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GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

DRAFT

SPECIFICATIONS AND STANDARDS FOR

ELECTRICAL MULTIPLE UNITS AND MAIN LINE ELECTRICAL MULTIPLE UNITS WITH IGBT BASED THREE PHASE ELECTRICS TO BE PROCURRED FROM RAIL COACH FACTORY AT KANCHARAPARA

Specification No. RDSO/PE/SPEC/EMU/0000-2010 (Rev. '0')

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Abbreviations

The following abbreviations are used in this Specifications and Standards:

Abbreviation	Full Name
AAR	Association of American Railroads
AC	Alternating Current
ASIC	Application Specific Integrated Circuit
ASHRAE	American Society of Heating, Refrigeration and Air-conditioning Engineers
ATP	Automatic Train Protection
BS	British Standards
DB	Dry Bulb
DC	Direct Current
EMC	Electro-magnetic Compatibility
EMI	Electro-magnetic Interference
EN	Euro Norm (European Standard)
EMU	Electrical Multiple Unit
EP	Electro Pneumatic
FEM	Finite Element Method
GPS	Global Positioning System
GSM	Global System for Mobile
GSM-R	Global System for Mobile – Railways
HT	High Tension voltage as defined in Indian Electricity Rules
IC	Integrated Circuit
IEC	International Electro technical Commission
IEEE	Institution of Electrical and Electronic Engineers
IGBT	Insulated Gate Bipolar Transistor
IPR	Intellectual Property Right
IR	Indian Railways
IS	Indian Standard
ISO	International Standards Organization

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Kmph	Kilometers per hour
LED	Light Emitting Diode
MCB	Miniature Circuit Breaker
MEMU	Main line Electrical Multiple Unit
OHE	Over Head Equipment
PCB	Printed Circuit Board
PIS	Public Information System
PA	Public Address
RAMS	Reliability, Availability, Maintainability and Safety
RDSO	Research Designs & Standards Organisation
RFP	Request For Proposal
SI	Systeme Internationale
SIL	Safety Integrity level
UHF	Ultra High Frequency
UIC	Union Internationale des Chemins de Fer (International Union of Railways)
VHF	Very High Frequency
VCU	Vehicle Control Unit
VCD	Vigilance Control Device
WB	Wet Bulb
WC	Water Closet (i.e. a flush toilet)

Definitions

In this Specifications and Standards, the following words and expressions shall, unless repugnant to the context or meaning thereof, have the meaning hereinafter respectively assigned to them:

Term	Definition
Agreement	shall mean the Procurement cum Maintenance Agreement for EMUs and MEMUs, published by the Government of India;
BOXN	shall mean the air braked open wagon used by IR;
Coach	shall mean a passenger carrying rail vehicle, either powered or non-powered;
Depot	shall mean the place where the EMU/MEMU can be repaired/maintained
ICF	shall mean the Integral Coach Factory Chennai
IP	shall mean degree of protection provided by enclosures according to IEC 60529;
L-10	shall mean life of bearing in accordance with ISO 281;
Ti	shall mean the temperature index of the insulation system;
Others	any capitalized term used herein not specifically defined shall have the meaning ascribed to such term in the Off-take Agreement.

Chapter 1

General Technical Requirement

1.1 Introduction

1.1.1 This specification outlines the requirement for EMU and MEMU cars to be procured from Rail Coach factor being set up at Kancharapara West Bengal.

1.1.2 This Specification and Standards referred to herein covers salient features for the supply of complete BG EMU and MEMU trains to ply on 25000 volts 50 Hz AC traction on Indian Railway network. The EMU and MEMU train shall be air ventilated or air-conditioned, vestibuled and propelled with 3-phase asynchronous induction motors fed from IGBT based, micro-processor controlled converter-inverter designed for high energy efficiency, auxiliary converter and associated filters etc. For providing maximum on board space for passengers traction equipments shall be under slung.

1.1.3 In developing the detailed design, the Company shall acquaint itself and take note of passenger loading density especially during peak time, the route , environmental and operating conditions especially the monsoon and dusty atmosphere .

1.1.4 The EMU stock shall be employed for short distance sub-urban services (up to 150 Kms) having frequent stops and starts and the MEMU stock shall be used for medium distance (300 to 500 Kms) passenger transportation on the existing track, signaling and overhead electrical supply systems. These shall be designed to meet the performance requirements enumerated in chapter 3.

1.1.5 Each EMU/MEMU train shall have 1 (one) driving coach at each end. One basic unit of EMU/MEMU shall comprise 1 (one) motor coach and 1(one) trailer coach. Presently, on Indian Railways the EMU trains are running in 9/12/15 coach formation whereas MEMU trains are running in 12/16/20 coach formation. The lengths of 9- coach formation EMU train and 12-coach formation MEMU train presently running on Indian Railways are 195 meter (approx.) and 267 meter (approx.) respectively. This shall be considered as the basic train length of one EMU and MEMU train however, it shall be possible to add one or more basic unit(s) to increase the length of EMU and MEMU train suitably.

1.2 References to various standards

1.2.1 The standards applicable and relevant to the complete EMU and MEMU and to the various sub-systems and systems shall be,

a) IEC publications;

b) EN;

c) UIC;

d) AAR;

e) IEEE;

f) BS;

g) IS; and

h) other standards referred to in Specification and Standards.

In the event of any contradiction in the aforesaid standards, the following standards shall have priority in the order listed:

(i) Standards mentioned in these Specification and Standards set forth herein;

(ii) IEC/EN publications ;

(iv) UIC/AAR; and

(v) IS

For avoidance of any doubt, in case of any conflict between the requirements of these standards, the stipulations of this Specifications and Standards shall have precedence.

1.2.2 The EMU, MEMU and their sub-systems and systems thereof shall comply with the standards as mentioned in Annexure – A4.

1.2.3 Latest version of the standards as issued up to 60 (sixty) days before the date of issue of RFP shall be considered for technical evaluation.

1.2.4 Alternative Standards:

The requirements listed in these Specifications and Standards are the minimum. The Company may adopt alternative internationally recognised codes, standards and specifications if it can demonstrate to the Government that such alternative is superior or more pertinent to the EMU and MEMU than the standards specified in these Specifications and Standards. The Company shall seek the prior approval of the Government for any alternate standards proposed to be used.

1.3 General Requirements

From the point of view of system performance, the general requirements of the EMU and MEMU shall be Safe, environment friendly, adapted to climatic condition prevailing in India; inclusive of protective measures against storms and other local climatic conditions, reliable, efficient, comfortable, aesthetic and accessible to public including physically challenged.

Notwithstanding the generality of the foregoing, where specific standards or specifications are prescribed in relation to any of the foregoing, the Company shall comply, at the minimum with such standards and/or specifications.

1.4 Engineering Philosophy and Requirements

1.4.1 The Company shall develop the engineering based on these Standards and Specifications and in accordance with Good Industry Practice.

1.4.2 Adequate margin shall be built into the engineering to protect against high ambient temperatures, seasonal humidity, corrosive conditions, and the effects of lightning strikes, etc. prevailing in India.

1.5 Quality Assurance

1.5.1 The Company shall develop and maintain a quality assurance system for design, manufacturing procedures and the interfaces between them. The quality plan shall also cover fully all quality assurance and quality management aspects of the design, manufacturing and maintenance of the EMU and MEMU.

1.5.2 The quality assurance programme and plan shall be implemented during the entire Agreement Period, and shall conform to EN ISO 9001:2000- Model for quality assurance in design/development and servicing or any higher standards.

1.6 Reliability, Availability, Maintainability and Safety (RAMS)

1.6.1 General

The Company shall design the EMU and MEMU to meet the specified Reliability, Availability standards and high degree of safety in order to provide a dependable service. The optimization of the system with respect to Reliability, Availability, maintainability and safety shall form an integral element of these Specifications and Standards.

The plan for Reliability, Availability, maintainability and safety shall conform to EN 50126/ IEC 62278. Reliability of electronic components shall conform to IEC 61709.

1.6.2 The Company shall develop RAMS targets both for the complete system and for the major sub-systems such as transformer, traction converter, auxiliary converter, electronics, traction motor, transmission system, bogie, suspension system, high voltage equipments, blowers and other auxiliary machines, such that it will provide a high level of dependability.

1.6.3 Components critical for safety shall fall into safe operating mode in case of malfunctioning. The system safety plan shall identify and list safety critical components and this list shall be updated periodically.

1.6.4 The Company shall establish and operate a detailed reliability, availability, maintainability and safety (RAMS) assessment system in support of the design, manufacture and subsequent testing, commissioning, operation and maintenance of the EMUs and MEMUs.

1.7 Definitions and Interpretation

1.7.1 The rules of interpretation as specified in Clause ---------- of the Agreement shall apply *mutates mutandis* to these Specifications and Standards.

1.7.2 The definitions contained in the Agreement shall apply to the provisions of these Specifications and Standards unless the context otherwise requires. Terms or words not defined in these Specifications and Standards or the Agreement shall be governed by the definitions contained in the standards applicable.

1.7.3 References to "**sub-system**" include equipment(s), unless the context otherwise requires.

Chapter 2

Operating & Service Conditions and Design Constraints

2.1 Leading parameters of EMU and MEMU

Each EMU/MEMU train shall have 1 (one) driving coach at each end. One basic unit of EMU/MEMU shall comprise 1 (one) motor coach and 1(one) trailer coach. The lengths of 9-coach formation EMU train and 12-coach formation MEMU train presently running on Indian Railways are 195 meter (approx.) and 267 meter (approx.) respectively. *This shall be considered as the basic train length of one EMU and MEMU train however, it shall be possible to add one or more basic unit(s) to increase the length of EMU and MEMU train up to 400 meter.*

Parameter	**EMU**	**MEMU**
Track gauge	1676 mm	1676 mm
Maximum width over body side	3658 mm	3245 mm
Maximum permissible axle load of motor coach	19.5 tonnes +/- 2%	16.25 tonnes +/- 2%
Maximum permissible axle load of trailer coach	19.5 tonnes +/- 2%	16.25 tonnes +/- 2%
Maximum centre buffer coupler height from rail level	1064 mm	1064 mm
Maximum service speed	130 Kmph	160 Kmph up gradable to 200 Kmph
Test speed	10 % more than maximum service speed	
Minimum clearance of all items except wheel from rail level in with payload as per clause 2.2.1 of these Specifications and Standardsand with fully worn wheels	102 mm	102 mm
Minimum clearance for the body mounted under slung equipment under tare condition with fully worn wheels	215 mm	215 mm
Height above rail level for high passenger platform	840 mm (maximum) 760 mm (minimum)	
Maximum height above rail level for low passenger platform	455 mm	

2.2 Payload and Weight Particulars :

2.2.1 The number of passengers to be carried in one basic train length as specified in clause no. 1.1.5 of these Standards and Specifications shall not be less than 3900 passengers for EMU train and 3300 passengers for MEMU train. Out of the above total number of passengers, seated passengers shall not be less than 630 passengers for EMU train and 790 passengers for MEMU train. For design calculation of payload the average weight of one passenger shall be considered as 65 (sixty five) Kgs.

2.2.2 **Weight Distribution**

(i) The equipment shall be so designed that the total overall axle load of the driving coach or motor coach or trailer coach, fitted with the three phase electrics and other accessories does not exceed maximum permissible axle load capacity as given in clause 2.1 of these Specifications and Standards after taking into consideration the payload as per clause 2.2.1.

(ii) Axle load limitation shall be taken into account while finalising and designing the equipment layout giving due consideration to weight unbalancing during tare and payload as per clause 2.2.1 of these Specifications and Standards.

(iii) The power equipment viz. converter-inverter, traction motor and transformer etc. shall be distributed amongst motor and trailer coaches for optimized weight distribution and axle load within the unit.

2.3 Gauge and Moving Dimensions

The EMU and MEMU coaches shall conform to the Indian Railways Schedule of Dimension – 1676 mm gauge revised 2004 with latest amendments. For EMUs chapter IV-B shall be applicable.

