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पैनेल का विशिष्टीकरण
SPECIFICATION FOR VOLTAGE REGULATING PANEL
FOR DIESEL ELECTRIC LOCOMOTIVES

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FOREWORD:

- 0.1 The Voltage Regulating panels (VRP) is an automatic voltage regulating and current limiting panel for the auxiliary generator for the use of battery charging and to supply control power. It maintains constant output voltage at 72 ± 2 volts and limit the output current to a preset value. The voltage regulator continuously samples the auxiliary generator output and regulates the output by varying the generator shunt field excitation. The Regulator Card (BN) continuously senses the voltage and current output of auxiliary generator and controls the flow of power to the generator field through Power Card (BY).
- 0.2 This specification requires reference to the following standard Specifications:-
- (1) IS:616 – Safety requirements for mains operated Electronics or related apparatus for household and similar general use.
 - (2) IEC:571-1 – Electronic equipments used on Rail vehicle.
 - (3) ELRS/SPEC/SI/0015 – Reliability of Electronics used in Rolling Stock application.
- 0.3 In order to ensure high reliability of Electronic components, the guidelines indicated in the RDSO Reliability assurance No. ELRS/SPEC/SI/0015 should be implemented to extent possible. A mention be made in the tender offer to the relevant clause, which are not followed and relaxation is required.

1.0 SCOPE:

- 1.1 The equipment shall be able to control the field current of the auxiliary generator to achieve the regulation and current limit in a manner as prescribed.
- 1.2 It is designed in such a way so as to also cater to higher field current requirement of auxiliary generator type AG3101 AY-1, whose field connections are connected in 3S-2P combination.

2.0 SERVICE CONDITION: The VRP shall operate satisfactorily under the following condition:-

- | | |
|-------------------------|----------------------------------------------------------------------------------------------------------------|
| 2.1 Ambient Temperature | : 0 to 70 deg. C. |
| 2.2 Relative Humidity | : 100% |
| 2.3 Atmosphere | : Dusty and corrosive. |
| 2.4 Vibrations | : Vertical : 1.0 g
Horizontal : 0.5 g
Longitudinal : 3.0 g
(Where “g” is acceleration due to gravity) |

3.0 CONSTRUCTION:

- 3.1 The VRP housing shall be rugged and suitable for retro fitment on the Diesel electric locomotives.
- 3.2 The general arrangement, mounting and terminals provision shall be as per drawing No. SKDP-3662.
- 3.3 The weight of VRP shall not be more than 8 Kg.

3.4 All terminal stands shall be of standard type M5, 12.5 mm long, separated by a minimum distance of 20 mm (center to center).

3.4.1 There shall be 4 terminals designated and marked as

- (i) A⁺ or A.
- (ii) F⁺ or F1.
- (iii) GJ or AGA2 or AGF2 or 44B.
- (iv) H or AG4.

3.4.2 The connection scheme shall be

- (i) Generator Armature between “A⁺” and “GJ”.
- (ii) Generator field between “F⁺” and “GJ”.
- (iii) Current shunt positive to “H” and negative to “GJ”.

4.0 TECHNICAL REQUIREMENTS:

4.1 Mode of regulation : Generator Field Control.

4.2 Generator Voltage : 72 V nominal.

4.3 Range of Adjustment : 69 to 75 at 1700 RPM.

4.4 Regulation : ± 2 V from 0 A load to 180 A load,
from 830 to 2400 RPM when not in current limit.

4.5 Adequate protection against surge shall be provided.

4.6 A suitable protective device shall be provided to prevent destruction of circuits in the event of polarity inversion. Moreover, all devices (supply circuits and circuits) shall be protected against external electrical fault.

4.7 Adjustment : Potentiometer adjustment for

- (i) Generator voltage.
- (ii) Generator current limit.

4.8 Generator Current Limit: It shall be possible to adjust current limit from 160A to 200 A (i.e. from 560 mV to 700 mV).

4.9 Equipment shall be able to operate satisfactorily under Environmental condition specified under clause 2.

5.0 GENERAL DESIGN FEATURES:

5.1 The equipment shall have built in reliability, achieved through screened components with respect to all critical parameters, filtered reference circuit, usage of redundant components, higher peak gate triggering current, self fast recovering commutation circuit.

