Specification for Electrics of Hybrid (Electric + battery mode) Self Propelled inspection Car (SPIC)

Chapter-1: GENERAL REQUIREMENTS AND SUPPLIER'S RESPONSIBILITIES

1.0 Introduction:

i) Indian Railways is one of the largest Railway Systems in the World. It has both Electrified and non-Electrified sections. Presently, diesel engine propelled Self Propelled Inspection Car (SPIC) is utilized to undertake patrolling, inspection of level crossings, overhead equipment, tracks, and stations in the divisions with a maximum operating speed of 110 kmph.To cater the sections having higher sectional speed, the need for SPICs with higher speed potential is necessitated.

ii) It is planned to induct SPICs with operational speed of 130 Kmph using catenary electric propulsion wherever OHE is available and Battery-Electric propulsion when OHE is not available. This dual mode SPIC should clock operational speed of 130 kmph in OHE mode and 80 Kmph in Battery mode for a range of 100 km in Battery mode.

1.1 Objective:

i) This technical specification is meant for design, development, manufacture, supply, testing and commissioning of IGBT based three-phase propulsion, control and other equipment for SPIC suitable for operation on 25kV AC OHE system as well as Battery mode during non-availability of OHE supply. An indicative block diagram for SPIC is enclosed as Annexure-XI for reference.

ii) Propulsion equipment such as transformers, 3-phase induction motors, gearbox assembly, Main compressor and battery etc. will be mounted on underframe/ on bogie, whereas, other sub-systems such as IGBT based traction converter, auxiliary converter, Battery converter,Train Control and Management System/VCU (wherever mentioned as TCMS), Brake Interface Unit, PA/PIS, CCTV etc. will be mounted on-board.

iii) SPIC shall also comprise of air conditioning system, aerodynamically designed driving cabs, PAPIS, CCTV cameras, Driver display unit and on board Wi-Fi for better communication, including direct and indirect LED interior lights, GPS capabilities and TCAS.

iv) All equipments with associated accessories shall be engineered to provide trouble free traction power with in-built safety & protection equipment. The controls shall be developed to provide regulated traction power to match the demand from driver's console command while maintaining the safety checks all the time during traction.

1.2 References:

Dual mode SPIC system shall comply with below standards:

Standard	Description
IEC –60571 (1998-02)	General requirements and tests for electronic equipment used on rail vehicles.
IEC–61287–1	Railway applications–Power converters installed on rolling stock.
IEC–60310	Rules for traction transformer and reactor.
IEC–60077 –1	Railway applications –Electric equipment for rolling stock –

Standard	Description
	part 1: General service conditions and general rules.
IEC–61373	Railway applications –rolling stock equipment –shock and vibration tests
EN–50121 –3 –2 (CENELEC)	Railway applications –Electromagnetic compatibility part 3 – 2: Rolling stock apparatus.
EN–50121 –2 (CENELEC)	Railway applications –Electromagnetic compatibility part 2: Emission of the whole Railway system to the outside world
EN–50153	Railway applications –Rolling stock –Proactive actions against electrical hazards.
IEC –60529	Degree of protection provided by enclosures (IP code)
EN–50126 / IEC 62278	Railway applications –Specification and demonstration of reliability, availability, maintainability and safety (RAMS).
EN–50238	Railway applications –Compatibility between rolling stock and train detection systems.
EN–50264	Railway applications –Railway rolling stock power and control cables having special fire performance.
IEC- 60349	Electric Traction Rotating Electrical Machines for Rail and Road Vehicles - Edition 2.0
IEC-60411	Single-Phase Traction Power Convertors
IEC 62279/EN 50128	Railways applications - Communications, signalling and processing systems - software for railway control and protection system
IEC 62425 /EN 50129	Railways applications - Communications, signalling and processing systems - Safety related electronic systems for signalling
IEC 62280 /EN 50159	Railways applications - Communications, signalling and processing systems - Safety related communication (part 1&2)
IEC 61131 part 1 to 9	Programming controllers languages
IEC-61375	Train communication network
IEC 61375 -1	General Architecture
IEC 61375 -2-5	Ethernet Train Backbone
IEC 61375 -3-3	CAN-open as vehicle bus
IEC 61375 - 2-1/2-2	Wire Train Bus
IEC 61375 - 2-6	Board to ground communication
IEC 61375 - 2-3	Communication profile
IEC 61375 - 3 -4	Ethernet consist network
IECTR 61375 -2-8 New	TCN conformance test
IEC 61375 -2-4	Application profile
IEC 60349-1,2	Traction Motor
IEC - 60411,	Power Rectifier
IEC - 60337, 60157, 60158, 77	Relays & Contactors
IEC - 68-2-14	Control cubicle

1.3 Abbreviations:

AC	Alternating current
DC	Direct current
HP	Horsepower
AH	Ampere hour
IGBT	Insulated Gate Bipolar Transistor
IEC	International Electro technical Commission
IR	Indian Railways
IS	Indian Standard
SPIC	Self-Propelled Inspection car
VVVF	Variable Voltage variable frequency
HV	High Voltage
TM	Traction Motor
TCMS	Train control and monitoring system
TCN	Train control network
Aux.	Auxiliary
ACU	Auxiliary Converter unit
TCU	Traction converter unit
OHE	Over-head electric
LTC	Line and traction converter unit
RDSO	Research Designs & Standards Organisation
TSD	Trouble shooting directory
SIL	Safety Integrity level

1.4 General Information

1.4.1 SALIENT FEATURES OF SELF-PROPELLED INSPECTION CAR:

i) Fully air-conditioned self-propelled coach.
ii) Profiled nose cone with driver's desk on both ends.
iii) GPS based PIS/PAS with digital speed indication.
iv) Bio toilets.
v) CCTV Cameras.
vi) Mini Pantry.
vii) LED Lighting.
viii) Under-slung Battery Power Pack for Propulsion system.
ix) On-board mounted three phase Electric propulsion system.

1.4.2 SPIC Requirement:

i) 130 KMPH on Electric (OHE) mode
ii) 80 KMPH on Battery-Electric mode

1.4.3 Power pack consists of following major components:

Under floor mounted:

- Traction Transformer
- Traction Motors
- Lithium -iron Phosphate Battery Power pack (For Traction)

On-board mounted:

- Control Cubicle
- Line and Traction Converter
- Auxiliary Converter
- Battery Converter
- Driver Desk

Over the roof:

- Pantograph along with other HT equipments
- Air -conditioning system

1.4.4 Overhead Electric mode and Battery-Electric mode operation:

Traction drive system for SPIC shall be capable of running both on Electrified and Non-Electrified tracks along with auxiliary power supply. The SPIC shall run in OHE mode if the OHE is available. If OHE is not available, the SPIC should smoothly run on Battery-electric mode or vice versa. Suitable measures shall be in place to ensure safe operation in both modes.

Chapter 2: General Requirements and Supplier's Responsibilities

2.0 General requirements

RDSO specification RDSO/PE/SPEC/EMU/0196-2019 (Rev.0) for "3 Phase Propulsion Equipments and Control system for Electric Trainsets" shall be referred with suitable modifications in relevant clauses applicable in this specification. The modifications in the relevant clauses/Annexures of above RDSO specifications are as under:

Approval by "RDSO" is replaced with "RCF/RDSO or its authorized agency" wherever applicable.

Existing Clause of RDSO spec RDSO/PE/SPEC/EMU/0196-2019 (Rev.0)	**Modified Clause**
Clause 1.3.2 The equipment and control systems in the scope of supply are listed (not exhaustive) in Chapter 4 of this specification. It shall also include various services and control packages required to build the complete Train.	The equipment and control systems in the scope of supply are listed (not exhaustive) in Chapter 5 of this specification. It shall also include various services and control packages required to build the complete SPIC.
Clause 1.3.4 Manufacturing/procurement of Car-body and Bogie assembly (for series rakes) as per designs made available by the Supplier, shall be in the scope of Purchaser. Fabrication and supply of complete bogie assemblies for all type of coaches of two prototype rakes shall be in the scope of Supplier. Brake equipment viz. EP units, brake cylinders & Auto brake controller including driver's brake valve, Parking Brake and isolating cock/switch will not to be in the scope of supply. However, the responsibility of interface with TCMS shall be in the scope of supplier only.	Manufacturing/procurement of Car-body and Bogie assembly shall be in the scope of Purchaser. Brake equipment viz. EP units, brake cylinders & Auto brake controller including driver's brake valve, Parking Brake and isolating cock/switch will not be in the scope of supply. However, the responsibility of interface with TCMS shall be in the scope of supplier only.
Clause 1.3.5 Weight of Train with passenger load (sitting passengers + 10 % extra @ 70 kg per passenger) without inclusion of scope of supply of equipment contained in this specification shall be 550 ton (Purchaser's scope). For performance evaluation purpose, the configuration of 16-car rake shall be two End Basic Units and two Middle Basic Units, fully vestibuled and at gross weight, which will be equivalent to	Weight of SPIC with passenger load (sitting passengers + 10 % extra @ 70 kg per passenger) without inclusion of scope of supply of equipment contained in this specification shall be 48 ton (Purchaser's scope). Performance evaluation of SPIC shall be carried out at gross weight, which will be equivalent to 48 ton plus weight of supplied equipment under scope of supply of this specification (all items mentioned in clause 5.1 of this specification to be considered).

550 ton and weight of supplied equipment under scope of supply of this specification (all items mentioned in clause 4.1 to be considered). Each basic unit shall consist of four Cars i.e. two motorized Car (MC) and two trailer Cars (TC)	
Clause 1.3.6	Deleted.
Clause 1.3.8 Leading Car of both the End Basic Units shall be provided with driving cab having driver's console housing the safety related equipment, instruments and combined master cum brake controller etc.	Both the ends of SPIC shall be provided with driving cab having driver's console housing the safety related equipment, instruments and combined master cum brake controller etc.
Clause 1.3.9 Each basic unit shall be provided with one pantograph along with associated high voltage equipment.	SPIC shall be provided with one pantograph along with associated high voltage equipment.
Clause 1.3.10; 1.3.11;1.3.12	Deleted.
Clause 1.4.1 Three-phase propulsion equipment shall be suitable for mounting on the underframe. Fitment of various equipment/ systems on underslung/ bogie will be so decided that the weight is properly distributed with least possible weight unbalancing during tare condition. No equipment or cubicles shall be generally permitted within the car body except at the ends of the coach. The load on axle for any car shall not exceed the maximum permissible axle load under any condition	Three-phase propulsion equipment shall be suitable for mounting on-board. Fitment of various equipment/ systems on-board/ underslung/ bogie will be so decided that the weight is properly distributed with least possible weight unbalancing during tare condition. The load on axle for SPIC shall not exceed the maximum permissible axle load under any condition.
Clause 1.4.5 The equipment design shall incorporate all essential features necessary to yield high traffic use, low maintenance requirements, easy maintainability, high regeneration, high efficiency, light in weight, user & environment friendly and high reliability in train operation. The design shall also facilitate easy erection, inspection, maintenance and replacement of the sub-units/ assemblies of all the equipment. The total weight of the items under scope of supply of this specification (all items mentioned in clause 4.1 to be considered) shall not exceed 410 ton	The equipment design shall incorporate all essential features necessary to yield high traffic use, low maintenance requirements, easy maintainability, high regeneration, high efficiency, light in weight, user & environment friendly and high reliability in SPIC operation. The design shall also facilitate easy erection, inspection, maintenance and replacement of the sub-units/ assemblies of all the equipment. The total weight of the items under scope of supply of this specification (all items mentioned in clause 5.1 to be considered) shall not exceed 25 ton

