



भारत सरकार
रेल मंत्रालय

**GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS**

ई ओ जी गाड़ियों के एस एल आर कोचों के 500 के वीए, 750
वोल्ट, ए.सी., 3-फेज शक्ति संयंत्र (अन्डर स्लंग) का तकनीकी
विशिष्ट

**TECHNICAL SPECIFICATION FOR 500 KVA, 750V, AC
3 PHASE UNDER SLUNG POWER PACK FOR SLR
COACHES OF EOG TRAINS**

विशिष्ट संख्या चा0श0-0.43.00.01
(संशोधन-0.00, मार्च 2004)
Specification no. MP-0.43.00.01
(Revision-0.00 of March 2004)

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TECHNICAL SPECIFICATION FOR 500 KVA, 750V, AC, 3-PHASE, UNDERSLUNG POWER PACK FOR SLR COACHES OF EOG TRAINS

0.0 INTRODUCTION

- 0.1 Conventional self-generating (SG) coaches have individual under slung axle driven alternator-rectifier-battery arrangement for feeding power required for AC and light/fan loads of the coach. This system is less efficient and requires more maintenance due to large no. of equipment involved. End On Generation (EOG) system consists of a DA Power Pack, located at one end of the Train, feeding the hotel load of the coaches in the Train, through Power Couplers. Its rating is determined, based on the connected Load and Diversity Factor of the Train Service. Due to reduction in the number of Power Related Equipment in individual Coaches of the Rake, this System has significant saving in Capital Cost and substantial reduction in Maintenance burden - hence enhanced reliability and operational efficiency, as compared to existing SG system.
- 0.2 In view of the above, it is proposed to try out the EOG System, for conventional Mail and Express Trains, equipping the End-SLR Coaches with under slung Diesel Power Packs.

1.0 SCOPE

- 1.1 This specification covers design, manufacture, supply, assembly, installation, testing and commissioning of under slung 750V, 3-phase diesel alternator set along with Power and Control Panel, interlocking equipment with instruments and associated accessories, for Alstom Design of 2nd class luggage cum brake van (SLR).
- 1.2 The Contractor shall supply all the equipment, such as DA sets, power and control panel with interlocking system etc. The Tenderer shall have adequate experience in the supply and commissioning of similar equipment for rolling stock application at RCF and / or ICF.
- 1.3 Type tests of all the major equipment shall be approved by RDSO/RCF. The Contractor shall undertake installation, commissioning and testing, of the above equipment on the SLR, at RCF. The Contractor shall be allowed to utilize material handling, welding & pipe bending facilities available in RCF, free of cost.
- 1.4 One SLR equipped with this power pack will be used to provide hotel load to a train consisting of 24 Alstom design (7 AC, 15 Non AC and 2 SLR Power Cars) coaches. The two SLR Power Cars (SLR-PC) shall be located, one at each end. Normally only one SLR-PC will supply the full load. Interlocking system shall be similar to

those in the existing EOG system of Rajdhani / Shatabdi trains. It shall not be possible for simultaneous supply of loads from both SLR-PCs, through the same feeder (in effect Paralleling both the Power Packs). However when the train is electrically uncoupled, each SLR shall be able to supply the hotel load to the portion of the train connected to it. In case of train parting due to accident etc., interlocking system shall be able to shut down the running power pack.

- 1.5 The System shall provide for Feeder supply to the Coaches of the Train, through TWO separate set of Feeders and Electric Power Couplers, comprising of Cable Boxes, Sockets, Plugs. Jumpers and Dummies, similar to those used in existing EOG System, each capable of transmitting 300 amps, per phase (Line).
- 1.6 It is desirable to build in remote on and off feature in to the EOG system to individually switch on and off the power packs, to switch on and off the power supply to each of the coaches in the train, to change the feeder in the power units, to change the feeder in the individual coaches etc.
- 1.7 The specification covers under slung power pack equipment to be mounted on the EOG SLR. Requirements of engine, alternator and control equipment are covered. The specification does not cover the design features of SLR on which these equipment will be mounted. SLR will be designed and manufactured by IR. Design of SLR shall be finalized by production unit in consultation with RDSO.

2.0 SERVICE CONDITIONS

The equipment shall be sturdy and suitable for the following service conditions normally to be met in service:

2.1 Environmental Conditions:

- Ambient : -5⁰C to 55⁰C
- Relative Humidity : upto 100% during rainy season
- Altitude : Max.1200m above sea level

2.2 Working Conditions:

- Train Speed : 160 kmph max.
- Vibration & Shocks :
 - a) Maximum vertical acceleration : 3.0 g
 - b) Maximum lateral acceleration : 2.0 g
 - c) Maximum longitudinal acceleration : 5.0 g
 - d) Frequency and amplitude:

Sinusoidal form of vibrations, the frequency 'f' lies between 1 Hz and 50 Hz and their amplitude 'a', expressed in mm, is given as a function 'f' by the equations:

$a = 25/f$ for values of 'f' between 1 Hz and 10 Hz

$a = 250/f^2$ for values of 'f' between 10 Hz and 50 Hz

- 2.2.1 Equipment and auxiliaries mounted above and below underframe shall not cause vibration on the car floor, walls, ceiling panels, stanchions, handholds or seat frames in excess of 2.0 mm peak-to-peak amplitude for the frequency range from 1.4 Hz to 20 Hz and in excess of 0.8mm per second peak vibration velocity for the frequency range above 20 Hz.
- 2.2.2 Noise in stationery conditions, with Diesel alternator set in working condition at full load, measured on a high level platform, at platform level, at a distance of 1500mm from platform edge should not exceed 85 dB.
- 2.3 The diesel alternator is required to work continuously with load varying from 75% to 100% of the connected load and under service conditions prescribed above, normally with Diversity factor of (D.F) 0.8 and occasionally with Unity DF for short duration.

3.0 GOVERNING SPECIFICATIONS:

- 3.1 Following UIC regulations as far as they can appropriately be applied to the coaches for Indian Railways shall be applicable:

UIC 564-2	Regulations relating to the fire protection and the fire fighting measures in passenger carrying railway vehicles or assimilated vehicles used on international services.
UIC 566	Loading of coach bodies and their components
UIC 567	General conditions for coaches
IEC 60571	Rules for electronic equipment used on the rail vehicles
IEC 60349	Rotating electrical machines for rail and road vehicles
IEC 60101	Rules for auxiliary machines on motor vehicles
VDEO100	Regulations for equipping power current plants upto 1000 V
IEC-60077	Rules for electric traction equipment

The supplier shall furnish the details of all the international standards viz. IEC/DIN/VDEO/EN/UIC to which the equipment shall conform.

- 3.2 Following Indian Standard/Specifications will be referred to unless stated otherwise:

IS:10000-80 Pt.IV, Am.1 OR BS5514 (Latest Version)	Methods of tests for internal combustion engine (Declaration of power, efficiency, fuel consumption and lubricating oil consumption).
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IS:10000-80 Pt.VI, Am.1 OR BS5514 (Latest Version)	Methods of tests for internal combustion engine (Recording of test results).
IS:10000-80 Pt.VII OR BS5514 (Latest Version)	Methods of tests for internal combustion engine (Governing tests for constant speed engines and selection of engines for use with electrical generators).
IS:10000-80 Pt.VIII OR BS5514 (Latest Version)	Methods of tests for internal combustion engine. (Performance tests).
IS:10000-80 Pt.IX OR BS5514 (Latest Version)	Methods of tests for internal combustion engine. (Performance tests).
IS:4722-68	Specification for rotating electrical machines
IS:7132-73	Guide for testing synchronous machines
IS:7306-74	Methods for determining synchronous machine quantities from tests.
IS:4868-68	Methods of determination of efficiency of rotating electrical machines.
IS:1460-95 Rev-III, Am2	Diesel fuels
IS:10114-82 Am.1	Enamelled and varnish bonded glass-covered rectangular copper wires.
Spec/E-14/01 Part-II Rev-II, 93	Flexible elastomeric cables with copper conductors for powered rolling stock applications

4.0 DESCRIPTION

4.1 **Diesel Alternator Set:**

- 4.1.1 The Diesel alternator set shall consist of an approved make horizontal diesel engine coupled with an approved make of alternator, both mounted on suitable suspension bracket in the under frame of the SLR.