2.4 Power Supply System

The overhead traction supply system is provided with polygonal type overhead equipment comprising of 107 mm^2 hard drawn grooved copper contact wire and 65 mm^2 catenary wire. The tension in both these conductors is 1000 Kgf, each which is maintained with the help of auto tensioning devices. The overhead equipments are fed from 25kV, 50Hz single-phase AC supply. The guaranteed performance of the rolling stock shall be based on supply voltage of 22.5 kV, 50Hz single-phase AC. The salient features of power supply system are as under:

Nominal supply voltage	22.5 kV, 50 Hz, single phase, AC
Normal variation in supply voltage	19 kV to 27.5 kV
Occasional maximum voltage	31 kV
Occasional minimum voltage	16.5 kV
Variation in supply frequency	± 8% (46 to 54 Hz)
Stagger of the contact wire	± 200mm on straight track

	Up to ±300mm on curves
Normal contact wire height in mid span	5.5 m from rail level
Max. contact wire height	5.8 m from rail level
Min. contact wire height	4.58 m from rail level
Neutral Sections	After every 25 to 50 Kms

2.5 Track parameters

The track parameters shall be the following:

Gauge	Broad Gauge 1676mm
Schedule of dimensions	Indian Railways Schedule of Dimensions for Broad Gauge (1676mm). Revised, 2004
Sharpest curve to be negotiated	Horizontal- 152.4 m radius; Vertical – 4000 m for group A routes - 3000 m for group B routes - 2500 m for group C,D and E routes
Sharpest reverse curve to be negotiated	152.4 m radius (horizontal) back to back with or without any straight portion in between
Sharpest turnout to be negotiated	6400 mm overriding switch (curved) BG (1673 mm) for 60 kg (UIC) or 52 kg rail for 1 in 8½ (crossing angle, tanθ) turnouts on pre stressed concrete sleepers
Permissible speed at turn outs 1. 1 in 8½ curved switch 52/60 Kg on PSC sleepers 2. 1 in 8½ symmetrical split with curved switches 52/60 Kg on PSC sleepers 3. 1 in 12 curved switch 52/60 Kg on PSC sleepers	 15 Kmph 30 Kmph 30 Kmph
Maximum Super elevation	165 mm for group A, B and C routes 140 mm for group C,D and E routes (in special case 185 mm for group A

	routes)	
Maximum cant deficiency	100 mm for group A and B routes 75 mm for group C.D and E routes	
Permissible track tolerances:	**BG Main Line**	**BG High Speed Route (C&M1 volume 1)**
➢ Unevenness (3.6 m base)	< 15 mm	< 10 mm
➢ Twist (3.6 m base)	< 2.78 mm/meter	<2.08 mm/meter
➢ Gauge variation	< ± 6 mm	< ± 3 mm
➢ Alignement (versine on 7.2 m chord)	< 5 mm	< 5 mm
Gauge widening:		
➢ On curves of > 350m radius	-5mm to +3mm	
➢ On curves of < 350m radius	Up to +10mm	

Note:

Group 'A' - Speeds up to 160 Kmph

Group 'B' - Speeds up to 130 Kmph

Group 'C - Suburban Sections Of Bombay, Delhi and Calcutta

Group 'D' - Sections where the sanctioned speed is 100 Kmph at present

Group 'E' - Sectional and branch line with the present sanctioned speed less than 100 Kmph

2.6 Climatic and Environmental Conditions:

➢ Atmospheric temperature	Maximum temperature of metallic surface under the Sun: 75 degree celsius and in shade: 55 degree celsius Minimum temperature: - 10 degree celsius (Also snow fall in certain areas during winter season)
➢ Humidity	100% saturation during rainy season
➢ Reference site conditions	i) Ambient temperature: 50 degree celsius ii) Humidity: 100% iii) Altitude: 1776 m above mean sea level (For avoidance of doubt it is clarified that the ambient temperature of 50 degree celcius may not happen at the altitude of 1776 m.)

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➢ Rain fall	Very heavy in certain areas (between 1750 to 6250 mm)
➢ Atmospheric conditions	Extremely dusty and desert terrain in certain areas. The dust concentration in air may reach a high value of 1.6 mg/m3. In most of iron ore and coal mine areas, the dust concentration is very high affecting the filter and air ventilation system
➢ Coastal area	humid and salt laden atmosphere with maximum pH value of 8.5, sulphate of 7 mg per liter, maximum concentration of chlorine 6 mg per liters and maximum conductivity of 130 micro siemens / cm
➢ Vibration	(i) The vibration levels at some intermittent points on the track may be higher than those specified by the relevant IEC publication. The suspension system and the mounting arrangements shall be so designed that the equipment's performance is not adversely affected due to such high vibrations and shocks and shall withstand satisfactorily in service as indicated below. (ii) The equipment and their mounting arrangements shall withstand satisfactorily the following (a) Max. Vertical acceleration - 3.0 g (b) Max. Longitudinal acceleration - 5.0 g (c) Max. Transverse acceleration - 2.0 g ('g' being acceleration due to gravity) (iii) Relationship between amplitude of vibrations 'a' (sine wave form) and their frequency between 1Hz and 50Hz, expressed in millimeters is given as a function of 'f' by the equation: - a = 25/f for values of 'f' from 1 Hz to 10 Hz. a = $250/f^2$ for values of 'f' exceeding 10 Hz and up to 50 Hz.
➢ Wind speed	Wind pressures as per IS 875

The EMU/MEMU equipment shall be designed to start up at the maximum temperature, which may be reached inside an EMU/MEMU standing in sun, without any requirement of pre-cooling of electronic equipment.

2.7 Signal and Telecommunication Installations:

2.7.1 Single/double distant colour light signalling system with relay / electronic interlocking is currently employed on Indian Railway.

2.7.2 The tracks over which the EMU and MEMU shall work may be equipped with DC track circuits, 83-1/3 Hz track circuits, audio frequency track circuits up to frequency of20.7 KHz. and other devices like digital axle counters(up to a frequency of 43 KHz), block instruments, point machines, auxiliary warning system, train protection and warning

system, etc.. On the communication network, control circuits, teleprinter circuits, as well as VHF/UHF and micro-wave circuits are employed.

2.7.3 The harmonic currents injected in the overhead electrical supply system (as also the track return current) can introduce voltage harmonics on power supply and can interfere with signal and telecom circuits. The design of the power electronics and control electronics provided on the propulsion system shall be such as not to cause levels of interference exceeding the levels specified below at any point in the operating envelope of one EMU or MEMU train. The value of interference current of individual motor coach shall not differ from each other & shall be in the same range.

	Interference Current	**Limit**
1.0	Psophometric current	10.0 A
2.0	DC component	4.7 A
3.0	Second Harmonic component (100 Hz)	3.0 A
4.0	1400 Hz to 5000 Hz	400 mA
5.0	More than 5000 Hz up to 50000 Hz	270 mA

Note: 1. The measurement of the interference current shall be done in track return current circuit of the EMU/MEMU.

2. The second harmonic current of each motor coach shall not exceed 0.5 Amps and shall preferably be governed by international standard (IEEE 519-1992).

Chapter 3

Performance Requirements

3.1 Acceleration and deacceleration

The equipment shall be designed for following operational parameters at payload as per clause 2.2.1 of these Specifications and Standards. at 22.5 kV OHE voltage and with half worn wheels.

Parameter	EMUs and MEMUs
Starting acceleration at full load (up to 50 Kmph)	0.8 m/s^2
Acceleration (residual) at maximum permissible speed	0.08 m/s^2
Deceleration (from maximum speed to 50 Kmph)	0.8 m/s^2
Deceleration (from 50 Kmph to 0 Kmph)	1.0 m/s^2
Emergency braking distance with payload as per clause 2.2.1 of these Specifications and Standards at 130 Kmph	less than 700 m
Emergency braking distance with payload as per clause 2.2.1 of these Specifications and Standards at 160 Kmph	less than 1200 m

3.2 Auxiliary power

Full auxiliary power shall be available in the specified normal range of variation of voltage of power supply in accordance with clause 2.4 of these Specifications and Standards. Reduction of power beyond the normal variation of voltage shall be permissible, but the EMU and MEMU shall be able to work and auxiliary output shall be available under such different voltage conditions..

3.3 Efficiency

The efficiency of traction system, consisting of transformer, power converter (line side converter and drive side inverter) and traction motor, of EMU/MEMU shall not be less than 87 % at full load. The efficiency of traction system shall be product of efficiency of transformer, power converter and traction motor, measured at full load. Similarly the efficiency of auxiliary converter shall not be less than 96% at full load. Efficiency at full load means, efficiency computed from parameters measured at conditions corresponding to full load and governed by IEC 60310 for transformer, IEC 61287-1 for power converter and auxiliary converter; and IEC 60349-2 for traction motor.

3.4 Train Resistance

Train resistance of the existing EMU and MEMU motor and trailer coaches is as under:

EMU and MEMU motor coach:

$R = 2.35 + (0.02922-0.00049xW)xV+(0.03722/W)xVxV$ Kg/t

EMU and MEMU trailer Coach:
R = 1.347 + 0.00385xV + 0.000165xVxV Kg/t
where W is the gross wt in tonnes,
R is the resistance in Kg/tonnes, and
V is the speed in Km/hour.

Starting train resistance: The starting train resistance for EMU and MEMU motor and trailer coaches is 4 kg/t.

3.5 Specific Energy consumption

The specific energy consumption calculated as KWH per 1000 Gross Tonnes Kms (KWH/1000 GTKm) shall not be more than 30 KWH/1000 GTKm for schedule speed (i.e. distance/(run time + stop time)) of 45 Kmph (approximately) in Bardhman Jn.- Chandanpur section (Chord line) with scheduled stops. The stop time shall be considered as 30 seconds. Full auxiliary load shall be taken into account except air- ventilation/ air-conditioning and emergency load. Duty cycle for the compressor and lights shall be taken as 50% and for the balance load 100% duty cycle shall be considered.

3.6 Continuous Operating Equipment

The capacity of the traction motors and other equipments shall be adequate to permit continuous and punctual operation in Bardhman Jn.- Chandanpur section (Chord line) stopping at all scheduled stations, with payload as per clause 2.2.1 of these Specifications and Standards under the operating and service conditions specified in chapter 2 of these Specifications and Standards.

3.7 Redundancy requirements

3.7.1 In the event of failure of one motor coach, the EMU/MEMU train shall be able to complete journey up to destination.

3.7.2 The capacity of traction motors shall be so designed that in the event of failure of one bogie, an EMU/MEMU train shall be able to complete its journey to destination without incurring a delay of more than five minutes. In case of failure of one converter, only one bogie shall be isolated.

3.8 Jerk limit

Under all normal operating conditions, the rate of change of coach acceleration or deceleration shall be less than 0.7 m/s^3. Failure of the jerk limiting system shall not limit braking effort. Emergency brake applications and any associated ramp down of tractive effort shall not be jerk limited. Reduction of tractive effort due to a power interruption need not be jerk limited.

3.9 Electro-magnetic compatibility requirements

3.9.1 All components on the EMU and MEMU coaches shall be designed and constructed to fulfill the requirements of EN 50121-3-2.

3.9.2 The complete EMU and MEMU trains shall meet the requirements of standard EN 50121-3-1.

Chapter 4

Technical Requirements

4.1 General

EMU and MEMU trains shall have air- conditioned or air-ventilated or mix of air-conditioned and air-ventilated coaches depending upon the type of services. As such the design of the coach shall be suitable for provision of air-conditioning unit, doubled sealed glass windows, power supply system and other accessories besides the provision of air ventilation system.

The air – conditioning equipments along with its associated equipments/fittings shall be optional requirement.

4.1.1 The EMU shall consist of following type of fully air-conditioned / air-ventilated coaches:

(i) Streamlined end driving coaches;
(ii) motor coaches; and
(iii) trailer coaches;

4.1.2 The MEMU shall consist of following type of fully air-conditioned / air-ventilated coaches:

(i) Streamlined end driving coaches with separate vendor/luggage compartment of 5 tonnes capacity and remaining portion shall be passenger area;
(ii) motor coaches; and
(iii) trailer coaches;

4.1.3 There are certain sections of the track that get flooded with water to standing depth of 760mm. The traction equipments and other under slung equipments shall be completely water proof to this height above rail level.

4.1.4 The traction equipments shall be designed and manufactured to run at 8 Km/h through water up to 203 mm above rail level, allowance to be made in addition for increase in the height of water level due to wave effect.

4.1.5 The equipment compartment having relays, contactors, electronic control panels, etc., shall be suitably protected from dust and water.

4.1.6 The equipment below the under frame sole bar shall be designed to with stand or be protected from repeated impacts from ballast up to 75 mm at speed of up to 160Kmph.

4.1.7 The EMU and MEMU train shall have distributed power so as to achieve the designed passenger carrying capacity and the acceleration/deceleration parameter as prescribed in clause 3.1. However, minimum number of pantograph shall be used in service in view of the type of catenary system employed on Indian Railway.

4.1.8 The three phase propulsion equipment shall be based on the latest IGBT based state-of-art technology and shall be suitable for regeneration.

4.1.9 Necessary precautions in accordance with Good Industry Practice shall be taken to ensure that any electromagnetic interference generated in the machine room does not adversely affect the performance of equipments.

4.1.10 Modular constructions shall be adopted and easy access for inspection and maintenance shall be given special consideration in the design and layout of the EMU and MEMU.

4.1.11 The power drawn by the pantograph(s) of the EMU/MEMU from OHE shall be at power factor better than 0.98, subject to the interference levels as specified in clause 2.7 of these Specifications and Standards.

4.1.12 Pantograph(s) bouncing shall not adversely affect the performance of traction equipments.

4.1.13 The voltage rating of IGBT shall be so chosen that at least 25% margin is available after taking into consideration the DC link voltage and voltage jump on account of inductance and capacitances in the circuit. The current rating of IGBT shall be such that the junction temperature has the minimum thermal margin of 10ºC in the worst loading conditions and under the ambient conditions as specified.

4.1.14 The design calculations of worst case temperature rise of equipment shall be made after taking into account 25% choking of filters and heat sink/radiator fins. A safety margin of at least 10ºC shall be kept with respect to maximum permissible junction temperature of power devices declared by the manufacturer.

4.1.15 All propulsion equipments i.e. traction motor, control, braking and driving equipments for EMU and MEMU shall be identical in all respects.

4.1.16 Energy metering (energy consumption and energy regeneration) function shall be integrated in the control software.

4.1.17 Use of materials likely to cause environmental damage during the manufacture, maintenance, operation and disposal of EMU and MEMU coaches shall be avoided. The material listed in this clause are a minimum list of restricted material and the Company shall provide adequate evidence to the Government that all materials used will not cause environmental damage.

The following material shall not be used:

a) Asbestos;

b) Chlorofluorocarbons;

c) Polychlorinated Biphenyls (PCBs);

d) Exposed Lead and paints containing lead;

e) Chromates;

f) Cadmium; and

g) Cyanide.