Clause 1.5.1 The noise levels emitted from the Train with supplied equipment shall be as low as possible and the equipment shall be designed to prevent drumming, rattles or vibrations throughout their Design Life. All noise levels specified below are in decibels referred to 20 micro Pascal as measured with "A" weighting network of standard Type 1 sound level meter with time weighting F. During the measurements, end wall doors between Cars, body side doors, intermediate doors and windows of the vehicle shall be kept closed, unless their influence upon the sound level inside the vehicle is to be investigated.	The noise levels emitted from the SPIC with supplied equipment shall be as low as possible and the equipment shall be designed to prevent drumming, rattles or vibrations throughout their Design Life. All noise levels specified below are in decibels referred to 20 micro Pascal as measured with "A" weighting network of standard Type 1 sound level meter with time weighting F. During the measurements, body side doors, intermediate doors and windows of the vehicle shall be kept closed, unless their influence upon the sound level inside the vehicle is to be investigated.
Clause 1.7.3 The Supplier shall submit software logic with detailed explanation along with complete software packages used in TCMS and Converter control before commissioning of the prototype rake. Parametric changes shall be possible in the software in order to meet the future requirements viz. change in acceleration & deceleration, bogie & coach suspension, train configurations, OHE voltage, frequency etc. within permissible limits. 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. Supplier shall submit one copy of the licensed software to the user Railway before uploading the same on the train.	The Supplier shall submit software logic with detailed explanation along with complete software packages used in TCMS and Converter control before commissioning of the prototype SPIC. Parametric changes shall be possible in the software in order to meet the future requirements viz. change in acceleration & deceleration, bogie & coach suspension, OHE voltage, frequency etc. within permissible limits. 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. Supplier shall submit one copy of the licensed software to the user Railway before uploading the same on the SPIC.
Clause 1.7.4 Software shall be fine tuned through simulations & real life working conditions based on the extensive trials, associating user Railways before putting the rake in commercial services. As it requires, instrumentation and expertise of Software Design Professionals, software expert(s) of Supplier shall be based at the work place along with commissioning engineers so that all software related issues are	Software shall be fine tuned through simulations & real life working conditions based on the extensive trials, associating user Railways before putting the SPIC in commercial services. As it requires, instrumentation and expertise of Software Design Professionals, software expert(s) of Supplier shall be based at the work place along with commissioning engineers so that all software related issues are expeditiously resolved before putting the SPIC

expeditiously resolved before putting the rake into commercial service.	into commercial service.
Clause 1.8.1 Supplier shall design the mounting arrangements of different equipment/ subassembly in scope of this specification, in consultation with Purchaser suitable for Cars to be manufactured. The accessories and hardware for mounting the equipment, safety links for underslung equipment shall be in the scope of supply.	Supplier shall design the mounting arrangements of different equipment/ subassembly in scope of this specification, in consultation with Purchaser suitable for SPICs to be manufactured. The accessories and hardware for mounting all the equipments including safety links for underslung equipments shall be in the scope of supply.
Clause 1.8.3 Commissioning of supplied equipment and control system on all Train set rakes at Purchaser's field units and tests & trials of prototype rakes at IR field units shall be carried out by the trained engineers of Supplier along with support staff to ensure that the each interface & equipment assembly perform its intended function	Commissioning of supplied equipment and control system on all SPICs at Purchaser's field units and tests & trials of prototype SPIC at IR field units shall be carried out by the trained engineers of Supplier along with support staff to ensure that the each interface & equipment assembly perform its intended function
Clause 1.8.5 The Supplier shall arrange required instrumentation and carry out detailed tests and service trials jointly with RDSO, Zonal Railway & Purchaser/ Railway maintenance shed/workshop/any other manufacturer nominated by IR as per Chapter 5 of this Specification	The Supplier shall arrange required instrumentation and carry out detailed tests and service trials jointly with RDSO, Zonal Railway & Purchaser/ Railway maintenance shed/workshop/any other manufacturer nominated by IR as per Chapter 6 of this Specification
Clause 1.8.12 Save otherwise exempted under this specification, two prototype rakes, fitted with the supplied equipment after the successful completion of all tests and trials and RDSO clearance shall undergo service trials for six months or one lakh km whichever is earlier. Clearance for supply of equipment for series rakes shall be given by RCF after successful service trials for three months or one lakh km as stated above for prototype rake. The supply of equipment for the "work in progress" for the period of service trials can commence 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 problem arise or feedback is obtained, which warrants a re-	Save otherwise exempted under this specification, one prototype unit, fitted with the supplied equipment after the successful completion of all tests and trials and RCF clearance shall undergo service trials for three months or Fifty Thousand km (including atleast 1000 Km exclusively in Battery mode) whichever is later. Clearance for supply of equipment for series rakes shall be given by RCF after successful service trials for three months or Fifty Thousand km as stated above for prototype SPIC. The supply of equipment for the "work in progress" for the period of service trials can commence 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 problem arise or feedback is obtained, which warrants a

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.	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 RCF on equipment/components already supplied as well as those to be supplied later.

Chapter 3: Operating and Service Conditions: Design Constraints

Existing Clause of RDSO spec RDSO/PE/SPEC/EMU/0196-2019 (Rev.0)	Modified Clause
Clause 2.1 Leading particulars For leading particulars of the Chair Cars, on which supplied equipment are to be fitted, following ICF Car layout OGA drawings may be referred: (Annexure: X) (i) TRAIN 18/DTC/AC-9-0-001 (ii) TRAIN 18/MC/AC-9-0-001 (iii) TRAIN 18/TC/AC-9-0-001 (iv) TRAIN 18/NDTC/AC-9-0-001	Leading particulars For leading particulars of the HS-SPIC, on which supplied equipment are to be fitted, RCF layout drawing SP90001 may be referred (Annexure-X).
Clause 2.1.1 The layouts for sleeper coaches are under finalization and will be madeavailable at appropriate stage.	Deleted
Clause 2.2.1 , 2.2.3	Deleted
Clause 2.2.4 Weight Distribution (i) All equipment/ materials under the scope of supply shall be so designed that the total overall axle load of the motor or trailer coach under fully loaded condition, fitted with the three-phase propulsion and other accessories does not exceed 17 tons after taking into consideration the unbalancing during tare and gross load conditions. (ii) Supplier shall submit weight disposition of all equipment in different Cars and shall submit calculation of overall centre of gravity with respect to bogie centers at the design stage. This shall also include calculation for unbalance of load under tare load and gross load conditions on both the bogies. Distribution of weight across the length of the coach shall be such that the axle load duly taking into account all the unbalance forces should not be more than the maximum limit of the axle load.	All equipment/ materials under the scope of supply shall be so designed that the total overall axle load of the SPIC under fully loaded condition, fitted with the three-phase propulsion and other accessories does not exceed 20.32 tons after taking into consideration the unbalancing during tare and gross load conditions. Supplier shall submit weight disposition of all equipment in SPIC and shall submit calculation of overall centre of gravity with respect to bogie centers at the design stage. This shall also include calculation for unbalance of load under tare load and gross load conditions on both the bogies. Distribution of weight across the length of the coach shall be such that the axle load duly taking into account all the unbalance forces should not be more than the maximum limit of the axle load.

(iii) The power equipment viz. traction converter, traction motor & transformer etc. shall be distributed amongst adjacent Cars for optimized weight distribution and reduced axle load within the basic unit. Supplier shall ensure that proposed arrangement shall be as per international practice 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 Cars, which shall be manufactured by Purchaser.	The power equipment viz. traction converter, traction motor & transformer etc. shall be mounted in SPIC as per clause 1.4.3 of this specification. Supplier shall ensure that proposed arrangement shall be as per international practice 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 SPIC, which shall be manufactured by Purchaser.
(v) The inter-vehicular couplers for high-tension connections between equipment, if used, shall be proven. Such couplers shall be exposed to vandalism activities. As such the coupler shall be designed to cater for all such abnormalities. Details of the coupling arrangement shall be furnished. To ensure safety of personnel, it shall be ensured coupling/ uncoupling of HT & power couplers shall be possible only in de-energised conditions.	Deleted
Clause 2.3 **Gauge and Moving Dimensions** Unless otherwise stated, the Train set coaches shall conform to the Indian Railways Schedule of Dimension – 1676 mm gauge of 2004 with latest amendments	**Gauge and Moving Dimensions** Unless otherwise stated, the SPIC shall conform to the Indian Railways Schedule of Dimension – 1676 mm gauge (BG) revised 2022 with latest amendments
Clause 2.5 (i) Max. service speed :160 KMPH (ii) Max. test speed :180 KMPH	Maximum service speed: 130 KMPH in OHE mode and 80 KMPH in Battery mode Maximum test speed: 143 KMPH in OHE mode and 88 KMPH in Battery mode
Clause 2.6.2 The guaranteed performance shall be available from 22.5 kV to 27.5 kV for gross train weight of 550 ton plus weight of equipment covered under this specification to be supplied by Supplier. The maximum current drawn by a 16-car loaded Train to meet the performance	The guaranteed performance shall be available from 22.5 kV to 27.5 kV for SPIC with gross weight of 73 Ton including weight of equipment covered under this specification to be supplied by Supplier. Regenerative braking system shall continue to operate when the supply voltage is in the range from 17kV to 30kV. SPIC operation

requirements of this specification at 22.5 kV shall not exceed 540 Amp. Regenerative braking system shall continue to operate when the supply voltage is in the range from 17kV to 30kV. Train operation shall be feasible at OHE voltage of 17 kV, may be with restricted power. It should be possible to run the Train up to 24-car formation with suitable parametric changes to take care of OHE limitations.	shall be feasible at OHE voltage of 17 kV, may be with suitable restricted power.
Clause 2.7.1 **25 kV AC Traction:** The overhead equipment (OHE) from which basic unit shall be drawing power through pantograph, is supplied through 2-phase grid system and step up/down transformers at the traction substations. Consecutive sections are not supplied from the same phase, therefore neutral sections are provided in between the traction feed from two adjacent substations. The length of the neutral section may be up to 42 meter. The OHE can be of regulated (fit up to 160 kmph) or unregulated type (fit up to 110 kmph).	**25 kV AC Traction:** The overhead equipment (OHE) from which SPIC shall be drawing power through pantograph, is supplied through 2-phase grid system and step up/down transformers at the traction substations. Consecutive sections are not supplied from the same phase, therefore neutral sections are provided in between the traction feed from two adjacent substations. The length of the neutral section may be up to 42 meter. The OHE can be of regulated (fit up to 160 kmph) or unregulated type (fit up to 110 kmph).
Clause 2.7.2 **Limit of Second Harmonic**: The second harmonic current of each motor coach shall not exceed 0.5A and shall be governed by international standard (IEEE 519-1992). The Supplier shall submit curves of harmonic currents vs load current per motor coach and per basic unit for rake configurations given in Clause 1.3.12.	**Limit of Second Harmonic**: The second harmonic current of SPIC shall not exceed 0.5A and shall be governed by international standard (IEEE 519-1992). The Supplier shall submit curves of harmonic currents vs. load current.
Clause 2.12.2 It may be noted that acceptable limits are indicated for one motor coach and also for complete rake. The Supplier shall ensure that even in worst possible combination in service conditions the overall limit prescribed per rake are adhered to. The Supplier shall submit at design stage the simulation results of the likely value of harmonic currents of fully loaded Train with the formation as	It may be noted that acceptable limits are indicated for one motor coach and also for complete rake. The Supplier shall ensure that even in worst possible combination in service conditions the overall limit prescribed per rake are adhered to. The Supplier shall submit at design stage the simulation results of the likely value of harmonic currents of fully loaded SPIC.

