RESEARCH DESIGNS AND STANDARDS ORGANISATION
MINISTRY OF RAILWAYS

POWER SUPPLY AND EMU DIRECTORATE

SPECIFICATION FOR 3 AND 4.5 KW ALTERNATOR INCLUDING RECTIFYING-CUM-REGULATING EQUIPMENT FOR 110V DC TRAIN LIGHTING SYSTEM USED ON BG AND MG COACH

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Date of amendment</th>
<th>Revision</th>
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APPROVED

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FOREWORD

0.1 The revised specification for 3 KW and 4.5 KW alternator is being issued incorporating all the five amendments in the previous specification NO. EL/TL/47 (REVISION ‘C’)

0.2 This specification is also intended to serve as a guideline for development of brushless alternator and rectifying-cum-regulating equipment. RDSO may permit any deviation considered an improvement over existing specification.

0.3 The alternator shall be driven from coach axle through ‘V’ grooved pulleys and ‘V’ belts for BG and through flat pulleys and flat belt for MG. V-belt drive shall be developed for MG coaches also.

0.4 The alternator shall work in conjunction with rectifier-cum-regulator unit. The battery shall be connected in parallel to the output of rectifier-cum-regulator unit. The battery shall consist of 54 cells of lead acid type cells.

0.5 The drawings mentioned in this standard are issued by Research Designs and Standards Organisation, Lucknow- 226011. The manufacturers are requested to refer to the latest version of the drawings only. Manufacturers are advised to get approved their manufacturing drawings before starting production.
1.0 SCOPE

1.1 This specification covers the design, testing, supply and supervision of installation of brushless alternators along with static type regulators and rectifier equipments on self-generating Railway coaches for supplying essential amenities viz lighting and ventilation etc.

1.2 This specification covers transom-mounted alternators suitable for BG stock and underframe-mounted alternators for MG stock.

1.3 The alternators are to be supplied as per SKEL-3942/A Alt.4 generally, with terminal box on caracass.

1.4 This specification shall also apply for procurement of alternators and rectifier-regulating equipment individually. Alternator and regulator when procured separately shall be tested with suitable regulator and alternator respectively.

1.5 The scope or supply shall include the following, unless otherwise specified.

   a) Alternator with safety chains.
   b) Alternator pulley with securing nut and locking arrangement
   c) Rectifier-cum-regulating equipment
   d) Crimping socket for alternator and regulator for outgoing / incoming cable.
   e) The hanger pin to suspend the alternator
   f) Tensioning arrangement, if any
   g) Axle pulley and set of rubber pad, fasteners etc. for V-belt/flat belt driven alternators.

2. TERMINOLOGY

2.0 For the purpose of this specification, the following definitions shall apply :-

2.1 Alternator – An axle driven power-generating machine mounted on the underframe of a coach / on bogie of a coach.

2.2 Axle pulley - A pulley fitted on the axle of the coach to drive the alternator by flat belt / ‘V’ belt.
2.3 Alternator pulley – A pulley fitted on alternator and driven by axle pulley through ‘V’ belt / flat belt.

2.4 Cut-in-speed - The alternator speed in rev./min at which rectified output is 108 V at no load.

2.5 Minimum speed for full output (MFO) – The minimum alternator speed in rev./min at which it gives full rated output current at rated voltage.

2.6 Voltage and current regulator – A device to limit voltage and current of alternator to pre-set values.

2.7 Rectifying equipment – A three-phase full-wave bridge connected assembly of silicon diodes to rectify the ac output of the alternator.

### 3.0 OPERATING CONDITIONS

3.1 The alternator shall function satisfactorily in the ambient temperature range from 0°C to 50°C. It shall function satisfactorily under conditions of 100% humidity. The equipment shall be designed for mounting either on coach underframe or bogie transom as specified by the purchaser and shall be suitable for working in heavily dust laden atmosphere which may also contain brake-block dust.

3.2 The coaches are expected to run up to a maximum speed of 130 kmph and 100 kmph for BG and MG respectively in varying climatic conditions throughout India. Alternator and all accessories to be mounted on the coach shall be designed to withstand the following vibration and shunting shocks.

<table>
<thead>
<tr>
<th>Type of Acceleration</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Vertical acceleration</td>
<td>3.0 g ('g' being the value of acceleration due to gravity)</td>
</tr>
<tr>
<td>Max. Lateral Acceleration</td>
<td>3.0 g</td>
</tr>
<tr>
<td>Max. Longitudinal Acceleration</td>
<td>5.0 g</td>
</tr>
</tbody>
</table>

3.3 The alternator and other associated equipments will fulfill the following broad requirements of service.

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a) High reliability  
b) Long life with minimum maintenance  
c) Satisfactory operation for full speed range of coaches and to provide full output above MFO speed irrespective of direction of motion  
d) Suitable for operations without battery on coaches  
e) Self exciting  
f) Free from unauthorized interference and pilferage.

4.0 RATINGS

4.1 The standard ratings at the dc output terminals of the rectifying and regulating equipment shall be –

(a) 3.0 kW, 25A, 120 Volts and  
(b) 4.5 kW, 37.5 A, 120 Volts

5.0 PARTICULARS OF DRIVE

5.1 The mounting arrangements and drive for the alternator of different ratings shall be as under.

(a) 3.0 kW underframe-mounted with flat belt drive for MG Coaches. V-belt drive can also be accepted provided max pulley dimensions are same as of existing pulleys.  
(b) 4.5 kW transom-mounted with ‘V’ belt driven for BG coaches.

5.2 The flat belt driven alternator shall be suitable for drive from a pulley fitted on the carriage axle. Details of the drive are shown in IRS Drg. No. 1300/67 for MG underframe. The standard size of axle pulley for flat belt drive and carriage wheels are given below for guidance:

<table>
<thead>
<tr>
<th>Gauge mm</th>
<th>Dia of carriage (New) (mm)</th>
<th>Dia of carriage (Fully worn) (mm)</th>
<th>Pitch circle dia of axle pulley (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 (MG)</td>
<td>725</td>
<td>650</td>
<td>381</td>
</tr>
</tbody>
</table>

5.2.1 The flat belt used for the drive shall conform to IS: 6583-1989 with Annexure - I. The belt size of 100 mm, 4 ply will be used.

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5.3 ‘V’ belt driven alternators shall be transom mounted and shall be suitable for taking drive from ‘V’ grooved axle pulleys mounted on the axle. ‘V’ belt driven alternator pulley shall be as per Drg. No. SKEL-3882 Alt.4 and axle pulley shall be as per Drg. No. 3883 Alt. 4. The pitch circle diameter of alternator and axle pulleys shall be 200 ± 0.3 mm and 572.6 ± 0.4 mm respectively. For BG coaches wheel dia is 915 mm when new and 813 mm when fully worn is to be considered for calculations of speed in rev./min. The alternator and axle pulley for normal weight alternator shall be to SKEL-3882 Alt. 4 and SKEL-3883 Alt.4 respectively. For lightweight alternator the alternator and axle pulley shall be to Drg. No. SKEL-4055 & SKEL- 4054 or to SKEL 3882 Alt 4 and SKEL-3883 Alt. 4 respectively as specified by the purchaser.

5.3.1 ‘V’ belts used for ‘V’ belt driven for alternators shall be of ‘C’ section size C-122 conforming to RDSO Specification ELPS/Spec/TL/04 June 94 or latest.