4.2 Coach Design

4.2.1 Coach Body

4.2.1.1 Coaches shall have adequate margin of safety against

(i) Derailment; and

(ii) overturning.

4.2.1.2 Crashworthiness

i) The coach structure and its supplemental energy absorption devices shall be designed to minimize accelerations transmitted to passengers, by absorbing collision

energy, whilst not permitting one vehicle to over-ride another, nor to telescope one into another.

ii) At high energy levels it shall ensure that collision energy is absorbed by progressive deformation of the vehicle end structure, thereby protecting the passengers and passenger area in the coach. There shall be least deformation between the body bolsters.

iii) Of particular concern is the cab front structure, which is required to protect the driver and vital control and communications equipment in the event of impact with an obstruction after a collision.

4.2.1.3 The coach body shall be lightweight and corrosion resistant. The body panelling shall have resistance to the tractive and braking effort as well as impact and accidental damage. The coach body shall conform to 'EN 12663:2000 – Railway applications – Structural requirements of railway vehicle bodies' or any other standard as applicable to coaches of an urban rail transport system Category P-III with increased end sill compression load of 2000 kN.

4.2.1.4 The coach body shall be metallic (Austenitic Stainless steel or Aluminum alloy). Where dissimilar materials are used, measures shall be provided to mitigate corrosion in the body due to electrolytic action.The coach body shall be of an integral design, where body and under frame (chassis) shall be integrated so that the body structure contributes to strength of under frame and the unit as a whole behaves as a rigid tube in its ability to withstand loads. The body ends of the coach shall incorporate an anti-telescopic feature.

4.2.1.5The coach shall have a suitable gangway connecting to the adjoining coaches excluding the driving cab. The gangways shall be completely weather and draught proof. The floor plate in the inter-coach gangway shall be maintained as nearly as possible at the same height as the rest of the coach floor. The height difference shall be kept to a minimum, and shall not exceed 20 mm during stationary condition or while on run. Height changes shall be suitably ramped so as not to cause inconvenience to passengers. The gangway floor shall be designed to meet the same strength requirements as the rest of the coach floor.

4.2.1.6 The coach body shall lend itself to repeated lifting in workshops by overhead cranes or jacks without risk of damage. Suitable lifting pads shall be provided and marked in a readily distinguishable manner on the coach body.

4.2.1.7 The design of the coach exterior shall generally be aesthetically pleasing, and shall minimize the buildup of dirt. Any surface preparation and wall thickness of roof, sides and end panels shall be without bulges or depressions and shall also not deform during service according to conditions specified herein.

4.2.1.8The front portion of the driving coach shall be provided with rugged cattle guard that can withstand collisions with animals weighing up to 600 kg and shall be strong enough and profiled to prevent the entry of animals under the coach after impact.

4. 2.1.9 Projectile Structure Resistance Design

The body and the attached component shall protect passengers and crew against the risk of injury from projectile as mentioned below and shall be validated by test.

a) Side and roof areas

All side and roof areas, with the exception of the windows shall withstand without any penetration into the coach interior an impact created by a sharp cornered hollow steel cube of 75 mm side and one kg mass, travelling corner first at a velocity of 80 Kmph.

b) Roof areas

The roof including any window which may form part of the roof shall withstand an impact from falling objects such as a sharp cornered concrete cube of mass 11 Kg, dropped from a height of 10 meter, corner first. No part of the falling object shall penetrate any part of the roof. Damage shall be limited to local roof deformation. Internal ceiling height shall be maintained after local roof deformation has occurred. A location shall be provided on the roof of the coach where emergency services may cut through to gain access to the interior of a coach that has rolled on to its side. This space shall be clearly labeled to enable emergency services to immediately identify the appropriate space and cut lines. The location shall be adequate to enable a stretcher born patient to be removed from the EMU/MEMU. The region to be cut shall be devoid of any cables/ pipes or miscellaneous equipments that may impede access.

c) Forward areas

All forward facing areas of leading and trailing driving coaches including the ends with the exception of the driver's wind screen shall withstand without any penetration, an end impact created by a sharp cornered hollow steel cube of 75mm side and one Kg mass travelling corner first at a velocity of 160 Kmph. The region of impact application shall be taken to be anywhere on the coach body forward facing area.

4.2.2 Coach Interior

4.2.2.1 Nominal clear height inside the coach shall be 2100 mm.

4.2.2.2 The coach shall be provided with aesthetically designed comfortable seats of fire resistant, vandal and scratch proof material. The seats shall be designed to prevent slipping when the EMU/MEMU accelerates and decelerates. The material selected for seats shall not become readily soiled, shall be easily cleaned, shall be impervious to and chemically unaffected by water, paint, human waste, graffiti removers, wash plant solutions, cleaning solutions, food and drink spills.

4.2.2.3 Each end coach of the EMU trains shall have space for one wheel chair and wheel chair restraint with a grab rail next to it. This space shall be near the door. On the outside of the coach, the location of the space for wheel chair shall be indicated.

4.2.2.4 Flooring shall be using material that meets or exceeds the skid resistance requirements of SATRA test TM 144 or equivalent with a coefficient of friction of at least 0.4, and shall be skid resistant when wet. The floor covering shall have as few seams as possible; all seams shall be fully sealed and welded and shall not create a tripping hazard. All floor covering material and joints shall be impervious to and chemically unaffected by water, paint, human waste, graffiti removers, wash plant solutions, cleaning solutions, food and

drink spills. Floor design shall allow the floor covering to be removed and replaced without damage to the floor sub structure.

4.2.2.5 Interior shall have colour design to have maximum visibility. Contrasting colour shall be used for improved visibility for visually impaired persons.

4.2.2.6 Grab pillars / rails and grab handle shall have bright colour.

4.2.2.7 Partitions and vestibule walls shall be aesthetic and have sufficiently good wear and tear properties.

4.2.2.8 The wall panels shall be designed as individual, self-supporting, easily replaceable modular units.

4.2.2.9 All permanent notices, warnings etc., of vandalism proof design, shall be displayed at least at 4 (four) locations inside the coach.

4.2.2.10 The coach interior shall have resistance to fire and conform to **NFPA-130, 2003 edition -- 'Standard for Fixed Guide way - Transit and Passenger Rail Systems'.** Each coach shall be provided with two dry powder type or other appropriate fire extinguishers located near the gangways. These shall be in a niche so as not to cause injury or obstruction to people.

4.2.2.11 Materials selected especially for internal fixtures, fittings, furniture and decorations shall be the ones, which will minimise the risk of fire and the spread and effects of fire.

4.2.2.12 Materials known to have hazardous properties shall not be used. Where it is unavoidable to use such materials, passengers shall be shielded from the effects of such materials.

4.2.2.13 Material used for interior of a coach shall be resistant to scratching, graffiti and detergents.

4.2.2.14 Environmental conditions for the equipment on board the coach shall conform to EN 50125 -1.

4.2.2.15 Luggage Racks

The Company shall provide lightweight luggage racks in each coach at a suitable height above the passenger seats. Due care shall be taken in its design so as to avoid any injury to passenger. These racks shall run longitudinally along the sidewalls and securely fixed. The material used for these racks shall be anodised Aluminium, of lightweight but of sturdy design. It shall meet the requirements given in UIC 566.

4.2.3 Body Side Doors and Windows

4.2.3.1 Body side doors shall meet the following requirements:

(i) The EMU and MEMU coaches shall have minimum 08 (eight) electrically powered, sliding bi parting doors, 04 (four) on each side;

(ii) the free passing through height of open door shall be 1900 mm minimum and the minimum door width shall be 1400 mm for EMU and 800 mm for MEMU;

(iii) the doors shall be suitable for air conditioning and provided with suitable sealing arrangement;

(iv) the door hand holds for MEMU train shall not project outside the coach profile to facilitate mechanized coach washing;

(v) the doors shall be vibration free and insulated against heat and sound transmission. The doors shall be sealed against draughts and water. Any ingressed water shall drain rapidly without affecting surrounding equipment or systems. The doors shall be as light and rigid as possible;

(vi) the doors shall have correct side door enabling provision which detects if the EMU/MEMU is correctly located in the platform halting position and thereafter allows door actuation on the platform side of the EMU/MEMU;

(vii) the passenger body side door shall fully open in not greater than 4.5 (four point five) seconds and shall close within 6 (six) seconds from the instance the driver operates the door. The door mechanism shall have safety provision whereby the EMU/MEMU cannot start unless all doors have been closed and electrically locked;

(viii) the door pitch shall be approximately equally spaced over the length of the EMU/MEMU train;

(ix) the doors shall be designed so as to retain the passengers during all service conditions and shall minimise risk in the event of an accident;

(x) the strength of the sliding doors shall be as per EN 14752 and the doors shall be able to resist the loads without deformation or damage; and

(xi) the doors shall have following additional safety features:

- Obstacle detection and preventing the EMU/MEMU from starting in case of obstruction;
- internal and external release;
- door closing warning by audible and flashing light indication.
- visual door open indication; and
- monitoring from the driver's cab.

Provision shall be made for passengers to open EMU/MEMU doors to permit evacuation from a stopped EMU/MEMU in an emergency.

4.2.3.2 Windows shall meet the following requirements:

(a) **Air-ventilated coaches**

All windows of air-ventilated coaches shall be provided with lift type wider windows flush with the exterior of the coach and having fixed type louver on top and movable glass window at the bottom.

OR

Air-conditioned coaches

All windows of air-conditioned coach shall be doubled sealed, flush with the exterior of the coach and shall normally be provided with double-glazed, toughened and laminated glass to the appropriate standard. The glazing shall have resistance to breakage and shall minimise danger on breakage, especially from objects hitting it, taking into account the speed of the EMU/MEMU. The exterior glazing shall withstand aero dynamic forces.

(b) Each coach shall have emergency ventilation windows, two on each side.

(c) All windows shall be highly resistant to acts of vandalism involving the etching or scratching of the glass and shall be easily cleaned. It shall be impervious to and chemically unaffected by water, paint, human waste, graffiti removers, wash plant solutions, cleaning solutions, food and drink spills.

(d) All windows shall be highly resistant to damage arising from the impact of ballast up to 75 mm at speed of up to 160 Kmph.

4.2.4 Driving Cabs

4.2.4.1 A cab shall be provided in the driving coach at each end of the EMU and MEMU train with provision for adequate forward visibility. The cab shall be adequately insulated against noise, vibration and heat and ingress of water and dust. Driving cabs shall be adequately reinforced and connected with the main under frame at the cab ends.

The cab shall be ergonomically designed for convenience and to minimize fatigue of the driver. The visibility diagram shall be in accordance with UIC 651.

There shall be provision of air conditioning including cooling, heating and ventilation arrangement in the cab space. There shall be sufficient space for four persons in the cab. The air conditioning and heating system shall maintain temperature as per UIC 651, during summers, by compressor cut in/ cut out and between 23-25 degree Celsius, during winters and humidity between 40% - 60%. In addition, provision of two cab fans shall also be made. Temperature and humidity indicators shall also be provided in the cab.

All windows, rearview mirror and door glasses shall be of shatterproof type laminated glass, set in sun and heat resisting synthetic rubber sections. Electric or electro pneumatic or pneumatic windscreen wipers with washers shall be provided on the lookout windows with foolproof drive arrangement and emergency manual control. Rolling blinds and sun visors shall be provided on the windscreens. The front look out glass shall be plastic laminated.

4.2.4.2 The layout of the driving cab and the driving position shall be ergonomically sound enabling the driver, in the interest of safety, to concentrate his attention outside of the cab to observe line side signals and instructions as applicable. The driver shall be able to undertake this task in both seated as well as standing position. A suitable adjustable seat shall be provided for the driver. All necessary controls and instrumentation shall be presented in a manner that shall aid the correct reflex action from the driver in both normal and emergency situations. The driving position shall be on the left side of the driving cab and the brake handles shall be located on the left hand side of the driver in the running direction. The relative positions of cab equipments shall be similar to those available on existing EMU/MEMU.

4.2.4.3 Access to the cab shall be from either side of the cab by means of sliding or inward opening doors having minimum height of 1900 mm and minimum width of 650 mm. The door leading to passenger area from cab shall open into the passenger area. The cab access doors shall be provided with lock and key. The position of hand holds provided for cab entry shall be so as to enable the climbing into the cab from ballast level.

4.2.4.4 Hinged grill for prevention of damage to the front glass panel of the windscreen shall be provided.

4.2.4.5 Horns

Dual tone (low tone and high tone) pneumatic horns without rubber parts shall be provided facing outwards at each driving cab. The horns shall be of sufficient size and power to provide sound level of 125 dB at a distance of 5 meters from the driving cab. Controls shall be provided in close proximity to the driver permitting the driver to operate either horn individually or both horns simultaneously. The high tone horn shall have fundamental frequency of 390 +/- 25 Hz and the low tone horn shall have fundamental frequency of 290 +/- 25 Hz. The sound level of horn as measured in associated driver cab shall not exceed 92 dB.

4.2.4.6 In addition to above, each driving cab shall be provided with the following:

(i) Two cabinets in the rear and locker for toolbox;

(ii) two fire extinguisher;

(iii) one LED based rechargeable torch with socket and charger;

(iv) space / room for installation of wireless set and automatic train protection/auxiliary warning system/ train protection warning system equipments;

(v) suitable trays with clamps for working time table, caution orders, walkie-talkie etc; and

(vi) suitable LED based lighting in cab. Lighting on the driver's console shall not be less than 60 lux measured at the console. The cab shall be provided with ceiling lights designed to provide 200 lux at 1 meter above floor level. There shall also be provision that during running of the EMU/MEMU only driver desk, timetable and caution order area shall be illuminated without causing any hindrance to the visibility of drivers.