mentioned in Clause 1.3.12 and will also include the worst conditions of Motor coach isolation as above	
Clause 2.12.3 The values of the currents for complete rake under the worst possible conditions shall be measured. The Supplier shall furnish detailed procedure, any special condition of measurements and specific instrumentation required for the purpose. It shall be the responsibility of the Supplier to arrange the instrumentation in order to conduct the measurements. The procedure shall be furnished by the Supplier and shall be finalized with the approval of RDSO. The tests shall also include the cases of isolation of motor coach/ basic units during service. These tests shall be conducted on the prototype rakes only	The values of the currents for SPIC under the worst possible conditions shall be measured. The Supplier shall furnish detailed procedure, any special condition of measurements and specific instrumentation required for the purpose. It shall be the responsibility of the Supplier to arrange the instrumentation in order to conduct the measurements. The procedure shall be furnished by the Supplier and shall be finalized with the approval of RDSO. These tests shall be conducted on the prototype SPIC only.
Clause 2.13 Reliability, Availability, Maintainability and Safety (RAMS)	New clause 2.13.13 added: Battery for Traction application: The supplier shall clearly specify the minimum guaranteed reliability of the equipment in terms of MTBF/MDBF. The equipment shall incorporate features to ensure high availability, low maintenance requirements, high reliability in operation and excellent overall efficiency.

Chapter 4: Performance Requirements

Existing Clause of RDSO spec RDSO/PE/SPEC/EMU/0196-2019 (Rev.0)	Modified Clause
Clause 3.1.1 (i) The capacity of the traction motor and the other equipment shall be adequate to permit continuous operation of 16-car train comprising 4 basic units of total weight 550 ton and items covered under scope of supply of this specification (all items mentioned in clause 4.1 to be considered) to be supplied by Supplier so as to meet the performance requirements specified herein. The design shall permit the operation of Train up to 24 cars under loaded conditions with the unit weight as above. All performance calculations/ evaluations shall be with respect to 16-Car train having four basic units unless stated otherwise.	The capacity of the traction motor and the other equipment shall be adequate to permit continuous operation of SPIC with total tare weight 48 ton plus items covered under scope of supply of this specification (all items mentioned in clause 5.1 to be considered) to be supplied by Supplier not exceeding 25 ton so as to meet the performance requirements specified herein. The design shall permit the operation of SPIC under loaded conditions with the unit weight as above.
Clause 3.1.3 Supplier shall submit the RMS current values of traction motor and temperature rise of propulsion equipment for a 16 Car rake operation for repeated all-out cycles of 10 km with a dwell time of 30 seconds up to stabilization of temperatures of all propulsion equipment. 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.	Supplier shall submit the RMS current values of traction motor and temperature rise of propulsion equipment for SPIC operation for repeated all-out cycles of 10 km with a dwell time of 30 seconds up to stabilization of temperatures of all propulsion equipment. 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.
Clause 3.2.1 The Traction performance shall be achieved for maximum gross weight of 550 ton plus weight of items in the scope of this specification (all items mentioned in Clause 4.1 to be	The Traction performance shall be achieved for maximum gross weight of 73 ton including weight of items in the scope of this specification (all items mentioned in Clause to be considered) to be supplied by Supplier for SPIC.

<table>
<tr><td>considered) to be supplied by Supplier for 16-car train.</td><td></td></tr>
<tr><td>Clause 3.2.4</td><td>To be read as:

<table><tr><th>SN</th><th>Parameter</th><th>OHE (*)</th><th>Battery mode (*)</th></tr><tr><td>1.</td><td>Starting acceleration at FL up to 40 kmph</td><td>0.7 m/s^2</td><td>0.4 m/s^2</td></tr><tr><td>2.</td><td>Acceleration residual at max permissible speed (130 kmph for OHE and 80 kmph for Battery mode)</td><td>0.09 m/s^2</td><td>0.09 m/s^2</td></tr><tr><td>3.</td><td>Deceleration (during full service braking)</td><td>0.8 m/s^2</td><td>0.8m/s^2</td></tr></table>
(*) subject to the requirements with respect to jerk rate specified in Clause 3.4 of RDSO Specification RDSO/PE/SPEC/EMU/0196-2019 (Rev.0).</td></tr>
<tr><td>Clause 3.2.5</td><td>Deleted</td></tr>
<tr><td>Clause 3.2.6
Train shall be capable of accelerating to a speed of 160 km/h in a maximum of 140 seconds</td><td>SPIC shall be capable of accelerating to a speed of 130 km/h in a maximum of 120 seconds.</td></tr>
<tr><td>Clause 3.2.9
For estimation of temperature rise of propulsion equipment, repeated all-out cycles of 10 km in loaded condition with dwell time of 30 sec till stabilization of all relevant temperatures, shall be used. Train shall be speeded up to 160kmph with full traction, maintain maximum service speed for required distance and then apply full service brake till standstill. On completion of the test as above the temperature of all equipment shall remain within respective permissible limits.</td><td>For estimation of temperature rise of propulsion equipment, repeated all-out cycles of 10 km in loaded condition with dwell time of 30 sec till stabilization of all relevant temperatures, shall be used. SPIC shall be speeded up to 130kmph with full traction, maintain maximum service speed for required distance and then apply full service brake till standstill. On completion of the test as above the temperature of all equipment shall remain within respective permissible limits.</td></tr>
<tr><td>Clause 3.3.1
All requirements specified in this clause shall be achieved when the Train load is as given in clause 2.2.</td><td>All requirements specified in this clause shall be achieved for the gross load condition for SPIC.</td></tr>
<tr><td>Clause 3.3.2
Train shall, achieve a minimum</td><td>SPIC shall, achieve a minimum deceleration of 0.8 m/s^2 during</td></tr>
</table>

deceleration of 0.8 m/s^2 during full service braking following the jerk limit as specified in clause no. 3.4.	full service braking following the jerk limit as specified in clause no. 3.4.
Clause 3.3.3 Train shall achieve a uniform full service braking across the whole speed rage from 0 to 160 km/h. The full service brake shall not achieve deceleration of greater than 1.0 m/s^2 at any speed.	SPIC shall achieve a uniform full service braking across the whole speed rage from 0 to 130 km/h. The full service brake shall not achieve deceleration of greater than 1.0 m/s^2 at any speed.
Clause 3.3.4 Train shall be fitted with an emergency brake, which can bring the Train to standstill in less than 1250 m when the Train is travelling at 160 km/h.	SPIC shall be fitted with an emergency brake, which can bring the SPIC to standstill in less than 850 m when the Train is travelling at 130 km/h.
Clause 3.5.3 Supplier shall submit the time, distance, maximum power, OHE current, energy consumed and energy regenerated in graphical as well as tabular form for one all-out cycle of 110, 130, 160 and 180 kmph in fully loaded condition. Performance parameters for one basic unit isolated condition shall also be submitted.	Supplier shall submit the time, distance, maximum power, OHE current, energy consumed and energy regenerated in graphical as well as tabular form for one all-out cycle of 80, 110, 130 and 145 kmph in fully loaded condition in OHE mode and 50, 60, 70, 80 & 90 kmph in Battery mode. Performance parameters for one bogie isolated condition shall also be submitted.
Clause 3.5.4 Efficiency curves of all equipment and tractive effort/braking effort (in kN) of a basic unit shall be furnished along with overall system efficiency curves. The total auxiliary power shall be furnished as break up of power requirement for lights, air-conditioning loads, auxiliary power required for propulsion system and control electronics.	Efficiency curves of all equipment and tractive effort/braking effort (in kN) of a SPIC in both OHE and Battery mode shall be furnished along with overall system efficiency curves. The total auxiliary power shall be furnished as break up of power requirement for lights, air-conditioning loads, auxiliary power required for propulsion system and control electronics.

Clause 3.5.6 The fully loaded 16-car rake with one basic unit isolated and already running continuously at sectional speed shall be capable of starting on a gradient of 1 in 37 and clear the section of 10 km with speed up to 60 kmph. The temperature rise of the traction motor and other propulsion equipment 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 as 22.5kV AC under traction. The time in which the section will be cleared and the maximum speed attainable shall be furnished by the Supplier. Supplier shall submit simulation results for the propulsion equipment temperature rise under the above conditions.	The fully loaded SPIC with one bogie isolated and already running continuously at sectional speed shall be capable of starting on a gradient of 1 in 37 and clear the section of 10 km. The temperature rise of the traction motor and other propulsion equipment shall be within thermal rating of the respective equipment as specified in chapter-5 of this specification. The one-hour rating of the Traction Motor shall be submitted. Average line voltage during the period shall be taken as 22.5kV AC under traction. The time in which the section will be cleared and the maximum speed attainable shall be furnished by the Supplier. Supplier shall submit simulation results for the propulsion equipment temperature rise under the above conditions.
Clause 3.5.10 **Regenerated Energy:** The regenerated energy for all out running (full traction up to max. service speed followed by full service braking up to standstill) shall not be less than 27 % of the energy consumed during powering at the specified voltage in Clause 2.6 of this Specification. Acceleration and braking rates shall be as defined in Clause 3.2& 3.3 of this Specification and full auxiliary load shall be taken into account except emergency load, RMPU & Pantry loads. Duty cycle of compressors shall be taken as 100% during the test. 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 their proportionate value.	**Regenerated Energy:** The regenerated energy for all out running (full traction up to max. service speed followed by full service braking up to standstill) shall not be less than 27 % of the energy consumed during powering at the specified voltage in Clause 2.6. Acceleration and braking rates shall be as defined in Clause 3.2 & 3.3 of Specification and full auxiliary load shall be taken into account except emergency load, RMPU & Pantry loads. Duty cycle of compressors shall be taken as 100% during the test. The net energy consumed or regenerated at the pantograph shall be used for calculating percentage regeneration energy.

