Specification No. RDSO/2008/EL/SPEC/0064(Rev' 3')

सत्यमेव जयते

Government of India
Ministry of Railways

Technical Specification For Zr Cu Punched type Resistance Ring for Resistance Ring Mechanically Interlocked to Endplate Design Rotor for Traction Motor type 6 FRA6068 for WAG9/WAP7 locos.

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Issued by
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SPECIFICATION FOR ZRCU PUNCHED TYPE RESISTANCE RING FOR ROTORS OF THREE PHASE TRACION MOTORS TYPE 6FRA 6068 USED IN WAG9/WAP7 LOCOMOTIVES

1. SCOPE:

This specification covers the requirement of Zr-Cu copper (C15000) Punched type Resistance Ring for modified rotors of the three phase traction motors type 6FRA 6068 used in WAG9/WAP7 Locomotives

2. GOVERNING SPECIFICATIONS:

In the preparation of this specification assistance has been taken from the following standards and specifications.

Table-1

Standard No.	Standard Name
ASTM B747	Specification for copper-zirconium alloys
ASTM E 255-07 (Or latest)	Standard specification for sampling Copper and Copper Alloys for the determination of Chemical Composition.
ASTM E478-08 (Or latest)	Standard test methods for Chemical analysis of copper alloys.
ASTM B 846-19a	Standard terminology for copper and copper alloys.
ASTM B 224-16 (Or latest)	Standard classification of coppers
ASTM B 601-18a (Or latest)	Standard classification for temper designation for copper and copper alloys – wrought and cast.
IS:1885 (pt. xxxiv) : 1993	Electrotechnical Vocabulary :Rotating Machines
IS:440 – 1964	Methods of chemical analysis of copper
IS:2826-1986	Dimensions and Tolerances for Copper and Copper Alloys Rods and Bars
IS 14811:2000	Copper Plate, sheet and strip for industrial purposes
IS:1608:1995	Method of tensile Testing of Cu Alloys
IS:1586:2000	Method for Rockwell Hardness Test for Metallic Materials

2.1. In case of any conflict or disparity between the contents of the above specification and this specification, the latter shall prevail.

2.2. Any deviation from this specification proposed by the tenderer to improve upon the performance of Punched type Resistance Ring made of ZrCu alloy shall be considered only on this merits provided full particulars with justification and financial implication are furnished by the tenderer.

2.3. For the purpose of this specification, the definitions given in IS:1885 (Pt. xxxiv) – 1993 shall apply.

3. ENVIRONMENTAL CONDITIONS:

Rotors are designed to work at a maximum temperature of 230^{0}C and so all the relevant properties shall remain intact over the complete operating range of temperature ,

4. MATERIAL:

The Punched type Resistance Ring shall be made from Zirconium Copper alloys conforming to UNS No - C15000-.The composition of the copper shall be as given in Table-2

5. CHEMICAL COMPOSITION

Chemical composition of ZrCu is given in Table 2 and tenderer must provide test result by spectrogrpahy at the time of prototype inspection for each lot both of finished as well as raw material from which resistance ring is drawn. The test report shall have clear traceability of raw material from which it is manufactured .

Table – 2
CHEMICAL COMPOSITION OF ZIRCONIUM COPPER

Element	In percent/ppm
Cu + Ag	99.80% min
Zr	0.1 –0.2 %
O_2	10PPM(Maximum)

6. PHYSICAL MECHANICAL AND ELECTRICAL PROPERTIES :

Table-3

Properties	Zirconium Copper of C15000
Composition	Cu+Ag 99.80% min and Zr 0.10-.2 %
Electrical Conductivity	93% IACS min at 20^{0}C
Resistivity in Ω-g/m2	0.16481
Tensile Strength in MPa	325-385
Elongation in 50 mm gauge length	11 %minimum
Hardness	90 HRF (Min)
Sp gravity	8.89

7. SOURCE OF RAW MATERIAL:

The tenderer shall use raw material of only reputed source who can supply the raw material strictly as per specification as well as submit documentary proof regarding quality of raw materials . The manufacturer of raw material shall be having experience of manufacturing Zirconium copper alloys and resistance ring/rotor bars/copper laminations manufactured with zirconium chromium copper alloys for induction motor applications.The raw material to be suitably processed to meet the requirement of standard as mentioned in Table 2 & 3. It is obligatory

to attach a copy of the documentary evidence of the same with inspection certificate.
However, introduction of new source of raw material should only be after successful prototype testing as well as successful field trial over specified period.