Approved make and type of diesel engine and alternator are:

- Diesel engine: M/s Cummins India Ltd. make KTA19-RG3, i.e. a variant of KTA19-G4 (Horizontal) diesel engine or alternatives if approved by RCF/ RDSO for specific applications in Alstom design SLR power car..
Capacity 540 BHP @ 1500 RPM at 55 degree centigrade at 1000 meter altitude with 10% overload capacity above 540 BHP for one hour every 12 hours.

-Alternator: M/s KEL make salient pole variant of TA3560 series alternators of rating. 500 KVA at site (as per clause 2.1)

4.1.2 The Diesel alternator set shall generally conform to the details indicated below:

4.1.2.1	System Details	(Alternator):
	Output Power	: 500 KVA at site (as per clause 2.1)
	System Voltage	: 750 V AC 3 phase
	Frequency	: 50 Hz \pm 3%
	Power factor	: 0.8

4.1.2.2 **Dimensional details:**

- i) Diesel alternator Set without radiator (Max.)
 - Length = 3200 mm
 - Width = 2000 mm
 - Height = 900 mm (with air duct)
 - Weight = 4500 kg (approx.)
- ii) Radiator Assly. (Max.):
 - Overall Dimensions:
 - Length = 3200 mm
 - Height = 610 mm
 - Width = 2300 mm
 - Weight = 1200 kg (approx.)

4.1.3 The Diesel alternator set shall be capable of developing the electric power of 500 KVA at 750V AC, 3 phase and 50 Hz with a power factor of 0.8 at site. In addition the system shall have 10% overload capability for one hour in every 12 hours of continuous working.

4.1.4 It shall be possible to accommodate the DA Set in under frame portion of coach within the moving dimensions as per EDO 590. The minimum clearance of 102 mm of DA set from rail level should be maintained with worn wheels in fully loaded conditions.

4.2 Anti vibration mounting:

4.2.1 Suitable anti-vibration mountings of proven design for under slung mounting of DA Set for rolling stock application as recommended by the supplier shall be provided to absorb the continuous vibrations and shocks encountered during service. AVM shall be suitable for under slung mounted power pack of diesel alternator set mounted under the Coach floor of SLR power car. The contractor shall submit detailed drawings for mounting the Diesel alternator assembly for approval of the same by RDSO/RCF.

4.2.2 The supplier shall furnish the design calculation for the diesel alternator assembly mounting brackets with the selection of AVMs suitable for under slung mounting of the DA Set for rolling stock application.

“Mounting location of under slung DA set shall be selected in such a way that the load distributions on the AVMs are reasonably uniform and are within safe limits.”

4.2.3 Positive Mounting of power pack should be done to avoid possibility of falling down in case of breakage of bolts. The mounting arrangement shall be finalized in consultation with RCF before undertaking manufacture of the SLR power car.

4.3 DIESEL ENGINE:

4.3.1 The Diesel engine shall be of robust and reliable design, turbo charged and water cooled, delivering 540 BHP at 55°C and 1500 RPM (continuous horsepower) at site.

4.3.2 Engine Cooling:

4.3.2.1 The engine shall be water-cooled and shall be supplied with Radiator. The radiator shall be mounted on roof. Necessary provision with the dished roof shall be made on the coach by RCF for mounting of radiator. The radiator cooling shall be done by means of suitable numbers of electrically driven fans of adequate capacity. The contractor shall get the drawings of radiator assembly alongwith fan and motor approved from RCF before supply.. The location of the radiator with respect to the coach roof and its mounting arrangements shall be mutually agreed between the supplier and RCF. The design of the radiator shall be such that it shall not infringe with the MMD as per EDO 590 copy enclosed.

4.3.2.2 The engine shall also be supplied with suitable circulating water pump, heat exchanger, lubrication oil pump, interconnecting pipes, silencer and exhaust pipes.

4.3.2.3 The cooling equipment (Radiator, water pump, pipe lines, radiator fan, motor etc.) shall be of adequate capacity such that the water temperature is maintained within the specified range with the engine operating at the full rated load at site conditions with radiator core clogged to 15%, as the radiator being mounted on the roof, will be less vulnerable to dust clogging.

4.3.2.4 Water temperature under full load shall not exceed 95 deg.C maximum

4.3.2.5 A low coolant level switch of reputed make with indication and alarm shall be provided to indicate loss of coolant during service, in the case of Roof mounted Radiator. This switch shall be integrated with the safety system such that in the event of loss of engine coolant, the engine shall shut-off automatically by de-energizing the shut down device in order to protect the engine from major failure.

4.3.2.6 A suitable electric powered water raising arrangement shall have to be provided to fill water in the Roof mounted radiator. The arrangement for the pump & the drawing of water raising equipment shall have prior approval of RDSO/RCF. Compressed air cannot be used for this purpose as it will not be available always.

4.3.3 Air filter:

4.3.3.1 The engine shall be equipped with air filter of adequate capacity suitable for operation in service conditions as per clause 2.0. Air filter selection will be such that it will not need cleaning in less than a week's time. The air filter shall be of a reputed make and shall be easily available.

4.3.3.2 The air filter location shall be selected in such a way that cabin crew / O&M personnel shall be able to check the filter condition for clogging and its attendance. To facilitate this, suitable restriction indicator will be provided.

4.3.4 Fuel Pipe Line:

4.3.4.1 The scope of supply, includes the supply and erection of seamless SS pipes and flexible hoses of appropriate size and length with necessary end fittings, isolating cocks, union sockets etc. as needed. The exact quantity shall be as required at site.

4.3.4.2 The coach will be provided with diesel tank(s) of suitable capacity for continuous working of upto 24 hours, with sedimentation tank, by RCF. The fuel system beyond the sedimentation tank shall be in the contractor's scope.

4.3.4.3 The fuel consumption at full load should not be more than 100 liters/hr.

4.3.5 Fuel/Lube Oil:

4.3.5.1 The engine shall normally be required to operate on diesel fuel grade 'A' to IS:1460. The diesel engine shall also be capable of operating with class-B fuel oil, in case of emergency.

4.3.5.2 Required quantity of Engine Lubricating oil, as first fill, for running the DA set on load at RCF shall be arranged by the contractor. The engine lubricating oil should be commercially available and should be of reputed make.

4.3.6 Silencer:

4.3.6.1 The silencer shall be suitable for location on the roof of the coach in the dished area adjacent to radiator exposed to atmosphere. Adequate length of the pipes,

flexible connection, elbows etc. for carrying the exhaust hot gas to the silencer and to the atmosphere shall be supplied and erected by the contractor. Provision shall also be made to prevent water entry into the silencer. The exhaust pipe from manifold to silencer shall be suitably and adequately lagged.

4.3.6.2 The lagged exhaust pipe lines shall also be clad with galvanized / aluminum sheet so as to ensure that there is no excessive heat in the proximity.

4.3.6.3 Silencer and exhaust system mounting arrangement shall have prior approval of RCF.

4.3.7 Governor:

4.3.7.1 The engine shall be supplied with electronic type Governor conforming to Class-A1 as per IS: 10000 Part-VII-1980 or relevant standards. The supplier shall also provide a suitable arrangement to facilitate varying of speed of diesel engine from idling speed to maximum no load speed.

4.3.7.2 The facility to use a microprocessor based Engine control system with self diagnostic control & indication panels/ tools should be provided. The software required for microprocessor should be provided by contractor to enable reading/ retrieving past/ logged data. For reprogramming of the microprocessor the necessary software and hardware should be available with the authorized service personnel.

4.3.7.3 If micro-controlled System is offered then an Event recorder to record various parameter like rpm, etc. shall be provided. Suitable instrument for down loading the events recorded, to facilitate analysis, shall also be supplied with each of the DA sets. A minimum of latest 60 faults shall be recorded.

4.3.8 Starter Motor: Firm shall submit complete details of the starter motor with data sheet and drawings for approval to RDSO/RCF.

4.3.8.1 Diesel engine shall be equipped with a starter motor working from 24V DC battery supply and associated accessories like starter solenoid, fuel solenoid etc. for cranking the engine. The motor shall be of adequate rating to crank the engine to firing speed under the service conditions specified in Clause 2.0.

4.3.8.2 The entire engine wiring shall be non-grounded. Starter motor shall be of reputed make. This shall be specified during tendering.

4.3.8.3 It shall not be possible to energize the starter motor when the engine is running at speed above the minimum firing speed. A starter cranking protection shall be provided which shall be through the engine oil pressure operated switch or speed sensing.