Clause 3.5.11.1 The peak efficiency of traction system consisting of traction transformer, traction converter (line side converter and drive side inverter) and traction motor shall not be less than 87% at one operating point in the maximum power zone of the driving operation characteristics under loading conditions specified in clause 2.2 with a line voltage as per clause 2.6. The efficiency of the traction system shall be calculated duly taking into account the energy consumed by the associated cooling equipment viz. blowers, pumps etc. of transformer, traction converter, traction motor etc. Efficiencies by running at constant speeds of 45, 110, 130 and 160 kmph shall also be measured and recorded. The measurement of the efficiency shall be performed on the combined test bed with full complement of equipment and shall be governed by IEC 61377.	The peak efficiency of traction system consisting of traction transformer, traction converter (line side converter and drive side inverter) and traction motor shall not be less than 87% at one operating point in the maximum power zone of the driving operation characteristics under loading conditions specified in clause 2.2 with a line voltage as per clause 2.6. The efficiency of the traction system shall be calculated duly taking into account the energy consumed by the associated cooling equipment viz. blowers, pumps etc. of transformer, traction converter, traction motor etc. Efficiencies by running at constant speeds of 45, 80,110 and 130 kmph shall also be measured and recorded. The measurement of the efficiency shall be performed on the combined test bed with full complement of equipment and shall be governed by IEC 61377.
Clause 3.5.12.1 The capacity of the traction motors and equipment under continuous duty cycle shall be adequate to permit continuous and punctual operation of fully loaded Train under the operating and service conditions prevailing on IR.	The capacity of the traction motors and equipment under continuous duty cycle shall be adequate to permit continuous and punctual operation of fully loaded SPIC under the operating and service conditions prevailing on IR.
Clause 3.5.12.2 Supplier shall submit the balancing speed for the fully loaded 16-Car train in normal and one basic unit isolated condition.	Supplier shall submit the balancing speed for the fully loaded SPIC in normal and one bogie isolated condition.
Clause 3.6 Neutral section (ii) The system shall ensure safe opening and closing of the circuit breakers of basic units sequentially while approaching and leaving the neutral section respectively.	Neutral section (ii) The system shall ensure safe opening and closing of the circuit breaker of SPIC while approaching and leaving the neutral section respectively.
Clause 3.8.1 **Starting Train resistance**: The starting train resistance for motor and trailer coaches may be taken as 4 kg/t.	**Starting Train resistance**: The starting train resistance for SPIC may be taken as 4 kg/t.

Clause 3.10 Minimum Clearance from Rail Level Under fully worn wheels and fully loaded condition of the coach, the minimum clearance of bogie-mounted equipment from rail level shall be more than prescribed in (IRSOD ACS 27 of July 2019) under worst conditions. The minimum clearance for the body mounted under slung equipment shall be 215 mm under tare condition with fully worn wheels.	Minimum Clearance from Rail Level Under fully worn wheels and fully loaded condition of the coach, the minimum clearance of bogie-mounted equipment from rail level shall be more than prescribed in (IRSOD 2022) under worst conditions. The minimum clearance for the body mounted under slung equipment shall be 215 mm under tare condition with fully worn wheels.

Chapter 5: Scope of Supply and Technical Specifications

5.1 Scope of Supply

5.1.1 For the design, development including simulation studies, manufacture, supply and commissioning of complete set of 3-phase drive equipment for dual mode SPIC (OHE mode and Battery mode), the scope of supply is as under unless stated otherwise in the bid document/ purchase order (in the event of non-inclusion of any item indicated hereunder, the accountal of respective weight shall continue as though in the scope of Supplier):

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

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

iii.) On-board mounted IGBT based PWM Traction Converter set including DC link with 100 HZ resonance filter (optional) and/or any other equipment necessary to reduce the effect of other harmonics on S&T equipment.

iv.) Three-phase induction motors compatible with IGBT based traction converter power supply, with coupling, gear box assembly, sensors and associated equipment.

v.) Microprocessor based Train Control and Management System (TCMS)/VCU including fault diagnosis and display system in the driving cab.

vi.) Train Control & Management System/VCU, multiplexing system for relevant control & other signals and any other equipment, cables & terminal equipment.

vii.) Event Recorder

viii.) Voice communication system, Passenger information system including coach displays, audio communication system, interface with the Train Monitoring System (TMS) and any equipment required for interfacing PIS with the Receiver-equipment of TMS.

ix.) Passenger Car Surveillance system.

x.) Cab recording equipment

xi.) Integration with TCMS of Brake system

xii.) Master cum Brake controller

xiii.) Complete pre-fabricated driver desk including Driver Control Panel (DCP) housing all the necessary equipment and driver/ guard seat. Cab radio may be provided by IR for sections with GSM-R.

xiv.) Automatic smoke/fire detection and alarm system

xv.) Speed Indicating cum recording equipment.

xvi.) Passenger alarm system.

xvii.) Control Equipment such as relays, contactors, circuit breakers and related switchgears etc. for propulsion system, controls, auxiliaries in the assembled form viz. cubicle or cabinet.

xviii.) Brake Interface Unit fulfilling the brake blending requirements. (Envisaged as a constituent of TCMS and not to be treated as a separate item for the purpose of SOR items)

xix.) Wheel slip/ slide control (Envisaged as part of propulsion control of motor coach not to be treated as a separate item for the purpose of SOR items).

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

xxi.) High Voltage cable.

xxii.) Auxiliary system including IGBT/ SiC power module based on-board mounted Auxiliary converter for auxiliary supplies.

xxiii.) Auxiliary machines such as oil pump, oil cooling blowers for traction transformer, blowers for traction converter, auxiliary converter etc.

xxiv.) Light system including coach lights, Headlight, Tail-light, Marker lights, Flasher lights and Disaster Management Light etc. including control switchgear thereof.

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

xxvi.) Complete air-conditioning system with necessary equipment such as Roof Mounted Package Unit (RMPU), control panel, micro-controller etc.

xxvii.) Power & control cables including termination equipment and cable ducts/ conduits/ trays.

xxviii.) Data/communication cables, fire survival cables as mentioned in relevant clauses.

xxix.) EPDM & EMC type cable glands for sealing & shielding.

xxx.) Pantograph & Earthing Switch.

xxxi.) VCB

xxxii.) APC receiver compatible with existing track magnets

xxxiii.) Any other equipment required for power isolation, interlocking & proper functioning of the traction equipment etc.

xxxiv.) Instrumentation required for commissioning and field-testing of the equipment. (May be taken back by the Supplier after completion of the commissioning and field testing activities)

xxxv.) 3-phase to single phase underslung Isolation transformer of adequate capacity for auxiliary loads (not less than 20 kVA rating) generally conforming but not limited to ICF specification no. ICF/Elec/160 Rev 0 or latest.

xxxvi.) On-board mounted Battery converter.

xxxvii.) Battery - Lithium iron phosphate or better for Traction application.

Existing Clause of RDSO spec RDSO/PE/SPEC/EMU/0196-2019 (Rev.0)	**Modified Clause**
Clause 4.5.1 The four-quadrant traction converter shall be of a proven design and established in service performance in similar applications, IGBT based with PWM control to ensure regeneration and the power factor near unity. The range of variation of power factor shall be submitted by the Supplier.	The four-quadrant traction converter shall be of a proven design and established in service performance in similar applications, IGBT based with PWM control to ensure regeneration and the power factor near unity. The range of variation of power factor shall be submitted by the Supplier. The traction converter shall be

The traction converter shall be installed underslung and shall have housing made of stainless steel SS304 or anodized sea-water proof aluminum. The traction converter shall be protected against ballast hitting as per the relevant international standards. There shall be no need of painting on housing.	installed on-board and shall have housing made of stainless steel SS304 or anodized sea-water proof aluminum. There shall be no need of painting on housing.
Clause 4.5.8 Suitable margin shall be provided in the equipment rating such that under emergency condition with isolation of single basic unit, there shall be no necessity to withdraw the rake from service. The short time rating/thermal rating as specified herein of the equipment should be resorted only in emergency condition and will not be exceeded under such operation. For such purpose, short time rating of the major electrical equipment such as main transformer, traction converter and traction motor etc. will be furnished. Supplier may also refer Clause 3.1.3.	Suitable margin shall be provided in the equipment rating such that under emergency condition with isolation of single bogie, there shall be no necessity to withdraw the SPIC from service. The short time rating/thermal rating as specified herein of the equipment should be resorted only in emergency condition and will not be exceeded under such operation. For such purpose, short time rating of the major electrical equipment such as main transformer, traction converter and traction motor etc. will be furnished. Supplier may also refer Clause 3.1.3.
Clause 4.5.10 The protection/alarm/indication circuit will normally have self-correcting features rather than cause tripping of the motor Car 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 from the driving cab itself. 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 Cars in the rake, if so desired.	The protection/alarm/indication circuit will normally have self-correcting features rather than cause tripping of the SPIC 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 from the driving cab itself. 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 Driver Desk in the SPIC, if so desired.
Clause 4.5.15 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. A suitable protection shall be included for DC link over voltage protection.	The propulsion system shall be suitable for operation on 25 kV AC as well as on Battery mode. Supplier may adopt DC link voltage suitably and submit the details with justification. A suitable protection shall be included for DC link over voltage protection.
Clause 4.7	Deleted
Clause 4.9.8	

The majority of control and monitoring function shall be implemented through software so as to reduce hardware and cables. 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 Cars. Necessary measures shall be taken to ensure that the control signals are not distorted by any type of interference.	The majority of control and monitoring function shall be implemented through software so as to reduce hardware and cables. The leading cab will be controlling the SPIC. Necessary provision shall be made for acquisition and transmission of data required for leading cabs and the controlled equipments. Necessary measures shall be taken to ensure that the control signals are not distorted by any type of interference.
Clause 4.9.10 The electronic cards and couplers/ connectors shall be polarized or suitably designed to ensure that insertion in wrong position is not possible. The TCMS system shall be modular in design and shall cater for at least 10% capacity with necessary input & outputs for expansion & future use over & above essential requirement for 24-Car Train.	The electronic cards and couplers/ connectors shall be polarized or suitably designed to ensure that insertion in wrong position is not possible. The TCMS system shall be modular in design and shall cater for at least 10% capacity with necessary input & outputs for expansion & future use over & above essential requirement for SPIC.
Clause 4.9.13 (ii) There shall be no single point of failure in safety loops like Emergency stop, Emergency Brake, cab occupation, door related safety loops and door operation etc., which can cause immobility of the Train;	There shall be no single point of failure in safety loops like Emergency stop, Emergency Brake and cab occupation etc., which can cause immobility of the SPIC;
Clause 4.9.13 (iii) There shall be two physically independent bus systems on Train as well as Basic Unit level;	There shall be two physically independent bus systems on SPIC;
Clause 4.9.13 (v) Availability of the Basic Unit even in case Auxiliary Converter(s) of that Basic Unit is (are) not available.	Deleted
Clause 4.9.21 There should be a Rescue Drive Mode (RDM) with restricted speed in case of failure of Train wide communication. Speed limit shall be decided at design stage in accordance with the best international practices. As a minimum, automatic opening and closing sequence of Main Circuit Breaker should be available along with manual activation of Enter Neutral	There should be a Rescue Drive Mode (RDM) with restricted speed in case of failure of Train communication. Speed limit shall be decided at design stage in accordance with the best international practices. As a minimum, automatic opening and closing sequence of Main Circuit Breaker should be available along with manual activation of Enter Neutral Section, HVAC, major indications viz.

