Note:

1. The deletions are marked in strikethrough and additions are italics and underlined.
2. The dotted segment indicates that rest of the clause not appearing here, is not affected and continue to remain same as in the original specification.

S. No.	Clause No.	Clause to be read as
1	4.1.6	~~The cooling agent for the transformer shall be arc resistant and shall have high flash point~~ *The cooling agent for the transformer shall be K-class, biodegradable, arc resistant and shall have high flash point (> 250 ºC) & high fire point (>300 ºC).* Supplier shall study the currently available cooling oils in India and employ these as far as possible. If, the imported cooling oil is used, Supplier shall study and furnish details of equivalent indigenous cooling oil.
2	4.19.1 (Adden./Corr.-2)	The Passenger Car Surveillance System (PRSS) shall comprise of an IP based close circuit television (CCTV) network, surveillance cameras, routers and cables, monitors and other accessories as per RDSO Telecom Directorate Specification no. ~~RDSO/SPN/TC/106/2022 (Version No. 2.1 or Latest) along with enclosed Annexure VI D~~ *RDSO/SPN/TC/106/2025 (Version No. 3.1 or Latest).*
3	Annexure-VI-D (Adden./Corr.-2)	Deleted
4	Annexure-XVIII 4.0(A) (xxviii)	~~Cab air-conditioning system complete with switch gear & control system~~ ***a) Roof Mounted Heating Unit (RMHU) consisting of Heater units, Blower unit with motor, Over heat sensors, temperature sensors, Fresh air filters, return air filters, connectors for Power and Control cable connections, flexible conduits*** ***b) Control Panel box(pre wired) Consisting of contactors, ~~control Transformer (230V/110V ac),~~ MCBs, Temperature Controller, Rotary switch, Terminal board and pre wired- connector type plug with sufficient length of cable (of approved make) to RMHU)*** **c) *Anti vibration mountings***
5	Annexure-XVIII 4.23.16	***The control circuit of the panel shall work on 110V ~~ac~~ DC. ~~single phase supply being derived from a control transformer in the panel (230V/110Vac)~~***
6	Annexure-XVIII 4.24.16.5	***The control circuit of the panel shall work on 110V ~~ac~~ DC ~~single phase supply being derived from a control transformer in the panel (230V/110Vac).~~***
7	Annexure-XVIII 4.24.5	***Heater unit Blower motor and defogger unit blower motor Rating shall be ~~230V~~ 415 V ac , ~~1 Phase,~~ 50Hz. and wattage should meet as clause 4.24.2 and max of 0.4 HP. ~~However, system available voltage in the coach is 415V, 3 Phase, ac.~~ Type of blower motor shall be capacitor start and run and shall conform to IS 996 latest.***
8	New Annexure-XX	Applicable for Air-conditioned EMUs only

Annexure- XX to Specification no. RDSO/PE/SPEC/EMU/0163 Rev. 3 -2022

(Applicable for Air-conditioned EMUs only)

Note:

1. The deletions are marked in strikethrough and additions are italics, bold and underlined.
2. The dotted segment indicates that rest of the clause not appearing here, is not affected and continue to remain same as in the original specification.

S. No.	Clause of the Specification	Changes in the Clauses
1	1.1.4(xiii)	The equipment shall be designed keeping in view that the EMUs/MEMUs operates with ***automatic*** doors ~~and windows wide open~~
2	1.1.5(v) New clause	***Smoke/Fire detection system compliant to ARGE Guideline Part 1 "Fire detection in railway vehicles" shall be deployed. These standards may be referred for details of Smoke/Fire detection time, Positioning and commissioning of the system etc. The system to be capable of detecting smoke / fire along with its location at incipient stage of fire. In passenger areas, the system to provide a dynamic two detector dependency (smoke and/or heat) along with provision of drift compensation in order to decrease the risk of false, or unwanted alarm.*** ***Prototype approval to ensure the compliance of the system to ARGE guidelines will be arranged by the supplier and will be witnessed by any accredited assessor for these systems in presence of consignee/RDSO. Issues related to interface of smoke/fire detection system with TCMS shall be finalized at detailed design stage.*** ***Air conditioning of each coach and Fresh air should be controllable as per fire system requirement***
3	2.1.2(v) New Clause	***Purchaser is to make effort to decrease weight of coaches as much as possible. Higher weight of any EMU coach than that of existing 3-phase EMU coaches will require multibody dynamic simulation by the purchaser to check & ensure riding behavior of coaches within permissible limits as per applicable criteria.***
4	2.1.2(vi) New Clause	***Load will be distributed in such a way that coaches remain balanced in longitudinal as well as lateral direction.***
5	2.3,3.1.8,3.1.20 ,4.12.8(i), Index Chapter-3, Annexure-II	Replace "1 in 100" by "1 in 34"
6	2.5, 3.1.3(a), 3.1.5,3.1.13, Annexure-II	Replace "2.4 Km" by "1.5 Km" in all the clauses.
7	2.7(ii), 4.4.17.1(i), 4.15	Replace "400 mm" by "760 mm" in all the clauses

Annexure- XX to Specification no. RDSO/PE/SPEC/EMU/0163 Rev. 3 -2022

(Applicable for Air-conditioned EMUs only)

S. No.	Clause of the Specification	Changes in the Clauses
8	3.1.6(iii)	Efficiency curves of each equipment and tractive effort/braking effort (in KN) for each motor coach shall be furnished along with overall system efficiency curves. The total auxiliary power shall be furnished as break up of power requirement for lights, fans, ***Air-conditioning*** and auxiliary power required for propulsion system.
9	3.1.17	**Regenerated Energy** -The regenerated energy for all out running up to 110 kmph(full traction up to 110 Kmph and full service braking up to standstill) shall not be less than 23% of the energy consumed during powering at the specified voltage for ~~both~~ EMU ~~& MEMU~~. Acceleration and braking rates shall be as defined in clause 2.4 of the Specification. Full auxiliary load shall be taken into account except emergency load and ~~ventilation load~~ ***RMPU load***. Also duty cycle of compressors shall be considered as 100%. The net energy consumed or regenerated at the pantograph shall be used for calculating percentage regeneration energy. In the event of failure of one Basic Unit I equipment less than or equivalent to that of one Basic Unit, reduction in the value of regenerated energy shall not be more than that of their proportionate value.
10	4.0(A)(xxxi) New clause	***Complete air-conditioning system with necessary equipment such as Roof Mounted Package Unit (RMPU), control panel, micro-controller etc.***
11	4.14.2	~~The auxiliary system shall be designed in such a way that in the event of failure of auxiliary converter(s) equivalent to one basic unit, all the loads including 100% traction load shall work normally. In case of failure of next auxiliary converter, the units with failed auxiliary converter shall work with 50% traction load, 50% light and fan load , 100 % ventilation load and all other loads shall be fully available~~. ***Each basic unit shall have at least 2(Two) auxiliary converters of same capacity. The auxiliary system shall be designed in such a way that:*** ***(i) In the event of failure of auxiliary converter(s) equivalent to one basic unit, all the loads (including air conditioning) shall work normally.*** ***(ii) In case of failure of next auxiliary converter(s) equivalent to one basic unit, all the loads (including air conditioning) shall work normally, the unit with failed auxiliary converter(s) shall work with 50% air conditioning i.e. one refrigerant cycle of each RMPU, and all other loads shall be fully available.*** ***(iii) In case one more auxiliary converter(s) fails equivalent to one basic unit, air conditioning shall be switched off and all other loads including fresh air ventilation shall work normally.*** ***The above-mentioned design rules shall be fulfilled with a 12-car rake. During design state the detailed auxiliary design concept shall be submitted for approval.*** The changeover shall be affected automatically ……..LED based head light as per RDSO specification No. RDSO/2017/EL/SPEC/0134 Rev. 1 dated 23.04.2019 shall be used.

S. No.	Clause of the Specification	Changes in the Clauses
12	4.16	**4.16 AUTOMATIC SMOKE / FIRE DETECTION WITH ALARM:** A reliable automatic fire detection and alarm system shall be provided in the train covering the following areas: (a) Electrical cabinets, traction converter, auxiliary converter etc. - Provision of Linear Heat Detector (LHD) cables (UL or EN approved). (b) LT/HT compartment – Provision of Smoke/Fire detectors (as per EN 54-7 and EN 54-5) at suitable locations. The sensitivity and location of detectors in LT & HT compartment has to fulfil requirements of ARGE Guideline -Part 1 "Fire detection in railway vehicles. (c) Provision of RDSO approved make of Aerosol based fire suppression system for electrical cabinets, traction converter, auxiliary converter with 100 gram of aerosol per cubic meter of the enclosure targetted. ***(d) Smoke/Fire detection system in passenger area also to be provided as per details contained in this Annexure***. The system to be capable of detecting smoke / fire in above areas along with its location at incipient stage of fire. On detection of a possible smoke / fire by means of Smoke/Fire detectors, the system shall have different levels of response (at-least two i.e. warning and alarm) to be finalised at design stage. System indications must be promptly available to driver via TCMS pop-up messages who shall then take necessary action to minimise the spread of fire. There should be a provision for isolation of faulty detectors to avoid any inconvenience in train operations The Smoke/Fire Detection system shall interface with TCMS in a redundant manner. Issues related to interface of smoke/fire detection system with TCMS shall be finalized at detailed design stage. All the major events (alarms, faults etc.) to be recorded in the detection system and should be retrievable on maintenance terminal for analyzing any issue. The System shall be designed for self-diagnostic to any failure/trouble within The System i.e. wiring break within the system, discontinuity in the circuit etc. The Supplier/OEM shall provide necessary diagnostic tools (softwares, hardwares etc.) in order to identify failures immediately.

S. No.	Clause of the Specification	Changes in the Clauses
		Prototype approval to ensure the compliance of the system to ARGE guidelines will be arranged by the supplier and will be witnessed by any accredited assessor for these systems in presence of consignee/RDSO.
13	4.20 New Clause	***4.20 Body Side Automatic Doors (Not in the scope of supply)*** ***Functional / TCMS interface requirements*** ***4.20.1 The Car(s) shall have maximum 08 (eight) electrically powered,*** ***Double Leaf Automatic Sliding Type Doors;*** ***4.20.2 The passenger body side door shall fully open in less than 4.5 (four point five) seconds and shall close within 6 (six) seconds from the instance the Train Operator operates the door. Minor adjustment in timings shall be possible.*** ***4.20.3 The end of the closing stroke (e.g. approximately 100mm) shall be damped or cushioned to reduce impact and minimize possible injury to passengers*** ***4.20.4 Obstacle detection Mechanism:*** • ***When a non – elastic rod with a maximum rectangular cross section of 15 mm x 60 mm is trapped with its long edge vertically between the door leading edge and the frame of the door shall not be indicated as closed and locked. The requirement shall be verified at three positions, the bottom, the middle and the top of the door. If soft horizontal bottom rubbers are provided, this requirement applies from the bottom edge of the door leaf upwards above the rubber*** • ***The maximum force exerted on an obstacle during final closing stroke shall not exceed the following values:*** • ***Peak force Fp< 300 N,*** • ***Effective force during first closing attempt Fe < 150 N,*** • ***Mean effective force including further closing attempts FE < 200 N,*** • ***The values specified shall be measured using a device and method as described in Annexure-D of EN 14752: 2015. Measurement on each door may not be required if the system provides constant performance.*** • ***An obstacle with maximum dimension of 10 mm x 50 mm trapped with its long edge vertically between the leading door edge and the***

S. No.	Clause of the Specification	Changes in the Clauses
		frame or between two door panels shall be withdrawn slowly in outward direction with a force not higher than 150 N, measured perpendicularly to the door surface. Alternatively, the door shall not be indicated closed and locked. The requirements shall be verified at the middle position only of the door. • ***Door system should be capable to detect an obstacle object of at least 10 mm.*** • ***If obstacle is faced during closing, the automatic door shall reclose 3 times, this shall be adjustable. In the event that the automatic door fails to close following the three attempts, further door movement shall cease on the offending automatic door and door will go to and remain in full open position unless again command has been not generated.*** • ***If obstacle is faced during opening, then door will move to close come in pause position and stay there unless again command has been not generated.*** • ***Door closed and obstruction sensing information shall be sent from each coach in the rake to Master Controller.*** • ***The number of obstructions during opening or closing shall be logged by the door control system as an aid to diagnosing door system problems*** ***4.20.5 The door mechanism shall have safety provision whereby the Train shall not start unless all doors have been closed and locked. An indication confirming that all doors are closed shall be provided in the Driving Cab.*** ***4.20.6 Provision shall be made for passengers to open the doors to permit evacuation from a stopped Train in an emergency. There shall be an internal and external manual release mechanism on each door.*** ***4.20.7 A door opening & closing warning shall be provided by audible and flashing light indication. This shall be provided at the centre of each door, both outside and inside, to indicate door status including isolated state. LED lamp shall flash during opening/closing and shall be in ON position during open/isolated condition.*** ***4.20.8 A door close announcement through PA/PIS followed by a chime controlled preferably by the DCU (scheme to be finalized during design stage) shall be triggered each time the "Door Close Announcement" button is pressed. The door close chime shall***

S. No.	Clause of the Specification	Changes in the Clauses
		continue to play till the Doors achieve locked position. The chime shall warn the passengers inside the train as well as those on the platform about the door operation. It shall be possible for maintenance depot to adjust the volume of speakers easily as per the need. Selection of the type and adjustment of volume of the chime shall be independent for external and internal. The adjustment of the volume of the chimes for internal shall be independent of the volume for announcements. ***4.20.9 It shall be possible to monitor the status and faults of each door on the TCMS.*** ***4.20.10 A microprocessor based Door Controller Unit (DCU) shall control each pair of door and shall be an integral part of door control assembly. The door controller unit shall communicate with TCMS.*** ***4.20.11 It shall be possible to modify/change the parameters or closure/opening logic of doors' circuit and implement the same as required by IR based on their operational and maintenance requirements.*** ***4.20.12 Doors shall be electrically operated from 110V d.c. (nominal) supply through train line. The door operating mechanism shall be of a proven design in service. The door system shall continue to operate correctly with the car battery voltage supply range between 77V to 137.5 V DC.*** ***4.20.13 Successful closing of doors should be confirmed by mechanical locking. Interlocks should prove the closed and locked position of door system and then application of traction power should be enabled.*** ***4.20.14 No spurious electrical signals shall cause any door to be released or opened. There shall be no single point failure of equipment or wiring, or two point failure with one failure undetected, which would cause a door to open without being commanded. The door controls shall be interlocked with the train's zero speed circuitry so that the doors cannot be opened until the train is stopped.*** ***4.20.15 The control architecture of body side door shall utilise the combination of hardware and software for reliable and robust control to avoid single point failure in the control on basic unit level***

<table>
<tr><th>S. No.</th><th>Clause of the Specification</th><th>Changes in the Clauses</th></tr>
<tr><td></td><td></td><td><u>and on train level.</u>

<u>4.20.16 It shall be the responsibility of the Supplier to jointly finalise the interface with the door supplier, which shall be facilitated by the Purchaser.</u></td></tr>
<tr><td>14</td><td>4.25
New Clause</td><td><u>4.25 Air-Conditioning System</u>

<u>4.25.1 All the Cars shall be air-conditioned with a minimum of two light weight preferably Aluminium body roof mounted packaged unit (RMPU) type airconditioning units in each Car. Driver's cab shall also be air-conditioned. Each packaged unit shall have two independent refrigerant circuits. It shall also be able to provide heating during winter through reverse cycle heating concept. The control of both the air-conditioning unit shall be performed by suitably designed single microprocessor controller. The complete air system shall have EER (Ratio of capacity in BTU/Hour and the total power consumption in watts) better than 7.0 under the specified conditions. No material shall be used in construction of air conditioning unit that is liable to be adversely affected by vibration, damp, rotting or growth of moulds. Fire retardant material only should be used.</u>
<u>4.25.2 The Cars shall be provided with refrigeration system using R 407C refrigerant or any other eco-friendly HFC refrigerant having zero ozone depletion potential and A1 safety category as per ASHRAE standards.</u>
<u>4.25.3 The air conditioning units shall be fed from the auxiliary converter. Provision of protective devices, relays/contactors in 3-phase supply of air conditioning unit shall be made for protection against short circuit / overload / earth fault and also to isolate the healthy air conditioning unit from the defective one.</u>
<u>4.25.4The TR/kW rating/cooling capacity of RMPU provided in each coach shall be same, which shall be finalized/calculated based on the necessary heat load calculations with the following known conditions and data:</u>

A. <u>For Other than Coastal Area:</u>

<table>
<tr><td><u>Summer condition</u></td><td><u>Dry bulb</u></td><td><u>Wet bulb</u></td><td><u>% R.H.</u></td></tr>
<tr><td><u>Outside (dry summer)</u></td><td><u>50°C</u></td><td><u>25°C</u></td><td><u>-</u></td></tr>
<tr><td><u>Outside (wet summer)</u></td><td><u>40°C</u></td><td><u>28°C</u></td><td><u>-</u></td></tr>
<tr><td><u>Inside (dry and wet)</u></td><td><u>20–25°C</u></td><td><u>-</u></td><td><u>60–40%</u></td></tr>
<tr><td colspan="4"><u>Winter conditions</u></td></tr>
</table></td></tr>
</table>

S. No.	Clause of the Specification	Changes in the Clauses

Outside	***- 5°C***			
Inside	***17-21°C***			
Number of passengers (SDCL)	***As defined in Annexure XVI***			
Fresh air requirement per passenger	***0.25 m3/min./passengers***			
The physical dimensions and thermal parameters (co-efficient of heat transfer etc.) of the coach and its glass window	***Shall be provided by the coach builder.***			

B: for Coastal Area:

Weather Conditions	***External Conditions***	***Internal Conditions***
Summer	***42°C Dry Bulb, 30% RH***	***23°C Dry Bulb, 40-60% RH***
Monsoon	***35°C Dry Bulb, 88-100% RH***	***23°C Dry Bulb, 40-60% RH***
Winter	***10°C***	***18°C***

4.25.4.1 For heat load calculation of coach, 10% of the calculated coach heat load shall be taken under consideration for infiltration of air through the opening/closing of the car doors and air leakage through the window gaskets etc.

4.25.4.2 Based on the coach (car) heat load calculations, the TR rating shall be decided, however, the cooling capacity shall not be less than 15TR/52.7 kW per RMPU. The manufacturer/supplier shall furnish the complete heat load calculation to RDSO for approval.

4.25.4.3 The TR/kW rating/cooling capacity of RMPU shall be tested at firm's premises maintaining the conditions as per clause 4.25.4 in the test room in the automatic psychometric test laboratory.

4.25.5 RMPUs shall be capable of pre-cooling the coach up to 23°C without passenger, with fresh air dampers closed, lights and fans switched on after raising the inside temperature to 45°C in less than 45 minutes. Further, capacity should be adequate to cool the coach in extreme summer condition within 2 hours when the coach is fully occupied, which will be verified by conducting pull down test on prototype rake/ coach (RDSO test program No.: ELPS/TP/AC/01 may be referred for guidance.

4.25.6 The design of RMPU shall be such as to restrict relative humidity

S. No.	Clause of the Specification	Changes in the Clauses
		inside the air conditioning compartment under all circumstances (even with ambient having RH as high as 98%) to a maximum of 60%. ***4.25.7 In the event of failure of one RMPU, the second RMPU shall cater 60% of the total air-conditioning load of the Car*** ***4.25.8 The single RMPU shall be able to work even with one condenser fan and the cooling capacity so obtained shall not be less than 75% of the rated capacity of the said RMPU.*** ***4.25.9 Supplier shall provide controller with smart automatic temperature settings based on thermal comfort index for comfort of passengers as per ASHARE or any other algorithm, which will be shared by RDSO with Supplier.*** ***4.25.10 All the equipment shall be capable of continuous operations without detriment to the operation of cut-outs and circuit breaker or over load, as per the environmental conditions mentioned in Clause no. 2.7 of this Specification.*** ***4.25.11 The minimum fresh air quantities shall not be less than 0.25 m3 / minute / person for all types of Cars. The air-flow parameters shall be as per ASHRAE / EN 13129:2016.*** ***4.25.12 Noise produced by the air-conditioning equipment in empty compartment with the stationary vehicle must not exceed 65 dB(A) as per EN 13129:2016. The Supplier shall associate with Purchaser at the design stage with regard to the interface requirement to minimize the noise levels.*** ***4.25.13 The RMPU shall be able to perform satisfactorily even at an ambient temperature of 57 °C without any tripping of the equipment and the same shall be tested on test room at manufacture's premises.*** ***4.25.14 The compressor suitable for traction environment, shall only be used and it shall have adequate capacity at 60°C condensing temperature & 5°C evaporating temperature. One of the compressors in each RMPU shall have automatic capacity control through VVVF control to optimize the efficiency of RMPU. The refrigerant evaporator unit shall comprise of cooling unit with automatic thermostatic expansion valve. The Heat exchanger shall be pre-coated and made of copper tubes with Aluminium fins. Heat exchanger shall pass 1000 hours salt fog test as per ASTM-B-117. However, tinned copper fins will also be acceptable.*** ***4.25.15 Each air conditioning unit shall be constructed as an integral module to enable removal from the Car as single complete item without the necessity to break any refrigerant lines or any part of Car or unit itself. All electrical connections and condensate outlets shall be fitted with standard quick heavy duty disconnect fittings. The connectors should be so positioned to ensure that it is not damaged when the air conditioning unit is removed from the Car and placed on a flat surface. Connectors shall conform to DIN EN***

S. No.	Clause of the Specification	Changes in the Clauses
		175301-801. ***4.25.16 All fresh air intake shall be filtered and the air filter elements shall be cleanable and shall not be of disposable type. The Supplier shall use a filtration system suitable for Indian conditions requiring minimum attention/cleaning/maintenance. Suitable device to indicate the pressure drop shall be installed so that filters can be replaced/cleaned after getting necessary indication for the same.*** ***4.25.17 Thermal comfort based Microprocessor controller shall be used for air conditioning system. However, in case of failure of microprocessor-based controller, it shall be possible to run the system with full capacity in manual mode with all major protections intact. The link between the microprocessor and interfaced cards shall be established by means of serial bus system or any other superior means to ensure error free high speed data transmission. The control and monitoring function shall be implemented through software to reduce hardware and cables. The complete control panel along with microprocessor controller shall be accessible from inside the Car without any requirement of going on roof.*** ***4.25.18 The microprocessor shall perform the task of fault diagnosis and display in addition to control task. It shall be a capable of monitoring the status of the equipment and faulty sensor/ cables continuously and the occurrence of the faults. It shall also take appropriate action and wherever necessary, it shall shutdown the equipment. The faults shall be stored in the memory of microprocessor and it shall be possible to download the same using commercial available USB pen drive or laptop.*** ***4.25.19 Various important parameters of the equipment as well as environmental data at the time of occurrence of the fault shall also be recorded. Application/diagnostic software tools as required for trouble shooting and analysis of the fault shall be provided. Adequate redundancy shall be built in the microprocessor.*** ***4.25.20 In the event of failure of air-conditioning unit/units, harmful quantities of the refrigerant shall not be released inside the compartment.*** ***4.25.21 In the event of the failure of 415V power supply in a Car, an emergency ventilation shall operate automatically to admit fresh air directly into Car to maintain the required oxygen level in fully loaded Car, in accordance with ASHRAE. The fresh air intake shall not be less than 15 m3 / hour / person under specified loading conditions. The emergency ventilation shall be fed from 110V DC supply with its dedicated inverter. As an alternative BLDC blower motors directly operating at 110 V DC will also be acceptable.*** ***4.25.22 Superstructure shall be provided with ducting arrangement for discharge / exhaust of air. It shall be ensured that water does not enter in such arrangement during heavy rains striking at 45° opposite to the movement of the train running at 110 kmph or***

S. No.	Clause of the Specification	Changes in the Clauses
		during Car washing. Design of connecting ducts along with outlets shall be developed in consultation with Purchaser. ***4.25.23 Outside smoke detection sensor, inside co2 level sensor and arrangement to provide bacteria free air into passenger area shall be provided.*** ***4.25.24 The design and layout of RMPU shall be such as to prevent water traps even if the vehicle is stopped on the slope or cant. Proper water drainage arrangement shall also be provided.*** ***4.25.25 The design of drainage of condensate water shall be finalized during development stage with the consultation of coach builder, so that the chances of falling of condensate water on electrical coupler, gangway, platform or any other equipment may be eliminated.*** ***4.25.26 The RMPU shall feature with reverse cycle feature, so that it can deliver heating power to keep the coach inside condition warm during winter. No electrical resistive heater shall be used for heating/warming the coach.*** ***4.25.27The RMPU shall be self-supporting and will not form part of the vehicle structure. For the module of unit, a separate structural frame shall be employed which will not rely on any of the installed components or equipment for rigidity or strength. All the parts that require periodic cleaning or maintenance shall be easily accessible when the unit is in installed condition. The parts that require periodical cleaning shall be easily removable with minimum tools and attended to for which facility shall be made available.*** ***4.25.28The electrical power & control connection to the motors, compressors etc. shall be through heavy duty connectors. The connectors shall be IP 67 protected. The location of the connectors shall be in such places, where the rain water directly should not fall on it.*** ***4.25.29 The weight of both RMPUs of one coach with its electrical control panels should not be more than 2100 kgs. This is over and above the weight of electrics specified in clause 2.1.2(i).***
15	4.27 New Clause	***Battery and Battery Charger*** ***4.27.1 Regulated 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 with current limitation to avoid overcharging or undercharging of batteries.*** ***4.27.2 Low maintenance Explosion proof batteries of adequate capacity shall be provided on each Basic Unit to feed the emergency 110V DC load for at least 90 minutes in the event OHE supply is not available. However, Ah capacity of battery shall not be less than 300 Ah. Nominal voltage of the battery shall be 110 V. Battery system will be tested in general as per IEC 62928, IEC 62620 & IEC***

S. No.	Clause of the Specification	Changes in the Clauses
		62619. ***4.27.3 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 voice recorder and flasher light. When auxiliary load is reconnected, the initial battery load shall not cause the battery output to oscillate.*** ***4.27.3.1 The batteries shall be maintained at an adequate level of charge to satisfy the requirements of following Emergency Loads for a duration of 90 minutes after the loss of OHE power:*** ***i. Emergency ventilation in all Cars including Driving Cabs*** ***ii. (Communication system (PIS and PA system)*** ***iii. Head light and Emergency light including Flasher lights*** ***iv. Diagonally opposite doors on either side*** ***v. Train controls (full load)*** ***vi. Fire detection system*** ***vii. For the purpose of capacity calculations, a total of 15 Close-Open operations of door per hour shall be considered*** ***4.27.4 The protection scheme of the auxiliary system shall ensure that:*** ***(i) A single earth fault does not have any adverse impact on the performance of the auxiliary system and auxiliary converters shall continue to feed the load.*** ***(ii) In the case of multiple earth faults or phase-to-phase faults, the affected equipment shall be immediately shut down and no damage to the equipment shall occur.*** ***4.27.5 There shall be provision for using the external power supply of 415 volts, 50 Hz, 3-phase on Basic Unit level, for testing of auxiliary machines, RMPU during maintenance in the depot and charging of battery. Movement of the Train is not required with this power supply.***

INDIAN RAILWAYS

सत्यमेव जयते

R.D.S.O.

Ministry of Railways

POWER SUPPLY & EMU DIRECTORATE

TECHNICAL SPECIFICATION
FOR
IGBT BASED THREE PHASE ELECTRICS (ON BOARD MOUNTED) FOR AC EMUs/MEMUs

RDSO/PE/SPEC/EMU/0163 (Rev. 3)-2022

ISSUED ON OCTOBER-2022

S. No.	Date of Revision/ Addendum	Revision/Addendum	Page no.	Remark
1	16.05.2012	Rev. 1	Refer list of changes	Railway Board's letter no. 2011/Eiect(G)/181/2 dated 25.04.2012
2	24.10.2014	Addendum No. 1	A per Addendum	Railway Board's letter no. 2011/Eiect(G)/181/2 Pt. dated 16.10.2014
3	30.06.2015	Addendum No. 2	A per Addendum	Railway Board's letter no. 2011/Eiect(G)/181/2 Pt. dated 22.06.2015.
4	27.02.2018	Addendum No. 3	A per Addendum	Railway Board's letter no. 95/Eiect.(G)/181/9/Pt. dated 19.02.2018
5	02.08.2021	Rev. 2	As per Rev. 2	1. Railway Board's letter no. 2021/Elect(G)/181/1 dated 19.02.2021 2. ICF/Chennai letter no. MD/DSS/3 Phase EMU/168 dated 10.02.2021
6	20.10.2021 & 17.11.2021	Addendum/Corrigendum No. 1 & 2	As per Addendum/Corrigendum	1. Based on pre-bid queries of ICF Tender No. 08/21/1311
7	14.10.2022	Rev. 3	As per Rev. 3	1. Railway Board's letter no. 2012/Elect(G)/181/7 Policy dated 06.06.21 2. Incorporating Addendum / Corrigendum No. 1 & 2 of Rev. 2

APPROVED

PED/PS & EMU

SSE/PS&EMU Prepared by	ED/EMU Checked By

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CHAPTER 1

GENERAL DESCRIPTION AND SUPPLIER'S RESPONSIBILITIES

CHAPTER 1

GENERAL DESCRIPTION AND SUPPLIER'S RESPONSIBILITIES

1.0 INTRODUCTION

1.1 The AC Electrical Multiple Units (EMUs) are running in Kolkata, Chennai, Delhi , Mumbai & other cities for commuter services, whereas MEMUs are currently running in NR, NER, ER, ECR, SER,SECR, SCR, SWR, SR ,WCR, WR and NCR etc. These rakes are fitted with IGBT device based traction/auxiliary converter, propulsion, control equipment and state-of-the-art Train Control and Management System (TCMS)..

These EMUs are normally working with a formation of 9/12 cars. Four basic units (two 'End basic units' & two 'Middle basic units') make a
12 car rake. Each 'End basic unit' comprises one Driving Trailer coach, Motor coachand one trailer coach. The 'Middle basic unit' comprises Non-Driving trailer coach, one motor coach and one trailer coach.

The general formation of 12 car EMU rake is DTC+MC+TC+NDTC+MC+TC+NDTC+MC+TC+ TC MC+DTC. Similarly, Four basic units (two
'End basic units' & two 'Middle basic units') make a 12 car rake. Five basic units (two 'End basic units' & three 'Middle basic units') make a 15 car rake. A list of drawings for bogie, suspension & brake arrangement etc. is enclosed at Annexure X.

1.1.1 Each basic unit of MEMU consists of 4 - cars i.e. one driving motor coach and three trailer coaches. The units are presently operated in 2/3/4 units in 8/12/16 car rake formation. The standard configuration of 8 car formation has 2 driving motor coaches at both ends and 6 trailer coaches in between. The list of drawings for bogie, suspension & brake arrangement etc is enclosed as Annexure-XI.

1.1.2 Purpose:-

The purpose of this specification is for design, development, manufacture, supply, testing and commissioning of microprocessor controlled IGBT based three phase propulsion equipments for AC Electrical Multiple Units (EMUs) as well as Main Line Electrical Multiple Units (MEMUs), operating on 25 kV AC voltage.

1.1.2.1 25 KV AC EMUs are to be provided with 3-phase asynchronous induction motors with associated IGBT based, micro-processor controlled power converter-inverter, auxiliary converter and filters etc. Three phase drive equipments shall be based on the latest technology and shall be suitable for regeneration.

1.1.2.2The EMU/MEMU coaches shall be manufactured at ICF, Chennai/RCF, Kapurthala or any other manufacturing unit as decided by Indian Railways as per the existing mechanical design, considering three phase on board mounted propulsion equipments

with associated electrics/equipments and other accessories supplied by the supplier at works of coach manufacturer i.e. ICF, Chennai/RCF, Kapurthala/any other manufacturing unit as decided by Indian Railways. The bogies shall be provided with pneumatic suspension in secondary and coil/conical suspension system in primary by Indian Railways. As such, no bogie suspension item shall be supplied by the supplier. The brake system and battery shall be provided by the purchaser. However, any modification, if considered necessary for maximizing the regenerative braking effort, brake blending etc. during empty/loaded condition of train and providing interface for any signals for Train Control & Management System (TCMS) and driver indication panel, shall be in the scope of supplier.

1.1.2.3 In developing the detailed design, the supplier will acquaint himself and take note of the passenger loading especially during the peak time, the route conditions and environmental operating conditions under heavy monsoon & track flooding conditions, saline, humid and dusty atmosphere etc. It is advisable for the bidder to visit the Mumbai suburban area to assess the equipment layout and distribution etc. in the existing AC EMU rakes and suburban section of NR, ER, SER, SCR and SR to familiarize with actual operating conditions.

1.1.3 The major three-phase propulsion equipments are:- self ventilated, fully suspended/Axle Hung Nose Suspended 3-phase asynchronous induction motors, IGBT based micro-processor controlled power converters-inverters, auxiliary converters, Train Control & Management System (TCMS) and traction transformer suitable for operating on 25 kV AC over head voltage.

Technical requirements of the equipments have been defined in chapter 4.

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1.1.3.1 Each Basic Unit (EMU) shall generally consist of one driving trailer coach (DTC), one motor coach (MC) with a Pantograph located above the High Tension Compartment along with an emergency Driving Cab and one trailer coach (TC). The coupling of two or more Basic Units to form train (rake) shall be possible, where, a train normally consisting of not less than three and not more than six Basic Units. In the rake formation, the inner DTCs shall have emergency cab which shall be provided with driver console duly mounted with the safety related equipments, instruments and combined master / brake controller (identical with that in DTC).

1.1.3.2 Each Basic Unit (MEMU) shall generally consist of one driving Motor coach (DMC) and three trailer coaches (TC) with a Pantograph located above the High Tension Compartment. The coupling of two or more Basic Units to form train (rake) shall be possible, where, a train normally consisting of not less than two and not more than six Basic Units.

1.1.4 General Design Requirements:-

i) 3-phase drive equipments should be capable of being mounted in the High

Tension (HT) compartment of the motor coaches, which shall not exceed 3.5 m and 3.9 m for EMUs and MEMUs respectively in length along the track. Fitment of various equipments will be so
decided that the weight is properly distributed with least possible weight unbalancing during tare condition. Mounting of converter/inverter panels on the roof or under frame is not permitted. The traction transformer, and compressor shall be mounted in the under carriage/under frame. Supplier shall decide on - Board/Roof/Under slung equipment layout and their mounting jointly with coach manufacturer.

ii) The stock fitted with the supplied equipment shall meet the operating/service conditions and performance requirements specified in Chapter 2 and Chapter 3 of this specification respectively and shall be suitable for varying loading conditions occurring in the Suburban Sections as defined in Clause 2.1.

iii) Notwithstanding the contents of this specification, the supplier shall ensure that the equipment supplied by them is complete in all respect so as to enable the desired operation of the EMU/MEMU rake fitted with their equipments.

iv) The equipment design shall incorporate all essential features necessary to yield high traffic use, low maintenance requirements, easy maintainability, high reliability in operation and high efficiency with low Specific Energy Consumption (SEC).

v) The entire equipment shall be designed to ensure satisfactory and safe operation under the running conditions specified in Chapter 2 and especially under sudden variations of load and electric pressure as may arise under working conditions due to faulty operation and short circuits.

vi) All working parts of the control and auxiliary circuit specifically electronics and PCBs, shall be suitably covered in cubicles with essential interlocks/keys to keep them free from moisture and dust. As a minimum, equipments shall be sealed to the standard below:

- Under frame mounted equipments (except traction motor) IP65
- Equipments mounted inside the car body IP54

Note that it may be necessary to protect some equipment to IP 67 in order to meet the requirements of flood proofing as mentioned in Clause 2.7, 4.4 and 4.15.

The protection level (IP level) shall be furnished by the supplier during design approval.

vii) All the electrical equipments shall comply with the latest edition of IEC specifications unless otherwise specified. The temperature rise shall be measured according to the procedure stipulated by IEC and shall comply with the limits specified and the ambient conditions defined in this specification. Specified temperature rise of equipment shall be calculated after taking into account at least 25 % choking of air filters and radiator fins etc. The supplier shall give traction motor air duct design and co-ordinate with coach builder for interfacing.

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

ix) Supplier shall study the currently available lubricants/cooling oils in India

and employ these as far as possible. Full lubrication scheme and schedule for the equipment shall be submitted. Wherever the imported lubricants or cooling oil are used, Supplier shall study and furnish details of equivalent Indian lubricants/oil.

x) The complete system shall be compatible with the Auxiliary Warning System(AWS)/Train Protection and Warning System (TPWS)/Train Collision Avoidance System (TCAS)/Communication Based Train Control (CBTC).
IR may provide Automatic Train Protection (ATP) in future . The complete system as supplied against this tender shall be fully compatible with the ATP and should be fully functional by simple interface such that in future it should be possible to interface the same with the ATP by simple interface catering for required input (speed, various pressures such as MR, BP.., EoT etc.,) and output (Service brake, Emergency brake, Traction Cut off, Auto Whistling) signals. There shall be provision for placing Driver Machine Interface on the Motor Man Desk. 110V DC Power Supply shall be made available for the ATP System. The supplier shall furnish the details of the interface arrangement so as to make the system functional on mutually agreed terms and conditions with the purchaser during currency of the contract. Appropriate space for equipment of Auxiliary Warning System (AWS)/Train Protection and Warning System (TPWS)/Train Collision Avoidance System (TCAS) Communication based Train Control (CBTC) may be demarked. The dimensions of equipments of TCAS fitted in different locomotives is shown in Annexure VIC.

The approximate size for installation of train protection warning system equipments is as under:

Cab equipment (WxHxD) : 450 mm x 360 mm x 150 mm

On board equipments (WxHxD) : 560 mm x 1350 mm x 550 mm

xi) The traction equipment shall be suitable for operation with 25 KV AC, 50 Hz supplied by overhead contact wires. In case of EMUs, the control equipment shall be suitable to permit multiple operation upto 18 (eighteen) coach formation of 06 (six) basic units where each basic unit shall comprise of 01 (one) motor coach and 02 (two) associated trailer coaches. Similarly, the control equipments shall be suitable to permit multiple operation up to 24 car rake formation of MEMUs.

xii) Coaches of same make and same type shall be Interchangeable from one unit to another.

xiii) The equipment shall be designed keeping in view that the EMUs/MEMUs operates with doors and windows wide open.

xiv) The design shall also facilitate easy erection by means of suitable tools & equipments, inspection, maintenance and replacement of the various units comprising the equipment.

xv) Software shall be written in a structured manner and fully documented during all stages of its design and development. This shall meet the requirements of EN 50126-2: Dependability for Guided Transport Systems - Part 2 : Safety, EN 50128 : Railway Applications : Software for Railway Control and Protection Systems, and EN 50129 : Safety-related Electronic Railway Control and Protection Systems. Any deviation from this requirement will need approval of RDSO in design stage. For control functions integrated in the TCMS, the requirements of EN 50126 and EN 50128 shall be applied. In particular, the risks associated with the integration of any control function shall be assessed and the design of the TCMS (SIL level according to EN 50128) shall reflect the level of risk identified.
The functionalities indicated as under (but not limited to) shall be minimum

SIL 2 Compliant for below defined vital and safety related control & monitoring functions:

1) Emergency brake 2) Standstill detection 3) Vigilance/dead man control 4) Speed control 5) Roll back detection 6) Speed indication 7) Traction release 8) Smoke and Fire detection Independent safety audit or safety assessment by an accredited agency shall be done for above functionalities for validation and certification of SIL levels according to prevailing EN standards and international practices.
TCMS system shall provide for real time distributed control and modular processing of Sub-systems in a redundant manner with high reliability and availability. The Train control bus and the Train controller shall be redundant.

xvi) Logic of the Software of various sub-systems shall be approved by RDSO in consultation with user railways at the design approval stage. The supplier shall submit the values of parameters, list of fault messages, their environmental data sets, hierarchy of fault display, fault categorization, trouble shooting of each fault, etc, for approval of RDSO. Changes in parameters shall be demonstrated with their effect on results.

xvii) The supplier shall submit software logic diagrams with detail explanation along with complete software packages to be loaded in train management system before the commissioning of the prototype rake. Parametric changes shall be possible in the software in order to meet future requirements, such as change in acceleration and deceleration, bogie and coach suspension, train configurations, OHE voltage and frequency, etc. While listing out the values of various parameters, the contractor must provide a range within which any change can be made without jeopardizing the functionality of the system.

xviii) Software shall be fine tuned through simulations & real life working conditions based on the extensive trials, associating user railways before putting the rake into commercial services. As it requires, instrumentation and expertise of Software Design Professional, software expert (s) of supplier shall be based at the work place along with the commissioning engineers so that all the software related issues are resolved before putting the rake into commercial service.

xix) Quality and efficacy of Trouble shooting manual, software tools and software documentation shall be validated during extensive field trials. Final version of these documents shall include the changes required based on the trials and experience of operating railways. This shall be approved by RDSO.

xx) All the changes, thereafter, in software shall be approved by RDSO in consultation with user railways before actual implementation and the supplier must give software release which shall include brief description of the problem, logics, explanations, parametric changes etc. to the satisfaction of Railways.

xxi) Software documentation shall be provided to give the full understanding of the software function and operation. Documentation shall be complete,clear and concise, and include all modifications up to final acceptance. Documentation shall include software block diagram showing signal flow, logic, and hardware interfaces. A top level flow diagram and description of detailed operation shall be provided.

xxii) The electronic cards and couplers / connectors shall be polarized or suitably designed to ensure that insertion in wrong position is not possible.

xxiii) 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.

xxiv) Supplier shall submit 3D models of propulsion & other equipments, cooling system, driver/shunting desk, cab layout and roof/under frame/HT compartment layouts populated with equipments etc.

xxv) **Proven Equipment.**

The design of the equipment shall be based on sound, proven and reliable engineering practices. The equipment used in different sub systems shall be of proven technology and design.

xxvi) Research Design & Standards Organization (RDSO) has been assigned the responsibility for approval of design and test specification. RDSO shall also be responsible for approving the prototype test procedures and coordinating, witnessing, and verifying prototype testing and results. In addition, RDSO shall be responsible for approval of modifications resulting in any changes in design and layout of the EMUs/MEMUs.

xxvii) Supplier shall enclose technical details of their system design, weight particulars and its disposition, covering all major items viz. Transformer, converter, inverter, auxiliary converter, traction motor, auxiliary machines, basic software specification, control electronics, compressor, communication protocols, display systems, possibility of system expandability and any other aspect/equipment which is within the scope of supply of the supplier. Supplier shall refer Annexure II while enclosing such details. Centre of gravity also to be submitted by the supplier along with weight.

xxviii) The electronics shall be designed to be sealed from the remaining part of the HT compartment so as to ensure that there is no dust ingress whatsoever in to the electronics. The electronics shall be designed with adequate margin so that there are no failures on thermal account and due to dust & mould growth on electronic PCBs.

xxix) The supplier shall design the mounting arrangements suitable for coaches to be manufactured by IR. The accessories for mounting the equipments shall be in the scope of supply. The hardware for mounting, safety links for under-slung equipments, the termination hardware also will be in the scope of supply all equipments.

xxx) All the electrical equipments which are explicitly mentioned in the bid document and agreed to in the contract should be same for EMUs and MEMUs.

xxxi) All underslung equipment shall have requisite protection against damage from ballast hitting during train running.

xxxii) deleted.

xxxiii) During detailed design, CG and weight balancing distribution of supplier equipment may be carried out in co-ordination with consignee Production Unit, to ensure similarity with similar rolling stock.

xxxiv) Suitable compensation methods to be adopted by supplier for avoiding Low Frequency Oscillation in Current/Voltage waveforms in the propulsion system design.

1.1.5 FIRE PREVENTION

i) The equipments shall be designed to minimize the risk of any fire. All entry/ exit points of cables in/ out of equipment/ cubicles and all cable cleats shall be provided with fire barriers (sealant) of intumescent material to prevent propagation of fire through cable insulation. Cable transit system with EPDM rubber modules should broadly conform to Specification no. RDSO/2008/EL/SPEC/0067, Rev. 3 or latest.

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 Supplier shall comply with specification EN 45545 (Railway applications- Fire protection on Railway vehicles). NF F 16-101: (Railway Rolling Stock Fire behaviour "Choice of Material"), NF F 16-102: (Railway Rolling Stock Fire behaviour "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. Whichever standard is selected for meeting the fire safety, the standard shall be declared and a copy shall be furnished to RDSO. Hazard level HL-2 as per EN45545 will be applicable for EMU/MEMUs.

iv) A reliable Automatic fire detection and alarm system shall be provided, in accordance with Clause 4.16 of this specification.

1.1.6 DEFINITIONS

Throughout this specification, the term

i) 'Bidder' means the firm or Company or Joint Venture who submits his offer for supply of the goods and services against the tender.

ii) 'Purchaser' means the President of Republic of India as represented by the Railway Organization entering into the contract.

iii) R.D.S.O., means Research Design & Standards Organization of Ministry of Railways

iv) 'Inspecting Officer' means the person nominated by purchaser/RDSO/IR to inspect the goods on their behalf.

v) 'Supplier' means the firm or Company or Joint venture with whom the order for supply of the goods and services has been placed.

vi) 'Sub-Supplier' means any firm or Company from whom the Supplier may obtain any material, service or fittings to be used for the goods.

vii) NCR, NR, ER, SR, SCR & SER means North Central Railway, Northern Railway, Eastern Railway, Southern Railway, South Central Railway and South Eastern Railway respectively..

viii) ICF means Integral Coach Factory, Chennai, RCF means Rail Coach Factory, Kapurthala – IR's manufacturing units designated for assembly /manufacture of EMUs and MEMUs.

ix) 'Basic Unit' means one Motor Coach with its associated Driving trailer coach and trailer coach.

x) 'DCL' means Dense Crush Load viz. Seating passengers plus standing passengers with density as 8 passengers/m^2 details can be referred in Chapter 2.

xi) 'SDCL' means Super Dense Crush Load viz. Seating passengers plus standing passengers with density as 16 passengers/m^2 details can be referred in Chapter 2.

xii) 'OEM' means 'Original Equipment Manufacturer' of assemblies, sub assemblies and components.

1.2 SCOPE OF SUPPLY

1.2.1 The details of scope of supply have been defined in – Schedule of Requirement of the Bid Document and corresponding Schedules. The scope shall also include the followings:

The supply of complete documentation for approval of design, relevant drawings and calculations to the satisfaction of purchaser and RDSO and support documentation associated with the operation and maintenance of the equipment supplied against this specification. The documents shall include the details as defined in Clause 1.4 "Approval of Design" of this specification.

Supplier shall submit list of equipments and facilities required for maintenance and overhaul of equipments offered. Supplier shall also interact with the coach manufacturer for finalising the layout design of construction/ modification of the existing facilities in respect of maintenance sheds/workshop.

1.3 SUPPLIER'S RESPONSIBILITIES

The Supplier's responsibilities will extend to the followings:

1.3.1 The Supplier shall supply detailed instructions, drawings and relevant specifications for proper installation of the equipment in coaches to ICF/RCF and RDSO or any other agency nominated by IR. For this purpose, the Supplier shall depute a team of engineers to ICF/RCF or any other manufacturer's premises for installation and pre-commissioning of the equipment in the motor coaches and trailer coaches for prototype rakes and subsequent all the EMU/MEMU rakes. Commissioning of all series rakes will be carried out by the supplier at ICF/RCF or EMU/MEMU maintenance shed/workshop of IR or any other manufacturer's premises in India.

Installation of equipment, pre-commissioning and commissioning of EMUs/MEMUs shall be supervised by the trained engineer of supplier along with supporting staff to ensure that the each interface & equipment mounting / assembly performs as per design document.

1.3.2 The Supplier shall be responsible for complete system integration, commissioning, testing and service trials of the equipments in service and depute team of engineers to user Railways for prototype rakes and commissioning of all the subsequent rakes.

1.3.3 The Supplier shall arrange the required instrumentation and carry out detailed tests and service trials jointly with RDSO, user Railways & ICF/RCF, EMU/MEMU maintenance shed/workshop/any other manufacturer nominated by IR as per Chapter 5 of this specification. The test protocols and procedures for the equipments shall be submitted to RDSO by the

supplier for approval.

1.3.4 The Supplier shall be entirely responsible for the execution of the Contract in accordance with the requirements of this Specification. The Supplier shall comply with the provisions of the General Conditions and the Special Conditions of the Contract in scheduling, executing, and obtaining the RDSO's approval of the design.

1.3.5 The Supplier shall submit a technical plan**,** giving details of overall system design, Project organization chart, project schedule clearly defining the start& completion of activity through PERT/Bar chart and schedule of submission of design documents/drawings to the Purchaser and RDSO as specified in delivery schedule of contract.

The software required for trouble shooting and software tools for maintenance of equipment at module level at depot shall be supplied. Supplier shall demonstrate the procedure of trouble shooting/fault diagnostic through software.

Complete information on equipment testing and commissioning at site/on train, their interface and complete system testing shall also be provided. The relevant customized hardware, if any, required for the purpose as above shall also be supplied to RDSO and user Railways.

1.3.6 Supply of drawings, operating manuals, maintenance manuals, trouble shooting/fault diagnostic manual and software manuals of the supplied equipment.

1.3.7 In addition to the equipments and services specified in this Specification, the Supplier shall supply handling tackles, special tools and appliances which may be necessary for the installation, testing and commissioning of the supplied equipment on the new manufacture EMUs/MEMUs, even though such material or work may not be specifically mentioned in this Specification.

1.3.8 The prototype rakes fitted with the supplied equipment after the successful completion of all tests and trials and RDSO clearance shall undergo service trials for four months. However, if the trial period is decided on the basis of time run than a minimum of 30,000 Km run for MEMUs and minimum 25,000 Km run for EMUs should have been completed. The balance equipments shall be supplied by the supplier only after successful prototype trials. However, the supply of equipments for the "work in progress" for the period of service trials can commence for the proven equipments and for the newly designed equipments as agreed by the supplier and purchaser so that the continuity of the production is not affected. During the prototype tests/service trials, if any problems arise or feedback information is obtained, which warrants a re- check of the design/manufacture/quality of the equipment and components, action will be taken as may be necessary by the Supplier to carry out the required investigations and to incorporate the modification considered most appropriate to reach compliance with the specification without any extra costs to the Purchaser and in a manner approved by the RDSO on equipment/components already supplied as well as those to be supplied later.

1.3.9 Before carrying out any modification, as found necessary on the basis of tests and trials, the drawings and execution plan shall be got approved from the RDSO.

1.3.10 CLAUSE BY CLAUSE COMMENTS:

The Bidder shall furnish clause-by-clause compliance on this technical specification. Supplier shall submit the detailed information desired vide

various clauses of the specification at the time of design stage giving clause by clause compliance and giving cross reference of the relevant section of the design. document. The comments like 'noted' against the respective clauses shall be considered as 'not complied' for the specific clause. Therefore, the Bidder shall clearly indicate the compliance or otherwise by writing 'Complied' or 'Not Complied'. Clause by clause compliance to the specification shall only be considered for evaluation of offers. Compliance against any clause means compliance of all of its sub-clauses. Other details given by Bidder shall not be given cognizance and shall not amount to the acceptance of the design/equipment/scheme. In case of any discrepancy, clause-by-clause compliance to the specification shall only be considered. It shall be the responsibility of the Supplier to meet the specification as per the clause-by clause compliance.

1.4 APPROVAL OF DESIGN

1.4.1 The design shall be developed based on the requirements given in this specification and sound engineering practices with specific consideration to the specified passenger loading condition, route conditions and environmental conditions. The basic design for system and major equipments shall be supplied by the Supplier with the required technical data and calculations to RDSO for approval. The manufacturing will commence after approval of the design by RDSO.

Any calculation which is evaluated on the basis of software simulations shall be supported with sample calculations. One copy each of RDSO approved design shall be supplied to the purchaser, user Railways & ICF/RCF, EMU maintenance shed/workshop of IR or any other manufacturer nominated by IR.

1.4.2 After the contract is signed, the Supplier shall furnish to RDSO and the purchaser the detailed schedule programme for submission of design documents for approval which shall be suitably staggered, to enable RDSO to plan for expeditious clearance.

1.4.3 The Supplier shall deliver all necessary data, designs, calculations, drawings, standards and specifications referred in their drawings and design documents in English language as required by RDSO for examination and shall provide explanation and clarification of the drawings for which approval is sought. The submission of design document for any equipment for approval by the supplier without the complete information as per the contract specification shall not be considered as submission of document. Approval or decision by RDSO shall normally be given within 3 weeks of submission of all clarifications by the Supplier to the satisfaction of the RDSO. For this purpose, the Supplier shall depute his technical experts to RDSO for design discussions and finalisation. After the final design is approved, the Supplier shall furnish complete set of applicable specifications as mentioned in the approved drawings & documents and shall also submit the list of equivalent Indian Standards wherever applicable.

Supplier shall submit technical details desired in annexure-IIA along with technical specification, functional specifications, block diagrams, schematic drawings, loading calculations, finite element analysis (FEA), circuits, wiring diagrams, basic design of converter, inverter & other power and control equipments, train control networking, protocols used and the connected software details for carrying out modifications as permissible, weight balancing calculations, drawings and ratings of all sub-Supplier's deliveries. The loading of electronic equipment/components calculated under the ambient conditions as specified, ventilation design, component rating etc. shall be got approved from RDSO. While the aspects covered, as above, are

not exhaustive, the Supplier shall supply/furnish complete technical details with respect to their system and equipment design and to the satisfaction of RDSO at the time of design approval. In this connection Annexure II A may be referred.

The design shall be developed in SI units.

1.4.4 The Supplier shall submit the technical specification of the components of sub-assemblies. The specification shall specifically be indicated on relevant drawings/documents.

1.4.5 Approval of design means approval of general design features. Notwithstanding the approval, the supplier shall wholly and completely be responsible for the performance of the complete system and equipment supplied by him. RDSO will not be responsible for the correctness of the dimensions indicated on the drawings, the materials used or the strength of parts. The Supplier shall, when submitting proposals or designs for approval of RDSO, draw specific attention to any deviation or departure from the specification involved in his proposals or designs.

1.4.6 The Supplier shall be responsible for carrying out improvements and modifications at his own expense on all the equipments supplied, provided such modifications/improvements are warranted by this specification or decided to be necessary jointly between Supplier and RDSO for meeting the requirements of reliability, performance & safety etc.

1.4.7 For the purpose of technical decisions on improvements/modifications etc. on equipment, the final authority from the purchaser's side will be RDSO.

1.4.8 Maintenance Manual, Spare Parts Catalogue & Material Specification

The detailed maintenance and service manual (including the trouble shooting directory) shall be prepared for the various equipments and 40 (forty) copies of the same shall be supplied free of charge. The draft contents of the manuals shall be submitted for approval of the RDSO.

Detailed spare parts catalogue listing all components manufactured or purchased by the supplier along with their rating, source & schematic position etc. (40 copies) each shall also be supplied free of charge. Supplier shall furnish purchase specification of the bought items as well.

The documentation shall be provided on compact discs (Blue Ray) along with relevant software and complete arrangements to read them or edit them in future and to take prints in colour.

1.4.9 **As made drawings**

Six complete sets of 'as made' drawings shall be supplied by the Supplier to the purchaser/RDSO.

1.4.10 **Size of drawings**

The drawings of the following parts shall be to the sizes indicated below:

I	Equipment details	-	full size or half size
II	Motor Assemblies	-	1 : 5
III	General assemblies	-	1 : 10

The dimensions, weight, capacity, etc, shall be in SI units. All drawings shall be submitted on CDs along with complete setup with software for reading

and taking prints through desk top PC and suitable printer. In case the format is not compatible with AUTOCAD necessary customized hardware and software shall be submitted.

1.4.11 Method of filing of drawings

To facilitate filing of drawings, it is essential that each drawing submitted for approval is marked so that it can be identified. The supplier is, therefore, required to ensure that all prints are marked legibly at the right hand bottom corner. The following information is required in respect of each drawing:

I. Supplier's drawing number.
II. Supplier's name and date of submission.
III. Contract no. given by the purchaser.
IV. Description of drawings.
V. Relevant Specifications

1.4.12 Photographs:

While the equipment is under manufacture, photographs and video shall be taken of the various assemblies and subassemblies in various stages of production and shall be furnished on digital media..

1.4.13 Binding

Each set of drawings together with a set of photographs shall be suitably bound within a cover of superior quality durable materials with the title block printed on the outside of the cover.

1.4.14 Marking of equipment

All main assemblies of the equipment shall bear serial number for identification and initials of the purchaser. Where the sub-assemblies/components of the main assemblies are not inter-changeable, the sub-assemblies shall also be marked with the serial numbers. of the main assembly of which they form a part.

1.4.15 Rating plate

All equipment/cubicles shall contain rating plates of anodized aluminum with embossed letters. The rating plate will give detailed rating specification and identification of equipment. The details of rating plate of each of the equipment shall be as approved by RDSO.

1.4.16 Change of Manufacturing unit

i) The change of manufacturing unit shall be restricted to only those items which are explicitly mentioned in the bid document and agreed to in the contract.

ii) All such items permitted for change of source and agreed so in the contract shall be re-type tested.

1.4.17 The design of the Train and the Sub-systems and systems thereof shall comply as per the standards mentioned in Annexure V. The latest version of the aforesaid codes, standards and specifications which have been published at least 60 days before the last date of bid submission shall be considered applicable.

1.5 INFRINGEMENT OF PATENT RIGHTS

Indian Railway shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, components used in design, development and manufacturing of propulsion system and any other factor which may be a cause such dispute. The responsibility to settle any issue lies with the manufacturer. Supplier shall submit an under taking for taking the responsibility of no Intellectual Property Right (IPR) infringement and if there is, it shall own the responsibility of patent right.

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CHAPTER 2

OPERATING AND SERVICE CONDITIONS, DESIGN CONSTRAINTS

CHAPTER 2

OPERATING AND SERVICE CONDITIONS, DESIGN CONSTRAINTS

2.0 LEADING PARTICULARS:

The leading particulars of the existing EMU/MEMU stock, are as follows:

		EMU	MEMU
i)	Track gauge	1676 mm	1676 mm
ii)	Coach length over body	20726 mm	21337 mm
iii)	Max. Width over body side	3622 mm	3245 mm
iv)	Distance between bogie centers	14630 mm	14783 mm
v)	Inside Length of the existing HT compartment	3500 mm	3900 mm
vi)	Inside width of the existing HT compartment	3300 mm	3000 mm
vii)	Maximum permissible axle load (motor coach)	20.32 T	20.32 T
viii)	Maximum permissible axle load (trailer coach)	20.32 T	20.32 T

In addition to H.T. compartment, there is a Low Tension (LT) compartment also of size 1800 x 3000 mm in DMC of MEMU. However, H.T. compartment may be merged with the L.T. compartment, which shall be decided jointly with coach manufacturer while finalizing the equipment layout and distribution.

The length and width of the HT/LT compartment of EMU/MEMU as indicated above is approximate.

2.1 PAYLOAD AND WEIGHT PARTICULARS :

2.1.1 The terms used for indicating various loading criteria are as follows:

Dense crush load (sitting plus 8 Passengers/m2 (standing)) and Super Dense Crush Load {sitting plus 16 Passengers/m^2 (standing)}. The EMUs/MEMUs operate under conditions of very heavy passenger load. The maximum payload may be calculated as follows:

Max. payload = Seating capacity + Standing capacity

Where 'standing capacity' in case of EMU may be calculated at the rate of 16 passengers / m^2 of free space; the free space shall include doorway area and the aisle, but shall not include the knee space of sitting passengers. Henceforth, such loading condition having loading equivalent to 16 standing passengers/m^2 shall be referred as SUPER DENSE CRUSH LOADING (SDCL).

The average weight per passenger has been taken as 60 Kg. The total payload will be as per the layout of Manufacturing Unit duly approved by RDSO and declared in Annexure XVI(format enclosed) of the specification.

Where 'standing capacity' in case of MEMU (DCL) may be calculated at the rate of 8 passengers / m^2 of free space; the free space shall include doorway area and the aisle, but shall not include the knee space of sitting passengers. The average weight per passenger has been taken as 60 Kg. The average weight per passenger has been taken as 60 Kg. The total payload will be as

per the layout of Manufacturing Unit duly approved by RDSO and declared in Annexure XVI(format enclosed) of the specification.

2.1.2 Weight Distribution

(i) The equipment shall be so designed that the total weight of the electrics supplied as per scope mentioned in para 4.0 (A) of this specification, should be

For EMU End Basic Unit : maximum 25 Tonnes(with maximum permissible deviation of +1% in the positive side) per basic unit
For EMU Middle Basic Unit : maximum 24.25 Tonnes(with maximum permissible deviation of +1% in the positive side) per basic unit
For MEMU Basic Unit : maximum 25 Tonnes(with maximum permissible deviation of +1% in the positive side) per basic unit

and total overall axle load of the motor coach or TCs, fitted with the three phase electrics and other accessories does not exceed 20.32 Tonnes after taking into consideration the SDCL loading of EMU and DCL loading of MEMU respectively and unbalancing during tare conditions.

(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 SDCL loading conditions of EMU and DCL loading conditions for MEMU. Supplier shall submit weight disposition of each equipment in Motor Coach (MC), DTC & TCs of EMU and Driving Motor Coach (DMC) & TC of MEMU. Calculation of overall centre of gravity with respect to bogie centers at the design stage shall be submitted. This shall also include calculation for unbalance of load under tare load and SDCL conditions of EMU and DCL loading conditions for MEMU on both the bogies.