(vii) destination indicator (head code) shall be provided on the driving coach face. The head code box shall be behind the lookout glass and flushed with the driver cab interior. A modern high resolution LED display in both English, regional language and Hindi shall be provided which shall be visible clearly from the platform from the distance of 100 meters minimum (in bright day light) while the train is approaching the platform. Data input shall be from the driver's console as a part of setting up procedure. The destination indicator shall have IP65 protection. The viewing angle for the destination indicators shall be such that it is visible to the person standing on platform, as such angle from his eyes to the destination board shall be 30 degree minimum.

4.2.5 Bogies

4.2.5.1 The bogies shall be of proven design and shall provide the required riding comfort, as set out in clause 4.2.4.6 of these Standards and Specifications. The suspension shall give a

low transmissibility of vibration to the bogie and the coach body and shall minimise impact, vibration and noise. Suspension characteristics shall be selected so as to avoid resonance.

4.2.5.2 The structural design of the bogie frame shall conform to **BS EN 13749:2005 –'Railway applications – method of specifying structural requirements of bogie frame'** or equivalent standard;

4.2.5.3 The bogies of powered coaches shall be of similar performance as **BS EN 13104:2009 – 'Railway applications – Wheel sets and bogies – Powered axle design method' or UIC 615 -4 Motive Power Units – Bogie and running gear – Bogie frame structural strength test'**

4.2.5.4 The bogies of non powered coaches shall be of similar performance as **BS EN 13103:2009 – 'railway applications – wheel sets and bogies – non-powered axle design method' or UIC 515-4 'Passenger rolling stock – Trailer bogies -- Running gear – bogie frame structural strength test'.**

4.2.5.5 The bogies shall have self air cooled asynchronous three phase AC motors suitable for IGBT based VVVF traction system.

4.2.5.6 The Sperling Ride index (RI) of the coach under all loading conditions, when travelling throughout the range of operating speeds and cant deficiencies provided in the track for the service life of all suspension components shall not exceed 2.75 in both vertical and horizontal directions.

The RI calculations shall be done as per Para 2.1 of ORE Report no. 8 of C 116 using FFT method (Fast Fourier Transform method).

4.2.5.7 The bogie shall be compatible with the track parameters specified in clause 2.5 of these Standards and Specifications. The bogie shall be capable of safe operation keeping the damping values positive, at all permitted combinations of track condition, vehicle speed, equivalent conicity, co-efficient of friction, operating conditions, maintenance condition, and loading. The suspension system shall prevent excessive forces transmitted by wheels leading to track damage/derailment and/or unloading of wheels leading to risk of derailment. The axle yaw stiffness and the rotational resistance of the complete bogie shall be such that lateral flange forces generated when negotiating the track alignments shall not cause excessive rail wear and flange wear, but shall be sufficient to obviate bogie and wheel set hunting.

4.2.6 Wheels, Axles and Roller Bearings

4.2.6.1 Wheels shall be in accordance with IRS R – 19/93 Pt. II (latest revision) and axles shall be to IRS R - 16 for non-powered axles and R - 43 for powered axles.

4.2.6.2 Currently Indian Railways uses wheels with 952 mm dia (new) as per RDSO's drawing no. SKETCH – K4004 (refer Annex - A1). The Company may explore the possibility of using either these wheels in the EMU/MEMU coach, or wheels in accordance with any international standards subject to compliance on the Indian Railway Schedule of Dimensions for 1676 mm gauge.

4.2.6.3 Wheel and axles dimensions shall meet the requirements of Indian Railways Schedule of Dimensions, 1676 mm gauge.

4.2.6.4 All roller bearings shall have a minimum life rating of 3×10^6 Kms, when computed as per method given in ISO Standard ISO 281/1.

4.2.7 Draw and Buffing Gear

4.2.7.1 The coaches shall be provided with automatic tight - lock centre buffer couplers with provision for automatic coupling of pneumatic and electrical connections between two coaches. End driving coaches shall be provided with high tensile automatic center buffer coupler (transition) with AAR "E" type coupler head and with AAR "F" type shank and AAR "F" type yoke and screw coupling in accordance with RDSO drawing No. SKDL 2494 (refer Annex - A2), on the front side. It shall conform to AAR specification No. M-211 with grade E steel. All couplers shall have crash worthiness features.

4.2.7.2 Draw and buffing gear provided between vehicles shall resist locking. Draw and buffing gear systems shall resist over riding and relative rotation to keep vehicles upright.

4.2.7.3 Capacity of draft gear shall be adequate to meet operating requirements of the fully loaded EMU and MEMU train up to 500-meter length.

4.2.8 Brake System

4.2.8.1 The brake system shall be of UIC approved type and shall meet at UIC requirements for air brakes on EMU type of passenger vehicles, operating at speed up to 200 kmph. The coaches shall be provided preferable with disc brakes and also, if considered necessary, with clasp brakes.

4.2.8.2 The brake system shall comprise the following types of brakes:

- Electric regenerative service brakes;
- Electro-Pneumatic (EP) service friction brakes;
- Brake-pipe controlled back-up brake system
- fail safe emergency pneumatic brakes; and
- spring applied, pneumatic release parking brakes.

4.2.8.3 It shall be possible to apply emergency brake from the drivers control position. The emergency braking system shall be designed to optimise the Train retardation and shall not be degraded by wheel slide protection equipment if provided.

If a door opens when an EMU/MEMU is in motion, emergency brake shall be applied to bring the EMU/MEMU to a standstill.

EMU/MEMU shall be provided with self-check method to ensure completeness of the train in all respects before emergency brake can be released.

4.2.8.4 For the service brake, the electrical brake is preferred, the use of pneumatic brake being limited to the lower speed range when the electric regenerative brake effort is insufficient. There shall be smooth blending of electro-pneumatic brakes and regenerative brakes.

4.2.8.5 The brake system shall provide for automatic wheel slip–slide protection.

4.2.8.6 The parking brake shall be automatic and shall be designed to hold an EMU/MEMU train with payload as per clause 2.2.1 of these Specifications and Standards on the gradient of 1 in 37 in the wind condition, in accordance with clause 2.6 of these standards and Specifications, for an unlimited time.

4.2.8.7 The complete brake system shall be of similar performance as **EN 13452-1:2003 – 'Railway application – Braking – Mass transit brake system performance requirements'** or equivalent standard.

4.2.8.8 The braking system shall interface with automatic train protection, auxiliary warning system and train protection and warning system equipment.

4.2.8.9 Adequate safety straps shall be provided below the moving components of brake rigging to prevent falling on the track in the event of failure of any component.

4.2.8.10 All piping shall be of stainless steel with flare less compression fittings for tropical conditions.

4.2.8.11 Compressed air system

The compressed air system shall comprise of air compressor, compatible air dryer and filters so as to ensure delivery of the compressed air complying with air quality class specified in ISO-8573.

(a) Compressor

The motor compressor unit of suitable free air delivery, shall be under slung, resiliently mounted with the under frame through stainless steel springs to minimize the levels of vibrations transmitted to the EMU and MEMU body. It shall be sized to fulfill all air requirements of each coach under all operating conditions. The mounting arrangement shall be of proven design. The compressor shall preferably be splash lubricated to avoid the need for oil pump, filter, valve, etc. The oil sump inlet shall be so designed to avoid any over filling during service. The company may offer alternative design such as, oil free compressor.

The intake air shall be directed through a properly designed filter, suitable for the specified dusty atmospheric conditions. The inlet air filter shall be so mounted on compressor so that it can be easily taken out for cleaning purpose. Arrangement shall be made so that the compressor does not start against backpressure. A non-return valve shall be provided between the compressor and the main reservoir supply line. A safety valve shall be provided to protect the compressor against excess pressure.

(b) Air Dryer

The air delivered to the pneumatic system shall be clean and dry, free from water vapor, oil and particles. A heatless regenerative type air dryer of matched capacity shall be provided between the air compressor and the main reservoir so as to provide dry compressed air to the EMU and MEMU brake system. The air dryer shall be preceded by automatic drain valve and oil separator, which collects and discharges bulk of the moisture and oil present in the compressed air, before it enters the air dryer. Air drier shall be so located /protected in under frame to avoid any hitting during run.

(c) Air Reservoirs

Reservoirs of adequate capacity and in numbers, made of corrosion resistant material, shall be provided with provision of suitable safety valve and automatic drain valve.

4.2.9 Lavatories

4.2.9.1 The coaches of MEMU, except the motor coaches shall have 02 (two) lavatories. One lavatory with Indian style WC and one lavatory with western style WC shall be provided along with all other standard fittings such as mirrors, washbasins, toilet paper holder, liquid soap dispensers and litter bin. The toilets shall be designed in such a way as to permit the wheel chair users to use them conveniently. Lavatory engaged / free indication light shall be provided at both ends inside the coach at convenient location.

4.2.9.2 The coaches shall be provided with modular lavatory/ controlled discharge toilet system so that sewage disposal can be done at terminals. Recycling of the wastewater shall be done for re-use in the lavatory.

4.2.9.3 Roof mounted or under slung water tanks of not less than 455 litres capacity per lavatory shall be provided. The tank shall be mounted so as to be readily removable for repairs. Side filling arrangement only shall be provided for filling water.

4.2.9.4 Suitable device for extraction of air from lavatory shall be provided.

4.2.10 External fittings

4.2.10.1 Door steps and hand holds shall be provided at all body side doors in all the coaches of MEMU and driving cab.

4.2.10.2 Continuous water wriggles from one end of the coach to the other shall be provided

4.2.10.3 Rain water gutters of suitable design over the doorways shall be provided.

4.2.11 Passenger alarm signal apparatus

4.2.11.1 Brake alarm pulls shall be provided in the compartments and lavatories of the coaches.

4.2.11.2 Provision shall be made for a warning signal to be given to the driver and/or guard in the event of passenger alarm being pulled in any coach. The operation of the alarm pull by a passenger shall not act directly on the train brakes but the brake operation shall be left to the decision of the driver/guard. An audio visual indication shall be provided to identify the coach and the location inside the coach from where the alarm pull has been operated.

4.2.11.3 It shall be possible to reset passenger alarm system from outside the coach.

4.2.12 Marking

The coach number shall be applied on both sides of each coach, both externally and internally and also inside the cab to be easily visible to the driver and maintenance personnel.

4.3 Electrical system

4.3.1 Pantograph

4.3.1.1 The basic unit of EMU and MEMU shall be equipped with one pantographs for current collection. Efficient current collection while traversing the OHE shall be ensured at all speed with least sparking. The maximum limit of contact loss should be of the order of 0.2 percent in the regulated OHE. The raising or lowering of the pantograph, with the EMU/MEMU in motion, shall not cause any undue disturbance to OHE.

4.3.1.2 It shall be possible for each of these pantographs to be electrically disconnected from the roof equipment and earthed in case of damage.

4.3.1.3 The profile of the pantograph shall generally be in accordance with the drawing no. SKEL-3871 enclosed as Annex-A3. Metalised carbon strip in accordance with RDSO's specification No: RDSO/2009/EL/SPEC/0097, Rev. '0' shall be used on the pantograph.

4.3.1.4 The pantograph shall be air spring operated type and suitable to work in areas having high wind pressure as specified in Clause 2.6 of these Specifications and Standards

4.3.1.5 In static condition, the pantograph shall exert upward force of 7 ± 0.4 kg on OHE.

4.3.1.6 Pantograph shall have auto drop function to drop the pantograph automatically when excessive height is detected.

4.3.2 Main Circuit Breaker

Each motor coach shall be provided with one main circuit breaker.

4.3.3 Lightning Arrestor

Two metal oxide gapless lightning arrestor, on each motor coach shall be provided on the roof of the motor coach for protection against the line voltage transients caused by lightning and system switching.

4.3.4 Traction Transformer

4.3.4.1 A fixed ratio transformer shall be provided with multi traction windings suiting the requirements of IGBT based power converter-inverters to meet the load of three- phase propulsion equipments and complete air-conditioning system. The number of secondary traction windings shall match the number of power converters duly phase shifted for the motor coach and one independent auxiliary winding to cater the air-conditioning and lighting loads.

4.3.4.2 The kVA rating of the transformer shall be specified at a line voltage of 22.5 kV and shall be designed to deliver the power at a total current corresponding to the continuous rated traction motor currents after accounting for the efficiency and power factor of traction motor, converter-inverters, auxiliary converter and converter/inverter for air-conditioning. The transformer shall be designed with overload capacity to permit full utilization of the

traction motor capacity during starting as well as running. Similarly, the auxiliary winding shall be designed suitably to cater the air-conditioning load of the same unit as well as 50% of the adjacent unit.

4.3.4.3 The transformer shall be designed to conform to IEC 60310 and temperature rise limits of the windings and oil shall correspond to IEC 60310 minus 20^0C under all conditions of operations.

4.3.4.4 The secondary windings shall have a very high magnetic de coupling.

4.3.4.5 The transformer shall be complete with oil pump and radiator with blower, conservator and protection equipment assembled in single module. Means shall be provided for letting out the oil from transformer to the underside of the coach in the event of any fault/electrical disturbance in the transformer causing oil to rush out. No part of the transformer shall protrude above floor level. Adequate care shall be taken in design in view of the high humidity for long duration (in coastal areas).