5.2 The cards and panels are protected from damage even if either of the cards is removed during operation by mistake.

5.3 Negligible battery drain even if the locomotive is held up with battery switch on.

5.4 The equipment and its mounting arrangement shall be of robust design for traction duty and shall withstand satisfactorily vibrations and shocks normally encountered in service as per IEC-571-1.

6.0 ARRANGEMENTS & FACILITIES:

The facilities for conducting routine and acceptance tests shall necessarily exist at the supplier's premises. Certain tests included in the type testing can however, be carried out in any recognized test laboratory, in case the facilities for conducting these tests

do not exist at the supplier's premises. The simulated testing for performance shall be carried out as per test programme for Electronic panels for Diesel electric locomotive [EXCP, VRP, TRP, ECP, MP Report No. MP.TP 16 (Rev. 0) Dec.'2001].

7.0 REQUIREMENTS:

The test programme requires the following:

- Adequate testing facility with auxiliary generator type AG3101AY-1 and load or connecting through external field with CRO in case the machine is not available for testing
- Voltage Regulator Panel with all associated hardware to be applied on board the locomotive

8.0 TESTING DETAILS :

This test programme is prepared for the purpose of conducting Type Test, Routine Test and Acceptance Test of the complete Voltage Regulator Panel (VRP). The complete panel shall be subjected to the following categories of test:

- Type Test.
- Routine Test.
- Acceptance Test

8.1 The tests for which the facilities are not available with the manufacturer shall be conducted at any Govt. laboratory subject to agreement between RDSO and supplier.

8.1.1 Type Test: The type test shall be conducted on one complete panel of RDSO approved design to verify that the product meets the requirements specified for the panel.

8.1.2 Routine Test: Routine test are to be carried out to verify that properties of the product correspond to those measured during type test. Routine tests are to be performed by the manufacturers on each panel.

8.1.3 Acceptance Test:- Acceptance test are to be carried out by the inspecting authority on each panel.

8.1.4 The tests to be carried out on complete panel are given in the following Table I:

Table I

S. No.	Name of the Test	Type Test	Routine Test	Acceptance Test
1.	Visual Inspection	Yes	Yes	Yes
2.	Performance Test	Yes	Yes	Yes
3.	Insulation Resistance Test	Yes	Yes	Yes
4.	Die-electric Test	Yes	Yes	Yes
5.	Voltage surge Test	Yes	No	No
6.	Cooling Test	Yes	No	No
7.	Temperature Rise Test (Dry Heat)	Yes	No	No
8.	Temperature Rise Test (Damp Heat)	Yes	No	No
9.	Salt mist Test	Yes	No	No

10.	Combined Dust Humidity & Heat Test	Yes	No	No
11.	Vibrations, Shock & Bump Test	Yes	No	No

9.0 **VISUAL INSPECTION** :

- 9.1 Inspect BX-96, BN-96 cards & the panel frame as per the following points.
- 9.1.1 Check that all the components like heat sink, core, wire wound resistors, potentiometers, diodes, transistors, relay, fuse, capacitor, thyristor etc. are rigidly mounted and that all other nuts, bolts etc. are well tightened.
- 9.1.2 Check that shaft of potentiometer can be moved freely by loosening the locknut and that they can be locked in any desired position by tightening the locknut.
- 9.1.3 Check that all cards are free from cracks.
- 9.1.4 Check that the plastic or varnish paste is uniformly and properly applied on all the relevant components wired on cards and on connecting wires.
- 9.1.5 Check that all cards fit properly in the panel frame, and are not loose after fixing/fitting.
- 9.1.6 Check that the complete unit is in line with **detailed assembly drawing** as submitted by the manufacturer. Mounting holes spacing should be checked carefully.
- 9.1.7 Check all the cards for their wiring as per the **layout and for the components used as per the bill of material.**
- 9.1.8 Check that components are secured properly and there are no sharp bends, or extra length of leads.
- 9.1.9 Check for the contact pin pressure on the base of the panel by a pressure checking gadget consisting of a spring balance (0-2 kg) and a male pin of electronic card. The minimum individual pin pressure should be 500 gm.

10.0 **PERFORMANCE TEST**

10.1 **WITH AG 3101AY-1 WITH FIELD CONNECTED IN 3S-2P COMBINATION (PARALLEL)**

- 10.1.1 **Bench testing:**
Measure and record value of capacitor C6. The value shall be 1000 μ fd \pm 10 %.
- 10.1.2 **Relay pick up voltage :**
Remove BX and BN cards from VR-96. Connect variable supply 0-72 V DC between TBA (+ve) and TBG (-ve). Increase the supply voltage slowly and record pick up voltage of VRL1. It must pick up between 30-50 volts.
- 10.1.3 **Testing with Auxiliary Generator machine AG 3101 AY-1 :**
Make connection of the regulator with machine as per fig-1.