8. SIZE, SHAPES, DIMENSIONS, WEIGHTS AND OTHER PROPERTIES OF PUNCHED TYPE RESISTANCE RING.

8.1. The dimensions for the Punched type Resistance Ring shall be as per RDSO Drg No. SKEL - 4742 (latest revision) & rotor specifications given below : Resistance Ring Mechanically Interlocked to Endplate Design as per Specification No. RDSO/2007/EL/SPEC/0061(Latest Rev) .

8.2. Machining of punched type resistance rings shall be carried out only on CNC machines only.

8.3. In addition to above, the specification is also applicable to other types of rotors used in three phase traction motors used in Electric Locomotives , as far as material of resistance rings is concerned.

8.4. JOINTS

There shall be no joint in the Punched type Resistance Ring..

8.5. FREEDOM FROM DEFECTS

8.5.1. The Punched type Resistance Ring shall be clean, smooth and free from all surface defects , both surface and internal defects, such as scales, peelings, sharp edges and other visual defects.

8.5.2. To check on this, suitable means shall be employed by the manufacturer by way of radiography/UT etc.

9. QAP

The tenderer shall submit the process of manufacturing in the form of QAP . Forging ratio and tests for grain structure shall be included in QAP.A sample QAP is enclosed as Annexure I which includes quality plan from the stage of raw material procurement , through in process and final tests. Tenderer must submit their QAP along with the tender. After getting the order , QAP shall be duly approved by RDSO/CLW before going for prototype production.

10. TESTS

10.1. After a purchase order is placed for supply of punched type resistance ring, the internal test results for all the tests specified in Causes 9 & 14 shall be furnished by the successful tenderer to the Director General (Electrical)/Research Designs & Standards Organisation, Manak Nagar, Lucknow – 226011/CLW Traction Motor Design Office, within the period stipulated for prototype approval in the order.

10.2. Any change required in the process of manufacture or the prototype as desired by the Director General (Electrical)/Research Designs & Standards Organisation, Manak Nagar, Lucknow-226011 (RDSO)/CLW

Traction Motor Design Office shall be carried out expeditiously by the manufacturer.

11. Type Testing Schedule

11.1. Prior to giving a call to the Director General (Elect) RDSO/CLW Traction Motor Design Office for inspection and testing of the prototype, the manufacturer shall submit a detailed test schedule consisting of flow chart for each of the tests and the number of days required to complete all the tests at one stretch. Once the schedule is approved, the tests shall invariably be done accordingly. However, during the process of type testing or even later, the Director General (Elect)RDSO/CLW Traction Motor design Office reserves the right to conduct any additional tests(s) besides those specified herein on punched type resistance ring so as to test the punched type resistance ring to his satisfaction or for gaining additional information and knowledge. In case any dispute or disagreement arises between the manufacturer and representative of the Director General (Elect)RDSO/CLW Traction Motor design Office during the process of testing as regards the procedure for type tests and/or the interpretation and acceptability of the results of type test, it shall be brought to the notice of the Director General (Elect)RDSO/CLW Traction Motor design Office as the case may be, whose decision shall be final and binding.

11.2. All the tests specified, unless otherwise mentioned elsewhere, in the specification shall be carried out preferably at manufacturer's works . However , these tests can also be carried out at National Test accredited Labs or any other labs as recommended by Railways. The manufacturer shall arrange all the necessary machinery, apparatus, labour and assistance required for conducting the tests without any extra cost.

12. BULK MANUFCTURE

12.1. Only after clear written approval of the results of the tests on the prototype is communicated by the Director General (Elect)RDSO/CLW Traction Motor Design Office, to the manufacturer, shall he take up bulk manufacture of the resistance ring which shall be strictly with the same material and process as adopted for the prototype.

12.2. Any Testing and approval by the purchaser of the design, drawing and prototype shall in no way absolve the supplier of his responsibilities under the terms and conditions of the contract.