Section, door operation, HVAC, major indications viz. Pantograph raise/lower, VCB ON/OFF, Brake/emergency brake loops status, Parking Brake function availability is to be ensured.	Pantograph raise/lower, VCB ON/OFF, Brake/emergency brake loops status, Parking Brake function availability is to be ensured.
Clause 4.9.23 In the event of removal of any Basic Unit from the Train or addition of a basic unit to the train, it shall be possible to automatically configure the modified train formation in TCMS.	Deleted
Clause 4.9.24 The faults occurring in any of the motor Car or trailer Car 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 no. 4.17. It shall be possible for the driver to select and take appropriate action viz. isolation of specific equipment of any motor Car etc. from the cab itself, if so desired. Different states of equipment and functions shall be displayed on HMI along with text message viz. idle, ready, working, warning, faulty, isolated, override, failure, inconsistent/implausible etc.	The faults occurring in SPIC shall be displayed in appropriate form in the driving cab. Faults shall be displayed with messages on LCD screen in driver's cab as per Clause no. 4.17. It shall be possible for the driver to select and take appropriate action viz. isolation of specific equipment etc. from the cab itself, if so desired. Different states of equipment and functions shall be displayed on HMI along with text message viz. idle, ready, working, warning, faulty, isolated, override, failure, inconsistent/implausible etc.
Clause 4.9.26 It shall be possible to read and record the energy consumption and regeneration figures for a particular time period for the individual basic unit and for the complete rake, along with train no., the name of the driver, date, time, distance, 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 laptop.	It shall be possible to read and record the energy consumption and regeneration figures for a particular time period for the SPIC along with train no., the name of the driver, date, time, distance, 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 laptop.
Clause 4.9.27 Isolation of any motor Car shall not affect the normal functioning of brake system. Under such conditions, the regenerative braking from other motor coaches shall not be affected adversely.	Deleted

Clause 4.9.28 It shall be possible to test the software after uploading the same by means of simulation facility or by some other means. The uploading of software and downloading of detail diagnostics etc. shall be feasible through any motor Car & DTC in the rake. 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 no. 1.4. It may be noted that the control for the complete range of operating speeds for one basic unit level shall also be preferred though the normal operation of the Train shall be in the formation given in Clause no. 1.3	It shall be possible to test the software after uploading the same by means of simulation facility or by some other means. The uploading of software and downloading of detail diagnostics etc. shall be feasible through any Driver desk in the SPIC.
Clause 4.9.34 TCMS 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.	TCMS shall be used for integrating and multiplexing of signals for control purpose and for monitoring of the SPIC, its systems and sub-systems within the appropriate safety framework as per the extant international practices. 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.
Clause 4.10 The event recorder shall monitor and record various events so that data is available for analysis to determine the probable cause of accident, incident or operational irregularities. There shall be one event recorder per rake of 16 Cars with redundant train control interface and it shall be designed to provide an intelligence based recording ..... event recorder shall be designed and tested in accordance with a recognized international standard such as the UK Railway Group Standard GM/RT2472 and EN 62625-1_2013.	The event recorder shall monitor and record various events so that data is available for analysis to determine the probable cause of accident, incident or operational irregularities. There shall be one event recorder per SPIC with redundant train control interface and it shall be designed to provide an intelligence based recording..... event recorder shall be designed and tested in accordance with a recognized international standard such as the UK Railway Group Standard GM/RT2472 and EN 62625-1_2013.

Clause 4.11.1 The Train shall provide a public address (PA) facility so that the Train Driver /Guard can make announcement to the passengers from driving / non-driving cab.	The SPIC shall provide a public address (PA) facility so that the Train Driver can make announcement to the passengers.
Clause 4.11.3 The public address intercom system shall have the Train Driver-Guard and Train Driver/Guard – Passenger communication. The Train Driver/Guard shall have the facility of adjusting the volume level from a minimum to maximum level by suitable mode provided in Driving Cab's dashboard.	The public address intercom system shall have the Train Driver and Passenger communication. The Train Driver shall have the facility of adjusting the volume level from a minimum to maximum level by suitable mode provided in Driving Cab's dashboard.
Clause 4.11.4	Deleted
Clause 4.11.5	Deleted
Clause 4.11.7 In case of failure of one unit of PA system or a passenger communication unit in one Car, there shall not be failure of the whole system. All the communication and control cables shall be conforming to international standards for fire survival characteristics suitable for the Train services so that full functionality for passenger communication is maintained.	In case of failure of one unit of PA system or a passenger communication unit in SPIC, there shall not be failure of the whole system. All the communication and control cables shall be conforming to international standards for fire survival characteristics suitable for the Train services so that full functionality for passenger communication is maintained.
Clause 4.11.8 A suitable interface shall be provided to enable the control centre to Passenger/Guard/Driver communication to be transmitted over the Train public address system.	A suitable interface shall be provided to enable the control centre to Passenger/Driver communication to be transmitted over the Train public address system.
Clause 4.11.9 An integrated main communication touch screen shall be provided to control the public address functions, cab-to-cab communication and passenger alarm communication.	An integrated main communication touch screen shall be provided to control the public address functions and passenger alarm communication.
Clause 4.11.10 At least 6 speakers shall be provided in each coach. The number, positioning and output of each loudspeaker and power amplifier shall be designed such that an even sound coverage in all areas of the passenger Car is achieved. The loudspeaker should be separated into two groups and each audio line should be supplied by its own amplifier.	At least 6 speakers shall be provided in SPIC. The number, positioning and output of each loudspeaker and power amplifier shall be designed such that an even sound coverage in all areas of the SPIC is achieved. The loudspeaker should be separated into two groups and each audio line should be supplied by its own amplifier.

Clause 4.11.13	Deleted
Clause 4.12.1 A passenger information system (PIS) shall be provided. This shall use GPS to determine the Train location and shall provide automatic announcement and the display of destination information on displays throughout the Train. The system shall be capable of making pre-recorded announcements (both audio and visual) by manual triggering from main communication panel if positional information is not available. Under such circumstances, messages shall operate automatically for the route from the TCMS information. Messages and announcements shall be triggered based on distance travelled and door operations.	A passenger information system (PIS) shall be provided. This shall use GPS to determine the Train location and shall provide automatic announcement and the display of destination information on LCD displays.
Clause 4.12.3 The PIS shall be designed to provide audible announcements and information displays in Hindi, English and regional language throughout the journey. Full facilities including any hardware/software tools for programming the displays and system shall be supplied. Supplier shall arrange training to program, edit and interface the display panels with the system.	The PIS shall be designed to provide audible announcements and information displays in Hindi and English. Full facilities including any hardware/software tools for programming the displays and system shall be supplied. Supplier shall arrange training to program, edit and interface the display panels with the system.
Clause 4.12.4 At least two passenger information LCD displays with backlit LED boards shall be provided in each Car. These displays shall show current location of the Train, next station, time to next station, next interchange points, running speed, platform side, passenger related safety information. Provision should be made to display any other information such as pictures/ video messages for advertisement or other purposes. Infotainment is part of the scope of Supplier. Approximate size for two displays will be 450mm x 700mm. The size of the letter and resolution shall be programmable and have adequate clarity and visibility for all the passengers of the	Four passenger information LCD displays (retractable type) with backlit LED boards shall be provided in SPIC. These displays shall show current location of the Train, running speed etc. Provision should be made to display any other information such as pictures/ video messages. Infotainment is part of the scope of Supplier. Approximate size for LCD displays will be 409mm (W) x 230mm (H) or 18.5 inches. The size of the letter and resolution shall be programmable and have adequate clarity and visibility for all the passengers of the Car. The station names shall be displayed in Hindi, & English. Detail specification, mounting arrangement and screen content shall be finalized during the design stage.

Car. The station names shall be displayed in Hindi, English & regional language. Detail specification, mounting arrangement and screen content shall be finalized during the design stage.	
Clause 4.12.5 Each Car shall be provided with two LED matrix destination boards (minimum size-128 x 16) on the outside (one on each side) in order to show the originating, destination station, Car number, Train number etc. The mounting of the destination boards will be inner side of look out glass	SPIC shall be provided with one LED matrix destination board or Headcode (minimum size-128 x 16) on each Nose cone in order to show the originating, destination station, Car/Train number etc. The mounting of the destination boards will be from inner side of look out glass.
Clause 4.12.6 The external displays shall have adequate brightness, which shall have auto adjustment with the outside ambient light.	The Headcode displays shall have adequate brightness, which shall have auto adjustment with the outside ambient light.
Clause 4.12.8 The external display screen shall be designed to guard against vandalism, pilferage, water and dust ingress. The encapsulation class shall not be less than IP 65.	The Headcode display shall be designed to guard against vandalism, pilferage, water and dust ingress. The encapsulation class shall not be less than IP 65.
Clause 4.13	**To be read as:** The CCTV surveillance system shall be as per Specification RDSO/SPN/TC/106/2022, Ver-2.1 however, the number of cameras shall be provided as shown in the layout drg. no. SP90001 to cover entire coach area with no blind spots including doorways, gangways and saloon area. Additionaly, at least one camera shall be placed in each Driving cab for gathering front end view, track and OHE conditions etc, Platform view cameras shall also be provided on both nose cones. One camera shall be installed on the roof facing towards Pantograph to monitor the roof equipments.
Clause 4.15	Deleted
--	New Clause 4.17.1 (iv) added: Driver Control Panel (DCP) with necessary switches and controls shall be provided in the Driver's cab preferably on the Desk or on the sidewall adjacent to Driver for controlling

	Lights, RMPU etc. from Driver desk to avoid movement to Electrical cabinet during train operation.
Clause 4.17.2 **Display Panel** A suitable touch screen 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 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 should cater 24 Car formations. Details shall be worked out during design stage. Supplier shall submit options available. The display system shall be protected against dust and moisture. The driver's display unit to display the status, fault diagnostic and operate the following systems: • Train overview • Basic unit overview • High voltage system, • Train performance parameters, • Propulsion system, • Auxiliary system, • Air supply system • Door system, • Air-conditioning systems, • Passenger alarm system, • Service brake, • Emergency brake, • TCMS • Air Spring Supervision • Graphical display of schematics for fault indication and troubleshooting etc. Additionally, there shall be a guard's display on the guard side to display the status and operate the following systems: • Train overview	**Display Panel** A suitable touch screen 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 each driver 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. Details shall be worked out during design stage. Supplier shall submit options available. The display system shall be protected against dust and moisture. The driver's display unit to display the status, fault diagnostic and operate the following systems: • Train overview • High voltage system, • Train performance parameters, • Propulsion system, • Auxiliary system, • Air supply system • Air-conditioning systems, • Passenger alarm system, • Service brake, • Emergency brake, • TCMS • Air Spring Supervision • Graphical display of schematics for fault indication and troubleshooting etc. Additionally, there shall be a guard's display on the guard side to display the status and operate the following systems: • Train overview • Comfort systems, •Emergency brake, •Passenger alarm system •PA & PIS • CCTV etc. Further details shall be worked out during the