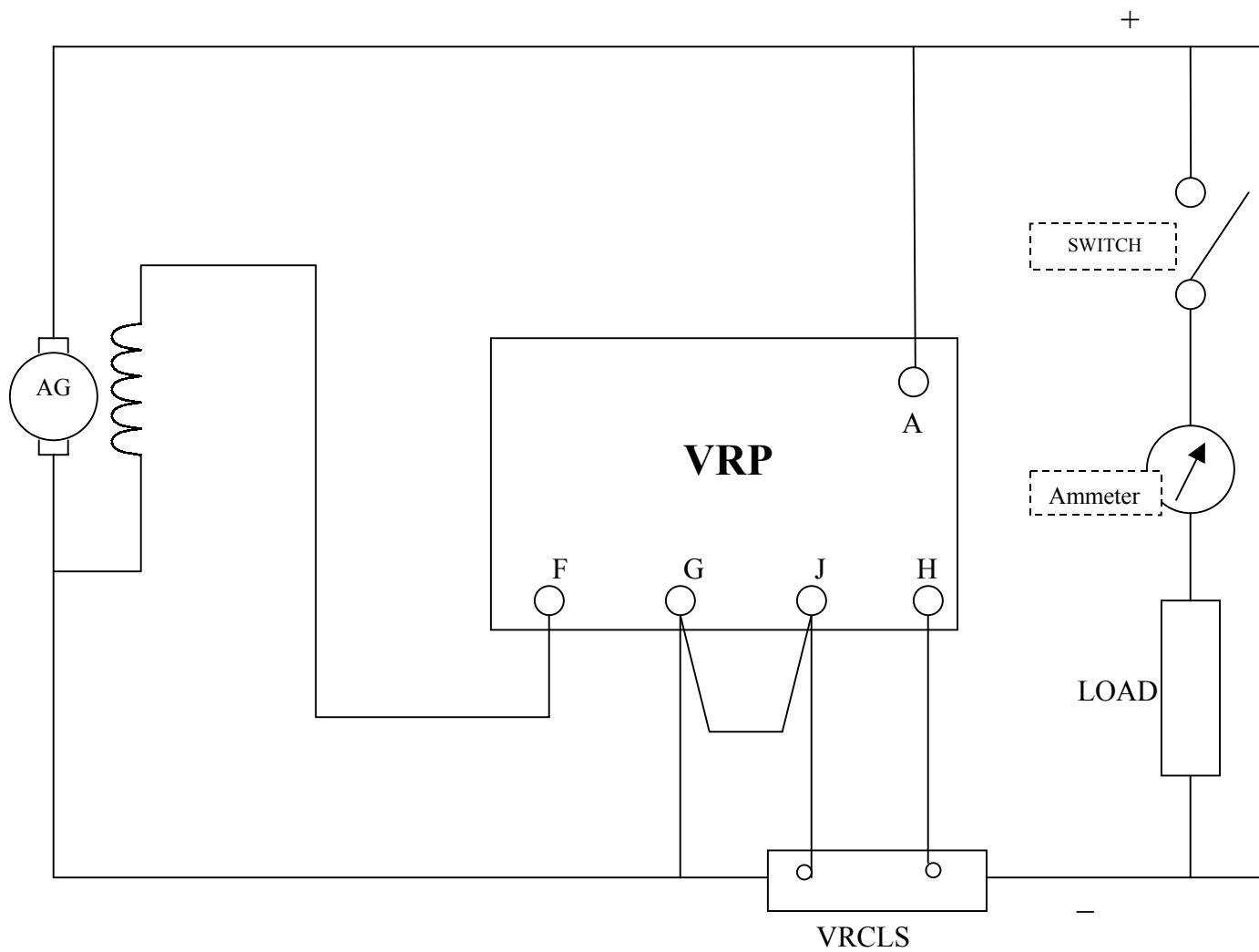


FIG.1

10.1.4 Regulation Test:

Run the motor generator set at 1700 rpm at no load conditions. Adjust potentiometer VVR provided on front bracket, to achieve output voltage 72 volt DC. Measure and record output voltage of AG at speeds and load conditions given in following Table II. Output voltage shall be within 72 ± 2 volt DC (70 to 74 volts).