(iii) Supplier shall distribute the power equipments viz. converter-inverter, traction motor & transformer etc. amongst motor and trailer coaches for optimized weight distribution and reduced axle load within the unit. The existing equipment layout of Motor coach & trailer coach is enclosed with annexure X & XI. It shall be noted that due to safety considerations, pantograph is essentially to be provided on the non passenger area i.e. HT compartment. However, supplier shall note that actual arrangement shall be of proven layout which has usually been adopted by the supplier in other rolling stocks and shall be in line with the basic guidelines as indicated above. As such the distribution of weight shall have to be compatible with the mechanical structure of the coaches which shall be manufactured at ICF/RCF as per the existing designs. The relevant mechanical drawings for the existing motor coach, driving trailer coach and plain trailer coach of EMU and DMC & TC Coaches of MEMU may be referred.

Supplier shall submit the relevant references where the proposed arrangement has already been supplied and is functioning satisfactorily for 3-phase drive systems (refer Annexure II).

(iv) The Supplier shall ensure that such weight disposition is of proven arrangement for ensuring reduced axle loads. The inter-vehicular couplers shall be of proven design. Such couplers are exposed to vandalism activities including people riding on the mechanical couplers etc. As such the coupler shall be designed to cater for all such abnormalities. Details of the coupling arrangement shall be furnished.

2.1.3 Tare Weight particulars of the existing EMU coaches provided with three phase propulsion equipments are as under:
(Ref.:- ICF letter no. MD/D/Weights/119 dated 29.11.2007)

Tare weight of existing MEMU coaches have been considered as per final speed certificate of MEMU stock having 3-phase IGBT propulsion with stainless steel body and pneumatic suspension in secondary stage (No. MC/MEMU/3-Phase dtd. 11.02.2019, layout and tare weight details of presently manufactured coaches are as under:

EMU:

Type of coach	Tare Weights (tonnes)
Motor Coach	53.868
Trailer Coach 'C' Type (TC)	36.775
Trailer Coach 'D' Type (DTC)	39.061
Trailer Coach 'D(HC)" (NDTC)	37.937

MEMU:

Driving Motor Coach(DMC) (As per layout MEMU/DMC3-9-0-301)	57.85
Trailer Coach(TC) (As per layout MEMU/TC2-9-0-201)	37.40

Tare weight particulars of EMU/MEMU coaches to be used for design/simulation/testing shall be taken from Annexure XVI to be specified by PUs during tendering..

2.2 GAUGE AND MOVING DIMENSIONS

Unless otherwise stated, the EMU/MEMU coaches shall conform to the Indian Railways Schedule of Dimension Broad Gauge Revision 2004 with latest amendments

2.3 TRACK CONDITIONS:

Gauge	Broad Gauge 1676mm
Sharpest curve to be negotiated	175 m (Horizontal) 2500 m (Vertical)
Sharpest reverse curve to be negotiated	Back-to-back with or without any straight portion in between with sharpest curve radius (Horizontal)
Steepest gradient to be negotiated	1 in 100: for EMU(other than Mumbai area) and MEMUs

Height for Mumbai suburban passenger platform	The height for Mumbai suburban passenger platform may be in range of 840mm-900mm for reducing gap between bottom of sole bar of EMU coach & platform floor and shall be applicable for operation of EMU stocks having height of bottom of sole bar above rail level not less than 1039 mm above rail level in fully loaded condition. The height of platform more than 840 mm shall be permitted by Competent Authority, after ensuring maintenance condition of track and maintenance condition of rolling stock
Sharpest turnout to be negotiated	1 in 8½ turnouts
Permissible track tolerances	The track shall be maintained to as per provisions of Indian Railways Permanent Way Manual, June-2020, containing track geometry standards under Para 522. The trials shall be conducted on track having parameter as specified by Standing Criteria Committee.
Maximum moving dimensions (Static Profile)	Maximum Moving Dimensions (static profile) shall be as per Diagram no. 1D which is as per ACS27 to IRSOD 1676mm Gauge (BG) Revised, 2004..
Overall dimension of rolling stock	Rolling stock over all dimension should be within the provisions of Indian Railway Schedule of Dimension (BG) Revised 2004

2.3.1 The track data of section between Delhi-Ambala-Delhi is enclosed as Annexure III A & III B. The largest peak in each Km for unevenness, Twist, Gauge and Alignment is also indicated in the Annexure attached. The mounting of the equipment shall be designed to suit the worst cases as per the Annexure III so that their performance is not affected adversely. It is to be noted that the track data attached is for guidance only as the actual track conditions may vary. Clause 2.7 (ix) may be referred in this regard. The section on which the performance shall be verified may change, accordingly, track data shall be made available to the supplier at design approval stage.

2.4 SPEED, ACCELERATION AND DECELERATION

The equipment shall be designed for following operational parameters at maximum gross weight SDCL for EMU and DCL for MEMU.

2.4.1 Acceleration

Starting acceleration (average from 0 to 40 Km/h) — 0.54 m/s^2 for EMU; 0.50 m/s^2 for MEMU

2.4.2 Deceleration

Service braking deceleration

i) Average from 110 Kmph to 50 Km/h — 0.76 m/s^2

ii) Average from 50 Km/h to standstill — 0.84 m/s^2

2.4.3 Maximum Speed

i) Maximum service speed	:	110 Km/h
ii) Minimum balancing speed on level track at any condition of wheel wear	:	120 Km/h
iii) Maximum test speed	:	120 Km/h

2.5 Traction Power Supply System

The equipment shall be suitable for operation on the electrical suburban sections of the user Railways. The general particulars are:

The operating voltage: **25KV AC power supply:**

i) Normal variation	: 19 KV to 27.5KV
ii) Occasional maximum (cut off)	: 30 KV
iii) Occasional minimum	: 16.5 KV
iv) Cut off voltage	: 16 KV
v) Frequency variation	: 47 Hz to 53 Hz

The power supply system shall be 25 KV, 50Hz single phase AC, 25 KV being the nominal voltage of the system. The guaranteed performance shall be based on voltage of 22.5 KV. However, the run time for all out run for 2.4 km section on level tangent track and SDCL loaded EMU train and all out run of 6 km section on level tangent track & DCL loaded MEMU train shall not deteriorate more than 5% as compared to that specified at clause 3.1.3 within the variation of OHE supply in the range 21KV to 28.5 KV and frequency variation of 47Hz to 53Hz. Train operation shall be feasible at OHE voltage of 16.5KV, may be with restricted power.

2.6 OVERHEAD EQUIPMENT

2.6.1 **25KV AC Traction**: The overhead equipment is supplied through 3 phase grid system and step up/down transformers at the traction substations. Current carrying capacity of conventional OHE is 540 Amp. Consecutive sections are not supplied from the same phase, therefore, neutral sections are provided in between the traction feed from two adjacent substations. The EMU/MEMU train shall be compatible with the following neutral section types:

- Overlap Type Neutral Section of 41m Length as per RDSO Drawing No. ETI/OHE/G/02161 –Rev. C used on IR; and
- Three types of Short Neutral Section of Length 5.48m, 9.5m & 14m are being used on IR.

2.6.2 **Limit of Second harmonic**: The second harmonic current of each motor coach shall not exceed 0.5 Amps and shall be governed by international standard (IEEE 519-2014).The Supplier shall submit curves of harmonic currents vs load current per motor coach and per 12/15/18 car EMU and 4/8/12/16/20/24 car MEMU rake respectively.

2.7 CLIMATIC AND ENVIRONMENTAL CONDITIONS

i) **Relative Humidity**: upto 98% saturation during rainy season which may be as long as five (5) months.

ii) Ambient temp. max. : 50º C

min. : -5º C

Average annual ambient temperature shall be taken as 35°C.

Maximum temperature inside HT compartment of motor coach may reach 55º C.

iii) The temperature of stationary rake in sun may go as high as 70-75º C. The equipment in HT compartment shall not be adversely affected in any way due to exposure to such high temperatures. Supplier shall furnish the precautions taken in equipment/component selection in order to conform to this requirement. The supplier will indicate the expected temperature rise in the machine room/HT compartment under the reference site conditions described above and shall submit the expected MTBF at such temperature.

iv) The area along both sides of the track is heavily populated. Bidder may assess the site conditions by visiting the railway suburban area. The air discharge from the cubicles, if any, shall be suitably regulated so that dust blow during the run is bare minimum and does not cause any inconvenience to passengers.

v) **Altitude**: At any altitude between 0 and 1000 m above mean sea level.

vi) **Rainfall**: Very heavy and continuous (up to 2500mm during rainy season)

All under slung equipment shall be designed suitably to ensure its normal working even in adverse conditions as above.

vii) The equipment shall be so designed 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. Incase of flood level increasing more than 203mm, the EMU/MEMU shall be made dead.

There are certain sections of the track that get flooded with water to standing depth of 400 mm(203 mm for traction motor of MEMUs). The traction gear and other under slung equipments must be completely water proof to this height above rail level. During the peak flood condition water may reach up to floor level. The equipment shall not get damaged due to such flooding and it should be possible to rejuvenate the equipments with minor attention without any adverse effect on their performance.

viii) **Atmosphere during hot weather**: Extremely dusty, humid and salty. The EMU/MEMU shall be working in coastal area also and thus shall be continuously exposed to highly corrosive, salty atmosphere along with industrial pollutants.

Special care shall be taken to ensure no damage to equipment due to deposition of atmospheric salts and industrial pollutants. Supplier shall enclose the details of specific measures adopted to ensure the satisfactory working of equipments against the deposition of salts & industrial pollution.

ix) **Vibrations**: Because of track irregularities, level of shocks and vibrations to which traction motors are exposed are far more than actually given in IEC for TM mounting arrangement. Measured data of vibration levels at critical locations of TMs and its mounting / suspension arrangement of existing AC/DC EMUs with 40Hz/100Hz low pass filter, which is placed as Annexure XIV, can be used for design. it is advised that supplier should carry out instrumented trials on existing stock for measurement of shocks and

vibrations in sub-urban area in consultation with RDSO, at design stage. The suspension system and the mounting arrangement shall be so designed that the equipment's performance is not adversely affected due to such high vibrations and shocks. The Bidder shall refer the track parameter vide clause 2.3. Bidders are also strongly advised to check and verify the existing track conditions over the sections of the Railway where the EMU/MEMU stock shall run.

x) Maximum wind pressure 216 kg/m2 as per IS: 875-Part 3 (2015).

2.8 SIGNAL AND TELECOMMUNICATION INSTALLATIONS:

2.8.1 The tracks over which the Trains shall work may be equipped with Semaphore/Multi Aspect Colour Light Signalling. The train detection may be through · DC Track Circuit/Audio Frequency Track Circuit/Axle Counter. Block working may be Absolute Block system/ Automatic Block system. Important minimum Signalling features of various standards of Interlocking prevailing in India Railways are stipulated in IRSEM Part-1. The telecommunication system includes OFC, Quad cable, mobile train radio communication.

2.8.2 ATP system like TCAS/TPWS/AWS/ETCS may be existing in the offered section or provided in near future. Rolling stock and locos shall have compatibility with the ATP system wherever and whenever it is available in the section and shall be equipped with compatible on-board equipments and interfaces as required . The Driver Machine Interface (DMI) shall be fitted towards loco pilot/motorman side.

2.8.3 CTC/TMS may be existing in the offered section or provided in near future.

2.8.4 EMI/EMC Compatibility of Rolling stock and EMUs/locos with Signaling & telecom system provided in the offered section shall be tested as per EN 50238 or equivalent standards by accredited test agency/RDSO and ensured that those are within specified limits . In case of RDSO, Supplier has to arrange for test and demonstrate the compliance. In addition to this following limits Is also required:

S. No.	Interference Current	Limits
1.0	Psophometric Current	10.0 Amps
2.0	DC component	4.7 Amps
3.0	Second Harmonic component(100 Hz) and 83.33 Hz component	8.5 Amps

2.8.5 The rake shall be certified for EN-50121 or equivalent standards for radiated EMI for which rolling stocks/locos shall be tested by accredited test agency and ensured that those are within specified limits.

2.8.6 The functioning and performance of existing Signaling & telecom gears shall not get affected with the running of rolling stock and locos. Rolling stock/locos should not infringe with prevailing Signaling & telecom gears in the section.

2.8.7 Provision of Train protection & Warning System (TPWS) shall be as per specification no. RDSO/SPN/183/2016 Ver 3.0.

2.8.8 Auxiliary warning system (AWS) is to be provided as per RDSO specification no. RDSO/SPN/213/2014 version 1.0 (Draft) of Advanced Auxiliary Warning System (AAWS).

2.9 MAINTAINABILITY:

2.9.1 Supplier shall submit the basic maintenance schedules of the proposed equipment. Minimum interval between two maintenance schedules for the equipment supplied under the specification in the depot shall be 90 days except for the pantograph strips and 3 years for major works in

workshop/major depot.

It may be noted that the periodicity of the present maintenance schedules are as under:-

TI	15 days
I 'A'	60 days
I 'C'	240 days
POH	24 months

The maintenance programme prepared by supplier shall have the following objectives ascertaining the above periodicity of maintenance schedules:

a) Enhancement of EMU/MEMU availability
b) Minimization of maintenance costs
c) Minimization of coach downtime /MTTS (meantime to restore serviceability).

2.9.2 Based on the proposed maintenance schedules the supplier will submit average downtime on account of scheduled maintenance for the equipments to be supplied excluding the time required for transfer of rake to and from the maintenance depot. Ineffective on this account should not exceed Two percent. Supplier should also submit an estimate for the downtime for unscheduled maintenance in respect of equipments to be supplied. The supplier shall assess and submit the figure for 'total percentage Ineffective', in terms of percentage of rakes expected to be ineffective/unserviceable due to schedule and unscheduled repairs/maintenance of equipment supplied (excluding the time taken for transfer of the rakes to and from maintenance depot) against the total number of rakes fitted with the equipment under his scope of supply. This ineffective figure shall not exceed FOUR percent in any week (Monday-Sunday) calculated on 24 hourly basis. If during the test and service trial period of prototype rakes, it is experienced that downtime due to unscheduled repairs/scheduled maintenance of the equipment supplied is excessive, supplier shall be required to take suitable remedial measures to bring the ineffective figure within the limit submitted during the design approval stage without any cost."

2.9.3 Modular design principles shall be employed. Requirements for adjustments after module interchange shall be avoided except as required in the specification.

All systems, components and structural areas serviced as part of inspection or periodic preventive maintenance shall be readily accessible for service and inspection.

2.10 RELIABILITY, AVAILABILITY, MAINTAINABILITY and SAFETY (RAMS):

2.10.1 General

The Supplier shall design the system to ensure Guaranteed Reliability, Guaranteed Availability 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 Specification and Standards. The plan for Reliability, Availability, maintainability and safety shall conform to EN 50126/IEC 61709/IEC 62278. Reliability of electronic components shall conform to IEC 61709.

2.10.2 The Supplier 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 and Suspension System, high voltage equipment, blowers and other auxiliary machines, such that it will provide a high level of dependability in conformity with the specifications.

2.10.3 Components critical for safety shall fall into safe operating mode in case of malfunctioning. If the same is not possible, the company shall demonstrate with respect to internationally accepted norms that the design is such that the likelihood malfunctioning is reduced to acceptable level The system safety plan shall identify and list safety critical components and this list shall be updated periodically.

2.10.4 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 Train.

2.10.5 Safety Assessment shall be carried out and shall include the following principles:

i) Degraded modes and emergency operations shall be considered as well as normal operations.

ii) Safety risk assessment shall utilize more than one methodology to assess risks.

iii) Safety risk assessment shall include the consideration of dependent failures, in particular the traction power, braking and control systems.

2.10.6 Every complete train, as well as each constituent component, assembly, subsystem and system element shall be designed in such a manner so as to perform its function reliably in revenue service. To ensure reliability of the system, redundancy shall be built-in so that the Brake performance of a 12 car EMU/ MEMU train shall not deteriorate under the following conditions:

i) In the event of failure of one Brake Electronic control Unit;

ii) In the event of failure of equipment in the Train, less than or equivalent to that of one Basic Unit;

Further, the redundancy shall be built-in so that the performance of the train shall not deteriorate in the event of failure of auxiliary supply system of one Basic Unit.

2.10.7 No single-point of failure shall cause complete failure of the traction system, auxiliary supply system or inability to control the brakes on Train.

2.10.8 Where the system design of the equipment incorporates component redundancy as the method of reducing the consequences of a single point failure, such redundancy shall not allow hidden faults to remain undetected.

2.11 ADHESION LIMITS:

The equipment shall be so designed that the co-efficient of adhesion requirement does not exceed 20% during powering and regenerative braking and 16% in case of only pneumatic brake application, under all requirements of performance as specified in this specification.

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CHAPTER 3

PERFORMANCE REQUIREMENTS

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3.1 PERFORMANCE REQUIREMENTS

3.1.1 General Description

(i) a) In case of EMU: The capacity of the traction motor and the other equipments shall be adequate to permit continuous operation of Super Dense Crush Loaded 12 coach train comprising 4 units of total weight defined in para 3.1.1(i) (c) below and with the formation of 4 motor coaches and 8 trailer coaches so as to meet the performance requirements as described herein. The design shall permit the operation of EMU train with different formations as per Clause 1.1.4 (xi) under loaded conditions with the unit weight as above. All performance calculations shall be with respect to 12 car trains unless stated otherwise.

b) In case of MEMU: The capacity of the traction motor and the other equipments shall be adequate to permit continuous operation of Dense Crush Loaded 12 coach MEMU train comprising 3 units of total weight defined in para 3.1.1(i) (c) below with the formation of 3 motor coaches and 9 trailer coaches so as to meet the performance requirements as described herein. The design shall permit the operation of MEMU train with different formations as per Clause1.1.4 (xi) under loaded conditions with the unit weight as above. All performance calculations shall be with respect to 12 car MEMU train unless stated otherwise.

c) Total Weight of EMU/MEMU:
Total weight =Tare Weight of coach (to be decided by Manufacturing unit as per Annexure XVI(format enclosed) without the propulsion electrics) + Weight of Propulsion Electrics (as per scope defined in para 4.0A and maximum permissible weight limit as defined in para 2.1.2) + payload (to be decided by Manufacturing unit as per RDSO approved layout as per Annexure XVI(format enclosed)).

(ii) The three phase drive equipments shall be based on the latest technology and shall be suitable for regeneration. The traction equipment shall be suitable for operation with 25KV AC, 50 Hz traction system supplied by overhead contact wires. Three Phase asynchronous induction motors with associated IGBT based and micro-processor controls are to be provided as per this specification.

(iii) Fitment of various equipments will be so decided that the weight is properly distributed. Mounting of converter/inverter & control electronics panels on the roof and under slung is not permitted.

(iv) The entire equipment shall be designed to ensure satisfactory and safe operation under the running conditions specified in Chapter I & 2, abnormal conditions such as sudden voltage variation, load variation, short circuits and track & weather conditions prevailing in suburban area/main line.

(v) All working parts of the control and auxiliary circuit shall be suitably covered to keep them free from moisture and dust.

(vi) All the electrical equipments shall comply with the latest editions of IEC specifications unless or otherwise specified. The temperature rise shall be measured according to the procedure stipulated by IEC and shall comply with limits specified in this specification.

(vii) The wheel dia of the new wheel is 952 mm. The performance shall be guaranteed with new wheel of 952 mm. Minimum clearances as specified in Clause 3.7 shall be ensured with the wheel dia of 877 mm.

The equipment design shall permit the train operation up to 850 mm if the purchaser decides to run the stock with reduced clearance in future.

3.1.2 The average acceleration requirements on level tangent track, according to stipulations of Clause 2.4 shall be fulfilled with an average OHE voltage of22.5 KV under AC traction with new wheels at SDCL load.

3.1.3 a) EMU: The typical run of 2.4 Km on level tangent track for all out running i.e. full acceleration and full braking without coasting and with regeneration braking for a super dense crush loaded (SDCI.) 12 car rake with nominal line voltage of 22.5 KV in AC traction and new wheels shall be considered as one traction cycle with reference to Clause 3.1.7. The train shall achieve the maximum speed of 110 kmph from standstill in less than 215 seconds. Supplier shall also ensure compliance to clause 2.5. However, the maximum current drawn from OHE at the average line voltages specified herein shall not be exceeded at lower voltages.

b) MEMU: The typical run of 6 Km on level tangent track for all out running i.e. full acceleration and full braking without coasting and with regeneration braking for a dense crush loaded (DCL) 12 car rake with nominal line voltage of 22.5 KV in AC traction and new wheels shall be considered as one traction cycle with reference to Clause 3.1.7. The train shall achieve the maximum speed of 110 kmph from standstill in less than 240 seconds. Supplier shall also ensure compliance to clause 2.5. However, the maximum current drawn from OHE at the average line voltages specified herein shall not be exceeded at lower voltages..

3.1.4 The speed of 12 car EMU SDCL/8 car MEMU DCL loaded train shall be as specified in the Clause 2.4

3.1.5 Supplier shall submit the RMS current values of traction motor and temperature rise of propulsion equipment for a SDCL 12 car EMU rake/DCL 12 Car MEMU rake operation under normal with below mentioned conditions, up to stabilization of temperature of all propulsion equipments with average line voltage of 22.5 KV.

a. repeated typical run(as defined in para 3.1.3) of 2.4 Km on level tangent track for all out running for EMUs other than Mumbai area, 6.0 km section for MEMUs
b. repeated all-out mode of Sabzimandi-Panipat-Sabzimandi with a dwell time of 30 sec. This should also be done with 1 motor coach isolated condition(only for submission of simulation together with temperature rise and validation on combined test bed as per clause 3.1.10).

Supplier shall also ensure compliance to Clause no. 2.5. The R.M.S. (root mean square) loading of the traction motor with regenerative braking in use for all out running as mentioned herein shall not exceed the continuous rating of

the traction motor.

3.1.6 Rating of equipments

i) The continuous rating of the traction converter, inverter & the traction transformer shall be based on the continuous rating of the traction motor by taking into account the efficiency & power factor and maximum loading of the equipment. The procedure for calculation of ratings is enclosed at Annexure II.

ii) Supplier shall submit the detailed calculations for maximum power loading of all major components of the traction system including the maximum R.M.S. currents, tractive effort and motor torque for motoring. Similar calculations for maximum power loading of all the major components of traction system including maximum R.M.S. current, braking effort and motor torque for braking shall be submitted. During traction mode, maximum auxiliary power shall be taken into account and during braking mode minimum loading of auxiliary power shall be considered. While deciding the ratings of equipment the supplier shall ensure that the performance of the EMU/MEMU shall conform to the conditions laid down in the Clause 2.5.

iii) Efficiency curves of each equipment and tractive effort/braking effort (in KN) for each motor coach shall be furnished along with overall system efficiency curves. The total auxiliary power shall be furnished as break up of power requirement for lights, fans and auxiliary power required for propulsion system.

3.1.7 Calculations/simulation for temperature rise of the traction motor for repeated traction cycle as specified above at 3.1.3 (without considering stoppage time) and the specified conditions shall be furnished by the supplier after award of the contract. The temperature rise shall not exceed the permissible value specified in clause 4.4.7.6. All the temperatures calculated on the basis of repeated runs/continuous duty cycles shall be deemed as stabilized temperatures.

3.1.8 The super dense crush loaded 12-car EMU/12-car dense crush loaded MEMU rake with one motor coach isolated and already running continuously in the section with new wheels shall be capable of starting on a gradient of 1 in 100and clear this section of 1 Km. The temperature rise of the traction motor and other equipments shall be within thermal rating of the respective equipment as specified in Chapter 4. The one hour rating of the Traction Motor shall be submitted. Average line voltage during the period shall be taken 22.5 KV AC under traction. The time, in which the section will be cleared and the maximum speed attainable shall be furnished by the supplier. The temperature rise of propulsion equipment shall not exceed the stipulated values. Supplier shall submit the traction motor temperature rise under the above conditions as per the Annexure II.

3.1.9 For a SDCL loaded 12 car EMU train/DCL loaded 12 car MEMU train with one motor coach cutout, starting after continuous working in the sections of Sabzimandi-Panipat as specified in clause 3.1.12, the specified thermal rating of traction motor and equipment shall not be exceeded for full one trip (maximum approx. 250 Km), either way starting from one end. Supplier shall also furnish temperature rise of traction motor and other equipments under such conditions and overall running time in Sabzimandi-

Panipat–section. Supplier shall refer to Annexure II for further details.

3.1.10 Calculation and simulation for temperature rise of the propulsion equipment for repeated typical run as specified in clause 3.1.3 without considering stoppage time and the specified conditions shall be furnished by the Supplier. The temperature rise of the propulsion equipment shall not exceed the permissible value as mentioned in this specification. All the temperatures calculated on the basis of repeated runs/continuous duty cycles shall be deemed as stabilized temperatures. The temperature rise of propulsion equipment shall be demonstrated by thermal simulation and measurement during combined system testing as well as vehicle testing in field. The simulation result of temperature rise of propulsion equipment shall also be submitted considering only regenerative braking except very low speeds in the above runs. After achieving stabilization of temperature, one more all out cycle shall be run in one Motor Coach cut out condition.

The validation of other design parameters, as described in the Clauses 3.1.3, 3.1.4, 3.1.5, 3.1.7 & 3.1.8 may not be possible on site. As such, these design features shall be validated during the performance tests on the combined test bed. Clause 5.7 may kindly be referred for further details.

3.1.11 The inter-sectional timings for the complete round trip of the train schedule specified for Sabzimandi-Panipat Section for obtaining minimum energy consumption and best overall schedule speed shall be furnished by the supplier after the design finalization. For this purpose, the supplier shall furnish the curves/graphs for the energy consumption, RMS loading of the traction motor with regenerative braking in use and overall schedule speed. RMS loading for all out running for the round trip shall not exceed the declared continuous rating of the Traction Motor and the temperature rise shall not exceed the stipulated limits.

3.1.12 Supplier shall also furnish the performance of 12 – car EMU/MEMU rake with all out run & with 10% coasting in time, variation of line current, speed, distance, inter-station timings, motoring energy consumption, regenerative energy and RMS loading of traction motor for complete round trip between Sabzimandi-Panipat-Sabzimandi section of Northern Railway. Route profile with details of temporary speed restrictions is placed at annexure IV. The performance shall be submitted in graphical and tabulated forms. All the performance values, as desired above, shall be submitted for maximum speeds of 120km/h, 110 Km/h & 100 km/h separately.

3.1.13 The variation of power/TE & BE with the OHE voltage, from starting to maximum speed, at the interval of 20 Km/h in the range of (i)16.5 KV to 22.5 KV AC in the steps of 1.5KV shall be submitted during design stage. The effect of the reduced power on run time for Sabzimandi-Panipat section and on a representative section of 2.4 km in case of EMU and 6 km in case of MEMU shall be submitted in graphical and tabulated forms.

3.1.14 It should be possible to form the 9/12/15/18 car EMU rakes and 8/12/16/20/24 car MEMU rakes. In each formation by addition of the unit(s), the train control should be possible only from one end of driving coach occupied by motorman. The supplier shall furnish performance parameters with the above combination of rake formation.

3.1.15 The equipments shall be so designed that the coefficient of adhesion does not exceed the optimized value during the powering or braking. The supplier

shall furnish the optimized value of coefficient of adhesion and the reason thereof.

3.1.16 Specified temperature rise of equipment shall be calculated after taking into account at least 25 % choking of air filters and radiator fins.

3.1.17 **Regenerated Energy** -The regenerated energy for all out running up to 110 kmph(full traction up to 110 Kmph and full service braking up to standstill) shall not be less than 23% of the energy consumed during powering at the specified voltage for both EMU & MEMU. Acceleration and braking rates shall be as defined in clause 2.4 of the Specification. Full auxiliary load shall be taken into account except emergency load and ventilation load. Also duty cycle of compressors shall be considered as 100%. The net energy consumed or regenerated at the pantograph shall be used for calculating percentage regeneration energy. In the event of failure of one Basic Unit/equipment less than or equivalent to that of one Basic Unit, reduction in the value of regenerated energy shall not be more than that of their proportionate value.

3.1.18 Deleted

3.1.19 **Continuous Operating Equipments:**

The capacity of the traction motors and other equipment shall be adequate to permit continuous and punctual operation of SDCL loaded EMU train/DCL loaded MEMU train under the operating and service conditions specified.

3.1.20 Supplier shall submit the residual acceleration for the SDCL loaded EMU/DCL loaded MEMU train starting on a rising gradient of 1 in 100along with the time and distance for attaining 110 kmph speed on straight and level tangent track.

3.2 POWER SUPPLY AND ENVIRONMENTAL CONDITIONS:

The details are specified in the Clause no 2.5, 2.6 & 2.7.

3.3 NEUTRAL SECTION:

(i) Neutral section is provided in the AC traction area. Suitable arrangement shall be provided by the supplier in every motor coach to ensure that the loss of main power for each motor coach, while traversing through neutral section, is restricted to bare minimum. The supplier shall also supply the design details & specifications of fixed equipment to be installed at each neutral section or alternatively shall ensure compatibility of their equipment with the track side equipment, if already installed by IR and are already in use at the neutral sections at the time of design finalization stage.

(ii) It shall be possible for the system to open or close the circuit breaker sequentially while approaching and leaving the neutral section respectively. The system shall have all necessary safety provisions.

3.4 INTERFERENCE TO SIGNAL AND TELECOMMUNICATION INSTALLATIONS

Interference to signal and telecommunication installation shall be as per the Clause no.2.8.

3.5 TRAIN RESISTANCE: Train Resistance of the existing EMU/MEMU motor and Trailer Coaches is as under:

Motor coach:

$R = 2.35 + (0.02922-0.00049xW)xV+(0.03722/W)xV^2$ Kg/t

Trailer/ Driving trailer Coach:

$R = 1.347 + 0.00385xV + 0.000165xV^2$ Kg/t

where W is the gross wt in ones,
R is the resistance in Kg/ ones, and
V is the speed in Km/hour.

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

The performance calculations shall be done with the train resistance formulae as indicated herein.

3.6 EQUIPMENT LAYOUT

3.6.1 Traction Motor

The modifications required for mounting of the traction motor on the existing bogie shall be minimal and shall be advised by supplier, if any. The present diameter of the axle at sleeve bearing zone is 180 mm. The inner diameter of the inner race shall be 196+ mm to be selected from the commercially available standard international sizes. The drawing for the finished machined axle shall be furnished by the Supplier for approval at design stage.

Finished machined axles to the approved drawing shall be supplied by Railways. Drawing of the rough axle is enclosed (refer annexure X & XI).

3.6.2 High Tension (HT) Compartment layout

(i) The Converter-Inverters, Auxiliary converter unit, Auxiliary compressor, Electrical Control Cabinet (ECC) and Auxiliary Control Panel (ACP) etc. are presently mounted in the High Tension equipment compartment provided on board of motor coaches of AC EMU. 3-phase drive equipments should be capable of being mounted in the H.T. compartment of the motor Coach of AC EMU & in Driving Motor Coach of MEMU. The supplier will ensure that the size of the HT compartment is not required to be increased as compared to that of existing AC EMU. Adjoining the HT Compartment, there is a driving compartment of same width and approximately 0.936 metre length. It will be possible to utilize a part of this space as well, as only the master controller for traction control and the brake controller for the brake control by the driver are required to be provided in this area. It should be possible to take out electrical/electronic modules for maintenance through shunting cab/HT compartment door.

(ii) Refer clause 2.0 for HT compartment dimension of EMU/MEMU for equipment layout.Supplier shall design the equipment accordingly so that enough space is available for maintenance works.Supplier shall submit the roof layout (plan & elevation) with all the equipment mounted.Details shall

be worked out during design stage. Suitable Boards/ stickers showing sequence of operation before entering into HT room shall be provided on the door of the HT compartment.

(iii) Presently, equipment mounting in the H.T. compartment is from the sides through hatch openings of 1.8 meters height and 1.3 meters width. However their height is likely to be changed due to dishing of the roof. It shall be possible to remove and take out the complete cubicles from the HT compartment without disturbing any other cubicle. Each cubicle shall have enough working space in its top & front for easy working.

(iv) Fitment of various equipments will be so decided that the body weight is properly distributed so that the axle load is within permissible limits after taking into consideration unbalance during the tare and SDCL loading conditions.

(v) Control equipments for the driver will also be required to be provided in the leading DTC of EMU and DMC of MEMU. EMU has clear cab space of 3.6 meters width and length varying from 1 meter at the ends to 1.2 meters at the middle of EMU. In case of MEMU, Para 2.0 may be referred.

(vi) Layout drawing of existing AC EMU/MEMU motor coach/DMC and DTC/TC may be referred at annexure-X & XI.

3.7 MINIMUM CLEARANCE FROM RAIL LEVEL

Under fully worn wheels and SDCL condition of the coach, the minimum vertical clearance of bogie-mounted equipment 91 mm from rail level for a width of 1220 mm on either side of center of track under worst conditions. The minimum clearance for the body mounted under slung equipment shall be 215 mm under SDCL condition with fully worn wheels. Minimum vertical clearance shall be maintained as per IRSOD (BG), Revised- 2004 with latest ACS.

3.8 All the requirements specified in chapter 3 of this Manual shall be achieved when the train has new as well as fully worn wheels. The tests shall be carried out with new wheels.

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CHAPTER 4

ELECTRICAL REQUIREMENT

SCOPE OF SUPPLY & TECHNICAL SPECIFICATIONS

4.0 A) SCOPE OF SUPPLY

The scope under this tender covers design, development including simulation studies, manufacture, supply and erection, commissioning of complete set of 3-phase drive equipment for 25 KV, 50 Hz AC BG EMU/MEMU coaches as detailed in the 'Schedule of Requirements' in the Bid document and will include:

i) Traction transformer with the required number of secondary traction windings along with protection equipments.

ii) Current transformer, Potential transformer and Gapless lightning arrestors for 25KVAC.

iii) IGBT based PWM power converter-inverter

iv) DC link with 100 HZ resonance filter and/or any other equipment necessary to reduce the effect of other harmonics on S&T equipments.

v) Asynchronous traction motors compatible with IGBT controlled power supply, with pinion and wheel gears, roller bearings, sensors and equipments necessary for provisions of mounting as specified in clause 4.4 of this specification.

vi) Microprocessor based traction control system including fault diagnosis and display system in the driving cab.

vii) Pre-charging resistors, braking resistor and associated power/control contactors.

viii) Auxiliary converter for auxiliary supplies and battery charging.

ix) Auxiliary machines such as oil pump, oil cooling blowers for traction transformer, blowers for power converter-inverter, auxiliary converter, lights and fans for motor and trailer coaches etc.

x) Pneumatic system comprising of main air compressor, air dryer, filters and auxiliary compressor

xi) VCB

xii) Pantograph & Earthing Switches - Single pantograph suitable for 25 KV AC supply shall be used on each motor coach.

xiii) Train Management System, Multiplexing system for relevant Control & other Signals and any other equipment, cables, inter-vehicular couplers & terminal equipments. Inter-vehicular couplers shall be supplied in assembled form. TCMS will also fulfill the brake blending requirements and all functions of brake electronics.

xiv) Power & control cables including terminal equipments and cable ducts/

conduits/trays.

xv) Complete pre-fabricated driver's and shunting desk. The cab shall include all the cab equipments e.g. combined master-cum-brake controller, instrument panel with back-lit instruments, gauges for pneumatic indications, control panels, driver's diagnostic display unit & driver's "log in" device, cab AC, driver and guard seat etc., ergonomically designed driver'

desk/console, pre-wired and terminated on a terminal board and multi-pin plugs/sockets for inter-equipment connections. Cab-equipments shall also include pneumatic horns, electric motor driven wind screen wipers, sun-screens, auxiliary head light with tail light for EMUs, marker light with tail light for MEMUs, safety related equipments like bell code system, flasher light and speedometer-cum-recorder. Cab radio may be provided by IR for sections with GSM-R. Appropriate space for cab radio may be demarked.

xvi) Carriage fans and lighting system including coach lighting, headlight and Auxiliary head light/marker light & tail light etc. Control switchgear shall also be supplied for these items.

xvii) Passenger information system including coach displays, head code, audio communication system, emergency talk back unit and interface with the existing train monitoring system on Railways and any equipment required for interfacing PIS with the Receiver-Equipment of existing train monitoring system on Railways. Receiver-Equipments of the existing Train Monitoring System is in the scope of supply of the purchaser and will be mounted in the driving cab. The specification shall be made available to the supplier at the design approval stage if required.

xviii) Complete set of MCBs contactors, relays etc. for propulsion system, controls, auxiliaries in the assembled form viz. cubicle or cabinet.

xix) Parking brake equipments complete with controls, associated valves & wiring
etc.

xx) APC receiver for neutral section operation applicable on both EMU and MEMU.

xxi) deleted.

xxii) Load weighing system including redundant weight sensors at bogie level. The scope of supply of pressure transducers shall be with Supplier.

xxiii) Any other equipment for power isolation and interlocking etc. and required for proper functioning of the traction equipments in AC operation.

xxiv) Instrumentation required for commissioning and field-testing of the equipment.

xxv) Special tools required for maintenance

xxvi) Maintenance spares for three years

xxvii) Passenger Car Surveillance system with facility to stream video in central server

xxviii) Cab air-conditioning system complete with switch gear & control system

xxix) EPDM & EMC type cable glands for sealing & shielding should broadly conform to Specification no. RDSO/2008/EL/SPEC/0067, Rev. 3 or latest.

xxx) Fire/Smoke Detector system as detailed in the specification.

B) TECHNICAL SPECIFICATIONS FOR 3-PHASE PROPULSION SYSTEM WITH SYSTEM AND ASSOCIATED EQUIPMENTS

The 3-phase drive equipments shall be based on the technology proven in successful service applications. The equipment shall be suitable for regeneration for the maximum speed range. The broad specification of the various equipments is furnished below:

4.1 TRACTION TRANSFORMER

4.1.1 A fixed ratio transformer will be provided with multi traction windings suiting the requirements of IGBT based power converter-inverters to meet the load of three-phase propulsion equipments. The number of secondary traction windings should match the number of power converters duly phase shifted for the motor coach.

4.1.2 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 & power factor of traction motor, converter-inverters, auxiliary converter for meeting the auxiliary load as specified in the specification clause 4.14.4. The guiding principle for calculation of rating shall be as per clause
3.1.6. Bidder shall note that the performance is required to be guaranteed for the range of voltage as per the clause 2.5. The transformer will be designed with overload capacity to permit full utilization of the traction motor capacity during starting as well as running.

4.1.3 The transformer will 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.

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

4.1.5 The transformer shall be of modular construction. To maintain the overall dimensions as to existing size, the improved insulation scheme shall be adopted to the extent possible. In case the change in the dimensions of the new transformer is inevitable, the change should be minimal. The transformer shall be complete with oil pump and radiator with blower,

conservator and protection equipment assembled in single module. Means will 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). The silica gel, if used, should not require attention in between the Schedule examination.

4.1.6 The cooling agent for the transformer shall be arc resistant and shall have high flash point. Supplier shall study the currently available cooling oils in India and employ these as far as possible. If, the imported cooling oil is used, Supplier shall study and furnish details of equivalent indigenous cooling oil.

4.1.7 The transformer shall be under slung and the mounting arrangement shall preferably be same as of existing transformer, otherwise it shall clearly be indicated by the supplier. The lower portion of the tank shall be of adequate strength so as to protect against hitting by extraneous objects while on run. Finite Element Analysis (FEA) for transformer tank and mounting arrangement shall be submitted at the design stage.

4.1.8 Current transformer, potential transformer and matching overload relay shall be in the scope of supply.

4.2 LIGHTNING ARRESTOR

Two metal oxide gapless lightning arrestors shall be provided on the roof of each Car fitted with a pantograph and/or traction transformer for protection against the line voltage transients caused by lightning and system switching. One lightning arrestor shall be connected to the high voltage circuit between the pantograph & the main circuit breaker and the other shall be connected to the high voltage circuit between the main circuit breaker and the transformer. These gapless lightning arrestors shall have discharge class-4 for primary and 3 for secondary.

4.3 POWER CONVERTER-INVERTER

4.3.1 The four quadrant power converter-inverter shall be of a design service proven in similar applications, IGBT based with PWM control to ensure regeneration and the power factor near to unity. The range of variation of power factor shall be submitted by the supplier.

4.3.2 Cooling System

Power Converter-Inverter offered shall be forced air/water cooled.

4.3.3 The voltage rating of IGBT would 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 capacitance in the circuit. The current rating of IGBT shall be such that the junction temperature has minimum thermal margin of 10^0C in the worst loading conditions and under the ambient conditions as specified considering 25% choking of filter and heat sink/radiator fins. Supplier shall submit the maximum junction temperature of the devices under worst operating conditions.

4.3.4 The catenary voltage fluctuates widely as indicted in the clause 2.6. The variation of frequency has also been indicated therein. The converter shall be provided with necessary control to provide the guaranteed performance under such fluctuations without exceeding the rated cut off current of IGBT and keeping minimum cut off time within limits.

4.3.5 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 will be provided in order to avoid the motor coach failure or reduction in performance due to such defects. Supplier shall specifically submit details of the redundancy provided in the system to this effect.

4.3.6 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 rake from service and journey is completed satisfactorily. The one hour rating/thermal rating as specified herein of the equipment will not be exceeded under such operation. For such purpose, short time rating of the major electrical equipment such as main transformer, power converter, auxiliary converter/inverter and traction motor etc. will be furnished. Bidder may also refer clause 3.1.9.

4.3.7 Selective isolation of individual bogies i.e. two motors, shall be ensured by providing individual and independent 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. Supplier shall also furnish the permissible diameter difference between the wheels of the same bogie and those on different bogies of the same coach as affected by the control of individual motors, individual bogies or of complete motor coach.

4.3.8 The protection/alarm/indication circuit will 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 will 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 rake, if so desired, from the driving cab itself.

4.3.9 Freedom from dust and protection from surges will be ensured. Modular construction will be adopted wherever considered possible. The converter/inverter system and transformer will be capable of withstanding the maximum short circuit current under fault conditions and these will be established as well. As such in case of any dead short circuit across the outgoing terminals of converter/inverter systems, the system shall provide adequate protection so that no damage is reflected on the converter/inverter system.

Inverter and line converter modules shall preferably be of identical design in

use, as far as possible, with identical components.

4.3.10 The propulsion system shall be suitable for operation on 25 KV AC. Supplier may adopt DC link voltage suitably and submit the details with justification along with the design

4.3.11 Only dry type capacitors shall be used for dc link / harmonic filter / resonant circuits.

4.3.12 The system shall be capable of withstanding the maximum short circuit current under fault conditions and these shall be established through calculations. The system shall also be designed to withstand extreme disturbances like short-circuit / open circuit etc. at all points of input / output interfaces with EMU/MEMU, without any failure. This shall be demonstrated during prototype tests as per the relevant clause of the IEC.

4.3.13 During the earth fault or phase to phase fault in the traction motor, protection scheme of the traction converter shall ensure that the fault does not have any adverse impact on the performance of the traction converter. Details of such a scheme shall be furnished by the Supplier.

4.3.14 The drive converter output ripple shall be such as to keep the torque pulsations and traction motor heating to a minimum. It is the Supplier's responsibility to make sure that output quality of the traction converter is entirely suitable for the traction motors.

4.3.15 Clause by Clause compliance for IEC-61287-1, 61287-2 and 60571 as applicable shall be provided during design submission stage.

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4.4 AC TRACTION MOTOR

Two type of TMs (Fully suspended, bogie mounted and Axle hung nose suspended) are presently available for EMU/MEMU bogies for operation up to 110 kmph in IR. Purchaser shall clearly specify in Annexure XVI for the type of traction motor based on compatibility with shell/bogie design duly ensuring that other requirements of the specification are met(flood level etc.) for the intended service.

Traction motor requirement has been defined in the following Para as per mounting arrangement:

A) Fully Suspended, bogie mounted:

Three phase asynchronous type of traction motor shall be fully suspended with Bo-Bo arrangement(Encapsulated design of traction motor will also be acceptable for MEMUs). There shall not be any cardan drive or hollow shaft arrangement for mounting of traction motors. The motor shall be mounted on the bogie frame via flexible coupling and gear unit, which shall be totally enclosed and free from lubricant leakage. The coupling design and the motor to gear unit mounting arrangement shall minimize coupling dynamic angular displacement. The motor shall be dynamic balanced.

B) Axle hung nose suspended:

Axle hung nose suspended 3-phase asynchronous type of traction motor

suitable for IGBT converter/ inverter shall be used. Traction motor shall be suspended on the nose of the bogie and shall be axle hung by means of roller bearing and suspension tube. The maximum working speed of traction motor corresponding to 110 kmph with full worn wheel of 877 mm diameter shall not exceed 3500 rpm. Traction motors with speed lower than the above will be preferred.

Roller Suspension Bearing: The motor shall be axle hung nose suspended and with roller suspension bearing. The bearing should be selected to have minimum L-10 life of 6 million Kms. For calculation of L-10 life, calculation of equivalent dynamic loading for the proposed motor suspension unit bearing shall be provided to IR for evaluation. Criteria of selection of the motor suspension unit bearings (equivalent dynamic and static loading of the system with respect to bearings, limiting speed, reference speed, etc.) and its lubrication system (thermal stability) should be brought out and all the calculations must be provided at the time of design stage. Motor suspension unit bearings shall be grease lubricated on both DE and NDE sides, independent from gear case lubricants. The design of suspension shall ensure no leakage or ingress of gear case compound into the roller bearing under any circumstances. Standard and proven bearings with at least one year successful service experience in axle hung nose suspended arrangement shall only be used. Details for the interference fit of bearings should be furnished during design approval. The suitability of the entire drive consisting of traction motor, gear and suspension including axle should be proved in a type test.

4.4.1 General Requirement for AC Traction Motor (applicable to Para 4.4 above)

4.4.1.1 Three Phase asynchronous type of traction motor compatible with IGBT based traction converter/inverter shall be used. The general design and manufacture of the motor will be done to the standard IEC 60349-2 in accordance with the modern traction practices. The design will include all those features which are known to have worked well in the tropical climatic conditions.

4.4.1.2 The motor will be rated as per the EMU/MEMU performance requirements for the most severe service operation as defined in IEC 60563. It shall withstand safely with adequate design margins to work satisfactorily at maximum power operating point under motoring & regenerating. Calculations for maximum power loading shall be furnished by the supplier taking into account gear efficiency.

4.4.1.3 The motor will be capable of withstanding transients such as line voltage fluctuations, switching surges caused by stalling and wheel-slips.

4.4.1.4 It should be possible to absorb the stresses resulting from short circuit so as to have sufficient safety against damage or loosening of electrical connections. The safety factors should be furnished during design review for approval. The supplier shall also comment on the design adequacy of the construction of the motor for the maximum to continuous tractive effort ratio and the specified speed. The supplier shall also submit a detailed note on the robustness of rotor bar construction with end rings, precautions against loosening of bar in slots, overheating etc. from the full

life cycle point of view. IR has experienced the failure of brazing joints of stator winding overhangs. In view of this, additional measures shall be taken for ensuring the adequate support arrangement of stator winding overhang. In this respect, the supplier shall furnish the detailed note during the design and suitable test scheme for ensuring the efficacy of the design.

Stator winding overhangs shall be suitably supported to the stator frame and rotor design shall take care torsional vibration, thermal and centrifugal stresses encountered during actual service conditions. Material of rotor bars shall be able to maintain its minimum values of properties with safety limits over the complete operating range of temperature and have high fatigue strength.

4.4.1.5 The following operational and environmental factor will be specially kept in view in the design of the motor:

4.4.1.5.1 Because of track irregularities, level of shocks and vibrations to which traction motors are exposed are far more than actually given in IEC 61373 for TM mounting arrangement. Supplier can obtain the data of vibration trial from IR. However, supplier must carry out instrumented trials on existing stock for measurement of shocks and vibrations in sub-urban area in consultation with RDSO, at design stage, only.

4.4.1.5.2 Prevalence of high temperature and humidity for the most part of the year.

4.4.1.5.3 Operation of the EMU/MEMU over a humid and salty terrain in which the climate varies from high rainfall for 4-5 months and extremely dusty atmosphere during rest of the year.

4.4.1.5.4 Traction motor drive system shall be self ventilated. Traction motors shall be capable of being mounted as specified in clause 4.4, with bare minimum changes/modifications on the existing bogies, axles and structure. Supplier shall submit the design details for the changes required in the bogie/axle/structure for mounting of traction motor. Such changes shall be incorporated by the coach manufacturer at their works. For any change in design of axle, bogie frame or any other part of bogie, design validation for changes as per applicable standards shall be submitted by the supplier.

4.4.1.5.5 In order to validate the design of vital components of traction motors, Finite Element Analysis (FEA) for mounting, complete rotor, Stator with winding overhangs, TM Bearing cage, Ventilating fan, cages of bearings used in transmission system and rotor shafts, along with its boundary conditions have to be provided at the design stage. The boundary conditions for FEA can be decided in consultation with RDSO.

4.4.7 Insulation System:

4.4.7.1 The insulation system to be employed will be particularly designed to withstand the adverse environmental conditions as specified in

specifications and standards. Imperviousness to moisture shall be ensured.

4.4.7.2 The evaluation of the insulation system for thermal endurance will be made with fabricated test models by way of accelerated ageing test as per the test programme drawn up in accordance with the norms specified in IEC: 60034-18 and IEC 60505/1999.

4.4.7.3 Various ageing parameters such as heat, vibration, mechanical / compressive stresses, special environmental effects of humidity with water immersion test, dust, metallic dust from bake shoes, etc. will be incorporated to simulate the actual working conditions as closely as possible.

4.4.7.4 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.

4.4.7.5 With regard to the system of insulation adopted and the climatic and environmental conditions, the supplier shall provide maximum possible margins in the temperature rise, for the prolonged life of the traction motors.

4.4.7.6 Maximum temperature rise of traction motor winding shall be limited to TI – 70 degree Celsius, considering 25% choking of filters. Thermal simulation of temperature rise in stator and rotor with given duty cycle of the EMU/MEMU operation shall be carried out to establish maximum temperature rise shall be within TI – 70. The simulation result shall be provided as part of Design Package. The temperature rise in stator and rotor winding shall be validated through physical measurement on traction motors during the Type Tests. The temperature rise in stator and rotor winding shall be validated through real- time temperature measurement by temperature sensors embedded on Stator and Rotor parts during temperature rise tests on traction motors during the Type Tests.

4.4.7.7 The motor will be designed in such a way that the “hot spot” temperature under conditions such as one hour, short-time and continuous rating of loading in any winding (stator and rotor) does not exceed the average temperature of that winding measured by resistance method by more than 20°C. For encapsulated design of traction motor of MEMUs, lower limit of hotspot temperature can be accepted.

4.4.7.8 With regard to the system of insulation adopted and the environmental conditions the maximum temperature rise in the traction motors will be less than the temperature index minus 70°C under all operating conditions including emergency operations.

4.4.7.9 The mechanical design of traction motor, its mounting arrangement , transmission system (pinions and gears, gear case etc.) shall be designed considering the measured data of shock and vibration, as mentioned in para 4.4.1.5.1. Various components of traction motors shall be manufactured with such tolerances so as to enable complete interchangeability of components from one motor to another of same design.

4.4.8. **Harmonic/Ripple Factor**: The traction motor will operate satisfactorily

over the entire range of loading, with harmonic/ripples imposed on from the IGBT based supply system (comprising transformer and converter/inverter both during motoring and regeneration braking conditions). With the harmonics/ripples generated by the converter, temperature rise in traction motor shall be in accordance with that mentioned in Paras 4.4.7.6 and
4.4.7.7. With regard to the system of insulation adopted and the climatic and environmental conditions, the supplier shall provide maximum margins in the temperature rise, for the prolonged life of the traction motors. The manufacturer shall conduct necessary tests on the traction motor to establish compliance with this requirement.

4.4.9 **Criteria for selection of the traction motor bearings** (equivalent dynamic and static loading of the system with respect to those of bearings, limiting speed, reference speed, etc.) and its lubrication system (thermal stability) should be brought out and all the calculations must be provided at the time of design stage. For vibration data Para 4.4.1.5.1 may please be referred.

The designed L10 life should be at least 2.5 million KM. If the insulated bearing is used, then the reason for the same should be specified in thedesign. For calculation of L-10 life, calculation of equivalent dynamic loading for the proposed traction motor bearing shall be provided to RDSO for evaluation.

Traction motor bearings shall be grease lubricated preferably rivet less on both DE and NDE sides, independent from gear case lubricants. Intermixing of TM bearing and gear case lubricants is not allowed. The greasing interval & overhauling frequency of the bearing may be specified. Standard and proven bearings with at least one year successful service experience in rolling stock application shall only be used.

4.4.10 The rotor shaft should be removable from rotor. The rotor should be reusable/repairable in case the rotor shaft gets defective.

4.4.11 While considering the design of cooling fans , vibration data of para 4.4.1.5.1 may please be referred. IR has got experience of breakage of these fans and so adequate design analysis, along with FEA shall be provided in support of the design.

4.4.12 The speed sensing device for control purposes, if necessary, shall be mounted on the traction motor itself.

4.4.13 Suitable provision shall be made to detect traction motor over temperature for ensuring timely protection to the traction motor before any damage occurs. Supplier shall substantiate the compliance. If any thermal model is used for temperature measurement, it shall be validated during prototype testing.

4.4.14 Speed sensing device and the temperature probe should be made accessible from the maintenance pit in the Depot/Car shed and should also be replaceable. The mounting arrangement of the speed sensing device and temperature probe shall consider the protection of these sensors against breakages during the train operation. Their

maintenance/replacement shall not require lifting of the motor coach. The arrangement should correspond to the flood-proofing requirement. The connecting leads should be protected from mechanical damages and should be fastened to the motor at least at one point. The end shields shall be provided with suitable protection arrangement to protect the windings from any damage due to flying ballast during run.

4.4.15 Design shall provide for the screened motor cables for control purpose. The screening should be grounded at the motor. The terminal markings should be legible permanently on the cables.

4.4.16 Traction Motor Tests: The traction motor shall be subjected to all the prototype & routine tests in line with IEC 60349-2. Prototype tests shall include continuous temperature rise test, short time rating tests, characteristics tests, over speed, power factor, efficiency, dielectric & torque measurement tests.

4.4.17 Special tests on traction motor:

The following special tests on traction motor shall be carried out along with those specified in IEC 60349-2:-

i) Flood proofing tests: Traction motor fitted with pinion & gear box running at 200 r.p.m (without gear, axle roller bearing housing & other attachment parts) to be immersed up to 400 mm(203 mm for MEMUs) from rail level for 24 hours. Following test parameters shall be recorded:

a) Insulation resistance before immersion test
b) Insulation resistance after immersion test
c) Visual inspection regarding seepage of water inside the gear box and motor

ii) Tests on speed/temperature sensors - in case of proven items, certified test reports shall be acceptable.

ii) Measurement of waveforms of the motor converter voltage, motor converter current, motor torque & space vector flux under different ranges of operation during heat run & characteristics test on converter supply.

iv) Vibration test as per IEC 60349-2.

v) Traction motor roller bearing test for adequacy of sealing of lubricants.

4.4.18 TRACTION MOTOR DRIVE

i) The torque transmission arrangement from traction motor to axle shall be simple and suitable for both traction and braking forces. The tractive/braking effort shall be directly transferred from the traction motor pinion to the wheel gear. Lubrication system for gear/pinion shall be kept physically segregated from traction motor bearings. Both the ends (drive and non-drive) of traction motor shall be grease lubricated, only. The complete arrangement shall be of proven design for same or higher traction/braking torque transmission. However, special care shall be taken

in design with respect to high track vibrations as mentioned in clause 2.3 and Para 4.4.1.5.1. Supplier shall submit relevant details in this regard along with the special measures taken in view of the specified track data and environmental conditions.

ii) Details for the interference fit of bearings should be furnished during design approval. The suitability of the entire drive consisting of traction motor, gear and suspension including axle should be proved in a type test.

iii) Gear case shall be made of steel and shall have sufficient mechanical strength so as not to get damaged due to hitting by ballast or any other foreign objects. Aluminum shall not be used anywhere in the under frame. The design of gear case shall ensure minimum loss of lubricant during run. Cast steel gear case shall be preferred. The oil circulation in gear case should be independent to the lubrication of bearings for the traction motor. The Use of helicals in the threaded holes for fastening of bolts shall not be permissible.

iv) **Traction gear:** All traction gears will be case hardened alloy steel of approved quality. The MTBF for the pinion should at least be 1 million Km and for the gear wheel at least 2 million Km. Pinion and gear wheel should be produced from case hardened alloy steel. The gear case design shall be furnished and finalized during design approval. Supplier shall submit proof of stability for gear tooth forming and total design, description of the gear tooth forming, provided materials, manufacturing and hardening procedures with corresponding specifications, Oil types and lubrication intervals.

4.5 MICROPROCESSOR CONTROL AND DIAGNOSTIC SYSTEM:

4.5.1 Microprocessor based control system will be used for converter control, DC link control, inverter control, traction control, braking control, auxiliary power control, slip & slide control, converter actuating, monitoring of commands to the control units and protection etc. The link between the microprocessor and the interfaced cards should be established by means of VME/PCI/Parallel bus/Serial bus system. Suitable physical bus interface, to ensure error free and high speed data transmission should be provided. It is desirable that majority of control and monitoring functions are implemented by software so as to reduce hardware and cables. All electronic cards shall be suitably protected against dust and moisture. The protection level and the arrangement shall be furnished by the supplier. The electronics shall be tested for its functionality in a dusty and humid environment. The electronics and other equipment shall be suitably protected against mould or fungus growth.

4.5.2 Microprocessor should perform the task of fault diagnostics and display in addition to control task. The microprocessor should be capable of monitoring the status of the equipment and continuity of jumper cables continuously and occurrence of faults. The microprocessor should also take appropriate action and where ever necessary shut down the equipment. The faults occurring in any of the motor or trailer coaches shall be displayed in appropriate form in the driving cab. Coach wise faults shall be displayed with messages on LCD screen in driver's cab as per clause 4.8. It

shall be possible for the driver to select and take appropriate action viz. isolation of specific equipment of any motor coach etc. from the cab itself, if so desired.

4.5.3 The faults should also be stored in the memory of the microprocessor and it should be possible to output the same by means of USB/serial interface/Ethernet Interface to commercially available printer or personal computer/laptop. The various important parameters of the equipment as well as environmental data at the time of occurrence of the faults should also be recorded with a view to enable proper fault analysis. Application/diagnostic software tools as required for trouble shooting and analysis of equipment wise and motor coach wise faults and maintenance of the EMU/MEMU and equipment shall be provided. Adequate redundancy should be built in the microprocessor.

4.5.4 It shall be possible to down load the data viz. event/fault, major diagnostic messages of the rake (of all the processors) from the single point in driving cab and shunting cab of EMU/MEMU without opening the H.T. door.. There shall be arrangement for online downloading of fault diagnostic messages through GSM or other suitable links from train to maintenance car sheds / depots. The communication link shall be the responsibility of IR; however integration shall be the responsibility of the supplier. The diagnostic messages of at least last 100 days shall be available in its memory.

4.5.5 It shall be possible to keep the EMU/MEMU at the desired speed irrespective of track profile. The speed control shall work within the limits of maximum electrical performance. The selection of speed shall be possible by press of a switch. However, the system shall be inherently fail safe and shall immediately come out of this mode to normal mode on actuation of master/ brake controller, actuation of AWS/TPWS or as required from safety considerations. In case preset/selected speed control is not used, the tractive effort control will enable the EMU/MEMU to be driven on the basis of tractive effort readings.

4.5.6 It shall be possible to read and record the energy consumption figures for regeneration and traction for a particular time period for the individual motor coach and for the full rake, along with train no., the name of the driver, date, time journey details etc. as fed through suitable electronic device in the driver's cab, details to be worked out during design stage. These figures shall be available readily on the driver's display panel as and when required and shall be retrieved through PC/laptop.

4.5.7 Isolation of motor coach shall not affect the normal functioning of brake system. Under such conditions, the regenerative braking from other motor coaches shall not be affected adversely. The regenerative braking shall be independent for each bogie and faults on one bogie shall not affect the regenerative braking performance on the other.

4.5.8 It shall be possible to test the software after uploading the same by means of simulation facility or by some other means. The downloading of the software, and detail diagnostics etc. shall be feasible through any motor coach or DTC in EMU and DMC of MEMU. The configuration of the motor

coaches for the purpose of interlacing etc. shall be automatic and without any manual interference in case of isolation of motor coaches during the service or change in the formation of the rake in the shed so as to ensure compliance to clause 2.8. Bidder may note that the control for the complete range of operating speeds for one basic unit (one DTC, one MC and one TC/NDTC for EMU and one DMC and 3 TC for MEMU) level shall also be preferred though the normal operation of the EMUs shall be in 12-car, 15-car or 18-car formation of EMU and 8-car, 12-car, 16-car, 20 car and 24 car formation of MEMU.

4.5.9 Acceleration and speed shall be clamped to a selectable value while opting for 'shunting' operation. The shunting operation shall be selectable and shall be recorded.

4.5.10 The microprocessor control and diagnostic system shall also provide for measurement and recording of speed of the EMU/MEMU in the driver's cab with the provision of wheel diameter correction, distance travelled and time.

4.5.11 The system shall ensure normal working & with out any adverse effect on any equipment while traversing the neutral section.

4.5.12 It shall be possible to selectively operate the circuit breakers or pantographs if so required by the driver. Sequential operation of VCB as desired vide clause 3.3 shall be ensured.

4.5.13 It shall be possible for the IR to execute any modification through software by changing the variable data or otherwise, if so required in future in order to improve the operation of EMU/MEMU. Supplier shall supply all necessary software/hardware tools required for the purpose. However, in case the implementation of the modification calls for any provision of any specific equipment, the purchaser shall provide the same. The modifications shall be restricted to parametric changes as permissible within the design constraints such as change in acceleration, deceleration, bogie & coach suspension, train configurations, OHE voltage, temperature /pressure/ voltage/ current sensor setting, maximum speed of EMU/MEMU, wheel diameter, tractive effort and frequency, etc. The list of parameters shall be finalized at design stage. While listing out the values of various parameters, the supplier must provide a range within which any change can be made without jeopardizing the functionality of the system. It shall be possible to configure these parameters through a laptop and menu-driven as well as easy to use, application software shall be provided for this purpose. Password protection shall be provided to safeguard against any misuse.