• Door system, • Comfort systems, •Emergency brake, •Passenger alarm system •PA & PIS • CCTV etc. Further details shall be worked out during the design stage	design stage
Clause 4.18.8.4 Fire survival cables shall be used for PA/PIS, ETB circuit, Passenger Alarm, supply and other essential circuits of Fire detection system and Door system for their continued functioning to the extent possible in the event of fire.	Fire survival cables shall be used for PA/PIS, Passenger Alarm, supply and other essential circuits of Fire detection system for their continued functioning to the extent possible in the event of fire.
Clause 4.19.1 Train shall have automatic fire/smoke detection system. This shall be capable of detecting a smoke/fire in any Car. On detection of a possible smoke/fire by means of suitable detection, the system shall have different levels of response to be finalised at design stage. Necessary integration with door-closing system shall be ensured so that in case of a smoke/fire, door shall open after the train has stopped.	SPIC shall have automatic fire/smoke detection system which shall be capable of detecting a smoke/fire. On detection of a possible smoke/fire by means of suitable detection, the system shall have different levels of response to be finalised at design stage.
Clause 4.21.2 The activation of the alarm shall be displayed in both driving cabs by hooter and indication. Further, the Car where the alarm was activated & the location shall be indicated on driver's and guard's display. The alarm shall be resettable by the driver or guard. In the event of alarm activation the guard and driver shall have the possibility to activate the CCTV screen of the related camera with single button operation	The activation of the alarm shall be displayed in both driving cabs by hooter and indication on driver's display. The alarm shall be resettable by the driver. In the event of alarm activation the driver shall have the possibility to activate the CCTV screen of the related camera with single button operation
Clause 4.23.1 Full utilization of the regenerative braking is envisaged such that it is available over full range of speed to be blended/interfaced with the existing EP brakes. The control system shall be designed such that in the EP brake region, for any set braking effort demand, as decided by the position of the brake	Full utilization of the regenerative braking is envisaged such that it is available over full range of speed to be blended/interfaced with the existing EP brakes. The control system shall be designed such 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

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.	regenerative energy.
Clause 4.23.2 Normally, in the EP service braking zone, only regenerative braking is applied in the motor coaches whereas the EP brakes are applied on the trailer coaches mainly to supplement the difference between the demand and the regenerative braking effort achieved. However, if the regenerative braking becomes ineffective, the EP brakes shall come on the motor coaches	Normally, in the EP service braking zone, only regenerative braking is applied in the SPIC however, if the regenerative braking becomes ineffective, the EP brakes shall come on.
Clause 4.27.3	Deleted
Claus 4.28.2 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 air conditioning) shall work normally. In case of failure of next auxiliary converter, the unit with failed auxiliary converter shall work with 50% air conditioning, 100 % fresh air ventilation and all other loads shall be fully available. In case one more auxiliary converter fails, 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 16-car rake with four 4-car basic units or higher. During design state the detailed auxiliary design concept shall be submitted for approval. The changeover/load sharing shall be affected automatically and without any time delay through control electronics. Auxiliary converter shall be capable to cater the full auxiliary (100%) load at input voltage range between 19 kV to 30 kV AC and shall perform up to 17 kV OHE voltage at reduced output power. Reduction in output power will be gradually with the	The auxiliary system shall be designed in such a way that in the event of failure of one auxiliary converter module, SPIC shall operate with 50% air conditioning, 100 % fresh air ventilation and all other loads shall be fully available. The changeover/load sharing shall be affected automatically and without any time delay through control electronics. Auxiliary converter shall be capable to cater the full auxiliary (100%) load at input voltage range between 19 kV to 30 kV AC and shall perform up to 17 kV OHE voltage at reduced output power. Reduction in output power will be gradually with the reduction of traction supply below the limit of 19kV. The auxiliary converter shall deliver at least 50% of the full rated capacity at 17 kV.

reduction of traction supply below the limit of 19kV. The auxiliary converter shall deliver at least 50% of the full rated capacity at 17 kV.	
Claus 4.28.5 Auxiliary converters of rake (For loads other than HVAC) shall be operated in synchronization for load sharing through three phase 415V, 50 Hz bus line.	Deleted
Clause 4.28.18 **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 Train for service. Capacity of auxiliary compressor shall not be less than 100 lpm/1 h.p. 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.	**Auxiliary Compressor Set**: A 110 V DC battery operated auxiliary compressor set having adequate capacity, will be provided in SPIC for feeding the auxiliary air reservoir for operation of the pantograph and main circuit breaker. Capacity of auxiliary compressor shall not be less than 100 lpm/1 h.p. Auxiliary compressor set complete comprising Governor/Pressure switch assembly, Controller including Safety Valve, Auxiliary Reservoir, Cooler assembly, Isolating cock, Flexible hoses, Mounting frame, AVM pads and accessories shall be 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.
Clause 4.29	Deleted
Clause 4.30.5 At least 50% of lights, evenly distributed over the Car area, shall remain energized and provide sufficient light for safety of passengers, in the event of a OHE failure or in the event of main auxiliary power failure even from adjacent unit. Minimum two light circuits per coach shall be provided.	At least 50% of lights, evenly distributed over the Car area, shall remain energized and provide sufficient light for safety of passengers, in the event of OHE failure or in the event of main auxiliary power failure. Minimum two light circuits per coach shall be provided.
Clause 4.30.6 Car wise indication of healthiness/working of lights shall be provided in the Driving Cab. It shall be possible to isolate 50% lights of the Train from either of the Driving Cabs.	Indication of healthiness/working of lights shall be provided in the Driving Cab. It shall be possible to isolate 50% lights of the SPIC from either of the Driving Cabs.
Clause 4.31.1 The front end of each Driving Car shall be provided with high intensity, long distance, dimmable twin beam LED headlight in	Both the ends of SPIC shall be provided with high intensity, long distance, dimmable twin beam LED headlight in accordance with Indian

accordance with Indian Railway practice.	Railway practice.
Clause 4.32.1 LED type tail light shall also be provided on each Driving Car. Tail light shall be steady red on one side and flashing amber on the other side	LED type tail light shall also be provided on each Nose cone of SPIC. Tail light shall be steady red on one side and flashing amber on the other side
Clause 4.36.4 The compressor shall preferably be of two-stage type, with necessary inter and after cooler (to cool the discharge air to within 15°C of ambient air). The compressor capacity shall be such that with isolation of one compressor in a 16- car rake, the remaining compressors shall adequately meet the compressed air requirement of the rake during service. During selection of compressor capacity, consideration shall be given to air leakages from pneumatic system, which starts taking place in course of time and age.	The compressor shall preferably be of two-stage type, with necessary inter and after cooler (to cool the discharge air to within 15°C of ambient air). During selection of compressor capacity, consideration shall be given to air leakages from pneumatic system, which starts taking place in course of time and age.
Clause 4.36.6 Details shall be submitted at the design stage to justify the rating of the compressor selected along with the time taken to charge a completely empty 16-car rake. Finite Element Analysis (FEA) for compressor mounting arrangement shall also be submitted at the design stage.	Details shall be submitted at the design stage to justify the rating of the compressor selected along with the time taken to charge a completely empty SPIC. Finite Element Analysis (FEA) for compressor mounting arrangement shall also be submitted at the design stage.
Clause 4.40 The equipment shall be designed for Train to run up to 8 km/h through water up to 203 mm above rail level, excluding the increase in the height of the water level due to wave effect. Waterproofing test will be conducted on Traction and Auxiliary Converter by dipping them up to a height equivalent to 650 mm from rail level (under fully wheel worn condition) in stationary water for 24 hours. There should be no water ingress and Converters shall function normal after the test. Traction Motor with gearbox shall be tested for waterproofing as defined in clause 4.6.23. Other underslung equipment shall have IP protection as mentioned in clause 2.10.	The equipment shall be designed for SPIC to run up to 8 km/h through water up to 203 mm above rail level, excluding the increase in the height of the water level due to wave effect. Traction Motor with gearbox shall be tested for waterproofing as defined in clause 4.6.23. Other underslung equipment shall have IP protection as mentioned in clause 2.10. However, even in case of flood levels more than the mentioned above, the equipment shall not get damaged and it should be possible to rejuvenate the equipment with minor attention without any adverse effect on their performance.

However, even in case of flood levels more than the mentioned above, the equipment shall not get damaged and it should be possible to rejuvenate the equipment with minor attention without any adverse effect on their performance.	
Clause 4.42.14	Deleted
Clause 4.43.1 Each Basic Unit shall have one Pantograph Car having one pantograph suitable for satisfactory operation up to a minimum speed of 200 Km/h under 25 kV AC power supply systems as given in Clause 2.6 and environmental conditions specified in Clause 2.11.	SPIC shall have one Pantograph suitable for satisfactory operation up to a minimum speed of 200 Km/h under 25 kV AC power supply systems as given in Clause 2.6 and environmental conditions specified in Clause 2.11.
Clause 4.43.3 In normal condition, 16-car Train shall work on two Pantographs. The pantograph selector switch shall be provided in the Driver's cab for raising and lowering of any of the pantographs. The raising or lowering of the pantograph, with the Train in motion, shall not cause any unwanted disturbance to OHE. In the event of failure/damage of pantographs, it shall still be possible to work with other healthy pantographs of the Train.	A switch shall be provided in the Driver's cab for raising and lowering of the pantograph. The raising or lowering of the pantograph, with the SPIC in motion, shall not cause any unwanted disturbance to OHE.
Clause 4.43.7	Deleted
Clause 4.44	Deleted
--	**New clause 4.45 added:** **On-board mounted Battery converter:** IGBT/SiC battery converter/charger of suitable capacity shall be provided to boost the battery voltage to DC link level when the system is powered from the battery and to charge the battery from the DC link when the OHE is available or the battery SOC is below the threshold. Battery converter shall be of a proven design and established in service performance in similar applications. Battery converter shall be mounted on-board and shall have housing made of stainless steel SS304 or anodized sea-water proof aluminum and there shall be no need of painting the housing.