Table-II

M/c RPM	Aux.Gen. Voltage (Volts)	Load current (Amps)	Remarks
830		0	
830		160	
1700		0	
1700		160	
2400		0	
2400		160	

10.1.5 Voltage adjustment range:

Run the motor generator set at 1700 rpm at no load conditions & check the following:

- Rotate VVR potentiometer fully anti clockwise and record the out put voltage. It shall be between 64 volts to 68 volts.
- Rotate VVR potentiometer fully clockwise and record the out put voltage. It shall be between 76 volts to 80 volts.
- Set output voltage at 72 volts DC by adjusting potentiometer VVR.

10.1.6 Current Limit test:

Stop motor generator set. Connect external mV supply through a potentiometer between H and J, with J as positive (fig. 2). Adjust potentiometer RX so that voltage between terminal J & H is zero. Run motor generator set at 1700 rpm. Measure the output voltage. It shall be 72 volts DC. Adjust, if required by potentiometer VVR. Now increase voltage between H & J slowly with the help of external potentiometer and observe output voltage of AG. Output voltage shall drop below 64 volts, when voltage between H & J terminal is between 560 to 700 mV (i.e. 160 to 200 Amps). Add resistance Rx as per the following Table III, if required. Stop motor generator set, disconnect external power supply and connecting shorting link between terminal G, H & J.

Table-III
Resistances for Rx

Sl. No.	Description
1.	Resistor 100K ohms \pm 1%, 1 watt metal film
2.	Resistor 120K ohms \pm 1%, 1 watt metal film
3.	Resistor 150K ohms \pm 1%, 1 watt metal film
4.	Resistor 180K ohms \pm 1%, 1 watt metal film

Note: If proper current setting is not achieved suitable value of resistance Rx (Table-III) in parallel to R32A may be used to achieve required current setting.

10.1.7 Load thrown off test:

10.1.7.1 Run the motor generator set at 950 rpm and load it at 150 amps for 3 minutes and after 3 minutes throw off complete load. Measure and record the generator voltage at no load and full load. It shall be within 72 ± 2 Volts.