4.5.14 The supplier shall submit separate lists of safety signals, control signals and priority signals with explanation.

4.5.15 In the event of air spring getting deflated due to some unforeseen reason during service, an air spring failure sensing system shall be provided in each coaches by the supplier to reduce the speed of the train automatically up to prescribed speed and to enable the driver to run the train at a predetermined restricted speed with bogies having deflated air springs. Audio visual indication of such failure shall be available on HMI/Display in cab. Indication in the driving cab shall include coach, bogie & deflated air spring position of the rake. Appropriate system at bogie level shall be

provided by the supplier. The supplier shall also be responsible for its interface with TCMS and software.

4.6 PROPULSION CONTROL, PASSENGER INFORMATION & COMMUNICATION

4.6.1 The leading cab will be controlling the motor coaches in the rake 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 the control signals are not distorted by any type of interference.

4.6.2 Passenger Information & Communication System

Passenger Information & Communication System shall be a proven one based on GPS system and shall provide following facilities:

i) Driver-guard or cab–cab communication between two driver's cabs on the train. The PIS shall include provision for the announcements to be made remotely by train controllers, however, the purchaser will provide suitable communication facilities. There should be provision of recording the voice of driver & Guard (both) in the flash memory (for a duration of at least 24 hours) and in crash protected memory (for a duration of at least 10 mins) of intelligence based recording described in clause 4.9.6. Mic provided on the driver desk shall be made use of, for this purpose.

ii) Public Address announcements or playing of taped information by the driver & 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. The details shall be collected by the supplier in association with the respective user railway and the control scheme finalized.

iii) Displays like type of service, class of coach destination, halts, name of the approaching station & platform direction etc. in the coaches on the LED (Multi-coloured) screens specifically designed against vandalism, water & dust ingression. Data input shall be from the driver's console as a part of setting up procedure from both driving trailer coaches (preferably by Guard but also possible by driver). Display panel for Passenger Information & Communication System shall be provided separately on driver's console than the display panel specified in clause 4.8.2. Coach displays will be both in Hindi, English and in one regional language as optional. The display should have two dimensional graphic LED matrix display for catering to display of advertisements in multicolor i.e more than two colors. Galvanic isolation and Video Display Processor (VDP) instead of Video Display Controller (VDC) may be used as per design requirements. The internal displays shall be IP 54 class.

There shall be two one-sided and two double-sided internal displays (single sided for end walls fixing & double sided (hanging type) for middle fixing displays) per coach for EMUs. For MEMUs there shall be two double-sided(hanging type) internal displays for middle fixing displays per coach. The encapsulation class shall not be less than IP 54 with the suitable arrangement to avoid damage to display due to vandalism. The size,

number, matrix & resolution of LEDs with L-70 life time shall be such that it shall be visible clearly from distance of 20 meters minimum. The viewing angle for the internal displays shall be 60 degree for uniform intensity and 90 degree with slight reduction in intensity.

iv) Two Destination indicator (Head Code) for EMUs and one Destination indicator (Head Code) for MEMU, shall be provided on the driving coach face . The head code shall be in a separate box above the lookout glass. A modern high resolution LED display in both English and Hindi in amber colour shall be provided which should be visible clearly from the platform from the distance of 50 meters minimum (in day light) while the train is approaching the platform. Full details of the data to be incorporated will be furnished to the Supplier at the design stage. Data input shall be from the driver's console as a part of setting up procedure. Head code display shall include Destination, location of Handicapped coach, Rake formation, Slow/Fast etc. However, the appropriate class and overall dimensions according to the location shall be frozen during the design stage. There shall be provision of manual over ride feature for setting the Head Code display in the event of failure of Passenger Information System (PIS) electronics.

The viewing angle for the destination indicators shall be 60 degree (+/- 30 degree from the centre line).

v) The microphone used by the driver shall be common for all voice modes and priority shall be allocated to various modes.

v) The PA intercom system shall be controlled by the keys in the driver's dashboard. 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.

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

viii) In case of failure of one unit of PA system or a passenger communication unit in one car, there will be no failure of the whole system. The loudspeakers shall be separated into two groups, each audio line being supplied by it's own power amplifier. Suitable arrangement for ensuring the adjustment of the volume of loudspeakers against the varying ambient noise shall be provided. While designing the system, adequate care shall be taken to prevent damage of equipment due to vandalism, water and dust as the EMUs/MEMUs shall run with doors wide open. This shall also have bearing in selection of amplifiers of adequate capacity. Suitable tools for configuring the system shall be provided.

At least 8 speakers shall be provided in each motor/trailer coach respectively so as to ensure the optimum audio level uniformly distributed in the passenger compartment. The exact number shall be decided during design stage. System shall provide adequate redundancy and expendability to undertake future requirements of IR. Supplier shall enclose detailed comments on this subject. It shall also be possible

for the driver/guard to manually adjust the amplification levels of the public address system. The complete integration of the system including the uploading of sound files, announcements and advertisements shall be the responsibility of the supplier. Any modification e.g. in announcement and advertisement files shall be user friendly.

ix) All the communication and control cables shall be conforming to international standards for fire retardant, fire survival characteristics suitable for the EMU/MEMU services. Fire survival cables according to EN 50200 shall be used for PA/PIS, ETB circuit, Passenger Alarm, supply and other essential circuits of Fire detection system and (Door system if applicable) for their continued functioning to the extent possible in the event of fire. Survivable duration classification of PH30 (30 minutes) or higher shall be suitable.

x) Few designated coaches as per latest guidelines of Railway Board in EMUs/MEMUs shall have the provision of talk back. Emergency buttons and talk back phones shall be located near the doors and gangways. Once pressed/operated , it shall be possible for the passenger to communicate with the Train Driver / Guard. Four ETBs (Two each on physically independent channels) shall be provided per coach. If more than one emergency device has been operated, each demand shall be independently acknowledged, and alarms shall be stored, displayed and answered sequentially. Provision shall be there for voice recording of the conversations with GPS stamping. The CCTV camera of the coach shall focus on the ETB area during the conversation. LED indication (engaged or free) at the passenger end shall communicate the status of ETBs.

xi) Provision of Volume Control in PA/PIS shall be provided from both the cabs.

4.7 MASTER CUM BRAKE CONTROLLER

4.7.1 A combined master cum brake controller, integrated into a single unit shall be used. This shall be of a proven design and shall be of step less type. Suitable provision shall be made to ensure unhindered operation in case of failure of master controller. It shall not be possible for unauthorized person to operate the master controller. Provision shall be made to ensure operation of the EMU/MEMU in the event of failure of master controller.

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

4.7.2 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
-- Over-speed control

4.7.3 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. Selection of reverse direction by key switch has to be acknowledged by the driver via Human Machine Interface (HMI) before releasing traction. This acknowledgement shall not be applicable for Rescue Drive Mode (RDM).

4.7.4 Maximum 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 with the EP brakes.

4.7.5 Identical master-cum-Brake Controller shall be provided in both driving as well as in shunting cab.

4.8 DRIVER'S CAB

4.8.1 Layout of Driver's Cab

i) Supplier shall design the complete pre-fabricated driver's and shunting desk in line with the UIC 651 to the extent possible. The layout of the crew area and control system shall be ergonomically designed to allow crew to efficiently operate all controls for safe train operation either sitting or standing. Ergonomic and human engineering aspects of the cab design shall be compatible with the range of 5^{th} percentile Indian adult female to 95^{th} percentile Indian adult male. The modification required to be implemented in the coach body viz. layout of pneumatic pipelines and adjustment to the cab depth etc. shall be implemented by the supplier in association with the manufacturer to the maximum possible extent.

The cab shall include all the cab equipments e.g. combined master-cum- brake controller, instrument panel with back-lit instruments, gauges for pneumatic indications, control panels, driver's diagnostic display unit & driver's "log in" device, driver and guard seat etc., ergonomically designed driver' desk/console, pre-wired and terminated on a terminal board and multi- pin plugs/sockets for inter-equipment connections. Cab-equipments shall also include pneumatic horns (supplier to provide hand operated hooter for driver in addition to foot pedal and this shall include push button on driver desk panel and magnetic valve. Foot pedal and guard side hand operated valve will remain as in existing stock), gauges for pneumatic indications, speedometer-cum-recorder, electric motor driven wind screen wipers (wiper should have wind screen washer & control as well), sun-screens, auxiliary head light with tail light, safety related equipments like bell code system, flasher light and speedometer-cum-recorder. This shall also include suitable 'bell code exchange' system between the cabs of the EMU train. Destination indicator (Head Code) shall be provided in a separate box above the lookout glass.

ii) All crew workstation/driving desk and cab area controls must be robust, of industrial quality and resist physical abuse and vandalism. Moulded FRP/Polycarbonate or better material suitable for such application must be used. The color scheme of interior shall be frozen at the time of design approval.

iii) The top of the driver's control workstation must accommodate documents such as timetable or similar books without interfering with the operation of the controls. Suitable space for keeping crew bag/briefcase, fire extinguisher and skids shall be provided in the cab.

iv) The positioning of crew interface controls must be such that they are within the range of vision, touch and audibility requirements whilst the crew is in his/her normal operating positions under all operation conditions.

v) Crew cab, pipes and conduits:
Equipments such as air pipes, conduits, ducts, cabling, terminals and connectors shall be hidden from the view and shall not interfere with the crew operations. The doors of such enclosures shall have proper locking arrangements with ease of handling

vi) Each functional position and/or range must be clearly marked by embossed or engraved letters. The labeling used must be by agreement.

vii) A circuit breaker listing must be included on the inside of any door or hatch that covers circuit breakers. The circuit breaker listing must relate the circuit breaker labeling to its function and the equipment which it isolates.

viii) **Ergonomically Designed Driver's Desk:**

Ergonomically designed driver's desk/console taking into account necessary traction controls, safety controls and passenger amenities items etc. shall be a part of the complete driver's and shunting cab. The design of the console shall also take into account the positioning of various pneumatic gauges, brake controller, AWS/TPWS equipments and any other equipment installed in the cab. The complete console shall be supplied pre-wired and terminated on the terminal board and multi-pin plugs/sockets for inter equipment connections. The cab shall be provided with ceiling lights designed to provide 100 lux (approx.) at 1 metre above floor level. Supplier shall be responsible for its proper commissioning.

All the equipments viz indication and instruments, panels, switches, lighting, driver and guard seat, sunscreens and gauges etc. required to be installed in the cab, shall be supplied by the supplier except for AWS/TPWS equipments and Auto Brake Controller which shall be supplied by the purchaser. A list of the equipments which is normally installed in the cab is placed at Annexure-I. As such the supplier shall have the complete responsibility of ergonomic design of driver's cab and supply, commissioning and interfacing of the complete cab equipment.

ix) The layout of the equipments on driver's desk shall be finalized during design approval stage to maintain uniformity with cab arrangement of a similar project of IR so that the cab layout remains same from driver's perspective to the extent possible. Based on the approved layout, a mock up of the complete driver's and shunting cab shall be made at ICF for EMU and at RCF for MEMU/nominated manufacturing works to finalize the finer details and freeze the design.

x) Chairs provided for driver / guard should provide comfortable seating and permit free movement inside cab.

4.8.2 DISPLAY PANEL:

A suitable display (back lit) with high resolution, wide viewing angle, suitably designed against vandalism, high impact, rough handling, ingress of water & dust and IP 54 protected robust & heavy duty input/output system as per the available technology, shall be provided on driver's desk to display fault status, energy values & status of various important parameters as selected by driver/ maintenance staff or as required for the satisfactory system operation. The selection of the display panel shall be liberal and details shall be worked out during design stage. Supplier shall submit options available. The display system shall be protected against dust and moisture. Display shall have light/glare intensity control (auto/manual).

4.8.3 Driving cab Air conditioning

4.8.3.1 The supplier shall provide an Air Conditioning Unit suitable for Roof Mounted design in the Driving Cabs generally conforming to RDSO specification No. RDSO/2007/EL/SPEC/0055 (latest revision).

4.8.3.2 The air conditioning system in the Drivinq Cabs shall be designed to achieve the specified performance with four people (inclusive of the Train Operator) in the Driving Cab as per the outside dry summer condition and inside temperature of 25 °C (dry bulb) and 40% RH.

4.8.3.3 The air conditioning and heating system shall maintain temperature as follows:

Summer	**Dry bulb**	**Wet bulb**	**% RH**
Outside(Dry summer)	51°C	25°C	-
Outside(wet summer)	40°C	28°C	-
Inside(dry &wet)	20 to 25°C	-	40-60
Winter			
Outside	-4°C	-	-
Inside	(17-21)°C	-	-

4.8.3.4 In addition to the air conditioning system, provision of two fans shall also be made.

4.8.3.5 Temperature indicators shall also be provided in the Driving Cab.

4.9 SAFETY MEASURES

4.9.1 All equipments will be adequately earthed, insulated, screened or enclosed and provided with essential interlocks and keys as may be appropriate to ensure the protection of equipment and safety of those concerned with operation and maintenance. An earth fault detection system shall be provided by the supplier.

4.9.2 **Fire prevention measures for equipment design:** The design of equipment shall incorporate all measures to prevent fire and will be such that should any fire take place, the effects shall be minimized and no spread of fire

should take place. Materials which are not fire retardant shall not be used. Hazard level HL-2 as per EN45545 will be applicable for EMU/MEMUs.The design and use in application of materials complying EN 45545-2 standard shall be ensured.

4.9.3 System shall provide foolproof safety against unauthorized person driving the train. The authorized person shall have to `log in' by means of suitable electronic device in the driver's cab and the details of the personnel and timing, journey details etc. shall be recorded in the memory. This shall be accessible as and when required. The details shall be worked out during design stage. .

4.9.4 Each driving cab shall be provided with speed indicating cum recording equipment as per the latest RDSO approved norms & specification no. MP.0.3700.07 (Rev. 04) of April'2007 or latest. The recording shall be on suitable media viz. CD or RAM cassette and thus should be readable in graphic and tabulated form. The capacity of the memory shall be such that it retains all data of at least one-month service period.

The speed indication cum recording equipment with electric drive will have a scale range of 0 – 120 Kmph. The equipment shall suitably interface with the controls to incorporate the wheel diameter correction and also take protective action in case of over speeding.

4.9.5 The existing safety provisions in the EMUs like passenger alarm system shall be provided by IR. These shall be suitably interfaced with the system by the supplier. The details shall be worked out during the design stage.

4.9.6 In order to analyze and to assist in determining the cause of accident, incidents or operating irregularities, TCMS shall have the facility to capture post trigger and pre-trigger background information on the occurrence of specific fault. The system 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). Event Recorder shall have one crash protected memory (not less than 8 GB) and one data logging memory (flash memory) (not less than 32 GB) for recording of data. The memory shall be allocated to store short-term data at 1 second interval for the last 72 hrs. in crash protected memory and long term data for 90 days with resolution of 20 seconds in data logging memory.
The following (not limited to below mentioned) 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 the activated Driving Cab

(k) Head light status on/off

(l) Flasher light status on/off

(m) Horn status on/off

(n) Status of penalty brake application (application of the service/emergency brake by AWS/TPWS)

(o) Wiper on/off

(p) Any other parameter considered necessary.

(q) Driver's set point of traction and braking mode

(r) Load weighing system status and air spring deflation faults

The system shall be designed to cover:

(i) Permit rapid extraction and analysis of data for the purpose of monitoring operation of EMU/MEMU Train;

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

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

The system shall be designed and constructed to ensure the integrity of the recorded data and the ability to extract data following an incident and it shall be tested in accordance with a recognized international standard such as the UK Railway Group Standard GM/RT 2472.

4.9.7 System shall provide for adequate safety measures against rolling back in case the train is to be started on a rising gradient.

4.9.8 **Selection of insulating materials:**

In selecting the materials of insulation, the moist tropical weather conditions and chemical pollution/corrosive atmosphere shall be kept in view. In this regard, the manufacturer will furnish information regarding the suitability of the selected materials under various climatic conditions referred to in the specification. Additional necessary tests, if any, for ensuring suitability of materials will be conducted by the supplier in the presence of IR's representative in the same way as executed by IR in INDIA and the test result advised to the purchaser.

4.10 CONTROL EQUIPMENT

The control equipments, relays and switches, and such other devices shall represent the latest and proven technology established under the most severe operating conditions defined in this specification with particular regard to reliability. Wherever considered necessary, the contacts should be duplicated to provide redundancy. The temperature of the equipment offered shall be governed by IEC minus 30^{O}C. The use of relays and

contactors shall be to bare minimum. All control equipments, relays and contactors shall be mounted on suitable panels placed in dust proof enclosures and shall remain in the scope of supply of the supplier including harnessing thereof.

The control cubicles for all type of coaches shall be in the scope of supply. The endwall cubicles for coaches for housing relays, contactors, control electronics, switchgears and end termination of control, data and power connections shall be mounted on either end walls with IP 54 enclosure. The cubicles shall have hinged doors with suitable locks. The cubicle shall be designed for flush fit in the end walls for EMUs. However, the cubicle design shall be finalized in consultation with Car body builder during detailed design stage.

4.11 POWER AND CONTROL ELECTRONIC EQUIPMENT

The traction converter/inverter shall meet the requirements of IEC-61287 & the control electronic and PCBs shall conform to IEC-60571 including compliance to the optional tests. However, due to higher ambient temperature in India, the temperature for dry heat test shall be 80^0 C. The electronic control equipments should be protected against unavoidable EMI in the machine compartment. The equipments shall be suitably mounted in the properly designed cabinets for cooling requirements of the electronic equipments (with or without doors) and shall remain in the scope of supply of the supplier. The vibration & shock tests and endurance tests shall be done as per IEC 61373 as per the requirements of design.

4.12 BRAKE BLENDING

4.12.1 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.

4.12.2 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. The supplier shall furnish the time delay for such a change over. In case the power supply fails for EP system, automatic brakes shall be applied immediately.

4.12.3 The supplier shall modify at his own cost the existing brake equipment for proper functioning of the brake blending scheme, in case the design calls for such a change. The design changes in brake system, if become imperative, shall be got approved by the supplier before implementation. The details of the existing brake system may be obtained from coach manufacturing unit.

4.12.4 Supplier shall furnish details of the system adopted for ensuring safe and

smooth changeover to EP brakes when regenerative brakes are rendered ineffective. In order to ensure smooth changeover from regenerative to EP brakes and vice versa, braking resistor shall be provided during the change over period. The supplier shall submit the respective distribution/proportion of electrical & mechanical brakes throughout the operational range of the EMU for achieving the specified rate of decelerations at clause 2.4.2.

4.12.5 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 shall be provided to ensure redundancies and shall perform the functions as defined in sub-clauses of Clause No. 4.12. Brake system integration test shall be performed through simulation on test bed at manufacturer's works.

4.12.6 It shall be possible for the driver to know the mal-functioning of brake system of a coach. A diagram of the EP brake unit is enclosed at annexure-XI.

The friction braking system shall function as the ultimate braking system on the car, acting as a backup during normal service braking and as the primary braking system during emergency stops and while parking.

The supplier shall provide suitable interface for the brake system with the existing auxiliary warning system (AWS)/Train Protection Warning System (TPWS) provided on IR and on the existing EMUs. .

System shall provide for adequate safety measures against rolling back of EMU/MEMU in case the train is to be started on a rising gradient.

4.12.7 Wheel Slip/Slide Protection & Anti Skid Controls

The brake system shall provide for automatic wheel slip–slide protection to be installed on motor coach. This equipment shall not operate during emergency braking. The Wheel slip/slide protection function & anti skid controls should be integrated/ interfaced with the Traction Control Wheel Spin and Protection function unit.

The wheel slip detection and correction system shall be an integral part of the Electric Train set 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 maximize adhesion and minimize wheel slipping / skidding.

4.12.8 PARKING BRAKE

i) A parking brake system shall be provided in each 3 car unit and shall be

capable of holding it under SDCL loaded condition of EMU and 4 car unit & shall be capable of holding it under DCL loading conditions for MEMU on a 1 in 100 gradient when there is no electrical power. A test scheme shall be submitted by the supplier to test the efficacy of parking brake system during the design stage. Detailed design calculation justifying the suitability of the offered system shall be submitted during design stage by the supplier. The system shall be tested for its satisfactory functioning in 12-car rake.

ii) Parking brake system working shall be optional and with the provision for isolation in case of mal-operation, if so desired, in emergency viz. bursting of air connection to parking brake cylinder etc. System shall immediately detect any mal-operation of the parking brake system before it causes any damage to wheels & the other connected item and shall take suitable protective action.

iii) The parking brakes shall be applied in the event of loss of the main compressed air supply. The design shall be such that the parking brakes will take effect prior to fading off of the service brakes. The parking brakes shall be capable of release from within the driver's/shunting cab when the compressed air supply is present. With no compressed air supply available, it shall be possible to release individual parking brake actuators manually from track level. Application of parking brakes shall also be controllable from the driver's/shunting cab.

iv) Status of train parking brake shall be displayed in the active driver's/shunting & guard's cab. A suitable pressure gauge shall also be provided and shall be in the scope of supply of the supplier.

4.12.9 JERK LIMIT

Under all normal operating conditions, the rate of change of coach acceleration or deceleration shall not exceed 1.0 m/s^3. Failure of the jerk limiting system shall not limit braking effort. Emergency brake applications and any associated ramp out of propulsion shall not be jerk limited. Reduction of propulsion effort due to a power interruption need not be jerk limited.

4.12.10 LOAD WEIGHING SYSTEM

Load weighing system shall be used to meet the requirements of rates of acceleration and braking. The pneumatic signal for the load weigh system can be taken from the air suspension to be provided by the purchaser on these EMUs/MEMUs. The load weighing compensation signals to the propulsion and braking systems shall be a continuous function available for all coach weights up to and including SDCL loading conditions of EMU and DCL loading conditions for MEMU. Adequate redundancy shall be provided in the load weighing system and failure shall be recorded in the diagnostic. If there is a failure of this system, the coach shall respond as if it was loaded to an SDCL level of EMU and DCL level for MEMU. A detailed control scheme shall be submitted by the supplier along with the calculations for the achieved levels for the acceleration and deceleration values. The proven schemes already in use by the supplier other similar

rolling stock applications shall also be given in support of the calculations submitted by the supplier. The same shall be examined during the design approval and decision shall be taken by the purchaser considering the features offered for their reliability, maintainability and ease of operation offered. The extent of advantage achieved on this account duly simulated shall be submitted by the supplier. The same shall be verified during the proto type approval by the purchaser for its effectiveness and implementation.

4.13 HIGH VOLTAGE PROTECTION

Roof mounted single bottle Vacuum Circuit breaker of proven and approved type shall be provided on 25 KV AC system.

A suitably rated high voltage cable conforming to the external application for running on the roof under the ambient conditions as per the specification shall be supplied to connect the VCB to the main transformer including end termination. The cable insulation and sheathing material shall be halogen free, flame retardant and shall have low smoke emission. The enclosure and termination of the cable shall be protected against rain water & wear. In the event of the breakdown of cable insulation or the termination, there shall not be any risk of electrocution, or other hazards to the persons inside or close to the outside of the coach. The supplier shall submit the cable layout schemes (preferably avoiding the passenger areas) during the design evaluation stage. All the safety measures must be listed along with the references of materials used by the supplier.

The HT cable shall be laid with proper protection and support. The supplier shall design the protection system and support clamps and these will be in the scope of supply.

All equipments and exposed cables in the undersframe should be suitably protected..

4.14 AUXILIARY SYSTEMS:

4.14.1 The Power supply for the auxiliaries will be through IGBT/SiC (based on suitability, merit of design and proven design) based converter/inverter suitable for AC traction supplies. The system shall be protected and devices shall be selected suitably to ensure that there is no damage on account of surges. Supplier shall submit protection scheme along with verification test plan at the time of design approval.

4.14.2 The auxiliary system shall be designed in such a way that in the event of failure of auxiliary converter(s) equivalent to one basic unit, all the loads including 100% traction load shall work normally. In case of failure of next auxiliary converter, the units with failed auxiliary converter shall work with 50% traction load, 50% light and fan load , 100 % ventilation load and all other loads shall be fully available.. 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 2.5 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 as specified in clause 2.5. The variation in the output of the auxiliary converter unit, if any, shall be submitted by the supplier for the entire voltage range of OHE as specified. However, auxiliary converter shall be capable to cater the full auxiliary (100%) load at input voltage range between 19 kV to 27.5 kV AC and shall perform up to 16.5 kV OHE voltage. Headlight shall not extinguish while traversing neutral section. However, control shall ensure that the battery does not get overloaded due to switching 'ON' of the headlight when overhead power is not available for long period. The power supply to headlights will be 110 V DC with LED based head light as per RDSO specification No. RDSO/2017/EL/SPEC/0134 Rev. 1 dated 23.04.2019 shall be used.

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

4.14.4 While calculating the rating of the Auxiliary converter, a provision of 10% in the auxiliary converter capacity shall be kept for future use. The complete equipment and connected accessories shall be supplied by the supplier.

The auxiliary load requirement of existing lights, fans & battery charger etc. of a unit (1-MC & 2 TCs) is of the order of 25 KVA. This shall be re-assessed by the supplier in view of the stipulations of the clause 4.14.16 and also taking care of the other loads either to feed through auxiliary converter and battery. The responsibility of the system integration and provision of any cable or termination equipment for other loads like flasher light, auxiliary head light, tail light, auxiliary compressor, alarm bells etc. shall rest with the supplier.

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

4.14.6 Motors for auxiliary machines shall generally be interchangeable. Coupling and mounting design requirements will be kept identical where applicable. Adequate redundancy shall be maintained while selecting the size of motors. Auxiliary machines shall confirm to IEC 60072 and 60034.

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

4.14.8 The standard low tension supply voltage for EMUs/MEMUs is 415 V, 3-phase,50 Hz AC. The supply voltage for the auxiliary machines will be 415 V +/-10%, 3-phase, 50 Hz +/- 3% AC.

4.14.9 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.

4.14.10 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, by the supplier at the design approval stage.

4.14.11 In the case of squirrel cage induction motors, aluminum alloy die cast rotor construction will be preferred.

4.14.12 L-10 life of bearings will not be generally less than 1,00,000 working hours when calculated as per ISO recommendation R-281. For motors higher than15 KW, flange bearing housing units will be used. The bearing design will 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 manufacturer.

4.14.13 All auxiliary motors separately & combined equipment like motor blower sets will be subjected to prototype tests as per relevant IEC specification If the operating conditions of the auxiliary machines differ from the specified test conditions in relevant IEC publications additional tests will be carried out.

4.14.14 Auxiliary Compressor Set: A 110 V DC battery operated auxiliary compressor set having adequate capacity, will be provided in each 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. A governor device will also be included in the scope of supply of the supplier. Any modification in the existing pneumatic control circuit shall not normally be preferred. However, if it becomes inevitable due to any design up gradation of the equipment, it shall be the responsibility of the supplier.

4.14.15 Lights And Fans:

i) Lights and fans shall be fed through the Auxiliary converter. With the existing available fans (each of 60 Watts) and the lights (each of 36 Watts), the light & fans load of the 3-car unit is calculated approx. 8KW. The design shall be such that the output from the fans and lights is not appreciably affected during extension of feed from adjoining coach in view of the consequential voltage drop.

ii) Supply of energy efficient LED based luminaries and fans for complete basic unit (1MC +1DTC+1TC), suitable for inverter supply, shall be in the supplier's scope of supply. At present, there are approx. 16 to 22 nos. fluorescent lights and 29 to 34 nos. AC fans/BLDC fan per coach

(quantities differ for MC, DTC, TC and NDTC). Similarly, there are 24 + 9 (Emergency) numbers of fluorescent lights and 24 AC fans in DMC and TC. Two number of BLDC fans shall be provided in each driver's cab. Each H.T. compartment shall also be provided with minimum two BLDC fans. The performance of the lights and fans as provided by the supplier shall not be lower than that what is provided by Railways at present. supplier shall rework and submit the lights and fans load requirement for assessing the Auxiliary converter load. The fan shall be designed for minimum delivery of 85 m^3 per minute under the worst conditions. The number and type of fans shall be decided on the basis of the ventilation requirements. Fans should be water jet washable, with sealed bearing & without any need of painting. All the fan switches shall also be the scope of supply of the supplier. Fan switches shall be flame retardant conforming to category V0, as per UL 94 suitable for traction duty application. Endurance test to be conducted at rated load for 1,20,000 operations.

iii) Lighting system shall generally conform to EN13272. The system shall be based on energy efficient LEDs and should meet the following requirement in general:

(a) The guaranteed life of the LEDs with their control system and optics/luminary shall not be less than 60000 burning hours.

(b) The specified Illumination level shaII be met till at the end of the life of 60,000 hours when the Illumination is not less than 70% of their original illumination level.

(c) The colour of the LEDs shall be warm white (temperature 4000K-5000K).

(d) The design of the heat dessipation arrangement shall be submitted in details with simulated results

(e) Colour rendering Index shaII not be less than 80.

(f) Complete light and energy simulation calculations shall be provided during design to prove validity of the proposed solution

Energy efficient, power LED based luminaries, meeting flame, smoke and toxicity requirements, shall be recessed into the ceiling paneling. The light fittings shall be simple with diffusers and arranged not to trap dirt, moisture and insects and shall be designed to minimize glare. Purchaser shall make necessary arrangement for fitment of these fittings. The LED based luminaries should have suitable reflector cover & should be sealed to IP 54.

iv) The size and number of light fittings shall be sufficient to provide a sensibly constant level of average illumination of 300 lux at a height of 1.5 m above floor level, along the entire length of the coach irrespective of the emergency feed extension in case of failure of auxiliary power or failure of main power during traversing of neutral section etc. The compartment shall be illuminated by sufficient number of parallel rows of energy efficient LED based luminaries extending full length of the coach. The coach lights and fans shall be able to work normally during the non-availability of the OHE when the train is traversing through the neutral section. The changeover to the alternative supply under such conditions shall be automatic and immediate.

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

coach.

vi) At least 50% of lamps 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. Light and fan control shall be provided from both the driving cabs.

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 rake from driver's 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. In case of battery reset, availability of emergency lights shall be ensured from direct battery supply.

ix) 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 100 lux at 1 metre above floor level.

x) Complete interface along with wiring, switch gears, relays and terminal equipments required for proper working of lights and fans shall be provided by the supplier.

xi) The Supplier shall submit layout of fittings, control circuit and service life of LED lamp during the design stage which shall be as per the best international practices.

xii) It shall be possible to replace defective LEDs/ block of LEDs with ease and minimum need for readjustments or otherwise.

xiii) **Disaster Management Light** : Separate self-contained disaster management LED type Emergency light units, 4 nos. in each Car having inbuilt primary/rechargeable battery (to provide backup of 12 hours) shall be provided. These lights shall be automatically switched ON in the event of non-availability of battery supply due to parting of Cars or derailment of Train.

4.14.16 Head, Tail & Flasher Lights

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

a) Head light - High intensity, long distance, halogen bulb or better, twin beam & with double filament (bright/dim). LED based head light should comply to RDSO specification No. RDSO/2017/EL/SPEC/0134 Rev. 1 or latest.

b) Auxiliary head light cum tail light (blinking during the service in rear cab) for EMUs or Marker light cum tail light (blinking during the service in rear cab) for MEMUs 01 nos. on each side of DTC. The tail light shall be red in colour and shall flash at a rate of 55-65 flashes per minute in operation.

c) Flasher light LED based of proven design and shall be of international

standards. The flasher light shall be amber in colour. The flasher light shall be designed to provide flashes at the rate of 30 flashes per minute.

Following shall also be provided and shall be in the scope of supply.

d) LED based step light for MEMUs with IP54 protection antitheft arrangement unbreakable cover along with switch.
e) The crew cab light and its control.
f) Indicator lights test switches.

These will work on the battery supply. The flashers will be used only in the emergencies arising from accidents to trains etc. Supplier shall ensure that a separate switch is provided in the driver's cab to switch ON/OFF the auxiliary head light independent of Head light and tail light (normal & blinking operation respectively).

4.14.17 Pneumatic system

Proven pneumatic system comprising of air compressor, compatible air dryer and filters shall be supplied so as to ensure delivery of the compressed air complying with air quality class 2 for solid particles and oil contents as specified in ISO-8573-1 of 2010 or latest. The air compressor shall be supplied as a complete unit containing all equipment required to supply all air systems with cool dry and filtered air and shall be sized to fulfill all air requirements of each car under all operating conditions. The compressor shall be directly driven by the motor and shall deliver required air for suspension, brakes and other requirements.

pneumatic pipelines should be color coded for easy identification by maintenance staff. The details shall be finalized at design stage

4.14.17.1 Main Motor-Compressor Set

i) Suitable compressor with motor having capacity of the order of minimum 900 lpm at 7 kg/cm^2 with duty cycle 30% to 80% shall be provided in each unit so as to meet compressed air requirement for brake system, control system and air suspension spring etc. The compressor shall be proven for satisfactory working in tropical and dusty conditions and shall require minimum attention/maintenance. Supplier shall quote for the proven low noise compressor of suitable capacity to suit the requirements as above. The final capacity shall be worked out during design approval. Supplier shall be responsible to submit the complete calculations for the duty cycle of the offered compressor, maintenance schedules, its provenness on similar rolling stock applications and environmental conditions given in the specification. Supplier shall also organize for the verification of the duty cycle on the EMUs/MEMUs.

The motor shall be 3-phase AC motor suitable for working from 3-phase output of the auxiliary converter. The Supplier may offer soft start motor with VVVF control of motor compressor suitable for under slung mounting. In case, Direct on Line (DOL) starting of compressor is adopted, supplier shall enclose a brief justification including the references and

specific design feature, which take care of fluctuations due to the compressor duty cycle.

ii) The motor-compressor unit shall be resiliently mounted with a 4-point suspension for minimizing the level of vibrations transmitted to the car body. Finite Element Analysis (FEA) for compressor mounting arrangement shall be submitted at the design stage. Safety sling shall be provided by the supplier.

ii) Bidder shall specifically ensure that the noise level of the compressor shall be as low as possible so as not to cause inconvenience to the commuters. The compressor shall be splash lubricated/oil free so as to avoid need for supplementary equipment such as oil pump, filter or valve etc**.** Noise emission level shall not be more than 68 dBA which shall be measured in accordance with ISO
3095:2001 norms satisfying the emission noise level for EMU/MEMU as mentioned in UIC guideline for procurement of new rolling stock.

iv) The capacity of the compressor shall be selected after taking into account the frequent purging of air by the air dryer (due to high ambient humidity), which may affect the compressor duty cycle.

v) Supplier shall offer the compressor of the proven design and ensure the provenness of such compressor in the dusty and humid climate as described in the Clause 2.7

vi) An air cooler that cools discharge air from the air dryer to within 10-15ºC of ambient air shall be provided.

4.14.17.2 AIR – DRYER AND AIR FILTER

i) Regenerative type air-dryer shall be provided at the outlet of the compressor to ensure that the dry air is available for controls and pneumatic operations. Due to heavy rainfall and high humidity as prevalent in most part of India, the air dryer shall be of heavy-duty type suitable for application in coastal areas and shall not require frequent attention & changing of the coalescing element and other chemicals. Supplier shall furnish the details in this regard. The mounting arrangement shall be such that the checking of the humidity indicator and changing of the chemicals shall not essentially require the pit.

ii) Air Dryer shall be provided with exhaust silencer so that the noise emanating out of the purging operation does not cause any discomfort to passengers or otherwise.

iii) The maximum relative humidity at the output of the air dryer shall be less than 35 %.

iv) Air shall be aspirated by the low-pressure cylinders and cleaned by a dry-type air-filter. The filter element shall be heavy-duty type and shall be specifically designed for high level of dust and debris as found in the vicinity of tracks in Mumbai. In any case, there should not be any need for cleaning the filter before the Schedule examination in the shed (refer clause 2.9.1).

Supplier shall declare the time period after which the filter shall require cleaning. Suitable mechanism shall be provided to indicate the quality of the air.

v) Under the ambient conditions, no condensation shall take place. Minimum particle size of 1 micron shall be removed and maximum 0.1mg/m^3 oil content shall be permissible as remnant. At least 95% liquid water shall be removed even at the worst condition/efficiency of the filter.

vi) The dryer shall be proven regenerative type under similar coastal conditions and shall preferably preceded by an automatic drain valve to collect and discharge the bulk of moisture in the compressed air before it enters the air dryer. An intercooler and after cooler of liberal capacity shall be supplied.

vii) The working of the air dryer shall be monitored and displayed in the driver's cab. In case of any malfunctioning of the dryer requiring isolation of the dryer, the system shall take suitable protective action without any interference from the driver.

4.14.18 FILTERS

All the filters as required by the supplier for satisfactory functioning of the equipment and complete system shall be supplied by him. IR has experienced that the cyclonic filters used in the existing rolling stock get choked with the debris lying around the track making the filter arrangement ineffective. Air filters assemblies of suitable type shall be selected accordingly and should be heavy industrial duty type.

The filtering capability, flow rate capacity, and overall size shall be appropriate for the application and the ambient conditions like prevalence of heavy dust and debris in India. It shall be possible to gain access to the filter element for replacement purposes. The design of capacity requirements shall take into account at least 25% choking in air filters & radiator fins vide clause 1.1.4 (vii).

4.15 Flood proofing of the equipment:

The equipment shall be designed to run at 8 km/h through water up to 203 mm above rail level, allowance to be made in addition, for the increase in the height of the water level due to wave effect. Further, due to certain sections of the tracks becoming flooded with water to a standing depth of 400 mm(203 mm for traction motor of MEMUs), the traction gear and other under slung equipment must be made completely waterproof to this height above rail level. During peak flood conditions water may reach up to floor level. Under such conditions, it shall be possible to rejuvenate the equipment with minimal maintenance.

4.16 AUTOMATIC SMOKE / FIRE DETECTION WITH ALARM:

A reliable automatic fire detection and alarm system shall be provided in the train covering the following areas:

(a) Electrical cabinets, traction converter, auxiliary converter etc. - Provision of Linear Heat Detector (LHD) cables (UL or EN approved).
(b) LT/HT compartment – Provision of Smoke/Fire detectors (as per EN 54-7 and EN 54-5) at suitable locations. The sensitivity and location of detectors in LT & HT compartment has to fulfil requirements of ARGE Guideline -Part 1 “Fire detection in railway vehicles
(c) Provision of RDSO approved make of Aerosol based fire suppression system for electrical cabinets, traction converter, auxiliary converter with 100 gram of aerosol per cubic meter of the enclosure targetted.

The system to be capable of detecting smoke / fire in above areas along with its location at incipient stage of fire. On detection of a possible smoke / fire by means of Smoke/Fire detectors, the system shall have different levels of response (at-least two i.e. warning and alarm) to be finalised at design stage. System indications must be promptly available to driver via TCMS pop-up messages who shall then take necessary action to minimise the spread of fire. There should be a provision for isolation of faulty detectors to avoid any inconvenience in train operations

The Smoke/Fire Detection system shall interface with TCMS in a redundant manner. Issues related to interface of smoke/fire detection system with TCMS shall be finalized at detailed design stage . All the major events (alarms, faults etc.) to be recorded in the detection system and should be retrievable on maintenance terminal for analyzing any issue. The System shall be designed for self-diagnostic to any failure/trouble within The System i.e. wiring break within the system, discontinuity in the circuit etc. The Supplier/OEM shall provide necessary diagnostic tools (softwares, hardwares etc.) in order to identify failures immediately.

Prototype approval to ensure the compliance of the system to ARGE guidelines will be arranged by the supplier and will be witnessed by any accredited assessor for these systems in presence of consignee/RDSO.

4.17 CABLES

(i) All power cables shall be electron beam irradiated & thin walled cables conforming to International standards using low smoke, low toxicity & halogen free materials suitable for EMU/MEMU applications.

(ii) All the auxiliary, communication, control and safety cables shall be conforming to international standards for fire retardant, fire survival characteristics suitable for the EMU/MEMU services.

Fire survival cables according to EN 50200 shall be used for PA/PIS, ETB circuit, Passenger Alarm, supply and other essential circuits of Fire detection system and (Door system if applicable) for their continued functioning to the extent possible in the event of fire.

(iii) The cables shall be de-rated to take care of the adverse ambient conditions. All de-rating factors shall be applied, together with the maximum permissible conductor temperature for the particular insulation type. In no case the conductor continuous temperature shall exceed 90^{o} C. The maximum short circuit temperature shall not exceed 250^{o} C. The cable insulation shall be capable of withstanding these temperatures.

(v) The length of power cables will be kept to minimum and cable connections from transformer to power converter will be minimized.

(vi) High voltage 3-phase AC and low voltage DC cables/connections will be physically separated from each other. Adequate number of standby vital spare control wires will be provided with adequate indications.

(vii) A systematic cable transit management & sealing system shall be provided for protection of cables against cutting, damage, fire, vibration, pull tension, temperature variation, dust, water, humidity & rodents as well. Cable management Transit System must be fire resistant, smoke and gas tight, and the pressure/vibration shall not damage it or compromise its seal or security. Cable transit system with EPDM rubber modules should broadly conform to Specification no. RDSO/2008/EL/SPEC/0067, Rev. 3 or latest.

4.17.1 The following operational and environmental factor will be specially kept in view while selecting the cable:

- Excessive vibrations that are experienced because of prevalent track maintenance conditions in India.
- Prevalence of high temperature and humidity for the most part of the year.
- Operation of the EMU/MEMU over a humid and salty terrain in which the climate varies from high rainfall for 4-5 months and extremely dusty atmosphere during rest of the year.

4.17.2 Wiring and Cabling:

(i) Optical fiber cables, if used for control signal purposes, shall be as per international practices & standards. Harnessed/optic fiber cables with end connectors shall be provided as 10% standby.

(ii) All connections shall be terminated on terminal bars of the approved design, provided for the purpose. The terminal and cable ends shall be suitably marked to facilitate correct connections. All the end wall panels in suitable enclosures as per the coach wiring requirements shall be the responsibility of the supplier.

(iii) Plugs/couplers and sockets will be used to connect pre assembled units and to facilitate maintenance & ensure a better layout.

(iv) No cable other than data/communication cable (like MVB/Ethernet etc.) having a conductor size of less than 1.5 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.

(v) Smaller size cables for internal wiring of panels, control cubicles, consistent with the mechanical and electrical requirements, may be adopted.

(vii) The layout of the cable will be such that contamination by oil is

avoided.

(viii) Loading of power cables will not be more than 75% of its capacity.

(ix) Cables for terminal connections will have only crimped joints.

(x) The cables for wiring will use high grade electrolytic copper stranded conductors tinned as per approved international standards and practice.

(xi) Suitable cable Layout to bring down EMI interference levels within acceptable limits. The supplier shall provide detailed cable layout, selection of rating, size and respective specifications.

(xii) EPDM based cable sealing arrangement to ensure air circulation shall be provided.

(xiii) The cables shall be supplied as harness duly cut to size, marked, connectorised/crimped along with protective accessories for protection against abrasion grouped according to area of use. The cable lay out shall be such that pre harness cables can be laid in the cars. The accessories for EMI and EMC protection also will be in the scope of supplier. Design and supply of trays for laying of harnessed cables and their accessories also will be in the scope of supply. The harness cables shall be supplied in sets of coach for drawal and uses. Further the harness so formed shall be sub-grouped to roof, endwall, under-frame, cab and HT compartment. The harness chart shall indicate all type of harness and end connection along with marking of wire numbers with prefixes and suffixes. All accessories for termination, branching, protection, jackets and end connectors etc., shall be in the scope of supply. Design and supply of all cable ducts/ conduits required for power cables and control cables along with mounting clamps and hardwares shall also be in the scope of supply for all ordered trains except ducts/conduits, which are integral part of car body.

4.17.3 Train Control & Management System (TCMS):

i) Train Control & Management system shall be used for integrating and multiplexing of signals for control purpose and for monitoring of the complete train, its systems and sub-systems within the appropriate safety framework as per the extant international practices so as to minimize the inter-vehicular cables. While designing the multiplexing the supplier shall have to ensure fail safe working of the safety related signals and also indicate the use of such system elsewhere in the similar traction applications.

Supplier shall submit details of the arrangement proposed to be adopted, the standard followed and the reference where similar system is functioning, maximum number of vehicles which can be connected to the network without need of gateway or repeater and the extent of multiplexing leading to reduction of the cables. The TCMS system shall be modular in design and shall cater for at least 10% capacity for expansion and future use. Necessary information, software & hardware tools as considered necessary shall be supplied to enable IR to interface compatible equipment with TCMS if so required in future.

TCMS shall not allow the traction (provision of traction cut-off) with indication to motorman in case system identifies that 50% or more bogies are in pneumatic brake isolated condition.

Rollback protection shall be provided in TCMS. Rollback protection shall be independent of parking brakes.

Adequate redundancy in the system design of TCMS, as permissible vide the standard adopted, shall be ensured. A complete schematic of the scheme with the redundancies shall be submitted by the supplier. Critical signals for train operation on hard wires shall be redundant. Details shall be finalized at design approval stage.

As a minimum following shall be included:
a) All Driver's Desk interfaces to TCMS shall be fully redundant.
b) There shall be no single point of failure in safety loops like Emergency stop, Emergency Brake & cab occupation etc, which can cause immobility of the Train.
c) There shall be two physically independent bus systems on Train as well as Basic Unit level;
d) The control of passenger amenities and safety functions shall be redundant.
e) Availability of the Basic Unit even in case Auxiliary Converter(s) of that Basic Unit is (are) not available.

ii) Communication Protocols

The communication protocols to be used by bidder for implementation of TCMS and for data, message, signal exchange and communication within the coach and the train shall be an open protocol conforming to ISO's Open System Interconnection model. IEC 61375 may be one of the options.

Supplier shall submit details of the communication protocols used in their design at different levels clearly indicating how the above requirements are complied with. Further, details along with any hardware/software tools required shall be submitted/ supplied during design stage so as to enable IR to implement permissible modifications and interface compatible equipment.

iii) The supplier shall provide sufficient spare train line cables in the IV couplers/jumpers, end wall panels with space for the door control for future provision of ventilation and Auto Door Closure with adequate redundancy in the svstem.

4.17.4 Train Line Cables, Inter Vehicular Electrical Couplers

i) The electrical coupler shall be capable of making all necessary electrical connections between adjacent cars to permit controls of all cars in a rake from the leading cab. On minimum radius curves, the covers shall not exceed the allowable clearance envelope of the car. Sufficient spare contacts (at least 30 %) shall be provided for catering to future needs of the IR. As such multiplexing of signal shall be adapted to the maximum extant possible in line with the current international practices.

ii) The outer cover of the electrical coupler shall be additionally strengthened to

protect the coupler against ballast or external hitting.

iii) 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.

iv) 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 car coupler may be subjected in service.

v) 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.

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

vii) All end connection and fittings will be supplied by supplier. The jumper cables assemblies i.e. jumper cables along with the inter-vehicular couplers in assembled condition shall be supplied by the supplier. These assemblies shall be tested for endurance test for 20 million cycles on test rigs simulating the conditions of end of coach at level, curves & crossings.

viii) These assemblies shall be supplied by the supplier and be fitted on the newly manufactured coaches by ICF/RCF/manufacturing unit. The electrical couplers to be used shall be designed for trouble free operation under all operating conditions.

ix) Couplers shall allow coupled coaches to negotiate curves of radius 175 meters 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 adjacent coaches up to 75 mm. Supplier shall ensure that the jumper cable assemblies do not touch/rub the couplers under any circumstances.

x) The coupler system shall permit train operation up to rake formation of 18 car in EMU and 24 car in MEMU and shall enable one cab in a rake to control all other cars in a rake through the electric train lines.

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

xii) All train lines and inter vehicular couplers shall be so designed that they are not susceptible to any damage due to vandalism and external hitting

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. Details of the arrangement shall be furnished during the design approval stage.

xiii) The supply of cables, termination equipment, couplers or any other material required for laying the cables in the rake shall be the responsibility of the supplier. This shall also include switch gears, relays, fittings and terminal equipment required for proper working of the equipment under supplier's scope.

4.18 PANTOGRAPH:

4.18.1 A single pantograph suitable for satisfactory operation up to 120 Km/h under 25 KV AC power supply systems as given in clause 2.5 and environmental conditions specified in clause 2.7 shall be provided.

4.18.2 The design of pantograph shall incorporate the following desired features:

(i) Pantograph shall be suitable for satisfactory working in dusty, humid and saline atmosphere with heavy rains during monsoon seasons. The IR has experienced the failure of nylon bushes, bolts, washers and plungers due to ingress of heavy dust. In view of this, their use shall not be acceptable. Auto drop function of the pantograph shall drop the pantograph automatically when excessive height is detected. An indication shall be provided to the driver when this function is operated.

(ii) The design shall provide for efficient damping arrangement for pan assembly and articulation assembly.

(iii) The minimization of the pan mass shall be preferred.

(iv) The adoption of proven "Air Raising Springs" for pans and hydraulic damping for articulation assembly shall be used.

(v) The limiting of aero dynamic effect from 3kgf to 5kgf for maximum speed by the use of aero foils shall be preferred.

(vi) Efficient current collection at all speed with least sparking while traversing the OHE shall be ensured. As a design criterion, the maximum limit of contact loss should be of the order of 0.2 percent in the regulated OHE. The current collection tests under the actual field conditions shall be the responsibility of the supplier. Simulated test results and performance of pantograph for the similar rolling stock and OHE system shall be preferred during the design stage.

The maximum electrical resistance between current collector and power take- off should be limited to 2 milli ohms.

(vii) The pantograph shall have the feature to protect itself in case there is any panto entanglement with OHE. The pantograph shall also have auto

drop function, in case of worn current collection strip or damaged pan head. The pantograph offered shall be complete with all parts and accessories including auto drop device as per clause 4.9 of IEC 60494-1-2002 and over reach detection device necessary for Its efficient operation.

(viii) Supplier shall conduct on line current collection test with GPS supported location recording system. The output report in soft copy shall be supplied for continuous / selective viewing of location having abnormal behavior and in hard copy with exception report of spark image, location wise report in excel/ word format for complete section selected for trial. One set of complete test equipment loaded with recording, analysis & reporting package in image and Microsoft word/excel format shall also be supplied to each EMU maintenance car sheds.

4.18.3 The insulation system of pantograph shall be suitably designed to ensure satisfactory operation under 25 KV AC systems without any need for attention other than the specified scheduled maintenance.

4.18.4 The pantograph shall be capable of sustained operation and satisfactory current collection from 100 mm above the collapsed pantograph level up to the full range of contact wire height, and at all operating speeds as specified.

4.18.5 Pantograph controls shall be configured in the cab car such that any one pantograph or all pantographs can be raised or lowered. When all pantographs are raised, there shall be a time delay function such that the instantaneous line current demand peak and inrush current characteristic are reduced to less than the operating limit of the traction power and OHE system.

4.19 Passenger Car Surveillance System

4.19.1 The Passenger Car Surveillance System (PRSS) shall comprise of an IP based close circuit television (CCTV) network, surveillance cameras, routers and cables, monitors and other accessories as required. On board equipment for streaming of video to the central server for selected cameras (maximum of 6 with 12 frame per second) will be in the scope of Supplier, however, network and central server will be facilitated by IR.

4.19.2 Each Car of Train shall be provided with minimum six surveillance camera devices at appropriate location to cover the maximum passenger area (including gangway and vestibule area).

4.19.3 Additionally, at least one camera shall be placed in driving cabs for gathering frontend view, track and OHE conditions etc. One camera shall be installed on the roof of all cars having pantograph facing towards pantograph to monitor the roof equipments. The camera shall be suitably selected in respect of resolution, clarity of images, illumination conditions for on-train applications and shall be of proven design. Additional two cameras per basic unit shall be placed on outer sides of the each Basic Unit as a minimum for gathering rear view of the platform. Mounting of camera shall be unobtrusive, flushed with, or recessed into the interior panel. Selection of type shall be finalized during design and shall ensure clear view of passengers on platform to Train Driver/Guard before start at

each station till Train leaves the platform completely. The system shall automatically switch to rear view when the Train stops and will go back to default mode after the Train leaves the platform.

4.19.4 An integrated screen shall be provided for the passenger Car surveillance system in each Driving Cab. It shall be so placed in the cab that normally it does not cause distraction to the Train operator but it shall be easily viewable by the Train Driver/Guard, when needed.

4.19.5 Under normal operation, the views gathered from each of the camera located in the Train shall be sequentially played in the monitor screens of both the cabs. Adequate controls shall be provided for necessary surveillance requirements and priorities.

4.19.6 The visual images from each camera shall be recorded in non-volatile memory. The on-board system should have capacity of recording such that it can be downloaded in the maintenance depot during the scheduled maintenance overhauling. The architecture of the CCTV system shall have NVR with high speed downloading port, at basic unit level. Storage memory (HDD) shall be removable from NVR and shall facilitate extraction of recorded data from docking station. The memory shall be expandable. The Supplier shall provide equipment and means for the downloading of the records.

4.19.7 The visual images from each camera shall be recorded in First in First Out (FIFO) non-volatile memory. The on-board system should have capacity of recording such that it can be downloaded in the maintenance depot during the scheduled maintenance. The capacity of the memory shall be expandable. The capacity of the memory shall be sufficient enough to record videos up to 25 frames per second, for a minimum period of 30 days @ 24 hours per day. The CCTV cameras shall conform to IEC 62676. The CCTV cameras have to meet the following minimum parameters:

- Image sensor : 1/2.8” or larger, CMOS sensor
- Minimum Illumination : 0.3 lux (colour)
- Lens : Focal length 2.8 mm or larger
- Resolution : 2 MP and above

The field of view-object size shall be upto (identify the target) as per IEC 62676-4 from 1.5 meters distance. The Supplier shall provide equipment and means for the downloading of the records.

4.19.8 IP based CCTV cameras are to be suitable for rolling stock to be worked in environments with extreme temperatures, humidity, vibration, dust. Cameras used in trains should also have EMI and surge protection to ensure consistent performance and to prevent damage to the equipment. The minimum requirements for electromagnetic compatibility in railway applications are defined by EN 50121-3-2 or IEC 62236-3-2 standards. Since some of these cameras are used on the exterior of trains, they should also support a feature to deliver high quality images in rain and fog conditions. The IP level of the outside cameras shall be IP 66. Secure and reliable disk access under extreme vibrations, as in the case of rolling stock, is absolutely essential to maintain data integrity and prevent data loss.

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CHAPTER 5

TESTS & TRIALS

CHAPTER 5

TESTS & TRIALS

5.1 General

5.1.1 The individual equipment, systems and sub systems shall be type and routine tested in accordance with the relevant IEC/UIC publications inclusive of the mandatory and optional tests along with the special tests as specified.

5.1.2 All type tests shall be carried out at the Supplier's cost where ever performed in presence of and to the satisfaction of RDSO, who reserves the right to witness any or all of the tests.

5.1.3 Wherever any equipment, system, sub system is not specifically covered by an international recognized specification or test procedure, the tests which are acceptable to both to Supplier and to the IR's representative shall be devised.

Without prejudice to any provisions of the contract, the purchaser reserves the right to witness any or all of the type tests and to require submission of any or all test specification and reports.

5.1.4 All the mandatory and performance tests/ trials shall be carried out in Sabzimandi-Panipat section for 12 car-SDCL EMUs/12 car DCL MEMU. This will include all the requirement as specified in chapter 3 & 5.

5.1.5 All tests as per IECs, Specifications and otherwise advised shall be done in actual condition. Any exception may be decided by tender inviting/contract awarding authority.

5.1.6 The design approval and prototype tests may be waived-off in case firm has supplied equipment/sub-assemblies having proven their product in Metro/DFCCIL/Indian Railway/Foreign Railway for at least 3 years, where the manufacturer can establish design of their product/sub-assemblies with respect to their application of use, voltage, rating of equipment, operating speed etc. In such a case, manufacturer shall submit necessary related documents for the same. Firm will submit relevant test reports, for compliance to the RDSO specification.

5.1.7 All performance tests on rake level carried out on prototype rakes as per IEC 61133, Oscillation trials, Braking distance trial, Coupler force trial (if required) with test scheme duly approved by RDSO on nominated section of IR will be witnessed by RDSO. Alternatively, the firm may get these tests done through Independent Safety Assessors (ISA) and submit the report to RDSO. ISA to be selected from the panel of ISAs proposed by manufacturer, after ascertaining that these ISAs and their nominated test agencies are capable to certify complete rolling stock systems and have accreditation as per ISO 17065, which is meant for conformity assessment for the bodies that provide certification.

5.2 Mechanical tests

5.2.1 Oscillation trials (on prototype rake only)

After commissioning of the rakes fitted with the equipment supplied by the supplier, IR may conduct oscillation trials in user Railways, if required, as per Third

Report of Criteria committee as applicable for EMU/MEMU. Trials and specific section for trials shall be decided at design stage. The supplier's representative shall be present in this trial to the extent of any problem related with the equipment under his scope of supply.

5.2.2 Braking Distance trial (on prototype rake only)

After the completion of satisfactory oscillation trial, the braking distance trails may also be conducted by IR for the rake formation on 12/15/18 coach EMU and
12/16/20/24 coach MEMU rake, if required. The rake formation shall be finally
decided during design stage. The supplier shall be associated with this test in respect of the items related to regenerative braking, brake blending and connected microprocessor controls.

5.2.3 Tests on Parking brakes (on prototype rake only)

Parking brakes shall be tested by applying the parking brakes fully and air brake released under the specified conditions as defined in the clause 4.12.8.

5.3 ELECTRICAL TESTS

5.3.1 Generally, test procedures shall be followed as per the recent IECs. Equipment/Systems/Subsystems testing.

(i) Alongwith 'mandatory' tests as described in the IECs, including 'optional and investigative' tests shall also be conducted. Any other tests which become imperative due to the specific requirement of this specification and is categorically mentioned in this specification shall also be carried out.

(ii) RDSO may waive some of these tests in case of equipments/sub assemblies where the manufacturer can establish to the satisfaction of RDSO that such tests have already been carried out earlier or where the equipments have been proved in service. In such a case, manufacturer shall submit complete test reports along with necessary certification.

5.3.2 Witness of tests: Type tests on major electrical equipment like transformer, traction motor, converter & inverter, auxiliary converter, control electronics and TMS / TCN shall be witnessed by representative of RDSO. Any new design of equipment offered by the supplier and accepted during the design stage shall also be type tested and witnessed by the representative of RDSO.

5.3.3 Raw material/Component and subsystem testing: RDSO may also in addition, require test results on raw materials and components of critical nature, so as to ensure that they meet the performance and reliability stipulations. This may extend to components/raw materials not manufactured in the manufacturer's works, but purchased by him. For proven materials, which have been tested before, tests need not be conducted again. Certified test report shall be submitted if so required by RDSO.

Subsystems like PIS, TCMS and control equipments etc. shall be supported with tests reports and certificates. However, in case such subsystems are required to meet any special requirement specified herein, the relevant tests shall be carried out by the supplier.

5.3.4 Cables: All cables shall be tested against the requirements as laid down in the relevant IEC/UIC specifications. Cables shall also be tested for ensuring its Fire retardant characteristics. Details shall be submitted by the supplier during the design stage.

5.3.5 TRACTION MOTOR TESTS: Details of the test requirements are as per Clause 4.4.

5.3.6 TESTS ON CONTROL ELECTRONICS and PCBs:

Control Electronics shall be tested as per IEC 60571/EN50155 and IEC 61373 including both compulsory and optional tests. Following tests shall be carried out on the electronics PCBs as per IEC 60571/EN 50155 and IEC 61373 with the modified parameters.

i) Dry Heat test: Dry Heat test shall be done at 80^0C. Along with the testing for the satisfactory performance, temperature stickers shall be put on the critical ICs, Controllers & capacitors etc. for monitoring the maxi mum temperature of these components during dry heat tests. However, LCD display units may be tested at 70°C.It shall be confirmed that the temperature recorded during dry heat test as above does not exceed the specified operating
/surface temperature of these components. For the purpose, data sheets of such components shall be referred and submitted during testing.

ii) Cyclic Humidity test: The tests shall be done for 2 cycles of 24 hours each and components shall be examined for the performance tests and physical damage if any. The humidity cycle shall be as specified in IEC 60571.

iii) Salt Mist Test: The test duration shall be 48 hours and after the tests the performance test shall be done. There shall be no physical damage, rusting or deterioration of the varnish/lacquer coating.

iv) Dust & Sand Test & Mould growth test: The tests to determine the performance of the electronics in Sand and Dust ambient shall be carried out with the dust settlement rate of 6gm/m^2/day. The dust particle size shall not be larger than 100 μm. Further details shall be worked out at design stage. The reference IEC shall be IEC 60068-10-2; test mould growth test and IEC721-2-5 test Dust and Sand. The component shall be protected against mould/fungal growth. The test scheme shall be finalized during design stage.

v) Further to the above, investigative tests for determining the limits the thermal limit of failure of the PCB and limit shocks and vibrations shall also be carried out.

5.3.7 Power & Auxiliary converter/Inverter: Tests shall be done as per IEC 61287.

5.3.8 AUXILIARY MACHINE

All auxiliary machines including the motor-compressor set shall be tested in accordance with the relevant IEC specifications. All auxiliary machines not covered in IEC shall be subjected to such tests as decided by RDSO during finalisation stage to ensure that it will meet the working conditions.

5.4 Complete train

Complete train shall be type & routine tested as per IEC 61133 and as per the test programme agreed by RDSO. After erection, the complete equipment shall satisfactorily withstand the dielectric voltages as specified in the IEC specification.

5.5 Sequence test: Connection shall be made to the 25 KV AC overhead contact system and all parts of the control and main power circuit shall be tested out to ensure correct sequence of operation, all interlock cut-out switches shall then be tested, and the pantograph shall be tested to prove the speed of raising and lowering.

5.6 Tests to determine levels of interference with Signal and Telecommunication equipment to prove that these are within the acceptable limits. Supplier shall arrange complete set of calibrated equipments/instruments for carrying-out these tests and trials.