	Battery converter offered shall be forced air/convection/oil/water-cooled and shall meet the requirements of IEC-61287 & the control electronic and PCBs shall conform to IEC-60571.
--	**New clause 4.46 added:** **Battery:** Explosion proof Lithium-iron phosphate batteries or better of adequate capacity suitable for Traction application shall be provided by the supplier. SPIC shall be capable to operate on service speed of 80 Kmph on battery power for a range of 100 Km with all auxiliary loads in working condition in single charge of batteries. The batteries shall be maintained at an adequate level of charge for traction and also satisfy the requirements of following Emergency Loads after the loss of OHE power: i.) Emergency ventilation. ii.) Head light, Flasher lights and 50% Coach lighting. iii.) Train controls (full load). iv.) Fire detection system. However, provision shall be made to switch on all electrical equipments in battery mode. No separate emergency battery and battery charger should be provided. The protection scheme of the auxiliary/DC system shall ensure that: (i) A single earth fault does not have any adverse impact on the performance of the DC/auxiliary system and the battery converter/auxiliary converter 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. There shall be provision for using the external power supply (shore supply) of 415 volts, 50 Hz, 3-phase for testing of auxiliary machines,

	RMPU etc. during maintenance in the depot and also for charging of traction battery at stations through shore supply battery charger integrated in on-board equipment. The interlock scheme for energizing battery charger converter and shore supply battery charger shall be got approved from RCF/RDSO. Compatible Plug shall also be supplied along with shore supply socket. Movement of the SPIC is not required with this power supply. Provision of thermal management of batteries shall include temperature dependent cooling system through external cooling for battery box cubicle and also interface with Traction control system in the event of any abnormalities (to be finalised during design stage). Provision of Linear Heat Detector (LHD) cable (UL or EN approved) automatic fire and smoke detection system shall be made on the battery box. Provision shall also be made on the battery box to check the battery voltage externally by the maintenance staff without powering on the SPIC. In running condition, the status of battery shall be displayed on Driver Display unit.

Chapter 6: Tests and Trials

Existing Clause of RDSO spec RDSO/PE/SPEC/EMU/0196-2019 (Rev.0)	Modified Clause
Clause 5.2.3 **Braking Distance trial (on prototype rake)** After the completion of satisfactory oscillation trial, the braking distance trials shall be conducted by IR for the rake formation of 16/20/24 Car rake. 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.	After the completion of satisfactory oscillation trial, the braking distance trials shall be conducted by IR for the SPIC. The supplier shall be associated with this test in respect of the items related to regenerative braking, brake blending and connected microprocessor controls.
Clause 5.3.2 **Witness of tests:** Type tests on major electrical equipment like traction transformer, traction motor, traction converter, auxiliary converter, control electronics, Air-conditioning unit, auto door closing system, air supply system and TCMS / 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.	**Witness of tests:** Type tests on major electrical equipment like traction transformer, traction motor, traction converter, auxiliary converter, Battery converter, control electronics, Air-conditioning unit, air supply system and TCMS/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.
Clause 5.8.1 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. Combined system test shall be performed on complete set-up of one basic unit with full compliment of propulsion equipment to assess the efficiency of combined propulsion system & temperature rise with full traction transformer loading.	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. Combined system test shall be performed on complete set-up of SPIC with full compliment of propulsion equipment to assess the efficiency of combined propulsion system & temperature rise with full traction transformer loading.
Clause 5.11.1 (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, 16-Car fully loaded train shall be tested. However, certain tests viz. TCMS, braking,	During the tests acceleration, deceleration, speed on straight level track and the energy consumption for a round trip shall be measured. In all cases, fully loaded SPIC shall be tested.

interference etc. shall be carried out on higher configuration also up to 24-cars.	
Clause 5.12 The supplier shall measure the required values of energy saving for a 16-car, fully loaded rake as per Clause no. 3.5.10; operation on the nominated section.....	The supplier shall measure the required values of energy saving for a fully loaded SPIC as per Clause no. 3.5.10; operation on the nominated section.....
Clause 5.14 **Commissioning of Trains at Purchaser's works and Maintenance depot:** Each rake shall be commissioned at Purchaser's works and maintenance depot / workshop of IR by the Supplier's staff before putting into commercial service. The Supplier shall be responsible for commissioning of two prototype rakes and all the series production of Train sets. The supplier shall furnish a Commissioning Schedule for the supplied equipment and the system which shall inter-alia include the following:- (i) Confirming satisfactory functioning of the all system. (ii) Test run to confirm specified operating parameters such as acceleration, deceleration, brake blending and energy consumption etc. (iii) Rectification / replacement of any malfunctioning equipment. (iv) Check of all the safety related items.	**Commissioning of Trains at Purchaser's works and Maintenance depot:** SPIC shall be commissioned at Purchaser's works and maintenance depot / workshop of IR by the Supplier's staff before putting into commercial service. The Supplier shall be responsible for commissioning of one prototype SPIC and all the series production of SPIC. The supplier shall furnish a Commissioning Schedule for the supplied equipment and the system which shall inter-alia include the following:- (i) Confirming satisfactory functioning of the all system. (ii) Test run to confirm specified operating parameters such as acceleration, deceleration, brake blending and energy consumption etc. (iii) Rectification/replacement of any malfunctioning equipment. (iv) Check of all the safety related items.

Annexure-I (of RDSO spec RDSO/PE/SPEC/EMU/0196-2019, Rev.0)

Design Data, Calculations and Drawings to be Submitted by the Supplier

Existing Clause of RDSO spec RDSO/PE/SPEC/EMU/ 0196-2019 (Rev.0)	Modified Clause
A)	Item 17, 24 **Deleted**. Item 26, 27 **Added** as follows: **26. On-board mounted Battery converter:** Make and type, number of cubicles per SPIC, thermal characteristics of IGBTs/SiC devices, heat sink details of IGBTs/SiC devices, cooling system design details including air/water flow rates and arrangement of filtered air, noise level, IP level, configuration with detail calculation of branch wise current proving adequacy of the devices used, Rating of each IGBT/SiC device, Thermal margin with calculations. Details of the protection of converter, the designed power loss in the converter. Input/Output voltage, current, power rating (KVA), number of IGBTs/SiC devices, rating and mode of connectivity / configuration (with technical data sheet), number of diodes (with technical data sheet), type of control, switching frequency, efficiency, power factor, weight, overall dimensions, dielectric strength, data sheets for power devices and their characteristic curves, interference currents **27. traction Battery:** Make and type of the battery, capacity and rating, Backup, Charge/Discharge characteristics, dimensions and weight.
B)	Design calculations should include: 21. Added as follows: Battery mode calculations.
C)	Following Drawings to be submitted as part of Design document including dimensions and material specifications: 18. Added as follows: Drawings of Battery and Battery converter. 1. OGA of Battery and Battery converter indicating interface requirements. 2. Complete wiring/Harness arrangement drawing.

Annexure-II (of RDSO spec RDSO/PE/SPEC/EMU/0196-2019, Rev.0)

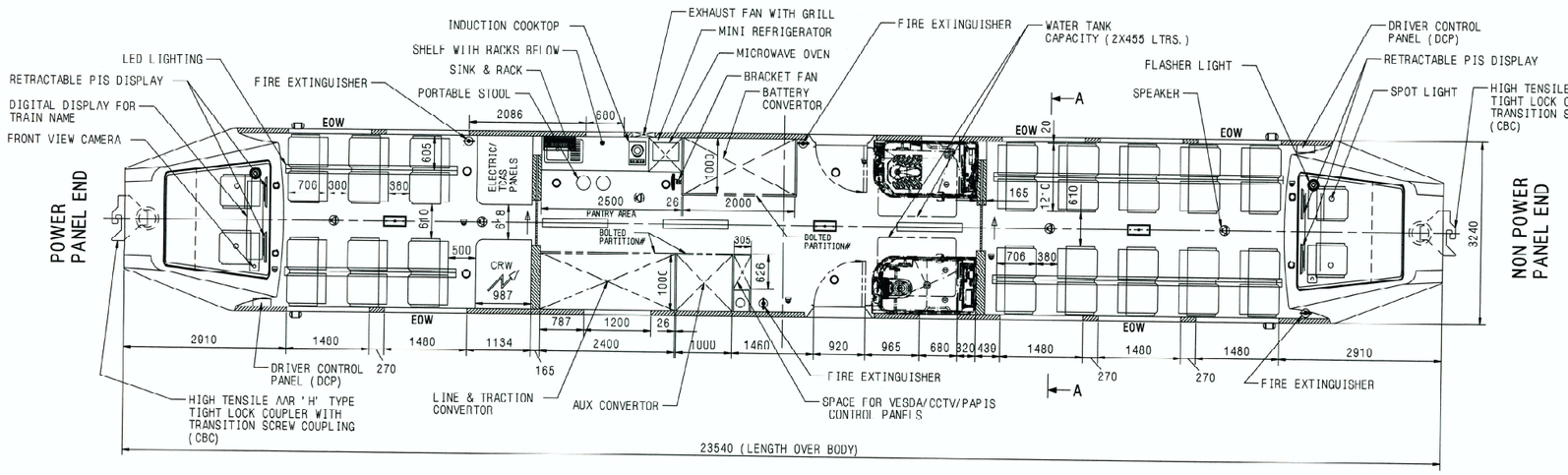
1. Performance simulations to be submitted by the supplier as applicable to SPIC as mentioned in a.) to h.)
2. In addition to above, Performance simulations to be submitted by the supplier as applicable to SPIC in Battery mode.

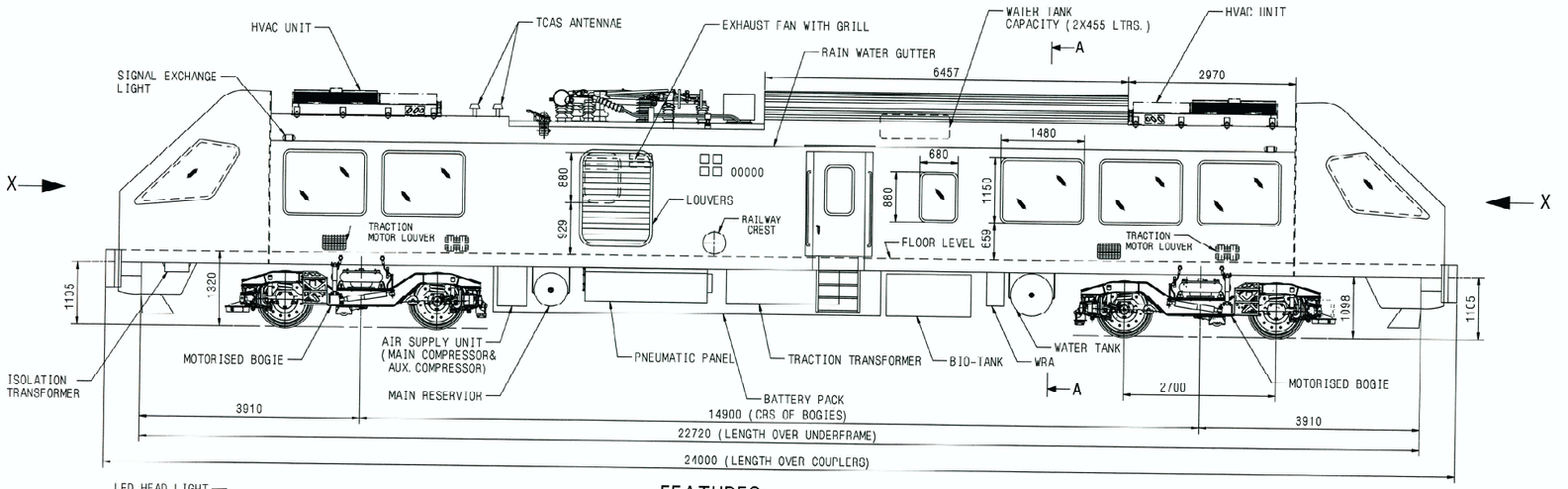
Annexure III to Annexure-X

Existing Annexure of RDSO spec RDSO/PE/SPEC/EMU/0196-2019, Rev.0	**Revised/Remarks**
Annexure-III	No Change
Annexure-IV	No Change
Annexure-V	No Change
Annexure-VI	No Change
Annexure-VII	No Change
Annexure-VIII	No Change
Annexure-IX	S.No. 25 – "Battery" - Added S.No. 26 – " Battery Converter" - Added
Annexure-X	Following RCF layout to be followed: 1. SP90001 (latest)
Annexure-XI	SKED-965, Block diagram for SPIC

