried out either by the contractor or by the RDSO or the Inspecting Officer.

1.8 Warantee:

Warranty shall be as per IRS standard conditions of contract.

1.9 Exhibited Drawings and standard Specifications:

- 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 OHE car must comply with the dimensions, and fittings included in the exhibited drawings as far as possible. Any deviation from there 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 OHE car.

1.9.6 Copies of drawings referred to in this specification and given in Annexure-1 may be obtained from RDSO/ICF 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 OHE car 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 Engineering:**

1.11.1 The Contractor shall arrange for the supervision of commissioning of the OHE car immediately after their receipt at ultimate destination. He is also required 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 OHE car within 30 days from the date of intimation by the consignee.

1.11.3 The performance of OHE Car shall be demonstrated by the contractor after its successful commissioning at the consignee's works.

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 service support for troubleshooting and for obtaining spare parts.

1.11.5 A well designed and informative electronic portal for lodging of complains and action taken by supplier shall made operative before dispatch of first prototype vehicle.

1.12 **Training:**

1.12.1 The Contractor shall arrange to provide training in operation & maintenance of the OHE car for two men for four days at their works and user's place respectively per tower wagon. The training material shall be supplied as per Annexure 8-D.The cost of training shall be included in the price of tower car. The charges for travel, boarding and lodging of trainees shall be borne by the Railways.

1.12.2 Technical experts of the manufacturer, during commissioning of OHE car at consignee's premises, shall also adequately train operators/ maintenance staff nominated by the consignee for minimum period of 3 days.

1.13 **Service Manuals and Spare Parts Catalogues:**

1.13.1 Detailed Maintenance & Service Manuals including the manual for trouble shooting & operational requirement, spare parts catalogues for the driver and maintenance staff for the OHE car shall be prepared and three copies supplied free of charge, per OHE car, 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 OHE cars of Spare Parts Catalogues& list of must change items with periodicity & sources of supply shall also be supplied to the consignee.

1.13.3 In addition, three copies each of the Maintenance/Service and trouble shooting manual along with 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 OHE cars 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 |

1.16.1 The prices for these spares shall be quoted separately. These spares shall be for every set of 10 OHE cars or part thereof. The prices shall not be used for tender evaluation purpose.

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 OHE Cars 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 tower car. The successful Tenderer shall submit the drawings and specification of tools required for the maintenance of the OHE Car.

1.18 **Testing Kit:**

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

1.18.2 The Tenderer shall also offer separately special jigs, tools and instruments, which shall essentially be required for maintenance of OHE Car body. Essential Equipments and facilities required for attending local damage to Stainless Steel structures, OHE Car interiors etc. in case of accidental damages should also be furnished.

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 OHE Maintenance equipments :

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

- a) The technical specification No. TI/SPC/OHE/TIPS/1031 with latest amendment for infra-red imaging system suitable for monitoring and measurement of hot spot temperature for different applications.
- b) One Hydraulic Jack of 5 t capacity,
- c) One tifter 3t, Two tifter 1.5 t, (As per RDSO's Specification No. TI/SPC/OHE/TOOLPL/0990).
- d) 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 Organisation 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)

1.21.1 The tenderer shall quote for AMC comprehensive of all equipments including, traction motors, alternators, Diesel Engine complete with transmission & cooling system, Air Brake system with compressor unit and Control System etc.

The Annual Maintenance shall be applicable for the period for 5 years beyond expiry of warantee. The tenderer shall quote year wise rates of AMC detailing the various schedules to be undertaken by them as well as submitting the requirement of material/spare parts, consumables 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 parts required to be replaced during each schedule, if required, either due to brake down 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. However, the decision to enter into AMC shall vest with Railway alone.

1.21.2 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 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.