5.4 The underframe / bogie mounting arrangement with different drives shall be so designed as not to infringe the standard moving dimensions for coaching stock.

6.0 OUTPUT CHARACTERISTICS

6.1 The cut in speed of alternator shall be as low as possible consistent with economical design. It shall correspond to a road speed not more than 21.5 Km/h i.e. 357 rev./min. with new wheels. The Minimum speed for full output shall not exceed 600 rev./min. in cold and hot conditions of the alternator. The alternator shall be capable of working at maximum road speed of 130 kmph i.e. 2428 rev./min with fully worn wheels. No negative tolerance is permitted on the voltage and current for measuring cut-in speed and minimum speed for full output. The minimum alternator speed in rev./min. at which it gives full rated current at rated voltage shall be measured. Temperature rise test at MFO shall also be done at this setting. For all other tests specified in the specification, the settings shall be made at 1500 rev./min., which shall not be changed for meeting any test requirement. The equipment shall be dispatched at 124 V setting and half rated current unless otherwise specified by the purchaser. For performance test at any speed a tolerance of +5% of the set voltage is permissible.

6.2 The alternator output in conjunction with the regulator and rectifier shall remain constant at all speeds above the minimum full output speed. The permissible tolerance on output voltage variation over the speed range from minimum full output speed to the maximum speed shall be within ±5% of the voltage setting. With a constant current output of 25 / 37.5 A respectively for 3 / 4.5 kW alternators.
6.3 The efficiency of the alternator and the rectifying and regulating equipment combined together shall not be less than 70% at full load and 1800 rev/min.

7.0 CONSTRUCTION OF ALTERNATOR AND ITS COMPONENTS

7.1 The brushless alternator shall be of robust construction and will be suitable for rough encountered in service, at repair facilities and on shop floor.

7.2 The alternator should be able to generate at least 2.0 V ac rms, at 300 rev/min. for proper functioning of rectifier-regulator equipment.

7.3 The brushless alternator shall not have any winding on the rotor. The winding shall be in the stator and shall be accessible by removing the complete rotor from one end. The field winding shall be axially fixed. The field winding shall have nominal resistance of $4.5 \pm 0.5 \text{ ohms}$ & stator winding shall have $0.4 \pm 0.05 \text{ ohms}$ for 4.5 kW alternator.

7.4 The yokes shall be of robust construction so as to withstand the vibrations and impacts in service without resulting in distortion. The suspension boss shall be fitted with a renewable bush having bore dia of $32.5 \text{ mm } \pm 0.20 \text{ mm}$ to take a standard alternator pin of diameter $31.75 \text{ mm } \pm 0.0 \text{ mm } / -0.10 \text{ mm}$. The suspension pin shall be as per RDSO’s Drg. No. SKEL-3939 Alt 2.

7.5 The rotor and pulley of the alternator shall be dynamically balanced separately. The permissible residual unbalance shall be less than $2.5 \text{ gm-cm/kg.}$ at 1500 rev./min. The mating of pulley with shaft shall be 80%.

7.6 Safety Chains - All alternators for BG and MG coaches shall be supplied complete with safety chains to RDSO Drg. SKEL:3934. The safety chain shall conform to IS: 2429-1969 ‘Electric butt welded steel chain short link and pitched or calibrated grade 30 for lifting purposes. ‘The overall factor of safety of the chains shall not be less than 4. The allowance shall be made for the stress in chain due to impact of the falling alternator.
7.7 Safety chains fitted to the alternator shall not in any way restrict the scope of its adjustments to provide adequate tension for stretched belt. The clearance maintained from the rail level when the alternator is hanging freely by safety chain shall not infringe with the maximum moving dimensions.

7.8 Alternator pulley - The flat pulleys for 3 kW alternator shall conform to SKEL:3111 Alt.5 for flat belt drive. The shaft-end of the alternator shall be machined as shown in SKEL:3111 Alt.5. The ‘V’ belt pulleys for 4.5 kW alternator shall conform to SKEL: 3882 Alt.4 (for cast iron) or SKEL:4055 (for SG Iron) for normal weight and light weight alternators respectively.

7.9 Alternator Terminals - The terminal box shall be welded as an integral part of the carcas. It shall be located such that the center of the terminal box is in the horizontal plane in line with the center of the axle viewed from the non-drive end. The terminals shall be provided with suitable threaded fasteners in steel zinc/cadmium plated and passivated of 10 mm dia for phases and 6 mm and 4 mm dia for field positive and negative respectively for fixing cable sockets of crimped type.

Copper PVC insulated cables (unsheathed) to IS:434 shall be used for 4.5KW brushless alternators. Copper cable for phase wire shall be 126 / 0.40 (16 Sq.mm) and field wire shall be 84 / 0.30 (6 Sq.mm). For 3.0KW brushless alternator copper cable for phase wire shall be 141 / 0.30 (10 Sq.mm) and field wire shall be 48 / 0.20 (1.5 Sq.mm). DC output Aluminum wires from regulator to junction box in the upper frame shall be of size 7/2.52 (35 Sq.mm) for 3 kW and 19/1.78 (50 Sq. mm) for 4.5 kW alternator respectively.

7.9.1 The detailed drawing of the terminal block assembly shall be as per RDSO Drg. No. RDSO/PE/SK/TL/0048- 2003 (Rev.O). The design shall incorporate the following features:

a) The terminal block shall not be loose when tightening or loosening the terminal screws.

b) Incoming socket shall be connected to one terminal post and outgoing socket shall be connected to second terminal post ensuring that flow of current through threaded screws and nuts shall be avoided.

c) The temperature rise of terminal post shall not exceed 50 deg. C at continuous rated current.
d) Spring washers should be used for fasteners

e) The insulating material used for the terminal board shall be impervious to moisture. Terminal post shall have through holes up to the edge of terminal board instead of blind hole.

f) The terminal block shall be fixed with the terminal box with slotted head hexagonal screws instead of counter sunk screws.

g) The cover of the terminal box shall be with hinged arrangement as per RDSO Drawing No. RDSO/PE/VS/TL/00027-2002 (Rev.01).

h) Terminal block assembly on alternator shall be provided with grommets of approved type.

i) 3-phase leads as well as positive and negative leads for the field coming out from alternator winding to the alternator terminal board shall be through independent hole for each lead.

j) The size of the terminal box without cover (outer) shall be 170mm x 220 mm.

7.9.2 Suitable anchoring arrangement shall be made for the main a.c. cables to avoid stress coming through the cables at the termination points in the terminal block assembly.

7.9.3 Crimping sockets indicated below shall be supplied along with the alternator. The cable sockets up to 16 sq mm shall be of insugrip type, which shall grip the insulation of the cable.

- Socket suitable for 16 sq. mm copper cable size – 126 / 0.40 for M10 stud - 6 Nos.

- Socket suitable for 6 sq mm copper cable size – 84 / 0.30 for (-) ve field terminal for M4 Stud. 2 Nos.

- Socket suitable for 6 sq mm copper cable – size 84 / 0.30 for (+) ve field terminal for M6 Stud. 2 Nos.

7.9.3.1 Single core unsheathed flexible copper cable conforming to IS: 694-1990 shall be used from alternator terminal board to the rectifier regulator. The size of cables shall be as given in Clause 7.9.3.