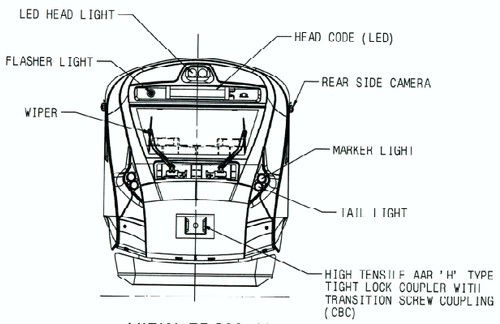
Annexure-X

ALT.NO	ALT.DATE	ZONE	ALTERATIONS	AUTHORITY
a	22/04/2024	D7 E18 03, 012 I17	DIMENSION 23540 WAS 23556. LABEL FOR MMD UPDATED AS PER IRSOD, REVISED 2022. DIMENSION 3910 WAS 4100. DIMENSION 22720 ADDED.	DY/CME/DP
b	19/06/2024	C, F-8 I-7	1. PLUG TYPE BODY SIDE ENTRANCE DOORS REPLACED WITH SWING TYPE DOORS. 2. NOTE-5 UPDATED ACCORDINGLY.	CHANGE REQUEST NO. 3500240009 DATED 18/06/2024





SECTION A-A



VIEW FROM-X

FEATURES:

1. INTERIOR PANELING WITH CONCEALED SCREWS WITH STREAMLINED FINISH.
2. LED LIGHT FITTINGS.
3. SIGNAL EXCHANGE LIGHT.
4. ANTI GRAFFITI EXTERIOR PAINTING.
5. SWING TYPE DOORS FOR COACH ENTRY.
6. FRP MODULAR TOILETS.
7. WIFI ROUTER.
8. BIO TOILETS.
9. MAXIMUM SPEED UPTO 160 KMPH.
10. FULLY SUSPENDED TRACTION MOTOR & BOLSTERLESS BOGIE.
11. PROVISION OF TCAS.
12. MOBILE CHARGING SOCKETS/POWER SUPPLY POINTS FOR EQUIPMENTS SHALL BE PROVIDED AS PER REQUIREMENT.
13. LOCATION OF U/F EQUIPMENTS ARE TENTATIVE/INDICATIVE ONLY.
14. VERY EARLY SMOKE DETECTION APPARATUS (VESDA).
15. GPS BASED PIS/PAS WITH DIGITAL SPEED INDICATION.
16. MOTORISED BOGIES.
17. LINE & TRACTION CONVERTOR, BATTERY CONVERTOR & AUX. CONVERTOR SHALL BE PROVIDED ON-BOARD.

18. BOLTED PARTITION SHALL BE PROVIDED WITH SUITABLE HATCHED OPENINGS FOR MAINTENANCE OF ELECTRICAL EQUIPMENTS.

NOTE:

1. SEATING CAPACITY
   INSPECTION STAFF —— 32
   LOCO PILOT —— 04
2. NO. OF LAVATORY —— 02
3. FIRE EXTINGUISHER —— 04
4. EMERGENCY OPENABLE WINDOW - 05 NOS.

O CIRCULAR LED LIGHT
LAVATORY LIGHT
CAB/LED LIGHT
SPEAKER
CCTV CAMERA
DISASTER MANAGEMENT LIGHT
EOW EMERGENCY OPENABLE WINDOW
LED LIGHTING
WRA WATER RAISING APPARATUS
BRACKET FAN
RAILWAY INITIALS
00000 COACH NUMBER

ANY MANUAL ALTERATION SHALL AUTOMATICALLY RENDER THIS DRAWING INVALID.
FOR UNTOLERANCED DIMENSIONS REFER MDG0008
DETAIL DRGS STARTING WITH "LI" ARE INTERNAL REFERENCE LISTS ONLY AND ARE NOT FOR ISSUE.
DATE OF FIRST ISSUE 20/02/2024 CGM BY

WELD LENGTH	ITEM	DESCRIPTION & DIMENSIONS	QPASSLY	DETAIL DRG	MATL. & SPEC.	REMARKS
NIL M		NIL	NIL	NIL	NIL	NIL
WEIGHT	GROUP	COACH LAYOUT AND INSTALLATION	SUPERSEDES: SP90001 ALT a			
NIL KG	FILE	SP90001b.prt (2D)				
S.AREA		LAYOUT OF SELF PROPELLED INSPECTION CAR				
NIL M²						
~~LENGTH/DIA~~						
NIL M		RAIL COACH FACTORY, KAPURTHALA				
~~WIDTH/THICK.~~						
NIL M		रेलकोच फैक्टरी कपूरथला IRS				
HEIGHT						
NIL M						

SCALE	SEE DRG	DES	CHK	APPD
1: 50	CHD			
	DRN			

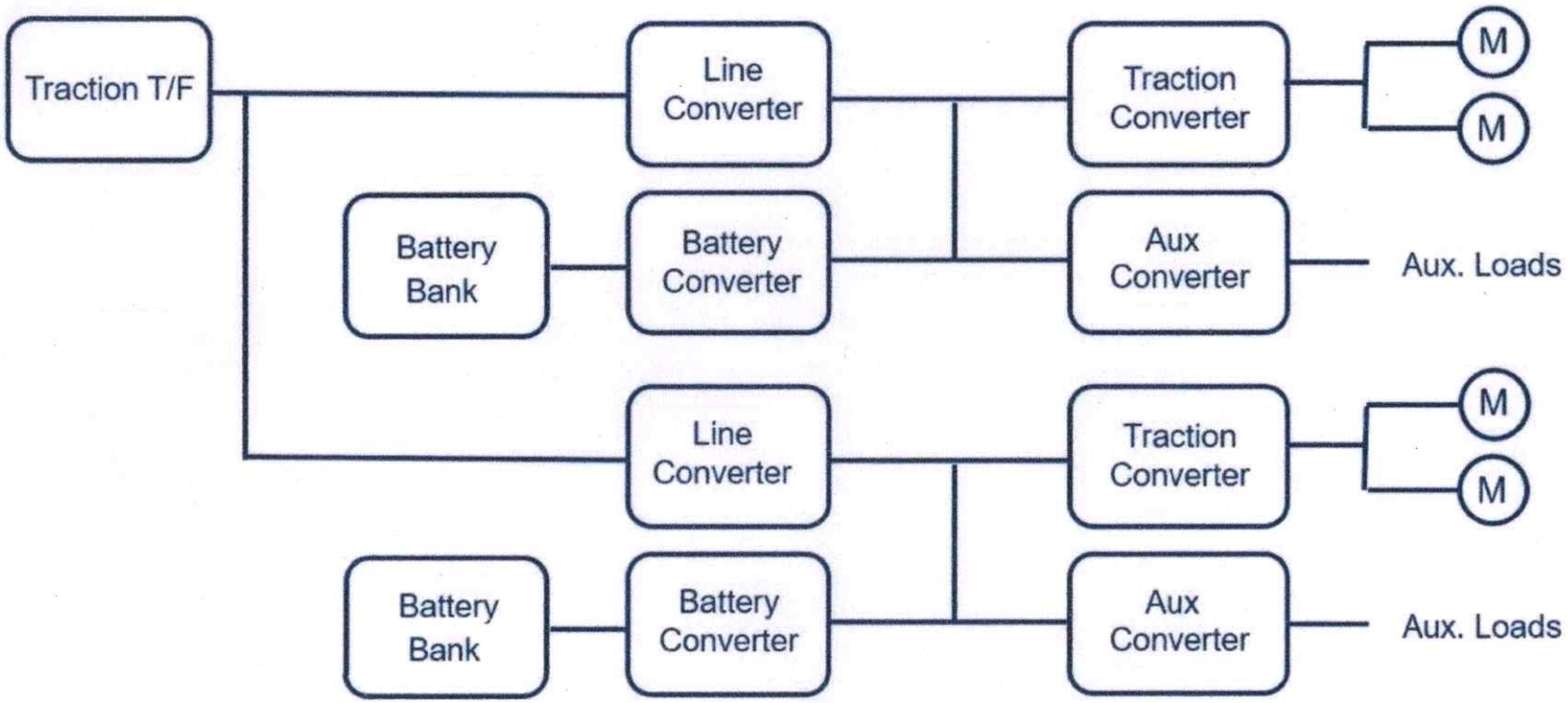
REF.DRG.No. SPCAC-9-0-001, RT90022

PL NO. NIL
DRG.NO. SP90001
ALT. b SIZE A SHEET 1/1

SEE/DSD | DY.CEE/D&D | DY.CSO/D/D&D | DY.CME/DP | DY.CME/D/TUR | CDE

ALT.NO	ALT.DATE	ZONE	ALTERATIONS	AUTHORITY
NIL	NIL	NIL	NIL	NIL

Dual Mode SPIC – With full redundancy



NIL		NIL	NIL	NIL	NIL
ITEM	DESCRIPTION & DIMENSIONS	QPASSLT	DETAIL DRG	MATL. & SPEC.	REMARKS
GROUP	ELECTRICAL	SUPERSEDES:	NIL		
FILE	D:\Pavan\NX Drawing\SPIC\SKED-965.prt				

WELD LENGTH NIL M
WEIGHT NIL KG
S.AREA NIL M²
~~LENGTH / DIA~~ NIL M
~~WIDTH / THICK~~ NIL M
HEIGHT NIL M

BLOCK DIAGRAM FOR
SELF PROPELLED INSPECTION CAR (SPIC)

RAIL COACH FACTORY, KAPURTHALA

रेल कोच फैक्टरी कपूरथला IRS

DY.CEE/D&D 13/7/24

SCALE | SSE/ED | CHD | DRN 13/07/24

REF.DRG.NO. NIL

PL NO. NIL

DRG.NO. SKED-965

ALT. NIL SIZE A3 SHEET 1/1

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FOR UNTOLERANCED DIMENSIONS REFER MDG0008 | DATE OF FIRST ISSUE | 13/07/2024