5.7 Test on combined test bed:

(i) Supplier shall furnish details of the test facilities available at their works or at the test laboratory where the system performance tests of the complete equipment is proposed to be carried out as per IEC 61377.

(ii) The supplier shall be responsible to arrange the testing of propulsion equipment on the combined test bed at manufacturer's works as per the stipulations of IEC 61377. Both the type and investigative tests shall be done at all the specified loads including the full load and special loading conditions with reference to the maximum wheel diameter difference. This shall also include measurement of system efficiency and monitoring of system response in case of failure of control signals.

(iii) While the system performance tests shall be carried out as per IEC 61377 as mentioned in para (ii) above, the balance tests, as required to be carried out as per IEC 61133, shall be carried out within the facilities as available at the combined test bed. In case where the bidder has only restrictive facilities available at the test bed with reference to the balance tests and thus has not been able to demonstrate the satisfactory completion of these system tests at full load at 25 kV AC on test bed, all the balance tests as identified in IEC 61133, read with IEC 61377, shall be completed on the vehicle at full load after equipment mounting and commissioning. The inspection certificate to supplier for prototype rake shall be issued only after successful completion of all the type, routine, investigative, combined system and performance test/trials.

(iv) Final testing of the EMU/MEMU train fitted with the supplied equipment shall be done at the site as per the approved test programme and IEC 61133.

5.8 Vibration and shock values: The equipment used in the cars shall conform to IEC 61373 for shocks and vibrations as specified on the basis of the location and mounting of the equipment. The tests shall also cover Endurance tests included herein.

5.9 Service trials

The prototype rakes fitted with the supplied equipment, shall be subjected to

pre-revenue service trials (refer clause 1.3.8). Service trials are intended to prove the satisfactory running performance of the supplied EMU/MEMU equipment and evaluate their reliability in service, ease of maintenance and operations. The performance of the equipment shall be assessed based on the experience gained during the service trials. Necessary modification as required and also as desired by the RDSO shall be implemented in the series production.

5.10 PERFORMANCE TEST (on prototype rake only)

The EMU's/MEMUs performance with regard to the supplied equipment shall be demonstrated in test runs and shall meet the target figures in Chapter 3.

5.10.1 Test Runs:

(i) Test runs shall be made on the Delhi-Ambala or any other sections on which the stock is to operate with sufficient number of trains to ensure that the train equipment meets the operating conditions. The duration and location of stoppages shall be selected in accordance with the scheduled time table stoppages. The Supplier shall arrange instrumentation and record speed, voltage, current, temperature rise of various equipments, energy consumption, tractive effort and any other relevant parameter shall be recorded. During the test run section distance may change subject to availability of sections.

(ii) During the operation of train in all out mode (without coasting) for a typical traction and braking cycle for a distance of 2.4 KM for EMU Train and 6 KM for a MEMU Train, the temperature rise of Propulsion Equipment and control electronics shall be within the specified limit as per these Specifications. These tests shall also be done with 'one Motor Coach' in isolated condition. The temperature rise shall be measured according to the procedure stipulated by IEC with all out all running (without coasting) till temperatures of various equipment are stabilized. Temperature rise shall comply with the limits specified and the ambient conditions defined in these Specification and Standards. Specified temperature rise of equipment shall be calculated after taking into account at least 25% choking of air filters and radiator fins etc..

(iii) The Supplier shall supervise and carry out the above tests both at his works on the combined test bed and also at the site as mentioned in clause 5.7 and shall provide all equipment necessary for such tests and such special consumable stores as oil, grease etc, for the first filling and for trial runs. Special measuring instruments shall be provided by the Supplier.

(iv) During the tests, acceleration, deceleration, speed on straight level track and the energy consumption for a round trip shall be measured. In all cases, 12-coach super dense crush loaded EMU / dense crush loaded MEMU shall be tested with an average line voltage of 22.5 KV AC.

5.11 ENERGY CONSUMPTION

(i) The required values of energy saving are as per Clause 3.1.17 The Supplier shall give guaranteed figures for a 12-car, SDCL, for round trip operation between Sabzimandi-Panipat for all out running without coasting and with 10% coasting and on the basis of halting at all stations for the following modes:

a) Traction energy consumption without electrical braking.

b) Regenerated energy through electrical braking.

c) Energy consumption by auxiliaries & efficiency of each power consumption point. For further details, refer Annexure II

(ii) The estimated specific energy consumption figures along with the break up as above in Para (i) of this clause and clause 3.1.18, will be submitted by the supplier for each section based on the train resistance formula and track profile & permanent speed restrictions, placed in Annexure IV.

(iii) The validation of efficiency and energy consumption shall be done on combined test bed and at field as per IEC 61377 and 61133..

(iv) Acceleration: The acceleration will be calculated from the time taken to reach a speed of 40 km/h. The time taken shall be from the instant master controller is switched on to the instant speed of 40 Km/h is touched.

(v) Tests will be conducted to confirm acceleration performance according to values specified with tolerance of 3%.

(vi) Test results shall also be recorded for wet rail condition.

(vii) The permissible tolerance for achieving balancing speed of 110 Km/h shall be 3%.

(viii) Deceleration: The deceleration test shall be taken after preliminary runs of 200 miles (320 km) in order to bed in the brake blocks. Deceleration shall be calculated by dividing the initial velocity by the time taken from the instant the brake controller is moved to the instant the train comes to a complete halt. The initial velocity shall be determined from the reading indicated by the speedometer which shall be calibrated prior to test. The test shall be taken on dry rail and the average of three tests will be taken as the final figure for deceleration.

5.12 Pre-commissioning Tests at ICF/RCF Chennai

Supplier shall list the tests that are to be carried out on the supplied equipment after it has been mounted on the EMUs/MEMUs at ICF, Chennai/RCF, Kapurthala or at EMU maintenance shed/workshop of IR or at any other manufacturer's premises. The test procedure, instrumentation and tolerance shall be furnished.

The supplier shall be responsible for these tests on prototypes and all series production of 12 /15/18 car (as per purchase order requirement) EMU rakes and 8/12/16/20 car (as per purchase order requirement) MEMU rakes and also train staff of ICF/RCF/EMU maintenance shed/workshop/any other manufacturer's works where the electrics supplied as per this specification shall be equipped in EMU/MEMU coaches in carrying out the tests. ICF/RCF or EMU maintenance shed/workshop of IR or any other manufacturer's works shall provide qualified staff for carrying out above tests.

5.13 Commissioning of EMUs/MEMUs in user Railway

Each rake shall be commissioned in user Railways by the supplier staff before putting into commercial service. The supplier will commission two prototype rakes and all series production of 12 /15/18 car (as per purchase order

requirement) EMU rakes and 8/12/16/20 car (as per purchase order requirement) MEMU rakes. The supplier shall furnish a

Commissioning Schedule for the supplied equipment and the system which shall also include the following:-

(i) Confirming satisfactory functioning of the all system.
(ii) Test run in for about 1500 km over 3 days to confirm specified operating parameters such as acceleration, deceleration, brake blending and energy consumption.
(iii) Rectification replacement of any malfunctioning equipment.
(iv) Check of all safety related items.

LIST OF ENCLOSURES

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S. No.	Enclosure type	Description
1.	Annexure-I	List of equipments to be provided in driver's cab
2.	Annexure-II	Salient design details to be submitted by the supplier
3.	Annexure-II A	Design data calculations & drawings to be submitted by the supplier.
4.	Annexure-III A	Track data, Delhi-Ambala & **Churchgate-Borivili** (unevenness, twist, gauge & alignment)
	Annexure-III B	Track data, Ambala-Delhi & **Borivili-Churchgate**(unevenness, twist, gauge &alignment)
5.	Annexure-IV	Route profile Delhi-Ambala Section & **Churchgate-Virar of WR and CSMT-Kasara of CR, Katra-Banihal section of Jammu & Kashmir**
6.	Annexure-V	List of specifications for testing of equipments
7.	Annexure-VIA	Limits of interference currents
	Annexure-VIB	Tele-communications cabling installation
	Annexure-VIC	Loco TCAS drawings
8.	Annexure-VII	Deleted.
9.	Annexure-VIII	Deleted
10	Annexure-IX	Drawing sheet format Nos. PE/F/0007 to 0010 (4 sheets)
11	Annexure-X	List of EMU rolling stock drawings for bogie, suspension, brake, equipment layouts and coach layouts etc. (supplied with the Bid Documents as Soft Copy on CD-1)
12.	Annexure-XI	List of MEMU rolling stock drawings for bogie, suspension, brake, equipment layouts and coach layouts etc. (supplied with the Bid Documents as Soft Copy on CD-1)
13.	Annexure-XII	List of equipments for which MTBF/MDBF to be submitted
14.	Annexure-XIII	ICF's letter no. MD/D/Weights/119, dated 29.11.2007
15	Annexure-XIV	Vibration levels at Critical Locations of Traction Motor & its Suspension, Mounting Arrangement of existing AC/DC EMU with 40/100 Hz low pass filter.
16	Annexure-XV	Deleted
17	Annexure-XVI	Tare weight, Payload & type of Motor to be used for EMUs and MEMUs
18	Annexure-XVII	Applicable to EMUs of Mumbai sub-urban only
19	Annexure-XVIII	Applicable to MEMUs of Jammu & Kashmir area and Hilly area only
20	Annexure-XIX	Applicable for Air-conditioned MEMUs only

Annexure- I

LIST OF EQUIPMENTS TO BE PROVIDED IN DRIVER'S CAB

The list of equipments and features required to be provided by Supplier (except auto brake controller and AWS) and to be considered for Ergonomic cab design are as under:-

- Combined Traction Controller and Brake Controller. Incorporating a traction control handle with Driver dead man control, key switch (es) and reverser handle.
- Driver's brake valve isolating cock switch if required
- Auto brake controller and AWS (to be supplied by IR).
- Driver's safety system foot pedal incorporated into the adjustable footrest. (To be supplied by IR)
- Air pressure analogue displays for Main Reservoir, Brake Pipe, Parking brake and Brake Cylinder Pressure.
- Speedometer cum recording (analogue display, contact less tacho meter).
- Human Machine Interface for driver display.
- Time table Light Switch and Clip.
- Windscreen Wiper with Control.
- Windscreen Washer with Control.
- Horn with Controls, one at each side of the driver's desk.
- Ventilation controls.
- Marker Light Switches.
- Headlight Switch.
- Headlight Fail Indicator.
- Bell code system
- Destination Indicator Panel.
- Train Parking Brake control and Indicator lights.
- Traction control reset buttons.
- Pantograph raise / lower indicator & button.
- Crew cab light control.
- Step lights on & off switch (es).
- Panel & Gauge lights dimmer switch.
- Indicator Lights Test switch.
- Intercom / PA switch.
- Vigilance System indicator and acknowledgement (AWS).
- Communication control station.
- Space for the diagram book, time table.

Note: for detailed list of equipment's to be provided in driver's cab kindly refer Clause no. 4.0(A) and 4.8 of main specification also.

Annexure- II

SALIENT DESIGN DETAILS TO BE SUBMITTED BY THE SUPPLIER

1. **Traction transformer**
   - Make
   - Continuous KVA rating at 22.5 KV
   - Continuous voltage
   - No. of secondary windings
   - Voltage of secondary windings at 22.5 KV primary voltage
   - Procedure for calculation of rating after taking into account stipulations of clause no. 3.1.6 enclosed (yes/no)
   - Short time KVA rating
   - Is the transformer of modular design (yes/no)
   - No. of Auxiliary winding
   - % impedance
   - Type of oil
   - Protection provided
   - Class of insulation
     - of conductors
     - cooling medium
   - Transformer losses at 22.5 KV
     - core loss (kW)
     - copper loss (kW)
     - total loss (kW)
   - Maximum temperature rise
     - of oil
     - of winding
   - Type of cooling
   - Transformer overall efficiency at 22.5 KV, 100% load & unity power factor
   - Radiator capacity
   - Overall dimensions
     - Weight including inductors, if any.
     - complete weight(with oil)
     - weight of tank
     - weight of oil
     - weight of core with winding
     - Clearance from ground under tare & SDCL loading
   - Material of transformer tank
   - Noise level
   - Any other details considered necessary as per the respective Clauses of the specification
   - Auxiliary winding
     - kVA rating
     - Voltage
2. **Inductors**
   - Make
   - Type
   - Inductance
   - Rated current

- Dimensions
- Weight

3. Traction motor

Description	
• Make • Type • Continuous Rating ➢ power ➢ voltage ➢ current ➢ frequency ➢ slip at full load ➢ shaft output ➢ power factor ➢ rpm • 1 hour rating ➢ power ➢ voltage ➢ current ➢ frequency ➢ slip ➢ shaft output ➢ power factor ➢ rpm	

- Motor efficiency at rated power
- Temperature rise of winding
- Maximum frequency
- Gear ratio
- Type of suspension
- Class of insulation
- Weight of traction motor
  - ➢ with pinion, gear wheel ,suspension tube and gear case
  - ➢ without pinion, gear wheel and gear case
- Maximum temperature index of winding insulation
- Overall dimensions
- Suspension type
- Material of gear and pinion
- Roller bearing type and number
- Constructional details viz. Rotor bar and rotor end ring arrangement, overhang to terminal box connection etc.
- Any other details considered necessary as per the

respective Clauses of the specification	

4. Converter / inverter / DC Bus

- Type
- Make
- Input voltage
- Input current
- Output voltage
- Power rating (KVA)
- Number of IGBTs and mode of connectivity / configuration
- Number of diodes (with technical data sheet)
- Type of control
- Switching frequency
- Noise level
- Number of modules per motor coach
- Power factor at rated power (with tech, data sheet)
- Type of cooling with the coiling circuit, system details
- Weight
- Overall dimensions
- DC bus voltage
- No. of motors controlled per inverter
- No. and type of harmonic filters
- Any other details considered necessary
- Maximum power rating
- Current rating
- Dielectric strength
- Data sheets for power devices and their characteristic curves
- Interference currents

5. Auxiliary machines

a) Transformer radiator

- KW rating / blower capacity (CMH)
- Voltage
- Rated current
- Insulation class
- No. of radiator motors
- Efficiency
- Weight
- Overall dimensions
- Mounting

b) Oil Pump Motor

- KW rating / blower capacity (CMH)
- Voltage
- Rated current
- Insulation class
- Efficiency

- Weight
- Overall dimensions
- Mounting
- Pump discharge rate – litters per minute & head

c) Compressor, Air dryer & filters

- Type
- Make
- Referred standard
- References where used
- Type of motor
- KW rating
- Voltage
- Rated current
- Insulation class
- Efficiency
- Mounting
- Type of compressor
- Capacity of compressor in lit / min , pressure
- Noise level.
- Air intake / filter system
- Type of lubrication
- Weight
- Overall dimensions

6. Pantograph

- Type no.
- Make
- Maximum current capability with complete technical details
- References where used
- Overall dimensions
- Weight
- Overall design parameters vis a vis specification requirements

7. Vacuum circuit breaker

- Type
- Make
- Complete technical details, incl. MVA rating normal and short circuit current, making and breaking time etc.
- Overall dimensions
- Weight

8. Lightning arrestors – Metal oxide gapless

for the 25 KV AC side

- Type
- Make
- Rated voltage and current
- Overall dimensions
- Weight

9. Auxiliary converter / inverter

- No. of inverters
  (The following technical details for the auxiliary inverter shall be furnished for each of the auxiliary converter / inverter offered)
- Capacity calculation
- Input voltage
- Input current
- No. of phases and output voltage
- Output current
- Power rating (KVA) & its break up
- Efficiency
- Type / No. of devices used with rating
- Type of control
- Carrier frequency
- Type of cooling
- Type of enclosure (on-board, IP-55 etc.)
- Weight
- Overall dimensions

10. Battery charger

- Rating
- Input – No. of phases – voltage
- Output voltage / current
- Line and load regulation
- Type and no. of devices used
- % ripple content in output
- Overall dimensions
- Weight

11. Combined Master cum brake controller

- Type no.
- Complete technical details, including use of other Railways
- Weight.
- Overall dimensions

12. Train Control & Management System

- Standard followed and details of protocols
- Details of standard and references
- Maximum number of coaches that can be attached without repeater/gateway/bus coupler.
- Optimization (minimization) of cable requirement
- Details of the system
- Scope of the system offered
- No. of signals multiplexed

13. Control Electronics and Displays

- Details of control electronics, PCBs
- Redundancy adopted at various levels
- Protection level against dust, moisture, corrosion and salty atmosphere
- Types of display, protection level against dust, moisture, vandalism and comparative advantages

- Devices for 'Log In' journey details
- Weight of Displays
- Overall dimensions of Displays

14. Passenger Information and Communication System

- Details of scheme and protocol
- No. of amplifiers and speakers, expendability, provisions / facilities
- Priorities incorporated
- Experience of the system offered
- Number of display per coach
- Type of display LED/LCD
- Display of advertisement
- Weight & size of displays

15. Cables

- Power and control cables
- Source
- Specifications
- Properties

16. Inter vehicular couplers (combined electrical – mechanical couplers)

- Details of design parameters
- Protection against water ingression due to flooding conditions in Mumbai
- No. of spare contact
- Weight
- Overall dimensions, layout
- Protection against vandalism

17. References of EMUs / Metros where distributed electrics with 3 phase drives has been supplied.

- Year and supply
- Configuration of the distribution (Ref. Clause 2.1.2)
- Relative advantages.

Note: Supplier shall further include any other left over item.

18. Supplier shall submit the performance calculations in the attached format in the following pages.

19. PERFORMANCE SIMULATIONS TO BE SUBMITTED BY THE SUPPLIER

(Refer Chapter 3)

A. REF. CLAUSE 3.1.3 AND 3.1.5

1. Conditions:-

i) 12/15 car SDCL EMU/DCL MEMU rake

ii) Line Voltage a) 22.5 kV AC (b) 21 kV AC

ii) All out run (without stop time)

iii) 100% regeneration

2. Simulations

a) Tabulation:-

Type of Stock	Section	Run time	RMS current of traction motor	Line current peak
EMU	2.4 km section on level tangent track			
MEMU	6 km section on level tangent track			

b) Graphical values

Time Vs Speed, Distance, Motor current, Line current

c) Speed Vs. time, time and distance to achieve speed of 100 kmph, 110 kmph & 120 kmph from standstill.

B REF. CLAUSE 3.1.8 AND 3.1.9 – EMERGENCY OPERATION

1. Conditions:

i) a) 9/12/15 car SDCL EMU rake with 1 motor coach cut out. b) 8/12 car DCL MEMU rake with 1 motor coach cut out.

ii) 22.5 kV AC

iii) 1 round trip at 100,110 and 120 kmph.

iv) All out run (without stop time)

2. Simulations:-

Section	Overall run time		RMS current of traction motor	
	EMU	MEMU	EMU	MEMU
Subzimandi-Panipat-Sabzimandi				
Start in 1 in 100 gradient, clear this section of 1 km	Max. speed attained			

C REF. CLAUSE 3.1.12 AND 3.1.18

1. Conditions:

i) 12/15 Car SDCL EMU/DCL MEMU rake ii) 22.5 kV AC

iii) Round trip at 100, 110 and 120 kmph

iv) (a) All out run (without stop time) (b) with coasting at 10% make up time (without stop time)

2. Simulation

Table for Subzimandi-Panipat-Sabzimandi Section

Stations	**All out**					**10 % Coasting**				
	Run time	Motoring energy at pantograph including aux. Load (Note 1)	Regenerative energy at pantograph including aux. Load (Note)	Motor rms current	Line current rms	Run time	Motoring energy at pantograph including aux. Load (Note 1)	Regenerative energy at pantograph including aux. Load (Note)	Motor rms current	Line current rms
Journey total										
Net aux. Consumption (Note 1)										
Energy consumption for ventilation (Note 2)										

Note : For simulating the motoring and regenerative energy, full auxiliary load shall be taken into account except emergency load. Duty cycle

for the compressor & lights shall be taken as 50% & for the balance load 100% duty cycle shall be considered. The net auxiliary consumption calculated as above shall also be furnished separately. Auxiliary load of the failed basic unit will not be considered while evaluating the case of regeneration in one basic unit failure.

- Graphical /Curves – As per specification clause.

D REF. CLAUSE 3.1.13

1. Conditions:-

i) 12/15 car SDCL EMU/DCL MEMU rake. ii) 21 kV AC

2. Simulation

a) Tabulation

Section	Run time	
	EMU	MEMU
Subzimandi-Panipat-Sabzimandi round trip 100 kmph, all out run		
Subzimandi-Panipat-Sabzimandi round trip at 110 kmph, all out run		

b) Graphical / curves – Speed Vs. Power (TE & BE) curves at the following voltages:-

- 21 kV AC, 19.5 kV AC, 17 kV AC

E SUMMARY OF RESULTS FOR TEMPERATURE RISE OF TRACTION MOTOR AND OTHER EQUIPMENT.

1. Conditions:-

i) 12/15 car SDCL EMU/DCL MEMU rake ii) 22.5 kV AC

iii) At 100 kmph for Subzimandi-Panipat-Sabzimandi section.

2. Simulation

Type of Stock	Section	Temp. rise of traction motor (stabilized)
EMU	Typical run of 2.4 km section on level tangent track for repeated traction cycles.	
MEMU	Typical run of 6 km section on level tangent track for repeated traction cycles.	
EMU/MEMU	Subzimandi-Panipat-Sabzimandirepeated round trips with all MC working and 1MC cut-out condition	

Note: Supplier shall certify the compliance to the specification clause 4.3.4 for converter, inverter and clause 4.1.3 for transformer under the above operation conditions.

F. SUMMARY OF RESULTS FOR TEMPERATURE RISE OF TRACTION MOTOR AND OTHER EQUIPMENT – EMERGENCY CONDITIONS.

REF. CLAUSE 3.1.8

1. Conditions:-

i) a) 9/12/15 car SDCL EMU rake b) 8/12 car DCL MEMU rake
i) 22.5 kV AC
ii) At 100 kmph stoping at all the stations
iii) All out run (without stop time)

2. Simulation

Type of Stock	Section	Final temp. rise of traction motor
EMU	All out run of Subzimandi-Panipat-Sabzimandi section on level tangent track by healthy 9 car SDCL rake followed by duty cycle of 1 MC isolation (33% cut out) starting on	
MEMU	All out run of Subzimandi-Panipat-Sabzimandi section on level tangent track by healthy 8 car DCL rake followed by duty cycle of 1 MC isolation (50% cut out) starting on	

Note: Supplier shall certify the compliance to the specification clause 4.3.4 for converter, inverter and clause 4.1.3 for transformer under the above operation conditions.

REF. CLAUSE 3.1.9

1. Conditions:

i) a) 9/12/15 car SDCL EMU rake (with 1 MC cut-out for each formation)
b) 8/12 car DCL MEMU rake (with 1 MC cut-out for each formation)

ii) 22.5 kV AC
iii) At 100 kmph stopping at all the stations
iv) All out run (without stop time)

2. Simulation

Type of Stock	Section	Final temp. rise of traction motor
EMU	Healthy rake under continuous duty cycle in Subzimandi-Panipat-Sabzimandi followed by 1 MC isolation (33% cut out) and completion of one round trip.	
MEMU	Healthy rake under continuous duty cycle in Subzimandi-Panipat-Sabzimandi followed by 1 MC isolation (50% cut out) and completion of one round trip.	

Note: Supplier shall certify the compliance to the specification clause 4.3.4 for converter, inverter and clause 4.1.3 for transformer under the above operation conditions.

G REQUIREMENT OF CHARACTERISTICS AND EFFICIENCY CURVES

REF. CLAUSE 3.1.6

1. **Performance curves for Motoring and regenerating.**
2. **Conditions**

22.5 kV AC, Wheel dia. 915 (Half worn wheel)

Parameters to be included in the curve

Speed Vs Tractive effort / Braking effort, Train resistance, Line current, Traction Motor voltage, Traction motor current, Traction motor power factor, Motor frequency, slip frequency, Balancing speed.

H EFFICIENCY CURVES FOR MOTORING AND BRAKING

REF. CLAUSE 3.1.6

Speed Vs. Gear efficiency, Inverter Efficiency, Converter efficiency, Transformer efficiency, Traction Motor efficiency, Overall system efficiency at 22.5 kV AC.

I TRACTION MOTOR CHARACTERISTICS AS PER IEC 349-2

J CLAUSE 2.10 – SIMULATION OF LIKELY VALUES OF HARMONIC CURRENTS.

<u>IMPORTANT:</u> The listed requirements as above are indicative, supplier is advised to refer the main clause before finalising the simulations.

20. RATINGS OF POWER EQUIPMENTS of EMU & MEMU AT 22.5 KV AC

(All out run & half worn –wheel condition)

I	II	III	IV	V	VI	VII	VIII
Sl.N	Parameters	Continuous Rating	1 Hour Rating	Average Section (1.5 km)	Subzimandi-Panipat	Subzimandi-Panipat 33% cutout (Cl. 3.1.9)	1 in 100 Gradient 1 Km section 33% cutout (Cl. 3.1.8)
1.	Traction Motor output power in KW						
2.	Traction Motor voltage						
3.	Traction Motor current						
4.	Efficiency of Traction Motor						
5.	Power factor of Traction Motor						
6.	Traction Motor input power in KVA						
7.	Inverter output power in KVA						
8.	Efficiency of inverter						
9.	DC link voltage						
10.	Inverter input power in KVA						
11.	Converter output power in KVA						
12.	Efficiency of Converter						
13.	Power factor of Converter						
14.	DC link current						
15.	Transformer secondary output power in KVA						
16.	Transformer secondary output voltage						
17.	Transformer secondary output current						
18.	Transformer efficiency						
19.	Auxiliary power KW						

- The rating chain calculations, as above, must match from TM to transformer including converter / inverter and auxiliary converter.

  The TM power rating shall be calculated based on the continuous rms current ,corresponding voltage, as specified, and at rated power factor & efficiency which shall be used for further rating calculations.

- Column VII pertains to emergency condition vide clause 3.1.9 and 3.1.8 for 9 car train with 1 MC isolated.

- All other columns III to VI are for normal 12/15 car EMU / 8 car MEMU train.

Annexure - II A

DESIGN DATA CALCULATIONS AND DRAWINGS TO BE SUBMITTED BY THE SUPPLIER.

DESIGN DATA

A) Design data should include following particulars:

1. **PANTOGRAPH:** Make and type, working and maximum range, variation of pressure over working range, rated current capacity, maximum and recommended operating speed, Dimension of mounting insulators, Lock down height, Clearance from roof, weight of the equipment.

2. **VACUUM CIRCUIT BREAKER:** Make and type, rated voltage and current, the maximum permissible operating voltage, rated short time current, total fault clearing time, making and breaking capacity, impulse voltage withstand, control circuit voltage, number and rating of auxiliary contacts, overall dimensions and weight of the equipment.

3. **TRANSFORMER:** Make and type, type of construction, particulars of windings with their continuous rating, permissible duty cycle, percentage impedance voltage of each winding with different combinations of windings shorted, no-load magnetisation current, current density in windings, transformer losses and efficiency, permissible temperature rise, details of cooling system, details of insulation of windings, dielectrics levels, overall dimensions and weight of the transformer with and without cooling equipment. Suspension arrangement and calculations.

4. **Details of the radiator, relays and other devices associated with the transformer.**

5. **Power Converter/Inverter:** Make and type, number of cubicles per motor coach, thermal characteristics of IGBTs, heat sink details of IGBTs, cooling system design details including air/water flow rates and arrangement of filtered air, noise level, configuration with detail calculation of branch wise current proving adequacy of the devices used, Rating of each IGBT, Thermal margin with calculations**.**

   Details of the capacitor for DC link as well as resonance circuit, if provided, details of the protection of power converter, the designed power loss in the converter.

6. **Train Management System:** Details of protocols, Software modification and interface requirements.

7. **Microprocessor control and diagnostic system**: Make and type, details of microprocessor, Complete functional description, details of faults to be displayed in driving cab and stored in permanent memory, procedure for down loading the details of faults from memory, details of all protection schemes of all equipments, details of control for converter, DC link, inverter, traction motor, braking etc.

8. **Auxiliary converter**: Make and type, number of cubicles per motor coach, arrangement of devices, margin in current, voltage and junction temperature, cooling system design details including air flow rates and arrangement of filtered air, noise level, protection system, overall dimensions and weight, maximum output current at the time of starting the auxiliaries.

9. **Filters:** Make and type, number and rating of the coils, inductance and ripple characteristics up to 1.7 times the rated transformer secondary current, details of the conductor and insulation system, current density, losses, temperature rise limit, details of cooling system, dielectric test voltages, overall dimensions and weight of the equipment.

10. **Traction Motor:** Make and type, continuous rating, one hour rating and short time rating, maximum starting current and duration, current ratings for various operating voltages, gear ratio, traction motor characteristics under different conditions, details and data of windings, estimated temperature rise of stator winding, air flow, ventilation to Watt loss ratio, maximum designed / test / service speed, unventilated rating, details of insulation, details of the bearings, L-10 life calculation of the bearings, FEM analysis of the rotor shaft, details of banding, data for motorette test, fits and clearances adopted, Details of lubrications to be used in gear case and different bearings, overall dimensions and weight of the traction motor.

11. **Gears and Pinions**: Make and type, grade of steel used, particulars of heat treatment, material and type of construction of gear case, make & type of compound of gear case.

12. **Auxiliary Machines & Blowers:-** Make and type of various auxiliary machines, nominal voltage, starting current and torque, torque speed characteristics at various voltages, continuous rating, speed, power factor and slip of the motor, type of enclosure, details of cooling fan, air gap, details of windings and insulation, conductor size, current density, type of conductor insulation, details of impregnation, details of lead wire, terminals and terminals block, material of core stampings and average flux density, details of rotor end rings and bars with current density, details of bearing giving sizes, clearances, tolerances, dimensions, L-10 life calculation of the bearings and weight of machines, tests conducted to ascertain the reliability of windings/motors. Make and type of the blower units, power consumption at rated capacity, dimensions and weight of the blower**.**

13. **Contactors / MCB:** Make and type, rated voltage and current, making and breaking capacity, number of auxiliary contacts with control circuits voltage, magnet valve and coil details, overall dimensions and weight, mechanical and electrical endurance test data.

14. **Lightning Arrestor:** Make and type, rated voltage, dry and wet power frequency withstand voltage, minimum power frequency spark over voltage, nominal discharge current, impulse spark over voltage, overall dimensions and weight.

15. **Master and Brake Controller:** Make and type, rated current, making and breaking current, positions of reverser and main handle and auxiliary interlocks, overall dimensions and weight, mechanical and electrical endurance test data.

16. **Relays:** Make and type of various relays, rated current and voltage, range of setting, rated control voltage, rating of contacts, details of material of the contact, type of enclosure, temperature rise limit, indication system provided, overall dimensions and weight, mechanical and electrical endurance test data.

17. **Compressor:** Make, type and model, number of stages, rated speed, maximum pressure, graph showing FAD against 8, 9 and 10 kg/cm^2 pressures, maximum permissible temperature at inlet and exhaust ports, details of drive arrangement and coupling, lubrication requirements, overall dimensions and weight.

18. **Battery Charger:** Make and type of the battery charger, capacity and rating, ripple content,

dimensions and weight.

19. **Isolating and Programme Switches:** Make and type, rated voltage and current, short time current, description and details of interlocking arrangement, number of auxiliary contacts, overall dimensions and weight, mechanical and electrical endurance test data.

20. **Auxiliary Compressor:** Make and type, capacity and pressure, speed, motor rating and working voltage, overall dimensions and weight.

21 **Regenerative Brake Blending Unit**: Make and type, functional description of complete system and individual components, operating pressure, overall dimensions and weight.

22. **Parking Brake**: Make and type, functional description, operating pressure, overall dimensions and weight.

B) Design Calculations shall include:-

a) Weights and centre gravity of each equipment together with weight unbalance calculations etc.

b) Adhesion calculation.

c) System performance calculations.

d) Gears pinions, analysis of stresses, selection of bearing, gear case and transmission assembly.

e) Calculations for lateral and longitudinal equipment balancing.

f) EP brake system, brake effort calculations, parking brake calculation. Braking distance calculations under gross load condition at maximum permissible operating speed at level track.

g) Cooling system calculations.

h) Tractive and braking effort vs speed curves showing balancing speed.

i) Detailed step-wise calculations for equipment ratings and performance requirement as per Chapter 3.

j) Curves of efficiency, power factor, frequency, slip as a function of speed.

k) Traction Motor performance curves.

l) Calculations for life of bearings used in Traction Motors and aux. machines.

m) Harmonic calculations.

n) Calculation of shaft strength for Traction and aux. Machines, calculation of moment of inertia, shaft strength etc.

o) Reliability predictions.

C) Drawings:

1 Layout drawing for roof, HT compartment, underfloor, driving cab motor and trailer coaches.

2 Schematic diagram of power, dynamic braking, control and auxiliary circuits including multiple operation.

3 Tractive effort transmission diagram.

4 Brake system diagram.

5 Drawing showing mounting arrangement of traction motor.

6 Motor suspension arrangement.

7 Traction motor outline assembly, longitudinal section, cross-section, stator, rotor, shaft details, motor terminal box and bearing housing.

8 Drawings for pantograph, pan and strips.

9 Auxiliary machines drawing giving longitudinal and cross section details of stator winding, motor construction etc.

10 Mounting details of major equipment.

11 General arrangement of transformer, winding, core and auxiliaries, if any.

12 General arrangement of circuit breaker, earthing switches, isolators, contactors, relays etc.

13 Master controller drawing showing driving controls, cam contacts and pneumatic and mechanical connections.

14 Traction motor cooling duct arrangement.

15 Transformer and power converter cooling arrangement.

16 General arrangement for wheel slip detection and correction system.

17 Parking brake arrangement.

Note: The items as above are indicative only. Supplier is advised to refer the relevant clauses of the specifications for submitting the details required and accordingly submit the offer. The final list shall be decided during contract finalization.

ANNEXURE III A

TRACK DATA
DELHI TO AMBALA SECTION

LARGEST PEAK IN EACH KM. IN DELHI TO UMBALA SECTION				
KILOMETER	UN-3.6	TW-3.6	GAUGE	AL-7.2
5-6	....	....	....	12
6-7	13	....	....	....
7-8	15	14	8	11
8-9	....	....	....	....
9-10	....	....	....	....
10-11	....	....	....	....
11-12	11	....	....	....
12-13	12	....	9	....
13-14	11	....	-10	14
14-15	....	....	12	10
15-16	....	....	....	....
16-17	....	....	....	....
17-18	....	....	....	....
18-19	....	....	....	....
19-20	....	....	-8	10
20-21	10	....	8	25
21-22	11	....	-12	....
22-23	12	....	....	....
23-24	11	12	-11	10
24-25	....	....	....	....
25-26	10	11	17	14
26-27	....	....	15	12
27-28	....	....	....	....
28-29	....	....	....	....
29-30	....	....	....	....
30-31	....	....	....	....
31-32	11	....	....	....
32-33	....	....	-9	20
33-34	-9	11	-9	26
34-35	10	....	....	....
35-36	....	....	....	....
36-37	10	....	....	....
37-38	....	....	....	....
38-39	11	....	8	....
39-40	....	....	....	....
40-41	11	....	....	....
41-42	10	....	....	....
42-43	10	....	9	....
43-44	10	....	13	19
44-45	....	....	....	....
45-46	10	....	....	....
46-47	....	....	....	....
47-48	....	....	8	....
48-49	....	....	....	....
49-50	....	....	....	....
50-51	10	....	8	14
51-52	16	....	....	....
52-53	11	....	....	....
53-54	11	....	....	....

54-55	....	....	....	....
55-56	....	....	....	....
56-57	12	....	11	....
57-58	10	....	....	....
58-59	14	....	-8	13
59-60	13	11	-11	19
60-61	10	....	....	....
61-62	....	....	....	....
62-63	....	....	....	....
63-64	....	....	....	....
64-65	10	11	-8	16
65-66	....	....	....	....
66-67	....	....	....	....
67-68	....	....	....	....
68-69	....	....	....	....
69-70	....	12	-10	18
70-71	11	....	9	14
71-72	....	....	....	....
72-73	....	....	....	10
73-74	....	....	....	....
74-75	....	....	....	....
75-76	....	....	....	....
76-77	....	....	....	....
77-78	....	....	....	....
78-79	11	....	-11	16
79-80	10	....	23	15
80-81	11	....	8	....
81-82	....	....	....	....
82-83	....	....	....	....
83-84	....	....	....	....
84-85	10	....	....	....
85-86	....	....	....	....
87-88	11	11	8	11
88-89	....	....	....	....
89-90	10	....	8	....
90-91	10	11	9	....
91-92	....	....	....	....
92-93	....	....	....	....
93-94	10	....	....	....
94-95	10	13	....	11
95-96	10	....	9	....
96-97	....	....	....	....
97-98	10	....	....	....
98-99	....	....	....	....
99-100	....	....	....	....
100-101	10	....	....	....
101-102	....	....	....	....
102-103	....	....	....	....
103-104	10	....	-8	....
104-105	12	13	-10	12
105-106	11	12	8	10
106-107	....	....	....	....
107-108	....	....	....	....
108-109	....	....	....	....
109-110	11	....	....	....
110-111	....	....	....	....
111-112	....	....	....	....
112-113	....	....	-16	13
113-114	10	11	15	17

114-115	....	....	....	....
115-116	....	....	....	....
116-117	....	....	....	....
117-118	....	....	....	....
118-119	....	....	....	....
119-120	....	....	....	....
120-121	....	....	....	....
121-122	13	....	9	12
122-123	....	....	11	11
123-124	....	....	8	16
124-125	....	....	....	....
125-126	10	....	....	....
126-127	11	....	....	....
127-128	....	....	....	....
128-129	11	....	-8	20
129-130	10	....	-18	18
130-131	....	....	....	....
131-132	....	....	....	....
132-133	....	....	....	....
133-134	11	....	....	....
134-135	....	....	....	10
135-136	....	....	12	20
136-137	....	....	....	....
137-138	....	12	....	10
138-139	12	13	-8	19
139-140	....	....	....	....
140-141	....	....	....	....
141-142	....	....	-13	21
142-143	....	....	....	....
143-144	....	....	....	....
144-145	....	....	....	....
145-146	....	....	....	....
146-147	11	13	9	10
147-148	....	....	....	....
148-149	....	....	....	....
149-150	....	....	....	....
150-151	....	....	....	....
151-152	....	....	....	....
152-153	....	....	....	....
153-154	11	....	....	....
154-155	15	11	-8	10
155-156	10	....	9	14
156-157	14	11	-9	....
157-158	10	....	....	....
158-159	....	....	....	....
159-160	....	....	....	....
160-161	11	....	9	17
161-162	12	....	-14	22
162-163	....	....	....	....
163-164	....	....	....	....
164-165	....	....	....	....
165-166	....	....	....	....
166-167	12	....	....	13
167-168	11	....	8	14
168-169	11	....	....	....
169170	....	....	....	....
170-171	....	....	....	....
171-172	11	....	....	10
172-173	10	....	9	13

173-174	....	....	....	....
174-175	....	....	....	....
175-176	11	....	....	....
176-177	15	14	8	23
177-178	11	....	-13	13
178-179	12	....	10	10
179-180	....	....	14	12
180-181	....	....	....	....
181-182	....	....	....	....
182-183	....	14	....	....
183-184	....	....	-18	20
184-185	....	....	....	....
185-186	....	....	....	....
186-187	10	....	....	....
187-188	11	....	8	10
188-189	15	....	8	15
189-190	17	....	....	14
190-191	....	....	....	....
191-192	13	....	....	....
192-193	14	11	9	11
193-194	....	....	....	....
194-195	12	....	....	....
195-196	....	....	....	....
196-197	....	....	....	....
197-198	....	....	....	....
198-199	....	....	....	....
199-200	....	....	....	....
200-201	....	....	....	....
201-202	....	....	....	....
202-203	....	....	....	....
203-204	....	....	....	....
204-205	....	....	....	....
205-206	16	....	19	12
206-207	12	....	....	11
207-208	10	....	....	....
208-209	....	....	....	....
209-210	10	....	....	....
210-211	41	42	....	....
211-212	77	37	....	....
212-213	45	48	....	....
213-214	69	28	....	....

ANNEXURE III A

TRACK DATA

LARGEST PEAK IN EACH KM. IN BOMBAY SUBURBAN SECTION CHURCHGATE TO BORIVELI OF 23 –12 – 98				
KM.	UN-3.6	TW-3.6	GAUGE	AL-7.2
5-6	11	16	10	19
6-7	10	11	11	13
7-8	NR	NR	NR	NR
8-9	18	18	7	20
9-10	15	12	8	11
10-11	13	19	13	15
11-12	13	16	7	12
12-13	13	22	17	26
13-14	15	13	13	14
14-15	19	17	21	18
15-16	15	16	18	25
16-17	8	12	12	14
17-18	14	14	10	14
18-19	15	16	10	14
19-20	17	13	8	12
20-21	14	18	19	12
21-22	17	18	13	15
22-23	16	26	19	22
23-24	15	20	13	14
24-25	15	20	13	29
25-26	21	24	10	24
26-27	18	26	13	14
27-28	17	27	18	16
28-29	16	13	9	10
29-30	17	20	9	14
30-31	19	21	11	14
31-32	18	17	9	12
32-33	17	18	10	13
33-34	11	12	7	13

LEGEND:

a) **UN-3.6**: Largest peak in the Kilometer measured on 3.6meter chord for unevenness parameters

b) **TW-3.6**: Largest peak in the Kilometer measured through Dynamic Cross Level on 3.6meter chord for twist parameter.

c) **AL-7.2**: Largest peak in the Kilometer measured on 7.2 meter chord for Alignment parameter.

d) **GAUGE**: Gauge measured through High Pass Filter

e) **NR**: Not recorded.

ANNEXURE III B

TRACK DATA
AMBALA TO DELHI SECTION

LARGEST PEAK IN EACH KM. IN UMBALA TO DELHI SECTION				
KILOMETER	**UN-3.6**	**TW-3.6**	**GAUGE**	**AL-7.2**
196-195	11	13	-	10
195-194	10	12	-	-
194-193	-	-	-	-
193-192	10	-	-	-
192-191	-	-	8	14
191-190	10	12	-13	-
190-189	12	-	-	-
189-188	-	-	-	-
188-187	-	-	9	12
187-186	-	-	-	-
186-185	-	-	-	-
185-184	11	-	-	-
184-183	-	-	-11	14
183-182	-	-	-	-
182-181	-	-	-	-
181-180	-	-	-	-
180-179	-	-	-	-
179-178	11	-	12	20
178-177	10	-	13	14
177-176	11	-	-	-
176-175	11	-	-	-
175-174	-	-	-	-
174-173	12	-	-	-
173-172	-	-	-13	15
172-171	-	-	-19	19
171-170	-	-	-	-
170-169	-	-	-	-
169-168	-	-	-	-
162-161	NR	NR	NR	NR
161-160	-	-	-9	13
160-159	-	-	-	-
159-158	-	-	-	-
158-157	10	-	-	-
157-156	NR	NR	NR	NR
156-155	NR	NR	NR	NR
155-154	NR	NR	NR	NR
154-153	-	-	-	-
153-152	-	-	-	-
152-151	-	-	-	-
151-150	-	-	-	-
150-149	-	-	-	-
149-148	-	-	-	-

148-147	-	-	-	-
147-146	11	12	-9	19
146-145	-	-	-	-
145-144	-	-	-	-
144-143	-	-	-	-
143-142	-	-	-	-
142-141	-	-	-	-
141-140	-	-	-	-
140-139	-	-	-	-
139-138	18	14	-	13
138-137	-	-	-	11
137-136	-	-	-	-
136-135	11	-	10	13
135-134	-	-	24	16
134-133	12	-	-	-
133-132	-	-	-	-
132-131	-	-	-	-
131-130	-	-	-	-
130-129	10	14	10	11
129-128	11	-	8	24
128-127	14	-	-8	-
127-126	14	-	8	11
126-125	-	-	-	-
125-124	-	-	-	-
124-123	10	11	10	10
123-122	14	-	-17	12
122-121	14	-	10	11
121-120	-	-	-	-
120-119	-	-	-	-
119-118	-	-	-	-
118-117	-	-	-	-
117-116	-	-	-	-
116-115	-	-	-	-
115-114	-	-	-	-
114-113	11	-	11	11
113-112	11	-	11	20
112-111	-	-	-	-
111-110	-	-	-	-
110-109	-	-	-	-
109-108	-	-	-	-
108-107	-	-	-	-
107-106	-	-	-	-
106-105	19	16	-9	14
105-104	10	-	-	10
104-103	11	12	-8	14
103-102	-	-	-	-
102-101	-	-	-	-
101-100	-	-	-	-
100-99	-	-	-	-

99-98	-	-	-	-
98-97	-	-	-	-
97-96	-	-	-	-
96-95	12	-	-12	11
95-94	13	-	10	11
94-93	-	-	-	-
93-92	-	-	-	-
92-91	-	-	-	-
91-90	-	-	-	-
90-89	-	-	-	10
89-88	NR	NR	NR	NR
88-87	10	-	-8	12
87-86	-	-	-	-
86-85	-	-	-	-
85-84	-	-	-	-
84-83	-	-	-	-
83-82	-	-	-	-
82-81	-	-	-9	-
81-80	13	14	8	12
80-79	11	-	-8	11
79-78	-	-	-	-
78-77	-	11	-	-
77-76	-	-	-	-
76-75	-	-	-	-
75-74	-	11	-9	-
74-73	-	-	-	-
73-72	-	-	-	-
72-71	10	-	11	10
71-70	-	-	-	-
70-69	-	-	-	-
69-68	-	-	-	-
68-67	10	-	-	-
67-66	-	-	-	-
66-65	-	-	11	12
65-64	-	-	9	21
64-63	-	-	-	-
63-62	-	-	-	-
62-61	-	-	-	-
61-60	-	-	-	-
60-59	11	-	-10	21
59-58	-	-	8	10
58-57	-	-	-	-
57-56	-	13	-	-
56-55	-	-	-	-
55-54	-	-	-	-
54-53	-	-	-	-
53-52	-	-	-	-
52-51	15	12	-10	13
51-50	-	19	-8	13

50-49	-	11	-	-
49-48	-	-	-	-
48-47	11	-	-	-
47-46	-	-	-	-
46-45	11	-	-	-
45-44	-	-	-	-
44-43	NR	NR	NR	NR
43-42	15	11	-10	14
42-41	-	-	-	-
41-40	-	-	-	-
40-39	-	-	-	-
39-38	-	11	-	-
38-37	10	11	-	-
37-36	-	-	-	-
36-35	10	11	-	-
35-34	11	11	-	
34-33	-	-	-	-
33-32	-	-	-8	14
32-31	-	-	-	-
31-30	-	-	9	-
30-29	-	-	-	-
29-28	-	-	-	-
28-27	-	-	-	-
27-26	10	11	8	11
26-25	10	-	-11	14
25-24	-	-	-	-
24-23	-	11	-	-
23-22	-	-	-	-
22-21	17	11	-	10
21-20	NR	NR	NR	NR
20-19	-	-	11	-
19-18	12	15	-8	-
18-17	-	-	-12	14
17-16	10	-	-	-
16-15	-	-	-	-
15-14	12	-	-	11
14-13	12	-	-	10
13-12	-	-	-	-
12-11	10	11	-	-
11-10	NR	NR	NR	NR
10-9	11	12	-	10
9-8	10	11	-	10
8-7	10	14	9	14
7-6	12	12	-	14
6-5	11	19	-	11
5-4	-	11	-	-
4-3	NR	NR	NR	NR

LEGEND:

a) **UN-3.6**: Largest peak in the Kilometer measured on 3.6 meter chord for unevenness parameters
b) **TW-3.6**: Largest peak in the Kilometer measured through Dynamic Cross Level on 3.6meter chord for twist parameter.
c) **AL-7.2**: Largest peak in the Kilometer measured on 7.2 meter chord for Alignment parameter.
d) **GAUGE**: Gauge measured through High Pass Filter
e) **NR**: Not recorded.

ANNEXURE III B

TRACK DATA

LARGEST PEAK IN EACH KM. IN BOMBAY SUBURBAN SECTION BORIVELI TO CHURCHGATE OF 23 –12 – 98				
KM.	UN-3.6	TW-3.6	GAUGE	AL-7.2
34-33	10	13	8	13
33-32	13	13	10	29
32-31	13	12	9	15
31-30	16	21	8	13
30-29	14	15	17	15
29-28	13	22	11	20
28-27	15	18	14	12
27-26	16	16	9	12
26-25	12	14	12	13
25-24	11	9	7	19
24-23	8	11	5	10
23-22	17	12	12	20
22-21	17	14	14	19
21-20	14	16	13	15
20-19	8	12	5	11
19-18	13	14	10	20
18-17	14	11	12	16
17-16	9	14	7	16
16-15	17	15	17	20
15-14	13	17	23	21
14-13	12	13	12	15
13-12	14	16	11	22
12-11	12	20	6	14
11-10	19	18	10	15
10-9	13	16	8	12
9-8	11	17	11	15
8-7	15	14	13	14
7-6	8	8	8	12
6-5	10	32	7	15

ANNEXURE –IV

ROUTE PROFILE
SECTION DELHI TO UMBALA (UP)

S. No.	LOCATION (IN KM) FROM	TO	GRADIENT + CURVE EFFECT	STN. NAME	SPEED RESTR. (KMPH)
1	0.00	1.30	0.00	DELHI	10
2	1.30	2.20	4.20		10
3	2.20	2.77	- 2.00	SUBZI MANDI	10
4	2.77	2.93	- 2.00		100
5	2.93	3.45	- 4.20		100
6	3.45	3.90	- 4.20		60
7	3.90	4.60	- 2.00		60
8	4.60	5.40	0.00		60
9	5.40	6.20	2.00		60
10	6.20	6.90	0.00		60
11	6.90	7.23	- 1.00	DELHI AZADPUR	60
12	7.23	7.80	- 1.00		60
13	7.80	8.45	0.00		60
14	8.45	8.90	0.00	NAVA AZADPUR	100
15	8.90	9.00	0.00		100
16	9.00	10.50	- 2.00		100
17	10.50	11.80	0.00		100
18	11.80	13.30	3.30		100
19	13.30	13.53	0.00	BADLI	100
20	13.53	14.20	0.00		100
21	14.20	14.80	1.00		100
22	14.80	16.20	0.0		100
23	16.20	16.93	- 2.50	KHERA KALAN	100
24	16.93	17.80	- 2.50		100
25	17.80	20.10	0.00	HOLAMBI KALAN	100
26	20.10	23.40	0.00		100
27	23.40	25.40	3.30		100
28	25.40	25.92	0.00	NARELA	100
29	25.92	26.40	0.00		100
30	26.40	27.90	- 3.30		100
31	27.90	31.10	0.00		100
32	31.10	32.40	3.30		100
33	32.40	32.79	0.00	RATHDHANA	100
34	32.79	33.20	0.00		100
35	33.20	33.80	- 3.30		100
36	33.80	37.74	0.00	HARSAN KALAN HALT	100
37	37.74	37.80	0.00		100
38	37.80	39.30	1.00		100

39	39.30	40.90	0.00		100
40	40.90	42.60	3.30		100
41	42.60	43.14	0.00	SONIPAT	100
42	43.14	45.40	0.00		100
43	45.40	45.80	2.00		100
44	45.80	46.40	0.00		100
45	46.40	47.80	- 3.30		100
46	47.80	48.80	0.00		100
46	48.80	50.10	1.00		100
47	50.10	51.55	0.00	SANDAL KALAN	100
48	51.55	52.00	0.00		100
49	52.00	52.60	1.00		100
50	52.60	53.80	0.00		100
51	53.80	54.50	2.00		100
52	54.50	54.55	0.00	RAJLU GARHI HALT	100
53	54.55	59.12	0.00	GANAUR	100
54	59.12	59.90	0.00		100
55	59.90	61.10	1.00		100
56	61.10	61.80	0.00		100
57	61.80	62.70	1.00		100
58	62.70	64.40	0.00		100
59	64.40	64.66	1.00	BHODWAL	100
60	64.66	71.32	0.00	SAMALKHA	100
61	71.32	71.70	0.00		100
62	71.70	72.80	1.00		100
63	72.80	73.40	0.00		100
64	73.40	74.90	3.30		100
65	74.90	76.40	1.00		100
66	76.40	79.40	0.00		100
67	79.40	80.08	1.00	DIWANA	100
68	80.08	80.40	1.00		100
69	80.40	81.60	0.00		100
70	81.60	83.40	1.00		100
71	83.40	86.50	0.00		100
72	86.50	87.70	- 1.00		100
73	87.70	88.28	0.00	PANIPAT	100
74	88.28	88.45	0.00		100
75	88.45	88.60	0.00		90
76	88.60	88.75	- 2.00		90
77	88.75	89.40	- 2.00		100
78	89.40	93.40	0.00		100
79	93.40	94.40	1.00		100
80	94.40	94.68	0.00	BABARPUR	100
81	94.68	96.10	0.00		100

82	96.10	98.20	1.00		100
83	98.20	99.48	0.00	KDHAND HALT	100
84	99.48	101.50	0.00		100
85	101.50	102.30	1.00		100
86	102.30	103.40	0.00		100
87	103.40	104.50	3.30		100
88	104.50	105.70	0.00	GHARUNDA	100
89	105.70	106.00	1.00		100
90	106.00	112.50	0.00		100
91	112.50	113.10	1.00	BAJDAN JATTAN	100
92	113.10	114.90	1.00		100
93	114.90	117.90	0.00		100
94	117.90	119.50	1.00		100
95	119.50	120.60	0.00		100
96	120.60	121.60	1.00		100
97	121.60	122.55	0.00	KARNAL	100
98	122.55	122.70	0.00		100
99	122.70	123.50	2.00		100
100	123.50	124.70	0.00		100
101	124.70	126.20	3.30		100
102	126.20	126.60	0.00		100
103	126.60	127.50	-3.30		100
104	127.50	129.53	0.00	BHANI KHURD	100
105	129.53	130.80	0.00		100
106	130.80	132.00	1.00		100
107	132.00	133.50	0.00		100
108	133.50	134.20	2.00		100
109	134.20	134.75	0.00	TARAORI	100
110	134.75	138.71	0.00	NILO KHERI	100
111	138.71	140.50	0.00		100
112	140.50	141.80	1.00		100
113	141.80	144.30	0.00		100
114	144.30	146.00	1.00		100
115	146.00	147.15	0.00	AMIN	100
116	147.15	152.70	0.00		100
117	152.70	154.00	-0.50		100
118	154.00	155.73	0.00	KURUKSHETRA	100
119	155.73	161.00	0.00		100
120	161.00	161.18	0.50	DHOD KHEDI	100
121	161.18	164.70	0.50		100
122	164.70	166.64	1.00		100
123	166.64	167.10	1.00		100
124	167.10	168.30	0.00		100
125	168.30	169.45	0.50		100
126	169.45	169.81	0.50		50

127	169.81	170.09	0.50		30
128	170.09	172.09	0.50	DHOLA MAZRA	100
129	172.09	174.40	0.50		100
130	174.40	176.20	1.00		100
131	176.20	177.30	0.00		100
132	177.30	177.74	1.00	SHAHBAD MARKANDA	100
133	177.74	178.20	1.00		100
134	178.20	179.20	4.27		100
135	179.20	179.60	0.11		100
136	179.60	180.40	-2.00		100
137	180.40	185.00	0.00		100
138	185.00	186.50	1.00		100
139	186.50	187.91	0.00	MOHRI	100
140	187.91	188.70	0.00		100
141	188.70	190.30	1.00		100
142	190.30	191.10	3.30		100
143	191.10	192.80	0.00		100
144	192.80	193.80	2.50		100
145	193.80	195.00	0.00		100
146	195.00	197.14	0.00	UMBALA	10

ROUTE PROFILE
SECTION UMBALA TO DELHI (DN)

S. No.	LOCATION (IN KM) FROM	TO	GRADIENT + CURVE EFFECT	STN. NAME	SPEED RESTR. (KMPH)
1	197.14	195.00	0.00	UMBALA	10
2	195.00	193.80	0.00		100
3	193.80	192.80	-2.50		100
4	192.80	191.10	0.00		100
5	191.10	190.30	-3.30		100
6	190.30	188.70	-1.00		100
7	188.70	187.91	0.00	MOHRI	100
8	187.91	186.50	0.00		100
9	186.50	185.00	-1.00		100
10	185.00	180.40	0.00		100
11	180.40	179.60	2.00		100
12	179.60	179.20	-0.11		100
13	179.20	178.20	-4.27		100
14	178.20	177.74	-1.00	SHAHBAD MARKANDA	100
15	177.74	177.30	-1.00		100
16	177.30	176.20	0.00		100
17	176.20	174.40	-1.00		100
18	174.40	172.09	-0.50	DHOLA MAZRA	100
19	172.09	168.30	-0.50		100
20	168.30	167.10	0.00		100
21	167.10	166.64	-1.00		100
22	166.64	164.70	-1.00		100
23	164.70	161.18	-0.50	DHOD KHEDI	100
24	161.18	161.00	-0.50		100
25	161.00	155.73	0.00	KURUKSHETRA	100
26	155.73	154.00	0.00		100
27	154.00	152.70	0.50		100
28	152.70	148.96	0.00		100
29	148.96	148.78			75
30	148.78	147.15		AMIN	100
31	147.15	146.00	0.00		100
32	146.00	144.30	-1.00		100
33	144.30	141.80	0.00		100
34	141.80	140.50	-1.00		100
35	140.50	138.71	0.00	NILOKHERI	100
36	138.71	134.75	0.00	TARAORI	100
37	134.75	134.20	0.00		100
38	134.20	133.50	-2.00		100
39	133.50	132.00	0.00		100
40	132.00	130.80	-1.00		100
41	130.80	129.53	0.00	BHANI KHURD	100

42	129.53	127.50	0.00		100
43	127.50	126.60	3.30		100
44	126.60	126.20	0.00		100
45	126.20	124.70	-3.30		100
46	124.70	123.50	0.00		100
46	123.50	122.70	-2.00		100
47	122.70	122.55	0.00	KARNAL	100
48	122.55	121.60	0.00		100
49	121.60	120.60	-1.00		100
50	120.60	119.50	0.00		100
51	119.50	117.90	-1.00		100
52	117.90	114.90	0.00		100
53	114.90	113.10	-1.00	BAJDAN JATTAN	100
54	113.10	112.50	-1.00		100
55	112.50	106.00	0.00		100
56	106.00	105.70	-1.00	GHARUNDA	100
57	105.70	104.50	0.00		100
58	104.50	103.40	-3.30		100
59	103.40	102.30	0.00		100
60	102.30	101.50	-1.00		100
61	101.50	99.48	0.00	KDHAND HALT	100
62	99.48	98.20	0.00		100
63	98.20	96.10	-1.00		100
64	96.10	94.68	0.00	BABARPUR	100
65	94.68	94.40	0.00		100
66	94.40	93.40	-1.00		100
67	93.40	89.40	0.00		100
68	89.40	88.60	2.00		100
69	88.60	88.28	0.00	PANIPAT	100
70	88.28	87.70	0.00		100
71	87.70	86.50	1.00		100
72	86.50	83.40	0.00		100
73	83.40	81.60	-1.00		100
74	81.60	80.40	0.00		100
75	80.40	80.08	-1.00	DIWANA	100
76	80.08	79.40	-1.00		100
77	79.40	76.40	0.00		100
78	76.40	74.90	-1.00		100
79	74.90	73.40	-3.30		100
80	73.40	72.80	0.00		100
81	72.80	71.70	-1.00		100
82	71.70	71.32	0.00	SAMALKHA	100
83	71.32	64.66	0.00	BHODWAL	100
84	64.66	64.40	-1.00		100
85	64.40	62.70	0.00		100
86	62.70	61.80	-1.00		100
87	61.80	61.10	0.00		100
88	61.10	59.90	-1.00		100
89	59.90	59.12	0.00	GANAUR	100

90	59.12	54.55	0.00	RAJLU GARHI HALT	100
91	54.55	54.50	0.00		100
92	54.50	53.80	-2.00		100
93	53.80	52.60	0.00		100
94	52.60	52.00	-1.00		100
95	52.00	51.55	0.00	SANDAL KALAN	100
96	51.55	50.10	0.00		100
97	50.10	48.80	-1.00		100
98	48.80	47.80	0.00		100
99	47.80	46.40	3.30		100
100	46.40	45.80	0.00		100
101	45.80	45.40	-2.00		100
102	45.40	43.14	0.00	SONIPAT	100
103	43.14	42.60	0.00		100
104	42.60	40.90	-3.30		100
105	40.90	39.30	0.00		100
106	39.30	37.80	-1.00		100
107	37.80	37.74	0.00	HARSAN KALAN HALT	100
108	37.74	33.80	0.00		100
109	33.80	33.20	3.30		100
110	33.20	32.79	0.00	RATHDHANA	100
111	32.79	32.40	0.00		100
112	32.40	31.10	-3.30		100
113	31.10	27.90	0.00		100
114	27.90	26.40	3.30		100
115	26.40	25.92	0.00	NARELA	100
116	25.92	25.40	0.00		100
117	25.40	23.40	-3.30		100
118	23.40	20.10	0.00	HOLAMBI KALAN	100
119	20.10	17.80	0.00		100
120	17.80	16.93	2.50	KHERA KALAN	100
121	16.93	16.20	2.50		100
122	16.20	14.80	0.00		100
123	14.80	14.20	-1.00		100
124	14.20	13.53	0.00	BADLI	100
125	13.53	13.30	0.00		100
126	13.30	11.80	-3.30		100
127	11.80	10.50	0.00		100
128	10.50	9.00	2.00		100
129	9.00	8.90	0.00	NAVA AZADPUR	100
130	8.90	8.45	0.00		100
131	8.45	7.80	0.00		60
132	7.80	7.23	1.00	DELHI AZADPUR	60
133	7.23	6.90	1.00		60
134	6.90	6.20	0.00		60
135	6.20	5.40	-2.00		60
136	5.40	4.60	0.00		60