1.21.3 The AMC Agreement shall be entered with the Zonal Railways as per the accepted rate in the Contract.

Chapter -II**DIMENSIONAL OPERATING AND OTHER REQUIREMENTS FOR OHE CAR**

2.0 The OHE Car shall dimensionally conform to the following:

1.	Track gauge	1676 mm
2.	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.
3.	Maximum super elevation	185 mm
4.	Maximum Super -elevation deficiency	100mm
5.	Maximum wind pressure	200 kg/m ²
6.	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 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.
7.	Maximum permissible wheel base length of the OHE car, over hang beyond bogie center, buffer height draw bar height	These shall conform to Indian railway, schedule of dimension 1676 mm gauge (BG) Revised 2004. Adequate clearance shall be allowed so that no component of the OHE car shall infringe a minimum of 102 mm above rail level with wheels in fully worn conditions, full deflection of springs and effect of dynamics.
8.	Maximum Axle load	20.32 t
9.	(a) Maximum Speed when coupled to a train (b) Max operating speed under its own power	110Km/h 110 km/h
10.	Brakes	All wheels with clasp brakes.
11.	Service Braking	Pneumatic

12.	Performance capabilities:-	i) Pay load (excluding Power equipment and hydraulic platform)	12tonnes(Approximately)
		ii) Period of continuous running at 110 km/h on generally tangent track followed by frequent to and fro movement at walking pace for 1-1/2 h).	5-1/2h total (4h+1-1/2h)
		iii) Period of continuous running at 40 km/h up or down gradient of 1 in 60 to be followed by frequent to and fro movement up to 5 km/h for 1-1/2 h on same gradient with speed control.	5-1/2h total (4h+1-1/2h)
		iv) Performance in monsoon and squally conditions.	Un- restricted
		v) OHE Car shall be capable of running at a speed of 75kmph with 2-loaded flat wagons weighing 120t at tangent track.	
		vi) The OHE Car shall be capable of running at a speed of 25 km/h on 1 in 33 up gradient	
		vii) The OHE car shall be capable of starting and hauling Two wagons weighing 60t each in gross load condition (Total 120 tonnes) on an up gradient of 1 in 33. Maximum operating speed of the OHE car for level and 1 in 33 up gradients shall be indicated with the offer.	
		viii) With the hydraulic platform in raised condition the OHE car shall run at a maximum speed of 10 km/h.	
		ix) The emergency braking distance (EBD) for fully loaded (20.32x4=81.28 t) OHE car from maximum speed of 110km/h to zero shall not be more than 800m on flat section. The contractor shall also submit calculation for EBD on 1 in 33 down gradient.	

- 2.1 The purchaser may at his option revise the layout so as to provide for an arrangement for front opening on one side to load and unload collapsible ladders from the trackside. Tenderer may offer alternative proposals with full details of the advantages of his system.
- 2.2 The OHE car 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 OHE Car:

2.3.1 Driving Cabs:

- i) Two driving cabs shall be provided, one at each end, with complete operating & driving control with dash boards to facilitate operation from either cab. Driver's seat shall be on the left side. 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 view and comfort and also the various panels /equipments 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.
 - ii) Foldable cushion sheet shall be provided in each of the driving cabs for 4 persons in addition to the Driver.
 - iii) 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.
 - iv) The OHE car shall be equipped with inter-communication equipment between cabs, Inspection compartment, working platform through hand free sets with their own battery.
 - v) Each driving cab shall be provided with one number 6 Inch TFT monitor connected with one number portable CCTV camera for viewing roof activities during OHE maintenance.
 - vi) 2 numbers, 110 V sockets for hand signals in each cab.
 - vii) Head Light, Flasher lights search lights and marker lights at both ends of the cab, refer para 4.5.
 - viii) OHE voltage sensing device in both the cabs.
 - ix) Full width single piece Stone proof lookout glass with Sun Screen shall be provided at the end wall of each Driver's compartment and these shall be glazed, clear, colourless polycarbonate to ICF Specification No.ICF/MD/SPEC-159 (latest revision).
 - x) Provision of wind screen Wiper arm and blade Assembly to be provided as per RDSO Specification no.C-K306 (Rev 01).
- 2.3.2 It is proposed to keep one drum each of contact and catenary wire, duly mounted on the stand, for erection during the restoration of breakdowns. Provision shall be made for rotating the contact wire drum

by 180 degree for matching contact wire groove in either direction is possible so that it shall be possible to pay out the wire in either direction. Stands shall be provided with hand brakes to control the tension in the wires during the laying out process. It shall be possible to lay-out wires in either direction and therefore these drum shall preferably be in the middle of the OHE car. The drums be loaded from a sliding door of adequate size on both sides. The laying out of the wire shall be from two of the openings of suitable size in the roof vertically above each of the drums. These openings shall normally be covered so as to prevent water falling into the OHE car.