10.1.7.2 Repeat above test at 1700 & 2400 rpm also.

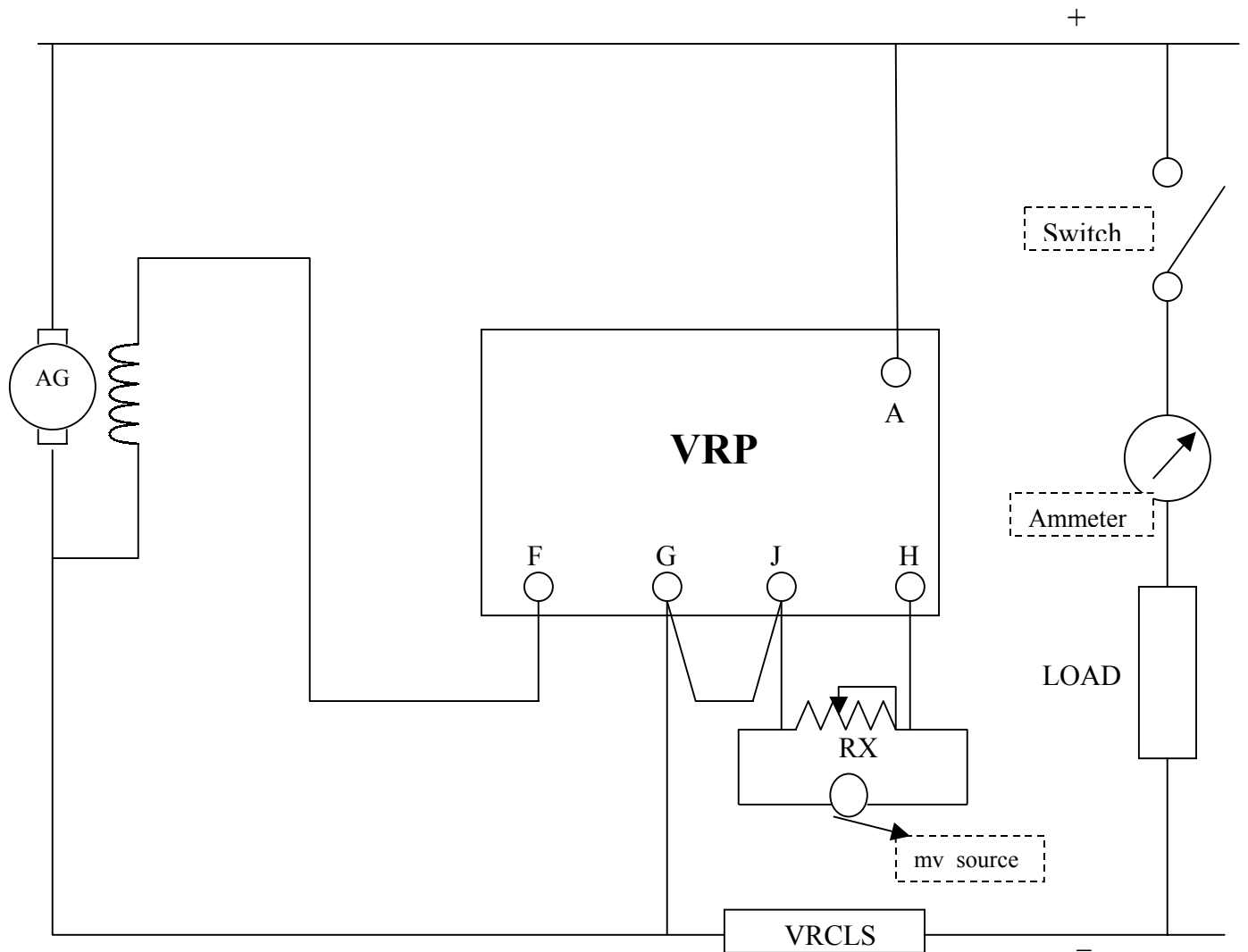


FIG.2

10.2 IF AUXILIARY MACHINE TYPE AG3101AY-1 IS NOT AVAILABLE FOR TESTING THE VRP, PERFORMANCE TEST OF VOLTAGE REGULATING PANEL (VRP) OTHER THAN PARA 9.0 MENTIONED ABOVE SHALL BE CARRIED OUT AS FOLLOWS:

10.2.1 Connect positive terminal of 72V power supply to terminal “A” of VRP and Negative terminal to G & J shorting of VRP. Connect CRO & FIELD between “F” & “G” terminals of VRP (as in fig. 3 below). Connect voltmeter between “C” of BN card & G of VRP.

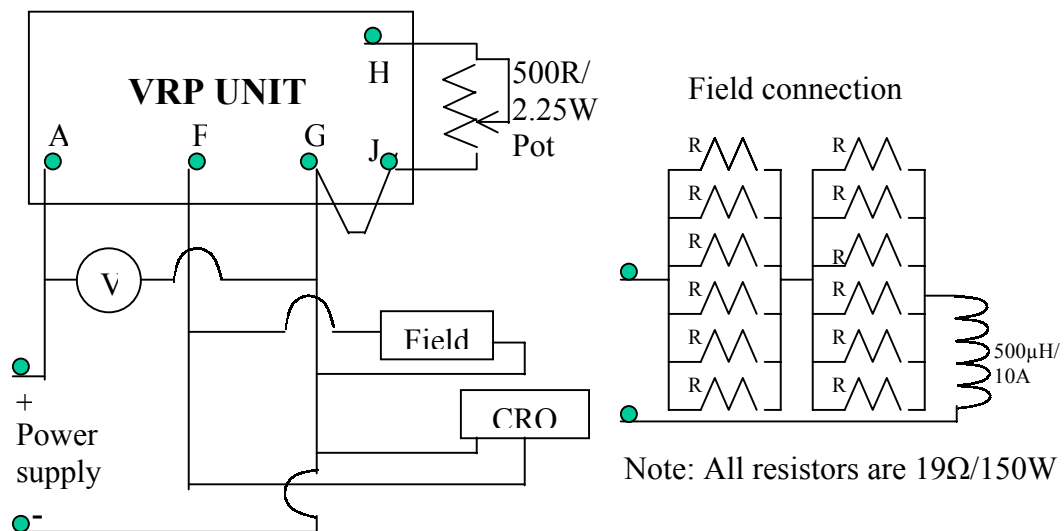


FIG.3 TEST BENCH SET UP FOR VRP

10.2.2 RELAY PICK VOLTAGE

Vary input voltage from zero, observe the voltage in voltmeter, note down the voltage at which voltmeter shows zero value i.e. Relay pick up voltage. It shall be in the range of 28V to 45V.