137	4.60	3.90	2.00		60
138	3.90	3.45	4.20		60
139	3.45	2.93	4.20		100
140	2.93	2.77	2.00	SUBZI MANDI	10
141	2.77	2.20	2.00		10
142	2.20	1.30	-4.20		10
143	1.30	0.00	0.00	DELHI	10

ANNEXURE IV

CENTRAL RAILWAY
SECTION CSTM TO KASARA
(DN LINE)

SR. NO.	LOCATION (IN KM) FROM	TO	GRADIENT	CURVE	STN. NAME
1.	0	0.333	0.000		CST
2.	0.333	0.733	-0.675		(0.00KM)
3.	0.733	1.000	-0.026		
4.	1.000	1.067	0.000	1458R	
5.	1.067	1.201	-0.095	590R	
6.	1.201	1.242	-0.081	590R	MASJID
7.	1.242	1.800	-0.081		(1.22KM)
8.	1.800	2.067	0.181	500L	
9.	2.067	2.368	1.000	500L	SANDHURST
10	2.368	2.500	0.250		RD.(2.08)
11.	2.500	2.904	0.250		
12.	2.904	3.450	-0.250		
13.	3.450	3.667	-0.250		
14.	3.667	3.800	0.250		
15.	3.800	4.000	-0.030	1300L	
16.	4.000	4.700	-0.030		BYCULLA
17.	4.700	4.900	-0.030	2500L	(4.04KM)
18.	4.900	5.100	-0.030	1458R	
19.	5.100	5.333	-0.030		CHINCHPOKLI
20.	5.333	5.990	-0.055		(5.53KM)
21.	5.990	6.400	0.020		
22.	6.400	7.067	0.020		CURREY RD
23.	7.067	7.500	0.020		(6.07KM)
24.	7.500	8.134	0.027		PAREL
25.	8.134	8.400	0.100		(7.65KM)
26.	8.400	8.550	0.100	2916L	
27.	8.550	8.886	0.100		DADAR
28.	8.886	9.200	0.100		(8.85KM)
29.	9.200	9.300	0.100	590L	
30.	9.300	9.600	0.038		
31.	9.600	10.633	0.083		MATUNGA
32.	10.633	11.000	0.045		(10.12KM)
33.	11.000	11.100	0.045	1944I	
34.	11.100	11.350	0.050		
35.	11.350	11.802	0.050	1450R	SION
36.	11.802	12.000	-0.312		(12.71KM)
37.	12.000	12.200	-0.312		
38.	12.200	12.534	-0.312	3500L	
39.	12.534	12.933	-0.312		
40.	12.933	13.200	0.112		
41.	13.200	13.501	0.112	2500L	
42.	13.501	14.034	-0.112		
43.	14.034	14.131	0.000		
44.	14.131	14.200	0.135	2187R	

45.	14.200	14.664	0.135		
46.	14.664	15.031	0.333		
47.	15.031	15.150	0.200	4375L	
48.	15.150	15.301	0.200	1346R	
49.	15.301	15.502	0.200		KURLA
51.	15.502	15.802	-0.07.5		15.39KM
52.	15.802	16.000	0.000	2500R	
53.	16.000	16.150	0.000	3.500L	
54.	16.150	17.667	0.000		
55.	17.667	17.900	0.417	875R	VIDYA VIHAR
56.	17.900	18.100	0.417		(17.8 KM)
57.	18.100	18.534	0.417	3500R	
58.	18.534	18.700	-0.166		
59.	18.700	19.308	-0.166	1850L	GHATKOPAR
60	19.308	20.400	-0.166		(19.3 KM)
61.	20.400	21.185	0.363		
62.	21.185	21.400	0.363		
63.	21.400	21.900	0.143		
64.	21.900	22.400	0.379		
65.	22.400	22.663	0.379	2.3.33L	
66.	22.663	23.032	-0.250	2.333L	VIKROLI
67.	23.032	23.116	-0.333		(22.85 KM)
68.	23.116	24.566	0.000	1116R	
69.	24.566	25.234	0.333	1000R	KANJUR
70.	25.234	25.350	0.133	1750R	(24.69 KM)
71.	25.350	26.100	0.133		BHANDUP
72.	26.100	26.266	0.133	2.333L	(2.5.56 KM)
73.	26.266	26.360	0.133		
74.	26.360	26.500	0.133	1750R	
75.	26.500	26.700	0.133		
76.	26.700	26.825	0.133	1750R	
77.	26.825	26.922	0.133	1750L	
78.	26.99.2	27.102	0.000		
79.	27.102	27.410	0.000		
80.	27.410	27.550	0.000	1750R	
81.	27.550	27.652	0.000		
82.	27.652	27.900	0.400	12.50L	
83.	27.900	28.230	0.000		
84.	28.230	28.324	0.000		
85.	28.324	28.752	0.000		
86.	28.752	29.430	-0.197		
87.	29.430	30.175	0.288	2250R	
88.	30.175	30.315	0.000		
89.	30.315	30.443	0.000		
90.	30.443	30.540	-0.242		
91.	30.540	30.663	-0.242		
92.	30.663	30.690	-0.242	3286R	MULUND
93.	30.690	31.000	0.000		(30.56KM)
94.	31.000	31.150	-0.333		
95.	31.150	31.450	0.000		
96.	31.450	31.500	0.263		
97.	31.500	31.871	0.000		
98.	31.871	32.200	0.000		
99.	-	-	-		
100.	32.200	32.283	-0.263	1397R	
101.	32.283	32.350	-0.263	1552R	

102.	32.350	32.582	-0.263	1377R	
103.	32.582	33.410	0.250		THANE
104.	33.410	33.610	0.250		(33.02 KM)
105.	33.610	34.190	0.000		
106.	34.190	34.230	0.000		
107.	34.230	34.690	-0.500		
108.	34.690	34.780	0.000		
109.	34.780	34.973	-0.500	1746R	
110.	34.973	36.050	-0.500		KALVA
111.	36.050	36.210	-0.333		(35.40 KM)
112.	36.210	36.774	0.000		
113.	36.774	37.310	0.000		
114.	37.310	37.630	-0.500		
115.	37.630	38.789	-1.124		
116.	38.789	38.900	-1.124	834L	
117.	38.900	39.324	-1.124	804L	
118.	39.324	39.783	-1.124		
119.	39.783	40.360	-1.124	804L	MUMBRA
120	40.360	41.130	-1.124		(39.98 KM)
121.	41.130	41.403	0.000	804L	
122.	41.403	41.781	0.000		
123.	41.781	41.912	0.000	1246R	
124.	41.912	42.047	0.000		
125.	42.047	42.257	0.000	1246R	
126.	42.257	42.319	0.000		
127.	42.319	42.516	0.000	2794R	DIVA
128.	42.516	42.718	0.000	2794R	(42.46 KM)
129.	42.718	43.049	0.000		
130.	43.049	43.183	0.000	1746R	
131.	43.183	43.317	0.000	1746L	
132.	43.317	43.585	0.000		
133.	43.585	44.164	0.000	1852L	
134.	44.164	45.700	0.000		
135.	45.700	45.800	-0.400		
136.	45.800	45.900	0.000		
136	45.900	47.556	-0.014		
137.	47.556	47.747	-0.014	1724L	
138.	47.747	48.500	-0.014		DOMBIVALI
139.	48.500	48.720	0.666	1923R	(48.06 KM)
140.	48.720	49.200	0.666		
141.	49.200	49.334	-0.666		
142.	49.334	49.597	-0.666	1111R	THAKRULI
143.	49.597	50.107	0.666		(49.5 KM)
144.	50.107	51.500	0.666		
145.	51.500	51.729	0.666		
146.	51.729	52.700	0.666		
147.	52.700	53.800	0.666		KALYAN
148.	53.800	54.500	-0.022		(53.21 KM)
149.	54.500	54.700	-0.022		
150.	54.700	54.837	-0.500		
151.	54.837	54.900	0.000		
152.	54.900	55.130	-0.758		
153.	55.130	55.700	-0.658	2500R	
154.	55.700	56.000	-0.658		
155.	56.000	56.400	0.150	770L	SHAHAD
156.	56.400	56.503	0.150	862L	(56.25 KM)
157.	56.503	56.704	0.150	2174L	

158.	56.704	57.110	0.150		
159.	57.110	57.700	0.150		
160.	57.700	57.800	0.000		
161.	57.800	58.650	0.562		AMRIVALI
162.	58.650	58.780	0.175	1470R	(57.93 KM)
163.	58.780	58.900	0.351	1470R	
164.	58.900	59.000	0.351		
165.	59.000	59.180	0.351	860R	
166.	59.180	59.300	0.000	806R	
167.	59.300	59.420	0.000	806R	
168.	57.420	59.970	0.250	806R	
169.	59.970	60.180	0.250		
170.	60.180	60.300	0.413		
171.	60.300	60.680	0.358	806L	
172.	60.680	60.950	0.358	806L	
173.	60.950	61.580	0.358		
174.	61.580	62.000	0.385		
175.	62.000	62.100	0.000		
176.	62.100	62.260	0.000	820R	
177.	62.260	62.550	0.757	820R	
178.	62.550	62.600	-0.729	820R	
179.	62.600	62.760	-0.729	776L	
180.	62.760	63.000	-0.249	776L	
181.	63.000	63.230	-0.408	776L	
182.	63.230	63.500	-0.617	776L	
183.	63.500	63.750	-0.617		
184.	63.750	63.900	-0.617	1351L	
185.	63.900	64.000	-0.617		
186.	64.000	64.300	-0.617	868R	TITWALA
187.	64.300	64.800	-0.769	868R	(64.05 KM)
188.	64.800	65.000	0.000	868R	
189.	65.000	65.420	0.000	1612L	
190.	65.420	65.980	-0.617	1612L	
191.	65.980	67.000	0.600	1612L	
192.	67.000	67.400	0.666		
193.	67.400	67.650	0.000		
194.	67.650	68.750	0.666		
195.	68.750	69.650	0.000		
196.	69.650	69.750	-0.500		
197.	69.750	70.250	0.000		
199.	70.400	70.500	0.378	798R	
200.	70.500	71.000	0.000	798R	
201.	71.000	71.350	0.000	798R	
202.	71.350	71.500	0.000	798R	KHADAVALI
203.	71.500	71.850	0.000		(71.4 KM)
204.	71.850	71.900	0.378		
205.	71.900	72.000	0.378	798L	
206.	72.000	72.350	0.378	798L	
207.	72.350	72.450	-0.259		
208.	72.450	73.200	-0.259	875L	
209.	73.200	73.550	0.379		
210.	73.550	73.950	0.000		
211.	73.950	74.700	0.757		
212.	74.700	75.050	0.757	87.5L	
213.	75.050	75.150	0.000	87.5L	
214.	75.150	75.500	0.000		
215.	75.500	75.650	-0.757	1.5.58R	

216.	75.650	75.900	-0.757		
217.	75.900	76.100	-0.666		
218.	76.100	76.250	0.000		
219.	76.250	76.600	-0.666		
220.	76.600	76.800	0.000		
221.	76.800	76.900	0.666		
222.	76.900	77.250	-0.666		
223.	77.250	77.500	-0.666		
224.	77.500	77.750	-0.666		
225.	77.750	77.850	-0.666		
226.	77.850	78.300	0.000		
227.	78.300	79.200	0.781		
228.	78.300	79.900	0.000		
229.	79.900	80.000	0.000		
230.	80.000	80.300	0.000		
231.	80.300	82.200	1.000		
232.	82.200	82.800	1.000	798L	
233.	82.800	83.980	1.000		VASIND
234.	83.980	84.160	1.000	777L	(79.4 KM)
235.	84.160	84.475	1.000		
236.	84.475	84.800	1.000	700R	
237.	84.800	84.850	1.000		
238.	84.850	84.976	0.000		
239.	84.976	85.200	0.000	2.32.3L	
240.	85.200	85.316	-0.454		
240.	85.316	85.800	0.000		ASANGAON
240.	85.800	86.000	0.000		(8.5.4.3 KM)
242.	86.000	86.400	0.000	777L	
243.	86.400	86.972	1.000	777L	
244.	86.972	87.160	1.000		
245.	87.160	87.900	1.000	1588R	
246.	87.900	88.170	1.000		
247.	88.170	88.700	1.000	875R	
248.	88.700	88.830	1.000		
249.	88.830	89.663	1.000	800R	
250.	89.663	89.730	1.000		
251.	89.730	90.134	1.000	736R	
252.	90.134	90.900	1.000	58.3L	
253.	90.900	90.996	0.303		
254.	90.996	91.000	0.303	4.38R	
255.	91.000	91.100	0.303	4.38R	
256.	91.100	91.300	0.000	4.38R	
257.	91.300	91.550	0.303	4.38R	
258.	91.550	91.600	0.909	4.38R	
259.	91.600	91.734	0.909		
260.	91.734	92.260	0.909	825R	
261.	92.260	92.327	0.909		
262.	92.327	92.900	0.909	777L	
263.	92.900	93.250	0.308	777L	
264.	93.250	93.650	0.000	777L	
265.	93.650	94.453	0.757	777L	
266.	94.453	94.788	0.757		
267.	94.788	96.375	0.757	777R	ATGAON
268.	96.375	96.757	0.757		(94.87 KM)
269.	96.757	97.000	0.757	82.5L	
270.	97.000	97.313	-0.295	82.5L	
271.	97.313	97.380	-0.295		
272.	97.380	97.400	-0.295	1750R	

273.	97.400	97.550	0.000	1750R	
274.	97.550	98.277	1.000	1750R	
275.	98.277	99.747	1.000		
276.	99.749	100.400	1.000	2333L	
277.	100.400	100.551	0.800		
278.	100.551	100.950	0.800		
279.	100.950	101.100	0.800	3500L	THANSIT
280.	101.100	101.400	0.000		(101.00 KM)
281.	101.400	101.450	0.000		
282.	101.450	102.485	1.000		
283.	102.485	102.881	1.000	1588R	
284.	102.881	102.948	1.000		
285.	102.948	103.350	1.000	777R	
286.	103.350	103.750	0.909		
287.	103.750	103.925	0.000		
288.	103.925	104.190	0.000		
289.	104.190	104.550	-0.500		
290.	104.550	104.600	0.000		
291.	104.600	104.859	1.000	738L	
292.	104.859	104.926	1.000		
293.	104.926	105.328	1.000	738R	
294.	105.328	105.925	1.000		
295.	105.925	106.450	1.000	1666R	
296.	106.450	106.518	1.000		
297.	106.518	106.550	1.000	855L	
298.	106.550	106.750	0.117	855L	
299.	106.750	107.550	-1.111	855L	KHARDI
300.	107.550	107.658	-1.111	855L	(107.03 KM)
301.	107.658	107.956	-1.111		
302.	107.956	108.000	-1.111	673L	
303.	108.000	108.308	0.000		
304.	108.308	108.830	0.000	875L	
305.	108.830	109.300	0.000		
306.	109.300	109.360			
307.	109.360	109.831	1.000	673L	
308.	109.831	110.050	1.000		
309.	110.050	110.225	0.819	673R	
310.	110.225	110.310	0.819		
311.	110.310	110.696	0.819	1346R	
312.	110.696	111.037	0.819		
313.	111.037	111.347	0.819	833R	
314.	111.347	111.500	0.819		
315.	111.500	111.853	0.819	875R	
316.	111.853	112.279	0.819		
317.	112.279	112.900	0.819	833L	
318.	112.900	113.192	0.769		UMBERMAL
319.	113.192	113.706	0.769	875L	(113.16 KM)
320.	113.706	113.900	0.769		
321.	113.900	114.663	0.454	833R	
322.	114.663	115.077	0.4.54		
323.	115.077	115.856	0.4.54	761L	
324.	115.856	116.000	0.4.54		
325.	116.000	116.055	0.000		
326.	116.055	116.900	0.000	761R	
327.	116.900	117.300	-0.500		
328.	117.300	117.411	0.000		
329.	117.411	117.480	0.000		
330.	117.480	117.800	0.000		

331.	117.800	117.900	0.885	625L	
332.	117.900	118.290	0.109		
333.	118.290	119.582	0.109	795L	795R
334.	119.582	119.603	0.109		
335.	119.603	119.700	0.000	795R	
336.	119.700	119.965	0.000		
337.	119.965	120.197	0.000		
338.	120.197	120.250	0.000	1166R	
339.	120.250	120.421	0.000		
340.	120.421	120.802	0.000		
341.	120.802	120.943	0.000	1750L	
342.	120.943	119.700	0.000		
343.	119.700	119.965	0.000		
344.	119.965	120.197	0.000		
345.	120.197	120.250	0.000		
346.	120.250	120.421	0.000		
347.	120.421	120.802	0.000		KASARA
348.	120.802	120.943	0.000		(120.56 KM)

NOTE: For the UP line section the values of gradient and radius of curve are same as shown for the DN line.

CENTRAL RAILWAY
GRADIENT DETAILS OF SECTION KYN - KJT

SECTION ID	START KM	END KM	GRADIENT	STATUS	LENGTH
KYN	51.110	53.800	150	FALLING (-)	2690
KYN	53.800	54.700	4450	FALLING (-)	900
KYN	51.110	53.800	150	RAISING (+)	2690
KYN	53.800	54.700	4450	RAISING (+)	900
KYN - VLDI	54.700	54.800	200	FALLING (-)	100
KYN - VLDI	54.800	54.900	0	LEVEL	100
KYN - VLDI	54.700	54.800	200	RAISING (+)	100
KYN - VLDI	54.800	54.900	0	LEVEL	100
VLDI	55.740	56.040	330	RAISING (+)	300
VLDI	56.040	56.580	352	FALLING (-)	540
VLDI	55.740	56.040	330	FALLING (-)	300
VLDI	56.040	56.580	352	RAISING (+)	540
VLDI - ULNR	56.619	57.040	150	RAISING (+)	421
VLDI - ULNR	56.619	57.040	150	FALLING (-)	421
ULNR	57.040	57.540	400	RAISING (+)	500
ULNR	57.540	57.680	412	RAISING (+)	140
ULNR	57.743	58.193	660	FALLING (-)	450
ULNR	58.441	58.791	150	RAISING (+)	350
ULNR	57.040	57.540	400	FALLING (-)	500
ULNR	57.540	57.680	412	FALLING (-)	140
ULNR	57.743	58.193	660	RAISING (+)	450
ULNR	58.441	58.791	150	FALLING (-)	350
ABH	59.040	59.791	150	RAISING (+)	751
ABH	59.791	60.253	200	RAISING (+)	462
ABH	60.253	60.493	600	RAISING (+)	240
ABH	59.040	59.791	150	FALLING (-)	751
ABH	59.791	60.253	200	FALLING (-)	462
ABH	60.253	60.493	600	FALLING (-)	240
ABH - BUD	60.556	62.440	200	RAISING (+)	1884

ABH - BUD	62.844	63.504	150	RAISING (+)	660
ABH - BUD	64.189	64.539	200	FALLING (-)	350
ABH - BUD	64.376	66.189	150	FALLING (-)	1813
ABH - BUD	60.556	62.440	200	FALLING (-)	1884
ABH - BUD	62.844	63.504	150	FALLING (-)	660
ABH - BUD	64.189	64.539	200	RAISING (+)	350
ABH - BUD	64.376	66.189	150	RAISING (+)	1813
BUD	66.252	67.126	200	FALLING (-)	874
BUD	67.126	67.756	580	RAISING (+)	630
BUD	67.756	68.356	445	FALLING (-)	600
BUD	68.356	68.656	264	FALLING (-)	300
BUD	68.656	71.446	1380	FALLING (-)	2790
BUD	71.446	73.344	5641	RAISING (+)	1898
BUD	66.252	67.126	200	RAISING (+)	874
BUD	67.126	67.756	580	FALLING (-)	630
BUD	67.756	68.356	445	RAISING (+)	600
BUD	68.356	68.656	264	RAISING (+)	300
BUD	68.656	71.446	1380	RAISING (+)	2790
BUD	71.446	73.344	5641	FALLING (-)	1898
BUD - VGI	73.344	74.040	330	RAISING (+)	696
BUD - VGI	74.378	76.446	150	RAISING (+)	2068
BUD - VGI	73.344	74.040	330	FALLING (-)	696
BUD - VGI	74.378	76.446	150	FALLING (-)	2068
VGI	76.446	77.426	150	RAISING (+)	980
VGI	78.040	78.180	3980	FALLING (-)	140
VGI	78.180	79.675	2038	FALLING (-)	1495
VGI	79.675	80.225	150	FALLING (-)	550
VGI	76.446	77.426	150	FALLING (-)	980
VGI	78.040	78.180	3980	RAISING (+)	140
VGI	78.180	79.675	2038	RAISING (+)	1495
VGI	79.675	80.225	150	RAISING (+)	550
VGI - NRL	80.940	82.000	330	RAISING (+)	1060
VGI - NRL	82.835	83.315	200	FALLING (-)	480
VGI - NRL	83.315	83.665	200	RAISING (+)	350
VGI - NRL	83.665	84.295	264	RAISING (+)	630
VGI - NRL	84.295	84.775	120	RAISING (+)	480
VGI - NRL	80.940	82.000	330	FALLING (-)	1060
VGI - NRL	82.835	83.315	200	RAISING (+)	480
VGI - NRL	83.315	83.665	200	FALLING (-)	350
VGI - NRL	83.665	84.295	264	FALLING (-)	630
VGI - NRL	84.295	84.775	120	FALLING (-)	480
NRL	84.775	85.136	265	RAISING (+)	361
NRL	87.399	88.179	150	RAISING (+)	780
NRL	84.775	85.136	265	FALLING (-)	361
NRL	87.399	88.179	150	FALLING (-)	780
NRL - BVS	88.179	88.764	200	RAISING (+)	585
NRL - BVS	88.764	89.464	200	FALLING (-)	700
NRL - BVS	89.464	90.484	546	RAISING (+)	1020
NRL - BVS	90.484	91.204	200	FALLING (-)	720
NRL - BVS	88.179	88.764	200	FALLING (-)	585
NRL - BVS	88.764	89.464	200	RAISING (+)	700
NRL - BVS	89.464	90.484	546	FALLING (-)	1020
NRL - BVS	90.484	91.204	200	RAISING (+)	720
BVS	91.629	92.189	330	RAISING (+)	560
BVS	92.040	93.340	400	FALLING (-)	1300
BVS	91.629	92.189	330	FALLING (-)	560
BVS	92.040	93.340	400	RAISING (+)	1300

BVS - KJT	94.189	95.554	880	FALLING (-)	1365
BVS - KJT	97.252	98.252	400	RAISING (+)	1000
BVS - KJT	94.189	95.554	880	RAISING (+)	1365
BVS - KJT	97.252	98.252	400	FALLING (-)	1000
KJT	98.790	100.520	247	FALLING (-)	1730
KJT	100.520	100.820	109	FALLING (-)	300
KJT	98.790	100.520	247	RAISING (+)	1730
KJT	100.520	100.820	109	RAISING (+)	300
KJT - PDI	100.820	101.100	647	RAISING (+)	280
KJT - PDI	101.100	101.910	189	RAISING (+)	810
KJT - PDI	101.910	102.530	100	RAISING (+)	620
KJT - PDI	102.530	102.730	1950	FALLING (-)	200
KJT - PDI	102.730	102.940	0	LEVEL	210
KJT - PDI	100.820	101.100	647	FALLING (-)	280
KJT - PDI	101.100	101.910	189	FALLING (-)	810
KJT - PDI	101.910	102.530	100	FALLING (-)	620
KJT - PDI	102.530	102.730	1950	RAISING (+)	200
KJT - PDI	102.730	102.940	0	LEVEL	210

CENTRAL RAILWAY

CURVE DETAILS OF SECTION KYN - KJT

Line	Section	Start KM	End KM	Degree of Curve	Max. Permissible Speed (KMPH)
DN MAIN	KYN - VLDI	51.320	51.700	1.54º	95
DN MAIN	KYN - VLDI	51.730	51.740	1.25º	95
DN MAIN	KYN - VLDI	52.130	52.590	1.12º	65
DN MAIN	KYN - VLDI	52.590	52.740	1.0º	55
DN MAIN	KYN - VLDI	53.500	54.060	4.20º	40
DN MAIN	KYN - VLDI	54.060	55.170	0.5º	90
DN MAIN	KYN - VLDI	55.200	55.400	1.1º	
DN MAIN	KYN - VLDI	55.400	55.640	0.933º	
DN MAIN	VLDI - ULNR	56.040	56.240	1.58º	
DN MAIN	VLDI - ULNR	56.400	57.048	2.0º	
DN MAIN	VLDI - ULNR	57.142	57.426	1.82º	
DN MAIN	ULNR - ABH	57.474	58.284	1.62º	
DN MAIN	ULNR - ABH	58.474	59.091	1.69º	
DN MAIN	ULNR - ABH	59.136	59.227	1.21º	
DN MAIN	ULNR - ABH	59.227	59.409	1.33º	
DN MAIN	ULNR - ABH	59.545	59.636	0.665º	80
DN MAIN	ABH - BUD	60.042	60.208	7.77º	
DN MAIN	ABH - BUD	60.833	61.174	1.64º	
DN MAIN	ABH - BUD	62.192	62.423	2.13º	
DN MAIN	ABH - BUD	62.423	63.182	2.12º	
DN MAIN	ABH - BUD	63.273	63.636	2.046º	
DN MAIN	ABH - BUD	64.348	64.565	1.35º	
DN MAIN	ABH - BUD	64.609	65.087	1.27º	
DN MAIN	ABH - BUD	65.435	66.182	1.078º	90
DN MAIN	ABH - BUD	66.227	67.182	2.19º	
DN MAIN	BUD - VGI	67.409	68.455	2.26º	
DN MAIN	BUD - VGI	69.261	69.565	1.19º	
DN MAIN	BUD - VGI	70.522	71.130	0.805º	
DN MAIN	BUD - VGI	71.435	72.080	2.24º	
DN MAIN	BUD - VGI	72.120	72.800	2.43º	
DN MAIN	BUD - VGI	73.308	74.182	1.24º	
DN MAIN	BUD - VGI	74.273	75.125	1.63º	
DN MAIN	BUD - VGI	75.250	75.667	1.68º	
DN MAIN	BUD - VGI	76.167	76.417	0.985º	
DN MAIN	BUD - VGI	77.200	77.400	1.2º	
DN MAIN	BUD - VGI	77.400	77.680	0.879º	
DN MAIN	VGI - SHLU	78.083	78.500	0.532º	
DN MAIN	VGI - SHLU	78.568	79.130	1.37º	
DN MAIN	VGI - SHLU	79.130	79.696	2.40º	
DN MAIN	VGI - SHLU	79.769	80.174	0.985º	
DN MAIN	VGI - SHLU	81.125	81.458	1.14º	

DN MAIN	VGI - SHLU	81.625	82.333	1.16º	
DN MAIN	SHLU - NRL	82.333	82.500	2.19º	
DN MAIN	SHLU - NRL	83.478	84.042	0.866º	
DN MAIN	NRL - BVS	86.417	87.435	2.02º	
DN MAIN	NRL - BVS	87.478	88.250	2.08º	
DN MAIN	NRL - BVS	88.417	89.261	0.603º	
DN MAIN	NRL - BVS	92.478	92.565	0.59º	90
DN MAIN	BVS - KJT	92.652	93.000	0.54º	90
DN MAIN	BVS - KJT	94.375	95.333	0.725º	90
DN MAIN	BVS - KJT	97.585	98.250	1.37º	90
DN MAIN	BVS - KJT	98.250	99.261	1.37º	90
DN MAIN	BVS - KJT	100.261	100.478	0.5º	80
UP MAIN	KYN - VLDI	51.380	51.700	1.40º	85
UP MAIN	KYN - VLDI	52.130	52.600	1.20º	65
UP MAIN	KYN - VLDI	52.600	53.016	1.12º	65
UP MAIN	KYN - VLDI	53.545	54.250	3.81º	60
UP MAIN	KYN - VLDI	54.360	55.105	0.94º	85
UP MAIN	VLDI - ULNR	55.291	55.916	0.735º	
UP MAIN	VLDI - ULNR	57.038	56.231	1.43º	
UP MAIN	VLDI - ULNR	56.423	57.077	2.01º	
UP MAIN	VLDI - ULNR	57.115	57.385	1.67º	
UP MAIN	ULNR - ABH	57.385	58.193	2.49º	
UP MAIN	ULNR - ABH	58.385	59.038	1.57º	90
UP MAIN	ABH - BUD	59.539	60.231	1.61º	
UP MAIN	ABH - BUD	60.640	61.200	1.60º	
UP MAIN	ABH - BUD	62.154	62.385	2.11º	
UP MAIN	ABH - BUD	62.424	63.154	2.12º	
UP MAIN	ABH - BUD	63.217	63.652	2.59º	
UP MAIN	ABH - BUD	64.318	64.591	1.22º	

UP MAIN	ABH - BUD	64.591	65.125	1.29º	
UP MAIN	ABH - BUD	65.417	66.208	1.06º	90
UP MAIN	ABH - BUD	66.208	67.228	2.19º	75
UP MAIN	BUD - VGI	67.364	68.500	2.22º	
UP MAIN	BUD - VGI	69.228	69.590	0.906º	
UP MAIN	BUD - VGI	70.500	71.167	0.837º	
UP MAIN	BUD - VGI	71.417	72.087	2.5º	
UP MAIN	BUD - VGI	72.087	72.174	2.17º	
UP MAIN	BUD - VGI	73.375	72.174	1.13º	
UP MAIN	BUD - VGI	74.261	75.120	1.03º	
UP MAIN	BUD - VGI	75.160	75.640	1.48º	
UP MAIN	BUD - VGI	76.160	76.400	0.987º	
UP MAIN	BUD - VGI	76.440	77.200	1.03º	
UP MAIN	VGI - SHLU	78.200	78.520	1.21º	
UP MAIN	VGI - SHLU	78.560	79.115	1.68º	
UP MAIN	VGI - SHLU	79.115	79.692	1.79º	
UP MAIN	VGI - SHLU	79.692	80.174	1.11º	
UP MAIN	VGI - SHLU	81.136	81.545	1.07º	
UP MAIN	SHLU - NRL	82.000	82.364	1.10º	
UP MAIN	SHLU - NRL	82.364	82.545	1.77º	
UP MAIN	SHLU - NRL	83.591	84.132	1.07º	
UP MAIN	NRL - BVS	86.542	87.037	2.25º	
UP MAIN	NRL - BVS	87.259	88.000	2.25º	
UP MAIN	NRL - BVS	88.269	89.286	0.68º	
UP MAIN	NRL - BVS	92.458	92.591	0.40º	90
UP MAIN	BVS - KJT	92.667	93.208	0.40º	90
UP MAIN	BVS - KJT	94.375	95.250	0.65º	90
UP MAIN	BVS - KJT	97.583	98.217	1.15º	90
UP MAIN	BVS - KJT	98.218	99.304	1.15º	90
UP MAIN	BVS - KJT	100.379	100.522	0.5º	80

PERMANENT SPEED RESTRICTION OF CENTRAL RAILWAY:

PERMANENT SPEED RESTRICTIONS OF SUBURBAN SECTION

1. The following restrictions in the speed of train to be observed.
2. Cancellation, addition and alteration in the permanent speed restrictions will be notified in the Railway Gazette from time to time by the Chief Operations Manager.

PERMANENT SPEED RESTRICTIONS AND BRIEF REASONS FOR THEM

Station / Bridge or between Stations	Between Kilometers	Speed Rest. in KMPH	Reasons	Loss of time in Mts/Sec.	Date of Imposition
DOWN LOCAL LINE (CSTM - KYN)					
CST Yard	WBS 9+47 to WAM 23+67	30	Due to curvature & insufficent cant due to turn outs	00.20	29-09-99
CST Yard	WAM 23+67 to WHT 29+63	40	- do -	00.20	16-07-93
CST - SNRD	ES 1/2 to ES 1/20	60	Inadequate track centres in curvatures	00.15	22-03-10
SNRD - BY	KM 3/8 to 3/23	80	Due to in adequate cant	00.10	29-12-94
CRD - PR	KM 7/9 to 7/13	65	Approach to Diamond on curve	00.30	15-04-49
PR - DR	KM 8/07 to 8/08	30	DN LL to DR PF 1 Only.	01.00	
DR - MTN	KM 8/23 to 9/01	30	DR PF 1 to DN LL	01.00	
SION - CLA	KM 15/01 to 15/04	30	DN LL to CLA PF 1 Only.	01.00	
MLND - TNA	KM 32/12 to 32/15	65	Approach to Diamond on curve	00.30	01-03-85
MLND - TNA	KM 32/18 to 32/20	30	1 in 12 T/out for TNA PF 3.	01.00	19-07-07
TNA - DIVA	KM 36/15 to 41/3	100	Due to curvature		01-04-72
DIVA - DI	KM 47/12 to 47/14 for DI PF 1	30	Due to in adequate isolation, Imposed by CRS	01.00	01-07-94
DI - THK	KM 47/12 to 47/14 for DI PF 1	25	For DI PF 1 exit, Imposed by CRS	01.00	01-07-94
DI - THK	KM 48/5 to 48/8 ex. DI PF 2	50	- do -	00.30	01-07-94
THK - KYN	KM 51/5 to 51/13	90	Due to curvature	00.20	01-04-42
THK - KYN	KM 52/7 to 52/13	55	Due to Diamond on curve	01.00	01-04-42

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Station / Bridge or between Stations	Between Kilometers	Speed Rest. in KMPH	Reasons	Loss of time in Mts/Sec.	Date of Imposition
UP LOCAL LINE (KYN - CSTM)					
KYN - THK	KM 52/13 to 52/7	65	Due to Diamond on curve	00.30	
KYN - THK	KM 51/13 to 51/4	65	- do -	00.30	
DIVA - TNA	KM 41/9 to 36/15	100	Due to curvature		01-04-43
KLVA - TNA	KM 33/11 to 33/08	30	Due to T/out for UP LL to TNA PF 4	00.30	
TNA - MLND	KM 30/15 to 30/12	65	- do -	00.30	01-04-42
VK Station	KM 22/11 to 22/6	65	- do -	00.20	01-04-42
GC - CLA	KM 18/5 to 18/2	65	- do -	00.20	01-04-42
MTN Station	KM 10/13 to 09/26	65	- do -	00.20	01-04-42
SNRD - CST	ES 1/20 to ES 1/2	60	Inadequate track centres in curvatures	00.20	22-03-10
CST Yard	KM 00/01 to SPL 'L' POR-6	30	Due to curvature & less track centres between UP & DN LOCAL LINE.	01.00	29-09-99
CST Yard	WHT 20+82 to WBS 9+47	30	Sharp curve with inadequate cant due to T/outs	00.50	29-09-99
DOWN THROUGH LINE (CSTM - KYN)					
CST west Yard to DN lines.	WBS 11+ 22 to WHT 17+86	35	Due to curvature & inadequate cant on T/out	00.30	31-03-04
CST East Yard	EBS 10 + 35 to 0/1	30	- do -	00.30	29-09-99
CST Yard	WAM 23+67 to 0/1	40	Due to curvature.	00.30	16-07-93
CST - MSD	WPO 20+82 to WAM 23+67	35	Due to sharp curvature & inadequate cant on T/out	00.30	31-03-04
CST - MSD	KM 0/1 to 1/4	30	- do -	00.30	29-09-99

Station / Bridge or between Stations	Between Kilometers	Speed Rest. in KMPH	Reasons	Loss of time in Mts/Sec.	Date of Imposition
CST - SNRD	ES 1/2 to ES 1/20	60	Inadequate track centres in curvatures		22-03-10
CST - SNRD	KM 1/4 to 1/15	70	Curve with inadequate cant	00.30	31-12-46
SNRD - BY	KM 2/14 to 2/16	60	Due to curvature & inadequate cant on T/out	01.00	28-04-89
SNRD - BY	KM 3/14 to 3/19	65	Curve with inadequate cant due to T/out	01.00	10-03-47
CRD - PR	KM 6/1 to 6/3	70	For AC DC EMU only, Less clearance under CRD ROB.	00.20	02-03-07
CRD - PR	KM 7/4 to 7/10	80	Curve with inadequate cant due to T/out	00.10	05-03-45
DR - MTN	DR PF No. 5 to DN Through Bet Signal S/48 & S/23	25	Only for Mail/Exp as per CRS recommendation.	01.00	09-06-94
CLA - GC	KM 17/15 to 18/4	65	Approach to Diamond on curve	00.40	01-04-42
GC - VK	KM 22/6 ES to 22/12 ES	65	- do -	00.40	01-04-42
TNA - DIVA	KM 33/1 to 33/13	80	Inadequate cant due to revers curve.	00.20	09-04-95
KYN PF No. 4	KM 52/15 to 53/9	30	Washable Appron	01.00	16-01-02
UP THROUGH LINE (KYN - CSTM)					
KYN PF No. 4	KM 53/9 to 52/15	30	Washable Appron	01.00	16-01-02
KYN PF No. 5	KM 53/16 to 53/10	30	- do -	01.00	18-12-82
DIVA - TNA	KM 33/13 to 33/2	80	Curve without cant due to T/out.	00.40	09-04-94
MTN - DR	KM 10/3 to 9/24	60	Reverse curve with inadequate straight in between	00.30	05-12-2005

Station / Bridge or between Stations	Between Kilometers	Speed Rest. in KMPH	Reasons	Loss of time in Mts.	Date of Imposition
PR - CRD	KM 7/11 to 7/4	80	Curve with insufficient cant due to T/out	00.20	04-04-88
PR - CRD	KM 6/3 to 6/1	70	For AC DC EMU only, Less clearance under CRD ROB.	00.20	02-03-07
CHG - BY	KM 4/10 to 4/6	65	Approach to Diamond on curve	00.30	05-03-45
BY - SNRD	KM 3/18 to 3/11	65	Curve with inadequate cant due to T/out	00.40	01-04-61
BY - SNRD	KM 2/18 to 2/16	50	- do -	00.40	19-02-47
SNRD - MSD	KM 1/17 to 1/5	65	- do -	00.30	29-09-99
SNRD - CST	ES 1/20 to ES 1/2	60	Inadequate track centres in curvatures	00.20	22-03-10
MSD - CST	KM 1/3 to 0/5	30	Due to sharp curve for M/Exp trains	00.30	31-12-46
MSD - CST	KM 0/1 to WAM 23+67	40	Due to curve with inadequate cant	00.30	16-07-96
CST East Yard	KM 0/1 to EBS 10+35	30	Due to curvature & inadequate cant due to turn outs	01.00	16-07-98
CST West Yard	WAM 23+67 to WPO 20+82	30	- do -	01.00	20-09-99
DOWN SOUTH EAST LINE (KYN - PDI)					
KYN - VLDI	KM 53/16 to 53/23	40	Due to inadequate cant and diamond on curve	00.40	01-04-45
ABH Stn	KM 59/13 to 60/4	95	Due to insufficient cant due to T/out	00.05	03-02-04
BUD STN Yard	KM 66/34 to 67/6	90	Inadequate cant on contra flexture T/out on 2^0 curves	00.05	01-07-73
BUD STN	KM 67/18 to 67/46	85	- do -	00.10	03-02-04
KJT - PDI	KM 98/12 to 102/20	80	Semi Ghat section & T/Out on 2^0 Curve	00.40	01-04-68

UP SOUTH EAST LINE (PDI - KYN)

Station / Bridge or between Stations	Between Kilometers	Speed Rest. in KMPH	Reasons	Loss of time in Mts/Sec.	Date of Imposition
PDI - KJT	KM 102/20 to 98/12	80	Inadequate cant on contra flexture T/out on 3^0 curves	00.30	01-04-68
BUD STN	KM 67/21 to 67/15	85	Inadequate cant on contra flexture T/out	00.10	03-02-04
BUD STN	KM 66/23 to 66/20	90	Inadequate cant on contra flexture T/out on 2.3^0 curves	00.05	
BRANCH LINE (PDI - KHPI - PDI)					
KJT - KHPI	KM 102/20 to 114/00	60	Modified non-interlock stn.Facing point 15 Kmph	02.00	
LWJ - KHPI	KM 113/12 to 113/16	30	Sharp reverse curve	00.30	24-09-00
DOWN NORTH EAST LINE (KYN - KSRA)					
KYN - SHD	KM 54/9 to 54/13	90	Due to curvature	00.10	01-04-68
ABY - TLA	KM 63/19 to 63/23	105	Due to sharp curve		01-08-97
ABY - KDV	KM 63/28 to 64/25	85	- do -	00.10	
KDV STN	KM 71/1 to 71/10	90	Inadequate cant on curve due to T/out	00.10	
VSD - ASO	KM 79/26 to 80/1	80	Inadequate cant on curve due to T/out	00.30	14-03-03
ASO - ATG	KM 89/18 to 90/26	80	- do -	00.30	01-04-42
ASO - ATG	KM 90/26 to 91/16	80	Due to sharp curve	00.30	14-03-03
ATG Yard	KM 95/14 to 95/19	85	Inadequate cant on contra flexture T/out	00.20	24-04-00
THS - KE	KM 102/15 to 103/25	105	Due to sharp curve		

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Station / Bridge or between Stations	Between Kilometers	Speed Rest. in KMPH	Reasons	Loss of time in Mts/Sec.	Date of Imposition
UP NORTH EAST LINE (KSRA - KYN)					
KSRA - OMB	KM 120/21 to 120/17	75	Due to sharp curve	00.15	
KSRA - OMB	KM 119/14 to 119/11	75	Due to inadequate cant on curve due to T/out	00.15	01-10-83
OMB - KE	KM 110/24 to 110/15	100	Due to sharp curve		
KE - ATG	KM 107/17 to 106/8	80	- do -	00.10	
THS - ATG	KM 95/17 95/14	80	Due to inadequate cant on curve due to T/out	00.10	01-04-42
ATG - ASO	KM 91/6 to 91/1	85	Due to sharp curve	00.10	01-04-42
ATG - ASO	KM 90/4 to 89/18	100	Due to sharp curve		
ASO - VSD	KM 80/1 to 79/26	75	Due to sharp curve	00.15	
VSD - KDV	KM 78/11 to 77/17	100	Due to sharp curve		
KDV STN	KM 71/16 to 71/4	85	- do -	00.10	01-04-42
KDV - TLA	KM 64/14 to 64/6	90	Curve with inadequate cant due to cross overs	00.05	01-04-42
TLA - ABY	KM 63/1 to 62/12	85	Due to sharp curve	00.10	14-03-03
SHD - KYN	KM 54/16 to 54/4	60	Diamond on curve	00.20	24-04-00

WESTERN RAILWAY

SECTION – CHURCHGATE TO ANDHERI

DN LINE

Sr. No.	Location (In Km) From	To	Gradient %	Curve	Station. Name
1.	0.000	0.360	-	700L	Churchgate
2.	0.360	0.860	-	175R	(0.00)
3.	0.860	1.225	-	875R	-
4.	1.225	1.925	+0.0714	1750R	Marine Lines (1.30)
5.	1.925	2.350	-	1750R	Charni Road (2.21)
6.	2.350	2.650	0.1	486L	-
7.	2.650	3.250	-0.2857	583L	-
8.	3.250	3.350	+0.1972	583L	-
9.	3.350	3.500	-	1166L	-
10.	3.500	3.600	-	1458L	Grant Road (3.59)
11.	3.600	3.800	-	1166L	-
12.	3.800	4.450	-0.075	-	-
13.	4.450	4.850	+0.1522	700L	Mumbai Central (4.48)
14.	4.850	5.100	-0.048	-	-
15.	5.100	5.250	-	585L	-
16.	5.250	5.550	-0.187	583R	-
17.	5.550	5.950	-0.072	583L	Mahalaxmi (5.95)
18.	5.950	6.250	+0.092	583R	-
19.	6.250	6.650	-	-	-
20.	6.650	6.750	+0.055	-	-
21.	6.750	7.150	-	-	-
22.	7.150	7.500	-0.167	857R	-
23.	7.500	7.600	-0.219	777L	-

WESTERN RAILWAY

SECTION – CHURCHGATE TO ANDHERI

DN LINE

Sr. No.	Location (In Km) From	To	Gradient %	Curve	Station. Name
24.	7.600	7.900	+0.0467	679R	Lower Parel (6.67)
25.	7.900	8.050	+0.0733	1750R	-
26.	8.050	8.225	+0.057	1750R	-
27.	8.225	8.275	+0.028	-	-
28.	8.275	9.000	-0.098	1167L	Elphinstone Road (8.98)
29.	9.000	9.100	+0.075	1750L	-
30.	9.100	9.700	-	1358L	-
31.	9.700	9.900	+0.299	-	-
32.	9.900	10.175	-0.172	1167R	Dadar (10.17)
33.	10.175	10.500	-0.046	1750R	-
34.	10.500	11.000	-0.46	1167R	-
35.	11.000	11.200	+0.073	1167R	-
36.	11.200	11.700	-0.046	1346R	-
37.	11.700	12.300	-	1306R	Matunga Road (11.75)
38.	12.300	12.750	+0.0844	-	-
39.	12.750	12.950	-0.09	-	Mahim (12.93)
40.	12.950	13.150	+0.11	-	-
41.	13.150	13.300	+0.28	-	-
42.	13.300	13.825	+0.04	-	-
43.	13.825	14.375	+0.109	-	-
44.	14.375	14.725	-0.157	2187L	Bandra (14.66)
45.	14.725	14.975	-0.123	1167L	-
46.	14.975	15.000	-0.311	1167L	-

WESTERN RAILWAY

SECTION – CHURCHGATE TO ANDHERI

DN LINE

Sr. No.	Location (In Km) From	To	Gradient %	Curve	Station. Name
47.	15.000	15.400	-	1167L	-
48.	15.400	16.000	+0.114	1167L	-
49.	16.000	16.400	+0.429	1760L	Khar Road (16.29)
50.	16.400	16.600	+0.144	1093L	-
51.	16.600	17.250	+0.385	-	-
52.	17.250	17.500	-0.0238	1750R	-
53.	17.500	17.800	-0.0238	875L	Santacruz (17.61)
54.	17.800	18.050	-0.0238	1167R	-
55.	18.050	18.700	-	-	-
56.	18.700	19.350	+0.145	-	-
57.	19.350	19.500	+0.145	1750R	-
58.	19.500	20.050	+0.08	1167L	Vile Parle (19.67)
59.	20.050	20.500	+0.08	1760R	-
60.	20.500	21.000	+0.064	-	-
61.	21.000	21.550	+0.132	-	-
62.	21.550	21.880	+0.088	-	Andheri (21.83)

WESTERN RAILWAY

GRADIENT DETAILS OF ANDHERI - VIRAR SECTION:

Sr. No.	Block Section	Location		Direction	Existing Gradient	Station Name
		KMF	KMT			
1.	VLP-ADH	22.188	22.250	Rising	1 in 284	
2.	VLP-ADH	22.250	22.313	Rising	1 in 1667	
3.	VLP-ADH	22.313	22.438	Rising	1 in 500	
4.	VLP-ADH	22.438	22.563	Rising	1 in 4000	
5.	ADH-JOS	22.563	22.938	Level	Level	
6.	ADH-JOS	22.938	23.375	Rising	1 in 500	
7.	ADH-GMN	23.375	24.563	Fall	1 in 500	Jogeshwari
8.	JOS-GMN	24.563	25.250	Level	Level	23.52 Km
9.	JOS-GMN	25.250	25.375	Fall	1 in 800	
10.	JOS-GMN	25.375	25.938	Level	Level	
11.	JOS-GMN	25.938	26.250	Fall	1 in 750	
12.	JOS-GMN	26.250	27.125	Level	Level	Goregaon
13.	GMN-MDD	27.125	27.688	Fall	1 in 300	26.90Km
14.	GMN-MDD	27.688	27.938	Fall	1 in 500	
15.	GMN-MDD	27.938	28.563	Level	Level	
16.	GMN-MDD	28.563	28.938	Rising	1 in 800	
17.	GMN-MDD	28.938	29.563	Level	Level	Malad
18.	MDD-KILE	29.563	30.063	Rising	1 in 3000	29.32Km
19.	MDD-KILE	30.063	30.938	Level	Level	
20.	KILE-BVI	30.938	31.750	Fall	1 in 800	Kandivli
21.	KILE-BVI	31.750	32.313	Level	Level	31.22Km
22.	KILE-BVI	32.313	32.063	Fall	1 in 1000	
23.	KILE-BVI	32.063	33.750	Rising	1 in 2000	Borivali
24.	KILE-BVI	33.750	34.188	Level	Level	33.98 Km
25.	KILE-BVI	34.188	34.938	Fall	1 in 767	
26.	BVI-DIC	34.938	35.375	Fall	1 in 327	
27.	BVI-DIC	35.375	35.875	Fall	1 in 515	
28.	BVI-DIC	35.875	36.563	Fall	1 in 275	Dahisar
29.	DIC-MIRA	36.563	37.063	Fall	1 in 500	36.34 Km
30.	DIC-MIRA	37.063	37.875	Fall	1 in 370	
31.	DIC-MIRA	37.875	38.438	Fall	1 in 660	
32.	DIC-MIRA	38.438	38.063	Level	Level	
33.	DIC-MIRA	38.063	38.813	Rising	1 in 460	
34.	DIC-MIRA	38.813	39.000	Level	Level	
35.	DIC-MIRA	39.000	39.375	Fall	1 in 300	
36.	DIC-MIRA	39.375	39.563	Fall	1 in 1300	Mira Road
37.	DIC-MIRA	39.563	40.688	Level	Level	39.76Km
38.	MIRA-BYR	40.688	41.250	Rising	1 in 1440	
39.	MIRA-BYR	41.250	41.813	Level	Level	
40.	MIRA-BYR	41.813	42.313	Fall	1 in 3393	
41.	MIRA-BYR	42.313	43.063	Rising	1 in 1225	
42.	BYR-NIG	43.063	43.375	Rising	1 in 2400	Bhayandar
43.	BYR-NIG	43.375	43.875	Rising	1 in 217	43.11Km
44.	BYR-NIG	43.875	45.313	Level	Level	
45.	BYR-NIG	45.313	45.563	Fall	1 in 350	
46.	BYR-NIG	45.563	45.688	Level	Level	
47.	BYR-NIG	45.688	46.125	Rising	1 in 350	
48.	BYR-NIG	46.125	46.625	Level	Level	

49.	BYR-NIG	46.625	46.938	Fall	1 in 210	
50.	BYR-NIG	46.938	47.375	Fall	1 in 381	
51.	NIG-BSR	47.375	48.438	Fall	1 in 2056	Naigaon
52.	NIG-BSR	48.438	50.438	Rising	1 in 4204	47.79Km
53.	NIG-BSR	50.438	51.875	Fall	1 in 5000	Vasai Road
54.	BSR-NSP	51.875	52.438	Rising	1 in 1800	51.78Km
55.	BSR-NSP	52.438	52.625	Fall	1 in 1720	
56.	BSR-NSP	52.625	53.063	Rising	1 in 2000	
57.	BSR-NSP	53.063	53.438	Rising	1 in 400	
58.	BSR-NSP	53.438	54.000	Fall	1 in 443	
59.	BSR-NSP	54.000	54.313	Level	Level	
60.	BSR-NSP	54.313	55.000	Rising	1 in 1830	Nalla Sopara
61.	BSR-NSP	55.000	56.375	Rising	1 in 2000	55.85Km
62.	NSP-VR	56.375	58.188	Level	Level	
63.	NSP-VR	58.188	59.250	Rising	1 in 640	
64.	NSP-VR	59.250	59.438	Rising	1 in 1000	
65.	NSP-VR	59.438	60.313	Rising	1 in 2300	Virar
66.	VR-VTN	60.313	60.688	Fall	1 in 1300	59.98Km

WESTERN RAILWAY

CURVE DETAILS OF ANDHERI-VIRAR SECTION

Sr. No.	Station between	Kilometers	Total Length (mtrs.)	Radius (mtrs.)
UP LINE				
1.	VLP-ADH	21/16 to 22/1	160	3125
2.	ADH-JOS	22/4 to 22/6	100	1000
3.	JOS-GMN	24/7 to 25/7	1040	5303
4.	GMN-MDD	28/7-29/12	1200	4375
5.	MDD-KILE	30/12-13	130	1167
6.	MDD-KILE	30/14-31/1	130	1167
7.	KILE-BVI	31/5-8	150	1750
8.	KILE-BVI	31/8-10	150	1750
9.	KILE-BVI	32/10- 32/13-14	190	1434
10.	KILE-BVI	32/13-33/1-2	170	1434
11.	KILE-BVI	33/8-10	120	500
12.	BVI-DIC	34/4 -34/7-8	130	1094
13.	BVI-DIC	34/8- 10B	120	1241
14.	BVI-DIC	35/2- 36/11	1600	5645
15.	MIRA-BYR	41/9-11	150	1750
16.	MIRA-BYR	41/17-18A	160	1750
17.	MIRA-BYR	42/9-12	200	1750
18.	MIRA-BYR	42/13-16	200	1750
19.	BYR-NIG	43/2-9	470	1750
20.	BYR-NIG	43/10-15	330	875
21.	BYR- NIG	43/2-9	430	1750
22.	BYR- NIG	43/10-15	250	875
23.	BYR-NIG	46/13-47/4	570	1167
24.	NIG-BSR	47/14-17	160	1167
25.	NIG-BYR	50/14-50/17	110	1167
26.	NIG-BYR	50/17-51/2	110	1167
27.	BSR-NSP	51/10-51/14	120	1750
28.	BSR-NSP	51/14-52/1	130	1750
29.	BSR-NSP	53/11-55/2	1410	4375
DN LINE				
1.	ADH-JOS	23/6 to 23/10	100	1167
2.	ADH-JOS		100	1167
3.	JOS-GMN	23/13 to 24/1	100	1167
4.	JOS-GMN		100	1167
5.	JOS-GMN	24/7 to 25/7	1040	5303
6.	GMN-KILE	28/7-29/12	1200	4375
7.	MDD-KILE	30/10-13	130	1167
8.	MDD-KILE	30/13-31/1	130	1167
9.	KILE-BVI	31/5-8	150	1750
10.	KILE-BVI	31/8-10	150	1750
11.	BVI-DIC	34/5-8	120	1190
12.	BVI-DIC	35/2-36/11	1620	5000
13.	MIRA-BYR	41/6-9	160	1750
14.	MIRA-BYR	41/9-11	160	1750
15.	MIRA-BYR	42/9-12	160	2200

16.	MIRA-BYR	42/12-16	170	2200
17.	MIRA-BYR	43/2-7	250	700
18.	BYR- NIG	43/7-9	260	875
19.	BYR- NIG	43/10-15	300	875
20.	BYR- NIG	43/2-7	190	700
21.	BYR- NIG	43/7-10	180	875
22.	BYR- NIG	43/10-15	260	875
23.	BYR-NIG	46/13-47/4	570	1167
24.	NIG-BSR	47/14-17	160	1167
25.	NIG-BYR	50/12-14	170	875
26.	NIG-BYR	50/14-51/1	120	1434
27.	NIG-BSR	51/10-51/39A	80	3500
28.	NIG-BSR	51/39A-51/45	80	2756
29.	BSR-NSP	53/11-55/2	1410	4375

NOTE: For the UP line section the values of gradient and radius of curve are same as shown for the DN line.

WESTERN RAILWAY

SECTION – ANDHERI TO CHURCHGATE

UP LINE

Sr. No.	Location (In Km) From	To	Gradient %	Curve	Station. Name
1.	21.800	21.550	0.088	-	Andheri (21.83)
2.	21.550	21.350	-0.132	-	-
3.	21.350	21.000	-0.132	-	-
4.	21.000	20.750	-0.064	1750L	-
5.	20.750	20.500	-0.064	1157R	-
6.	20.500	20.050	-0.08	-	-
7.	20.050	19.500	-0.08	-	Vile Parle (19.67)
8.	19.500	19.350	-0.145	-	-
9.	19.350	18.700	-0.145	-	-
10.	18.700	18.050	-	-	-
11.	18.050	17.800	+0.0238	-	-
12.	17.800	17.500	+0.0238	-	Santacruz (17.61)
13.	17.500	17.250	+0.238	-	-
14.	17.250	16.600	-0.385	-	-
15.	16.600	16.400	-0.144	-	-

WESTERN RAILWAY

SECTION – ANDHERI TO CHURCHGATE

UP LINE

Sr. No.	Location (In Km) From	To	Gradient %	Curve	Station. Name
16.	16.400	16.000	-0.429	-	Khar Road (16.29)
17.	16.000	15.725	-0.114	-	-
18.	15.725	15.400	-0.114	-	-
19.	15.400	15.000	-	1750R	-
20.	15.000	14.975	-0.311	1364R	-
21.	14.975	14.725	-0.123	1364R	-
22.	14.725	14.500	+0.157	875R	Bandra (14.66)
23.	14.500	14.375	+0.157	-	-
24.	14.375	13.875	-0.109	-	-
25.	13.875	13.300	-0.04	-	-
26.	13.300	13.150	-0.28	-	-
27.	13.150	12.950	-0.11	-	-
28.	12.950	12.750	+0.09	-	Mahim (12.93)
29.	12.750	12.303	-0.0844	1750L	-
30.	12.303	11.700	-	1750L	Matunga Road (11.75)
31.	11.700	11.200	+0.046	1166L	-
32.	11.200	11.000	-0.076	-	-
33.	11.000	10.700	+0.046	1166L	-
34.	10.700	10.500	+0.046	-	-
35.	10.500	10.150	+0.046	1166L	Dadar (10.17)
36.	10.150	9.900	-0.172	875L	-

WESTERN RAILWAY

SECTION – ANDHERI TO CHURCHGATE

UP LINE

Sr. No.	Location (In Km) From	To	Gradient %	Curve	Station. Name
37.	9.900	9.700	-0.299	-	-
38.	9.700	9.350	-	-	-
39.	9.350	9.100	-	583L	-
40.	9.100	9.000	-0.057	700L	Elphistone Road (8.98)
41.	9.000	8.900	+0.098	-	-
42.	8.900	8.725	+0.098	583L	-
43.	8.725	8.225	-0.028	1750L	-
44.	8.225	8.050	-0.057	1750L	-
45.	8.050	7.900	+0.0733	-	-
46.	7.900	7.600	-0.0467	-	-
47.	7.600	7.500	-0.167	-	-
48.	7.500	7.150	-0.167	-	-
49.	7.150	6.950	-	-	-
50.	6.950	6.650	-0.055	-	Lower Parel (6.67)
51.	6.650	6.250	-	-	-
52.	6.250	5.950	-0.092	700L	Mahalaxmi (5.95)
53.	5.920	5.550	+0.072	700L	-
54.	5.550	5.250	+0.187	-	-
55.	5.250	5.100	-	583R	-
56.	5.100	4.850	-0.048	-	-
57.	4.850	4.450	-0.1522	500R	Mumbai Central

WESTERN RAILWAY

SECTION – ANDHERI TO CHURCHGATE

UP LINE

Sr. No.	Location (In Km) From	To	Gradient %	Curve	Station. Name
58.	4.450	4.220	+0.0754	-	-
59.	4.220	3.800	+0.0754	486L	-
60.	3.800	3.600	-	-	-
61.	3.600	3.500	-	1485R	Grant Road (3.59)
62.	3.500	3.350	-	875R	-
63.	3.350	3.250	-0.1972	583R	-
64.	3.250	2.650	+0.2857	583R	-
65.	2.650	2.350	+0.100	486R	-
66.	2.350	1.925	-	1750L	Charni Road (2.4)
67.	1.925	1.225	-0.0714	1750L	Marine Lines (1.30)
68.	1.225	0.860	-	875L	-
69.	0.860	0.360	-	1750L	-
70.	0.360	0.150	-	100L	-
71.	0.150	0.000	-	-	Churchgate (0.000)

PERMANENT SPEED RESTRICTION OF WESTERN RAILWAY:

PERMANENT SPEED RESTICTIONS ON SUBURBAN SECTION

Section or Station	Kilometers	Restricted Speed in Kmph.	Brief Reasons
DOWN LOCAL			
CHURCHGATE	0/5 To 0/8	20 Kmph	Due to subway at North end
CHURCHGATE-MARINE LINES	0/0 To 1/5	40 Kmph	Due to inadequate SE & Points taking off from curve of 2.5 degree
CHARNI ROAD-GRANT ROAD	2/6 To 3/7	75 Kmph	Due to inadequate super elevation in curve of 3.6 degree
GRANT ROAD-MUMBAI CENTRAL	4/4 To 4/12	75 Kmph	Due to inadequate super elevation in curve of 3.6 degree
MUMBAI CENTRAL-MAHALAXMI	5/18 To 6/1	40 Kmph	Main Line on turn out side.
MAHALXMI-LOWER PAREL	6/1 To 7/12	75 Kmph	Due to inadequate super elevation in curve of 3 degree
LOWER PAREL-ELPHINSTONE ROAD	7/12 To 8/3	30 Kmph	Main Line on turn out side.
ELPHINSTONE ROAD -DADAR	8/3 To 9/6	75 Kmph	Due to inadequate super elevation.
BANDRA-KHAR (Main Line)	15/6 To 15/10	50 Kmph	Due to inadequate super elevation & point taking off from transition length.
JOGESHWARI-GOREGAON	25/1 To 26/1	80 Kmph	Due to reverse curve & inadequate SE.
MIRA ROAD – NAIGAON	43/2 To 46/10	80 Kmph	Due to Cracks in the PSC girders
NAIGAON - VASAI ROAD	50/14 To 51/12	80 Kmph	Due to inadequate SE & Pts. taking off from transition length.
DOWN LOCAL: (INDEPENDENT LINE TO HARBOUR LINE)			
BANDRA-KHAR	15/6 To 15/10	15 Kmph	Being turn out side.
DOWN THROUGH LINE			
CHURCHGATE-MARINE LINES	0/0 To 1/5	40 Kmph	Due to inadequate SE & Points taking off from Curves
CHARNI ROAD-MUMBAI CENTRAL	2/7 To 4/11	75 Kmph	Due to inadequate SE on Points taking off from Curves of 4 degree
MUMBAI CENTRAL MAIN YARD	4/19 To 5/5	15 Kmph	1 in 8½ Diamond with slip.
MUMBAI CENTRAL (North Local)-MAHALAXMI	4/11 To 5/9	50 Kmph	Point on transition length of curve of 3 degree.
BANDRA-KHAR ROAD	14/22 To 16/1	60 Kmph	Points taking off from transition length of curve with inadequate transition
VILLE PARLE-ANDHERI	20/10 To 21/7	50 Kmph	Points taking off from transition length of curve with inadequate transition
ANDHERI-JOGESHWARI	21/16 To 22/7	50 Kmph	Points taking off from transition length of curve with inadequate transition length & crack in girder of bridge no 40.
BORIVALI-DAHISAR	34/10 To 34/15	100Kmph	Unregulated OHE.Due to inadequate transition length and SE(34/8 -34/11A)
DAHISAR-BHAYANDAR	39/14 To 40/10	90 Kmph	No straight length in reverse curve.
NAIGAON - NALLASOPARA	49/17 To 53/14	100 Kmph	Unregulated OHE.
NALLASOPARA - VIRAR	59/03 To 59/14	100 Kmph	Due to inadequate transition length and SE.