- 2.3.3 Successful tenderer shall submit mounting drawings for conductor drum as per principle details given below for approval of RDSO.

The principal details of the conductor drums are-

- (a) Diameter 1900 mm
- (b) Width- 950 mm
- (c) Bore for mounting on the stand- 105mm x 105mm
- (d) Facility shall be provided to rotate the conductor drums to enable pay out the conductor in either direction

- 2.3.4 The facilities to be provided in the OHE Car shall be as described briefly in the following Clauses.

2.3.4.1 **Material Cabin:** A material cabin shall be provided adjoining one of the driving cabs having adequate space and proper locking arrangement for the storage of costly equipments and fittings. A reasonable number of cup-boards having sufficient number of pigeon holes shall be provided inside the material cabin for storage of fittings, tools and tackles, lighting equipment and other fragile spares. Suitable shelves/racks shall also be provided for storage of about 50 MS tubes of upto 47 mm dia and upto 4m long, hangers for insulators, apart from these two steel almirah (with five shelves) shall be provided for keeping costly items & essential records.

2.3.4.2 **Workshop:** A well-ventilated workshop shall be provided in the middle equipped with exhaust fans, ceiling fans and windows, with a room for 4 persons to stand and work. On one side a workbench of size 2500mm x 900mm shall be provided. It shall be fitted with two vices to under take minor repair work along with one drilling machine. On the side opposite the workbench, racks/cup board shall be provided for tools and plant. Design/ drawings of these equipments shall be submitted to RDSO for approval.

2.3.4.3 **Storage space:** Adequate space shall be provided for installation and storage of equipment such as emergency lighting equipment and other items supplied with the OHE Car.

2.3.4.4 Staff Cabins: One cabin for Officers with four cushioned Berths and one Cabin for staff (if possible) with two cushioned Berths shall be provided. The Cabins shall have separate entry and have windows on both sides. The Cabins shall preferably be not over the wheels as far as possible. An Indian style WC with separate over head Tank, Stainless Steel Sink and other accessory fitting and a folding cushioned seat including shower with flexible Hose shall be provided. The WC shall be provided with an exhaust Fan. Provision of two Mobile Charging points to be made in Officer and Staff's Cabin as well as in both the driving cab and working area. In addition two folding berths shall be provided at suitable location without cabin.

2.3.4.5 Communicating doors: Each driving cab shall have independent entry from both sides. The OHE car lobby shall have entry from both the cab. Through communication inside the OHE car shall be provided. It shall be possible to isolate the cabins using sliding doors with locking arrangements.

2.3.5 Facilities on roof:

- i) The OHE car shall be provided with a pantograph similar to AM-12 type with foot insulators and its complete actuating mechanism on one bogie center. Pantograph shall be graduated to enable manual measurement of stagger on either side of track center.
- ii) For illumination of roof for night inspection four water proof industrial plug points shall be provided for fixing portable lights.
- iii) Two pneumatic points for connecting pneumatic operated/driven tools and fasteners shall be provided.
- iv) **Observation dome:** An observation dome shall be provided in the roof near the pantograph so as to observe interaction between the contact wire of the OHE and the pantograph. Two to three persons shall be able to sit comfortably in the observation dome. The upper portion of the dome shall be of polycarbonate /FRP with reinforcement if required for adequate strength and shall also be insulated for 25 KV. The arrangement shall be such that an unobstructed view of the contact between contact wire and pantograph is obtained by the persons in the observation dome without any strain. For this it is essential to have suitable ergonomical design of sitting arrangement. The chair provided in the observation dome shall have adjustable height, back rest with back and front adjustment just like in an automobile OHE car.

- v) **Lifting and swiveling platform:** A lifting and swiveling platform with hydraulically operated mechanized adjustment for height and rotation and capable of taking minimum 600 kg load with under-noted features shall be provided over the fixed platform:-

- | | |
|---|---------|
| (a) Length | 5700 mm |
| (b) Width | 1500 mm |
| (c) Platform floor level above rail when elevated. | 6150 mm |
| (d) Maxim lifting time to full height | 45 s |
| (e) Rotation range of Platform towards sides. | 90° |
| (f) Side shifting reach of platform | 4200 mm |
| (g) Full height of collapsible railing above platform floor | 800 mm |
| (h) Maximum time of rotation from 0° position to 90° | 45 s |

NOTE:

