SPECIFICATION FOR RESISTANCE BOX 500kW MMG

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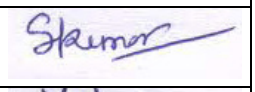
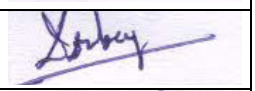
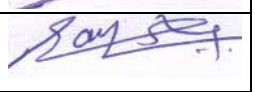
Prepared By:	Santosh Kumar	Design Engineer	
Checked By	Dinesh Dubey	Dy.Manager(D)	
Approved By:	Rajesh Kumar Sharma	DGM(D)	

HISTORY OF REVISIONS

Issue	Description
00	Concept release, original version
01	Modified as per system design requirement
02	SS grade and Vibration shock analysis added.

1. SCOPE

Supplier has to design, develop, manufacture, test & supply the Resistance box as per the requirements called in this specification.
Resistance box to house the following Nickel Chrome (80:20) material resistor grids for 660 V grade:

Starting Resistor (STR) resistance shall be of 0.05Ohm value rated for 800 Amps continuous current. 6000 Amps current shall flow for 10 Second in every 10 minutes.

2. Technical Requirements

2.1	Resistance grids shall be robust, corrosion resistant, unbreakable, suitable for natural air cooled, saline atmosphere & withstanding vibration & shock as per clause 10.7 of this specification.
2.2	The limiting dimensions of enclosure are 600 mm wide x 650 mm deep x 700 mm height for accommodating resistance grid. The enclosure shall be provided with 4 nos. mounting holes at the bottom and 2 nos holes at the top back side size 16 mm.. Refer Drg No.36710030008 for General Arrangement details. Smaller design size of the box shall be accepted, however the size should be reduced only height wise.
2.3	The enclosure of the resistance boxes shall be stainless steel (SS316L Marine grade) welded structure of standard size preferably 50 x 50 x 5 mm. Four numbers lifting holes to be provided at the top four corners for lifting and slinging arrangement.
2.4	The Element length, dia and end support etc. shall be so designed that buckling, sagging etc do not restrict / hamper the performance of resistors over the entire range of operating temperature and load.
2.5	Material for insulators shall be temperature resistant, non-hygroscopic, shock proof ceramic material capable of withstanding 900 ^{0}C continuously and resistance to thermal shock at 300 ^{0}C.
2.6	Ceramic material used for insulators should be free from sulphur to prevent corrosion of resistor grid due to emission of sulphur dioxide at high temperature.
2.7	All materials other than grid element material & ceramic insulators used for assembly of Resistance Box shall be suitable to withstand temperature of at least 850^{0}C continuously.
2.8	Adequate clearance and creepage distance shall be maintained to avoid flash over. The clearance through air shall not be less than 25 mm and creepage distance along the surface shall not be less than 25 mm. The electrical clearance between the live parts & the body shall be minimum 25 mm.
2.9	Bolted terminations shall be with adequate locking.
2.10	Precautions shall be taken to give adequate protection against corrosion for all components.
2.11	Suitable Earthing Terminal shall be provided on the Box as given in Drg No

	36710030008.
2.12	Resistance connection and terminal disposition have been shown in Drg No 36710030008.
2.13	Terminals shall be brought out at lower back side as shown in the drawing for connecting copper cable. The care shall be taken so that the heat generated in the resistances does not affect the resistance materials and also the connecting cables.
2.14	The Inter connections required to be made among the elements to obtain the desired resistor values shall be made using Electrolytic grade copper.
2.15	All the Copper Connections shall be Electro Tin plating.
2.16	The size of Copper busbar used for copper connections shall be minimum 4mm x 20mm.
2.17	The terminal numbers to be punched on the terminals and shall be marked clearly on insulating support bar.
2.18	**Material**: The basic structure is expected to be made of Stainless Steel material.
2.19	The Resistor Box should be suitable for working in saline atmosphere for long time without any corrosion and function deterioration.

3.Welding and Brazing Process

The welding and brazing process is suggested as per the following standard.

Brazing by using silver bearing brazing rods (RUPTAM16)	:	IS 4667
Electric Arc Welding	:	IS 6008
TIG Welding	:	1. IS10186 Cu to Cu 2. IS 2811 Stainless Steel

4. Surface finish

Outer structure shall be mat finish of Stainless steel and no painting is envisaged.