13. TECHNICAL DATA

The tenderer shall furnish along with the offer the guaranteed performance data and other technical particulars of the Punched type Resistance Ring. The guaranteed values shall have to be proved by tests.

14. TESTS ON PUNNCHED TYPE RESISTANCE RING

14.1. TYPE TESTS:

In addition to the Test Certificate and Guarantee Certificate (TC/GC) of raw material issued in original by OEM for lot offered, the following type tests shall be carried out on the samples of the Punched type Resistance Ring :

14.1.1 Visual Examination
14.1.2 Measurement of dimensions
14.1.3 Electrical Conductivity
14.1.4 Tensile & yield strength/elongation test
14.1.5 Hardness
14.1.6 Chemical composition
14.1.7 Ultrasonic/eddy current test

14.2 ROUTINE TESTS:

In addition to the Test Certificate and Guarantee Certificate (TC/GC) of raw material issued in original by OEM for lot offered, the following routine tests shall be carried out on the samples of the Punched type Resistance Ring:

14.2.1 Visual Examination
14.2.2 Measurement of dimensions
14.2.3 Electrical Conductivity
14.2.4 Tensile & yield strength/elongation test
14.2.5 Hardness
14.2.6 Ultrasonic/eddy current testing
14.2.7 Chemical composition

The manufacturer shall test one sample from every lot of Punched type Resistance Ring for chemical composition, if forging has been done by another agency on the test piece as per clause-15.

14.3 MANUFACTURER'S TESTS:

14.3.1 The manufacturer shall test all the Punched type Resistance Ring for visual examination and measurement of dimensions. All the Punched type Resistance Ring shall be free from any piping, crow feet, indentations, foreign particles or inclusions, surface defects, twists and entanglements.

14.3.2 The manufacturer shall test every lot of Punched type Resistance Ring for chemical composition and micro-structure examination.

14.3.3 Records of the results of the tests shall be maintained by the manufacturer and checked by the Railway's Inspector.

14.3.4 Manufacturer must carry out ultrasonic test on 10% of the offered quantity with the help of Govt. Approved Lab and record shall be kept.

14.3.5 In addition to the above TC, issued by OEM ,lot-wise and proof import/purchase documents , as the case may be, shall be maintained and checked by Railway's Inspector during acceptance test.

14.3.6 CRITERIA FOR ACCEPTANCE

Criteria for acceptance of the lot shall be in accordance with Table 2 & 3.

15. METHODS OF TESTS

Preparation of Samples for Tensile Strength, yield strength, Elongation ,Rockwell Hardness :-

For above tests , the firm shall prepare integrated or separately forged(forged under same conditions as the finished products)test piece in each lot of resistance rings offered by them. For carrying out test for these tests , samples , as prepared above , shall be selected by Inspecting Official out of two test pieces from the lot of resistance rings (finished products) offered for inspection and seal it for testing in NABL approved labs. In case the firm has in house facility to carry out above tests , the same can be carried out at the firm's premises , to be witnessed by Inspecting Official , after confirmation of validity of calibration certificate of the testing equipments. Even if the firm has in house testing facilities for these tests , the inspector shall seal one test piece for sending to NABL approved labs for verification of the results of these tests. For each lot of the resistance rings offered by the firm , integrated or separately forged(forged under same conditions as the finished products)test piece , shall be tested as above.

15.1. VISUAL EXAMINATION:

The surface of Punched type Resistance Ring shall be fairly smooth, free from inclusions or foreign particles, indentation, surface defects, scales, twists, entanglements etc.

15.2. MEASUREMENT OF DIMENSIONS

Dimension of Punched type Resistance Ring shall be measured with the help of duly calibrated vernier calipers/micrometer and values shall be as per Clause 8 for respective rotor drawings, preferably on three dimensional co-ordinate measuring machine.

15.3. TENSILE & YEILD STRENGTH/ELONGATION TEST:

When tested in accordance with IS:1608:1995, "Method for tensile testing of copper and alloy" for tensile strength ,yield strength and elongation, the material shall have a tensile strength and elongation as per Table 3 .The sampling plan shall be as per clause 15.