4.3.9 Safety devices/Gauges/Instruments:

- 4.3.9.1 The engine shall be provided with fuel solenoid and safety devices such that in the event of high water temperature, Low engine Lube Oil Pressure, Over Speed and Low Water level, the engine shall automatically shut-off. A list of protective devices, gauges and meters offered, shall be clearly indicated in tender.
- 4.3.9.2 The engine (DA set) being under slung mounted, the performance monitoring panel (remote gauge panel) shall be mounted inside the crew cabin to facilitate monitoring / starting of diesel engine from the cabin itself. The audio and visual alarm for the fault shall also be provided in the crew cabin itself so that fault can be understood and attended promptly by Cabin Crew. The interconnecting cables, if any, shall be supplied by the contractor. The Control panels shall also have the starting switch for operating the engine and a STOP PUSH BUTTON.
- 4.3.9.3 During the emergency and other failures, stopping of the engine shall be by De-energizing the fuel shut-off valve only.

4.4 Alternator:

- 4.4.1 The alternator shall have a rated capacity at site condition specified in clause 2.0 of 500 KVA at 0.8 pf, 3-phase, 4 wire 750 V, 50 Hz+/-3%.
- 4.4.2 Alternator shall be of the self-ventilated, brush less design. Voltage regulation of the alternator shall be of the dual control type i.e. both electric and electronic. The electric control shall be through compound, transformer or magnetic amplifier and electronic regulation through a solid state automatic voltage control both sensing from all the three phases. The combined regulation shall be within +/- 2.5% or better. "Stand-by" facility to ensure regulation within +/-5%, even in the event of failure of the automatic electronic voltage regulator (AVR/AVRs) shall be provided.
- 4.4.3 AVR (automatic voltage regulator) shall be modular type suitable for remote mounting in power and control panel in crew room. Interconnecting cables and coupling arrangement between alternator and AVR shall also be in the scope of contractor . Dimensions and layout drawing of AVR shall be got approved before supply.
- 4.4.4 The alternator shall have stator insulation of class 'H', rotor insulation of class 'H' and exciter insulation of class 'F'. Slot liners and slot wedges used in main stator exciter shall be of class 'H' and 4KV (min) breakdown voltage. All sleeves shall be of class 'H' insulation. All winding wires used in main stator, exciter and main rotor shall be insulated with class 'H' insulation and all the wound components shall be impregnated with class 'H' varnish by vacuum pressure, impregnation process. Temperature rise limit for Class-F and Class-H insulation shall be 90 deg. C and 115 deg.C, respectively.

- 4.4.5 The corresponding rating at the normal ambient temperature conditions (40 deg. C) as per IS:4722 shall also be specified by the contractor along with the type number, dimensions and weight of the alternator, as also the deration factor.
- 4.4.6 The alternator shall be capable of catering to at least 25% of unbalanced load in any one or two of the phases with the current, in any of the phases, not exceeding the rated current with the regulation maintained at 5% or less and 2.5% or better in manual and AVR mode of operation respectively.
- 4.4.7 The cables required for manual stand-by control device leading from the alternator to the OV/UV sensing device provided externally shall be in the scope of contractor. Cables shall be Electron beam irradiated cables.
- 4.4.8 The input leads to the AVR shall have fuse protection with appropriately rated fuse . The AVR shall be of the plug in type. AVR and over voltage sensing device shall meet the environmental condition as per IEC-571-77, in respect of Dry Heat & Vibrations.
- 4.4.9 The rotating diodes used for supplying DC power to the main field winding shall be of current rating equal to at least 2 times, the loading on them under full rated load of the alternator. They shall be of minimum 1000V, PIV rating. Under the full load operating conditions the case temperature of the diodes shall be at least 20 deg. C below, the limit recommended by the manufacturer. Provision of appropriately rated fuses on the input side of the rectifier bridge is desirable.

4.4.10 Terminal Box:

The terminal box shall be located at the non-drive end. Suitable cut away with a cover plate having cable entry holes (suitable for 150sq.mm elastomeric copper cables) for output power cables shall be provided. The internal and external cable terminations shall be on a fibre-glass DMC/SMC terminal board located across each other without crisscrossing and suitable for crimped terminations connected palm to palm. The spacing between terminals shall be minimum 75mm between phase to phase and phase to neutral. The head of the terminal studs (preferably hexagonal) shall be embedded on the rear of the terminal board and be further secured on top by a nut. For securing cable lugs, nuts, lock nuts, flat and spring washers shall be provided. The location of terminal box is to be approved by RCF.

4.4.11 ALTERNATOR VENTILATION.

In order to prevent dust ingress, the cooling air will be drawn from the inside of the coach or through the side walls, through dry type, air filters and ducts. Subject to the layout permitting,. MS ducts in the under frame shall inter connect the alternator and on board ducting.

The over all dimensions of the various ducts and their orientation shall be mutually discussed and finalized. These ducts shall be manufactured and installed by RCF. The provision of filters will be in the scope of supply of contractor.

5.0 POWER CONTROL PANEL (P&C Panel)

Power control panel & Light & Fan Panel as per Annexure-E.

5.1 25 KVA / 3KVA TRANSFORMERS.(For Non AC-SLR only)

5.1.1 The 25 KVA, 3 phase, D/Y11, 750/415 Volts, class 'H' – wound transformer, generally conforming to RDSO specification, EL/EOG/6/93 shall also integrate the 3 KVA, 110 Volts (Single Phase Voltage) distribution transformer (Y11 secondary) in the same enclosure. It shall be designed with IP55 protection level.

5.1.2 This equipment weighing about 250 Kgs., shall be mounted in the under frame.

5.1.3 The 3 phase, 415 Volts, supply, from the 25 KVA transformer shall be brought to a junction or a distribution box provided in the underframe, for taking supply for various auxiliary equipment, like, radiator fans, battery chargers etc.

5.2 STARTER BATTERY CHARGER.

5.2.1 The starter battery charger, shall conform to specification No. ICF / ELE / 848.

5.2.2 This equipment shall also be made suitable for underframe mounting,

5.3 EMERGENCY BATTERY CHARGER.

5.3.1 The emergency battery Charger, shall conform to Specification No. ICF / Elec. / 902. should be mounted underslung.

6.0 STARTER BATTERY

6.1 This equipment shall be under slung.

6.1.1 The Starter Battery is of 2x12V, 290 AH Lead Acid Type of approved make.

6.1.2 The battery shall be able to crank more than 8 times before discharging.

7.0 EMERGENCY BATTERY.

7.1 For Emergency Light application, a VRLA, type, 24 V 120 AH, battery shall be used.

7.2 This battery shall also be mounted in the under Frame, in a suitable battery box as per drawing no.CC71820.

7.3 The battery box shall be in the scope of RCF's supply

8.0 DISTRIBUTION – JUNCTION BOX.

8.1 Depending on the space availability in the Power & Control panel, the supply distribution arrangement from 25 KVA transformer may be accommodated in the Power and Control Panel, if the space permits, If not this shall be provided separately in the control room itself.

8.2 Power IV couplers shall be provided for feeding power to coaches.

8.3 Smoke Detectors , if considered necessary for use in Power Panel, shall be provided by RCF.

8.4 Load Balancing and Equipment Layout are to be done by RCF.

9.0 General:

9.1 Tenderers shall quote a price for complete set as per bill of material clause 7.0.

9.2 Information as per annexure-A, B, & C are to be furnished by the tenderer alongwith the tender.

9.3 The tenderer shall make his own arrangements for welding rods, and welders for fabrication work to be done at site.

9.4 The tenderer shall furnish detailed drawings of the radiator indicating the overall and mounting dimensions and other details to facilitate installation of the Radiator separately. Technical particulars about the Radiator like minimum air flow required through the radiator at 55 deg. C ambient, its total heat rejection capacity (when new), the pressure drop across the radiator etc. shall also be furnished alongwith the tender.

9.5 The relevant drawings indicated against each of the work are for guideline only and any effective improvement of the system may be studied by the tenderer and the tenderer shall submit their own drawing for RDSO/RCF's approval.

9.6 The engine electrical wiring system (schematic) with the details of components used (protection gears, solenoids, contactors switches gauges, etc) clearly spelt out shall be submitted by the tenderer to RDSO/RCF.