4.3.4.6 The cooling agent for the transformer shall be arc resistant and shall have high flash point.

4.3.4.7 The transformer shall be under slung. The lower portion of the tank shall be of adequately strong so as to protect against hitting by extraneous objects while on run.

4.3.5 High Voltage Cable Assembly

High voltage cable assembly, from the roof of coach to traction transformer of adequate size having interface with transformer bushing at the transformer end and with cable head termination bushing fitted at the coach roof, shall be provided in accordance with the Good Industry Practice.

4.3.6 Power Converter-Inverter

4.3.6.1 The four quadrant power converter-inverter shall be IGBT based with PWM control to ensure regeneration and the power factor to near unity. The power converter-inverter shall be under slung. The power converter shall be either natural air or forced air-cooled. However, natural air-cooling shall be preferred. If forced cooling is adopted proper method of dust filtration shall be ensured.

4.3.6.2 The wheel slip detection and correction system shall be an integral part of the EMU/MEMU control system and if necessary also of the power converters-inverter which shall capture any excessive acceleration, differential speeds between axles, over speed and any other parameter considered necessary to □elsius□ adhesion and □elsius□ wheel slipping / skidding.

4.3.6.3 The converter and inverter system shall be capable of withstanding the maximum short circuit current under fault conditions, in accordance with Good Industry Practice The converter and inverter system shall also be designed to withstand extreme disturbances like short-circuit / open circuit at all points of input / output interfaces with EMU/MEMU, with minimised effects/damages. This shall be according to the relevant provisions of the IEC 61287.

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4.3.6.4 During the earth fault or phase to phase fault in the traction motor, protection scheme of the converter and inverter shall ensure that the fault does not have any adverse impact on the performance of the converter/inverter.

4.3.6.5 In the vital units of power control circuit like power supplies etc., where any defect/failure of component would cause complete failure of the motor coach, suitable means for redundancy shall be provided in order to avoid the motor coach failure or reduction in performance due to such defects.

4.3.6.6 Suitable margin shall be provided in the equipment rating such that under emergency condition with isolation of single traction unit such as converter, traction motor etc., there shall be no necessity to withdraw the EMU and MEMU train from service and journey is completed satisfactorily.

4.3.6.7 Selective isolation of individual bogies i.e. two motors, shall be ensured by providing individual and independent converter-inverter for each bogie of the motor coach. The propulsion equipment shall ensure the guaranteed performance for wheel diameter differences for at least up to 6 mm within any bogie and up to 13 mm between bogies without any adverse affect on any equipment. If the wheel diameter tolerances exceed the above limits then no damage shall occur to any equipment.

4.3.6.8 The protection/alarm/indication circuit shall normally have self correcting features rather than cause tripping of the motor coach for reduction of the tractive effort. If the driver intervention is needed, sufficient indication shall be given to the driver to enable corrective action to be taken in time. It shall be possible for the driver to take any protective action, or any other action as indicated to him through diagnostic display, on any of the motor coaches in the train, if so desired, from the driving cab itself.

4.3.6.9 Only dry type capacitors (having self healing property) shall be used for DC link / harmonic filter / resonant circuits.

4.3.6.10 Converter output**:**

The motor converter output current ripple shall be such as to keep the torque pulsations and traction motor heating to a minimum.

4.3.7 Traction motor and drive

4.3.7.1 The traction motor shall be designed for climatic and environmental conditions as specified in clause 2.6 of these Specifications and Standards. The general design and manufacture of the motor shall be done to the standard IEC 60349-2 in accordance with the modern traction practices. 4.3.7.2 The traction motor shall be suitably rated according to the EMU and MEMU performance requirements for the 'most severe normal service' as defined in clause 2.2(a) of IEC 60077-1.

4.3.7.2 The traction motor shall be self ventilated three phase asynchronous motor.

4.3.7.3 The traction motor shall be designed so as to be capable of withstanding transients such as line voltage fluctuations, switching surges and such other conditions as caused by stalling and wheel-slips under different operational conditions.

4.3.7.4 In determining the ratings, design parameters and construction of the traction motor, full consideration shall be given to the duties imposed by requirement of regenerative braking.

4.3.7.5 The motor shall be designed such that the hot spot temperature under any condition of loading in winding does not exceed the average temperature of that winding measured by resistance method, by more than 15 degree Celsius.

4.3.7.6 Insulation system

(i) The insulation system to be employed shall be particularly designed to withstand the adverse climatic and environmental conditions specified in these Specifications and Standards. Imperviousness to moisture shall be ensured.

(ii) the evaluation of the insulation system for thermal endurance shall be with fabricated test models by way of accelerated ageing tests based on the test programme drawn up in accordance with the norms specified in IEC: 60034-18. Evaluation of the insulation system shall be done according to IEC 60034-18.

(iii) ageing parameters of heat, vibration, mechanical/compressive stresses, special environmental effects of humidity, dust and metallic dust from brake shoes shall be incorporated to simulate the actual working conditions as closely as possible.

(iv) the temperature at which an extrapolated life of 20,000 hours is obtained shall be treated as the thermal endurance limit (Temperature Index) of the insulation system.

(v) with regard to the system of insulation adopted and the climatic and environmental conditions, the Company shall provide maximum possible margins in the temperature rise, for prolonged life of the traction motors.

4.3.7.7 Lubrication system for gear/pinion shall be kept physically segregated from the traction motor bearings.

4.3.7.8 Maximum temperature rise of traction motor winding shall be limited to Ti – 70 degree celsius, considering 25% choking of filters.

4.3.7.9 The following operational and environmental factors shall also be kept in view in the design of the motor:

(i) Prevalence of high temperature and humidity and highly dusty environments for most part of the year; and

(ii) operation of the MEMU over a long country terrain in which the climate shall vary from excessive dry heat on one end to high humidity on the other end or during winter months from very cold conditions at one end to moderately warm and humid conditions at the other.

4.3.7.10 Harmonic/Ripple factor:

The traction motor shall operate satisfactorily over the entire range of loading, with harmonics/ripples imposed from the supply system comprising of transformer, converter and inverter, both during motoring and regenerative braking conditions. The Company

shall conduct necessary tests on the traction motor to establish compliance with this requirement.

4.3.7.11 The L-10 life of traction motor bearings shall be 1.2 million Kms.

4.3.7.12 Various components of traction motor shall be manufactured with such tolerances so as to enable complete interchangeability of components from one motor to another of same design.

4.3.7.13 The lubricant shall be so chosen that the viscosity of the lubricant is not lost even at highest temperature during operation. Temperature rise of the gears shall be in the range of 30 degree □elsius above the ambient temperature.

4.3.8 Electronics, Control and Communication

4.3.8.1 The general provisions of this clause shall also be applicable to the electronics used for power and auxiliary converters. The electronics used shall conform to IEC-60571. However, due to higher ambient temperature in India, it shall be suitable for working for short time (at least 15 minutes) at high temperatures as expected to be encountered in EMU/MEMU standing under sun. Therefore there shall be no requirement of pre-cooling of the electronics on EMU and MEMU standing in summer sun for long duration. The electronic control equipments shall be protected against unavoidable EMI.

4.3.8.2 The leading driving cab of EMU/MEMU shall be controlling the motor coaches in the train formation. Necessary provision shall be made for acquisition and transmission of data required for leading cabs and the controlled equipment on other coaches. Necessary measures shall be taken to ensure that any type of interference does not distort the control signals.

4.3.8.3 Control and communication shall be based on open control architecture and compliant to IEC-61375 "Train Communication Network" protocol or any other equivalent, internationally published protocol. The programmable devices should be programmed using language compliant to IEC-61131.

4.3.8.4 Majority of control and monitoring function shall preferably be implemented by software so as to reduce hardware and cables.

4.3.8.5 The control system shall integrate the task of fault diagnostics and display in addition to control task. It should be capable of real time monitoring the status of all the vital equipment continuously and occurrence of faults. It shall also take appropriate protective action and shut down the equipment wherever necessary. Features of self-check, calibration and plausibility checks shall be incorporated in the design.

4.3.8.6 The vehicle control unit (VCU) shall be interfaced with the brake system. The automatic flasher operation (in case of train parting) and the vigilance control functionality shall be implemented.

4.3.8.7 The vehicle control unit (VCU) shall have a diagnostics computer, with non-volatile memory, to store all the relevant diagnostic data. On occurrence of each fault affecting operation, besides the fault information on equipment parameters, background data with time stamp along with GPS data shall also be captured and stored with a view to enable proper fault analysis. There shall be facility to capture post trigger and pre-trigger background information. The diagnostic computer shall specify diagnostic of fault up to card level. The diagnostic system shall be able to identify and log the faults of the EMU

and MEMU on account of wrong operation by the driver and such data shall be stored in the diagnostic computer for a period of not less than 100 days. Application software shall be provided to facilitate the fault diagnosis and the analysis of equipment wise failures. The steps required for investigation to be done, shall be displayed in simple language along with background information. Such software shall be compatible for working on commercially available operating systems.

4.3.8.8 The vehicle control unit (VCU) shall also provide on-line, context sensitive trouble shooting assistance to the driver in case of any fault, through the driver's display. The fault display to driver shall also accompany the standard trouble shooting instructions in simple English language.

4.3.8.9 It shall be possible to access all the processors of all the motor coaches in an EMU/MEMU, from the driving coach, over wired train bus (WTB) in accordance with IEC 61375 or any other equivalent, internationally published protocol, using a standard laptop connected to one of the ports provided in the driving cab. Such access is needed for visualization of process parameters and also force or record the same and downloading the diagnostic data. Required interfaces shall be built in the VCU so that standard laptops, with commercially available operating system, shall be directly plugged to the VCU port, provided in the driving cab, without any special interface. A suitable software tool shall also be provided in the laptops. Using this tool, it shall be possible to reset the diagnostic memory for further recording. This tool shall also provide detailed off line analysis facility.

4.3.8.10 It shall be possible for the Government to execute parametric changes in the software viz: modifying some of the permissible parameters like current and voltage sensor settings, horse power, temperature sensor setting, pressure sensor setting, maximum speed of the EMU and MEMU, wheel diameter, main reservoir pressure setting for loading & unloading of compressor, vigilance control timer settings and maximum tractive effort etc., for adjusting the characteristic within permissible range, changing preset values, limits, characteristics etc. and behavior of the EMU and MEMU in general, and add/alter the protection features, if so required in future in order to improve the operation of EMU/MEMU. It shall be possible to configure these parameters through laptop. A menu driven easy to use application software shall be provided for loading on the laptop for this purpose. Password protection shall be provided to safeguard against misuse.

4.3.8.11 The EMU and MEMU shall be provided with remote diagnostic and tracking equipment. The equipment shall be based on GPS, GSM and GSM-R technologies. This equipment shall perform the function of tracking of the EMU/MEMU and also communicate with the EMU/MEMU diagnostic system, and pass on this information to the central server. The central server shall be provided by the Company at a place to be nominated by the Government. It shall be possible to remotely send and obtain the information stored in the diagnostic memory of the computer system, depending on availability of communication channel, for control and diagnosis, with the aim of facilitating and speeding up the maintenance process of the EMUs and MEMUs.

4.3.8.12 The electronics shall be designed to be sealed from the remaining part of the machine room so as to ensure that there is no dust ingress whatsoever in to the electronics. The cooling arrangement of the electronics shall be designed so that the temperature of components of cards do not rise more than 20 degree □elsius above outside ambient for industrial grade components suitable for 85 degree □elsius environment.

4.3.8.13 Use of Application Specific Integrated Circuits (ASICs) shall, preferably, be avoided. Circuit boards shall use general purpose Ics to the extent possible.

4.3.8.14 The electronic cards shall be mechanically coded to ensure that insertion of card in wrong slot is not possible.

4.3.8.15 Capacitors shall be suitably rated, keeping in view the high ambient temperature specified, vibrations of electric rolling stock and electrical surges expected during operation. High failure rates of electrolytic capacitors mounted on PCBs of electronic cards are expected due to high operating temperature / voltage / current vis-à-vis designed operating temperature / voltage / current. Dry type of capacitors shall preferably be used. Expected life of the cards, and electronics in general shall be at least 18 years under actual working conditions.

4.3.8.16 Features of the electronic systems:

(i) The diagnostic computer in the EMU/MEMU shall be able to differentiate between fault in rest of the EMU and MEMU and fault in the electronic equipment; and

(ii) should the fault be found on electronic equipment, the diagnostic computer shall enable fault finding to be carried out at module level.

4.3.9 Train Line Cables, Inter Vehicular Electrical Couplers

4.3.9.1 The electrical coupler shall be capable of making all necessary electrical connections between adjacent coaches to permit controls of all coaches in a train from the leading driving cab. On minimum radius curves, the covers shall not exceed the allowable clearance envelope of the coach. Sufficient spare contacts (at least 15 %) shall be provided for catering to future needs of the Government. As such multiplexing of signal shall be adapted to the maximum extant possible in line with the current international practices.

4.3.9.2 The outer cover of the electrical coupler shall be additionally strengthened to protect the coupler against ballast or external hitting.

4.3.9.3 In order to secure the cables from external hitting, the cables connected with the coupler shall not hang lower than the lowermost face of the coupler and shall be suitably secured to arrest any dangling.

4.3.9.4 Electric couplers shall use a configuration so that any end of the standard unit can couple to any end of any other standard-unit. Contacts shall preferably be spring loaded, of silver surfaced alloy, shall have sufficient capacity, shape and positive action to prevent fouling in coupling, shall maintain positive contact under all specified operating conditions and shall be capable to work even with the impacts to which the coach coupler may be subjected in service.