7.9.4 The air clearance between un-insulated live parts and body of alternator shall not be less than 10mm. The minimum air clearance between the un-insulated live parts shall not be less than 4mm.

7.10 Insulation - The insulation to be used in the alternator shall be class ‘F’ type conforming to IS: 1271-1958

7.10.1 Super enameled winding wire conforming to IS: 13730 Part 13 of 1993 shall be used for field and stator winding coils. The winding wire shall be purchased only from RDSO’s approved sources.
7.10.2 The stator and field windings shall be brought to terminal box by lead wires and
bush as shown in RDSO Drg. No. SKEL:3938

7.10.3 Connection to the alternator terminal board shall be brought from winding by
uninyvin type glass braided flexible cable or silicon rubber flexible glass braided
cable having cross-section 13.3 sq mm for phase wire and 3.3 sq mm for field
wire (+ ve & -ve).

The flexible lead shall be capable of withstanding dielectric value of 5 KV rms for
1 min. Silver brazed (minimum 43% silver) / fused joints for connecting terminal
lead and winding wire shall be used.

7.11 TENSION INDICATOR - The alternator designed for flat belt drives shall be
provided with readily visible belt tension indicator in the end shield or hanger
bracket to ensure correct belt tension. The indication of the device shall be so
designed as to be easily visible from a distance of 3 m when the alternator is
mounted on a coach.

7.11.1 For transmission of power through belts, it is essential that belts are provided with
adequate initial tension. While in V belt drive arrangement, initial tension will
be provided by suitable tensioning devices, for flat belt drive, it would be
preferred, if initial tension is provided by weight of the machine when the same is
hanging at an angle of 45 deg. from the vertical with belt. In case of 3.0 kW
capacity alternator, the alternator weight with pulley shall not be less than (200 +
1 kg) and no tensioning arrangement will be provided unless otherwise agreed to
by RDSO. The tensioning device for transom-mounted 3/4.5 kW alternators shall
be as per SKEL: 3940, Sheet I Alt.2 and Sheet No. II Alt.4.

7.12 Facilities for checking alignment of alternator with respect to track rails : The
alternator shall have necessary arrangements to check its alignment to ensure
proper installation. On pulley end side, the pulley extraction holes shall be used
to screw a checking plate. The checking plate shall have 8 mm dia pin in the
center, which shall be used to suspend plumb bob. On non-drive side, end shield
bearing cap shall have a threaded hole M8 x 1.25 mm deep (minimum) in the
center, to suspend the plumb bob to check the alignment of the alternator.
7.12.1 Bearings and the end-shields: The bearing shall be identical for 3.0 kW and 4.5 kW alternators. The end-shields shall be of robust construction. The bearings housing shall be dust proof. The bearing used shall have L10 life of not less that 16 million kilometers at 1500 rev./min. The re-lubrication interval shall not be less than 30 months or 6 lac kms. NU 311 bearing shall be used on drive end and 6309 shall be used on non-drive end. Bearings of SKF / FAG Germany/ shall only be used.

7.13 Colour of alternator and rectifier regulating equipment:
The equipment shall be finished in the colour Code No. 309 Canary Yellow to IS:5-1961 “Colours for ready mixed paint”. Painting should be in accordance with specification and Code of Practice for raw materials, hardware and anti-corrosive treatment of train-lighting equipment. The fins for heat sink on regulator may be painted black. The rectifier regulator housing shall be zinc sprayed conforming to IS: 5905.

8.0 RECTIFIER-CUM-REGULATING EQUIPMENT

8.1 The housing of rectifier-cum-regulating equipment shall be as per drg. No. SKEL 2260/A unless otherwise approved by RDSO. The housing shall be water and dust proof.

8.2 The rectifying-cum-regulating equipment shall be suitable to work with both 3 & 4.5 kW alternators. The rectifier-cum-regulating equipment shall be of magnetic amplifier type.

8.3 It is desirable that voltage regulation and current limit with above setting shall be within the specified limits. However, specific relaxations can be granted provided the setting should not damage any component in alternator and rectifier-regulator unit. The terminal arrangement shall be generally as per RDSO’s Drg. No. SKEL-3549.
8.4 The power diodes used shall have average forward current at 180-degree conduction, not less than 50A. The peak repetitive reverse voltage (VRRM) shall be not less than 1200 V (PIV). The power diode shall be with stud cathode only for easy maintenance. Field diodes shall have average forward current at 180-degree conduction, not less than 12A and the peak repetitive reverse voltage (VRRM) shall be not less than 1200 Volts (PIV). The field diodes shall be with stud base cathode only for easy maintenance. The threading in power diodes shall be M 8 x 1.25 and for field diode (12A rating) shall be M 6 x 1.

8.5 The output shall be set for full rated current. After making the required setting, it shall be possible to lock the setting, to prevent inadvertent disturbance. The output setting tolerance on the marked value shall not exceed $\pm 5\%$.

8.6 The dc output voltage shall be capable of being set at 120, 122 and 124 volts at 1500 rpm at a reference load of 12.5 Amp and 19 Amp for 3 KW and 4.5 KW alternator with rectifier cum regulator respectively.

Suitable terminals for voltage setting will be brought out and connected to a rotary switch enabling selection of any particular setting. Current setting will be stepless by means of Potentiometer. The potentiometers for current limit and voltage setting adjustments shall be of types and makes approved by RDSO.

8.7 The ripple content in d.c out-put shall not exceed 15%.

8.8 Current limiting protection shall be provided to limit output current to the rated value with maximum tolerance of 15%. When current is increased to 115%, the voltage should reduce and it should become difficult to get 115% current. For the purpose of testing, 115% current remains for a short time, which may not be indicated by indicating instrument. However, it should be recorded properly by tested authority.

8.9 The operating conditions have been specified in clauses 3.1 to 3.3 of this standard. If the total current output of the alternator is less than rated current output, the rectifier-cum-regulating equipment shall regulate the output voltage of the alternator so as to maintain pre-set voltage, subject to the tolerance indicated in clause 6.2, at the rectifier terminals under following conditions.

a) At the speed varying from MFO speed to maximum speed
b) At all loads ranging from zero to the rated output of the alternator.

8.10 The semi-conductors and other parts used shall conform to “Reliability Assurance Specification for Electronic Components used in Rolling Stock” - RDSO Specification No. ELRS/SPEC/SI/0015 of Oct. 2001 unless otherwise approved by RDSO.
8.11 Necessary de-rating, screening and quality control of electronic components, resistances and capacitances, etc. shall be as per specification No. ELRS/SPEC/SI/0015 of Oct. 2001.

8.12 Other than magnetic amplifier, no other circuitry shall be epoxy molded. All other circuitry for voltage control, current control and other functions shall be brought in printed circuit board. This is not applicable to power diodes and field diodes.

8.13 In case of failure of any component, it shall not damage the major components of the train-lighting system. The device shall be fail-safe.

8.14 For the purpose of prototype testing, the rectifier-cum-regulating equipment shall be tested with minimum of any 3 makes of alternators in addition to one of the manufacturer. For this purpose accelerated temperature rise test for electronic equipment as stipulated in Clause 12.5 shall be done. For routine, Acceptance and type testing, testing with any one make shall be considered sufficient.

8.15 For the purpose for universal regulator with other makes, the MFO speed can be permitted a tolerance of ± 50 rev./min on speeds specified in Clause 6.1.