9.7 The interlocking system schematics along with wiring diagram, details of feeders and IV couplers used along with functional description of the complete system shall be submitted by the firm to RDSO/RCF for approval. The details of the regulating

system shall be clearly explained with schematic diagrams by the tenderer with tender.

- 9.8 Calculations for the adequacy of the diodes selected with their characteristics shall be submitted for the approval by the tenderer.
- 9.9 The tenderer shall submit recommended list of spares for diesel alternator and list of special tools if required any and quote separately alongwith the list for both individually.
- 9.10 Two sets of maintenance and operation manuals in hard copies and two in soft copies shall be supplied separately and got accounted for and NOT kept inside the packing cases of the engine AND/OR alternator free of cost with each DA set.
- 9.11 Details of type, acceptance & routine test procedure / protocol adopted by the manufacturer for major equipment such as DA set, control and interlocking equipment etc. shall be furnished along with tender for approval by RDSO/RCF.
- 9.12 Once a type approval for a make, type and rating of the alternator has been granted, based on the prototype results, the design of the same shall not be changed without the specific and written approval of the RDSO/purchaser. In the event of any of the parameter that have a bearing on the performance, deviating from the prototype values, beyond the permissible tolerances, the RDSO/purchaser reserves the right to repeat the prototype tests.
- 9.13 A certificate to the effect that after sales service will be rendered for diesel engine and alternator at Bombay, Calcutta, New Delhi, Secunderabad, Chennai and other major cities alongwith the name, address and telephone number of the service personnel shall be furnished. This information shall also be included in the maintenance manuals.
- 9.14 The tenderers shall furnish complete information as per Annexure-'A' for the diesel engine and Annexure-'B' for the alternator alongwith their tender to RDSO/RCF.
- 9.15 A clause-by-clause comment on the specification shall be furnished with tender. Any clause not commented upon would be deemed to have acceptable.
- 9.16 Cables for interconnection between various equipments shall be supplied and laid by the contractor. All The cables must be of electron beam, irradiated cables to RDSO spec.
- 9.17 Every effort shall be made by the contractor to ensure completion of all wiring works within three weeks of loading of the equipment and arrange for testing and commissioning within two weeks, thereafter. Necessary co-ordination and assistance in this regards will be rendered by RCF.

10.0 Bill of materials:

The bill of materials of Diesel Alternator and other equipment for SLR EOG shall be as per the table given below, beside that any other equipment required to make the DA set system fully functional should also be included:

S.No.	Description	QPC
10.1	Cummins make Diesel Engine Model KTA19-RG3 a variant of KTA19-G4 or alternative as approved by RCF for specific application in SLR Power cars The diesel engine set shall consist of following accessories:	1 set
i)	Fly wheel	1 No.
ii)	Radiator assembly complete with radiator, level sensor indicator, radiator fan/s, motors frame work, fan housing, AVMs, WRA etc. as per approved drawing.	1 set
iii)	Engine air cleaner mounted on board, for collecting air from the side wall opening of the coach along with the free length pipes, elbow and clamps for elbows (quantity as required at site).	1 set
iv)	Lube oil cooler and filter mounted on engine.	1 set
v)	Fuel filter mounted on Engine.	1 set
vi)	Engine coolant loose in kit.	1 No.
vii)	Exhaust piping complete with metallic flexible pipe, rigid pipes, elbows, flanges, cladding of the exhaust pipes, silencer with clamps (quantity as required at site).	1 lot
ix)	Fuel circuit piping including seamless stainless steel pipes, flexible hoses, pipe fitting (brass). Non-return valves (as required at site).	1 lot
Xi)	Safety devices (cutouts) for automatic tripping of engine in the event of high water temperature, low lube oil pressure and over-speed mounted on the engine	1 set
Xii)	Starting motor for diesel engine for 24 V with solenoid.	1 set
Xiii)	Starter battery charger	1 No.
xiv)	Electronic governor	1 No.
Xv)	Anti-vibration mounting and mounting brackets.	1 set
Xvi)	Coolant piping with fittings connected between radiator and engine (Quantity as required at site).	1 lot
Xvii)	2x12V, 290 AH lead acid starter battery..	1 No.
xviii)	Engine lubricating oil	1 lot.
10.2	Self ventilated brush-less 500 KVA (at site), 750 V alternator complete	1 set.
10.3	Power and control panel.	1 No.
10.4	Copper crimping sockets of Dowell's / Tyco / Kippon / other railway approved makes.	1 lot
10.5	25 KVA / 3 KVA transformer	1 no.
10.6	24 V, 120 AH, VRLA Emergency battery.	1 no.
10.7	SMPS type emergency battery charger	1 no.
10.8	Electron Beam irradiated cables of various sizes as required (cl.4.4.6)	1 lot

10.9	Installation, testing and commissioning of the diesel alternator set in SLR Coach.	1 lot
10.10	Recommended spares for the Diesel Engine alternator, power panel etc. for two years (list of items as recommended to be submitted with tender).	1 set
10.11	Set of special tools required for maintenance, if any (list to be submitted by tenderer)	1 set
10.12	Lights & Fans Panel	1 no.
10.13	Distribution box (if not accommodated in P&C Panel)	1 no.
10.14	Microprocessor based event recorder (For Microprocessor controlled diesel engine)	1 no.

11.0 Tests and inspection:

11.1 Type test:

All the type tests mentioned in the table given in clause 9.1 & 9.2 shall be carried out on a prototype unit. The prototype equipment manufactured for first time shall be got tested by RDSO/RCF and approved by RDSO.

11.2 Acceptance Test:

All acceptance tests mentioned in table in clause 12.1 & 12.2 shall be carried out by an inspecting authority nominated by the RDSO/purchaser at the works of the manufacturer as decided by the inspecting authority.

11.3 Routine test:

Routine tests mentioned in table in clause 12.1 & 12.2 shall be carried out on each unit by the manufacturer at his premises to ensure compliance with the specification and the drawing.

11.4 Commissioning tests

These tests are to be conducted after commissioning of DA sets in Power car at RCF. These tests shall comprise of following:

- a) Continuity test.
- b) Insulation resistance test.
- c) HV Test.
- d) Sequence test for individual and group of equipments.
- e) Performance test – on water load (Load bank to be provided by RCF)

Firm will require to make complete booklet of these test conducted on each power car jointly signed with the RCF team and should submit to CDE office for clearance of commissioning on coach.

- 11.5 All type & acceptance tests shall be carried out at firms premises at the manufacturer's cost. Inspecting officer will witness the tests on each unit. A copy of internal test conducted by the firm shall be supplied to inspecting / purchasing authority. Valid calibrated measuring instruments shall be made available by the manufacturer for conducting the tests.
- 11.6 The performance of the alternator and diesel engine shall be tested at the rating corresponding to NTP conditions during type , acceptance and routine tests.
- 11.7 Temperature rise test shall be conducted as part of prototype test, in any make, type and rating of alternator NOT subjected to such tests by ICF, RDSO, RCF or Railways previously as per relevant IS or tests specified in test table.
- 11.8 For series supply, the internal test certificate for routine tests conducted on each engine by the manufacturer may normally be acceptable with the approval of IRC. However, the purchaser reserves the right to witness the routine tests on any of the engines/alternators.
- 11.9 Subject to agreement between RDSO and manufacturer, some or all the type tests shall be repeated once in two years on sample basis so as to confirm the quality of the product. This will be part of revalidation of vendor renewal. In addition, the manufacturer shall repeat all the type tests after 5 years without any additional cost. Type test may also be repeated in any of the following cases :
- Major modification of equipment, which is likely to affect its functionality or performance.
 - Failure or major performance variations established during type or routine testing.
 - Resumption of production after an interruption of more than two years.
 - At the time of indigenisation, if the firm has supplied original product with foreign collaboration.
- 11.10 Firm will not change any scheme and approved BOM without seeking prior approval from RDSO/RCF.
- 11.11 Any defects noticed / design improvements found necessary as a result of the test / trial shall be carried out by the tenderer in the least possible time. Total cost of such modifications/design changes shall be borne by the manufacturer.
- 11.12 All the instruments used for testing should be duly calibrated. The calibration certificates are to be shown to RDSO/RCF representative(s) on demand.