4.3.9.5 The inter-vehicular coupler arrangement for both power and control system shall be proven and shall conform to international standards. However, special arrangement shall be made to ensure that it is not damaged due to external reasons like vandalism, ballast hitting and the flooding conditions. The layout shall be such that it is out of the reach of any passenger or common man.

4.3.9.6 The design shall cater for relative movements between the coaches. It shall be that there is no disruption and sparking due to vehicle behaviour under worst conditions of operation.

4.3.9.7 Couplers shall allow coupled coaches to negotiate curves of radius 152.4 metres and shall be capable of passage in either direction over standard 1 in 8 ½ turn outs and shall function satisfactorily with difference in head stock heights of adjascent coaches up to 75 mm. It shall be ensured that the jumper cable assemblies do not touch/rub the couplers under any circumstances.

4.3.9.8 Coupling shall be capable of being accomplished by one person and shall be practicable with longitudinal axes misalignment between coaches of eight degrees and 100 millimeters different in height.

4.3.9.9 All train lines and inter vehicular couplers shall be so designed that they are not susceptible to any damage due to vandalism and external hittings during the run. Further, adequate safety measures shall be taken to safeguard against ballast hitting, vandalism, rains and flood water. The layout shall be such that they are accessible to maintenance staff only. Adequate measures shall be taken to reduce the number of train lines to bare minimum.

4.3.9.10 The 25 kV coupler, provided on the roof, between two coaches shall be operable from inside the coach.

4.3.10 Auxiliary Systems

4.3.10.1 The power supply for the auxiliaries shall be through IGBT based converter-inverter supplies. The auxiliary converter-inverter shall be under slung. The auxiliary converter shall be either natural air or forced air-cooled. However, natural air-cooling shall be preferred. If forced cooling is adopted proper method of dust filtration shall be ensured.

4.3.10.2 The auxiliary converter-inverter provided on each basic unit of EMU/MEMU shall cater for the complete auxiliary load of the unit and additionally shall cater for air conditioning/air ventilation, lights and fans and any other emergency requirements of the adjoining unit which shall have to be fed in case of failure of auxiliary converter. The changeover shall be affected automatically and without any time delay through control electronics. The full power availability of the auxiliary converter shall be ensured throughout the voltage limits specified for traction system in clause 2.4 of these Standards and Specifications, so that the loads connected to the auxiliary converter shall not have to be reduced / adjusted in the entire voltage variation from minimum to maximum.

4.3.10.3 While traversing the neutral section or in the event of momentary non availability of OHE during the service, the lights and fans shall work normally.

4.3.10.4 While calculating the rating of the auxiliary converter, a provision of 10% in the auxiliary converter capacity shall be kept for future use.

4.3.10.5 Separate inverter shall be provided for supplying power to the compressor, independent of other loads like pumps, blower motors etc.

4.3.10.6 All the drive motors shall be designed for three phase AC supply with suitable protection against single phasing and short circuits and over loads.

4.3.10.7 The supply voltage for the auxiliary machines shall be 415 V +/-. 10%, 3-phase, 50 Hz, sine wave AC. The control voltage shall be 110 Volt DC.

4.3.10.8 Power quality of the 415 V three phase sine wave AC under all working conditions shall be as under:

- Output Voltage : 415V ± 5%
- Output Frequency : 50Hz ± 3%
- Short time current overload rating : 125% for 20 sec.
- Total harmonic distortion (THD) : Less than 10% in output voltage
- dv/dt : Less than 10 V / Microsecond
- Voltage unbalance : Less than 1 %

4.3.10.9 In addition to above, galvanically isolated 230 V AC and 110 V AC, single phase supply of 1 kVA shall also be made available, in driving cabs, to enable powering any small equipment.

4.3.10.10 Totally enclosed fan cooled design is to be considered for auxiliary machines if the use of such machines is likely to result in freedom from dust and contamination and in general better performance. Internally ventilated auxiliary machines having encapsulated stator windings may also be considered for this application if considered to be advantageous over totally enclosed fan cooled design.

4.3.10.11 The temperature rise limits for auxiliary machines will be reduced compared to IEC limits to take care of the higher ambient in India.

Only insulation system of class H and higher will be acceptable. The permitted temperature rise for different classes will be:

Class H:- 80 degree C
Class C:-100 degree C

Vacuum pressure impregnation (VPI) of the stator winding must be done using solvent less varnish having thermal index above 200^0C. Any other method utilized in place of VPI may be considered provided its advantages are listed and provenness is ensured, for the environmental conditions existing in India.,

4.3.10.12 In the case of squirrel cage motors, aluminum alloy die cast rotor construction shall be preferred.

4.3.10.13 L-10 life of bearings shall not be generally less than 1,00,000 working hours when calculated as per ISO recommendation R-281. For motors higher than 15 KW, flange bearing housing units shall be used. The bearing design shall be such that no greasing or any intermediate attention may be required to be done for at least one and half year after each greasing/adopting maintenance schedule as recommended by the manufacturer.

4.3.10.14 Battery and battery charger

(i) An automatic static battery charger fed from three phase auxiliary supply shall be provided. Its rating and charging characteristics shall be matched to the battery, by

monitoring of charging current and voltage and shall have a provision for fine adjustment and good stability to avoid overcharging or undercharging of batteries;

(ii) low maintenance batteries of adequate capacity (C5 capacity) shall be provided on the EMU and MEMU. Nominal voltage of the battery shall be 110 V. The batteries shall be maintained at an adequate level of charge to satisfy the requirements as given below:

System maintained	**time**
Emergency ventilation	90 minutes after the loss of OHE power
Communication system (PIS and PA system)	4 hours after the loss of OHE power
Emergency lighting	4 hours after the loss of OHE power
Door release of alternate doors on either side	4 hours after the loss of OHE power
Train controls (full load)	4 hours after the loss of OHE power
Fire detection system	4 hours after the loss of OHE power

; and

(iii) the design and control of the battery shall ensure that the battery gets disconnected from non essential loads when the battery gets discharged, however there shall be sufficient capacity left under all conditions to raise pantograph and to power event recorder and flasher light. When auxiliary load is reconnected, the initial battery load shall not cause the battery output to oscillate.

4.3.10.15 Auxiliary Compressor Set

A 110 V DC battery operated auxiliary compressor set having adequate capacity, shall be provided in each basic unit for feeding the auxiliary air reservoir for operation of the pantograph and main circuit breaker during the preparation of the EMU/MEMU for service.

4.3.10.16 Lights and fan circuit

I) Lights and fans shall be fed by the auxiliary converter.

ii) Separately protected lighting circuits shall be used, such that in the event of one tripping, the others provide evenly distributed lighting throughout the coach.

iii) For lighting the interior of the coach, suitable lamps shall be used. During night, the illumination shall be not less than 200 lux at the floor of the coach and not less than 300 lux at seating positions. **Electric lighting shall be of similar or equivalent performance to EN 13272:2001 – 'Railway application – Electrical lighting for**

rolling stock in public transport systems' as applicable to urban rail transport systems.

iv) Electrical socket for charging batteries for portable electronic devices or for powering a laptop computer shall be provided in the coaches.

v) At least 50% of lights and fans, evenly distributed over the coach area, shall remain energized and provide sufficient light for safety of passengers, in the event of a main auxiliary power failure even from the adjacent unit.

vi) All electrical circuits shall be fused or otherwise protected to avoid danger from overheating or arcing.

vii) Coach wise indication of healthiness/working of lights and fans circuit shall be provided in the driving cab. In case it is required to changeover to emergency feed, same shall be possible from driver's cab. It shall be possible to isolate 50 % lights of the train from driver cab when the EMU/MEMU is stabled in yards or shed.

viii) Emergency lights (at least 8 nos. per coach) shall be provided in each coach to be fed by battery in case of total failure of auxiliary supplies.

ix) The wirings, switchgears, relays and terminal equipment required for proper working of lights and fans shall be provided.

4.3.10.17 Head light, marker and tail lights

The front end of each driving coach shall be provided with:

a) Head light – Twin beam head lights shall be provided at each end, working on 110 V halogen lamps having two filaments or LED lamps. Headlight units shall be pre-focused, capable of giving minimum 3.2 lux at a distance of 305 meters. The design shall provide for easy replacement of bulb. Arrangement shall be made for dimming the headlight output when required. The head lights shall be provided in suitable waterproof enclosures conforming to IP 65. The head light shall work in neutral section also;

b) tail light (blinking at a rate of 55-65 flashes per minute during the service);

c) flasher light to provide flashes at the rate of 40 +/- 5 flashes per minute; and

d) two twin marker lights with suitable waterproof enclosures conforming to IP 65 and window toughened front glass. Each twin marker light shall provide one white and one red array. If the marker lights are mounted with the twin lenses side by side the red lens or array shall be towards the outside of the coach. If the marker lights are mounted with the twin lenses one on top of the other, the red lens or array shall be on the top. The marker lamp shall have a nominal light output of 40 lux at 1 meter. The marker light shall work in neutral section also.

These shall work on the battery supply. A separate switch shall be provided in the driver's cab to switch ON/OFF the auxiliary head light independent of head light and tail light (normal & blinking operation).

4.3.11 Air Ventilation

4.3.11.1 The coach shall be air ventilated with minimum two roof mounted packaged unit type air ventilation units in each coach in addition to coach fans. The air ventilation units shall be fed from auxiliary converter.

4.3.11.2 The design of the ventilation unit shall be such that CO_2 level inside the with payload as per clause 2.2.1 of these Specifications and Standards shall not exceed the permissible threshold limit of the order of 700 PPM above the CO2 concentration in air outside the coach.

4.3.11.3Air-ventilation units shall be so provided in EMU and MEMU coaches that the coach can be converted into air conditioned coach by providing only air conditioning unit in future without change in envelope.

OR

Air conditioning

a) The coach shall be air-conditioned with minimum two roof mounted packaged unit type air-conditioning units in each coach. Air-conditioning in coaches shall conform to EN 14750 or equivalent and to internationally accepted standards and practices. The air conditioning units shall be fed from auxiliary converter.

b) Interior temperature shall be 25°C (DB) and 16°C (WB) at an ambient of 50°C. Relative humidity inside coach shall not be more than 60%. Indoor air quality shall be as per ASHRAE norms. Refrigerant used shall be eco friendly for next 30 years as per Montreal protocol.

c) In the event of failure of air-conditioning unit/units, harmful quantities of the refrigerant shall not be released inside the compartment and there shall be an arrangement for forced ventilation of the coach/coaches.

d) The air-conditioning system shall provide a high rate of renewed air, maintenance of constant temperature and take into account, frequent door opening and high User density. The units shall be compact; roof mounted and of low power consumption.

e) Emergency ventilation

In the event of power failure to all air-conditioning unit exceeding 2 (two) minutes, a minimum of 1000 liters per second of fresh air shall be introduced to the coach and distributed evenly through the passenger areas. This is not expected to be cooled air. The EMU/MEMU shall be able to maintain this air supply for at least 90 minutes.

4.3.12 Passenger Information and Communication System

Passenger information and communication system shall be based on GPS system and shall provide following facilities:

i) public address announcements or playing of recorded information by the driver and connectivity of the public address system of the train with the announcements made by train controller through Train Monitoring System installed by respective user Railways on the speakers provided in the coach;

ii) coach shall be provided with 06 (six) numbers LED based passenger information display board inside the coach and 02 (two) numbers LED based destination board out side the coach(one on each side). These shall show current location of the EMU/MEMU, next station, time to next station, next interchange points, platform side, passenger related safety information; and any other important information in Hindi, English and regional languages.

iii) the microphone used by the driver shall be common for all voice modes and priority shall be allocated to various modes;

iv) the public address intercom system shall have the driver-guard and driver/guard – passenger communication. The driver shall have the facility of adjusting the volume level from a minimum to maximum level by suitable mode provided in driver's dashboard. Emergency buttons and talk back phones shall be located near all the doors and gangways;

v) the communication shall be in full duplex mode and multiplexed with suitable measures to prevent acoustic feedback. The priorities of different functions of the public address system shall be defined;

vi) in case of failure of one unit of PA system or a passenger communication unit in one coach, there will be no failure of the whole system; and

vii) all the communication and control cables shall be conforming to international standards for fire retardant, fire survival characteristics suitable for the EMU services.

4.3.13 Master Cum Brake Controller

4.3.13.1 A combined master cum brake controller, integrated into a single unit shall be used. This shall be of step less type. Suitable provision shall be made to ensure unhindered operation in case of failure of master controller.

The master controller shall be provided with a device which shall have to be remained activated manually and consciously by the driver. In case of the driver gets incapacitated and the device is released, the emergency brakes shall apply through direct opening to atmosphere.

4.3.13.2 The master controller shall be suitable to ensure controlled speed. For the purpose of wheel slip and slide control, the 3-phase drive traction/braking control system shall supervise the following condition and take corrective action:-

-- Excessive acceleration;
-- differential speed between axles; and
-- over-speed control.

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4.3.13.3 Suitable forward/reverse interlocks and interlocks with braking system shall be incorporated in the master controller. The traction shall be possible only from one cab at a time.

4.3.14 Brake Blending

4.3.14.1 Full utilization of the regenerative braking is envisaged in the 3-phase drive system such that regenerative braking is available over full range of speed to be blended/ interfaced with the existing EP brakes. The control system shall be designed that in the EP brake region, for any set braking effort demand, as decided by the position of the brake handle, maximum possible brake effort is obtained from the regenerative energy of the motor coaches and the EP brakes of the trailer coaches are applied mainly to supplement the difference between the demand and the regenerative braking effort achieved.