PERMANENT SPEED RESTICTIONS ON SUBURBAN SECTION

Section or Station	Kilometers	Restricted Speed in Kmph.	Brief Reasons
DOWN HARBOUR LINE			
CHATRAPATI SHIVAJI TERMINUS YARD	WBS11+ 22 to WHT 17+ 86	35 Kmph	Due to sharp curvature with inadequate cant due to T/Outs.
CHATRAPATI SHIVAJI TERMINUS- MASJID	WPO 27 + 15 to 0/1	40 Kmph	Curvature with inadequate cant due to T/Outs.
CHATRAPATI SHIVAJI TERMINUS- SANDHURST ROAD	ES 1/2 to ES 1/20	60 Kmph	Inadequate track centres in curvarture.
MASJID-SANDHURST ROAD	1/17 to 1/19	60 Kmph	Heavy grade & Sharp curve
SANDHURST ROAD	1/19 to 2/8	40 Kmph	Inadequate cant due to infringement on flyover
DOCK YARD ROAD- COTTON GREEN	2/15 to 2/25	55 Kmph	Heavy grade & Sharp curve
DOCK YARD ROAD- COTTON GREEN	3/10 to 3/18	50 Kmph	Due to sharp curvature
DOCK YARD ROAD- COTTON GREEN	4/12 to 5/17	60 Kmph	Heavy grade & Sharp curve
WADALA ROAD-MAHIM	10/27 to 12/00	50 Kmph	Heavy grade on Vertical curve
KINGS CIRCLE-MAHIM	12/0 To 12/14	35 Kmph	Due to inadequate super elevation in 4 degree curve.
BANDRA	14/10 To 14/12	35 Kmph	Due to inadequate super elevation.
BANDRA-KHAR ROAD	15/1E To 16/2F	40 Kmph	On fly over due to sharp curve and steep grade.
KHAR ROAD-SANTACRUZ	16/4 To 16/9	65 Kmph	Due to reverse curve and inadequate SE
KHAR ROAD-SANTACRUZ	17/7 To 17/13	60 Kmph	Due to inadequate SE
SANTACRUZ-VILLE PARLE	17/14 To 18/1	75 Kmph	Due to non-transition curve.
VILEPARLE-ANDHERI	20/15 To 21/7	50 Kmph	Due to inadequate super elevation.
DOWN STA LINE			
MUMBAI CENTRAL-MAHALAXMI	5/8 To 6/0	30 Kmph	Exit from BCT terminal due to series of points and Crossing on curves.
ELPHINSTONE ROAD-DADAR	8/13 To 9/3	40 Kmph	Series of reverse curves.
MATUNGA ROAD-MAHIM	12/0 To 12/4	50 Kmph	Due to inadequate SE.
MATUNGA ROAD-MAHIM	12/8 To 12/11	15 Kmph	Negotiating 1 in 8 1/2 turn out on curves.
MATUNGA ROAD-MAHIM	12/11 To 12/14	35 Kmph	Due to inadequate SE.
MAHIM-BANDRA	14/10 To 14/12	35 Kmph	Due to inadequate SE.
MAHIM-BANDRA	14/1009	10 Kmph	Negotiating 1 in 8 1/2 turn out.
BANDRA-BDTS	15/1087	15 Kmph	Due to inadequate SE in reverse curve.
BDTS-SANTACRUZ	16/1195	15 Kmph	Series of reverse curve with inadequate SE
ANDHERI YARD	21/13 To 22/12	50 Kmph	Inadiquate SE & Points taking off from transition position.
JOGESHWARI YARD	23/14 A To 24/12	55 Kmph	Inadiquate SE & Points taking off from transition position.
KANDIVALI YARD	31/05 To 31/12	60 Kmph	Transition length & Points taking off from transition position.
KANDIVALI YARD	31/12 To 32/09	50 Kmph	Transition length & Points taking off from transition position.

PERMANENT SPEED RESTICTIONS ON SUBURBAN SECTION

Section or Station	Kilometers	Restricted Speed in Kmph.	Brief Reasons
UP LOCAL LINE			
NAIGAON - MIRA ROAD	46/12 To 42/13	80 Kmph	Due to Cracks in the PSC girders
KHAR-BANDRA	15/12 To 14/11	75 Kmph	Due to inadequate super elevation..
BANDRA (SOUTH)	14/11 To 14/9	50 Kmph	Due to inadequate SE and for want of isolation.
DADAR-MUMBAI CENTRAL LOCAL	9/6 To 5/6	75 Kmph	Due to inadequate SE
MAHALAXMI-MUMBAI CENTRAL LOCAL	5/6 To 4/6	30 Kmph	Due to inadequate SE
MUMBAI CENTRAL-MARINE LINES	4/5 To 1/5	75 Kmph	Due to inadequate SE and points taking off from curves.
MARINE LINES	1/12	20 Kmph	Landing of FOB at North end of MARINE LINES.
MARINE LINES-CHURCHGATE	1/5 To 0/0	40 Kmph	Due to inadequate SE and points taking off from curves
CHURCHGATE	0/5	20 Kmph	Due to subway at North end
UP THROUGH LINE			
VIRAR - NALLASOPARA	59/14 To 59/03	100 kmph	Due to inadequate transition length & super elevation.
NALLASOPARA - NAIGAON	52/02 To 49/17	100 kmph	Due to inadequate transition length & SE.Unregulated OHE
BHAYANDER - MIRA ROAD	39/16 To 39/14	100 kmph	Due to inadequate transition length & super elevation.
DAHISAR - BORIVALI	34/15 To 33/15	100 kmph	Unregulated OHE & Due to inadequate transition length & SE(34/11A-34/08).
JOGESHWARI-ANDHERI	22/5 To 21/3	50 Kmph	Due to inadequate SE.
SANTACRUZ-KHAR ROAD	17/8 To 17/2	50 Kmph	Points taking off from transition curve.
DADAR-ELPHINSTONE ROAD (ONLY FOR EMU STOPING TRAINS ON DADAR PF 4)	10/5 To 9/15	30 Kmph	Only for stoping EMU services on Platform No.4 at Dadar due to inediquate Platform width.
LOWER PAREL-MUMBAI CENTRAL	6/3 To 5/4	75 Kmph	Due to inadequate SE
MUMBAI CENTRAL (MAIN YARD)	5/4 To 4/7	15 Kmph	Due to Points and crossing at terminal
GRANT ROAD - CHARNI ROAD	3/9 To 2/6	75 Kmph	Due to inadequate SE
MARINE LINES - CHURCHGATE	0/11 To 0/0	50 Kmph	Points taking off from Curve

PERMANENT SPEED RESTICTIONS ON SUBURBAN SECTION

Section or Station	Kilometers	Restricted Speed in Kmph.	Brief Reasons
UP HARBOUR LINE			
ANDHERI-VILLEPARLE	21/7 To 20/16	50 Kmph	Due to inadequate super elevation.
SANTACRUZ- KHAR ROAD	17/12 To 17/07	60 Kmph	Due to inadequate SE& transitional length.
SANTACRUZ- KHAR ROAD	16/9 To 16/05	75 Kmph	Due to inadequate Transition length & super elevation on reverse curve.
KHAR ROAD - BANDRA	15/34 To 15/1E	40 Kmph	On Flyover due to sharp curve & Steep grade.
BANDRA - MAHIM	14/8 To 14/5	15 Kmph	Due to Diamond Crossing with single slip.
BANDRA - MAHIM	13/04 To 13/02	35 Kmph	Due to inadequate SE.
MAHIM-KINGS CIRCLE	12/14 To 12/11	35 Kmph	Due to inadequate SE.
KINGS CIRCLE-WADALA	10/04 To 9/36	50 Kmph	Due to gradient on flyover & Vertical curve
COTTON GREEN - DOCK YARD ROAD	5/16 To 2/19	60 Kmph	Heavy grade and Sharp curve of 6.75 degree
SANDHURST ROAD	2/8 To 1/17	40 Kmph	Inadequate cant due to infringement
SANDHURST ROAD - CHATRAPATI SHIVAJI TERMINUS	ES 1/20 to ES 1/2	60Kmph	Inadequate tracks centres in curvatures.
CHATRAPATI SHIVAJI TERMINUS YARD	0/1 To WAM 23+67	40 Kmph	Due to curvature & inadequate cant due to T / Out
CHATRAPATI SHIVAJI TERMINUS YARD	SPL "L" POR -1 To WBS 8+00	30 Kmph	Due to curvature with & inediquate cant due to T / Out
UP STA LINE			
BORIVALI-KANDIVALI	32/04 To 30/13A	50 Kmph	Points taking off from transition curve.
GOREGAON-JOGESHWARI	24/02A-1C To 23/05	55 Kmph	Inadiquate SE & Points taking off from transition curve.
ANDHERI YARD	22/01 C To 21/03	50 Kmph	Inadiquate SE & Points taking off from transition curve.
SANTACRUZ (SOUTH) -BANDRA	17/05	15 Kmph	Entry to BDTS negotiating 1in81/2 turn out.
SANTACRUZ-BDTS	16/1136	15 Kmph	Negotiating turn out on curves.
BANDRA (SOUTH) - MAHIM	14/08 To 14/05	15 Kmph	Negotiating Diamond on single slips.
MAHIM (NORTH)-	13/04 To 13/02	35 Kmph	Due to inadequate SE.
MAHIM (SOUTH)-MATUNGA ROAD	12/11 To 12/08	15 Kmph	Negotiating series of turn outs on curves.
MAHIM-MATUNGA ROAD	12/04 To 12/00	50 Kmph	Due to inadequate SE.
DADAR -ELPHINSTONE ROAD	09/03 To 08/13	40 Kmph	Series of reverse curves.
MAHALAKSHMI-MUMBAI CENTRAL	06/00 To 05/08	30 Kmph	Entry to BCT Terminal / Series of turn outs.

THE FOLLOWING CROSSOVER POINTS AND TURNOUTS PERMITTED UP TO 30 KMPH.

Section or Station	POINT NUMBER OF TURNOUTS PERMITTED UP TO 30 KMPH.SPEED
CHRUCHGATE	ALL POINTS AND CROSSOVERS FROM MARINE LINE SOUTH TO CHURCHGATE.
MARINE LINES (NORTH)	101-102 UP LOCAL LINE TO DOWN LOCAL LINE. 103-104 UP THROUGH LINE TO DOWN THROUGH LINE.
DADAR (SOUTH)	117-118 STA TO UP THROUGH LINE (In UP direction only).
DADAR (NORTH)	131-133,134-135 PLATFORM 5 TO DOWN THROUGH LINE. 133-131 UP THROUGH LINE TO PLATFORM 5.
BANDRA (SOUTH)	111 OF UP LOCAL LINE. 113-114 DOWN LOCAL LINE TO PLATFORM 2.
BANDRA (NORTH)	161-162 PLATFORM 2 TO DOWN LOCAL LINE.
KHAR ROAD (SOUTH)	199-200 By Pass LINE TO DOWN HARBOUR LINE.
GOREGAON	117-118 Common Loop LINE TO UP THROUGH LINE.
	112-111 & 104-103 UP THROUGH TO UP LOCAL.
	111-112 & 117-118 DOWN THROUGH TO LOOP.
	148-147,146-145 UP LOCAL LINE TO UP THROUGH LINE
BORIVALI	129-130 DOWN LOCAL LINE TO PLATFORM 8. 155-156 DOWN LOCAL LINE TO PLATFORM 2.
	177-178 PLATFORM 2 TO DOWN LOCAL LINE. 148-147 PLATFORM 6 to UP THROUGH LINE.
	157-158,141-142 UP LOCAL TO UP THROUGH .191-192 & 199-200 DOWN THROUGH , UP LOCAL & DOWN LOCAL LINE.
	198-197 & 196-195 UP THROUGH, DOWN THROUGH & UP LOCAL LINE.
BHAYANDAR	105-106 DOWN THROUGH TO COMMON LOOP. 107-108 COMMON LOOP TO UP THROUGH.
VASAI ROAD	101-102 & 103-104 DOWN LOCAL TO DOWN THROUGH.
	105-106 & 113-114 DOWN THROUGH TO DOWN DIVA. 127-128 DOWN DIVA TO LOOP.
NALLA SOPARA	153-154 DOWN LOCAL TO VR CAR SHED
VIRAR	147-148 PLATFORM 1 TO UP LOCAL. 143-144 DOWN LOCAL TO PLATFORM 2. 137-138 R/S TO UP
	129-130 DPWN THROUGH TO PLATFORM 2. 111-112 & 121-122 DOWN LOCAL TO PLATFORM 8.
	123-124 UP THROUGH TO DOWN THROUGH. 131-132 DOWN THROUGH TO UP THROUGH.

THE FOLLOWING CROSSOVER POINTS AND TURNOUTS PERMITTED UP TO 10 KMPH.

Section or Station	POINT NUMBER OF TURNOUTS PERMITTED UP TO 10 KMPH.SPEED
MUMBAI CENTRAL-MAHALAKSHMI	144-143 UP THROUGH LINE TO LOCAL LINE due to Diamond in curve.
MUMBAI CENTRAL-MAHALAKSHMI	114-115 DOWN LOCAL LINE TO CARSHED LINE Diamond with single slip.
LOWER PAREL	43-44, 45-46, 47-48, 49-50, 58-59 all diversion due to Diamond with slip.
BANDRA-MAHIM Jn.	101-102 DOWN HARBOUR LINE TO UP HARBOUR LINE due to Diamond with slip.

For all other crossovers on Main Line unless specially notified, the speed will be 15 KMPH.

Annexure-IV

Annexue-1

ROUTE PROFILE (Statement of Gradient)				
SECTION KARTA TO BANIHAL (UP)				
S.NO	LOCATION (IN KM)		GRADIENT	STN. NAME
	FROM	TO		
1	25.5	25.7	1 in 1000 F	
2	25.7	27.238	1 in 100 F	
3	27.238	30	Level	
4	30	31.02	1 in 120.04 F	
5	31.02	31.708	1 in 300 R	
6	31.7	33.14	1 in 120.04 F	
7	33.14	33.22	Level	
8	33.22	35.76	1 in 200 R	
9	35.76	38.36	1 in 142.85 F	
10	38.36	40	Level	
11	40	42.2	1 in 100 R	
12	42.2	43.24	1 in 400 R	Reasi
13	43.24	44.6	1 in 100 R	
14	44.6	45.4	1 in 105.125 R	
15	45.4	48.9	1 in 118.369R	
16	48.9	50.1	1 in 400 F	Salal
17	50.1	51.26	Level	
18	51.26	51.75	1 in 400 R	
19	51.75	53.06	1 in 112.21 R	
22	53.06	54.535	1 in 100 R (C)	
23	54.535	56.15	1 in 93.922 R	
24	56.15	60.5	1 in 100 R (C)	
25	60.5	60.99	1 in 400 R (C)	
26	60.99	61.2	1 in 400 F (C)	
27	61.2	61.71	1 in 400 R (C)	Dugga
28	61.71	62.02	1 in 200 R	
29	62.02	69.5	1 in 80 C	
30	69.5	71.02	1 in 400 R (C)	Basindhadhar
31	71.02	76.94	1 in 80 R (C)	
32	76.94	77.12	Level	
33	77.12	77.28	1 in 80 R	
34	77.28	78.8	1 in 90.342 R	
35	78.8	81.91	1 in 85 R	
36	81.91	83.01	1 in 91.24 R	
37	83.01	85.5	1 in 85 R	
38	85.5	86.57	1 in 91.51 R	
39	86.57	86.827	1 in 80 R	
40	91.35	91.4	1 in 121.40 R	
41	91.4	91.6	1 in 112.038 R	
42	91.6	92.18	1 in 113 R	
43	92.18	93.71	1 in 406 R	Sangaldan

ROUTE PROFILE (Statement of Gradient)				
SECTION KARTA TO BANIHAL (UP)				
S.NO	LOCATION (IN KM)		GRADIENT	STN. NAME
	FROM	TO		
44	93.71	94.64	1 in 115 R	
45	94.64	94.86	1 in 155.29 R	
46	94.86	96.11	1 in 98.87 R	
47	96.11	96.74	1 in 105 R	
48	96.74	97.12	1 in 97 R	
49	97.12	97.62	1 in 118.369 R	
50	97.62	98.2	1 in 106 R	
51	98.2	98.74	1 in 108.315 R	
52	98.74	99.24	1 in 101 R	
53	99.24	99.54	1 in 105.77 R	
54	99.54	99.94	1 in 100 R	
55	99.94	101.186	1 in 212.51 R	
56	101.186	101.52	1 in 219.25 R	
57	99.86	100.04	1 in 213 R	
58	100.04	100.23	1 in 117 R	
59	100.23	102.45	1 in 80 R	
60	102.45	103.69	1 in 86.02 R	
61	103.69	106.25	1 in 80 R	
62	106.25	107.75	1 in 87.52 R	
63	107.75	109.28	1 in 80 R	
64	109.28	109.67	1 in 90.95 R	
65	109.67	109.75	1 in 130 R	
66	109.75	109.86	1 in 260 R	
67	109.86	109.933	Level	
68	109.933	110.01	1 in 260F	
69	110.01	110.085	1 in 130F	
70	110.085	110.16	1 in 260F	
71	110.16	110.22	Level	
72	110.22	111.48	1 in 750 R	Sumber
73	111.48	111.69	1 in 200 R	
74	111.69	111.74	1 in 130 R	
75	111.74	112.799	1 in 80 R (C)	
76	112.799	113.044	1 in 80 R	
77	113.044	114.522	1 in 80 R (C)	
78	114.522	114.903	1 in 80 R	
79	114.903	115.465	1 in 80 R (C)	
80	115.465	116.449	1 in 80 R	
81	116.449	117.702	1 in 80 R (C)	
82	117.702	118.825	1 in 80 R	
83	118.825	119.533	1 in 87.82 R	
84	119.533	121.268	1 in 90 R	
85	121.268	122.525	1 in 96.78 R	

ROUTE PROFILE (Statement of Gradient)				
SECTION KARTA TO BANIHAL (UP)				
S.NO	LOCATION (IN KM)		GRADIENT	STN. NAME
	FROM	TO		
86	122.525	122.993	1 in 89.99 R	
87	122.993	123.46	1 in 99.79 R	
88	123.46	123.67	1 in 125.03 R	
89	123.67	123.92	1 in 200 R	
90	123.92	125.02	1 in 411.85 R	Arpinchala
91	125.02	125.4	1 in 216.45 R	
92	125.4	126.24	1 in 127.065 R	
93	126.24	127.12	1 in 92.93 R	
94	127.12	133.081	1 in 80 R (C)	
95	145.742	146.65	1 in 100 R	
96	146.65	147.25	1 in 111.11 R	
97	147.25	147.42	1 in 100 R	
98	147.42	148.04	1 in 91.4 R (C)	
99	148.04	148.1	1 in 83.82 R (C)	
100	148.1	148.37	1 in 100.5 R (C)	
101	148.37	148.62	1 in 100 R	
102	148.62	148.948	1 in 112.323 R	
103	148.948	149.42	1 in 100 R	
104	149.42	149.56	1 in 97.56 R	
105	149.56	150.44	1 in 110.35 R	
106	150.44	151.8	1 in 400 R	Banihal

Annexure-IV

Annexue-2

ROUTE PROFILE (Statement of Curve)					
SECTION KARTA TO BANIHAL (UP)					
S.NO	LOCATION (IN KM)		Curve no.	Degree of curve	ST'N. NAME
	FROM	TO			
1	25.749	26.961	9	3.7R	
2	27.738	27.981	10	3.55L	
3	28.364	29.127	11	4L	
4	29.302	29.859	12	4R	
5	31.020	31.58	1	2.74R	
6	31.665	32.858	2	1L	
7	34.034	34.935	3	1R	
8	37.140	38.249	4	2L	
9	39.307	40.279	12	2.74L	
10	40.617	41.502	13	1.5R	
11	41.807	42.355	14	3.25R	
12	43.481	44.537	15	2R	
13	47.953	49.967	16	1.4L	
14	51.446	53.051	17	2.74R	
15	53.489	53.693	18	2.06L	
16	53.743	54.472	19	2.059R	
17	54.599	56.311	20	2.74L	
18	56.761	57.783	21	2.33R	
19	57.836	58.849	22	2.333R	
20	60.220	60.375	23	1.795R	
21	60.968	61.523	24	2L	
22	64.664	65.684	25	0.7R	
23	70.464	71.468	26	1.996L	
24	71.641	73.145	27	1.996L	
25	75.546	76.644	28	1.996R	
26	77.287	78.795	29	1.996R	
27	81.911	83.004	30	1.996L	
28	85.501	86.562	31	1.996L	
29	91.398	92.325	41	2.74L	
30	93.778	94.487	42	3.50R	
31	94.641	94.864	43	3.50L	
32	97.069	97.973	44	2.74L	
33	98.035	98.85	45	2.74R	
34	99.764	100.208	46	3L	
35	100.362	101.629	47	3.5R	
36	102.468	103.668	1	2.1875R	
37	106.252	107.733	2	2.1875L	
38	109.281	109.800	3	1.666R	
39	110.622	111.147	4	2.92L	Sumber
40	111.589	112.799	5	2.73R	
41	113.043	114.522	6	1.52L	
42	114.903	115.465	7	1.17L	

ROUTE PROFILE (Statement of Curve)					
SECTION KARTA TO BANIHAL (UP)					
S.NO	LOCATION (IN KM)		Curve no.	Degree of curve	ST'N. NAME
	FROM	TO			
43	116.449	117.701	8	1.25L	
44	118.824	119.532	9	1.46R	
45	121.268	122.525	10	1.94L	
46	122.993	123.460	11	2.73R	
47	125.263	126.005	14	3.93R	
48	126.035	127.110	15	2.495R	
49	129.778	131.569	16	1.996L	
50	131.662	132.179	17	0.998L	
51	132.827	133.081	18	1.455R	
52	133.534	134.335	19/22	1.25R	
53	146.245	146.614	23	2.74L	
54	146.651	147.258	24	4L	
55	147.428	148.039	25	4.861R	
56	148.090	148.515	26	4.861L	
57	148.628	148.933	27	2.74L	
58	149.584	150.812	28	1.5R	

ANNEXURE - V

LIST OF SPECIFICATIONS FOR TESTING OF EQUIPMENTS

All the equipment shall be type and routine tested with the relevant latest specification. Supplier shall conduct all type and routine tests of all clauses of RDSO/IEC/BS/DIN/JIS/IS or equivalent specification whichever is applicable, including optional tests. Detailed test programme shall be furnished by the supplier and approved by RDSO before undertaking the type tests.

S.No.	Equipment	Specification
1.	Complete EMU rake	IEC 61133 (1992 or latest): Railway Application: Rolling Stock: testing of rolling stock on completion of construction and before entry into service. IEC 61376: General service conditions and general rules for electric equipment for rolling stock. IEC 61373: Shock and vibration requirements for rolling stock equipment. IEC 61377: System tests on Combined test bed
2.	Pantograph	IEC 60494 (1974 or latest): Rules for pantographs for electric rolling stock.
3.	Lighting arrestor	IEC 60099 (1990,91 or latest): Surge arrestors, parts 1, 3 or 4 as applicable.
4.	Cables	Relevant IEC as applicable to the type of cable used: IEC 60332-1 (1993 or latest); 60332-3 (1992 or latest); 60754-2 (1991 or latest) Amendment 1 (1997) or latest ; 61034-2 UIC 895, UIC 541-2, UITP Part 2; VDE 0298-T3
5.	Vacuum circuit breaker	IEC 60056 (1987 or latest): With amendments 1 (1992) 2 (1995) and 3 (1996) – High voltage alternating current circuit breakers. IEC 60077 (1968 or latest): Electric equipment for rolling stock Electro technical components. Part 1: General rules. Part 2: Rules for DC circuit breakers.
6.	Relays & contactors	IEC 60077 (1968 or latest) IEC 60158: Low voltage control gear. Part 2 (1982 or latest) Semi conductor contactors (solid state contactors). Part 3 (1985 or latest): Additional requirements for conductors subject to certification. IEC 60947-5 (1990 or latest) : Control switches (low voltage switching devices for control and auxiliary circuits, including contactor relays) Part 1 (1998 or latest), 2 (1998 or latest), 3, 4: General requirements.

7.	Electronic equipment	IEC 60571 (1998 or latest)/EN50155: Electric equipment used on rail vehicles.
8.	Transformer & smoothing reactor	IEC 60310 (1991 or latest) : Traction transformers and inductors. IEC 60296 (1982 or latest) and amendment (1986 or latest) : Specification for unused mineral insulating oil for transformer and switch gear.
9.	Static power Converter/inverter and Auxiliary converter	IEC 61287 (1995 or latest): Power converters installed on board rolling stock. Part 2: Characteristics and test methods. IEC 60411-2 (1978 or latest): Additional technical information (report) IEC 61377 (1996 or latest): Electric traction – rolling stock- combined testing of inverter fed alternating current motors and their control.
10.	Capacitors	IEC 61881: Power Electronic capacitors used on rail vehicles
11.	Traction motor & Auxiliary motors	IEC 60349 (1991 or latest): Electric traction Rotating electrical machines for rail and road vehicles. Part 2 (1993 or latest): Electronic converter fed alternating current motors. Part 3 (1995 or latest): Determination of the total losses of converter fed alternating current motors by summation of the component losses. IEC 60034-1 (1996 or latest) and amendment 1 (1997): Rotating electrical machines. Rating and performance.
12.	Wind Screen Wiper	RDSO Spec. No. CK-306, Rev. 1 or latest (March 2006)
13.	Compatibility between rolling stock & train detection system	EN 50238
14.	Electromagnetic compatibility	EN 50121

ANNEXURE VI – A

LIMITS OF INTERFERENCE CURRENTS

S. No.	Interference Current	Over all limit
1.	Psophometric current AC traction	10.0 A
2.	DC components in AC mode	4.7 A
3.	Second Harmonic component (100 Hz) in AC traction per basic unit	0.5 A
4.	1400 Hz to 5000 Hz	400 mA
5 (i)	More than 5000 Hz up to 32000 Hz	270 mA
5 (ii)	39500 Hz up to 43500 Hz	270 mA
6.	50 Hz components in DC mode	2.4 A

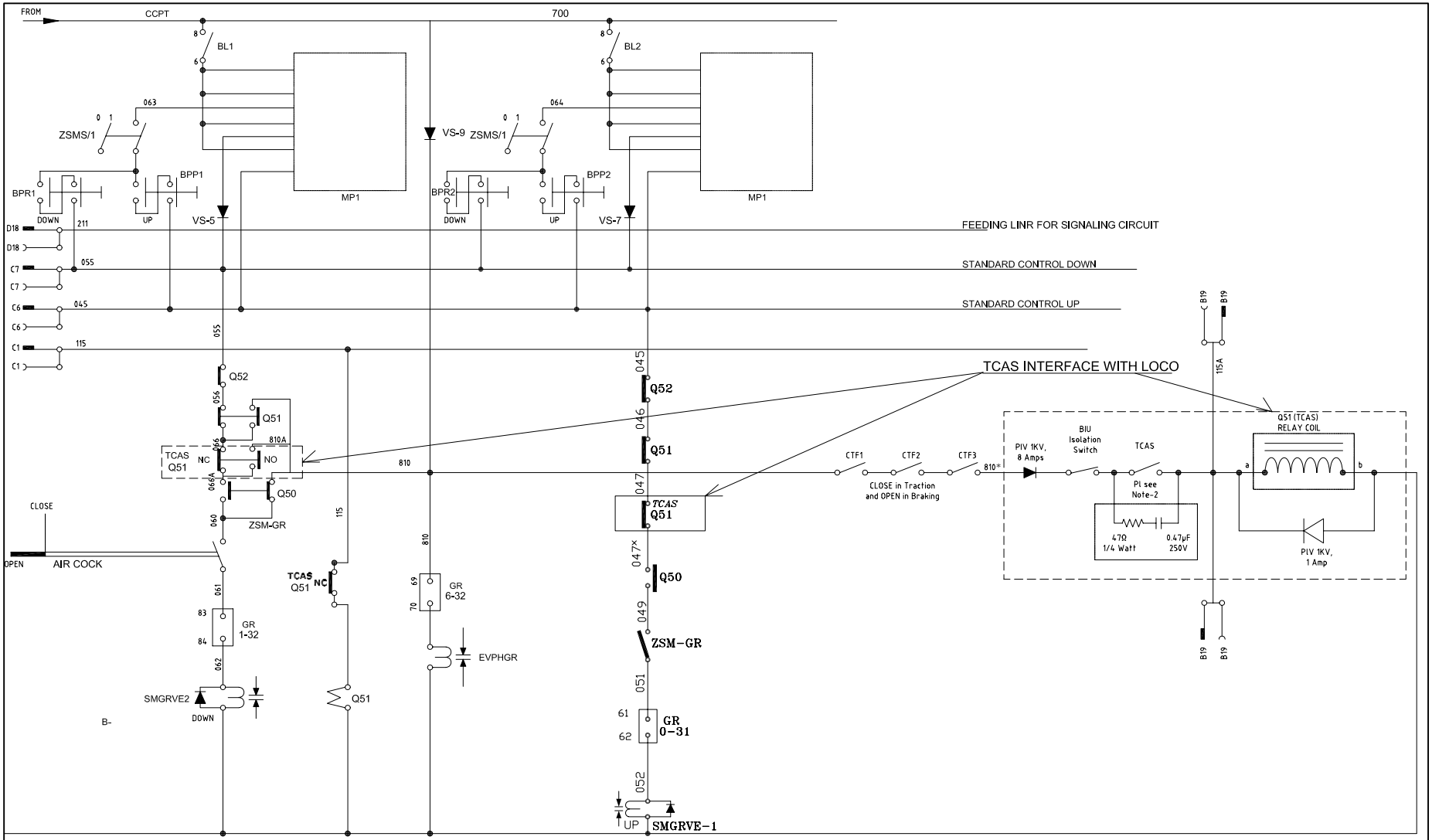
1. Testing methodology and instrumentation to be used defined the worst case scenario of converter failure/bypassing of EMI-EMC filter provided in any converter resulting in isolation of the effected converter to ensure any negative repercussions on the signalling gear.
2. FTT (Fast Fourier Transformation) Analysis of total current should be carried out from 1400 Hz to 5000 Hz and 5 KHz to 50 kHz separately to find out frequency of higher amplitude in band for both individual motor coaches and complete rack.
3. The frequencies in (>320000 Hz to <39500 Hz) and (>43500 Hz to 50000 Hz) frequency bands for which the values exceed 270mA shall be identical and indicated along with their actual values.

ANNEXURE – VI B

Signal and Telecommunication Installations

The EMU/MEMU stock shall not interfere with, or degrade the operation of, the following signal and telecommunication installation types:

- Single and / or double distant including automatic colour light signalling systems with relay and / or electronic interlocking.
- DC track circuits.
- 83⅓ Hz track circuits.
- Audio frequency track circuits up to a maximum frequency of 20.7 kHz.
- Digital axle counters (up to a frequency of 43 kHz).
- Block instruments.
- Point machines.
- Auxiliary warning system (AWS).
- Train protection and warning system (TPWS).
- Telephone circuits.
- Teleprinter circuits.
- Control circuits.
- VHF and UHF transmission systems.
- Microwave transmission system



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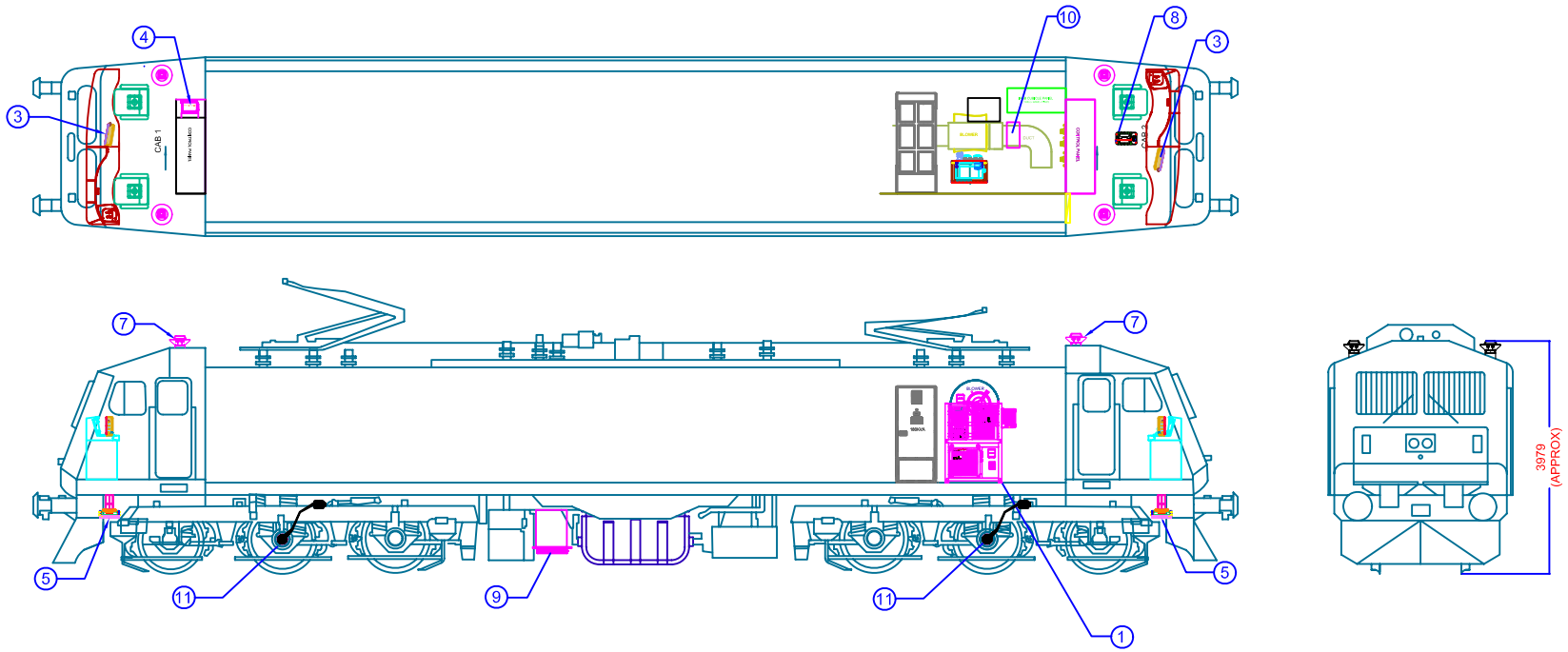
REF. :	SCALE - 1 : 20	APPD. BY. (For Dg)
AUTO REGRESSION CIRCUIT FOR TCAS FITTED WITH AC CONVENTIONAL LOCOMOTIVES		FIRST ISSUED
		SUPERSEDES
R.D.S.O. ELECT. DTE.	SKEL - 5044 ALT - 0	SUPERSEDED BY

Annexure-VI C



SNO	DESCRIPTION	LOCATION
11	SPEED SENSOR	AXLE BOX No. 3 & 9
10	BTM Unit Dimensions: L400 X W500 X H350	DUCT
9	BTM Antenna Dimensions: L560 X W460 X H140	TXFR
8	GPS_GSM ANTENNA Dimensions: L450 X W250 X H250	ROOF TOP CAB 2
7	RF Antenna Dimensions: L410 X W180 X H260	ROOF TOP CAB 1 AND CAB 2
6	CAB Input Box Dimensions: L300 X W150 X H400	MCP-3
5	RFID Reader Dimensions: L560 X W440 X H630 (Above 450Mm from Rail level)	BEHIND CATTLE GUARD
4	Radio Unit Dimensions: L310 X W230 X H340	CAB 1 AND CAB 2
3	DMI Unit Dimensions: L400 X W200 X H420	CAB 1 AND CAB 2
2	BIU Unit: Dimensions: L610 X W420 X H1250	180KVA UNIT
1	TCAS Unit: Dimensions: L650 X W435 X H1150	180KVA UNIT

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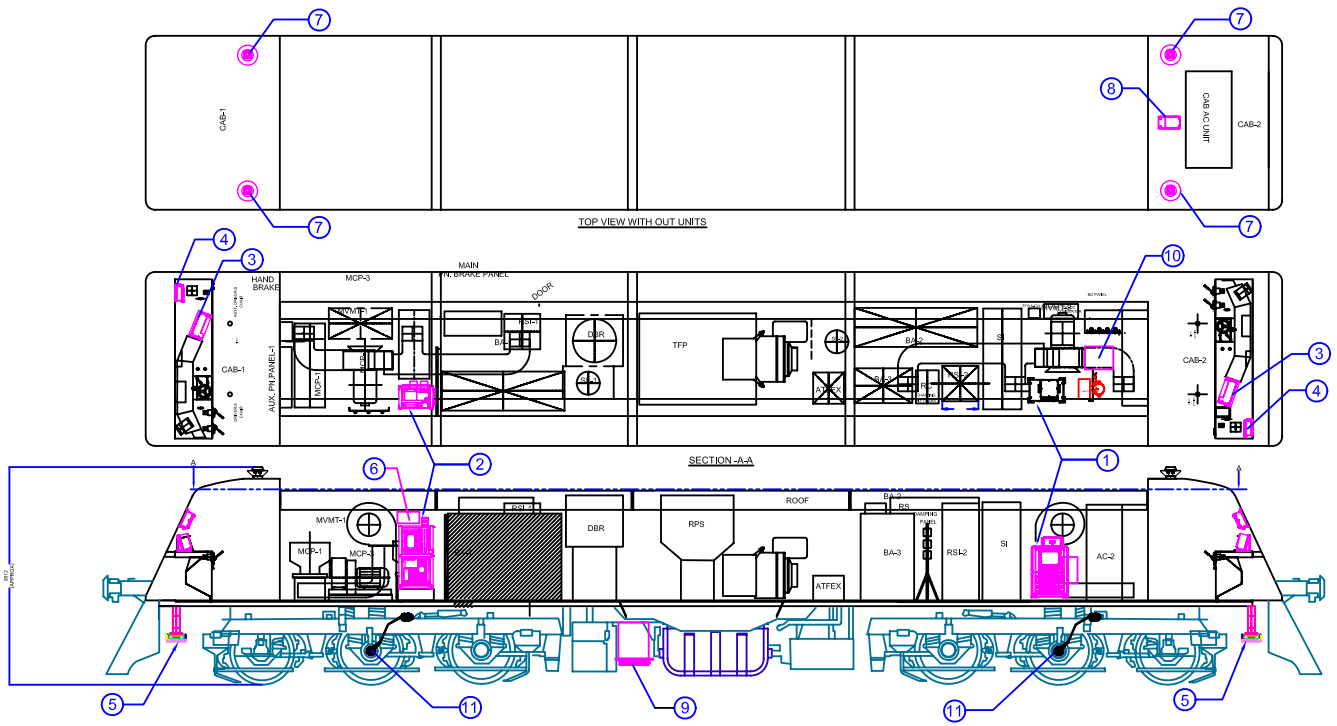
REF. :	SCALE - 1 : 20	APPD. BY. (For Dg)
TCAS EQUIPMENT LAYOUT WAG-7		FIRST ISSUED
		SUPERSEDES
R.D.S.O. ELECT. DTE.	SKEL - 5045 ALT - 0	SUPERSEDED BY



SNO	DESCRIPTION	LOCATION
11	SPEED SENSOR	AXLE BOX No. 3 & 9
10	BTM Unit Dimensions: L400 X W500 X H350	BD PANEL
9	BTM Antenna Dimensions: L560 X W460 X H140	TRACTION TXFR
8	GPS_GSM ANTENNA Dimensions: L450 X W250 X H250	ROOF TOP CAB 2
7	RF Antenna Dimensions: L410 X W180 X H260	ROOF TOP CAB 1 AND CAB 2
6	CAB Input Box Dimensions: L300 X W150 X H400	MCP-3
5	RFID Reader Dimensions: L560 X W440 X H630 (Above 450Mm from Rail level)	BEHIND CATTLE GUARD
4	Radio Unit Dimensions: L310 X W230 X H340	CAB 1 AND CAB 2
3	DMI Unit Dimensions: L400 X W200 X H420	CAB 1 AND CAB 2
2	BIU Unit: Dimensions: L610 X W420 X H1250	MCP-3
1	TCAS Unit: Dimensions: L650 X W435 X H1150	SI UNIT

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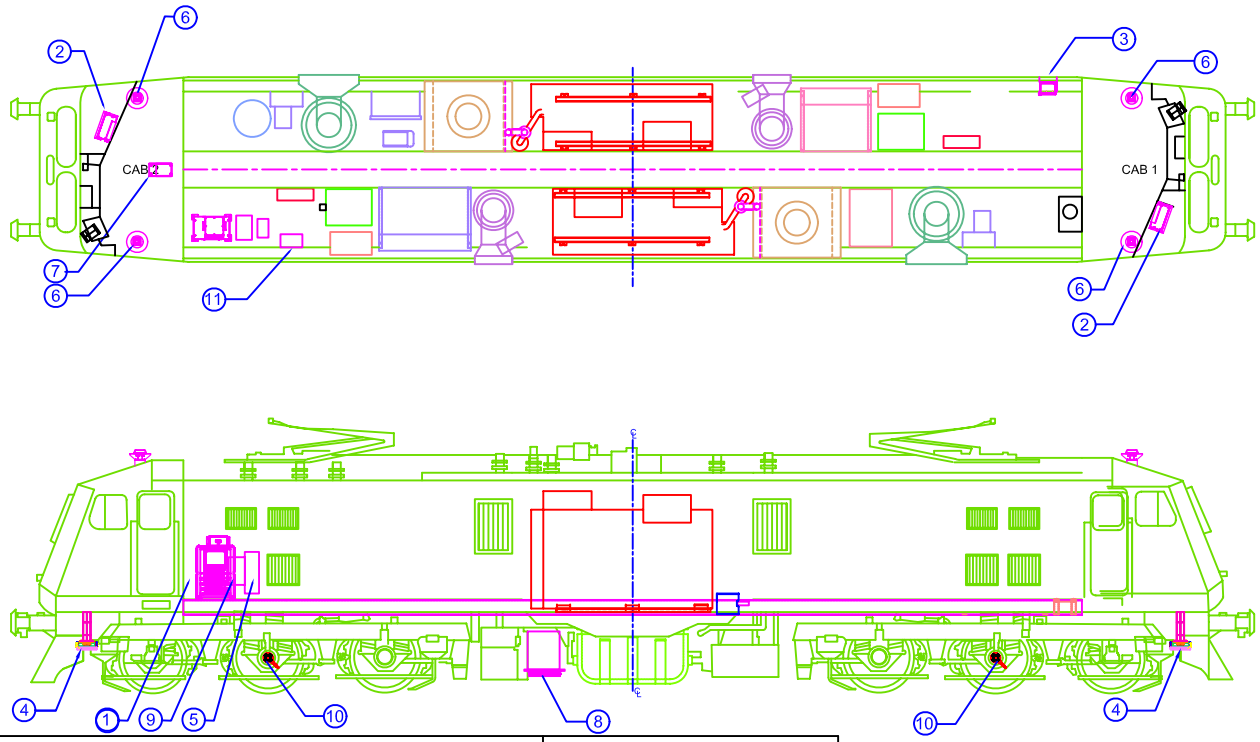
REF. :	SCALE - 1 : 20	APPD. BY. (For Dg)
TCAS EQUIPMENT LAYOUT WAG-7 (CREW FRIENDLY)		FIRST ISSUED
		SUPERSEDES
R.D.S.O. ELECT. DTE.	SKEL - 5046 ALT - 0	SUPERSEDED BY



SNO	DESCRIPTION	LOCATION
11	LOCO TCAS E70 INTERFACE UNIT	MAIN RESERVOIR
10	SPEED SENSOR	AXLE BOX No. 3 & 9
9	BTM Unit Dimensions: L400 X W500 X H350	DUCT
8	BTM Antenna Dimensions: L560 X W460 X H140	TXFR
7	GPS_GSM ANTENNA Dimensions: L450 X W250 X H250	ROOF TOP CAB 2
6	RF Antenna Dimensions: L410 X W180 X H260	ROOF TOP CAB 1 AND CAB 2
5	CAB Input Box Dimensions: L300 X W150 X H400	MAIN RESERVOIR
4	RFID Reader Dimensions: L560 X W440 X H630 (Above 450Mm from Rail level)	BEHIND CATTLE GUARD
3	Radio Unit Dimensions: L310 X W230 X H340	CAB 1 AND CAB 2
2	DMI Unit Dimensions: L400 X W200 X H420	CAB 1 AND CAB 2
1	TCAS Unit: Dimensions: L650 X W435 X H1150	MAIN RESERVOIR

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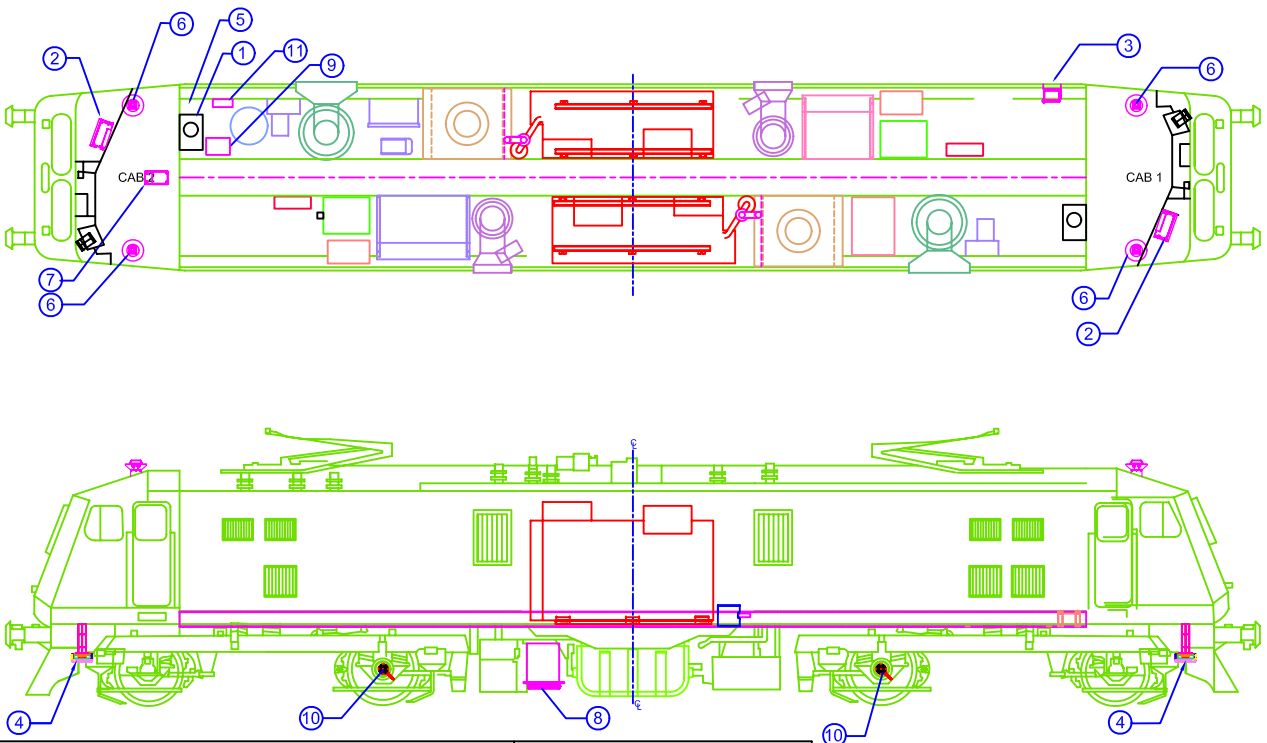
REF. :	SCALE - 1 : 20	APPD. BY. (For Dg)
TCAS EQUIPMENT LAYOUT WAG 9		FIRST ISSUED
		SUPERSEDES
R.D.S.O. ELECT. DTE.	SKEL - 5047 ALT - 0	SUPERSEDED BY



SNO	DESCRIPTION	LOCATION
11	LOCO TCAS E70 INTERFACE UNIT	FIRE EXTINGUISHER CAB2
10	SPEED SENSOR	AXLE BOX No. 3 & 5
9	BTM Unit Dimensions: L400 X W500 X H350	DUCT
8	BTM Antenna Dimensions: L560 X W460 X H140	TXFR
7	GPS_GSM ANTENNA Dimensions: L450 X W250 X H250	ROOF TOP CAB 2
6	RF Antenna Dimensions: L410 X W180 X H260	ROOF TOP CAB 1 AND CAB 2
5	CAB Input Box Dimensions: L300 X W150 X H400	FIRE EXTINGUISHER CAB2
4	RFID Reader Dimensions: L560 X W440 X H630 (Above 450Mm from Rail level)	BEHIND CATTLE GUARD
3	Radio Unit Dimensions: L310 X W230 X H340	CAB 1 AND CAB 2
2	DMI Unit Dimensions: L400 X W200 X H420	CAB 1 AND CAB 2
1	TCAS Unit: Dimensions: L650 X W435 X H1150	FIRE EXTINGUISHER CAB2

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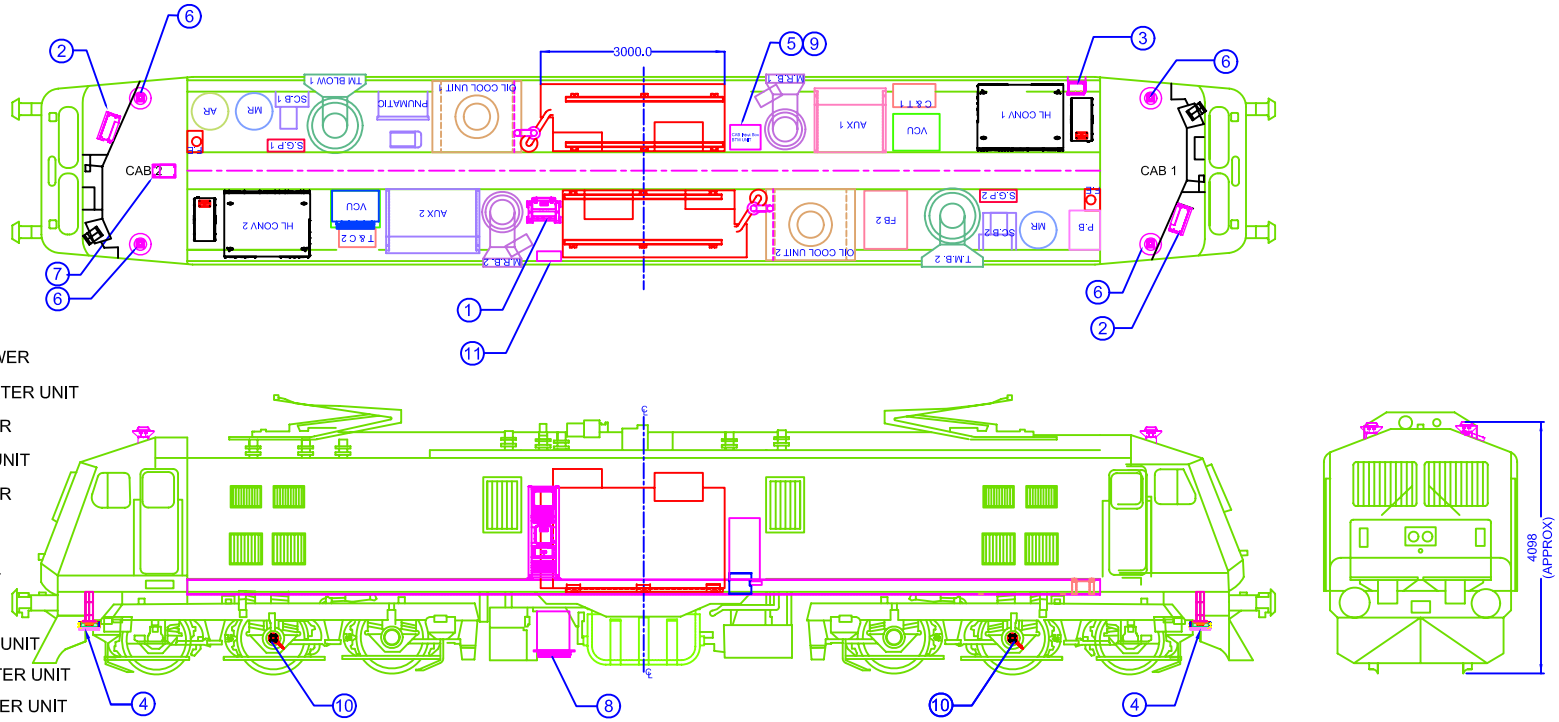
REF. :	SCALE - 1 : 20	APPD. BY. (For Dg)	
TCAS EQUIPMENT LAYOUT WAP 5			FIRST ISSUED
			SUPERSEDES
R.D.S.O. ELECT. DTE.	SKEL - 5048 ALT - 0		SUPERSEDED BY

FE --- FIRE EXTINGUISHER
PB --- PARKING BRAKE
AR --- AUXLARY RESERVOIR
MR --- MAIN RESERVOIR
SCB --- SCAVENGING BLOWER
SGP --- SWITCH GARE PART
TMB --- TRACTION MOTOR BLOWER
TR CONV --- TRACTION CONVERTER UNIT
MRB --- MACHINE ROOM BLOWER
OCB --- OIL COOLING BLOWER UNIT
MRB --- MACHINE ROOM BLOWER
PNU --- PNUMATIC PANEL
DISP --- DISPLAY UNIT
VCU --- VEHICLE CONTROL UNIT
FB --- FILTER BLOCK
AUX --- AUXILIARY CONVERTER UNIT
HL SF --- HOTEL LOAD SINE FILTER UNIT
HL SF --- HOTEL LOAD SINE FILTER UNIT
HL CONVERTER --- HOTEL LOAD CONVERTER UNIT



SNO	DESCRIPTION	LOCATION
11	LOCO TCAS E70 INTERFACE UNIT	M.R.B - 2
10	SPEED SENSOR	AXLE BOX No. 3 & 9
9	BTM UNIT DIMENSIONS: L400 X W500 X H350	M.R.B - 1
8	BTM ANTENNA DIMENSIONS: L560 X W460 X H140	TXFR
7	GPS_GSM ANTENNA DIMENSIONS: L450 X W250 X H250	ROOF TOP CAB 2
6	RF ANTENNA DIMENSIONS: L410 X W180 X H260	ROOF TOP CAB 1 AND CAB 2
5	CAB INPUT BOX DIMENSIONS:L300 X W150 X H400	M.R.B - 1
4	RFID READER DIMENSIONS: L560 X W440 X H630 (Above 450Mm from Rail level)	BEHIND CATTLE GUARD
3	RADIO UNIT DIMENSIONS: L310 X W230 X H340	CAB 1 AND TCAS UNIT
2	DMI UNIT DIMENSIONS: L400 X W200 X H420	CAB 1 AND CAB 2
1	TCAS UNIT: DIMENSIONS: L500 X W380 X H1150	M.R.B - 2

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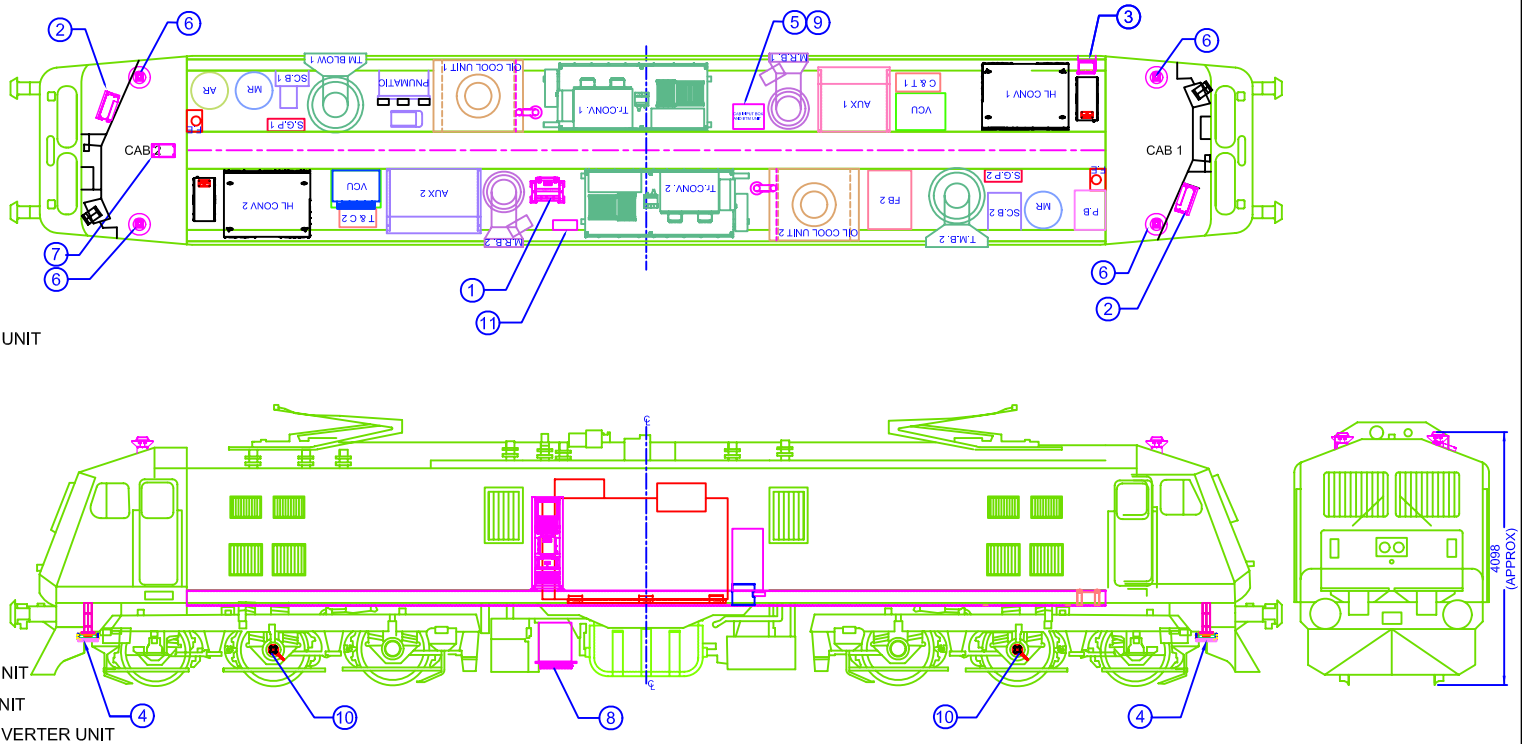
REF. :	SCALE - 1 : 20	APPD. BY. (For Dg)
TCAS EQUIPMENT LAYOUT WAP 7 (GTO PROPULSION SYSTEM)		FIRST ISSUED / SUPERSEDES
R.D.S.O. ELECT. DTE.	SKEL - 5049 ALT - 0	SUPERSEDED BY

FE --- FIRE EXTINGUISHER
PB --- PARKING BRAKE
AR --- AUXLARY RESERVOIR
MR --- MAIN RESERVOIR
SCB --- SCAVENGING BLOWER
SGP --- SWITCH GARE PART
TMB --- TRACTION MOTOR BLOWER
TR CONV --- TRACTION CONVERTER UNIT
MRB --- MACHINE ROOM BLOWER
OCB --- OIL COOLING BLOWER UNIT
MRB --- MACHINE ROOM BLOWER
PNU --- PNUMATIC PANEL
DISP --- DISPLAY UNIT
VCU --- VEHICLE CONTROL UNIT
FB --- FILTER BLOCK
AUX --- AUXILIARY CONVERTER UNIT
HL SF --- HOTEL LOAD SINE FILTER UNIT
HL SF --- HOTEL LOAD SINE FILTER UNIT
HL CONVERTER --- HOTEL LOAD CONVERTER UNIT



SNO	DESCRIPTION	LOCATION
11	LOCO TCAS E70 INTERFACE UNIT	M.R.B - 2
10	SPEED SENSOR	AXLE BOX No. 3 & 9
9	BTM UNIT DIMENSIONS: L400 X W500 X H350	M.R.B - 1
8	BTM ANTENNA DIMENSIONS: L560 X W460 X H140	TXFR
7	GPS_GSM ANTENNA DIMENSIONS: L450 X W250 X H250	ROOF TOP CAB 2
6	RF ANTENNA DIMENSIONS: L410 X W180 X H260	ROOF TOP CAB 1 AND CAB 2
5	CAB INPUT BOX DIMENSIONS:L300 X W150 X H400	M.R.B - 1
4	RFID READER DIMENSIONS: L560 X W440 X H630 (Above 450Mm from Rail level)	BEHIND CATTLE GUARD
3	RADIO UNIT DIMENSIONS: L310 X W230 X H340	CAB 1 AND TCAS UNIT
2	DMI UNIT DIMENSIONS: L400 X W200 X H420	CAB 1 AND CAB 2
1	TCAS UNIT: DIMENSIONS: L500 X W380 X H1150	M.R.B - 2