10.2.3 COMMUTATION VOLTAGE:

Connect voltmeter between terminals ‘A’ & ‘J’ of VRP and observe the reading from CRO. Note down the voltage at which waveform appears i.e. commutation starting point. It shall be in the range of 40V to 50V.

10.2.4 VOLTAGE LIMITS:

Keeping VR8 potentiometer of VRP at maximum position, increase the voltage slowly, the waveform in the CRO cuts off. Slowly decrease the voltage, the waveform reappears. Take the reading at which waveform reappears (i.e. upper voltage limit). It shall be between 76V to 80V.

Keeping VR8 potentiometer of VRP at minimum position, decrease the voltage slowly, the waveform reappears. Take the reading at which waveform reappears (i.e. Lower voltage limit). It shall be in the range of 66V to 70V.

10.2.5 ZENER VOLTAGE & PULSE WIDTH:

Keeping the voltage at 72V see the pulse width of the waveform and the voltage across zener diodes ZD1 (in BN card) & ZD2 (in BX card). The values shall be in the range as shown below:

ZD1	---	24.0 V to 28.5 V
ZD2	---	10.8 V to 13.5V
Pulse width	---	4 to 5 milli sec.

10.2.6 CURRENT LIMIT:

Keep the input voltage at 60V. Connect a 500 ohms potentiometer between 'H' & 'J' terminals of VRP. Connect voltmeter across the potentiometer. Vary the potentiometer and observe the waveform in the CRO, the waveform disappears. Now slowly decrease potentiometer, the waveform re-appears note down the reading (i.e. current limit). It shall be in the range of 560 to 590 mv (186A to 196A).

NOTE: Keep VR8 potentiometer in maximum position for current limit test.

11.0 INSULATION RESISTANCE TEST:

Plug in the two cards in the panel frame. Short all the outgoing terminals of the VRP frame together. Megger the shorted terminals to panel frame with a 500 V megger. The insulation resistance shall be more than 10 Mega Ohm.

12.0 DIELECTRIC TEST (Clause 5.3 of IEC-571-1)

Apply 1KV r.m.s with as near as possible to sine wave form & frequency at 50 Hz. between shorted terminals and the panel frame for 1 minute. The test shall be considered satisfactory if neither a disruptive discharge nor a flash over occurs.

13.0 SURGE TEST (Clause 5.4 of IEC-571-1)

The panel shall be subjected to transient non repetitive surge between the supply points at 1.8 KV for 45µsec duration (using capacitor discharge circuit). The surge voltage shall be applied in both positive and negative direction. The test shall be considered satisfactory if the equipment continues to operate without malfunction or damage both during and following application of the voltage surge. After this, the performance test shall be carried as mentioned in para 10 above.

14.0 COOLING TEST (Clause 5.5 of IEC-571-1)

The panel without any power applied shall be placed in a chamber where the temperature is progressively lowered from the ambient to -10 deg. C over a period of at least half hour. The panel shall be kept in this condition for 2 hours.

After this test, the performance test shall be carried out, keeping the equipment at low temperature.

15.0 **TEMPERATURE RISE TEST (DRY HEAT) (Clause 5.6 of IEC-571-1)**

The panel with power applied shall be placed in a test chamber where the temperature is progressively raised from the ambient to 70 ± 2 deg centigrade over a period of at least half an hour. The unit shall be kept in this condition for 6 hours starting from the time when the temperature inside the chamber is uniform. At the end of this period, performance test shall be carried out as mentioned in para 10 above.

16.0 **TEMPERATURE RISE TEST (DAMP HEAT) (Clause 5.7 of IEC-571-1)**

The panel without power applied shall be placed in a test chamber where the temperature is progressively raised from the ambient to 55 ± 2 deg centigrade over a period of 1.5 to 2.5 hours, the relative humidity being between 95% and 100%. The unit shall be kept in this condition for 10 hours. At the end of this period, the temperature is lowered to the ambient temperature over a period of 3 hours, relative humidity being between 95% and 100%. At the end of this period, performance test shall be carried out as mentioned in para 10 above.