4.3.14.2 Normally, in the EP service braking zone, only regenerative braking is applied in the motor coaches where as the EP brakes are applied on the trailer coaches. However, if the regenerative braking becomes ineffective, the EP brakes shall come on the motor coaches.

4.3.14.3 In order to ensure smooth changeover from regenerative to EP brakes and vice versa, braking resistor shall be provided during the change over period.

4.3.14.4 Adequate redundancy shall be provided to ensure that the EP brakes do not become non functional in case of failure of power supplies, isolation of motor coach or failure of control electronics and pressure transducers etc. In case of isolation of any EP valve due to any defect, the brake electronics shall take adequate corrective action with least system isolation. System shall provide enough redundancy in the brake electronics and controls so that the isolation of motor coach does not lead to non-functioning of EP brakes of the motor coach.

Separate brake electronic control unit of proven design compliant to SIL 4 shall be provided to ensure redundancies and shall perform the functions as defined in sub-clauses of this clause.

4.3.14.5 It shall be possible for the driver to know the mal functioning of brake system of a coach. Selective isolation of EP valves (coach wise) shall be possible.

4.3.14.6 The friction braking system shall function as the ultimate braking system on the coach, acting as a backup during normal service braking and as the primary braking system during emergency stops and while parking. It shall provide adequate safety against rolling back of EMU and MEMU train in case the train is to be started on a rising gradient.

4.3.15 Display Panel

A suitable LCD display (back lit) with rob high resolution, all time visibility, wide viewing angle, suitably designed against vandalism, high impact, rough handling, ingress of water and dust and IP 54 protected robust and heavy duty input/output system as per the available technology, shall be provided on driver's desk to display fault status, energy

values and status of various important parameters as selected by driver/ maintenance staff or as required for the satisfactory system operation.

4.3.16 Instruments and gauges

OHE line voltage, battery voltage, tractive/braking efforts, energy consumed / regenerated, pressures in the main reservoir pipe, brake actuators, brake pipe and feed pipe and indication of air flow in the brake pipe and any other indication considered important / relevant for the driver shall be displayed on both end driving cab consoles.

4.3.17 Wiring and cabling

4.3.17.1 The cables for wiring in the EMU and MEMU and equipments shall use high grade electrolytic copper stranded conductors tinned in accordance with Good Industry Practice.

4.3.17.2 Electron beam irradiated/chemically cross linked, thin walled, halogen free, low smoke and less toxic cables according to relevant international standards and the Good Industry Practice for rolling stock application, shall be used. The insulation/sheathing material shall be EPDM/EVA and shall be fire survival type according to EN 50264. At locations in the EMU/MEMU, where high temperatures are likely to be encountered, special cables shall be used.

4.3.17.3 The layout of the cables shall be such that there is no contamination by oil. Length of power cables shall be kept to minimum. Cables and connections carrying different types of voltages shall be physically segregated from each other. For vital circuits, adequate numbers of spare control wires shall be provided with clear identification. Cable layout shall be according to EN50343.

4.3.17.4 Loading of power cables shall be such that in no case conductor temperature shall exceed maximum temperature according to data sheet minus 10 degree □elsius. The power cable layout shall ensure equal sharing of current in all power cables. Derating of cables due to bunching effect and cable layout shall be taken into account during design

4.3.17.5 All connections shall be terminated on terminal bars manufactured in accordance with Good Industry Practice. The terminals and wire cable ends shall be suitably marked to facilitate correct connections.

4.3.17.6 Plugs/couplers and sockets shall be used to connect pre-assembled units to facilitate maintenance and ensure a better layout.

4.3.17.7 No cable having a conductor size of less than 2.5 sq. mm shall be used except for multi core cables where 1.0 sq. mm cable is permitted. Smaller size cables for internal wiring of panels, control cubicles, consistent with the mechanical and electrical requirements, may be adopted.

4.3.18 Speed indicating and recording equipment

The speed indicating-cum-recording equipment shall be provided in each driving cab of EMU and MEMU. The speed indicating-cum-recording equipments with electrical/electronic type of drive having scale range of 0 to 160 Kmph in EMU and 0 to

200 Kmph in MEMU shall be used. The equipment shall also incorporate the feature of indicating and recording kilometers traveled by the EMU and MEMU.

4.3.19 Event recorder

The event recorder shall monitor and record various events so that data is available for analysis to assist in determining the cause of accident, incident or operating irregularities. The equipment shall be designed in such a way so as to provide an intelligence based recording of the following parameters against the time axis (time interval shall be decided by recorder itself whenever there is a change in the respective parameter). Most recent data for below mentioned events for a minimum of the last 30 minutes in loop form shall be recorded.

The following parameters shall be recorded:

(a) Speed in Kmph;

(b) OHE voltage;

(c) OHE current;

(d) tractive/braking effort;

(e) battery voltage;

(f) brake pipe pressure;

(g) pantograph up/down position;

(h) status of main circuit breaker i.e., open/close;

(i) mode of operation i.e., traction mode/braking mode;

(j) direction of travel i.e., forward/reverse with respect to activated cab;

(k) head light status on/off;

(l) flasher light status on/off;

(m) horn status on/off;

(n) status of penalty brake application;

(o) wiper on/off; and

(p) any other parameter considered necessary.

The event recorder shall be designed to:

(i) Permit rapid extraction and analysis of data for the purpose of monitoring driver or EMU/MEMU system ;

(ii) assist retrieval of data after an incident or accident; and

(iii) mitigate the effects on recorded data of foreseeable impact or derailment.

4.3.20 Control equipment

4.3.21.1 All control equipment, including driver's controls and indications for electrical, pneumatic, air pressure, brake and other circuits shall be provided. Necessary operational, protective and safety devices in the form of relays, contactors, switches as may be required by the circuit design shall also be incorporated for proper functioning of the power and auxiliary equipments and brakes etc.

4.3.20.2 The control equipments, relays and switches, and such other devices shall be in accordance with the Good Industry Practice.

4.3.20.3 All vital contacts for operation of the EMU/MEMU shall be duplicated to provide redundancy.

4.3.20.4 Interlocks and auxiliary contacts of relays of protective, operation, control, auxiliary and safety circuits shall be housed in dustproof enclosures either by providing the complete equipment in dust-proof cabinets and/or pressuring the cabinets or by covering the contacts only by dust-proof covers.

4.3.20.5 The working of all relays and contactors shall be in the range –30 % / +25 % of nominal battery voltage when the operating coils are at their rated temperature and the contacts are subjected to normal pressure.

4.3.20.6 The temperature of the equipments shall be governed by IEC minus 30^{o}C.

4.3.20.7 Rubber components, such as pistons, 'O' rings etc. wherever employed in the control gear, brake system and their controls shall be suitable for the specified humid and environmentally severe conditions. The life of rubber components shall not be less than six years.

4.3.20.8 Surge suppression circuits shall be incorporated to eliminate surges, wherever required.

4.3.20.9 Endurance tests, both mechanical and electrical, shall be in accordance with IEC 60337.

4.4 Environmental Noise Standards

The following noise standards shall be followed.

4.4.1 Stationary EMU/MEMU

Noise level inside the coach and cab.

The noise level inside the coach and the cab shall not exceed 68 dB (A) with all auxiliary equipment operating at its greatest noise output. The noise level shall be measured in the coach along the center line between 1200 mm and 1600 mm above the floor and at a distance over 600 mm from the end of the coach. The measurement shall be done as per ISO 3381.

Noise level outside the EMU/MEMU

The noise level outside the Train shall not exceed 68 dB (A) with all Auxiliary Equipment operating. The noise level shall be measured at a point 7.5 m from the EMU/MEMU centerline at a point between 1200 mm and 1500 mm above the rail level. The measurement shall be done as per ISO 3095.

4.4.2 Moving EMU/MEMU

Noise level inside the coach and cab.

The noise level when running at the scheduled maximum speed shall not exceed 72 dB (A). The noise level shall be measured in the coach along the center line between 1200 mm and 1600 mm above the floor and at a distance over 600 mm from the end of the coach. The measurement shall be done as per ISO 3381.

Noise level outside the EMU/MEMU

The noise level when it is moving at the scheduled maximum speed shall not exceed 85 dB (A) with all auxiliary systems operating. The noise level shall be measured at a point 7.5 m from the EMU/MEMU centerline at a point between 1200 mm and 1500 mm above the rail level. The measurement shall be done as per ISO 3095.

4.4.3 All noise levels listed above are in decibels referred to 20 micro Pascal as measured with "A" weighting network of standard Type 1 sound level meter with time weighting F.

4.5 Safety measures

4.5.1 All exterior components including under slung equipments shall be attached with use of secondary restraints, redundant fixings or secondary latches as appropriate to ensure that no single point failure shall cause equipment to either physically detach or protrude out of gauge.

4.5.2 Standard protective systems shall be provided, in accordance with the Good Industry Practice, for protection of the electrical equipments against abnormal currents, excessive voltages, etc., with indicating facilities, so as to ensure safe and correct

operations. All equipments shall be adequately earthed, insulated, screened or enclosed and provided with essential interlocks and keys as may be appropriate to ensure the protection of the equipments and safety of those concerned with its operation and maintenance.

A sensitive and reliable protection arrangement against earth fault shall be provided in each circuit group.

All electrical circuits shall be fully insulated from the superstructure on both the positive and negative sides and the super-structure shall not be used as a part of any earth return circuit.

Relevant provisions stipulated in Indian Electricity Rule 1956 (or latest) shall strictly be followed in the interest of safety of passengers/staff as well as for equipments/instruments provided in the EMU and MEMU coaches.

4.5.3 Fire prevention measure

i) The equipments shall be designed to minimize the risk of any fire.

ii) Materials used in the manufacture of equipments shall be selected to reduce the heat load, rate of heat release, propensity to ignite, rate of flame spread, smoke emission and toxicity of combustion gases.

iii) The equipments shall comply with specification NF F 16-101: (Railway Rolling Stock Fire behavior "Choice of Material"), NF F 16-102: (Railway Rolling Stock Fire behavior "Material choosing, application for electric system" category A2), BS 6853 – 1999 Category II or DIN 5510 or any other equivalent/superior international standard for fire safety plan in respect of their equipment.

iv) All safety features in design, construction and materials used shall conform to the best safety standards and shall in particular prevent fires in EMU/MEMU in accordance with Good Industry Practice.

4.5.4 Fire detection system

The EMU and MEMU shall have a fire detection system. This shall be capable of detecting a fire in any coach or driver's cab. On detection of a possible fire by means of suitable detection, the system shall have two levels of response that shall indicate the coach involved, the level and the location to within less than 8 (eight) meters (measured longitudinally) within the coach in which the possible fire is located.

The two level of alarm shall be:

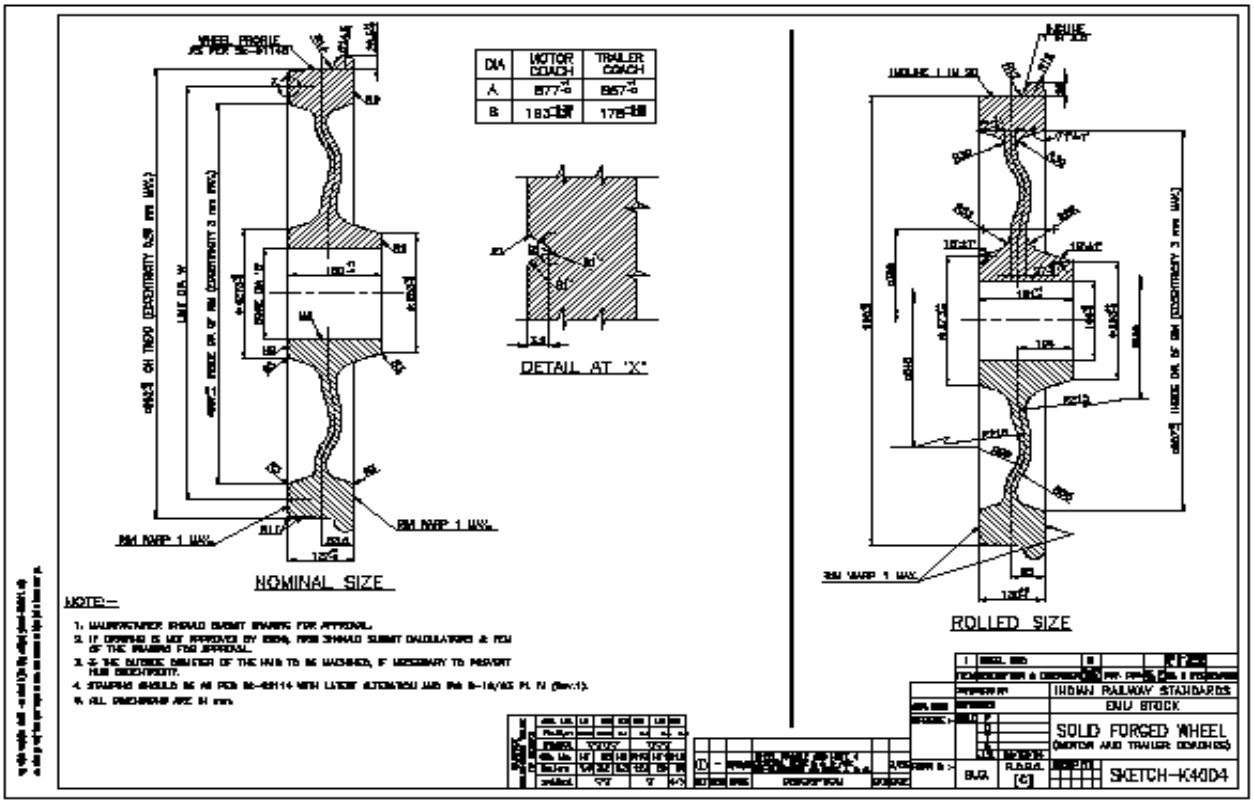
a) First alarm: sent to the driver indicating that a fire may have started and that this is a first stage alarm.

b) Second alarm: if the detection system detects a large heat source or denser smoke it shall send a further alarm to the driver indicating that this is a second stage alarm. The second stage alarm shall also be sent to the coach involved to alert the

passengers. The audio video indication for second stage alarm in the coaches shall be provided near the niche provided for fire extinguishers.