5. Temperature rise

The maximum temperature rise of resistor elements shall not be more than 400 ^{0}C above an ambient of 45 ^{0}C in either continuous operation mode or intermittent mode as defined in SI.No. 1 scope of this specification.

6. Environmental conditions

Ambient Temperature	-10 to 85° C
Humidity	98% , Continuous condensing
Atmosphere	The equipment shall be designed to work in Humid, salt laden and corrosive atmosphere

7. Equipment Availability

The probability that the equipment will be available (i.e., not undergoing corrective maintenance) at any instant during the operational period is to be not less than 99.85%.

8. Equipment Reliability

The probability that the equipment will survive a period of 2500 hours continuous operation without a failure is to be greater than 99%.

9. Quality & Workmanship

The workmanship and quality of the material shall be in accordance with the relevant national/international standards.

10.Testing

Following tests shall be carried out on fully assembled resistance box with resistor elements. The test certificate in duplicate shall be supplied against each test.

S.No	Test Description	Routine test	Type test	Remarks
1	Visual Inspection/Dimensional Check	√	√	
2	IR Value test	√	√	
3	Dielectric test	√	√	
4	Resistance Value Test	√	√	
5	Temperature rise test		√	
6	Hygroscopic test		√	
7	Check on material characteristics	√	√	

10.1 Visual Inspection/Dimensional Check

Units shall be checked as per the approved OGA drawings before and after the temperature rise test.

10.2 Insulation Resistance (IR) Value test

IR value between the resistor elements and the enclosure should not be less than 100M ohm when measured with 1000V meggar.

10.3 Dielectric test

Dielectric test shall be carried out at 3.3 KV AC / 50Hz voltage as per IEC 60332. The test voltage is applied progressively in 10 seconds, maintained at the prescribed value i.e. 3.3KV AC for 60 sec and then decreased progressively to zero. There shall not be any flashover or sparking during the test.

10.4 Resistance Value Test

The measured value of the required resistors shall be within +5%, -0% of the specified value at 25°C . Micro-ohm meter with a valid calibration and of Basic Accuracy >/ = 0.02 % to be used for measurement of resistance values.

10.5 Temperature rise test

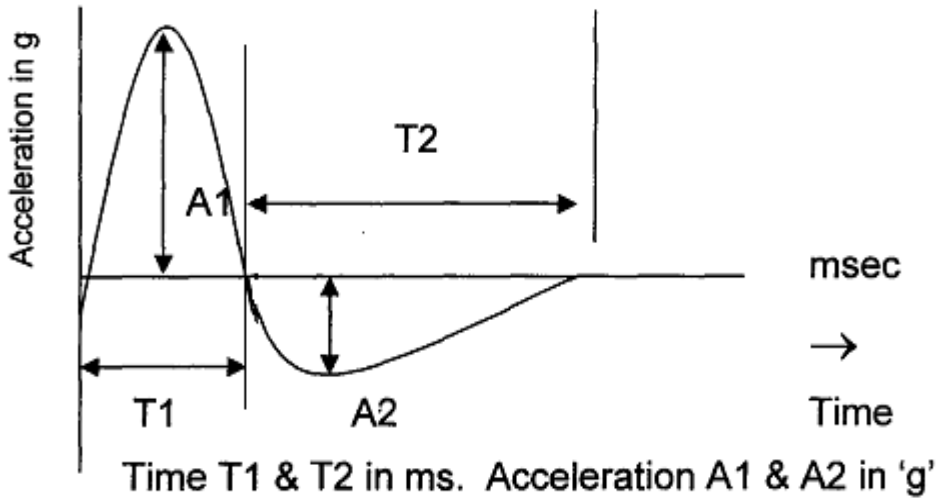
The resistor values shall be measured and recorded at room temperature before the temperature rise test. It should be within +5%, -0% of the specified value.
The required current as specified in the sl no 1 "scope" shall be flown through the element and temperature of the element shall be monitored using thermocouples. The maximum temperature rise allowed for each element at the specified rating shall be ≤ 400 °C.
The above test shall be carried out on each element and results should be tabulated in Table form. The resistors shall be allowed to cool at room temperature and value of each element will also be measured after temperature rise test. It should be within 3 % of the value measured before the test.
Due to limitation of power source temp rise test may be carried out on element with appropriate calculated current and voltage. Test procedure for this will be submitted to BHEL for approval. BHEL may choose to witness this test at vendor's works.