12.0 Tests for Diesel Engine:

12.1 Type, acceptance and routine tests as mentioned in the table given below shall be conducted on the diesel engine

TESTS ON DIESEL ENGINE

SN	Tests	Type test	Acceptance test	Routine test	CI of Relevant IS
1.	Rating test. During the test the following recordings shall be made besides torque and speed. a) Fuel consumption rate b) Lube oil consumption c) Cooling water inlet and outlet temperature d) Exhaust temperature e) Smoke test	Yes	Yes	Yes	BIS-5541
2.	Governing test	Yes	Yes	Yes	2.1.3 (c) of IS:10000 Pt.VIII OR Equivalent
3.	Specific fuel consumption	Yes	Yes	Yes	2.3 of IS:10000, Pt-VIII or equivalent.
4.	Endurance test	Yes	No	No	2 of IS:10000, Pt-IX or equivalent
5.	Radiator capacity test (at simulated or equated site conditions 55 deg.C)	Yes	No	No	Annexure-C.

12.2 Tests for Alternator:

12.2.1 Type, acceptance and routine tests as mentioned in the table given below shall be carried out on the alternator in accordance with IS:4722-1868, in conjunction with IEC-60349 (Pt-I), IS:7132-1973, IS:7306-74 and IEEE-115 to check for adequacy of the design to meet the stipulations in respect of designs, workmanship and materials.

TESTS ON ALTERNATOR

SN o	Tests	Type test	Acceptanc e test	Routi ne test	Cl. of Relevant IEC/IS
1.	Measurement of resistance	Yes	Yes	Yes	Cl 8 of IS:7132-73
2.	Phase sequence test	Yes	Yes	Yes	Cl 11 of IS:7132-73
3.	Regulation test	Yes	Yes	Yes	Cl 7 of IS:7306-74
4.	Measurement of leakage reactance & potier reactance	Yes	Yes	No	Cl 5.2 & 5.3 of IS:7306-74
5.	Measurement of OCC (open circuit characteristics)	Yes	No	No	IEC-60349 (Pt-I), clause - 8.2.5.
6.	Measurement of short circuit characteristics	Yes	No	No	IEC-60349 (Pt-I), clause - 8.2.5
7.	Efficiency test	Yes	No	No	Cl 6.2 of IS:4889-68
8.	Temperature rise test for windings.	Yes	No	No	IEC-60349 (Pt-I), clause - 8.1.
9.	Temperature rise test on rotating diodes	Yes	No	No	Cl 24&25 of IEC-60571-77
10.	Overload test	Yes	Yes	Yes	IEC-60349 (Pt-I), clause - 9.1.
11.	Over speed test	Yes	Yes	Yes	IEC-60349 (Pt-I), clause - 9.4.
12.	Insulation resistance test	Yes	Yes	Yes	Cl.22 of IS:4722-68
13.	High Voltage test	Yes	Yes	Yes	IEC-60349 (Pt-I), clause - 9.5.
14.	Determination of waveform deviation factor	Yes	No	No	Cl .12.1 of IS:7132-73
15.	Determination of waveform distortion factor	Yes	No	No	Cl .12.2 of IS:7132-73
16.	Determination for telephone harmonic factor	Yes	No	No	Cl .12.3 of IS:7132-73
17.	Test for manual by pass with automatic changeover arrangement	Yes	Yes	No	
18.	Test on AVR for environment	Yes	No	No	Cl.26, 27, 28, 29 of IEC-60571-77

19.	Test on over-voltage sensing device for environment	Yes	No	No	Cl.26, 27, 28, 29 of IEC-60571-77
20.	Endurance test on over voltage sensing device-500 operation at 30 sec. ON & 30 Sec. OFF.	Yes	No	No	IEC-571-77
21.	Verification of full rating points during OCC and SCC tests.	No	No	Yes	IEC-60349 (Pt-I), clause - 9.2.6.
22.	Vibration Test (For vibration produced by machine itself on test bed)	Yes	No	Yes	IEC-60349 (Pt-I), clause - 8.8 for type and clause – 9.6 for routine test.
23.	Transient test (Short circuit to simulate fault condition)	Yes	No	No	IEC-60349 (Pt-I), clause – 8.5.
24.	Noise test	Yes	No	No	Annexure – C of IEC-60349 (Pt-I),

13.0 Enclosures:

S.No.	Annexure No.	Description
1.	Annexure-A	Technical data sheet for diesel engine
2.	Annexure-B	Technical data sheet for alternator
3.	Annexure-C	Technical details for radiator system
4.	Annexure-D	List of drawings and specifications.
5.	Annexure-E	Technical spec of Power, Control & L&P Panel

14.0 WARRANTY

All power and control equipment shall be warranted for satisfactory and trouble free operation for a period of five years from the date of commissioning or six years from the date of supply whichever is earlier. All aspects of workmanship and design shall be covered by this warranty. The manufacturer shall immediately provide arrangement for rectification of failures reported under warranty.

Warranty period of any equipment may be extended as per mutual agreement between RDSO/RCF and supplier if the equipment has undergone major design modifications during the warranty period.

15.0 FAILURES DURING WARRANTY PERIOD UNDER MAINTENANCE CONTRACT

15.1 In case of any failures, the details of failure and action taken to arrest re-occurrence of similar failure in future with failure analysis report etc. is to be submitted to RDSO/RCF.

15.2 In case of repeated failures, necessary changes in design on the units put in service or in production line are to be made by the manufacturer. Investigation tests, if considered necessary, are to be arranged/conducted by the manufacturer.

16.0 MARKING AND PACKING

16.1 Major power and control equipment shall bear for identification a serial number, type, year of manufacture, mass and manufacturer's name as well as important nominal and short time ratings.

16.2 All equipment shall be suitably packed in strong water proof boxes to prevent any damage during transit and handling.

Annexure - A

PARTICULARS TO BE SUPPLIED BY THE TENDERER

1. Following particulars pertaining to diesel engine and auxiliary equipment shall be submitted by the tenderer to RDSO/RCF for approval:

1.1 Diesel Engine

I General Data

1. Exact description and model of the engine.
2. Rated output of the engine under NTP and site condition.
3. Rated engine speed.
4. Number and arrangement of cylinders.
5. Cylinder bore.
6. Piston stroke.
7. Compression Ratio.
8. Mean Piston Speed.
9. BMEP at rated output.
10. Normal no load idling speed.
11. Peak firing pressure.
12. Full test result and data pertaining to engine tests.
13. Specific fuel consumption at half, full and 10% overload conditions with tolerance band under NTP and site conditions. Indicate the lower calorific value of the fuel used in arriving at the specific fuel consumption figure.
14. Fuel oil consumption at idle speeds (normal & low)
15. Lube oil consumption at rated output as percentage of fuel oil consumption.
16. De-rating calculation for site condition.
17. Safety devices provided:
 - Over speed
 - Low lube oil pressure
 - High cooling water temperature
 - Any other
18. Number of engines of this type in traction service.
19. Weight of engine excluding oil and water.
20. Volume and weight of water contained in the engine
21. Volume and weight of oil contained in the engine.
22. Weight of major equipment.
 - Turbocharger
 - After - Cooler
 - Cylinder block

- Piston and connecting rod
 - Cylinder liner
 - Cylinder head
23. Temperature of exhaust gas at turbo inlet at rated out put under NTP and site conditions.
 24. Method of starting giving details of equipment.
 25. Periodicity of overhauling the following critical items:
 - Turbocharger
 - Piston and piston rings
 - Air and exhaust valve
 - Main bearings
 - Connecting rod bearings
 - Fuel injection pump
 - Fuel injectors
 26. General arrangement and dimensional details.
 27. Characteristic curves for torque, output and specific fuel consumption for different loads.
 28. The curve of fuel consumption against load.

II **Fuel Injection System**

1. Type of fuel injection system.

III **Turbocharger**

1. Number of turbocharger used per engine.
2. Make and model.
3. Air flow at rated output.
4. Speed of turbocharger at rated output.
5. Types of bearings.
6. Details of lubrication.
7. Whether pre and post lubrication provided.
8. Booster pressure at full load.

IV **After Cooler**

1. Type of cooler
2. Details of mounting indicating whether cooler can be removed without removing turbocharger.

V **Exhaust System**

1. Type of exhaust system.
2. Number of exhaust gas entry segments.
3. Whether the exhaust manifold is shrouded/insulated.

VI Piston and Rings

1. Material specification of piston and rings.
2. Method of cooling.
3. Shape of bowl in piston crown.
4. Number and configuration of piston rings.

VII Valves

1. Material specification of valve.
2. Single/composite type.
3. Whether valve rotators used.
4. Recommended tappet clearance.
5. Angle of valve and seat.