- (i) Control for lifting, lowering and swiveling shall be provided on the platform. The raising and swiveling of the platform shall be gradual and without jerks. In addition two emergency stop switches shall be provided on each side of the platform to bring the OHE Car to an emergency halt.
- (ii) Two search lights of 250 W metal halide lamps shall be provided on the platform for inspection of the overhead equipment while on the run. Searchlights shall be capable of swiveling on universal joints type support and swiveling control shall be from inside of the either cab.
- (iii) Except space for pantograph and observation dome the remaining roof shall be covered with a 2325mm wide fixed working platform at maximum possible height but within the maximum moving dimensions. This fixed platform shall be provided with four approach ladders, two on each side to climb on to the platform from the ground.

2.3.6 Provision shall be made to OHE carry 3 OHE masts of 9.5 m and 1 of 12 m lengths. The masts may either be rolled I beam of 150mm x 200mm size or fabricated structure of 250mm x 300mm.

2.3.7 Suitable safety measures including interlocks between various equipments, access doors and line equipment shall be provided to ensure.

- (i) Safety of men and
- (ii) Stability of the OHE Car while in operation.

The tenderer shall indicate the proposed interlocking and safety aspects.

2.3.8 The entire OHE Car including bogies, superstructure alongwith equipment is to be effectively earthed as per standard practice for rolling stock. Schematic and other detailed drawings for earthing shall be got approved by RDSO.

2.3.9 The equipment fixed to the underframe shall be secured properly by providing extra metallic chains of adequate strength to safeguard the equipment and to perform efficiently.

2.3.10 Fire prevention OHE Car shall suitably be provided as per RDSO's Specification No. RDSO/PE/CP/EMU/0001 Rev.0 of Aug.'2003(Amendment No.1 of July'2006) and with latest revision

Chapter - III

3.0 MECHANICAL DESIGN

3.1 Superstructure:

3.1.1 General: The OHE Car 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 OHE Car 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 OHE car 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 OHE 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 OHE car shall also not exceed 10mm under any loading condition detailed at (i) to (iii) above.

Completed shell of prototype OHE car shall be strain gauged for stress analysis under tare and loaded conditions with squeeze load. OHE Car shall be tested for leakage through roof and body sides and ends at the works of the manufacturer. To OHE 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. Manufacturer can use better material than IRS: M-41 for body pillar but without cost implication and supplier shall provide proof of better material.
- (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 DETC. 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 OHE 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 OHE Car 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. The arrangement shall be such that OHE Car shall be able to couple with existing BG rolling stock of Indian Railways.

- 3.1.10 **Lifting Pads:** The OHE Car 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 OHE car body.
- 3.1.11 **Solebar:** 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 OHE Car. 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 OHE 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 OHE Car, 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 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 Two (02) openings shall be provided in the roof for erection of catenary and contact wires in either direction. The openings shall be of suitable size to permit paying out of the conductors in any direction, when the OHE car is moving slowly at 5-10 km/h speed, without any obstruction, rubbing or scrapping.

3.2.3 **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.

3.2.4 **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 OHE Car 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 OHE 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. Hasps for external padlocking shall also be provided on all doors opening out of the OHE car.

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 OHE car profile.

3.5 **Roof Water Tank:** Roof water tank 4 mm thick of aluminum not less than 450 liters capacity shall be provided. The tank shall be mounted so as to be readily removable for repairs. Side filling arrangement only shall be provided for water filling. The water tank shall be tested to hydraulic pressure of 0.35 kg/cm². The inside of all water tank shall be

painted with bituminous , black lead free, acid, alkali, water and chlorine resisting paint to IS:9862-1981 and properly dried before assembly in the car.

3.6 **BOGIES:**

3.6.1 General Design: OHE Car 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 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 air spring suspension in secondary stage. The Bogie Design shall be as per ICF Drawing No AC/EMU/M/ASR-0-0-001 with latest Alteration.

The manufacturer of diesel electric tower car shall purchase bogie frame alongwith its accessories from the approved Vendors of Indian Railways.

3.6.3 The design shall be capable of negotiating curves of 152.4 m radius, turnout of 1 in 8 and 1/2 and gradients of 1 in 100.

3.7 **WHEEL, AXLES AND AXLE BOXES**

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

3.7.2 Wheel assembly shall be of 952 mm diameter and shall be provided with roller bearings No 22328 C/C3. The wheels of tower car 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.