10.6 Hygroscopic test

The resistance box assembly shall be placed in humid enclosure at temperature of 20-25 °C and showing a relative humidity of 98% for 24 hours.
As soon as possible and in any case, less than 5 minutes after removal from the humid enclosure and after wiping off extraneous surface moisture with a clean cloth, a dielectric test shall be carried out at 2.5 KV AC / 50Hz voltage as per IEC 60332. The test voltage is applied progressively in 10 seconds, maintained at the prescribed value i.e. 2.5KV AC for 60 sec and then decreased progressively to zero. There shall not be any flashover or sparking during the test.

10.7 Shock and Vibration Test

Shock. The equipment design shall be suitable for shock value of 51g for 36ms. Vibration details are furnished below. However the shock and vibration tests are not in the scope of the supplier. 3D model and analysis using simulation in ANSYS/ I-DEAS shall be furnished to ascertain the suitability of the design.



Weight in Kgs	Vertical				Longitudinal				Horizontal			
	A1	T1	A2	T2	A1	T1	A2	T2	A1	T1	A2	T2
0-60	180	3	83.5	6.5	220	2.5	59.5	9	280	3	94	9.0
60-140	170	2	36	9.5	245	2.5	54	11.5	300	2	34	17.5
140-200	130	2.5	35	9	280	2.5.	90.5	7.5	280	2	34	16.5

Specification of the requirement of shock analysis of equipment. The guidelines for shock analysis are follows:-

(a) Shock analysis of the equipment is to be carried out to ensure the proper functioning of the equipment under the shock loading. **The shock loads shall be 51g for 36 ms for shock analysis.**

(b) The shock analysis may be performed either by equivalent static load approach or transient dynamic analysis approach. The shock analysis is to be undertaken either in ANSYS or I-DEAS software. For equivalent static load approach, maximum shock amplitude is to be applied as inertia load and the response of the equipment is to be obtained. The stresses and deflections under the shock loading should not exceed the allowable limit. For transient dynamic analysis, the shock pulse indicated is to be applied as ground excitation. Generally, linear analysis is to be carried out if there is no non-linearity involved in the model. However, if the model has got inherent non-linearity, non-linear transient analysis has to be carried out.

(c)Apart from the above analysis, the designer/manufacturer shall carry out the normal mode dynamic analysis of the equipment to estimate the natural frequency of the equipment. The normal mode analysis is to be carried out by Block – Lanczos method.
(d) The shock mount need not be modelled in the analysis as the shock amplitude specified is above the shock mount. Therefore, the fixed points of the equipments (the

shock mount locations) is to be modelled as translational restraint which means that all three translational degrees of freedom will be fixed and all three rational degrees of freedom will be free.

Vibration Levels. Vibration levels in 1/3 Octave band frequency range from 25 Hz to 8 KHz with a reference to 1 x 10^{-5} m/sec^2 when measured above shock absorbers should not exceed the straight line joining the values as specified : -

(a) At 5 Hz : 48 db

(b) At 8 KHz: 80 dB

Vibration Resistance. The equipment should be able to withstand vibration levels as specified below, with equipment rigidly installed (without shock mounts) :-

(a) 01 Hz to 5 Hz – Acceleration of 0.1g

(b) 05 Hz to 50 Hz – Acceleration of 2.0 g

10.8 Check on material characteristics

Test certificate of the original material supplier is to be submitted against this test. The supplier has to test the Element material for the desired compositions or else has to supply test certificate of the supplier for the same supported by relevant copies of original purchase documents.

11. Drawings & Approvals

The complete assembly drawing and 3D model of the Resistance Box shall be submitted to BHEL for approval and only after written approval, manufacturing action shall be taken. Approval of documents from BHEL does not absolve supplier from the responsibility of desired performance of the equipment supplied by them. Since this is the development item, alterations in design are expected due to very stringent testing requirements of system. Those changes are to be incorporated at BHEL Bhopal by the vendor free of cost.

12. Warranty

The supplied equipment shall be guaranteed for the period of 12 months after comissioning at customer place or 18 months after supply whichever is earlier. The supplier shall replace/ repair all failed equipments during warranty at his own expenses. Further if any design modification is required to be made on any part of the equipment for the design in the scope of supplier, the equipment shall be gauranteed for further 18 months. Also ,the modification shall be carried out in all the equipments supplied till that time free of cost and at place wherever equipment is made available within India.