9.0 STANDARDISATION

9.1 All mechanical and electrical parts of the alternators shall be common and interchangeable for the same make and capacity, except lamination stack length stator carcass, shaft associated field and stator coils and winding wire. Any make of alternator should work with any other make of rectifier cum regulating unit of same capacity. For this performance tests of alternator shall be carried out with three other makes of RRU at ICF / RCF or Railway workshop or firm’s premises. For this purpose Load test as per Clause 12.9, current Vs voltage characteristic test as per Clause. 12.9.3 and current limiting characteristic test as per Clause. 12.13.1 shall be carried out.

9.2 The Rectifier-cum-Regulating equipment shall be universal type i.e. it shall be interchangeable between 3 kW / 4.5 kW normal weight and light alternators of any make approved by RDSO for use on coaches without needing any alteration in voltage settings. However, current setting can be adjusted for each type of alternator.

10.0 MAINTENANCE

Firm should submit maintenance manual specifying the minimum maintenance required by the equipment. Firm should bring design improvements to reduce the maintenance requirement. Bearings of alternator should require greasing after 30 months of service. Maintenance Manual shall be approved by RDSO before given to purchaser by the firm.

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11.0 MARKING

11.1 The alternators shall be provided with suitable name plates, on which the following shall be marked.

  a) Maker’s name and trade mark;
  b) Rated capacity of the alternator;
  c) Voltage and current; and
  d) Class of insulation.

Space should also be provided on the name plate for the purchaser to mark the Railway Administration’s Code initials and serial No.

11.2 The serial number of the alternator and rectifier-regulator shall be as under :-

<table>
<thead>
<tr>
<th>First two digits</th>
<th>Next two digits</th>
<th>Next two /three digits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year of manufacture</td>
<td>Month of manufacture</td>
<td>No. of machine manufactured in the particular month</td>
</tr>
</tbody>
</table>

  e.g. Serial No. 031015
  03 - 2003
  10 - October
  15 - Serial NO of machine manufactured in October. Serial number of the alternator shall be punched at suspension bracket.

12.0 TESTS

12.1 Classification and definitions of tests :

12.1.1 Prototype test -

A prototype test is the test which is to be carried out on an alternator declared as a prototype under the following conditions.

  a) A manufacturer undertakes to manufacture for the first time.
  b) An important change in design details of the machines is introduced.
  c) Specification is modified necessitating re-designing of equipment.

The prototype tests shall be carried out at the works of the manufacturer by RDSO / Lucknow

The following shall constitute the prototype tests :

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1. Verification of dimensions and specifications of all assemblies and sub-assemblies (Cl. 12.3) including checking of reliability aspects.
2. Measurement of stator an field resistance of alternator (Cl.12.4)
3. Temperature rise test of alternator, regulator-rectifying equipment (Cl.12.5)
4. Insulation resistance test of alternator, regulator-rectifying equipment (Cl.12.6).
5. High voltage test (Cl.12.7)
6. Open circuit test (Cl.12.8)
7. Load test (Cl.12.9)
8. Mechanical over speed and induced voltage test (Cl.12.10)
9. Short-circuit characteristic test (Cl.12.11)
10. Drooping voltage characteristic test (Cl.12.12)
11. Current limiting characteristic of alternator and regulator (Cl.12.12.1)
12. Over Voltage Protection Test (Cl. 12.12.2)
13. Surge protection test (Cl.12.13)
14. Efficiency test (Cl.12.14)
15. Special tests (Cl.12.15)

   i. Ripple content test (CL.12.16.1)
   ii. Mating of pulley with shaft (CL.12.6.2)
   iii. Shorting of power diode (CL.12.16.3)
   iv. Open circuiting of diode (CL.12.16.4)
   v. Computation of junction temperature of semi-conductor etc. (CL.12.16.5)
   vi. Checking dynamic balancing of rotor and pulley (CL.12.16.6)
   vii. Measurement of (MFO) Minimum speed for full output at cold and hot condition of alternator (CL.12.16.7)
   viii. Measurement of (MHO) Minimum speed for half output of alternator (CL.12.16.8)
   ix. Hose proof test (CL.12.16.9)
   x. Maximum field current temperature rise test for regulator only (CL.12.16.10)
   xi. Fire retardant test for terminal boards (CL.12.16.11)
   xii. Environmental tests for rectifier-regulator as per IEC:571 (CL.12.16.12)

12.1.2 Type test:

A type test is to be carried out by the manufacturer on alternator / alternators and regulating-cum-rectifying equipment picked up at random at the rate of one
out of every fifty numbers of equipment manufactured to ensure compliance with this specification in detail. These tests are to be carried out at manufacturer’s premises. The following shall constitute type tests:

1. Verification of dimensions of assemblies of alternator, regulator-rectifier equipment as a whole (CL.12.3) including checking of reliability aspects.
2. Temperature rise test (CL.12.5)
3. Insulation resistance test (CL.12.6)
4. High voltage test (CL.12.7)
5. Load test (CL.12.9)
6. Mechanical over speed and induced voltage test (CL.12.10)
7. Drooping voltage characteristics test (CL.12.12)
8. Current-limiting characteristics test (CL.12.13.1)
9. Over Voltage Protection Test (Cl. 12.12.2)
10. Surge protection test (CL.12.13)
11. Measurement of stator and field resistance (CL.12.4)

Note: Tests marked * are to be conducted in both the direction of rotation.

12.1.3 Routine Tests:

The routine tests are to be carried out by the manufacturers at their premises on every alternator manufactured to ensure compliance with specification declared by the manufacturer and approved by RDSO. The following shall constitute routine tests:

1. Verification of dimensions as a whole (CL.12.3) including checking of reliability aspects.
2. Insulation resistance test (CL.12.6)
3. High voltage test (CL.12.7)
4. Load test (CL.12.9)
5. Current limiting characteristic test (CL.12.13.1)
6. Measurement of stator and field resistance (CL.12.4)

12.1.4 Acceptance tests:

These tests are to be carried out by an Inspecting Authority nominated by the purchaser at manufacturer’s premises to ensure compliance with the specification on alternator / alternators picked up at random as specified in clause 12.2. In addition, the manufacturer shall submit the following test
results to the Inspecting officer at the time of offering the machines for inspection.

1. Type test results.
2. Routing tests results.
3. Drawings and design booklet approved by RDSO (Clause 14.1)
   The Inspecting officer can ask for repetition of any / all tests if he so desires.
   However, Inspection officer shall witness type tests at least on one machine.
   The following shall constitute acceptance tests.

1. Verification of dimensions as a whole and checking of reliability aspects (CL.12.3)
2. Insulation resistance test (CL.12.6)
3. High voltage test (CL.12.7)
4. Load test (CL.12.9)
5. Current limiting characteristics test (CL.12.13.1)
6. Over Voltage Protection Test (Cl. 12.12.2)
7. Measurement of stator and field resistance (CL.12.4)

12.1.5 Revalidation tests:
For renewal of registration of firm, following re-type test shall be done at
firm’s premises after five years from previous date of registration / renewal.