17.0 **CORROSIVE ATMOSPHERE SALT MIST TEST (Clause 5.8 of IEC-571-1)**

The solution for producing the salt mist is prepared by dissolving 50 ± 1 gm Sodium chloride (NaCl) analytical reagent quality, in distilled demineralised water to make (1 ± 0.02) liters of final solution at 20 deg. centigrade; if the PH does not lie between 6.5 & 7.2, the solution should be rejected.

TEST PROCEDURE:

During the test, the temperature in the test chamber shall be maintained at 35 ± 2 Deg. C. The test chamber is kept closed & spraying of the salt solution should continue without interruption during the whole conditioning period of three hours. At the end of the test, the equipment is washed in running tap water for 5 minutes, rinsed in distilled or demineralised water, then shaken by hand to remove droplets of water and stored, under standard atmospheric condition of the testing area for a period not less than one hour nor more than two hours. After this cycle, the performance test shall be carried out as mentioned in para 10 above.

18.0 **COMBINED DUST HUMIDITY & HEAT TEST (Clause 5.9 of IEC-571-1)**

The panel with power applied shall be placed in a test chamber where the temperature is progressively raised from the ambient temperature to 70 ± 2 deg. centigrade in a period of time between 1.5 hr. and 2.5 hr. with a relative humidity of 95% to 100%. Quantity of dust mutually agreed shall then be sprayed over the equipment. At the end of this period, the performance test and dielectric test shall be carried out as mentioned in para 10 above.

19.0 **VIBRATION, SHOCK & BUMP TEST (Clause 5.10 of IEC-571-1)**

19.1 The panel shall be subjected to this test in three orthogonal planes, under ambient temperature condition of the testing area. For this test, the equipment is secured in a suitable position to a machine producing vibrations of sinusoidal form with adjustable amplitude and frequency.

19.2 Determination of resonant frequencies:

In order to determine the possible existence of critical frequencies producing resonance, the frequency shall be varied progressively from 1Hz to 100 Hz within a time of not less than 4 min. The amplitude of the oscillations 'a' expressed in mm shall be given as a function of frequency 'f' by the equations

$$a = 25/f \text{ for values of 'f' between 1 Hz to 10 Hz.}$$

$$a = 250/f^2 \text{ for values of 'f' between 10 Hz to 100 Hz.}$$

If resonance is produced, the corresponding frequency shall be maintained for 4 minutes in each case.

19.3 Test with Sustained Vibrations:

The equipment with power applied shall be subjected to sustained vibrations for a period of a minimum 8 hours in all the three directions at the frequency-

- Either at the critical frequencies, if any such well-defined frequency has been detected
- Otherwise at a frequency of 10 Hz

In both the cases, the amplitude of the vibrating table shall be adjusted to the value corresponding to the frequency concerned.

19.4 Test to simulate the effect of shunting shocks:

The equipment with power applied shall be subjected to a series of three successive shocks at 50 Hz vibrations each corresponding to a maximum acceleration of 3g in all the three direction.

19.5 Results of tests :

The tests are considered to be satisfactory if there is no resulting damage or abnormality in operation. The assembly shall be able to withstand successfully the performance test and dielectric test as mentioned in paras 10 & 12 above.

20.0 **DRAWING DATA AND SAMPLES:**

20.1 The tenderer shall submit 4 copies of drawing giving mechanical, circuit details and connection technical data, internal test results for the offered system.

20.2 The successful tenderer shall submit a prototype sample for inspection/testing and approval by the purchaser before undertaking the bulk manufacturer.

20.3 The supplier shall undertake bulk manufacturing incorporating modification/improvements as may be considered necessary in course of service trials and as directed by purchaser with the frame work of the specification. In case of major change, the unit shall be type tested again.