3.7.3 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.

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

- 3.7.5 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.
- 3.7.6 All wheel and gear seats and traction motor suspension bearing journals are required to be cold rolled together with stress relieving grooves machined in the axle, between wheel seat and gear seat and between the wheel and traction motor suspension bearing journal of the axles.
- 3.7.7 Facilities for oil injection for removal of wheel shall necessarily be provided.
- 3.7.8 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 submerged 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 design of labyrinth will be such as to prevent the ingress of dust in to or outflow of grease from axle boxes.
- 3.7.9 One of the axle box and cover (not the leading one) shall house speedometer generator with suitable adopter. OHE care 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 preferable be taken from the top of the axle box.
- 3.7.10 Complete working drawing of the axle box , guide arrangement with bearing and its components shall be submitted for approval along with maintenance instructions
- 3.7.11 The axle box body shall preferably be of cast steel.
- 3.7.12 The contractor will be required to provide recommended lubricants which should have been proven in similar railway service of the axle bearings.
- 3.7.13 An alternative lubricant, manufactured in India shall also be identified by the contractor in conjunction with the bearing manufacturer, and the lubricants manufacturing industry.
- 3.7.14 Design calculation for the powered axle shall be submitted for approval of RDSO.

3.8 Brake System:

3.8.1 The OHE Car 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.

3.8.3 The Emergency Braking Distance (EBD) for fully loaded (20.32x4=81.28 t) OHE car 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 OHE Car 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 OHE car 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 OHE Car 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 OHE car 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 Spec. 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 specification 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 ferule pipe fitting consisting of body, front ferrule, back ferrule and nut shall be 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 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 OHE Car 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 OHE Car.
- 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).

- 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 OHE Car 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 OHE Car may be washed mechanically. Tenderers may also note that the exterior of the OHE Car may be washed in automatic OHE car washing plants. Exterior of the OHE Car 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 OHE car 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 underslungequipments, 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 OHE car.

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 OHE Car 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) OHE Car shall be treated after fabrication as per UIC Code 842-5.
- iv) In addition to above, the OHE Car 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 OHE Cars manufactured by him.
- vi) The Tenderer shall note that OHE car 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 OHE Car 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 OHE Car 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 OHE Car, showing the layout of the major equipments along with principal dimensions.

- (iii) Side elevation of the proposed OHE car.
- (iv) A "Sectional" side elevation of the OHE Car underframe showing the disposition of the major equipments on the underframe.
- (v) To demonstrate his capability for designing OHE car body, the tenderer shall submit a set of actual calculations pertaining to OHE car 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 OHE car structure shall be furnished alongwith the tender. Also weights of principal assemblies mounted on the OHE car 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 OHE car 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.
- (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 inspection OHE car shall be submitted as per Annexure-7.

Chapter - IV

ELECTRICAL EQUIPMENTS

- 4.0 **Illumination:** Driving Cabs, officers/Staff cabins, Workshop & Storage space shall be provided with level of Illumination of at least 30 Lux at the working plane level (1m above the floor level).OHE Car 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 cabs, officers/staff cabins 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 battery charger & DG sets:**
- 4.3.1 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 OHE car is stationary and with engine running at low idling speed.
- 4.3.2 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 Alternator shall cater for battery charging for diesel engine starting battery, 24V.
- 4.3.3 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.

4.3.4 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 OHE Car. The Gen set shall be mounted on anti-vibration mounting to reduce the vibrations.

4.3.5 A skid mounted portable Diesel Generator similar to Honda make (petrol start kerosene run or petrol start petrol run) of 3kVA (minimum), 240V, 50 Hz along with 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.

4.4 **Circuitry**

4.4.1 The load shall be suitably distributed based on standard practice.

4.4.2 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.

4.5 **Power for head lights, tail lights**

4.5.1 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 OHE car.

4.5.2 **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.

4.5.3 **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.

4.5.4 **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 OHE car.

4.5.5 **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 OHE car.

4.5.6 **Search Light:** OHE car shall be provided with two 250 Watts searchlights 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.

4.5.7 **Wiring**-All Electrical wiring in the tower 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.

4.5.8 **Horns:** The OHE car 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.

4.5.9 **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. One cab of OHE Car shall have one recorder-cum-indicator and the other cab shall have one speed indicator only.