1. Measurement of stator and field resistance (CL.12.4)
2. Temperature rise test (CL.12.5)
3. Insulation resistance test (CL.12.6)
4. High voltage test (CL.12.7)
5. Load test (CL.12.9)
6. Mechanical over speed and induced voltage test. (Clause 12.10)
7. Over voltage protection test (Clause 12.13.2)

12.1.6 Instruments used for tests:
The indicating instruments used in electrical measurement shall conform to IS:
1248-1956 (Spec. for Electrical Indicating Instruments). Instruments with the
following accuracies shall be used:

1. For prototype, type, acceptance and routine tests – Instruments of class 0.5
   accuracy.
2. For surge protection test the amplitude and duration of the surge voltage
   shall be measured by oscilloscope.
3. Stator resistance shall be measured by a micro Ohm meter, or ammeter
   voltmeter method.
4. Use of digital type instruments is preferable.

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12.2 Sampling and Rejection:

12.2.1 The sampling for conducting various tests shall be done as per the following table:

<table>
<thead>
<tr>
<th>CLASSIFICATION OF TEST</th>
<th>QTY. OF EACH TYPE OF ALT. OFFERED FOR INSPECTION &amp; PRODUCED BY MANUFACTURER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>QTY. UP TO 49 FROM 50 TO 149 FROM 150 TO 299 ABOVE</td>
</tr>
</tbody>
</table>

- a) PROTOTYPE As specified by RDSO
- b) Re-PROTOTYPE -do-
- c) TYPE 1 2 4 4
- d) ROUTINE ALL ALL ALL ALL
- e) ACCEPTANCE 2 4 6 8

12.2.2 The rejection procedure shall be adopted as given below:

<table>
<thead>
<tr>
<th>Classification</th>
<th>Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROTOTYPE</td>
<td>II</td>
</tr>
<tr>
<td>Re-PROTOTYPE</td>
<td>III</td>
</tr>
<tr>
<td>TYPE</td>
<td></td>
</tr>
<tr>
<td>ACCEPTANCE</td>
<td></td>
</tr>
</tbody>
</table>

a) Visual

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b) Insulation resistance test If any selected samples as recommended in clause 12.2.1 fails, Check 100% basis & accept the machines which pass the test.

c) High voltage age test instruct manufacturer to correct and re-tender Ask manufacturer to correct defective machines and re-tender for 100% inspection.

d) Load test the whole lot

e) Current Limiting Test.

12.3 Verification of dimensions and specification of assemblies and sub-assemblies: This test is to check the dimensions of assemblies and specifications thereof to ensure that they are consistent with good engineering practice and where interchangeability aspects with alternator and regulating –cum –rectifying equipment in current use are to be borne in mind. Details of tests/ checks shall be prepared by the manufacturer in consultation with RDSO and got approved. The de-rating, screening and quality control shall ensured as per RDSO Specn. ELRS/SPEC/SI/0015 of Oct.2001

12.4 Measurement of stator and field resistance of alternator:

Stator and field resistances shall be measured either by voltmeter ammeter method or by suitable resistance measuring device when the alternator is at ambient temperature. Ambient temperature at the time of carrying out the test shall also be recorded. The manufacturer shall declare the value of the field and phase-to-phase resistances at 20 deg. Centigrade based, on the average of first 10 machines. The resistance of any stator and field winding shall not vary by more than $\pm 7\%$ from the declared value.

12.5 Temperature rise test:

The test shall be conducted under the following two conditions separately.

1. At minimum speed for full output.
2. At 2500 rev./min.
The alternator in conjunction with the regulating–cum-rectifying equipment shall be run at rated current and voltage for a period of 24 hours under forced air cooling of 6m/sec. for alternator and 4m/sec. for regulating-cum-rectifying equipment. The air velocity at the location where the alternator and regulator are to be located for tests shall be adjusted to 6m/sec. and 4m/sec. respectively prior to mounting of equipment in position under test. The equipment shall be placed in position after obtaining the required ventilation conditions.

Alternatively an accelerated test for about 3 hours for type testing can be done. For prototype 24 hours testing is essential. Initially the machine will be run without any ventilation and frame temperature shall be noted. As soon as frame temperature rise is less by 5 °C to the temperature rise observed in 24 hours testing, the ventilation of 6m/sec. for alternator and 4m/sec. for rectifier-cum-regulator shall be switched on. Frame temperature readings shall be taken every 15 minutes till temperature stabilizes as evidenced by three consecutive readings of temperature but not earlier than 3 hours.

Temperature rise of the stator winding, field winding, terminals and frame in case of alternator shall be measured. The temperature rise above the ambient of 50 °C shall not exceed the following values:

<table>
<thead>
<tr>
<th>Class of Insulation</th>
<th>Temperature rise</th>
<th>Method of measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>90 °C</td>
<td>Resistance</td>
</tr>
</tbody>
</table>

Temperature rise of terminals, frames, etc. shall be as low as possible. The maximum bearing temperature at the highest ambient temperature of 50 °C shall not exceed 85 °C. The temperature measurements on all locations shall be made by point contact pyrometers unless otherwise specified.

With regard to regulating-cum-rectifying equipment, the temperature rise of main diodes, auxiliary or field diodes and current transformer shall be less than designed temperature limits of each components under worst operating conditions.

While accepting the first lot of the machines, after the approval of prototype, temperature rise test should be carried out on five machines and the temperature rise shall be averaged. This average temperature shall serve as the basis of acceptance or rejection of subsequent machines. The temperature rise of the windings of subsequent machines shall be regarded as satisfactory if it does not exceed by more than 8% with a minimum of 10 °C of the declared temperature rise value. If averaging of temperature rise of five machines is not possible due to...
to certain reasons, the prototype test results conducted by RDSO may be treated as “average” temperature rise figure, with prior approval of RDSO for specific period. The temperature rise shall be recorded within 45 seconds, of commencement of cooling and successive readings shall be taken at an interval of 20 seconds. A curve shall be plotted in accordance with IEC-349 Clause 35.5 to ascertain correct temperature rise by extra-polation.

12.6 Insulation resistance test:

The insulation resistance shall be measured before and after high voltage test between all live terminals shorted together and body with a 500v dc megger and these values shall not be less than 20 mega ohm. For regulating-cum-rectifying equipment the insulation resistance shall be measured with all live parts shorted together and the body.

12.7 High voltage test:

Immediately after the temperature rise test, an ac potential of 1500v rms at 50 Hz shall be applied between all external terminals of the alternator shorted together and the frame for a period of 1 minute. The test shall be commenced at a voltage of less than one third the test voltage and shall be increased gradually to the full test voltage. For regulating-cum-rectifying equipment the test voltage shall be applied between all live terminals shorted together and housing body of the equipment. During acceptance test, the test voltage of 1500v for a period of 5 seconds shall be applied without conducting temperature rise test. The leakage current shall not exceed 15 mA for the above tests.

12.8 Open circuit test:

The alternator shall be run at not less than five speeds viz 500, 900, 1500, 1800, 2500 rpm covering the entire speed range. The field shall be separately excited and the excitation varied over the range recommended by the manufacturer. The output voltage of the alternator terminal corresponding to each setting of field excitation shall be measured and curve plotted. Selected speed during the test should be kept substantially constant.
12.9  Load Test:

The alternator shall be run in conjunction with the regulating-cum-rectifying equipment. The test shall be conducted with a resistive load and / or with battery. Preferably this test shall be conducted with a resistive load and a full coach set of battery consisting of 18 mono-blocs of lead acid 120 Ah capacity. The test shall consist of the following.

a)  No load test
b)  Speed Vs output voltage characteristic at half & full load.
d)  Current vs voltage characteristics.