VIII Cylinder Head

1. Material
2. Coolant flow distribution.
3. Whether reclaimable by welding.

IX Cylinder Block

1. Material
2. Whether cast or fabricated.
3. Is the mounting rigid or on resilient pads.
4. Experience regarding block distortion.

X Crankshaft

1. Material specification.
2. Type of bearings calculate bearing loads.
3. Particulars of vibration damper.

XI Cylinder Liner

1. Material
2. Dry or wet liners
3. Water sealing arrangement between liner and cylinder block.

XII Connecting Rod and Bearings

1. Material of connecting rod.
2. Material composition of bearing shells.

XIII Governor

1. Make and type.
2. Minimum idle speed,. Rated full load speed and droop characteristics.
3. Torque available on the output shaft.
4. Control/safety feature provided.

XIV Cooling Water System

1. Detail of cooling circuit.
2. Type of water pump and its characteristic viz delivery vs flow resistance.
3. Is the cooling system pressurized? If so, up to what pressure?
4. Max permitted cooling water temperature at inlet & outlet of circuit.
5. Normal cooling water temperature at full load under NTP and site conditions.
6. Radiator construction and dimensional details.

XV Lube Oil System

1. Details of circuit.
2. Lube oil pressure at full & idle speed.
3. Max temperature at hottest point.
4. Lube oil pump characteristic and power absorption at various points.
5. Details of all filters used in the lube oil circuit.
6. Efficiency of filtration and periodicity of attention.

XVI Fuel System

1. Schematic fuel oil circuit.
2. Details of fuel oil lift pump and its drive.
3. Details of filters used in fuel oil circuit.
4. Periodicity of attention.

XVII Intake Air System

1. Details of engine intake air system.
2. Type of primary and secondary stage filters and their efficiency.
3. Pressure drop permitted at the operating point for periodicity of attention.

ANNEXURE-B

Technical data sheet for Alternator

Following particulars shall be supplied by the tenderer for the alternator and switch gears to RDSO/RCF for approval.

B-1.0 Alternator:

B-1.1 Make & Model

B-1.2 Rating (continuous) at NTP

- a) Output KVA
- b) Current Amps.
- c) Voltage/phase Voltage
- d) Frequency Hz.
- e) Power factor at full load
- f) De-rating factor
- g) Max current
- h) Max voltage
- i) service speed

B-1.3 Number of poles.

B-1.4 Class of insulation

- a) Stator winding
- b) Rotor winding

B-1.5 Excitation system

- a) Type of excitation
- b) Excitation system voltage
- c) Excitation current

B-1.6 Efficiency at

- a) Full load %
- b) Half load %
- c) 110% full load %

B-1.7 Weight of alternator with exciter unit

B-1.8 Overall dimensions with outline drawing (alternator)

B-1.9 Overall dimension of complete set with drawing

B-2.0 Over voltage sensing device-make

B-2.1 Diesel engine control panel with details of instruments and interlocks

- B-2.2 Setting of trip at – volts
- B-2.3 Rating of contacts – Amps.
- B-2.4 Rating of contacts – Volts.
- B-2.5 Circuit diagrams and wiring diagrams of control and interlocking system.
- B-2.6 Details of IV couplers, feeder contactors and junction boxes etc. with drawings.
- B-3.0 The details of the regulating system and schematic diagrams.
- B-3.1 OCC and SCC characteristic curves of alternator.
- B-3.2 Details of the bearing arrangement.
- B-4.0 Calculations for the adequacy of the diode selected with their characteristics.

ANNEXURE-C**Technical details of Radiator System**

- C-1.0 **Radiator System:**
- C-1.1 The radiator shall be suitable for mounting in the dish area provided in the roof of the coach. The dimensions shall NOT exceed those in clause 4.1.2.
- C-1.2 The radiator size shall be such that it shall be capable of maintaining the engine temperature within the designed temperature. Also, the design shall permit the trouble free operation of engine for the site conditions as per clause no. 2.0. The cooling system being roof mounted type, an extra capacity of 15% towards clogging of core shall be provided.
- C.1.3 The radiator cooling fan/s will have an air handling capacity (in cu. Meter / hour) of atleast 10% more than the minimum requirements of the radiator to maintain the engine cooling water temperature at the specified level under continuous full rated load of the engine at site conditions.
- C.1.4 The drive motor/s for fan/s shall be a squirrel cage induction motor of a reputed make with cumulative rating not exceeding 30 KW.
- C.1.6. Tests:
- C.1.6.1 Radiator fan motor/s shall be subjected to type and acceptance tests in accordance to the relevant IS specification.
- C.1.6.2 Radiator capacity test (at simulated or equated site conditions at 55 deg.C) (type test):
- Testing procedure for this test is given below:
- C.1.6.2.1 Under this test, diesel engine is connected to the radiator designed for use in the high capacity power car and operated at 100% and 110% load. This test is conducted with the radiator in the free and 15% choked condition. For the latter the surface area of the radiator is blocked in a distributed manner for 15% of the area. During this test, the inlet and outlet temperature and the flow of water and air are measured.
- C.1.6.2.2 The water temperature, the heat transferred through water and air are computed and compared with the declared heat balance characteristics.
- C.1.6.2.3 If the radiator inlet air is not preheated to 55 deg.C (for simulation) then the test is conducted in the prevailing ambient temperature and the water temperature at the equated site conditions is determined. The radiator inlet water temperature recorded shall be well below the maximum permissible

temperature by the value equal to the difference between 55 deg. C and the test ambient temperature.

C.1.6.2.4 For the purpose of the test thermostat regulating the water flow through the radiator shall be kept open.

C-1.6.3 Capacity of the radiator cooling fan shall be specified.

ANNEXURE-D**List of drawings and specifications**

S.No.	Drg/Spec.No.	Description
1.		Diesel engine /alternator set arrangement.
2.		Diesel engine /generator set mounting.
3.		Radiator for engine.
4.		Cooling system mounting.
5.		Exhaust system mounting
6.		Silencer
7.		Grill air combustion mounting
8.		Combustion air duct
9.		Air grill combustion air
10.		Fuel system supply, mounting Rev-D
11		Air ducting of alternator

ANNEXURE-E

SPECIFICATION FOR POWER AND CONTROL PANEL OF 750V,3-Ph,SLR POWER CAR WITH UNDERSLUNG DA SET

1. SCOPE

- 1.1 This specification is for design, manufacture, testing and supply of switch board cabinet consisting of all the power/control switchgear related to control of one diesel alternator set rated at 500 KVA (at site) 750 Volts, 3 phase, 50 Hz.
- 1.2 The quality, aesthetics, design and overall workmanship of switch board cabinet as a whole shall be to international standards and the quality of existing LHB design shall be considered prime basis.
- 1.3 The Tenderer/Supplier shall have adequate experience of design, development and manufacturing of similar Panels for Power cars and shall be capable of developing materials to the required quality and standards.
- 1.4 The Supplier shall maintain datewise in-house quality control system, in-house quality control records etc for in-stage process inspection and testing and the same shall be made available to the inspecting official during type testing.

2. Service conditions:

2.1 Environmental conditions:

Ambient Temperature	-5 deg.C to 60 deg.C
Max. Relative humidity	up to 100% during rainy season
Altitude	Max.1200 meters

2.2 Working conditions:

Train Speed	:	160 km/h
Vibration & shock	:	
a) Max. Vertical Acceleration	:	3.0 g
b) Max. lateral Acceleration	:	2 g
c) Max. longitudinal	:	5.0 g
d) Frequency and amplitude	:	Sinusoidal form of vibration, the frequency Lies between 1 Hz and 100 Hz and their amplitude 'a' expressed in mm is given as function of 'f' by the equation. a=25/f for values of 'f' between 1 and 10 Hz a=25/f ² for values of f between 10 and 100 Hz