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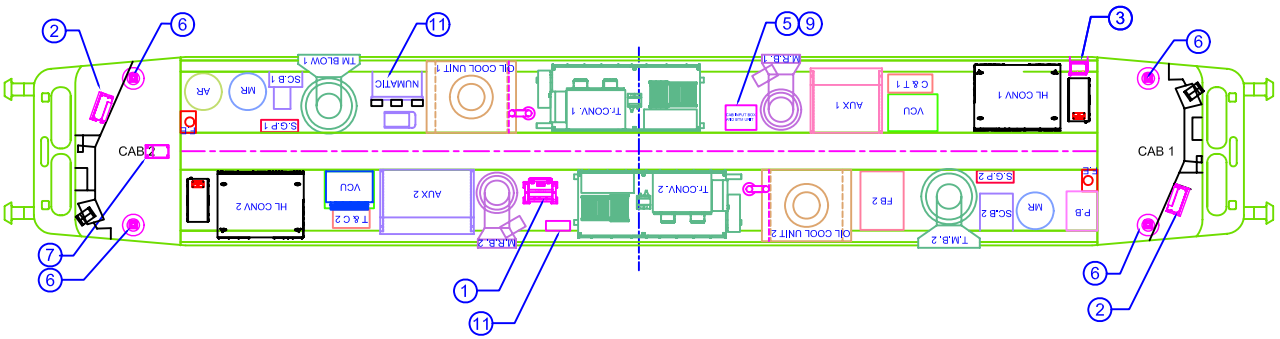
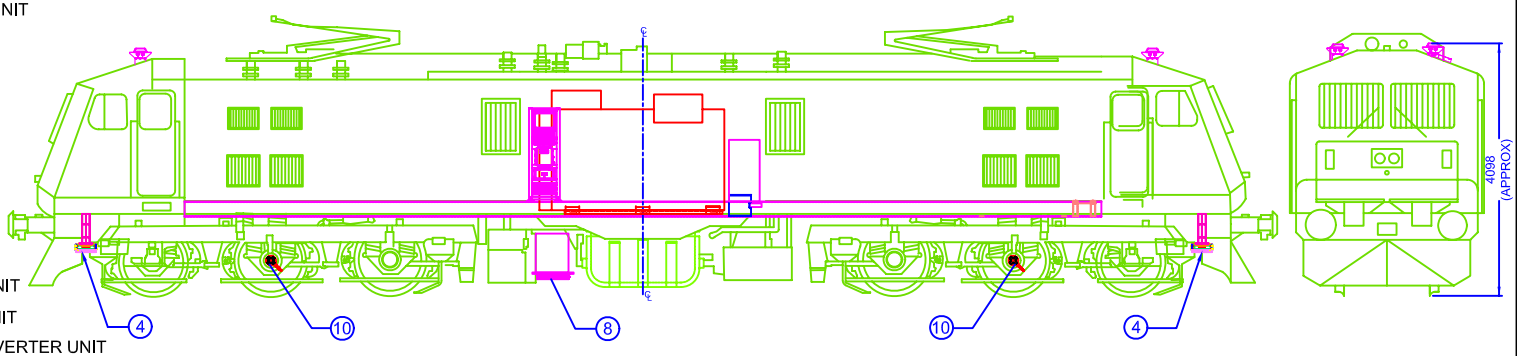
REF. :	SCALE - 1 : 20	APPD. BY. (For Dg)
TCAS EQUIPMENT LAYOUT WAP 7 (IGBT PROPULSION SYSTEM)		FIRST ISSUED
		SUPERSEDES
R.D.S.O. ELECT. DTE.	SKEL - 5050 ALT - 0	SUPERSEDED BY





FE --- FIRE EXTINGUISHER
PB --- PARKING BRAKE
AR --- AUXLARY RESERVOIR
MR --- MAIN RESERVOIR
SCB --- SCAVENGING BLOWER
SGP --- SWITCH GARE PART
TMB --- TRACTION MOTOR BLOWER
TR CONV --- TRACTION CONVERTER UNIT
MRB --- MACHINE ROOM BLOWER
OCB --- OIL COOLING BLOWER UNIT
MRB --- MACHINE ROOM BLOWER
PNU --- PNUMATIC PANEL
DISP --- DISPLAY UNIT
VCU --- VEHICLE CONTROL UNIT
FB --- FILTER BLOCK
AUX --- AUXILIARY CONVERTER UNIT
HL SF --- HOTEL LOAD SINE FILTER UNIT
HL SF --- HOTEL LOAD SINE FILTER UNIT
HL CONVERTER --- HOTEL LOAD CONVERTER UNIT

SNO	DESCRIPTION	LOCATION
11	LOCO TCAS E70 INTERFACE UNIT	M.R.B - 2
10	SPEED SENSOR	AXLE BOX No. 3 & 9
9	BTM UNIT DIMENSIONS: L400 X W500 X H350	M.R.B - 1
8	BTM ANTENNA DIMENSIONS: L560 X W460 X H140	TXFR
7	GPS_GSM ANTENNA DIMENSIONS: L450 X W250 X H250	ROOF TOP CAB 2
6	RF ANTENNA DIMENSIONS: L410 X W180 X H260	ROOF TOP CAB 1 AND CAB 2
5	CAB INPUT BOX DIMENSIONS:L300 X W150 X H400	M.R.B - 1
4	RFID READER DIMENSIONS: L560 X W440 X H630 (Above 450Mm from Rail level)	BEHIND CATTLE GUARD
3	RADIO UNIT DIMENSIONS: L310 X W230 X H340	CAB 1 AND TCAS UNIT
2	DMI UNIT DIMENSIONS: L400 X W200 X H420	CAB 1 AND CAB 2
1	TCAS UNIT: DIMENSIONS: L500 X W380 X H1150	M.R.B - 2

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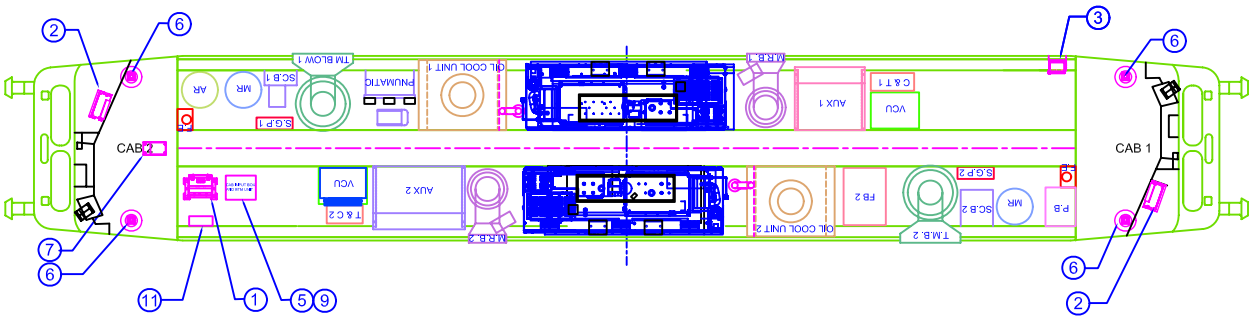
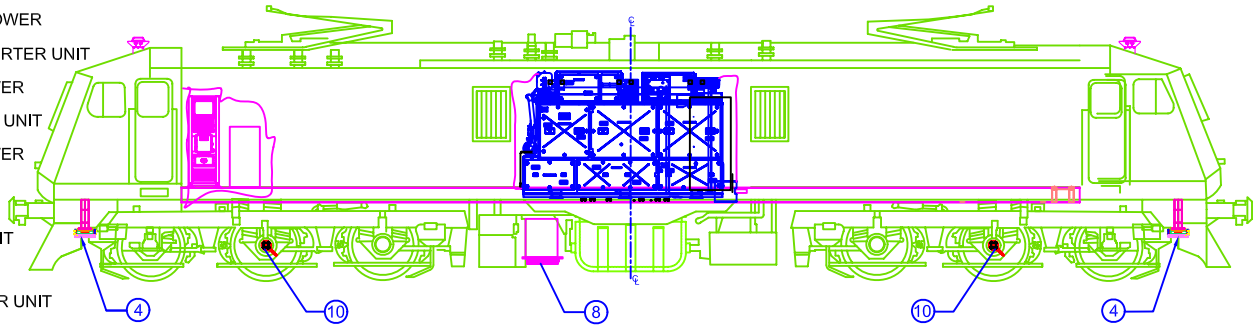
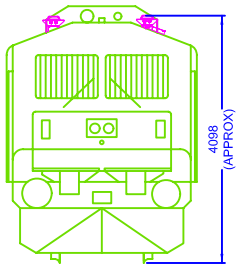
REF. :	SCALE - 1 : 20	APPD. BY. (For Dg)
TCAS EQUIPMENT LAYOUT WAP 7 (HOTEL LOAD)		FIRST ISSUED / SUPERSEDES
R.D.S.O. ELECT. DTE.	SKEL - 5051 ALT - 0	SUPERSEDED BY



FE --- FIRE EXTINGUISHER
PB --- PARKING BRAKE
AR --- AUXLARY RESERVOIR
MR --- MAIN RESERVOIR
SCB --- SCAVENGING BLOWER
SGP --- SWITCH GARE PART
TMB --- TRACTION MOTOR BLOWER
TR CONV --- TRACTION CONVERTER UNIT
MRB --- MACHINE ROOM BLOWER
OCB --- OIL COOLING BLOWER UNIT
MRB --- MACHINE ROOM BLOWER
PNU --- PNUMATIC PANEL
DISP --- DISPLAY UNIT
VCU --- VEHICLE CONTROL UNIT
FB --- FILTER BLOCK
AUX --- AUXILIARY CONVERTER UNIT





SNO	DESCRIPTION	LOCATION
11	LOCO TCAS E70 INTERFACE UNIT	VCU - 2
10	SPEED SENSOR	AXLE BOX No. 3 & 9
9	BTM UNIT DIMENSIONS: L400 X W500 X H350	VCU - 2
8	BTM ANTENNA DIMENSIONS: L560 X W460 X H140	TXFR
7	GPS_GSM ANTENNA DIMENSIONS: L450 X W250 X H250	ROOF TOP CAB 2
6	RF ANTENNA DIMENSIONS: L410 X W180 X H260	ROOF TOP CAB 1 AND CAB 2
5	CAB INPUT BOX DIMENSIONS:L300 X W150 X H400	VCU - 2
4	RFID READER DIMENSIONS: L560 X W440 X H630 (Above 450Mm from Rail level)	BEHIND CATTLE GUARD
3	RADIO UNIT DIMENSIONS: L310 X W230 X H340	CAB 1 AND TCAS UNIT
2	DMI UNIT DIMENSIONS: L400 X W200 X H420	CAB 1 AND CAB 2
1	TCAS Unit: Dimensions: L650 X W435 X H1150	VCU - 2

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REF. :	SCALE - 1 : 20	APPD. BY. (For Dg)	
TCAS EQUIPMENT LAYOUT WAP 7 PROPULTION WITH COMPOSITE CONVERTER			FIRST ISSUED
			SUPERSEDES
R.D.S.O. ELECT. DTE.	SKEL - 5052 ALT - 0		SUPERSEDED BY

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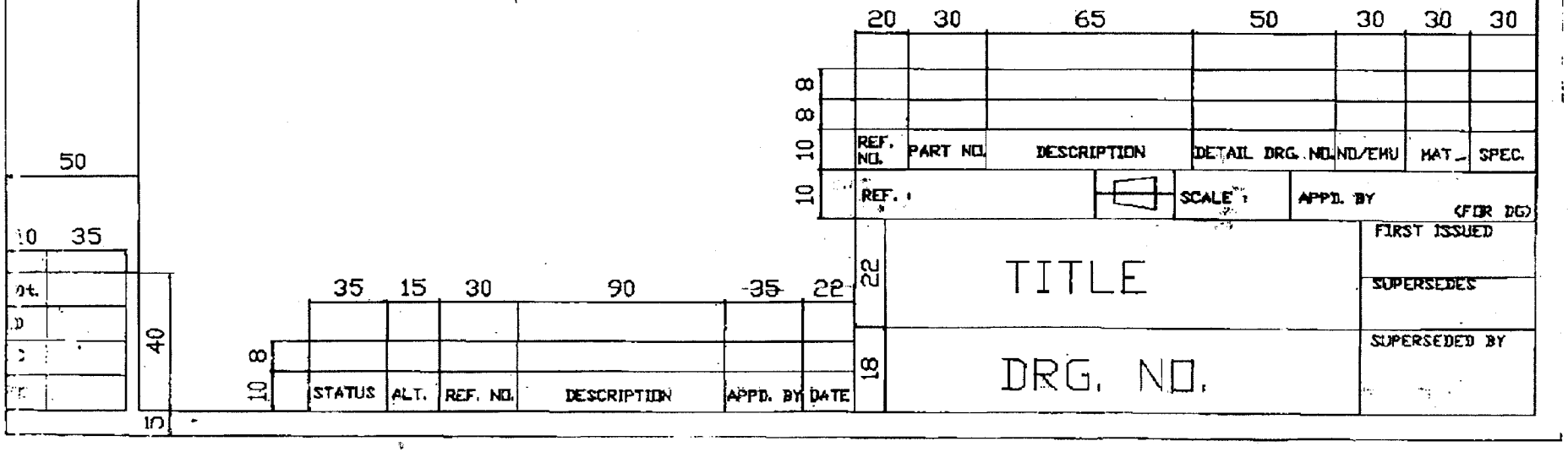
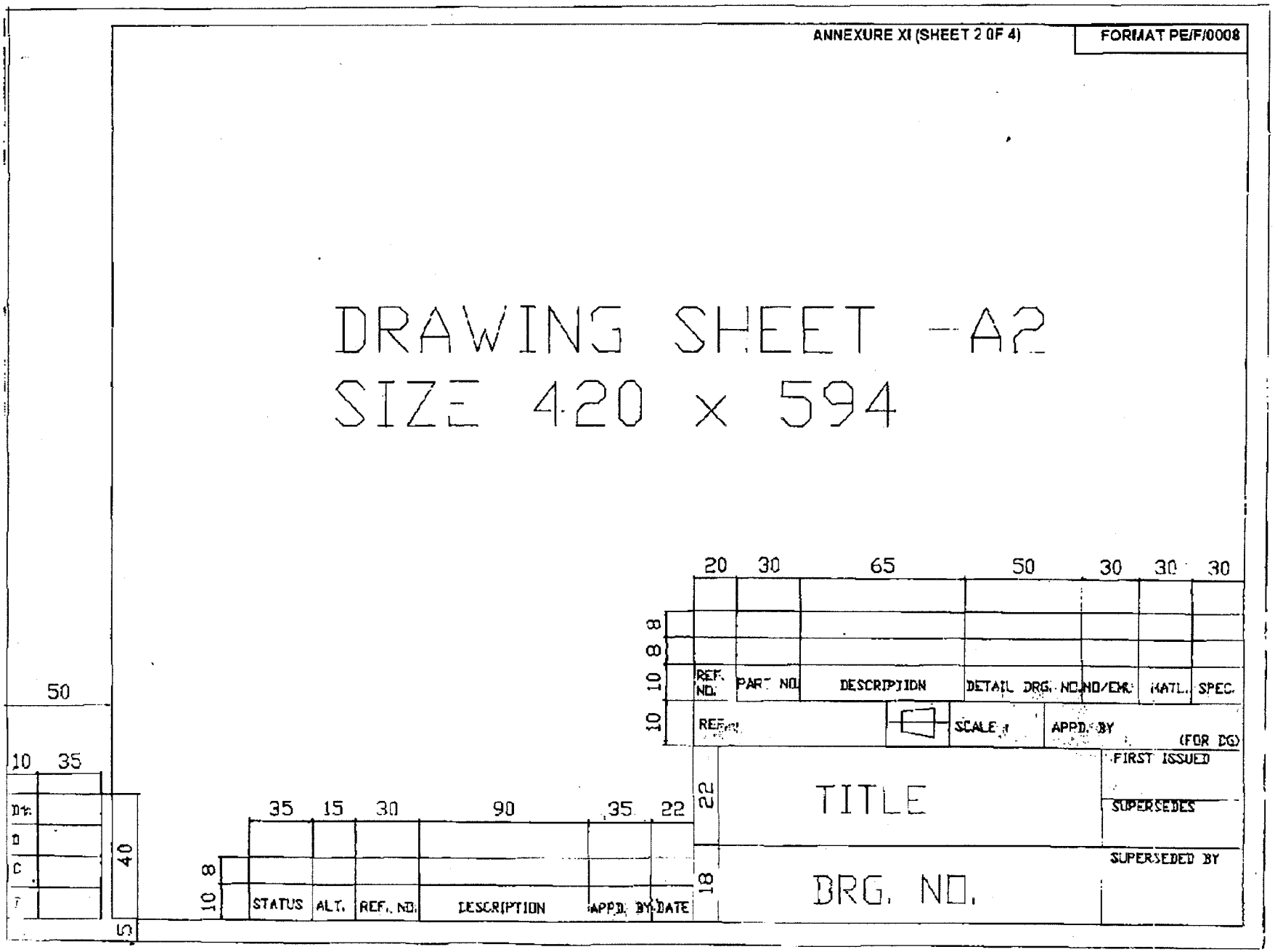
SIZE 594 X 841

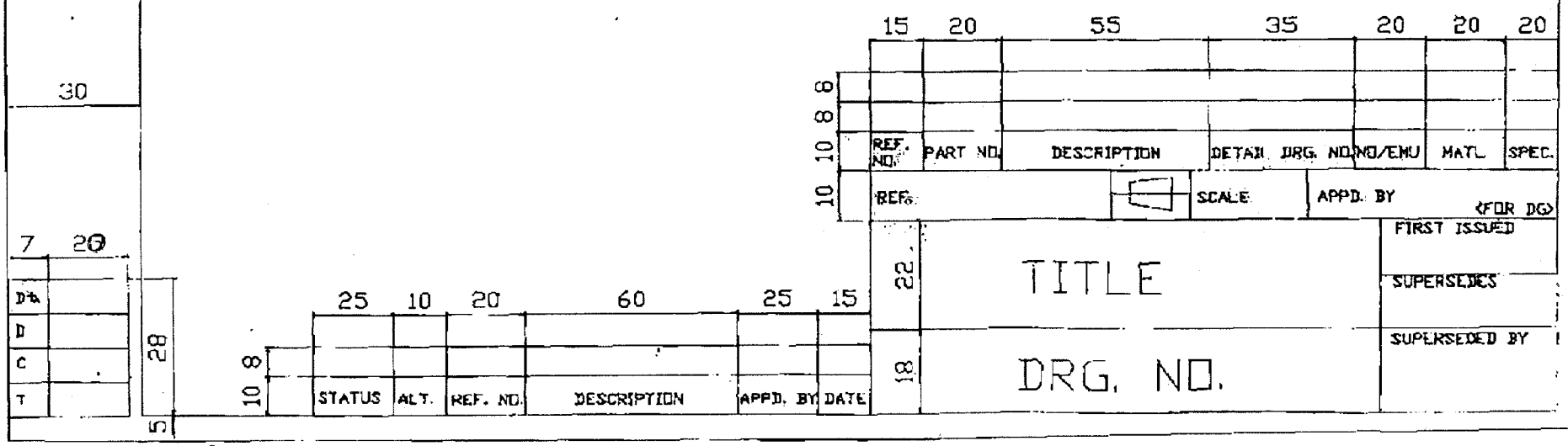




ANNEXUREIX
SHEET 2 OF 4

FORMAT PE/F/0009

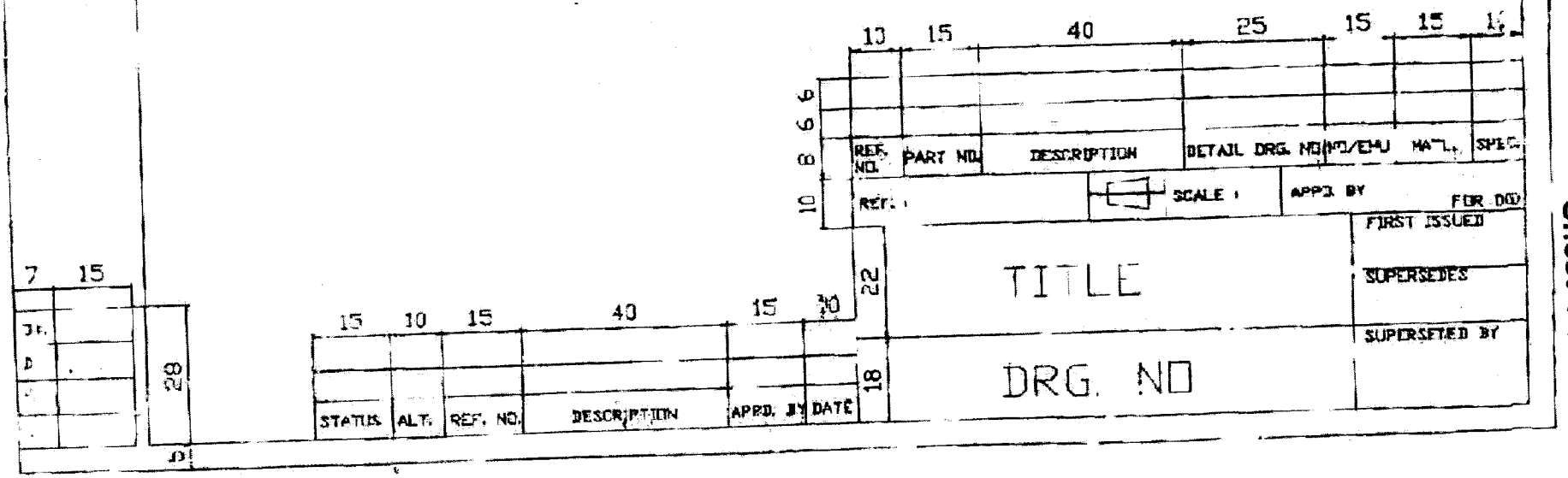
DRAWING SHEET -A3
SIZE 297 X 420



ANNEXURE XI (SHEET 4 OF 4)

FORMAT PE/F/0010

DRAWING SHEET -A4
SIZE 210 x 297



Annexure IX
Sheet 4 of 4

ANNEXURE - X

LIST OF 3-PHASE AC EMU ROLLING STOCK DRAWINGS FOR BOGIE, SUSPENSION & BRAKE ARRANGEMENT

(Copies Supplied as Soft Copy on digital media)

Note: These below mentioned drawings are only for reference purpose. The actual drawings to be used for manufacturing of EMU/MEMU will be supplied by PUs.

SL No.	Drawing no. or latest	Description of drawing
1	EMU/M/3PH-0-0-001/Col.1&2	Bogie general arrangement for 3-phase AC EMU Motor coac with air spring suspension
2	ICF/MRVC/D/BT-0-0-001Col.2&5	Bogie general arrangement for Driving trailer 'D' coach 'with air spring suspension
3	ICF/MRVC/D/BT-0-0-001Col.4&6	Bogie general arrangement for 'D' trailer coach 'with handicapped compartment and air spring suspension
4	ICF/MRVC/C/BT-0-0-001Col.2&3	Bogie general arrangement for 'C' trailer coach 'with air spring suspension
5	AC/DC EMU/M2-0-1-201	Axle box guide arrangement
6	EMU/M-0-2-016/Col-3	Roller bearing axle box arrangement for motor coach
7	DMU/DPC/SS-0-2-001	Wheel and axle arrangement for motor coach
8	EMU/M-0-2-001/Col-11	Roller bearing axle box arrangement for trailer coach
9	DC/EMU/H-0-1-202	Wheel and axle arrangement for trailer coach
10	DMU/DPC/SS-0-3-001	Bogie frame arrangement for motor coach
11	ICF/MRVC/D-0-3-001	Bogie frame arrangement for trailer coach
12	AC/DC/EMU/D2-0-3-201	Fixing arrangement of AWS engine magnet and APC receiver
13	ICF/MRVC/C-0-4-001 or DMU/DPC10-0-4-001	Bogie bolster arrangement for air spring bogie
14	ICF/MRVC/M/BT-0-5-001/COL-2	Bolster suspension arrangement for Motor coach
15	ICF/MRVC/M/BT-0-5-001/COL-3	Bolster suspension arrangement for trailer coach

SL No.	Drawing no. or latest	Description of drawing
16	DMU/DPC7-0-5-702	Pneumatic piping arrangement for 4point suspension air spring bogie
17	DMU/DPC7-3-2-701	Bogie brake piping arrangement
18	DMU/DPC7-3-2-702	Bogie brake piping and parking brake arrangement
19	EMU/M-3-2-064	Bogie brake arrangement
20	ICF/MRVC/M-9-0-006	Suspension diagrammatic arrangement for Motor coach
21	ICF/MRVC/C-9-0-004	Suspension diagrammatic arrangement for trailer coaches
22	CG-K4028	Schematic diagram for spring applied parking brake system with selection valve for EMU, MEMU & DMU stock
23	Latest drawing	Layout of all type of coaches

ANNEXURE - XI

LIST OF 3-PHASE MEMU ROLLING STOCK DRAWINGS FOR BOGIE, SUSPENSION & BRAKE ARRANGEMENT

(Copies Supplied as Soft Copy on digital media)

Note: These below mentioned drawings are only for reference purpose. The actual drawings to be used for manufacturing of EMU/MEMU will be supplied by PUs.

Sl. No.	Drawing no. or latest	Description of drawing
1	EMU/M/3PH-0-0-001/Col.3&4	Bogie general arrangement for 3-phase AC EMU Motor coach with air spring suspension (applicable for MEMU/DMC)
2	ICF/MRVC/C/BT-0-0-001Col.2&3	Bogie general arrangement for 'C' trailer coach 'with air spring suspension (applicable for MEMU TC)
3	AC/DC EMU/M2-0-1-201	Axle box guide arrangement
4	EMU/M-0-2-016/Col-3	Roller bearing axle box arrangement for motor coach
5	DMU/DPC/SS-0-2-001	Wheel and axle arrangement for motor coach
6	EMU/M-0-2-001/Col-11	Roller bearing axle box arrangement for trailer coach
7	DC/EMU/H-0-1-202	Wheel and axle arrangement for trailer coach
8	DMU/DPC/SS-0-3-001	Bogie frame arrangement for motor coach
9	ICF/MRVC/D-0-3-001	Bogie frame arrangement for trailer coach
10	AC/DC/EMU/D2-0-3-201	Fixing arrangement of AWS engine magnet and APC receiver
11	ICF/MRVC/C-0-4-001 or DMU/DPC10-0-4-001	Bogie bolster arrangement for air spring bogie
12	ICF/MRVC/M/BT-0-5-001/COL-2	Bolster suspension arrangement for Motor coach
13	ICF/MRVC/M/BT-0-5-001/COL-3	Bolster suspension arrangement for trailer coach
14	DMU/DPC7-0-5-702	Pneumatic piping arrangement for 4point suspension air spring bogie

Sl. No.	Drawing no. or latest	Description of drawing
15	DMU/DPC7-3-2-701	Bogie brake piping arrangement
16	DMU/DPC7-3-2-702	Bogie brake piping and parking brake arrangement
17	EMU/M-3-2-064	Bogie brake arrangement
18	ICF/MRVC/M-9-0-006	Suspension diagrammatic arrangement for DMC
19	ICF/MRVC/C-9-0-004	Suspension diagrammatic arrangement for trailer coaches
20	CG-K4028	Schematic diagram for spring applied parking brake system with selection valve for EMU, MEMU & DMU stock
21	Latest drawings	Layout of all type of coaches

Annexure-XII

LIST OF EQUIPMENTS FOR WHICH MTBF/MDBF TO BE SUBMITTED.

S.No.	Equipment	MTBF/MDBF
1.	Traction Transformer	
2.	Traction Motor	
3.	Traction Converter	
4.	IGBT modules	
5.	Pantograph	
6.	Compressor, Air Dryer & Filters	
7.	Vaccum Circuit Breaker	
8.	Lightning Arrestors	
9.	Auxiliary Converter	
10.	Master cum Brake Controller	
11.	Train Management System	
12.	Passenger Information & Communication system	
13.	Cables	
14.	Inter Vehicular couplers	
15.	Brake Electronic Control Unit	

ANNEXURE-XIII

INDIAN RAILWAYS
INTEGRAL COACH FACTORY, CHENNAI-38.
Telefax: 044-2626182

No. MD/D/Weights/119

Office of the
General Manager/ Mech. Design
November 29, 2007

Director General (Carriage)
RDSO, Lucknow – 226 011. Fax: 0522-2450679

(Kind attn: Shri Vineet Singh, Dir./ Carr.)

Sub: Measured weight of AC/DC EMU (MRVC) coaches.

Measured weights of fully-furnished AC/DC EMU coaches (Tare condition) are given below.

Data	Motor coach	C-Trailer	D-Trailer	D(HC) Trailer
Coach no.	M-10	C-14	D-6	DHC-7
Weight of body 't'	34.114	23.415	25.701	24.475
Weight of two bogies 't'	19.754	13.360	13.360	13.360
Tare weight of coach 't'	53.868	36.775	39.061	37.835
Unbalance 't'	4.324 (HT end bogie)	0.349 (Alarm end bogie)	1.527 (Driving end bogie)	0.223 (Alarm end bogie)
ESTIMATED WEIGHTS				
Tare weight of coach 't'	54.200	37.101	37.648	37.937
Unbalance 't'	7.311 (HT end bogie)	–	0.493 (Driving en d bogie)	–

(S. Srinivas)
Dy. CME/ SPV
For General Manager/ Mech. Design

Copy to:
ED (PS&EMU)/ RDSO/ LKO

Annexure XIV

EMU Mumbai

Shocks and Vibration Measurements

Table 1 : Rakes , Train Services and Routes for Measurement

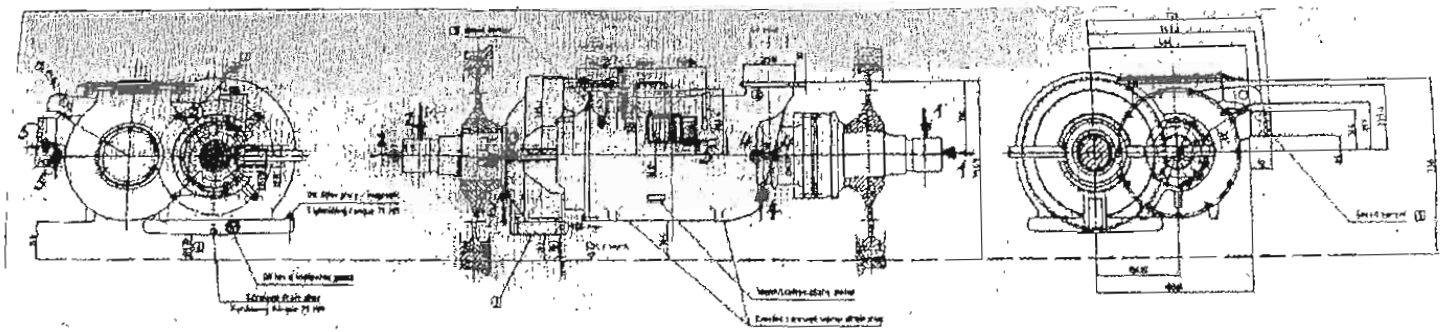
Date	Rake	Track	Corridors	Runs	Comment
10-07-04	Alstom No. 915B	Western line	Up through	3	Normal passenger service in regular trains (Churchgate-Borivali)
			Down through	3	
			Up local	1	
			Down local	1	
11-07-4	Alstom No. 915B	Western line	Up through	1	Special service without passengers (Churchgate-Andheir) Max. speed – 85 km/h
			Down through	1	
16-07-04	BHEL No. 303	Western line	Up through	1	Special service without passengers (Churchgate-Andheir) Max. speed – 85 km/h
			Down through	1	
17-07-04	BHEL No. 303	Harbour line	Feeder down	1	Special service without passengers (CST-Vashi)
			Up	1	
			Down	1	

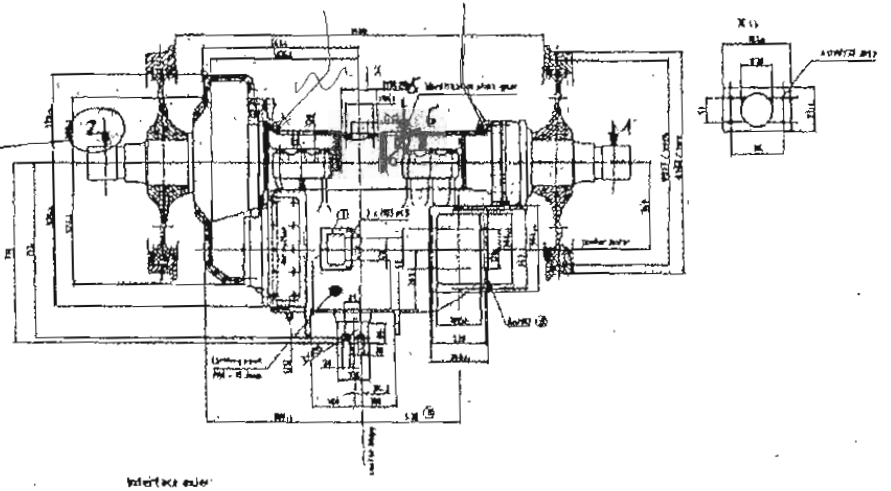
Table 2 : Location of Sensors : Alstom Rake

Location		Sensor	Direction		
Converter Cubicle – floor	Frame profile	Accelerometer	1x	1y	1z
Converter Cubicle – rack	1.5 m height	Accelerometer	2x	2y	2z
Converter Cubicle – top	Earth terminal	Accelerometer	3x	3y	3z
Axle bearing box	Drive end	Accelerometer	4x	4y	4z
Axle bearing box	Non-drive end	Accelerometer	5x	5y	5z
Suspension tube bearing housing	Drive end	Accelerometer	6x	6y	6z
Suspension tube bearing housing	Non-drive end	Accelerometer	7x	7y	7z
Gear case		Accelerometer	8x	8y	8z
Torque nose motor		Accelerometer	9x	9y	9z
Torque bracket bogie		Accelerometer		10y	10z
Torque bracket – between motor/bogie		Displacement transducer			

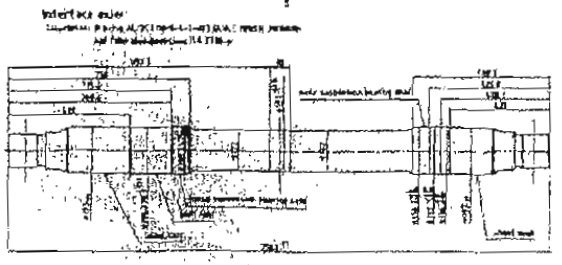
Table 3 : Location of Sensors : BHEL Rake

Location		Sensor	Direction		
Converter Cubicle – floor	Frame profile	Accelerometer	1x	1y	1x
Converter Cubicle – rack	1.5 m height	Accelerometer	2x	2y	2z
Axle bearing box	Drive end	Accelerometer	4x	4y	4z
Axle bearing box	Non-drive end	Accelerometer	5x	5y	5z
Suspension tube bearing housing	Drive end	Accelerometer	6x	6y	6z
Torque nose motor		Accelerometer	9x	9y	9z
Torque bracket bogie		Accelerometer		10y	10z
Torque bracket – between motor/bogie		Displacement transducer			





Indicator measuring points



~~Footer~~

To be read in conjunction with Submission no 7 dt 25.06.04

Rev. 0 to 1

Table 4: Extreme Values with 40 Hz Low pass filtered /100 Hz Low pass filtered

			all signale are filtered by 40 Hz lowpass												All signale are filtered by 100 Hz lowpass																		
Extreme values		max. speed Km/h	Converter Department floor			Converter Department- rack 1.5 m height			Converter Department- Earth terminal			Axle Bearing Box drive End			Axle Bearing Box NDE			Suspension tube DE bearing			Suspension tube NDE bearing			Gear Case			Torque nose- motor			Torque bracket bogie		Torque bracket between motor bogie
			X m/s²	Y m/s²	Z m/s²	X m/s²	Y m/s²	Z m/s²	X m/s²	Y m/s²	Z m/s²	X m/s²	Y m/s²	Z m/s²	X m/s²	Y m/s²	Z m/s²	X m/s²	Y m/s²	Z m/s²	X m/s²	Y m/s²	Z m/s²	X m/s²	Y m/s²	Z m/s²	X m/s²	Y m/s²	Z m/s²	X m/s²	Y m/s²	Z m/s²	Y m/s²	Z m/s²	(mm)
Alstom	Up through	73	1.1	2.4	13.7	4.2	6.4	23.4	33.6	6.0	30.9	85	41	229	69	48	228	59	69	164	102	53	186	57	53	149	75	72	46	70	78	28
	Down through	71	1.6	1.1	1.8	1.9	2.8	2.2	6.7	4.0	5.6	73	43	221	67	31	209	56	68	139	70	66	175	65	61	133	52	84	43	51	41	26
	Up Local	73	0.8	1.2	2.1	2.0	4.0	2.4	8.8	4.8	5.7	78	43	186	81	32	239	62	57	134	83	55	165	62	43	117	60	54	47	60	58	29
	Down Local	71	0.9	1.2	2.0	2.2	3.2	3.6	7.7	4.7	6.4	71	43	204	67	40	248	78	65	164	90	52	150	59	46	127	69	61	49	82	54	29
	Up through 85 km/h	85	1.0	2.1	8.9	2.7	3.3	25.6	21.1	4.7	21.3	107	44	259	71	33	260	64	67	163	121	54	198	67	58	136	86	84	42	59	64	28
	Down through 85/km/h	85	3.8	23.6	2.2	1.9	3.0	3.6	7.5	4.3	5.0	99	61	321	65	36	219	81	62	185	75	65	182	68	58	155	56	82	49	48	55	25
BHEL	Up through 100 km/h	100	0.9	1.8	5.5	4.0	3.3	4.0				61	32	-	69	40	362										45	48	91	16	62	49
	Down through 100 km/h	100										59	36	-	53	37	274										54	48	71	17	55	43
	Feeder Harbour down		1.2	1.4	7.1	3.3	2.0	2.7				46	30	239	60	32	268	77	60	175							40	47	93	15	32	45
	Harbour up											44	28	203	48	34	191	100	52	171							40	41	63	13	35	43
	Harbour down											44	29	207	57	34	220	72	59	147							36	42	72	13	31	46

Max. extrem values of the rakes

Max. extrem values of the tests

ANNEXURE - XVI

Tare weight, Payload, Type of Motor to be used for EMUs and MEMUs

(To be declared by Manufacturing units as per approved Layouts of EMU/MEMU Coaches by RDSO)

A) For EMUs

Basic unit composition: ……

S.No.	Type of Coach	Tare weight(in tonnes) excluding only the electrics as mentioned in clause 4.0A	Payload (in Tonnes) considering weight of each passenger as 60 kg
1			
2.			
3.			
4.			

Total Tare weight(excluding only the electrics as mentioned in para 4.0(A)) of one End Basic unit in Tonnes: ……..

Total Tare weight((excluding only the electrics as mentioned in para 4.0(A)) of one Middle Basic unit in Tonnes: ……..

Total Payload of one End Basic unit in Tonnes: ……..

Total Payload of one Middle Basic unit in Tonnes: ……..

Type of Bogie: ……..

Type of Shell: ……

Type of Motor : Axle hung, Nose Suspended/ Fully Suspended ……

B) For MEMUs

Basic unit composition: ……

S.No.	Type of Coach	Tare weight(in tonnes) excluding only the electrics as mentioned in clause 4.0A	Payload (in Tonnes) considering weight of each passenger as 60 kg
1			
2.			

Total Tare weight(excluding only the electrics as mentioned in para 4.0(A)) of one Basic unit in Tonnes: ……..

Total Payload of one Basic unit in Tonnes: ……..

Type of Bogie: ……..

Type of Shell: ……

Type of Motor : Axle hung, Nose Suspended/ Fully Suspended ……

Annexure-XVII to Specification no. RDSO/PE/SPEC/EMU/0163 (Rev. 3)-2022

(Applicable for EMUs of Mumbai sub-urban area only)

Note:

1. The deletions are marked in strikethrough and additions are italics, bold and underlined.
2. The dotted segment indicates that rest of the clause not appearing here, is not affected and continue to remain same as in the original specification.

Sl. No.	Clause of the Specification	Changes in the Clauses
1.	2.3	Steepest gradient to be negotiated: 1 in ~~100~~ ***34:*** for EMUs(~~other than~~ ***for*** Mumbai area) ~~and MEMUs~~ Other description of the clause will be same.
2.	2.3.1	The track data of section between ~~Delhi-Ambala-Delhi~~ ***Churchgate–Andheri-Virar section of CR and Mumbai CSMT–Thane –Kasara section of WR*** is enclosed as Annexure III A & III B. The largest peak in each Km for unevenness, Twist, Gauge and Alignment is also indicated in the Annexure attached. The mounting of the equipment shall be designed to suit the worst cases as per the Annexure III so that their performance is not affected adversely. It is to be noted that the track data attached is for guidance only as the actual track conditions may vary. Clause 2.7 (ix) may be referred in this regard. The section on which the performance shall be verified may change, accordingly, track data shall be made available to the supplier at design approval stage
3.	2.5, 3.1.3(a), 3.1.5,3.1.13, Annexure-II	Replace "2.4 Km" by "***1.5 Km***" in all the clauses
4.	2.7(v)	Altitude: ~~At any altitude between 0 and 1776 m above mean sea level~~ ***Coastal area***
5.	2.7(vii)	The equipment …… made dead. There are certain sections of the track that get flooded with water to standing depth of ~~400~~ ***760*** mm(203 mm for traction motor of MEMUs). The traction gear and other under slung equipments must be completely water proof to this height above rail level. During the peak flood condition water may reach up to floor level. The equipment shall not get damaged due to such flooding and it should be possible to rejuvenate the equipments with minor attention without any adverse effect on their performance
6.	Index (Chapter 3)	Performance in 1 in ~~100~~***34*** grade
7.	3.1.5	Supplier shall submit the RMS current values of traction motor and temperature rise of propulsion equipment for a SDCL 12 car EMU rake/~~DCL 12 Car MEMU rake~~ operation under normal with below mentioned conditions, to stabilization of temperature of all propulsion equipments with average line voltage of 22.5 KV. a. repeated typical run(as defined in para 3.1.3) of ~~2.4~~ ***1.5 Km*** on level tangent track for all-out running for EMUs ~~other than~~ ***for*** Mumbai area, ~~6.0 km section for MEMUs~~ b. repeated all-out mode of ~~Sabzimandi-Panipat-Sabzimandi~~

Sl. No.	Clause of the Specification	Changes in the Clauses
		Churchgate–Andheri-Virar section of CR and/or Mumbai CSMT–Thane -Kasara section of WR with a dwell time of 30 sec. This should also be done with 1 motor coach isolated condition (only for submission of simulation together with temperature rise and validation on combined test bed as per clause 3.1.10). Supplier shall also ensure compliance to Clause no. 2.5. The R.M.S. (root mean square) loading of the traction motor with regenerative braking in use for all out running as mentioned herein shall not exceed the continuous rating of the traction motor..
8.	3.1.8	The super dense crush loaded ~~9~~ ***12***-car EMU/~~8~~ ***12*** ~~car dense crush loaded MEMU~~ rake with one motor coach isolated and already running continuously in the section with new wheels shall be capable of starting on a gradient of 1 in ~~100~~ ***34*** and clear this section of 1 Km. The temperature rise …….. conditions as per the Annexure II.
9.	3.1.9, 3.1.11, 3.1.12, 3.1.13, 5.11(i) & Annexure-II	Replace "Sabzimandi-Panipat section" by **"Churchgate–Andheri-Virar section of CR and/or Mumbai CSMT–Thane -Kasara section of WR**"
10.	3.1.20	Supplier …….. SDCL loaded EMU/~~DCL loaded MEMU~~ train starting on a rising gradient of 1 in ~~100~~ ***34*** along with the time and distance for attaining 110 kmph speed on straight and level tangent track.
11.	4.4.17(i)	Flood proofing tests: Traction motor fitted with pinion & gear box running at 200 r.p.m (without gear, axle roller bearing housing & other attachment parts) to be immersed up to ~~400~~ ***760*** mm(203 mm for MEMUs) from rail level for 24 hours. Following test parameters shall be recorded: a) Insulation resistance before immersion test b) Insulation resistance after immersion test c) Visual inspection regarding seepage of water inside the gear box and motor
12.	4.12.8(i)	A parking brake system shall be provided in each 3 car unit and shall be capable of holding it under SDCL loaded condition of EMU ~~and 4 car unit & shall be capable of holding it under DCL loading conditions for MEMU~~ on a 1 in ~~100~~ ***34*** gradient when there is no electrical power. A test scheme shall be submitted by the supplier to test the efficacy of parking brake system during the design stage. Detailed design calculation justifying the suitability of the offered system shall be submitted during design stage by the supplier. The system shall be tested for its satisfactory functioning in 12-car rake.
13.	4.14.19 New clause	***VENTILATION*** ***The implementation of the proposed modifications to the extent of mounting and ducting arrangements etc. shall be the responsibility of ICF/nominated manufacturing unit. However, interface of the electrical equipment with the system shall be done by the supplier.*** ***(i) The ventilation design furnished by the supplier shall be adopted on the new built RDSO design EMU stock which shall be manufactured at ICF. The***

Sl. No.	Clause of the Specification	Changes in the Clauses
		existing layout of ventilation shall be followed; however, any improvement in the layout proposed by the supplier shall be examined at the design stage. ***(ii) In the existing EMU stock, already in service in Mumbai suburban services, during the peak rush hour i.e with SDCL loading condition of passengers, the natural ventilation gets retarded due to blocking of doors and windows by the passengers and CO2 level in the coach goes to uncomfortable limits. This accumulation of CO2 which may go beyond threshold limits, leads to highly uncomfortable conditions specially for standing passengers in the coach.*** ***(iii) Bidder is advised to study the problems of ventilation in the existing EMU stock operating in Mumbai area. Based on the study the Bidder shall assess the CO2 level inside the SDCL loaded coach and design the coach ventilation such that CO2 level inside the SDCL loaded coach does not exceed the permissible threshold limit of the order of 700 PPM above the CO2 concentration in air outside. The bidder shall submit the fresh air requirement for the purpose as above without taking the effect of natural ventilation, As such the air flow of the order of 15,000 m3 /hr per coach shall be maintained. The ventilation design as proposed by the supplier shall be such that control of CO2 level is through natural ventilation arrangement to maximum possible extent and may be supplemented by forced ventilation, if required, to achieve a desired comfort level. Supplier after the detailed study may suggest the modifications along with the complete drawings required in the existing design of ICF built stock to improve the natural ventilation without any major modification in the structure. It shall be the responsibility of the Supplier to ensure the ventilation level as desired. Ashrae standard shall be referred for any clarification.*** ***(iv) The coach ventilation arrangements shall be so designed that in event of failure of forced ventilation, there is still reasonable level of comfort to passengers not necessitating immediate withdrawal of coach.*** ***(v) Bidder shall furnish detailed calculation and design philosophy adopted and reason thereof. The energy consumption of arrangement shall also be furnished. Suitable test procedure shall be furnished by the Supplier during design stage to validate the ventilation design.*** ***(vi) For forced ventilation, fresh & filtered air will be introduced into the cars via longitudinally arranged diffusers situated in the ceiling. As the ambient conditions in Mumbai are extremely humid, the design shall ensure automatic draining of condensate from the duct. The Supplier shall furnish detailed design drawings of the duct arrangement and any other such modification at the time of design approval stage.*** ***(vii) Superstructure shall be provided with ducting arrangement for discharge / exhaust of air. It shall be ensured that water does not enter in such arrangement during rains or car washing. Complete duct for the forced ventilation system shall be provided in the prototype unit only for measurement of air flow in actual conditions. Special care shall be taken to***

Sl. No.	Clause of the Specification	Changes in the Clauses
		ensure that there is no ingress of water at the worst conditions, when there is heavy rain striking at 45 degree opposite to the movement of the train running at 110 kmph. This shall be verified by simulating on the mockup at equipment manufacturer's works. ***(viii) Suitable mechanism to adjust the air flow/speed of the ventilators, depending upon rush hours and seasonal requirements, shall be provided. Load weigh signal shall be used for adjustment of the ventilation in suitable steps. Alternative provision shall also be provided with the driver, which may be actuated if so desired during exigencies. The loading pattern varies during 24 hours due to typical traffic pattern in suburban systems.*** ***Ventilation broadly conform to ICF specification no. ICF/Elec./0159 latest revision.***
14.	4.15	The equipment shall be designed to run at 8 km/h through water up to 203 mm above rail level, allowance to be made in addition, for the increase in the height of the water level due to wave effect. Further, due to certain sections of the tracks becoming flooded with water to a standing depth of ~~400~~ ***760*** mm (203 mm for traction motor of MEMUs), the traction gear and other under slung equipment must be made completely waterproof to this height above rail level. During peak flood conditions water may reach up to floor level. Under such conditions, it shall be possible to rejuvenate the equipment with minimal maintenance.
15.	5.1.4	All the mandatory and performance tests/ trials/ shall be carried out in ~~Sabzimandi-Panipat~~ ***Churchgate–Andheri-Virar section of CR and/or Mumbai CSMT–Thane-Kasara section of WR*** for 12 car SDCL EMUs~~/12 car DCL MEMUs~~. ***However, Oscillation/EBD trial and Radio Frequency Interference performance test shall be carried out for 12/15/18 Car SDCL EMUs (As per purchase order requirement).*** This will include all the requirement as specified in Chapter 3 & 5.
16.	5.10.1(i)	Test runs shall be made on the ~~Delhi-Ambala~~ ***Churchgate–Andheri-Virar section of CR and/or Mumbai CSMT–Thane -Kasara section of WR*** or any other sections on which the stock is to operate with sufficient number of trains to ensure that the train equipment meets the operating conditions. The duration …… availability of sections.
17.	Annexure-II	Replace "1 in 100" by "***1 in 34***"

Annexure-XVIII to Specification no. RDSO/PE/SPEC/EMU/0163 (Rev. 3)-2022

(Applicable for MEMUs of Jammu & Kashmir area and Hilly areas only)

Note:

1. The deletions are marked in strikethrough and additions are italics, bold and underlined.
2. The dotted segment indicates that rest of the clause not appearing here, is not affected and continue to remain same as in the original specification.

S. No.	Clause of the Specification	Changes in the Clauses
1	1.1.5(v) New clause	***Smoke/Fire detection system compliant to ARGE Guideline Part 1 "Fire detection in railway vehicles" shall be deployed. These standards may be referred for details of Smoke/Fire detection time, Positioning and commissioning of the system etc. The system to be capable of detecting smoke / fire along with its location at incipient stage of fire. In passenger areas, the system to provide a dynamic two detector dependency (smoke and/or heat) along with provision of drift compensation in order to decrease the risk of false, or unwanted alarm.*** ***Prototype approval to ensure the compliance of the system to ARGE guidelines will be arranged by the supplier and will be witnessed by any accredited assessor for these systems in presence of consignee/RDSO. Issues related to interface of smoke/fire detection system with TCMS shall be finalized at detailed design stage***. ***Air conditioning of each coach and Fresh air and return air ducts should be controllable as per fire system requirement***
2	2.3	Steepest gradient to be negotiated: 1 in ~~100~~ ***34:*** for ~~EMU(other than mumbai) and~~ MEMUs Other description of the clause will be same.
3	2.3.1	The track data of section between ~~Delhi-Ambala-Delhi~~ ***Katra-Banihal section and back*** is enclosed as Annexure III A & III B. The largest peak in each Km for unevenness, Twist, Gauge and Alignment is also indicated in the Annexure attached. The mounting of the equipment shall be designed to suit the worst cases as per the Annexure III so that their performance is not affected adversely. It is to be noted that the track data attached is for guidance only as the actual track conditions may vary. Clause 2.7 (ix) may be referred in this regard. The section on which the performance shall be verified may change, accordingly, track data shall be made available to the supplier at design approval stage
4	2.7(ii)	Ambient temp. max. : 50º C min. : ~~-5~~ ***-10*** C Average annual ambient temperature shall be taken as 35°C. Maximum temperature inside HT compartment of motor coach may reach 55º C.
5	2.7(v)	**Altitude**: At any altitude between 0 and ~~1000~~ ***1776*** m above mean sea level
6	3.1.3(b)	MEMU: The typical run of 6 Km on level tangent track for all out running i.e. full acceleration and full braking without coasting and with regeneration braking for a dense crush loaded (DCL) 12 car rake with nominal line voltage of 22.5 KV in AC traction and new wheels shall be considered as one traction cycle with

S. No.	Clause of the Specification	Changes in the Clauses
		reference to Clause 3.1.7. The train shall achieve the maximum speed of ~~110~~ ***100*** kmph from standstill in less than 240 seconds ***in continuous up gradient section of 1 in 80 grade***. Supplier shall also ensure compliance to clause 2.5. However, the maximum current drawn from OHE at the average line voltages specified herein shall not be exceeded at lower voltages.
7	3.1.5	Supplier shall submit the RMS current values of traction motor and temperature rise of propulsion equipment for a ~~SDCL 12 car EMU rake~~/DCL 12 Car MEMU rake operation under normal with below mentioned conditions, to stabilization of temperature of all propulsion equipments with average line voltage of 22.5 KV. a. repeated typical run(as defined in para 3.1.3) of ~~2.4~~ ***6.0*** Km on level tangent track for all-out running for ~~EMUs~~ MEMUs ~~other than for Mumbai area, 6.0 km section for MEMUs.~~ b. repeated all-out mode of ~~Sabzimandi-Panipat-Sabzimandi~~ ***Katra – Banihal-Katra section*** with a dwell time of 30 sec ***at speed of 100 kmph***. This should also be done with 1 motor coach isolated condition (only for submission of simulation together with temperature rise and validation on combined test bed as per clause 3.1.10). Supplier shall also ensure compliance to Clause no. 2.5. The R.M.S. (root mean square) loading of the traction motor with regenerative braking in use for all out running as mentioned herein shall not exceed the continuous rating of the traction motor..
8	3.1.8	The ~~super dense crush loaded~~ ~~12-car EMU~~/12 car dense crush loaded MEMU rake with one motor coach isolated and already running continuously in the section with new wheels shall be capable of starting on a gradient of 1 in ~~100~~ ***34*** and clear this section of 1 Km. The temperature rise …….. conditions as per the Annexure II.
9	3.1.9, 3.1.11, 3.1.12, 3.1.13, 5.11(i) & Annexure-II	Replace "Sabzimandi-Panipat section" by **"*Katra-Banihal section***"
10	3.1.17	Regenerated Energy -The regenerated energy for all out running up to 110 kmph(full traction up to 110 Kmph and full service braking up to standstill) shall not be less than 23% of the energy consumed during powering at the specified voltage for ~~both EMU &~~ MEMU. Acceleration and braking rates shall be as defined in clause 2.4 of the Specification. Full auxiliary load shall be taken into account except emergency load and ~~ventilation load~~ ***RMHU load***. Also duty cycle of compressors shall be considered as 100%. The net energy consumed or regenerated at the pantograph shall be used for calculating percentage regeneration energy. In the event of failure of one Basic Unit/equipment less than or equivalent to that of one Basic Unit, reduction in the value of regenerated energy shall not be more than that of their proportionate value.
11	3.1.20	Supplier shall submit the residual acceleration for the ~~SDCL loaded EMU/~~DCL loaded MEMU train starting on a rising gradient of 1 in ~~100~~ ***34*** along with

S. No.	Clause of the Specification	Changes in the Clauses
		the time and distance for attaining 110 kmph speed on straight and level tangent track.
12	4.0(A)(xv)	Complete pre-fabricated driver's and shunting desk. The cab shall include all the cab equipments e.g. combined master-cum-brake controller instrument panel with back-lit instruments, gauges for pneumatic indications, control panels, driver's diagnostic display unit & driver's "log in" device, ~~cab AC~~, ***cab heater unit and defogging unit with blower(with control panel, anti vibration mountings, interconnecting ducts for defogging unit, air diffuser of de-fogging unit for wind screen)***, driver and guard seat etc., ergonomically designed driver
13	4.0(A)(xxviii)	~~Cab air-conditioning system complete with switch gear & control system~~ ***a) Roof Mounted Heating Unit (RMHU) consisting of Heater units, Blower unit with motor, Over heat sensors, temperature sensors, Fresh air filters, return air filters, connectors for Power and Control cable connections, flexible conduits*** ***b) Control Panel box(pre wired) Consisting of contactors, control Transformer (230V/110V ac), MCBs, Temperature Controller, Rotary switch, Terminal board and pre wired- connector type plug with sufficient length of cable (of approved make) to RMHU)*** **c) *Anti vibration mountings***
14	4.12.8(i)	A parking brake system shall be provided in ~~each 3 car unit and shall be capable of holding it under SDCL loaded condition of EMU and~~ 4 car unit & shall be capable of holding it under DCL loading conditions for MEMU on a 1 in ~~100~~ ***3 4*** gradient when there is no electrical power. A test scheme shall be submitted by the supplier to test the efficacy of parking brake system during the design stage. Detailed design calculation justifying the suitability of the offered system shall be submitted during design stage by the supplier. The system shall be tested for its satisfactory functioning in 12-car rake .
15	4.14.2	***The auxiliary system shall be designed in such a way that in the event of failure of auxiliary converter(s) equivalent to one basic unit, all the loads including 100% traction and 100% RMHU load shall work normally. In case of failure of next auxiliary converter, the units with failed auxiliary converter shall work with 50% traction load, 50% light and fan load, 50% heating element of RMHU, 100 % fresh air ventilation and all other loads shall be fully available...*** The changeover shall be affected automatically ……..LED based head light as per RDSO specification No. RDSO/2017/EL/SPEC/0134 Rev. 1 dated 23.04.2019 shall be used
16	4.14.20 New clause	***Provision has to kept for supply of power to water heater of tank for coaches as well as water raising apparatus/mono block pump for water tank(Water heater of tank and water raising apparatus/mono block pump for water tank not in the scope of supply of this specification)***

S. No.	Clause of the Specification	Changes in the Clauses
17	4.16	**4.16 AUTOMATIC SMOKE / FIRE DETECTION WITH ALARM:** A reliable automatic fire detection and alarm system shall be provided in the train covering the following areas: (a) Electrical cabinets, traction converter, auxiliary converter etc. - Provision of Linear Heat Detector (LHD) cables (UL or EN approved). (b) LT/HT compartment – Provision of Smoke/Fire detectors (as per EN 54-7 and EN 54-5) at suitable locations. The sensitivity and location of detectors in LT & HT compartment has to fulfil requirements of ARGE Guideline -Part 1 "Fire detection in railway vehicles (c) Provision of RDSO approved make of Aerosol based fire suppression system for electrical cabinets, traction converter, auxiliary converter with 100 gram of aerosol per cubic meter of the enclosure targetted. (d) ***Smoke/Fire detection system in passenger area also to be provided as per details contained in this Annexure***. The system to be capable of detecting smoke / fire in above areas along with its location at incipient stage of fire. On detection of a possible smoke / fire by means of Smoke/Fire detectors, the system shall have different levels of response (at-least two i.e. warning and alarm) to be finalised at design stage. System indications must be promptly available to driver via TCMS pop-up messages who shall then take necessary action to minimise the spread of fire. There should be a provision for isolation of faulty detectors to avoid any inconvenience in train operations The Smoke/Fire Detection system shall interface with TCMS in a redundant manner. Issues related to interface of smoke/fire detection system with TCMS shall be finalized at detailed design stage All the major events (alarms, faults etc.) to be recorded in the detection system and should be retrievable on maintenance terminal for analyzing any issue. The System shall be designed for self-diagnostic to any failure/trouble within The System i.e. wiring break within the system, discontinuity in the circuit etc. The Supplier/OEM shall provide necessary diagnostic tools (softwares, hardwares etc.) in order to identify failures immediately. Prototype approval to ensure the compliance of the system to ARGE guidelines will be arranged by the supplier and will be witnessed by any accredited assessor

S. No.	Clause of the Specification	Changes in the Clauses
		for these systems in presence of consignee/RDSO..
18	4.20 New Clause	***4.20 Body Side Automatic Doors (Not in the scope of supply)*** ***Functional / TCMS interface requirements*** ***4.20.1 The Car(s) shall have maximum 04 (four) electrically powered,*** ***Double Leaf Automatic Sliding Type Doors;*** ***4.20.2 The passenger body side door shall fully open in less than 4.5 (four point five) seconds and shall close within 6 (six) seconds from the instance the Train Operator operates the door. Minor adjustment in timings shall be possible.*** ***4.20.3 The end of the closing stroke (e.g. approximately 100mm) shall be damped or cushioned to reduce impact and minimize possible injury to passengers*** ***4.20.4 Obstacle detection Mechanism:*** • ***When a non – elastic rod with a maximum rectangular cross section of 15 mm x 60 mm is trapped with its long edge vertically between the door leading edge and the frame of the door shall not be indicated as closed and locked. The requirement shall be verified at three positions, the bottom, the middle and the top of the door. If soft horizontal bottom rubbers are provided, this requirement applies from the bottom edge of the door leaf upwards above the rubber*** • ***The maximum force exerted on an obstacle during final closing stroke shall not exceed the following values:*** • ***Peak force Fp < 300 N,*** • ***Effective force during first closing attempt Fe < 150 N,*** • ***Mean effective force including further closing attempts FE < 200 N,*** • ***The values specified shall be measured using a device and method as described in Annexure-D of EN 14752: 2015. Measurement on each door may not be required if the system provides constant performance.*** • ***An obstacle with maximum dimension of 10 mm x 50 mm trapped with its long edge vertically between the leading door edge and the frame or between two door panels shall be withdrawn slowly in outward direction with a force not higher than 150 N, measured***