12.9.1  For no load test the speed shall be adjusted at MFO, 900, 1500, 1800 and 2500 rev./min and corresponding dc voltage available at output terminals of rectifying equipment shall be measured. The voltage variation should not exceed ±5%. The cut-in-speed shall also be noted in this test. For conducting the no load test, base load of 1A shall be allowed.

12.9.2  Speed versus output voltage characteristic shall be done at full rated current and 50% of full load rated current. The speed shall be adjusted at MFO, 900, 1500, 1800, 2500 rev./min. The voltage shall not vary by more than ±5%. The minimum speed for full output shall be noted.

12.9.3  Current vs. voltage characteristic test:

This test shall be done at full rated output at 1800 rev./min. The current shall be varied from minimum to maximum, after keeping the speed constant. The voltage variation shall be within ±5%. Current limiting characteristic shall also be checked as specified in clause 12.13.1.

12.10  Mechanical over speed and induced voltage test:

This test is to be conducted as soon as possible, after temperature rise test or load test while the alternator is still hot. The alternator shall be run for a period of 2 minutes in each direction with the stator winding open circuited and field excited separately at the level corresponding to cut-in speed at a speed of 3000 rev./min. No part of the alternator shall show any sign of damage / deterioration.
12.11 Short circuit characteristic test:

The output terminals of the alternator shall be short-circuited with an ammeter in circuit before starting this test and excitation shall be adjusted in such a way that 25, 50, 75 and 100% of full load current flows through the field windings. The test shall be carried out at various speeds covering complete range. The speeds selected for this test shall be same as given for open circuit test, clause 12.8. This test shall be carried out on a cold machine.

12.12 Drooping Voltage characteristic test: This test is to be conducted on Alternator in conjunction with rectifying & regulating equipment, if this facility has been provided in the design of regulating equipment. The purpose of this test is to find out whether battery can be protected against over charging. The voltage setting of regulator shall be 120 Volt & current setting shall be rated current. When the total load on alternator is less than 40%, the preset voltage will be reduced, however the reduction shall not be more than 2 Volt. This test can be done at any convenient speed.

12.12.1 Current limiting characteristic test for alternator and regulator:

This test is to be conducted at any speed, which is more than minimum speed for full output. The voltage setting shall be kept at 120v and current setting at full rated current. When current is increased from full rated current value, the necessary drop in set voltage shall be observed to ensure that alternator is protected against over-loading. The increase in current may be in steps of 2A.

12.12.2 Over Voltage Protection:

Due to component failure / open circuit in regulator over voltage can occur, therefore, over voltage protection circuit should be provided with no nuisance tripping under no load or when the system running with VRLA / Conventional lead Acid battery connected at output. During sudden throwing of load without battery connected, the over voltage may trip but must reset automatically. Latching of the relay may be achieved under fault condition with battery supply available at the DC output. Suitable time delay (within 3 sec.) may be provided for relay operation so that relay does not trip when load in thrown off suddenly with battery connected. However, the time delay provided should be minimum in order to protect the system under genuine fault condition. The tripping voltage of relay may be set at 145 ± 2 V, which will be verified during type testing. It should be solid state relay only and circuit should use electronic components of industrial grade and reputed make. Over voltage protection shall be tested as per following test programme.
<table>
<thead>
<tr>
<th>S. N</th>
<th>Load</th>
<th>Speed of testing</th>
<th>Condition of RRU</th>
<th>Status of relay</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 Amp DC</td>
<td>357,600, 1500, 2500 rpm</td>
<td>Control winding Zener intact (RRU normal working)</td>
<td>Tripping/Not tripping</td>
<td>Transient/Stabilized voltage to be recorded</td>
</tr>
<tr>
<td>2</td>
<td>1 Amp DC</td>
<td>600,1500, 2500 rpm</td>
<td>(a) Opening of control winding (b) Opening of reference Zener for voltage</td>
<td>-do-</td>
<td>-do-</td>
</tr>
<tr>
<td>3</td>
<td>19 Amp DC</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
</tr>
<tr>
<td>4</td>
<td>37.5 Amp DC</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
</tr>
<tr>
<td>5</td>
<td>Throwing off 37.5 Amp load to no load</td>
<td>-do-</td>
<td>Control winding Zener intact (RRU normal working)</td>
<td>-do-</td>
<td>-do-</td>
</tr>
<tr>
<td>6</td>
<td>Sudden loading from No load to full load</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
</tr>
</tbody>
</table>

**Note:**

1. During the testing of OVP, the status of relay (tripping / not tripping) and DC output voltage shall be recorded under the above conditions. However, for prototype test machines the transient / steady state DC Output voltage along with rise/fall time shall be recorded using digital storage oscilloscope having suitable interface with PC/Printer for downloading the waveform.

2. OVP shall not trip under condition at item 1, 5 & 6.

3. Battery Circuit shall be kept out of circuit while testing OVP as per condition mentioned at item no. 1, 5 & 6.

4. OVP testing as mentioned at S.No.2,3 & 4 shall be done using battery bank of adequate capacity (preferably 120 AH) and same shall be kept in perfect healthy condition.

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12.14 Surge protection test:

This test is to be conducted on alternator in conjunction with rectifying and regulating equipment. A speed of 1800 rev./min. shall be adjusted with full rated current output. Then suddenly full load shall be thrown off and the output terminal voltage rise shall be noted. The terminal voltage may rise to any value but it will not damage alternator, regulator-rectifying equipment. Again, only 1A resistive load shall be kept in the circuit and balance load shall be suddenly thrown off and output terminal voltage of the alternator shall not rise beyond 400V and shall drop to normal value in less than 3 seconds.

12.15 Efficiency test:

The efficiency test shall be done by all the manufacturers on their machines by separation of losses method at 1800 rpm by dynometer / direct coupling / V- belt drive. The speed vs efficiency curve shall be plotted at rated output at output terminals of the rectifying regulating equipment at full load and 1800 rev./min. i.e. regulator losses shall also be considered and efficiency shall not be less than 70%. The test shall be conduct conforming to IS: 4889-1968.

12.16 Special tests:

a) Ripple content test (Cl.12.16.1)
b) Mating of pulley with shaft (Cl.12.16.2)
c) Shorting of power diode (Cl.12.16.3)
d) Open circuiting of power diode (Cl.12.16.4)
e) Computation of junction temperature of semi-conductor etc. (Cl.12.16.5)
f) Checking dynamic balancing of rotor & pulley (Cl.12.16.6)
g) Measurement of (MFO) minimum speed for full output in cold and hot conditions of alternator (Cl.12.16.7)
h) Measurement of (MHO) minimum speed for half output (Cl.12.16.8)
i) Hose proof test (Cl.12.16.9)
j) Maximum field current temperature rise test for regulator only (Cl.12.16.10)
k) Fire retardant test for terminal board (Cl.12.16.11)
l) Environmental test for rectifier-regulator (Cl.12.16.12)
12.17 Ripple content test:
The ripple content in dc output shall not exceed 15% and ripple content shall be computed from oscilloscope measurement as under:

\[
\text{Ripple content} = \frac{V_{\text{max}} - V_{\text{min}}}{V_{\text{max}} + V_{\text{min}}} \times 100
\]

Where \( V_{\text{max}} \) = maximum voltage
\( V_{\text{min}} \) = minimum voltage

This test shall be carried out at 2000 rev./min.