3.0 GOVERNING SPECIFICATIONS:

3.1 Reference shall be made to following standard/specification.

IS:13947 (Pt.1)-1993	Low voltage switchgear and control gear Part-1 General Rules
IS:13947 (Pt.3)-1993	Low voltage switch gear and control gear Part-3 – Switches, disconnectors and fuse combination units
IS:8623-1993 Pt.1	Low voltage switchgear and control gear assemblies part-1. Requirements for the type tested and partially type tested assemblies.
IS:10118-1982	Code of practice for selection, installation and maintenance of the switchgear and the control gear
IS:13703-1993	Low voltage fuses for voltages not exceeding 1000 volts or 1500 volts DC
IS:1248 part-II-1983	Direct acting indicating analog electrical measuring instruments and their accessories (ammeter and voltmeters etc.)
IS:8828-1996	Electrical accessories, circuit breakers for over current protection for household and similar installations.
IS:1573-1986	Electroplated coatings of Zinc on Iron and Steel
IS:1364-1992	Hexagon head bolts, screws and nuts of product grades A and B
UIC550	Power supply installation for Passenger stock
IS:2516-1985	Circuit Breakers
IS:2705-1992	Current Transformer

4. CONSTRUCTIONAL REQUIREMENTS

4.1 The panels shall be suitably subdivided to group the Power handling components in the Main Panel with all Protective Relays ,fuse gears / MCBs, Instrumentation etc in suitable sub –Panels segregating as far as possible the voltage groups and Power wiring and Control wiring. The Provisional list of components, which form part of the Power and Control Panel is as mentioned in Annexure-1 to this specification. Additional items required if any to make the System functionally complete shall also be arranged and the list updated on completion of the prototype

Some of the MAIN components required for the Power Car which constitute the Main Panel are highlighted below:

Air circuit breaker (1000v,3 Phase, 800 Amps) with built in Protective Relays for Over-current and earth leakage (feeders).

Power Contactors (Air-break) 1000V, 500 Amps ,3 Ph, 4 –wire for Feeder Control

(All the above from RDSO/RCF/ICF approved /accepted sources only)

Digital Meter- (incorporating Current, Voltage, Power Factor, KWH, Frequency & Power)

In addition the required number of CTs, HRC Fuses, Relays, Control Contactors and Terminal Blocks of different rating and Tinned Copper Sockets of Different sizes,

(General guidance may be taken from RCF'S Specification NO EDTS 103)

The internal wiring of the Power AND Control Panel shall be done with Electron Beam Irradiated Cables of approved make.

- 4.2 The switch board cabinet shall be made CRCA steel conforming to IS:513 (latest). The sheet steel covering on angle / channel frame work shall not be less than 1.0 mm. In the case of PROTO TYPE, sizing and rework are envisaged, keeping in mind the need for limiting encroachment to Revenue area to the bare minimum, without compromising on safety and functionality. However the overall size of the panel shall not exceed :

2000mm (Height) x 1800mm (Width) x 450/750mm(Depth)

(750x750x750 in ACB Location)

Efforts should be made to keep the size minimum. The mounting of panel & Location should be got approved from RDSO/RCF.

- 4.3 Appropriate circuitry and switch gear with grounded protection will also be provided for connecting to the 25 KVA and 3 KVA transformers.
- 4.4 The following PROVISIONAL drawings for the PROTOTYPE panel shall be submitted by the Contractor, for approval to RDSO/RCF, before finalization of the System and the manufacture of the Prototype.
1. Electrical switch cabinet layout scheme, including sub-panels, as considered necessary.
 2. Line diagram of circuit.

- 4.5 Suitable insulated tie rods duly covered with minimum 1.6mm thick fire retardant PVC sleeves or PTFE Tapping of standard market thickness shall be provided for securing the cables. PVC tapes shall not be used to insulate the tie rods. Alternatively, Ellen screwed tie rods resting on suitable bushes shall be provided.
- 4.6 All the devices fitted in the switchboard cabinet shall allow access for easy maintenance of all the equipments from the front of the panel.
- 4.7 Panel shall be powder coated in a pleasant light grey shade after giving requisite surface treatment. The paint used should be of a reputed make.
- 4.8 The internal wiring shall be done with Halogen free electron beam irradiated cables. The size/type of cables shall be decided after discussion. Cables/wiring shall be colour coded according to phases. Control wiring and power cables shall be segregated according to the voltage and adequately secured with cable ties.
- 4.9 All components provided inside the panel shall be identified by screen/photo printed legend plates. These should be mounted near the concerned components duly ensuring visibility. Circuits and components shall also be provided with the nameplates indicating the operation/function of the switches/circuits. Balance indicating/measuring switchgear/devices installed on front door shall be identified by Aluminum anodized legend plates shall be secured by adhesive of approved brand on the front doors itself. No riveting is allowed on front door.
- 4.10
- a) The outgoing/incoming terminal connections shall be brought out to an adequately rated cage clamp type terminal block/MCB.
 - b) Separators/intermediate plates shall be provided between adjacent terminal blocks, wherever required.
 - c) All cables leading to a terminal block shall be properly secured/clamped before termination.
 - d) It shall be ensured that not more than two wires are terminated at one point.
 - e) The bending radius for the cables especially feeder cables shall be five times the diameter (5D).
 - f) The power panel shall be complete with all necessary crimping sockets and ferrules for ready connections. Rings/tubular crimping sockets shall be used with suitable palm size to prevent loose connections during vibrations. Only copper crimping sockets of approved make shall be used. Crimping sockets of sizes smaller than 16 sq. mm. shall be with metal reinforcement.
 - g) Marking ferrules shall be of computer generated type for easy identification of the cables with the help of shrinking sleeves (self extinguishing) of suitable

size horizontally printed or with the help of multi mark carrier label of M/s TYCO or any other approved make.

- h) All cut outs wherein cables enter/exit the switchboard cabinet shall be provided with V-grooved rubber grommets from protection against sharp edges.
- 4.11 Earthing boss of tinned copper shall be provided on all the Panels/Sub- Panels Earthing of the metal parts/sub-assemblies inside the panel shall also be done with suitable wire size as determined vide clause 7.4.3.1.7 (a) of IS:8623 (Pt.1)-1993.
- 4.12 For earthing braided copper cables of sizes as indicated below and 300mm in length duly crimped (suitable for M12 stud size) shall be supplied alongwith each panel.
2x70 sqmm Main panel to each body
2x70 sqmm Between Panels/Sub panels
- 4.13 Manufacturer's nameplate indicating name and address, S.No. of the panel, Specification no., month and year of manufacturer and weight shall be fixed on the front door of the panel.
- 4.14 Danger notice plate shall be fixed on front of the lower panel door conforming to IS:2551-82 for 750V.
- 4.15 Electrical wiring diagram and fuse, MCB and terminal codification charts shall be screen/photo printed and riveted on inner face of the front door of the panel.
- 4.16 Care shall be taken to achieve a neat and symmetrical layout.
- 4.17 Only makes mentioned in the bill of material as per Annexure-1 shall be used. For any deviation prior approval shall be taken.
- 4.18 All the equipment fitted in the panel shall be easily accessible for replacement/checking.
- 4.19 All rotary switches shall conform to IS:13947(Pt.III)-93 and shall be suitable for universal mounting.
- 4.20 All fasteners used shall be zinc plated and passivated according to IS:1573-86 and conforming to IS:1364-92.Suitable EYE BOLTS shall be provided on the top of panel for handling, loading & unloading of the panel.
- 4.21 All the components including paint shall be fire retardant and Panel manufacturer shall certify this requirement.

- 4.22 General and safety requirements shall be governed by IS:13947 (PT-1)-93 & IS:8623-93.
- 4.23 The general construction of the switch board cabinet shall be such as to keep various voltage level separated against each other as far as possible.
- 4.24 The switchboard cabinet shall be divided into two parts-Upper & lower with further sub divisions as required as per Voltage/Control and Functional requirements

5.0 TESTS

5.1 Type test:-All the type test mentioned in clause 5.4 shall be carried out on prototype unit .The firm manufacturing for the first time shall get the prototype approved from RDSO/RCF.

5.2 Routine test:- The Test to be carried out at manufacturers premises at their own cost. Inspecting officer shall witness the tests. A copy of the internal tests conducted by the firm shall be supplied to the inspecting authority.

5.3 Acceptance test :- Acceptance test as per clause 5.4 to be carried out by the nominated inspecting authority at the works of the manufacturer at manufacturers cost. Inspecting officer shall witness the tests. A copy of the internal test conducted by firm shall be supplied to Inspecting/Purchasing authority.