In the event of detection of a fire the ventilation and air-conditioning system shall be controlled to minimize the spread of fire to promote the escape of passenger. In the event of detection of smoke outside the EMU/MEMU an alarm shall be provided to the driver. The driver shall then be able to remotely close the ventilation and air conditioning unit's fresh air intake.

Annex- A1



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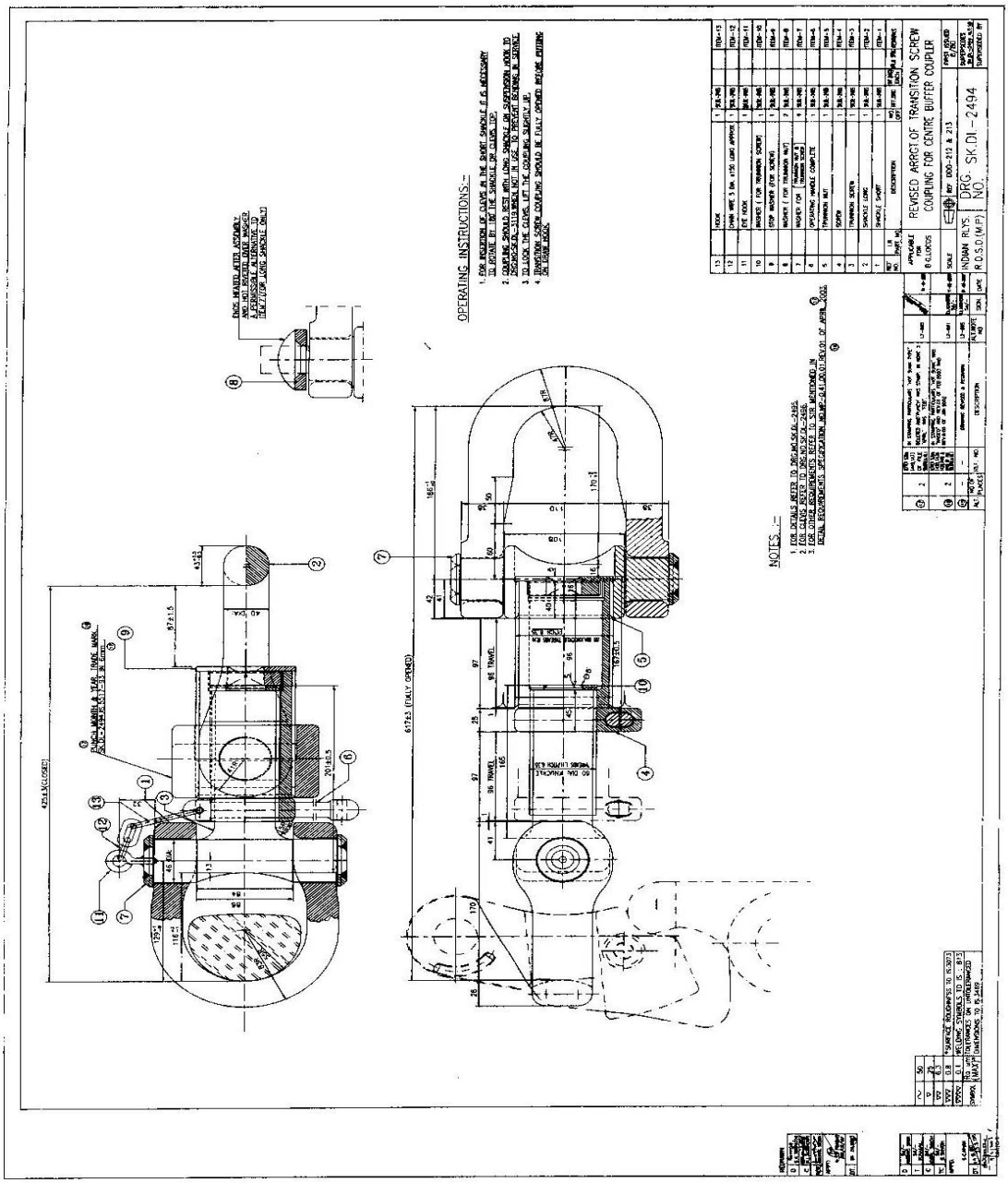
Annex- A2



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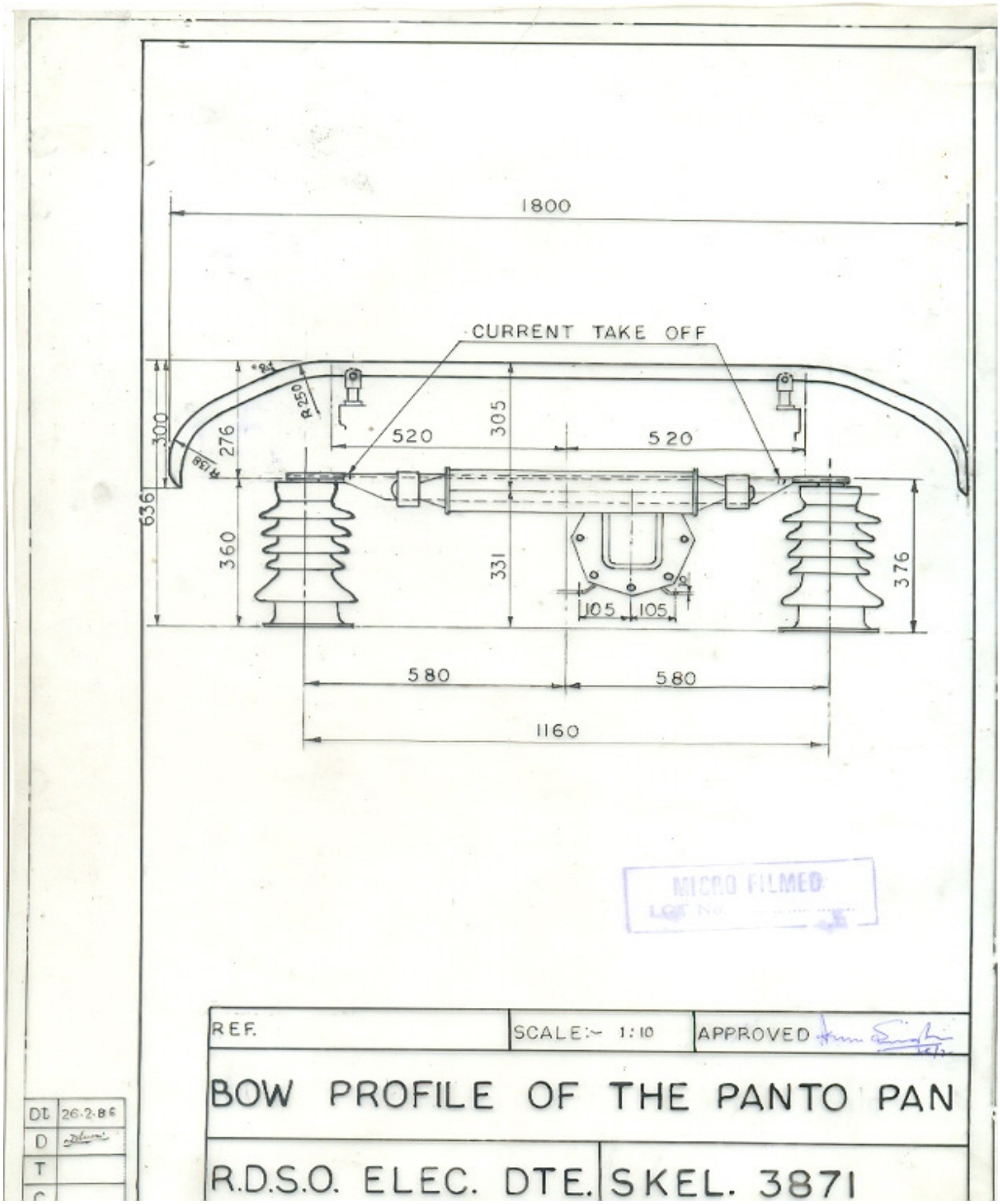
Annex. A3



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Annex. –A4

List of Standards

1.	Axle Non powered Powered	IRS R-16 IRS R-43
2.	AAR approved couplers and coupler yokes	M-211
3.	Brake system	EN 13452-1:2003
4.	Batteries	IEC 60623
5.	Cables	IEC 60228, IS 10810
6.	Control cubicle	IEC 60068
7.	Degree of protection provided by enclosures	IEC 60529
8	Draw and buffing gear	SKDL 2494
9	Electric traction – rolling stock – test methods for electric and thermal /electric rolling stock on completion of construction and before entry into service	IEC 61133
10	Electronic equipment used on rail vehicles	IEC-61287 IEC-61287-1
11	Electronic converter fed alternating current motors	IEC 60349 –2 IEC-60563
12	Electric railway equipment-train communication network	IEC 61375
13	Environmental conditions for the equipment on board the coach	EN 50125-1
14	Guide for the evaluation and identification of insulation systems of electrical equipment	IEC 60505
15	Guide lines for evaluating passenger comfort in relation to vibration in Railway vehicles	UK 513 E
16	High voltage AC circuit breaker	IEC 60056
17	Indian Electricity Rules	Indian Electricity Rules-1956 (or latest)

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18	Lightning arrestor	IEC 60099-4, IS 3070 pt III
19	Limit of second harmonic	IEEE 591-1992
20	Layout of driver's cab in Locomotives, Rail cars, Multiple unit trains and Driving trailers	UIC 651
21	Loading of coach bodies and their components	UIC 566
22	Metallised carbon strip for pantograph	Specification No: RDSO/2009/EL/SPEC/0097, Rev. '0'
23	Noise level Out side the coach In side the coach	ISO 3095 ISO 3381
24	Programming languages for PLC	IEC 61131
25	Power converter installed on board rolling stock – Part 1: Characteristics and test methods	IEC 61287-1
26	Power converter installed on board rolling stock– Part 2: Additional technical information	IEC 61287-2
27	Power factor correction	IEC 60871
28	Railway application – rolling stock – Part 1: combined testing of inverter fed alternative current motors and their control system	IEC 61377-1
29	Rotating electrical machines: Functional evaluation of insulation systems	IEC 60034-18
30	Railway applications – electromagnetic compatibility – Part 3-2: rolling stock – Apparatus	EN 50121-3-2/ EN 50121-3-1 /IEC 62236-3-2
31	Railway applications – electromagnetic compatibility – Part 2: emission of the whole railway system to the outside world	EN 50121-2/ IEC 62236-2
32	Railway applications – compatibility between rolling stock and train detection system	EN 50238
33	Rules for pantograph of electric rolling stock	IEC: 60494 Pt.I

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34	Relays, contactors and switches	IS 3231, IEC 60337, 60947
35	Railway applications – rolling stock equipment – shock and vibration test	IEC 61373
36	Railway applications – electric equipment for rolling stock	IEC 60077-1
37	Railway application – rolling stock protective provisions against electrical hazards	IEC 61881
38	Rules for installation of cabling	EN 50343
39	Railway applications, welding of railway vehicles and components. Inspection, testing and documentation	EN15085
40	Reliability of electronic component	IEC 61709
41	Reliability , Availability, Maintainability and Safety (RAMS)	EN 50126/ IEC 62278
42	Railway applications; Body entrance systems	EN 14752
43	Railway applications , Methods of specifying structural requirements of bogie frames	BS EN 13749:2005
44	Railway applications, Wheel sets and bogies , Non powered axles, Design methods	BS EN 13103:2009 UIC 515-4
45	Railway applications, Wheel sets and bogies , Powered axles, Design methods	BS EN 13104:2009 UIC 615-4
46	Ride quality of the coach (RI)	RDSO report no. MT-334 ORE report no. 8 of C 116
47	Resistance to fire (Coach interior)	NFPA-130 2010
48	Railway rolling stock cables having special fire performance	EN 50264
49	Specific rules concerning the electronic control part of converters	IEC-60571
50	Solid forged wheels (motor and trailer coaches)	IRS R-19 Drg. No. SKETCH-K4004
51	Schedule of Dimension for broad gauge	IR Schedule Of Dimension for Broad Gauge, revision 2004

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52	Structural requirements of railway vehicle bodies	EN 12663 – 2000
53	Slip/ skid resistance test for floors	SATRA TM 144
54	Safety measures	NF F 16-101 NF F 16-102 BS 6853-1999 DIN 5510
55	Transformer and chokes	IEC 60310
56	Transformer oil	IEC 60296/ IS12463
57	Wind loads on buildings and structures	IS- 875