20.4 The final set of drawings and maintenance/operating manual is to be supplied with each order.

21.0 **GUARANTEE:**

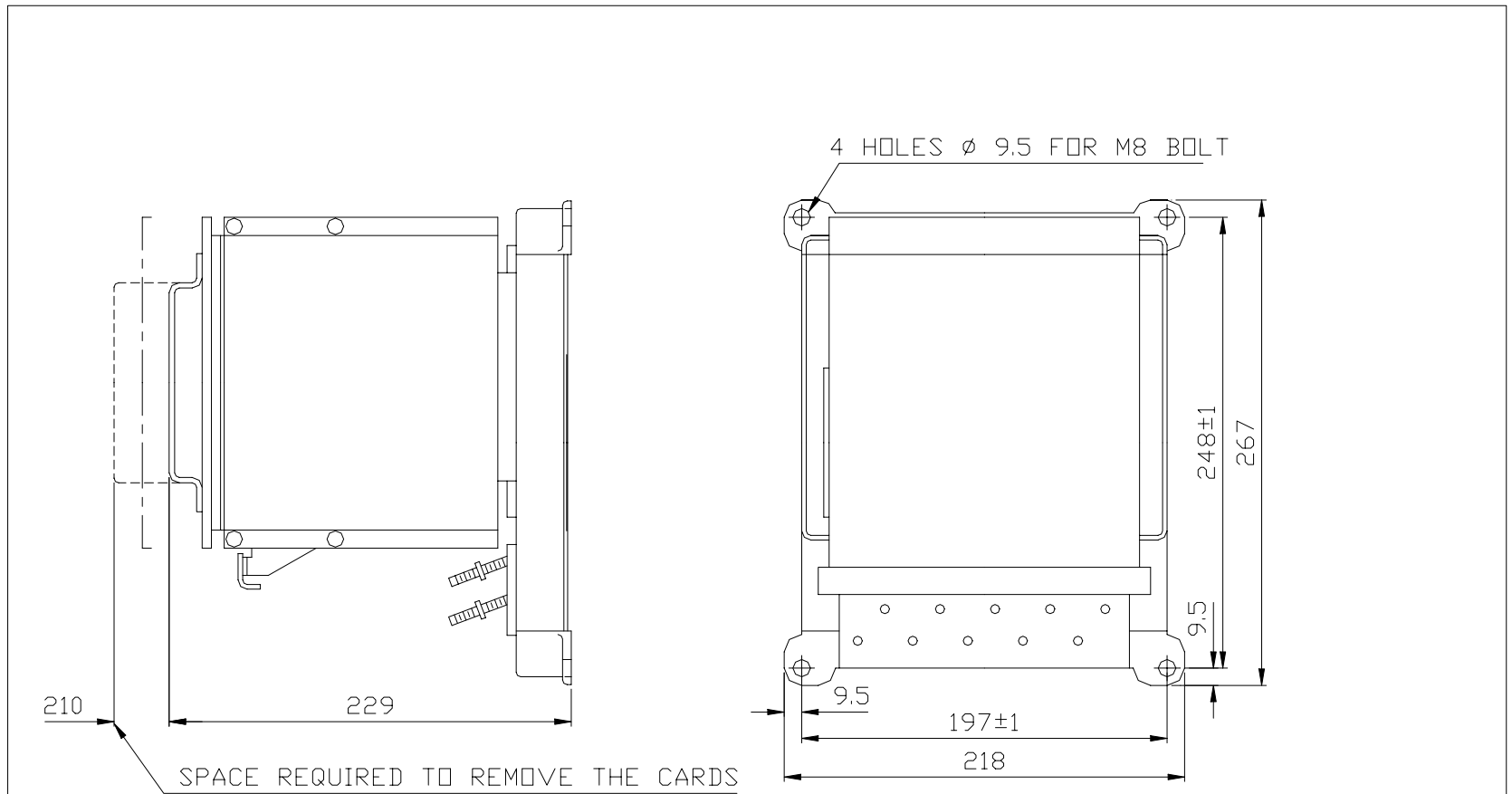
The manufacturer shall give warrantee of 12 months from the date of installation and 18 months from the date of dispatch which ever is earlier for any manufacturing/ design defects.

22.0 **MARKING:**

The manufacturer shall engrave/emboss/imprint/stencil permanent identification marks indicating their names/brand name/monogram and also the month and year of manufacturer at a prominent place.

23.0 **WITHDRAWAL OF APPROVAL:**

The approval granted to the manufacturer is liable to be withdrawn in the event of noticing any change at a later date in the design or change from the bill of material as approved earlier without seeking RDSO's approval or using components of inferior specification/or compromising quality so as to assess reliability.



OUT LINE & MOUNTING ARRGT.
OF
VOLTAGE REGULATOR PANEL

SCALE: N.T.S. REF:

DRG. NO. SKDP-3662

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C	
APPD.	
Dt	03/02

ALT	NO. OF PLACES	REF. NO.	DESCRIPTION	ALT. NOTE NO.	SIGN.	DATE	FIRST ISSUED	SUPERSEDES	SUPERSEDED BY