4.5.10 **Mobile Charging:** Four mobile charging points one each in Staff Cabin and both the Driver's Cab shall be provided as per RDSO approved source.

4.5.11 **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 in clause 5.9.1

4.5.12 **Flood lights:** Four flood lights giving diffused light of 75 watts shall be provided with each OHE car. Detailed design of it shall be finalized at the design approval stage.

4.5.13 **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.

4.5.14 **Earthing Arrangement of Tower OHE Car:**

All metallic parts of tower wagon including the working platform, shell structure & bogie shall be integrated electrically to ensure proper earthing of tower OHE car through wheels to Rail. The body of the lifting motor, control panels, swiveling motor at platform 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 tower OHE car& 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 - 2.0 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 along with 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 OHE Car 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 one 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 OHE car can still be worked 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 Tower Car, 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 55°C. 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 OHE car 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.
- 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 tower 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 OHE car 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°C 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 °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 OHE car 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.

5.5 **A Tests on Diesel Engine:**

- i) Type, Routine and acceptance Tests on the Diesel Engine shall be performed in accordance with International Union of Railway Code No. UIC-623 OR with latest Edition. Para nos 4.3.2, 4.3.3, 4.3.5 of UIC-623-2 OR should be followed for test on Diesel Engine.
- ii) The type tests shall comprise of 12 hours running of Engine load cycle 100%, 110%, 75% and 50%.
- iii) At the end of run, the parameters like high idle rpm, low idle rpm and lube oil pressure at high and low idle rpm shall be recorded.
- iv) The Oil consumption test and Exhaust smoke shall be measured in accordance with BS standards.
- v) All the performance parameters shall be recorded measured in accordance with UIC-623-2 OR with latest edition.

- vi) The type test/routine test schedule shall be submitted and got approved from RDSO. The tests shall be carried out in presence of RDSO's representative.

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 OHE Car). 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 locating type ball bearings.

5.7.3 The winding of the traction alternator for both stator and rotor shall be with Class H (180 deg.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 suitable to 8WDETC TA 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.

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 DETC. 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 Intelligent OHE recording car). The rectifiers shall be suitable for under slung forced cooled and well protected. **In case there is a space constraint in fitting under slung rectifier, the same shall be provided on board and this aspect shall be decided at design approval stage.** 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 axle 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 OHE car. 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.

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 **tapper 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, **tapper 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.
- 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 OHE car 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 DETC 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 inspection OHE Car 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 OHE car- 10 amps.
- ii. Lights and fans load of the OHE Car-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.
- 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 OHE 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 OHE car 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.

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 operation 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.
- 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 OHE car, 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 OHE car. The equipment and controls shall be arranged in both the driving cabs of the OHE car so that the OHE car can be worked from any one of the driving cabs. Interlocks shall be provided such that OHE car 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 interchangeability 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 tower wagon 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 OHE Car 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 OHE Car 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 OHE car 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 DETC. 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. Gradations 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 inspection OHE Car:

- 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 OHE Car 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 OHE Car. 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 the entire OHE car 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 OHE Car.

6.5 Weighment:

- 6.5.1 Each completed OHE car 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 OHE car after passing or adjustment shall be made to the OHE car 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.
- 6.5.2 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 OHE car 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 OHE 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 OHE car.
- 7.5 In the event of dispute between the Inspecting Officer and the Contractor, the decision of the purchaser shall be final and binding.
- 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 OHE carried out during manufacture and before dispatch of the OHE car to India it shall be subjected to the following tests before final acceptance.

7.8.1 **Performance capability tests.**

The OHE car 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.

7.8.2 **Riding quality tests.**

The riding quality tests shall be based on detailed oscillation trial conducted at a speed 10% higher than the maximum specified operating speed on a section of mainline track conforming to test stretch as mentioned in 3rd criteria committee report to establish the performance at the specified maximum operating speed.

7.8.3 Emergency Braking Distance (EBD) and haulage capability Test shall be conducted.

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

(i) **Track structure:**

The track shall be to a minimum standard of 90 R rail on sleepers with M+ 4 densities and minimum depth of ballast cushion below sleeper of 200 mm, which may consists of at least of 75 mm clean and the rest in caked up condition on compact and stable formation. However speed will depend on the axle load, Axle spacing, dynamic augment value the rolling stock etc.