S. No.	Clause of the Specification	Changes in the Clauses
		perpendicularly to the door surface. Alternatively, the door shall not be indicated closed and locked. The requirements shall be verified at the middle position only of the door. • ***Door system should be capable to detect an obstacle object of at least 10 mm.*** • ***If obstacle is faced during closing, the automatic door shall reclose 3 times, this shall be adjustable. In the event that the automatic door fails to close following the three attempts, further door movement shall cease on the offending automatic door and door will go to and remain in full open position unless again command has been not generated.*** • ***If obstacle is faced during opening, then door will move to close come in pause position and stay there unless again command has been not generated.*** • ***Door closed and obstruction sensing information shall be sent from each coach in the rake to Master Controller.*** • ***The number of obstructions during opening or closing shall be logged by the door control system as an aid to diagnosing door system problems*** ***4.20.5 The door mechanism shall have safety provision whereby the Train shall not start unless all doors have been closed and locked. An indication confirming that all doors are closed shall be provided in the Driving Cab.*** ***4.20.6 Provision shall be made for passengers to open the doors to permit evacuation from a stopped Train in an emergency. There shall be an internal and external manual release mechanism on each door.*** ***4.20.7 A door opening & closing warning shall be provided by audible and flashing light indication. This shall be provided at the centre of each door, both outside and inside, to indicate door status including isolated state. LED lamp shall flash during opening/closing and shall be in ON position during open/isolated condition.*** ***4.20.8 A door close announcement through PA/PIS followed by a chime controlled preferably by the DCU (scheme to be finalized during design stage) shall be triggered each time the "Door Close Announcement" button is pressed. The door close chime shall continue to play till the Doors achieve locked position. The chime shall warn the passengers inside the train as well as those on the***

S. No.	Clause of the Specification	Changes in the Clauses
		platform about the door operation. It shall be possible for maintenance depot to adjust the volume of speakers easily as per the need. Selection of the type and adjustment of volume of the chime shall be independent for external and internal. The adjustment of the volume of the chimes for internal shall be independent of the volume for announcements. ***4.20.9 It shall be possible to monitor the status and faults of each door on the TCMS.*** ***4.20.10 A microprocessor based Door Controller Unit (DCU) shall control each pair of door and shall be an integral part of door control assembly. The door controller unit shall communicate with TCMS.*** ***4.20.11 It shall be possible to modify/change the parameters or closure/opening logic of doors' circuit and implement the same as required by IR based on their operational and maintenance requirements.*** ***4.20.12 Doors shall be electrically operated from 110V d.c. (nominal) supply through train line. The door operating mechanism shall be of a proven design in service. The door system shall continue to operate correctly with the car battery voltage supply range between 77V to 137.5 V DC.*** ***4.20.13 Successful closing of doors should be confirmed by mechanical locking. Interlocks should prove the closed and locked position of door system and then application of traction power should be enabled.*** ***4.20.14 No spurious electrical signals shall cause any door to be released or opened. There shall be no single point failure of equipment or wiring, or two point failure with one failure undetected, which would cause a door to open without being commanded. The door controls shall be interlocked with the train's zero speed circuitry so that the doors cannot be opened until the train is stopped.*** ***4.20.15 The control architecture of body side door shall utilise the combination of hardware and software for reliable and robust control to avoid single point failure in the control on basic unit level and on train level.*** ***4.20.16 It shall be the responsibility of the Supplier to jointly finalise the***

S. No.	Clause of the Specification	Changes in the Clauses
		interface with the door supplier, which shall be facilitated by the Purchaser.
19	4.21 New Clause	**4.21 CENTRALIZED HEATING SYSTEM:** ***4.21.1 Each coach shall have the provision of centralized heating system to take care of cold climatic conditions.*** ***4.21.2 Each coach shall have the provision of Roof Mounted Heating Unit (RMHU) that shall provide heating for the coach.*** ***4.21.3 Each trailer coach shall be provided with 2 sets of (RMHU + Blower) arrangement.*** ***4.21.4 Each DMC shall be provided with one set of (RMHU + blower) arrangement.*** ***4.21.5 There shall be 415 volts, 3 phase supply for supplying electrical power from Auxiliary converter to all the RMHU's and blowers of the rake consisting of (DMCs & TCs).*** ***4.21.6 The minimum fresh air quantities shall not be less than 0.25 m3 / minute /person for all types of Cars. The air-flow parameters shall be as per ASHRAE /EN 13129:2016.***
20	4.22 New Clause	***4.22 ROOF MOUNTED HEATING UNIT (RMHU)*** ***4.22.1 Each RMHU shall consist of heating coil of 12 kW(2 banks each of 6 kW) and 3-phase, 415 V blower motor(induction, squirrel cage) of 1.1 kW capacity.*** ***4.22.2 Each RMHU shall deliver 4000 m3/Hour air at 20 mm static pressure.*** ***4.22.3 The complete body of the RMHU shall be made from stainless steel. The frame work of the RMHU shall be of 18 gauge stainless sheet steel grade 304. The frame work shall be of welded one.*** ***4.22.4 The filters of fire retardant material shall be used. Design of the filter shall be easy for dry cleaning.*** ***4.22.5 Heater inside the RMHU shall be in two banks with 6kW each rating and formed in two circuits to give the effective rating of the unit 12 kW capacity. Each bank of the heater shall have it's own overheat protection system. This OHP sensing the over heat in temperature scale cuts off the three phase ac supply to the heater units through the contactors . The temperature is set on 65. degree C and location of OHP sensor will be on the skin of the heater element. On reaching this temperature of the heater unit the RMHU is switched off.*** ***4.22.6 In addition to the thermal sensor mentioned at 4.22.5 above, each heating bank shall have a physical fuse link(liquid filled glass bulb) disconnect controller, which shall physically cut OFF 3- phase power supply to the heater in case of excessive heating. Temperature setting of the over heat protector will be 85 deg. C. and the manufacturer can decide the current setting accordingly. Two devices will be used, one for each heating bank in the RMHU.*** ***4.22.7 There shall be an interlock to electrically switch OFF the heater in***

S. No.	Clause of the Specification	Changes in the Clauses
		case the blower motor trips on overload. ***4.22.8 Fresh air openings shall be provided on each side of the RMHU, which will be connected through duct to the end wall of the coach on both sides through waterproof louvers and filters and the same shall be in the supplier scope. The required length of the ducting arrangement shall be supplied by the supplier for execution in the coach. The other end of the duct will be connected to the RMHU through fire retardant flexible duct which will be supplied by the supplier along with the RMHU.*** ***4.22.9 Blower motor shall conform to IS 325 latest and IS 1253 latest for dimensions.*** ***4.22.10 Enclosure protection shall be IP55 protected.*** ***4.22.11 The weight of the whole unit shall be as minimum as possible as the unit is to provided on the roof frame work and shall not exceed 250kg. This weight will be over and above the weight of electrics/ Propulsion equipment mentioned in clause 2.1.2.*** ***4.22.12 Two earthing bosses of dual metal with M10 screw connection shall be welded to the RMHU on both sides for earthing to the coach body member.*** ***4.22.13 Only fire retarding type material shall be used for the construction of RMHU.*** ***4.22.14 The heater unit shall be fixed in either path of the blower fan with motor unit i.e. the heater may be placed either in the front or back of the blower unit. Suck through arrangement is preferable.*** ***4.22.15 The Thermal insulation for the whole unit in the RMHU shall be of glass-wool jacketed in the two layers of stainless steel sheet. This arrangement shall prevent fire propagation.*** ***4.22.16 Fresh air filters shall be provided on each fresh air opening of the RMHU and the filters shall be of synthetic fibre, fire retardant, dry, cleanable type. The cleaning method and frequency of cleaning shall be indicated in the 'Maintenance Manual'.*** ***4.22.17 The weight of the whole unit shall be as minimum as possible as the unit is to provided on the roof frame work and shall not exceed 250 kg.*** ***4.22.18 The roof mounted heater unit with blower fan and motor shall be provided with electrically operated heater unit in an enclosed sheet steel frame work. There shall be hinged type opening on top of the heater units and the blower motor from the top of the unit for easy attention and replacement if required during service.*** ***4.22.19 Pre wired power and control cables of fire retarding quality, separately connected to the connectors to match the parting connectors of RHMU, of sufficient length for interconnection between RHMU and control panel located in the cubicle shall be supplied along with the unit.*** ***4.22.20 A drawing showing the complete arrangement of heater units, blower fan and Motor, the wiring arrangement, type of connection***

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		including the stud size etc. shall be submitted in the tender for approval by PUs(ICF/RCF/MCF etc.) ***4.22.21 Indicative Overall dimensions details of RMHU shall be as per ICF specification no. ICF/Elec./089 Rev 01 or latest. Final Dimensions to be approved by PUs(ICF/RCF/MCF etc.) during design approval stage.***
21	4.23 New Clause	**4.23** ***CONTROL PANEL FOR ROOF MOUNTED HEATING UNIT (RMHU)*** ***4.23.1 Microprocessor based controller will be provided which will maintain the inside temperature of coaches as follows:*** ***Outside: -10 º C*** ***Inside: 17 - 21 º C*** ***This will be done by switching off and on of the heater grids of both the RMHUs of a coach.However in case of failure of microprocessor based controller it shall be possible to run the system with full/selected capacity in manual mode with all major protections available. .*** ***4.23.2 There shall be one control panel for each RMHU.Control panel shall consist of MCB's for main power supply, blower motor and for each banks of the heater.*** ***4.23.3 One contactor for blower motor and two contactors for the heater, one for each bank of the heater, shall be used. Ratings of the contactors shall be sufficient for the application. A bus-bar shall be used for distribution of the power supply.*** ***4.23.4 Electronic thermostat shall be provided in the return air path on both side of the unit for sensing the air temperature.*** ***4.23.5 Meters shall be provided for continuous indication of temperature inside the coach and outside ambient temperature.*** ***4.23.6 The control circuit wiring shall be e-beam / PTFE multi stand, tin coated.*** ***4.23.7 The power connection of the heater unit shall be brought in to a connector located on the right hand side of the unit when viewing from the front of the unit. The internal cable for the purpose shall be of either e-beam or PTFE cables of adequate rating. The cables shall he run on metallic flexible conduits for internal connection. Any terminal board arrangement if used inside the heater unit shall be of fire retarding fibre glass SMC type only..*** ***4.23.8 The harness connecting the RMHU and the control panel shall be through fire retardant reinforced flexible conduit.*** ***4.23.9 The complete RMHU unit and blower motor shall be required to work under J&K atmospheric conditions and the unit shall be suitable for rugged service normally experienced for rolling stock where locomotives are expected to run up to a maximum operational speed of 110 kmph in varying climatic conditions existing throughout India.*** ***4.23.10 LED light indications for ON and OFF conditions of blower motors***

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		and heaters shall be provided. ***4.23.11 In case of hot air supply from heater is not required; it should be possible to operate the blower motor alone without the heater for air circulation.*** ***4.23.12 There shall be two earth bosses on each side of the panel for earthing to the coach body.*** ***4.23.13 The internal wiring of the control panel and RMHU shall be wired with "e-beam irradiated cables". Electron beam, irradiated, 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. At locations in the Train, where high temperatures are likely to be encountered, special cables shall be used. The Supplier shall submit details of cables conforming to EN 50264 for fire retardant, fire survival characteristics.*** ***4.23.14 The connections to the respective circuit shall be with crimped type connectors.*** ***4.23.15 For working during failure of microprocessor based controller i.e in manual mode, a rotary switch of sufficient rating shall be provided in the panel for selection of the function of RMHU as OFF, VENT, HEAT I(Blower + Heater I), Heat II (Blower + Heater II) and Heat I & II (Blower + Heater I & Heater II).*** ***4.23.16 The control circuit of the panel shall work on 110V ac single phase supply being derived from a control transformer in the panel (230V/110Vac).*** ***4.23.17 Supplier shall submit detailed rating of contactor, rotary switch, MCBs, control transformer, connector and other switch gear along with the design document.*** ***4.23.18 Detailed power & control scheme along with protection scheme of RMHU will be submitted.*** ***4.23.19 Indicative Overall dimensions details of RMHU shall be as per ICF specification no. ICF/Elec./089 Rev 01 or latest. Final Dimensions to be approved by PUs(ICF/RCF/MCF etc.) during design approval stage*** ***4.23.20 RMHU shall be interfaced with TCMS for controlling through DDU display and health status monitoring.*** ***4.23.21 In the event of the failure of 415V power supply in a Car, an emergency ventilation shall operate automatically to admit fresh air directly into Car to maintain the required oxygen level in fully loaded Car, in accordance with ASHRAE. The fresh air intake shall not be less than 15 m3 / hour / person under specified loading conditions. The emergency ventilation shall be fed from 110V DC supply with its dedicated inverter, which shall not employ 50 Hz transformer. As an alternative BLDC blower motors directly operating at 110 V DC will also be acceptable***.
22	4.24 New Clause	***Cab Heating Unit and De-fogging unit with blower:*** ***4.24.1 The driver cabin is provided with heater unit for heating the cabin. heater element rating of cab heater shall be 2 kW. Heater unit blower rating shall be 300(CMH) at 20 mm static pressure.*** ***4.24.2 The driver cabin is provided with de-fogging unit for the wind shield. The de-fogging unit is manually operated by driver as and when required. In case of extremely cold weather the de-fogging unit shall***

S. No.	Clause of the Specification	Changes in the Clauses
		also be used to give additional heat to the driver's cab. Element rating of defogging unit shall be 1 kW(each). blower rating shall be 150(CMH) at 20 mm static pressure. ***4.24.3 The IP rating of enclosure for Cab Heating Unit and De-fogging unit shall be IP55.*** ***4.24.4 Necessary electrical and thermal protection measures for Cab Heating Unit and De-fogging unit shall be ensured by the supplier.*** ***4.24.5 Heater unit Blower motor and defogger unit blower motor Rating shall be 230V ac , 1 Phase, 50Hz. and wattage should meet as clause 4.24.2 and max of 0.4 HP. However, system available voltage in the coach is 4l5V, 3 Phase, ac. Type of blower motor shall be capacitor start and run and shall conform to IS 996 latest.*** ***4.24.6 The complete body of the Heater Unit shall be made out of stainless steel .The frame work of the Heater Unit and de-fogging unit shall be made out of 18 gauge stainless sheet steel grade 304. The frame work shall be of welded one.*** ***4.24.7 There shall be thermal insulation for the whole unit. The Thermal insulation in the Heater unit shall be of High temperature and Fire Retardant Grade Nitrite Rubber or equivalent/better insulation. This arrangement shall prevent fire propagation.*** ***4.24.8 Only fire retarding type material shall be used for the construction of Heater Unit.*** ***4.24.9 All safety precautions and proven engineering manufacturing methods shall be adopted for the design and manufacturing the equipment. There shall not be any fire accident due to operation of the equipment inside the driver's cab with the extreme ambient conditions.*** ***4.24.10 Interconnecting flexible ducts shall be of fire retarding quality material.*** ***4.24.11 Each bank of heating unit shall be provided with over heat protection arrangement. This OHP sensing the over heat in temperature scale cuts off the power supply to the heater unit through the contactors. The temperature for set on is 150 degree C. On reaching this temperature the heater unit should be switched off.*** ***4.24.12 The Heater Unit shall be provided with an additional over heat protection having physical fuse link (liquid filled glass bulb) to disconnect the single phase ac supply, physically cutting off the single phase supply to the heater in case of excessive heating.*** ***4.24.13 Electronic Thermostat shall be provided at a suitable location inside the cab for sensing the air temperature. The de-fogging will be operated by the driver as and when required. In case of extremely cold weather, the de-fogging unit shall also to be used to give additional heat to the driver's cab for increased comfort.*** ***4.24.14 Pre wired power and control cables of fire retarding quality, separately connected to the plug-in type connectors to match the connectors of heating units of sufficient length for interconnection***

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		between Heater units and the control panel located in the cubicle shall be supplied along with the unit. ***4.24.15 A drawing showing the complete arrangement of Heater units, blower fan and Motor, the wiring arrangement, type of connection including the stud size for connection etc shall. be submitted in the tender for approval by production units(ICF/RCF/MCF etc.)*** ***4.24.16 Control panel:*** ***4.24.16.1 There shall be one control panel for Heater Unit and de-fogging unit.*** ***4.24.16.2 LED light indications for ON and OFF conditions of blower motors and heaters shall be provided on the cover of the panel for easy visibility and status of the operation of the panel.*** ***4.24.16.3 In case of hot air supply from heater is not required, it should be possible to operate the blower motor alone without the heater for air circulation.*** ***4.24.16.4 The control circuit shall switch off the Heater when the blower motor trips on overload.*** ***4.24.16.5 The control circuit of the panel shall work on 110V ac single phase supply being derived from a control transformer in the panel (230V/110Vac).*** ***4.24.17 Detailed power & control scheme along with protection scheme of cab heater and defogger unit along with control panel will be submitted.*** ***4.24.18 Overall Dimensional drawing of cab heater and defogger unit along with control panel will be approved by PUs(ICF/RCF/MCF etc.)***
23	5.1.4	All the mandatory and performance tests/ trials/ shall be carried out in ~~Sabzimandi-Panipat~~ ***Katra-Banihal section*** for ~~12 car SDCL EMUs/~~12 car DCL MEMUs. ***However, Oscillation/EBD trial and Radio Frequency Interference performance test shall be carried out for 12/16/20 Car DCL MEMUs (As per purchase order requirement).*** This will include all the requirement as specified in Chapter 3 & 5.
24	5.10.1(i)	Test runs shall be made on the ~~Delhi-Ambala~~ ***Katra-Banihal section*** or any other sections on which the stock is to operate with sufficient number of trains to ensure that the train equipment meets the operating conditions. The duration …….. availability of sections.
25	19C of Annexure-II	Replace ”Subzimandi-Panipat-Sabzimandi, 51.7 kmph schedule speed, 1320 sec. dwelling time and calculation of SEC” by “***Katra-Banihal section***”
26	Annexure-II	Replace “1 in 100” by “***1 in 34***”

Annexure-XIX to Specification no. RDSO/PE/SPEC/EMU/0163 Rev. 3 -2022

(Applicable for Air-conditioned MEMUs only)

Note:

1. The deletions are marked in strikethrough and additions are italics, bold and underlined.
2. The dotted segment indicates that rest of the clause not appearing here, is not affected and continue to remain same as in the original specification.

S. No.	Clause of the Specification	Changes in the Clauses
1	1.1.4(xiii)	The equipment shall be designed keeping in view that the EMUs/MEMUs operates with ***automatic*** doors ~~and windows wide open~~
2	1.1.5(v) New clause	***Smoke/Fire detection system compliant to ARGE Guideline Part 1 "Fire detection in railway vehicles" shall be deployed. These standards may be referred for details of Smoke/Fire detection time, Positioning and commissioning of the system etc. The system to be capable of detecting smoke / fire along with its location at incipient stage of fire. In passenger areas, the system to provide a dynamic two detector dependency (smoke and/or heat) along with provision of drift compensation in order to decrease the risk of false, or unwanted alarm.*** ***Prototype approval to ensure the compliance of the system to ARGE guidelines will be arranged by the supplier and will be witnessed by any accredited assessor for these systems in presence of consignee/RDSO. Issues related to interface of smoke/fire detection system with TCMS shall be finalized at detailed design stage.*** ***Air conditioning of each coach and Fresh air and return air ducts should be controllable as per fire system requirement***
3	2.1.2(v) New Clause	***Purchaser is to make effort to decrease weight of coaches as much as possible. Higher weight of any MEMU coach than that of existing 3-phase MEMU coaches will require multibody dynamic simulation by the purchaser to check & ensure riding behavior of coaches within permissible limits as per applicable criteria.***
4	2.1.2(vi) New Clause	***Load will be distributed in such a way that coaches remain balanced in longitudinal as well as lateral direction.***
5	3.1.6(iii)	Efficiency curves of each equipment and tractive effort/braking effort (in KN) for each motor coach shall be furnished along with overall system efficiency curves. The total auxiliary power shall be furnished as break up of power requirement for lights, fans, ***Air-conditioning*** and auxiliary power required for propulsion system.
6	3.1.17	**Regenerated Energy** -The regenerated energy for all out running up to 110 kmph(full traction up to 110 Kmph and full service braking up to standstill) shall not be less than 23% of the energy consumed during powering at the specified voltage for ~~both EMU &~~ MEMU. Acceleration and braking rates shall be as defined in clause 2.4 of the Specification. Full auxiliary load shall be taken into account except emergency load and ~~ventilation load~~ ***RMPU load***. Also duty cycle of compressors shall be considered as 100%. The net

S. No.	Clause of the Specification	Changes in the Clauses
		energy consumed or regenerated at the pantograph shall be used for calculating percentage regeneration energy. In the event of failure of one Basic Unit I equipment less than or equivalent to that of one Basic Unit, reduction in the value of regenerated energy shall not be more than that of their proportionate value.
7	4.0(A)(xxxi) New clause	***Complete air-conditioning system with necessary equipment such as Roof Mounted Package Unit (RMPU), control panel, micro-controller etc.***
8	4.14.2	~~The auxiliary system shall be designed in such a way that in the event of failure of auxiliary converter(s) equivalent to one basic unit, all the loads including 100% traction load shall work normally. In case of failure of next auxiliary converter, the units with failed auxiliary converter shall work with 50% traction load, 50% light and fan load , 100 % ventilation load and all other loads shall be fully available.~~***The auxiliary system shall be designed in such a way that in the event of failure of auxiliary converter(s) equivalent to one basic unit, all the loads (including air-conditioning) shall work normally. In case of failure of next auxiliary converter, all the units shall work with 50% air conditioning, 100% fresh air ventilation and all other loads of failed units(including traction) shall work with minimum 50% load and all other loads of healthy unit (including traction) will work with 100% load.*** The changeover shall be affected automatically ……..LED based head light as per RDSO specification No. RDSO/2017/EL/SPEC/0134 Rev. 1 dated 23.04.2019 shall be used.
9	4.16	**4.16 AUTOMATIC SMOKE / FIRE DETECTION WITH ALARM:** A reliable automatic fire detection and alarm system shall be provided in the train covering the following areas: (a) Electrical cabinets, traction converter, auxiliary converter etc. - Provision of Linear Heat Detector (LHD) cables (UL or EN approved). (b) LT/HT compartment – Provision of Smoke/Fire detectors (as per EN 54-7 and EN 54-5) at suitable locations. The sensitivity and location of detectors in LT & HT compartment has to fulfil requirements of ARGE Guideline -Part 1 "Fire detection in railway vehicles. (c) Provision of RDSO approved make of Aerosol based fire suppression system for electrical cabinets, traction converter, auxiliary converter with 100 gram of aerosol per cubic meter of the enclosure targetted. ***(d) Smoke/Fire detection system in passenger area also to be provided as per details contained in this Annexure***. The system to be capable of detecting smoke / fire in above areas along with its location at incipient stage of

S. No.	Clause of the Specification	Changes in the Clauses
		fire. On detection of a possible smoke / fire by means of Smoke/Fire detectors, the system shall have different levels of response (at-least two i.e. warning and alarm) to be finalised at design stage. System indications must be promptly available to driver via TCMS pop-up messages who shall then take necessary action to minimise the spread of fire. There should be a provision for isolation of faulty detectors to avoid any inconvenience in train operations The Smoke/Fire Detection system shall interface with TCMS in a redundant manner. Issues related to interface of smoke/fire detection system with TCMS shall be finalized at detailed design stage. All the major events (alarms, faults etc.) to be recorded in the detection system and should be retrievable on maintenance terminal for analyzing any issue. The System shall be designed for self-diagnostic to any failure/trouble within The System i.e. wiring break within the system, discontinuity in the circuit etc. The Supplier/OEM shall provide necessary diagnostic tools (softwares, hardwares etc.) in order to identify failures immediately. Prototype approval to ensure the compliance of the system to ARGE guidelines will be arranged by the supplier and will be witnessed by any accredited assessor for these systems in presence of consignee/RDSO.
10	4.20 New Clause	***4.20 Body Side Automatic Doors (Not in the scope of supply)*** ***Functional / TCMS interface requirements*** ***4.20.1 The Car(s) shall have maximum 04 (four) electrically powered,*** ***Double Leaf Automatic Sliding Type Doors;*** ***4.20.2 The passenger body side door shall fully open in less than 4.5 (four point five) seconds and shall close within 6 (six) seconds from the instance the Train Operator operates the door. Minor adjustment in timings shall be possible.*** ***4.20.3 The end of the closing stroke (e.g. approximately 100mm) shall be damped or cushioned to reduce impact and minimize possible injury to passengers*** ***4.20.4 Obstacle detection Mechanism:*** • ***When a non – elastic rod with a maximum rectangular cross section***

S. No.	Clause of the Specification	Changes in the Clauses
		of 15 mm x 60 mm is trapped with its long edge vertically between the door leading edge and the frame of the door shall not be indicated as closed and locked. The requirement shall be verified at three positions, the bottom, the middle and the top of the door. If soft horizontal bottom rubbers are provided, this requirement applies from the bottom edge of the door leaf upwards above the rubber • ***The maximum force exerted on an obstacle during final closing stroke shall not exceed the following values:*** • ***Peak force Fp< 300 N,*** • ***Effective force during first closing attempt Fe < 150 N,*** • ***Mean effective force including further closing attempts FE < 200 N,*** • ***The values specified shall be measured using a device and method as described in Annexure-D of EN 14752: 2015. Measurement on each door may not be required if the system provides constant performance.*** • ***An obstacle with maximum dimension of 10 mm x 50 mm trapped with its long edge vertically between the leading door edge and the frame or between two door panels shall be withdrawn slowly in outward direction with a force not higher than 150 N, measured perpendicularly to the door surface. Alternatively, the door shall not be indicated closed and locked. The requirements shall be verified at the middle position only of the door.*** • ***Door system should be capable to detect an obstacle object of at least 10 mm.*** • ***If obstacle is faced during closing, the automatic door shall reclose 3 times, this shall be adjustable. In the event that the automatic door fails to close following the three attempts, further door movement shall cease on the offending automatic door and door will go to and remain in full open position unless again command has been not generated.*** • ***If obstacle is faced during opening, then door will move to close come in pause position and stay there unless again command has been not generated.*** • ***Door closed and obstruction sensing information shall be sent from each coach in the rake to Master Controller.*** • ***The number of obstructions during opening or closing shall be logged by the door control system as an aid to diagnosing door system problems***

S. No.	Clause of the Specification	Changes in the Clauses
		4.20.5 The door mechanism shall have safety provision whereby the Train shall not start unless all doors have been closed and locked. An indication confirming that all doors are closed shall be provided in the Driving Cab. ***4.20.6 Provision shall be made for passengers to open the doors to permit evacuation from a stopped Train in an emergency. There shall be an internal and external manual release mechanism on each door.*** ***4.20.7 A door opening & closing warning shall be provided by audible and flashing light indication. This shall be provided at the centre of each door, both outside and inside, to indicate door status including isolated state. LED lamp shall flash during opening/closing and shall be in ON position during open/isolated condition.*** ***4.20.8 A door close announcement through PA/PIS followed by a chime controlled preferably by the DCU (scheme to be finalized during design stage) shall be triggered each time the "Door Close Announcement" button is pressed. The door close chime shall continue to play till the Doors achieve locked position. The chime shall warn the passengers inside the train as well as those on the platform about the door operation. It shall be possible for maintenance depot to adjust the volume of speakers easily as per the need. Selection of the type and adjustment of volume of the chime shall be independent for external and internal. The adjustment of the volume of the chimes for internal shall be independent of the volume for announcements.*** ***4.20.9 It shall be possible to monitor the status and faults of each door on the TCMS.*** ***4.20.10 A microprocessor based Door Controller Unit (DCU) shall control each pair of door and shall be an integral part of door control assembly. The door controller unit shall communicate with TCMS.*** ***4.20.11 It shall be possible to modify/change the parameters or closure/opening logic of doors' circuit and implement the same as required by IR based on their operational and maintenance requirements.*** ***4.20.12 Doors shall be electrically operated from 110V d.c. (nominal) supply through train line. The door operating mechanism shall be of a proven design in service. The door system shall continue to***

S. No.	Clause of the Specification	Changes in the Clauses
		operate correctly with the car battery voltage supply range between 77V to 137.5 V DC. ***4.20.13 Successful closing of doors should be confirmed by mechanical locking. Interlocks should prove the closed and locked position of door system and then application of traction power should be enabled.*** ***4.20.14 No spurious electrical signals shall cause any door to be released or opened. There shall be no single point failure of equipment or wiring, or two point failure with one failure undetected, which would cause a door to open without being commanded. The door controls shall be interlocked with the train's zero speed circuitry so that the doors cannot be opened until the train is stopped.*** ***4.20.15 The control architecture of body side door shall utilise the combination of hardware and software for reliable and robust control to avoid single point failure in the control on basic unit level and on train level.*** ***4.20.16 It shall be the responsibility of the Supplier to jointly finalise the interface with the door supplier, which shall be facilitated by the Purchaser.***
11	4.25 New Clause	***4.25 Air-Conditioning System*** ***4.25.1 All the Cars shall be air-conditioned with a minimum of two light weight preferably Aluminium body roof mounted packaged unit (RMPU) type airconditioning units in each Car. Driver's cab shall also be air-conditioned. Each packaged unit shall have two independent refrigerant circuits. It shall also be able to provide heating during winter through reverse cycle heating concept. The control of both the air-conditioning unit shall be performed by suitably designed single microprocessor controller. The complete air system shall have EER (Ratio of capacity in BTU/Hour and the total power consumption in watts) better than 7.0 under the specified conditions. No material shall be used in construction of air conditioning unit that is liable to be adversely affected by vibration, damp, rotting or growth of moulds. Fire retardant material only should be used.*** ***4.25.2 The Cars shall be provided with refrigeration system using R 407C refrigerant or any other eco-friendly HFC refrigerant having zero ozone depletion potential and A1 safety category as per ASHRAE standards.*** ***4.25.3 The air conditioning units shall be fed from the auxiliary converter. Provision of protective devices, relays/contactors in 3-phase supply***

<table>
<tr><th>S. No.</th><th>Clause of the Specification</th><th>Changes in the Clauses</th></tr>
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<u>of air conditioning unit shall be made for protection against short circuit / overload / earth fault and also to isolate the healthy air conditioning unit from the defective one.</u>
<u>4.25.4The TR/kW rating/cooling capacity of RMPU provided in each coach shall be same, which shall be finalized/calculated based on the necessary heat load calculations with the following known conditions and data:</u>
<table>
<tr><td><u>Summer condition</u></td><td><u>Dry bulb</u></td><td><u>Wet bulb</u></td><td><u>% R.H.</u></td></tr>
<tr><td><u>Outside (dry summer)</u></td><td><u>50°C</u></td><td><u>25°C</u></td><td><u>-</u></td></tr>
<tr><td><u>Outside (wet summer)</u></td><td><u>40°C</u></td><td><u>28°C</u></td><td><u>-</u></td></tr>
<tr><td><u>Inside (dry and wet)</u></td><td><u>20–25°C</u></td><td><u>-</u></td><td><u>60–40%</u></td></tr>
<tr><td colspan="4"><u>Winter conditions</u></td></tr>
<tr><td><u>Outside</u></td><td><u>- 5°C</u></td><td></td><td></td></tr>
<tr><td><u>Inside</u></td><td><u>17-21°C</u></td><td></td><td></td></tr>
<tr><td><u>Number of passengers (DCL)</u></td><td colspan="3"><u>As defined in Annexure XVI</u></td></tr>
<tr><td><u>Fresh air requirement per passenger</u></td><td colspan="3"><u>0.25 m3/min./passengers</u></td></tr>
<tr><td><u>The physical dimensions and thermal parameters(co-efficient of heat transfer etc.) of the coach and its glass window</u></td><td colspan="3"><u>Shall be provided by the coach builder.</u></td></tr>
</table>
<u>4.25.4.1 For heat load calculation of coach, 10% of the calculated coach heat load shall be taken under consideration for infiltration of air through the opening/closing of the car doors and air leakage through the window gaskets etc.</u>
<u>4.25.4.2 Based on the coach (car) heat load calculations, the TR rating shall be decided, however, the cooling capacity shall not be less than 15TR/52.7 kW. The manufacturer/supplier shall furnish the complete heat load calculation to RDSO for approval.</u>
<u>4.25.4.3 The TR/kW rating/cooling capacity of RMPU shall be tested at firm’s premises maintaining the conditions as per clause 4.25.4 in the test room in the automatic psychometric test laboratory.</u>
<u>4.25.5 RMPUs shall be capable of pre-cooling the coach up to 23o C without passenger, with fresh air dampers closed, lights and fans switched on after raising the inside temperature to 45o C in less than 45 minutes. Further, capacity should be adequate to cool the</u>
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S. No.	Clause of the Specification	Changes in the Clauses
		coach in extreme summer condition within 2 hours when the coach is fully occupied, which will be verified by conducting pull down test on prototype rake/ coach (RDSO test program No.: ELPS/TP/AC/01 may be referred for guidance. ***4.25.6 The design of RMPU shall be such as to restrict relative humidity inside the air conditioning compartment under all circumstances (even with ambient having RH as high as 98%) to a maximum of 60%.*** ***4.25.7 In the event of failure of one RMPU, the second RMPU shall cater 60% of the total air-conditioning load of the Car*** ***4.25.8 The single RMPU shall be able to work even with one condenser fan and the cooling capacity so obtained shall not be less than 75% of the rated capacity of the said RMPU.*** ***4.25.9 Supplier shall provide controller with smart automatic temperature settings based on thermal comfort index for comfort of passengers as per ASHARE or any other algorithm, which will be shared by RDSO with Supplier.*** ***4.25.10 All the equipment shall be capable of continuous operations without detriment to the operation of cut-outs and circuit breaker or over load, as per the environmental conditions mentioned in Clause no. 2.7 of this Specification.*** ***4.25.11 The minimum fresh air quantities shall not be less than 0.25 m3 / minute / person for all types of Cars. The air-flow parameters shall be as per ASHRAE / EN 13129:2016.*** ***4.25.12 Noise produced by the air-conditioning equipment in empty compartment with the stationary vehicle must not exceed 65 dB(A) as per EN 13129:2016. The Supplier shall associate with Purchaser at the design stage with regard to the interface requirement to minimize the noise levels.*** ***4.25.13 The RMPU shall be able to perform satisfactorily even at an ambient temperature of 57 °C without any tripping of the equipment and the same shall be tested on test room at manufacture's premises.*** ***4.25.14 The compressor suitable for traction environment, shall only be used and it shall have adequate capacity at 60°C condensing temperature & 5°C evaporating temperature. One of the compressors in each RMPU shall have automatic capacity control through VVVF control to optimize the efficiency of RMPU. The refrigerant evaporator unit shall comprise of cooling unit with automatic thermostatic expansion valve. The Heat exchanger shall be pre-coated and made of copper tubes with Aluminium fins. Heat exchanger shall pass 1000 hours salt fog test as per ASTM-B-117. However, tinned copper fins will also be acceptable.*** ***4.25.15 Each air conditioning unit shall be constructed as an integral module to enable removal from the Car as single complete item without the necessity to break any refrigerant lines or any part of***

S. No.	Clause of the Specification	Changes in the Clauses
		Car or unit itself. All electrical connections and condensate outlets shall be fitted with standard quick heavy duty disconnect fittings. The connectors should be so positioned to ensure that it is not damaged when the air conditioning unit is removed from the Car and placed on a flat surface. Connectors shall conform to DIN EN 175301-801. ***4.25.16 All fresh air intake shall be filtered and the air filter elements shall be cleanable and shall not be of disposable type. The Supplier shall use a filtration system suitable for Indian conditions requiring minimum attention/cleaning/maintenance. Suitable device to indicate the pressure drop shall be installed so that filters can be replaced/cleaned after getting necessary indication for the same.*** ***4.25.17 Thermal comfort based Microprocessor controller shall be used for air conditioning system. However, in case of failure of microprocessor-based controller, it shall be possible to run the system with full capacity in manual mode with all major protections intact. The link between the microprocessor and interfaced cards shall be established by means of serial bus system or any other superior means to ensure error free high speed data transmission. The control and monitoring function shall be implemented through software to reduce hardware and cables. The complete control panel along with microprocessor controller shall be accessible from inside the Car without any requirement of going on roof.*** ***4.25.18 The microprocessor shall perform the task of fault diagnosis and display in addition to control task. It shall be a capable of monitoring the status of the equipment and faulty sensor/ cables continuously and the occurrence of the faults. It shall also take appropriate action and wherever necessary, it shall shutdown the equipment. The faults shall be stored in the memory of microprocessor and it shall be possible to download the same using commercial available USB pen drive or laptop.*** ***4.25.19 Various important parameters of the equipment as well as environmental data at the time of occurrence of the fault shall also be recorded. Application/diagnostic software tools as required for trouble shooting and analysis of the fault shall be provided. Adequate redundancy shall be built in the microprocessor.*** ***4.25.20 In the event of failure of air-conditioning unit/units, harmful quantities of the refrigerant shall not be released inside the compartment.*** ***4.25.21 In the event of the failure of 415V power supply in a Car, an emergency ventilation shall operate automatically to admit fresh air directly into Car to maintain the required oxygen level in fully loaded Car, in accordance with ASHRAE. The fresh air intake shall not be less than 15 m3 / hour / person under specified loading conditions. The emergency ventilation shall be fed from 110V DC supply with its dedicated inverter. As an alternative BLDC blower***

S. No.	Clause of the Specification	Changes in the Clauses
		motors directly operating at 110 V DC will also be acceptable. ***4.25.22 Superstructure shall be provided with ducting arrangement for discharge / exhaust of air. It shall be ensured that water does not enter in such arrangement during heavy rains striking at 45° opposite to the movement of the train running at 110 kmph or during Car washing. Design of connecting ducts along with outlets shall be developed in consultation with Purchaser.*** ***4.25.23 Outside smoke detection sensor, inside co2 level sensor and arrangement to provide bacteria free air into passenger area shall be provided.*** ***4.25.24 The design and layout of RMPU shall be such as to prevent water traps even if the vehicle is stopped on the slope or cant. Proper water drainage arrangement shall also be provided.*** ***4.25.25 The design of drainage of condensate water shall be finalized during development stage with the consultation of coach builder, so that the chances of falling of condensate water on electrical coupler, gangway, platform or any other equipment may be eliminated.*** ***4.25.26 The RMPU shall feature with reverse cycle feature, so that it can deliver heating power to keep the coach inside condition warm during winter. No electrical resistive heater shall be used for heating/warming the coach.*** ***4.25.27The RMPU shall be self-supporting and will not form part of the vehicle structure. For the module of unit, a separate structural frame shall be employed which will not rely on any of the installed components or equipment for rigidity or strength. All the parts that require periodic cleaning or maintenance shall be easily accessible when the unit is in installed condition. The parts that require periodical cleaning shall be easily removable with minimum tools and attended to for which facility shall be made available.*** ***4.25.28The electrical power & control connection to the motors, compressors etc. shall be through heavy duty connectors. The connectors shall be IP 67 protected. The location of the connectors shall be in such places, where the rain water directly should not fall on it.*** ***4.25.29 The weight of both RMPUs of one coach with its electrical control panels should not be more than 2100 kgs. This is over and above the weight of electrics specified in clause 2.1.2(i).***

File No.RDSO-PE0CEMU(EMMU)/3/2023-PED/PSEMU/RDSO

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No. EL/0.3.1 Date: As Signed

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Sub: Addendum/Corrigendum No. 1 & 2 to technical specification no. RDSO/PE/SPEC/EMU/0163-2022 Rev. 3 for IGBT based three phase electrics (on-board mounted) for AC EMUs/MEMUs.

Addendum/Corrigendum No. 1 & 2 of technical specification no. RDSO/PE/SPEC/EMU/0163-2022 Rev. 3 for IGBT based three phase electrics (on-board mounted) for AC EMUs/MEMUs has been prepared and hereby issued as Addendum/Corrigendum No. 1 & 2 of technical specification no. RDSO/PE/SPEC/EMU/0163-2022 Rev. 3. The same is being sent along with specification no. RDSO/PE/SPEC/EMU/0163-2022 Rev. 3, for kind information and necessary action please.

DA: As above

Digitally Signed by Gaurav Mathur
Date: 27-10-2023 17:19:39
Reason: Approved

(Gaurav Mathur)
ED/EMU
For Director General/RDSO

Copy to: OSD/Elect. Engg.(Gen.), Railway Board, Rail Bhawan, New Delhi-110001- for kind information.

Note:

1. The deletions are marked in strikethrough and additions are italics and underlined.
2. The dotted segment indicates that rest of the clause not appearing here, is not affected and continue to remain same as in the original specification.

Sr No	Clause No	To be read as
1.	**4.6.2 (i)**	Driver-guard or cab–cab communication between two driver‟s cabs on the train. The PIS shall include provision for the announcements to be made remotely by train controllers, however, the purchaser will provide suitable communication facilities. There should be provision of recording the voice of driver & Guard (both) in the flash memory (for a duration of at least 24 hours) and in crash protected memory (for a duration of at least ~~10~~ ***60*** mins) of intelligence based recording described in clause 4.9.6. Mic provided on the driver desk shall be made use of, for this purpose.
2.	**4.6.2 (x)**	Few designated coaches as per latest guidelines of Railway Board in EMUs/MEMUs shall have the provision of talk back. Emergency buttons and talk back phones shall be located near the doors and gangways. Once pressed/operated, it shall be possible for the passenger to communicate with the Train Driver / Guard. Four ETBs (Two each on physically independent channels) shall be provided per coach. If more than one emergency device has been operated, each demand shall be independently acknowledged, and alarms shall be stored, displayed and answered sequentially. Provision shall be there for voice recording of the conversations with GPS stamping ***in the flash memory (for a duration of at least 24 hours) and in crash protected memory (for a duration of at least 60 mins) of intelligence based recording described in clause 4.9.6.*** The CCTV camera of the coach shall focus on the ETB area during the conversation. LED indication (engaged or free) at the passenger end shall communicate the status of ETBs.
3	***4.14.16(c)***	Flasher light LED based of proven design and shall be of international standards. The flasher light shall be amber in colour. The flasher light shall be designed to provide flashes at the rate of ~~30~~ ***40 ± 5*** flashes per minute. Following shall also be provided and shall be in the scope of supply
4.	***4.26 (New Clause)***	***CAB Recording Facility:*** ***In the CCTV network, one separate and independent camera with inbuilt microphone in each cab shall be installed at appropriate location to clearly make out various actions (audio & video) of crew from the recorded data. The CCTV data (audio & video) of these cab cameras will be stored in following locations and as described below:*** ***(i) Crash protected memory of Event Recorder for a minimum duration of 60 mins.*** ***(ii) Flash memory of Event Recorder for last 24 hrs.*** ***Apart from this, CCTV data in NVR should continue to be stored normally, for full duration of 30 days.***

5	2.1.2 (Annexure-XVIII)	The equipment shall be so designed …… ~~For EMU End Basic Unit : maximum 25 Tonnes(with maximum permissible deviation of +1% in the positive side) per basic unit~~ ~~For EMU Middle Basic Unit : maximum 24.25 Tonnes(with maximum permissible deviation of +1% in the positive side) per basic unit~~ For MEMU Basic Unit : maximum ~~25~~ ***28*** Tonnes(with maximum permissible deviation of +1% in the positive side) per basic unit. and total overall axle load of …… during tare conditions.
6	2.11 (Annexure-XVIII)	The equipment shall be so designed that the co-efficient of adhesion requirement does not exceed ~~20%~~ ***22%*** during powering and regenerative braking and 16% in case of only pneumatic brake application, under all requirements of performance as specified in this specification
7	3.1.3(b) (Annexure-XVIII)	MEMU: The typical run of 6 Km on level tangent track for all out running i.e. full acceleration and full braking without coasting and with regeneration braking for a dense crush loaded (DCL) 12 car rake with nominal line voltage of 22.5 KV in AC traction and new wheels shall be considered as one traction cycle with reference to Clause 3.1.7. The train shall achieve the maximum speed of 100 kmph from standstill in less than ~~240~~ ***260*** seconds in continuous up gradient section of 1 in 80 grade. Supplier shall also ensure compliance to clause 2.5. However, the maximum current drawn from OHE at the average line voltages specified herein shall not be exceeded at lower voltages.
8	3.1.20 (Annexure-XVIII)	Supplier shall submit the residual acceleration for the DCL loaded MEMU train starting on a rising gradient of 1 in ~~34~~ ***80*** ***on achieving speed of 100 kmph.*** ~~along with~~ ***Also*** the time and distance for attaining 110 kmph speed on straight and level tangent track to be submitted.
9	4.22.11 (Annexure-XVIII)	The weight of the whole unit shall be as minimum as possible as the unit is to provided on the roof frame work ~~and shall not exceed 250kg. This weight will be over and above the weight of electrics/ Propulsion equipment mentioned in clause 2.1.2~~

Addendum/Corrigendum No. 2 to
RDSO Specification No. RDSO/PE/SPEC/EMU/0163(Rev. 3)-2022 Issued on October, 2023

Note:

1. The deletions are marked in strikethrough and additions are italic, bold and underlined.
2. The dotted segment indicates that rest of the clause not appearing here, is not affected and continue to remain same as in the original specification.

Sr No	Clause No	To be read as
1.	**1.3.7**	In addition to the equipments and services specified in this Specification, the Supplier shall supply handling tackles, special tools, ***suitable connectors*** and appliances which may be necessary for the installation, testing and commissioning of the supplied equipment on the new manufacture EMUs/MEMUs, even though such material or work may not be specifically mentioned in this Specification.
2.	**4.6.2(ii)**	Public Address announcements or playing of taped information by the driver & 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. The details shall be collected by the supplier in association with the respective user railway and the control scheme finalized. ***Voice recording of Public address announcement done by Driver/Guard shall be recorded in the flash memory (for a duration of at least 24 hours) and in crash protected memory (for a duration of at least 60 mins) of intelligence based recording described in clause 4.9.6.***
3	**4.19.1**	The Passenger Car Surveillance System (PRSS) shall comprise of an IP based close circuit television (CCTV) network, surveillance cameras, routers and cables, monitors and other accessories as ***per RDSO Telecom Directorate Specification no. RDSO/SPN/TC/106/2022 (Version No. 2.1 or Latest) along with enclosed Annexure VI D*** ~~required. On board equipment for streaming of video to the central server for selected cameras (maximum of 6 with 12 frame per second) will be in the scope of Supplier, however, network and central server will be facilitated by IR.~~
4.	**4.19.2**	Each Car of Train shall be provided with ~~minimum six~~ ***tentatively eight nos. of*** surveillance camera devices at appropriate location to cover the maximum passenger area (including gangway and vestibule area). ***The fixing protocol for installation of the CCTV cameras for the proposed car will be finalized during design stage.***
5	**4.19.3**	~~Additionally, at least one camera shall be placed in driving cabs for gathering frontend view, track and OHE conditions etc. One camera shall be installed on the roof of all cars having pantograph facing towards pantograph to monitor the roof equipments. The camera shall be suitably selected in respect of resolution, clarity of images, illumination conditions for on-train applications and shall be of proven design. Additional two cameras per basic unit shall be placed on outer sides of the each Basic Unit as a minimum for gathering rear view of the platform. Mounting of camera shall be unobtrusive, flushed with, or recessed into the interior panel. Selection of type shall be finalized during design and shall ensure clear view of passengers on platform to Train Driver/Guard before start at each station till Train leaves the platform completely. The system shall automatically switch to rear view when the Train stops and will go back to default mode after the Train leaves the platform~~ deleted
6	**4.19.4**	~~An integrated screen shall be provided for the passenger Car surveillance system in each Driving Cab. It shall be so placed in the cab that normally it~~

Sr No	Clause No	To be read as
		~~does not cause distraction to the Train operator but it shall be easily viewable by the Train Driver/Guard, when needed~~ deleted
7	**4.19.5**	~~Under normal operation, the views gathered from each of the camera located in the Train shall be sequentially played in the monitor screens of both the cabs. Adequate controls shall be provided for necessary surveillance requirements and priorities~~ deleted
8	**4.19.6**	~~The visual images from each camera shall be recorded in non-volatile memory. The on-board system should have capacity of recording such that it can be downloaded in the maintenance depot during the scheduled maintenance overhauling. The architecture of the CCTV system shall have NVR with high speed downloading port, at basic unit level. Storage memory (HDD) shall be removable from NVR and shall facilitate extraction of recorded data from docking station. The memory shall be expandable. The Supplier shall provide equipment and means for the downloading of the records~~ deleted
9	**4.19.7**	~~The visual images from each camera shall be recorded in First in First Out (FIFO) non-volatile memory. The on-board system should have capacity of recording such that it can be downloaded in the maintenance depot during the scheduled maintenance. The capacity of the memory shall be expandable. The capacity of the memory shall be sufficient enough to record videos up to 25 frames per second, for a minimum period of 30 days @ 24 hours per day. The CCTV cameras shall conform to IEC 62676. The CCTV cameras have to meet the following minimum parameters:~~ ~~• Image sensor : 1/2.8" or larger, CMOS sensor~~ ~~• Minimum Illumination : 0.3 lux (colour)~~ ~~• Lens : Focal length 2.8 mm or larger~~ ~~• Resolution : 2 MP and above~~ ~~The field of view-object size shall be upto (identify the target) as per IEC 62676-4 from 1.5 meters distance. The Supplier shall provide equipment and means for the downloading of the records~~ deleted
10	**4.19.8**	~~IP based CCTV cameras are to be suitable for rolling stock to be worked in environments with extreme temperatures, humidity, vibration, dust. Cameras used in trains should also have EMI and surge protection to ensure consistent performance and to prevent damage to the equipment. The minimum requirements for electromagnetic compatibility in railway applications are defined by EN 50121-3-2 or IEC 62236-3-2 standards. Since some of these cameras are used on the exterior of trains, they should also support a feature to deliver high quality images in rain and fog conditions. The IP level of the outside cameras shall be IP 66. Secure and reliable disk access under extreme vibrations, as in the case of rolling stock, is absolutely essential to maintain data integrity and prevent data loss.~~ deleted

Annexure- VI-D

Addendum/Corrigendum to RDSO Telecom Directorate Specification no. RDSO/SPN/TC/106/2022 (Version No. 2.1) for EMU/MEMU type Rakes Issued on October, 2023:

Note:

1. The deletions are marked in strikethrough and additions are bold, italics and underlined.

S. No.	Clause No.	Proposed changes/addition
1.	**2.2**	~~Each Coach shall be provided with a~~ Video Recorder Unit or Mobile Network Video Recorder (Mobile NVR) along with System Software ***shall be provided at suitable location***.
2.	**2.4**	~~Each Coach shall be provided with~~ Wi-fi Access Point and LTE for connecting the Video Recorder Unit/ Mobile NVR to the Data Centre/Centralized location/Cloud ***shall be provided at suitable location***. Video Recorder Unit /Mobile NVR should be provided with GPS/Indian Regional Navigation Satellite System (IRNSS) module for GPS/ Indian Regional Navigation Satellite System (IRNSS) applications within the housing as specified in clause 3.16.
3.	***2.9 (New Clause)***	***If any ETBU (Emergency Talk Back Unit) is operated in any of the coach in case of emergency, immediately nearby two camera views are override on priority on CCTV display unit. These ETBU nearby camera views are displayed immediately after initiate the call from passenger. If driver / guard reject the call, display will go back to the previous screen. If driver / guard accept the call, ETBU nearby camera views are continuously displayed till the ETBU call ends by driver / guard.***
4.	***2.10(New Clause)***	***Additionally, at least one camera shall be placed in cab for gathering front-end view, track and OHE conditions etc. The camera shall be suitably selected in respect of resolution, clarity of images, illumination conditions for on-train applications and shall be of proven design. Additional two cameras per basic unit shall be placed on outer sides of the each Basic Unit as a minimum for gathering rear view of the platform. Mounting of camera shall be unobtrusive, flushed with, or recessed into the interior panel. Selection of type shall be finalized during design and shall ensure clear view of passengers on platform to Train Driver/Guard before start at each station till Train leaves the platform completely. The system shall automatically switch to rear view when the Train stops and will go back to default mode after the Train leaves the platform. One/two camera(s) shall be installed on the roof towards pantograph to monitor the roof equipment.***

Annexure- VI-D

Addendum/Corrigendum to RDSO Telecom Directorate Specification no. RDSO/SPN/TC/106/2022 (Version No. 2.1) for EMU/MEMU type Rakes Issued on October, 2023:

5.	***2.11(New Clause)***	***Since some of these cameras are used on the exterior of trains, they should also support a feature to deliver high quality images in rain and fog conditions. Secure and reliable disk access under extreme vibrations, as in the case of rolling stock, is absolutely essential to maintain data integrity and prevent data loss.***
6.	***2.12(New Clause)***	***An integrated screen shall be provided for the passenger Car surveillance system in each Driving Cab. It shall be so placed in the cab that normally it does not cause distraction to the Train operator but it shall be easily viewable by the Train Driver/Guard, when needed.***
7.	***2.13(New Clause)***	***Under normal operation, the views gathered from each of the camera located in the Train shall be sequentially played in the monitor screens of both the cabs. Adequate controls shall be provided for necessary surveillance requirements and priorities.***
8.	***2.14(New Clause)***	***The system shall have self-diagnostics and communicate the same suitably to train operator/maintainer. The health of the complete CCTV surveillance system shall be displayed in CCTV display in both driver cabs.***
9.	***2.15(New Clause)***	***The architecture of the CCTV system shall have NVR with high speed downloading port, at basic unit level. The visual images of surveillance cameras of all coaches shall be downloadable from centralized location.***

Note:

1. The deletions are marked in strikethrough and additions are italics and underlined.
2. The dotted segment indicates that rest of the clause not appearing here, is not affected and continue to remain same as in the original specification.

S. No.	Clause No.	Clause to be read as
1	**1.1.4(vi)**	All working parts of the control and auxiliary circuit specifically electronics and PCBs, shall be suitably covered in cubicles with essential interlocks/keys to keep them free from moisture and dust. As a minimum, equipments shall be sealed to the standard below: • Under frame mounted equipments (except traction motor) IP65 • Equipments mounted inside the car body IP54 ***(except diaphragm part of microphone and cab/saloon speakers)*** Note that it may be necessary to protect some equipment to IP 67 in order to meet the requirements of flood proofing as mentioned in Clause 2.7, 4.4 and 4.15. The protection level (IP level) shall be furnished by the supplier during design approval.
2	**4.5.4**	It shall be possible to down load …… The diagnostic messages of ~~at least last 100 days~~ ***record duration as per clause 4.9.9*** shall be available in its memory
3	4.9.6	In order to analyze and to assist in determining the cause of accident, incidents or operating irregularities, ……shall have one crash protected memory (not less than 8 GB) and one data logging memory (flash memory) (not less than 32 GB) for recording of data. The memory shall be allocated ~~to store short-term data at 1 second interval for the last 72 hrs. in crash protected memory and long term data for 90 days with resolution of 20 seconds in data logging memory~~ ***for record duration as per clause 4.9.9.*** The following (not limited to below mentioned) parameters…… … shall be tested in accordance with a recognized international standard such as the UK Railway Group Standard GM/RT 2472.
4	4.6.2(i) of Addendum/ Corrigendum no. 1	Driver-guard or cab–cab communication between two driver"s cabs on the train. The PIS shall include provision for the announcements to be made remotely by train controllers, however, the purchaser will provide suitable communication facilities. There should be provision of recording the voice of driver & Guard (both) ~~in the flash memory (for a duration of at least 24 hours) and in crash protected memory (for a duration of at least 60 mins)~~ ***for record duration as per clause 4.9.9*** of intelligence based recording described in clause 4.9.6. Mic provided on the driver desk shall be made use of, for this purpose.
5	4.6.2(ii) of Addendum/ Corrigendum no. 2	Public Address announcements or playing of taped information ……Voice recording of Public address announcement done by Driver/Guard shall be recorded ~~in the flash memory (for a duration of at least 24 hours) and in crash protected memory (for a duration of at least 60 mins)~~ ***for record duration as per clause 4.9.9*** of intelligence based recording described in clause 4.9.6.
6	4.6.2 (x) of Addendum/ Corrigendu	Few designated coaches as per latest guidelines of Railway Board in EMUs/MEMUs shall have the provision of talk back. Emergency buttons …… Provision shall be there for voice

<table>
<tr><th>S. No.</th><th>Clause No.</th><th>Clause to be read as</th></tr>
<tr><td></td><td>m no. 1</td><td>recording of the conversations with GPS stamping ~~in the flash memory (for a duration of at least 24 hours) and in crash protected memory (for a duration of at least 60 mins)~~ <u>for record duration as per clause 4.9.9</u> of intelligence based recording described in clause 4.9.6. The CCTV camera of the coach shall focus on the ETB area during the conversation. LED indication (engaged or free) at the passenger end shall communicate the status of ETBs.</td></tr>
<tr><td>7</td><td>4.9.9 (New Clause)</td><td>Record duration of Memory: Record duration of various memories are as under:
<table>
<tr><th rowspan="2">S. No.</th><th rowspan="2">Data Type</th><th colspan="2">Record Duration</th></tr>
<tr><th>Crash Protected Memory as per RGS GM/RT/2472</th><th>Internal Flash Memory</th></tr>
<tr><td>1</td><td>Short-term Data</td><td>1 Second interval for the last 72 Hrs</td><td>1 Second interval for the last 72 Hrs</td></tr>
<tr><td>2</td><td>Long -term Data</td><td>20 Second interval for 90 Days</td><td>20 Second interval for 90 Days</td></tr>
<tr><td>3</td><td>Faults data (along with facility to capture post-trigger and pre-trigger background information)</td><td>120 Days</td><td>120 Days</td></tr>
<tr><td>4</td><td>Energy data</td><td>120 Days</td><td>120 Days</td></tr>
<tr><td>5</td><td>Cab Cameras Audio & Video Recording (Single file)</td><td>60 Minutes</td><td>24 Hrs</td></tr>
<tr><td>6</td><td>Driver-Guard Recording (Cab to Cab voice recording)</td><td>60 Minutes</td><td>24 Hrs</td></tr>
<tr><td>7</td><td>Emergency Talk Back Unit (Driver/Guard–Passenger Voice Recording)</td><td>60 Minutes</td><td>24 Hrs</td></tr>
<tr><td>8</td><td>Public Announcement done by driver/guard</td><td>60 Minutes</td><td>24 Hrs</td></tr>
</table></td></tr>
<tr><td>8</td><td>4.26 of Addendum/ Corrigendum no. 1</td><td>CAB Recording Facility:
In the CCTV network, one separate and independent camera with inbuilt microphone in each cab shall be installed at appropriate location to clearly make out various actions (audio & video) of crew from the recorded data. The CCTV data (audio & video) of these cab cameras will be stored in following locations and as described below:
(i) Crash protected memory of Event Recorder ~~for a minimum duration of 60 mins~~ <u>for record duration as per clause 4.9.9.</u>
(ii) Flash memory of Event Recorder ~~for last 24 hrs~~ <u>for record duration as per clause 4.9.9</u>.
Apart from this, CCTV data in NVR should continue to be stored normally, for full duration of 30 days.</td></tr>
</table>

Note:

1. The deletions are marked in strikethrough and additions are italics and underlined.
2. The dotted segment indicates that rest of the clause not appearing here, is not affected and continue to remain same as in the original specification.

<table>
<tr><th>S. No.</th><th>Clause No.</th><th>Clause to be read as</th></tr>
<tr><td>1</td><td>4.9.9 (Addendum / Corrigendum-3)</td><td>Record duration of Memory: Record duration of various memories are as under:
<table>
<tr><th rowspan="2">SN</th><th rowspan="2">Data Type</th><th colspan="2">Record Duration</th></tr>
<tr><th>Crash Protected Memory as per RGS GM/RT/2472</th><th>Internal Flash Memory</th></tr>
<tr><td>1.</td><td>Short-term Data</td><td>1 Second interval for the last 72 Hrs</td><td>1 Second interval for the last 72 Hrs</td></tr>
<tr><td>2.</td><td>Long -term Data</td><td>20 Second interval for 90 Days</td><td>20 Second interval for 90 Days</td></tr>
<tr><td>3.</td><td>Faults data (along with facility to capture post-trigger and pre-trigger background information)</td><td><s>120</s> <u>3</u> Days</td><td>120 Days</td></tr>
<tr><td>4.</td><td>Energy data</td><td>120 Days</td><td>120 Days</td></tr>
<tr><td>5.</td><td>Cab Cameras Audio & Video Recording (Single file)</td><td>60 Minutes</td><td>24 Hrs</td></tr>
<tr><td>6.</td><td>Driver-Guard Recording (Cab to Cab voice recording)</td><td>60 Minutes</td><td rowspan="3"><u>24 Hrs (See Note)</u></td></tr>
<tr><td>7.</td><td>Emergency Talk Back Unit (Driver/Guard–Passenger Voice Recording)</td><td>60 Minutes</td></tr>
<tr><td>8.</td><td>Public Announcement done by driver/guard</td><td>60 Minutes</td></tr>
</table>
<u>Note- Memory for the total duration of 24Hrs allocated for the three types of audio data viz. Driver- Guard Recording, ETBU audio recording and Public Announcement recording to be stored in Internal Flash Memory. Since the three audio data are related to Guard's involvement for the same, the recording will continuous to record all the three types of audio data on sharing basis for 24hrs and any one of the three types of audio data can be recorded upto duration of 24hrs based on the actual usage/consumption in the train, if other type of data are not utilized currently. Otherwise the recording length will be equally distributed among the three types of data. The data/recording duration as specified is for period of actual communication in various mode.</u></td></tr>
<tr><td>2</td><td>4.18.4</td><td>The pantograph shall be capable of sustained operation and satisfactory current collection from <s>100</s> <u>150</u> mm above the collapsed pantograph level up to the full range of contact wire height, and at all operating speeds as specified.</td></tr>
</table>