12.16.1 Mating of pulley with shaft:

Alternator pulley shall be checked for mating on shaft. The area in contact shall not be less than 80%. The test shall be conducted using plug and ring gauge and Prussian blue as media.

12.16.2 Shorting of power diode:

The alternator with RRU shall be run at 1800 rpm at full load. Stop the alternator, then any one power diode shall be shorted and alternator with RRU shall be run again at 1800 rpm. The pre set full load shall be connected across DC output terminal for 2 minute. After the test, no component of alternator or rectifier-regulator shall get damaged. DC output voltage and current shall be recorded.

12.16.3 Open circuiting of power diode:

The alternator with rectifier-regulator unit shall be run at 1800 rev./min and set the full load in three steps. Stop the alternator then any power diode shall be opened and Alternator with RRU shall be run again at 1800 rpm at No Load for 2 minute & then the full load shall be applied gradually in 3 steps for 2 minutes. After the test, no component of alternator or rectifier-regulator shall get damaged. D.C. out-put voltage & current shall be recorded.

12.16.4 Computation of junction temperature of semi-conductors used in rectifier-regulator equipment.

The junction temperature of power diodes, auxiliary diodes, and transistors shall be computed. The temperature rise of the junction shall not exceed 110°C.

12.16.5 Checking dynamic balancing of rotor & pulley:
The dynamic balancing of rotor and pulley shall be checked individually on a balancing machine at 1500 rev./min. The residual unbalance shall not exceed 2.5 gm-cm / kg in any case.

12.16.6 Measurement of MFO at cold and hot conditions of alternator:

The minimum speed for full output of the alternator both in cold and hot conditions shall not exceed 600 rev./min.

12.16.7 Measurement of minimum speed for half output (MHO):

The alternator shall be run at a speed of 500 rev./min. The current at 120v output setting shall be measured. It shall not be less than 50% of rated current. The rev./min. at which 50% rated current is available shall also be measured.

12.16.8 Hose proof test:

The rectifier-regulator equipment shall be tested for water tightness by spraying water through a water hose for 15 minutes. Rectifier regulating housing shall be checked for water ingress to ensure that there is no water ingress. The test shall be conducted as per IS: 4691-1968.

12.16.9 Maximum field current temperature rise test:

The field current is maximum between cut-in-speed and minimum speed for full output. Machine shall be run for 30 minutes at the speed corresponding to maximum field current with maximum load, which it can take without drop in pre-set voltage and without any air-cooling of the equipment. Junction temperature of semi-conductors shall be computed. The temperature rise of the junction shall not exceed 110°C Similarly temperature rise of winding of magnetic amplifier will be noted to see that it is below the designed limit.

12.16.10 Fire retardant test for terminal board:

The terminal board of brushless alternator and rectifier-regulator shall be tested for resistance to spread of flame in the manner given below:

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The piece of terminal board of brushless alternator and rectifier regulator material measuring about 150 mm x 25 mm shall be subjected to a luminous bats wing flame, preferably supplied by a Bunsen burner. The specimen shall be held with the flat side up at an angle of 45 degree C to the horizontal. The flame shall be 25mm in width across the tips.

The flame shall be applied to the specimen at the lower side end for 30 seconds and removed for similar period and then applied again to the same end for a second period of 30 seconds and then again removed. This test shall be carried out with the decorative surface facing downwards.

Should the specimen get ignited, it shall not continue to burn for more than 50 seconds after the flame has been finally removed.

12.16.11 Environmental test :

This test shall be conducted as per clause 24 section FIVE of IEC-571. This shall include following tests :
   a) Temperature rise test (dry heat)
   b) Temperature rise test (damp heat)
   c) Test in a corrosive atmosphere
   d) Combined dust, humidity and heat test
   e) Vibration, shock and bump test.

13. PERFORMANCE DATA

13.1 The maker shall furnish the purchaser with a schedule of technical performance date in the form shown at Appendix – ‘A’ at the time of tendering.

13.2 The maker shall furnish a copy of the routine tests conducted on each machine and a copy of type test results to the consignee duly counter signed by the purchaser’s inspector.

13.3 The maker shall also furnish the copies of type test results to R.D.S.O. and the respective indenters whenever demanded.

14. DRAWINGS & DESIGNS ETC.

14.1 After completion of prototype test manufacturer shall submit following documents in bound booklet for in two copies. One copy duly approved shall be returned to manufacturer. Booklet should contain :
1) ISO certificate
2) Design details 
3) Circuit diagrams and detailed drawings of alternator and regulator .
4) Bill of material .
5) Quality assurance plan.
6) Prototype test results and field trial reports.
7) Maintenance manual

Soft copy of drawings in auto cad should also be given along with hard copy .

14.2 The following shall be supplied as required by purchaser:

1. Reproducible prints / ferro prints of drawings showing the over all dimensions of the alternator supplied including dimensions of suspension boss and pulley in position.

2. Twenty five sets of approved maintenance manual with spare parts catalogue for every lot of 100 Nos. alternators or part there-of

14.3 The following designs shall be submitted.

1. Shaft stress calculation
2. MTBF prediction calculation for rectifier-regulator
3. Bearing life and lubrication interval calculation

15. APPROVAL BY RDSO

15.1 The prototype of each type of alternator shall have the approval of RDSO (Research, Designs & Standards Oraganisation, Lucknow- 226011) before affecting the supply to Railways or manufacturing units. For this purpose, the manufacturer shall submit to RDSO the results of the prototype testing along with other details as per clause 14.1. The maker shall afford all facilities to RDSO for conducting the prototype tests as per clause 12.1.1. In case it is necessary to conduct any of the prototype test at a testing house / institution, the full cost of such tests shall be borne by the manufacturer.
15.2 The manufacturer shall submit assembly and part drawings to RDSO for approval.

15.3 The prototype approval shall be valid for a period of five years from the date of issue of approval letter. Before expiry the manufacturer shall have to apply for the revalidation of approval. However RDSO may conduct the type test at short interval in case of need for implementation of design/reliability related modification.

While applying for renewal of type test approval following information shall be given by the manufacturer.

   a) Deviations from the bill of material, QAP approved by RDSO earlier.
   b) Implementation of all maintenance / reliability improvement modifications issued by RDSO.
   c) Addition/Deletion of machinery and plant.
   d) Details of purchase orders executed in last three years i.e. PO No., Qty., Rate (Including taxes), Date of supply, consignee.
   e) Retype tests shall be done as per clause 12.1.5 for revalidation

16. INFORMATION TO BE SUPPLIED

16.1 At the time of placing the order, the purchaser shall give the following information to the manufacturer

   a) Rated capacity of alternator, 3 or 4.5 kW
   b) Type of alternator

17. GUARANTEE /WARRANTY

Guarantee/Warranty shall be applicable for a period as mentioned in IRS conditions of contract or tender.

18.0 QAP TO BE FOLLOWED DURING MANUFACTURING OF ALTERNATOR

18.1 The manufacturer shall intimate to RDSO regarding their internal quality assurance process being followed by them. Certificates of the QAP will also be given with each lot of alternator to Inspecting Authority.