5.4 Test as mentioned below shall be carried out as per respective clauses of IS:8623 (PT-1)-93

S NO	CLAUSE OF IS:8623	TEST	TYPE TEST	ROUTINE TEST	ACCEPTANCE TEST
1.	8.3.1	Visual inspection including inspection of wiring & electrical operations	YES	YES	YES
2	8.2.1	Temperature rise test	YES	NO	NO
3	Clause 7 of this spec	Mechanical operation & sequence test	YES	YES	YES
4	8.2.5	Test for verification of clearance and creepage distance	YES	NO	NO
5	8.2.2	Test for verification of dielectric properties	YES	YES	YES

6	As per clause 6 of this spec	Test for verification of insulation resistance	YES	YES	YES
7.	8.3.3	Continuity and sequence tests	YES	YES	YES
8.	8.2.4	Verification for effectiveness of protective circuits	YES	YES	YES

5.5 The accuracy of measuring instruments used for both type and routine tests shall be of class 1.5.

5.6 For the commissioning of first panel, panel manufacturer shall depute his staff at RCF for interface with the coach distribution panel.

6.0 INSULATION RESISTANCE TEST:

Insulation resistance test shall be carried out on all the circuits. The meggering voltage and the value of the insulation for the various circuits shall be given as under:

S.No.	Rated circuit voltage	Meggering voltage	Insulation Resistance value
1.	750 volts a.c.	1000 V dc	Not less than 5 M ohms
2.	415 volts a.c.	500 V dc	Not less than 3 M ohms
3.	230 volts a.c.	500 V dc	Not less than 2 M ohms
4.	190 volts a.c.	500 V dc	Not less than 2 M ohms
5.	110 volts a.c.	500 V dc	Not less than 2 M ohms
6.	24 volts a.c./dc	500 V dc	Not less than 2 M ohms

7. SEQUENCE TEST:

This sequence test is conducted to confirm the correct sequence of operation of the various circuits involved in the manufacture of the panel. The firm should give this sequence of operation for RDSO/RCF approval along with drawings.

Various indication lamps for indicating the following information for each plant shall be provided on the front door of the appropriate panels

- a) Alternator ON (one lamp)
- b) DC control supply ON (one lamp)

Indication lamps for indicating faults are as follows. These shall be RED in colour.

- a) High water temperature
- b) Over speed
- c) Low lube oil pressure

- d) Under voltage Trip.
- e) Over voltage relay Trip.
- f) Alternator Earth Leakage Relay (AEL)
- g) Fault lamp to represent any of the above faults and it is lit when the hooter is isolated

MAIN PANEL

- a) Air circuit breaker ON
 - b) Transformer ON
 - c) Safety loop ON
 - d) Starter battery charger ON
 - e) 24V O.K.
- Indication lamps for the faults are as follows
- f) Feeder earth leakage
 - g) Feeder Overload
 - h) Starter battery charger defect

8. LIGHTS & FANS PANEL (L&F Panel).

- 8.1 The 3 phase 110 V ac supply from the 3KVA distribution Transformer (integrated in the 25 KVA Transformer) for normal lights and fans and the 24 V DC supply from the emergency battery are brought to the L&F panel, to facilitate power supply with proper controls and protection, to the normal and emergency lights and fans.
- 8.2 The wiring, in the coach for lights and fans shall be done by RCF / Railways, tapping respective supplies from L&F panel, location of which, in the coach, shall be mutually decided.
- 8.3 To facilitate any combination of layout of Lights & Fans (like, R,Y,B and emergency lights, repeating the sequence), the L&F panel will have, an incoming fuse protected RYB, with neutral link, then with separate FUSE Protected RYB Circuit for normal lights and fans, from which the coach supply is to be taken.
- 8.4 The 24 VDC supply from emergency battery is brought to the L&F panel and through FUSE protection on both positive and negative, is fed to the emergency lights, through an emergency relay contact, whose DC coil supply is taken from a 3 phase bridge rectifier. Fed from normal light supply, such that unless the supply from at least TWO phases are off, the emergency lights will not glow.

9. SPECIAL TOOLS

Special tools for the panels such as Door lock key etc. shall be supplied loose @ 2 keys per panel.

10. APPROVALS

10.1 The firm manufacturing for the first time will arrange in-stage inspection by the representative of RDSO/RCF at the following stages

- Manufacture/fabrication of the enclosure of the panel
- Structural/dimensional drawings of SBC
- Mounting/fixing of equipment and layout of the switchgears
- Power/control wing
- Final inspection/testing

10.2 The supplier may also be required to attend joint reviews regarding the development of prototype unit.

10.3 The tenderer may seek technical clarifications, if any, in writing 30 days before opening the tenders.

10.4 The tenderer may quote separately for the panel and the commissioning of the same at R.C.F Kapurthala

11. COMMISSIONING

The panel manufacturer shall quote separately for the commissioning of the panel as under.

- a. Budgetary quote of the panel without commissioning.
- b. Budgetary quote for the panel commissioning in the coach at R.C.F

ANNEXURE-1
LIST OF COMPONENTS

S.No.	Description Main Panel	Qty.	Make
1.	AMMETER @	1 Nos	AE
2.	VOLTMETER @	1 Nos.	AE
3.	FREQUENCY METER @	1 Nos.	AE
4.	KILOWATT METER @	1 Nos.	AE
5.	TRANSDUCER FOR K.W METER @ @ Note :Not required, if Digital meter (L&T) or RISHAB is used	1 Nos.	AE
6.	CURRENT TRANSFORMER 500/5A	3 No.	Kappa Electricals India
7.	NEUTRAL Current Transformer 400/8.75A	1 No.	Kappa Electricals India
8.	CORE BALANCING CT 50/5A	3 Nos.	Kappa Electricals
9.	ACB 1000 V/800 A	1 Nos.	L&T

10.	UNDER VOLTAGE RELAY	1 Nos.	L&T ,D&P& NOVAGO
11.	ALTERNATORS EL RELAY	1 Nos	D&P, SSK, Trinitron.
12.	FEEDER EL Relay	2Nos.	D&P, L&T, Power Aids
13.	Ammeter selector Switch (SRP 136 MA) @	1 No.	KAYCEE
14.	VOLTMETER selector switch (SRP 136 VS) @	1 No.	KAYCEE
15.	Master controller switch with key (SRP 146 V)	1 Nos	KAYCEE
16.	PLANT SLEECTOR SWITCH (SPR 1412C)	1 Nos	KAYCEE
17.	DC ISOLATION SWITCH (RP123)	2 Nos.	KAYCEE
18.	FEEDER CONTACTOR (1000 V)	2 Nos.	Telemenicanique LC1F 500A
19.	DC RELAY 24 V 2 NO/2NC CM X4G	8 Nos.	SCHNEIDER
20.	DC RELAY 24 V 3 NO/ 1 NC CMX 4G	1 Nos.	SCHNEIDER
21.	DC RELAY ON SMC BOARD MCC	2 No.	SCHNEIDER
22.	FEEDER T.O.L RELAY	2 No.	L&T
23.	PUSH BUTTON RED 1 NC/1 NO	4Nos.	L & T
24.	PUSH BUTTON YELLOW 2 NO.2 NC	2Nos.	L & T
25.	PUSH BUTTON YELLOW 3 NO/3 NC	1 Nos	L & T
26.	PUSH BUTTON GREEN 1NO/1 NC	3 Nos.	L&T
27.	PUSH BUTTON GREEN 2 NO/2 NC	1 No.	L&T
28.	PUSH BUTTON GREEN 3 NO/3 NC	1 No.	L&T, India
29.	INDLAMP HOLDER RED	9 Nos.	ESSEN
30.	IND LAMP HOLDER AMBER	6 Nos.	ESSEN
33	INCANDESCENT LAMP 24 V 7W SCREW TYPE	15	OMEX
34	LAMP HOLDER BC CAP	2	VIJAY, ESSEN
35	INCANDESCENT LAMP 24 V 20W(PIL)	2	OMEX
36	FUSE BASE 16A	20	L&T
37	FUSE LINK 10A	2	L&T
38	FUSE LINK 6A	18	L&T
39	STEP DOWN TRANSFORMER 750V, 3PHASE,4WIRE/24V 1 PHASE	1	D&P, SSK, Trinitron
40	FSRD	1	D&P, SSK, Trinitron
41	TRIGGERING PCB	1	D&P, SSK, Trinitron
42	HOOTER 24 V	1	ROOTS
43	DIODES ON SMC BOARD 3A/1800V	7	MELTRON
44	CABLES POWER/CONTROL (ELECTRON BEAM IRRADIATED CABLE) DIFF SIZE, AS REQD.		NICCO
45	PIANO KEY SWITCH FOR PANEL LAMP		RECORD