(ii) **Permitted irregularities:**

The track is maintained as per Indian Permanent Way Manual and para 607 (i) gives details of track category for various parameters. Third report of criteria committee shall be considered for number of peaks per kilometer, if specified any.

~~7.10—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.99003	Draw gear arrangement	3.8.4
3.	RDSO/SK.No.98145	Side buffer arrangement	3.8.4
4.	RDSO/SK.No.99001	Screw coupling assembly.	3.8.4
5.	C/BF/113	Tail lamp bracket.	3.14 (iii)
6.	W/WL-1660	Wheel	3.21.2
7.	RDSO STR No.56-BD-07	For CBC	3.19
8.	ICF Drg No WL.RRM4-7-3-401 with latest alteration	Roof Ventilators	3.2.3
9.	ICF Drawing No ICF Drawing No. AC/EMU/M/ASR-0-0-001 with latest Alteration. with latest Alteration.	Bogie design	3.6.2
10.	RDSO Drawing No. SK-K4004	Wheels	3.7.2
11.	ICF Drawing No. EMU/M-3-2-064 (Latest)	Brake Rigging	3.8.2
12.	ICF EMU/4C/ASR-5-4-402 with latest alteration	Lift type window made of powder coated aluminum	3.3
13.	RCF Drawing No.EM.26108 (Latest)	Cattle Guard	3.15
14.	ICF Drawing No. EMU/M.ASR-41-001 with latest alteration.	Flooring construction of the vehicle	3.13
15.	RDSO sketch No 91146 with latest alteration	The wheel profile.	3.7.4
16.	RDSO's approved source	Tapper Roller Suspension Bearing	5.8.16

ANNEXURE - 2

List of Drawings/calculations to be submitted to RDSO for approval before undertaking manufacture of prototype inspection OHE car

Sl.N.	Drawing/Documents to be submitted to RDSO for approval
1	Layout of OHE car
2	Suspension arrangement.
3	Helical coil spring
4	Load vs 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	Braking effort and Emergency Braking Distance calculation on plane section with maximum load and without load.
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 OHE car
22	Power pack arrangement
23	Under frame arrangement
24	Trammeling diagram
25	OHE Car lifting arrangement
26	Details of weight transfer calculation.
27	Loading Diagram
28	Roof Equipment layout
29	Estimated weight of the OHE Car structure and weight of principal assembly mounted on the OHE Car
30	FEM calculation of body shell and bogie.
31	Un sprung mass OHE car
32	Calculation of centre gravity from rail level and Balancing calculation under tare and loaded condition.
33	Power pack arrangement
34	Axle (powered)/ Motorised 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 OHE car
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 OHE Car
45	The block diagram showing power circuit.
46	Calculation for safety against derailment. Calculation for stability of the OHE car against wind force.
47	Details of weight transfer calculation.
48	Electrical wiring diagram for electrical gadgets.

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 5°C 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 °C 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.Sump 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 regreasing
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

- 6. Current density
 - Arm. end
 - 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 a t 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 rmps
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 N kg 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

Continuos

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

1.10 Magnetic Circuit

1. 1 hr rating values

	$\frac{\text{Magnetic}}{\text{Area} \times \text{length}}$	$\frac{FF_{\text{Leakage}}}{B \text{ AT}}$
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. Kilometerage 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 IOHE CAR 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 give 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 Width</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. OHE care 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.

- 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.

ANNEXURE - 6**DESIGN OF TRACTION MOTORS AND SWITCH GEARS**

- 1.0 Number and arrangement of motors
- 1.1 Each OHE car 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 INSPECTION OF THE CAR

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

- | | | |
|----|--|---------------------------------|
| 1 | Length of the OHE car over head stock. | ...mm |
| 2 | Total wheel rigid base | ...mm |
| 3 | Height of OHE car 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 OHE car 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 OHE car. | ...mm |
| 10 | Minimum height above rail level of any component with the OHE car 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 OHE car. | |
| | - in fully loaded condition | ...t |
| | - in empty condition | ...t |
| 15 | Maximum speed of the OHE car. | |
| | - 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/h |
| | (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 8-wheeler Diesel electric Inspection & Maintenance Car.

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 tacho Meter(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 40 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 8-wheeler Diesel Electric Inspection & Maintenance Car.

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