18.2 The material purchased form outside agencies shall conform to the relevant Standard Specification as specified in RDSO / IS Specification. The certificate conforming to RDSO / IS Specification should also be made available for each lot.
of machines. It is also preferred that in-house test facilities for purchased items should be developed by the firm so that testing of these materials can be done within the factory premises so that as check can be exercised by the Inspecting Authority in case necessary, otherwise, the testing of these materials should be done by Government recognized Testing Houses conforming to RDSO / IS Specification.

18.3 The Ultrasonic testing shall be conducted on each rotor shaft and certificate of the same shall be attached with each lot at the time of Inspection.

19.0 No design change shall be undertaken by manufacturer from prototype without prior approval of RDSO.

20.0 DESIGN DETAILS OF ALTERNATOR & RECTIFIER REGULATOR

20.1 Manufacturers shall submit complete detail of components used for alternator and rectifier regulator to RDSO along with information as per Annexures enclosed before offering the machine for prototype testing.

21.0 INFRINGEMENT OF PATENT RIGHTS / ISO 9000 ACCREDITATION

Indian Railways shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, use of similar components in the design, development of the Alternator/RUU and any other factor not mentioned herein which may cause such a dispute. The entire responsibility to settle any such disputes/matters lies with the manufacturer.

The firm seeking RDSO’s approval for manufacture and supply of Alternator/RUU conforming to this Specification shall have ISO 9000 accreditation or equivalent certification to ensure its conformance to Quality Systems laid down in the standard for design, manufacturing processes, raw material, testing, quality control at different stages etc.
Appendix – A

SCHEDULE OF TECHNICAL DATA TO BE FURNISHED BY THE MANUFACTURER ALONG WITH THE TENDER

Particulars to be filled in

A.1 Alternator particulars.
A.1.1 Rated capacity
A.1.2 Maker’s type
A.1.3 Full load voltage range From V To V
A.1.4 Cut-in speed rev./min.
A.1.5 Min. speed for full output
A.1.6 Max. permissible speed
A.1.7 Drive
A.1.8 Mounting Underframe / Bogie
A.1.9 Weight of alternator with pulley Kg.
A.1.10 Class of insulation
   a) Stator
   b) Field
A.1.11 Make and type of bearing
   a) Drive end
   b) Non drive end
A.1.12 Recommended grease (specify I.O.C. brand), frequency of greasing including quantity and method of greasing.

A.2 Regulator particulars
A.2.1 Make
A.2.2 Dimensions length x width x height mm
A.2.3 Weight Kg.
A.2.4 Voltage adjustment range V
A.2.5 Current adjustment range A

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ANNEXURE - I

Details to be furnished by Alternator Manufacturers

I. Alternator particulars

(a) Rated capacity
(b) Maker’s type
(c) No load to full load voltage range
(d) Cut in speed
(e) MFO speed
(f) Max. permissible speed
(g) Drive/Mounting
(h) Overall length
(i) Overall dia
(j) Wt. Of alternator without pulley
(k) Weight of pulley: Alternator Axle
(l) Both side bearing particulars

II. Alternator Shell particulars

(a) Material of the shell
(b) Length of the shell
(c) Outer dia of the shell
(d) Inner dia of the shell
(e) Drg. Of the Shell with all tolerances and manufacturing process

III. Alternator Stator particulars

Alternator Stator particulars

(a) Inner dia of stamping
(b) Outer dia of stamping
© Thickness of stamping
(d) No. of stampings used
(e) Wt. Of stator core
(f) Grade of magnetic material used
(g) Supplier’s name

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<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(h)</td>
<td>Power loss per kg</td>
</tr>
<tr>
<td>(i)</td>
<td>Material specification</td>
</tr>
<tr>
<td>(j)</td>
<td>Details of locking arrangement of stator core of both side.</td>
</tr>
<tr>
<td>(k)</td>
<td>Pressure used to install the lamination in position</td>
</tr>
<tr>
<td>(l)</td>
<td>Checking methods adopted to ensure true-bore of stator</td>
</tr>
<tr>
<td>(m)</td>
<td>Total length of stator lamination.</td>
</tr>
</tbody>
</table>

### IV. Alternator Rotor particulars.

(a) Total length of rotor shaft  
(b) Material of rotor shaft  
(c) Inner dia of stamping  
(d) Outer dia of stamping  
(e) Total length of stamping  
(f) Thickness of stamping  
(g) No. of stampings used  
(h) Wt. Of rotor core  
(i) Grade of Magnetic material used  
(j) Supplier’s name  
(k) Power loss per kg  
(l) Material specification  
(m) Details of locking arrangement of rotor stamping of both side  
(n) Pressure used to install the lamination in position  
(o) Checking methods adopted to ensure outer dia of rotor  
(p) Finished shaft drawing clearly indicating bearing seat, dimension on shaft and dimension of bearing with tolerances.  
(q) Both ends end-shield manufacturing drawing  
(r) Rotor skew angle  

### V. Windings of alternators.

(a) Size of copper wire (Stator with specification and maker)  
(b) Size of copper wire (Field with specification & maker)  
(c) No. of turns per coil (stator)  
(d) No. of turns per coil (field)  
(e) Type of varnish used for impregnation  
(f) Method of impregnation used  
(g) Type of slot insulation used  
(h) Type of wedge insulation used  
(i) Type of insulation used on overhang  
(j) Details of lead wire  
(k) Method of lead and winding wire joint.  
(l) Type of winding used.
Details of Rectifier Regulator

Main Circuit:

- Working principle
- Wiring diagram with T. No.

(A) Current Sensing:

(a) CT/Shunt

- Type
- Rating
- Type of insulation
- Bus Bar Size
- Accuracy/ burden details.

(b) Rectifier

- 3 Phase full wave bridge
- No. of diodes
- Current (I)
- PIV
- Type
- Make
- Heat Sink
- Temperature rise(Max.)

(c) Current Detector

- Rating of all the fixed resistances
- Numbers
- Make
- Type
- Tolerance
(d) **Zener Diode**

- Current (I)
- PIV
- Type
- Make
- Heat Sink
- Rating (Voltage, Wattage)

B) **Voltage Sensing:**

(a) **Voltage Detector**

- Rating of all the fixed resistors
- Numbers
- Make
- Type
- Tolerance

(b) **Zener Diode**

- Current (I)
- PIV
- Type
- Make
- Heat Sink
- Rating (Voltage, Wattage)

(c) **Rectifier**

- 3 Phase full wave bridge
- No. of diodes
- Current (I)
- PIV
- Type
- Make
- Heat Sink
- Temperature rise(Max.)

| Prepared by | Checked by |
(C) Magnetic Amplifier

(a) Main Winding
- No. of windings
- Turns
- Size of winding wire
- Current paths
- Insulation (Class of insulation)
- Temperature rise (Max)

(b) Control Winding
- No. of windings
- Turns
- Size of winding wire
- Current paths
- Insulation (Class of insulation)
- Temperature rise (Max)

(D) Excitation Transformer

(a) Auto Transformer Type
- Current Rating of Primary and Secondary
- Turns
- Size
- Current paths
- Insulation
- Temperature rise (max)

(b) Isolation Type
- Current Rating of Primary and Secondary
- Turns
- Size
- Current paths
- Insulation
- Temperature rise (max)
(E) **Main Rectifier**

- Full wave
- No. of diodes
- Current rating
- PIV
- Type
- Make
- Temperature rise (Max.)
- Type of thread
- Type of polarity

(F) **Snubber network**

Details of condensor/resistors
- Type
- Make
- Rating
- Type of insulation

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