15.4. CHEMICAL COMPOSTION

The material shall have the chemical composition as given in Table-2. The The copper shall be determined in accordance with IS:440-2006. For oxygen content, certificate from the manufacturer of copper shall be furnished.

15.5. ULTRASONIC TEST

Ultra sonic test should be carried out from NABL approved laboratory on number of samples as stipulated in the specification mentioned in the PO. In case the supplier of the finished product has in house ultrasonic testing facilities and govt. approved operator of ultrasonic equipment, in that case ultrasonic test can be witnessed by Railway Inspector on 10 % quantity after confirming validity of calibration certificates of the ultrasonic test equipment, test certificate of the operator. The operator shall be valid ASNT/ISNT level II certification. Even, if supplier has in house ultrasonic test facility, one sample should be selected at random for ultrasonic test at NABL approved laboratory.

15.6. HARDNESS TEST

Hardness of sample of punched type resistance rings shall be determined on Rockwell hardness in F scale with 1.587mm ball dia and 60 kg load in accordance with IS:1586:2000 on two samples from lot as per clause 15

15.7. ELECTRICAL CONDUCTIVITY TEST

Conductivity of the Punched type Resistance Ring shall be measured with help of calibrated Conductivity meters. Calculated value of resistivity to be furnished.

Note: The Inspector shall check the accuracy and calibration of the measuring equipment by resistivity/conductivity of known value.

16. SELECTION OF SAMPLE FOR TESTS AND CRITERIA OF APPROVAL

Stipulation made in clause no. 15 shall be followed in totality before acceptance of material. The reports for the tests mentioned in these clauses shall be annexed to inspection certificates. Only NABL approved independent test laboratories shall be utilized for carrying out these tests. The cost of such tests shall be borne by the supplier.

17. PACKING

The finished product shall be suitable packed so as to ensure safe transportation of material without any damage.

18. MARKING OF PUNCHED TYPE RESISTANCE RING

The material shall be labeled securely and indelibly (i.e. with an adhesive label on an appendage) with the following information –

a) Name of the manufacturer, purchase order reference and date.
b) Name and trade mark of raw material supplier
c) Item, size, quantity, batch no., date of manufacture of the material.
d) Special precaution for storage, if applicable for the material.

ANNEXURE I

Manufacturing Quality Plan of Punched type ZrCu Resistance Ring

(A) RAW MATERIAL:										
S N	Material/Process	Characteristics to be checked	Process of Checking	Quantum of Checking	Reference documents/ Recording	Acceptance Norms	Inspection agency			Remarks, if any
							P	W	V	
1.0	Copper Billet	Chemical composition	By Spectrometer/ weight analysis	Per cast	T.C. of vendor	Specification No. RDSO/2008/EL/SPEC/0064(Rev-2)	2	-	1	
		Electrical conductivity	Electrical conductivity measuring equipment	Per cast	T.C. of vendor	Specification No. RDSO/2008/EL/SPEC/0064(Rev-2)	2	-	1	
(B)	IN PROCESS:									
1.0	Forging	Hammer, Press, Dies Lubricants etc.	Suppliers Certificate .	100%	-	Process requirement	2	-	-	Closed die forging
		Heating furnace and its temperature, Die temperature	By thermocouple	100%	T.C. of vendor	Process requirement	2	-	-	
		Atmosphere	By outlet and pressure valve	100%	T.C. of vendor	Process requirement	2	-	-	
		Amount of reduction per stroke.	By vernier scale	100%	T.C. of vendor	Process requirement	2	-	-	
2.0	Ring Rolling	Mandrel characteristics	Suppliers Certificate .	100%	-	Vendor's requirement	2	-	-	
3.0	H/T(Along with test bar)	Temperature	By thermocouple	100%	T.C. of vendor	Process requirement	2	-	-	
4.0	Machining	Dimension	By measuring scale		T.C. of vendor	Vendor's requirement	2	-	1	
		Surface defect	Visual		T.C. of vendor	Vendor's requirement	2	-	1	
5.0	Slot making	Slots dimensions	Vernier scale	100%	T.C of vendor	Drg No.4742 (latest revision)	2	-	1	

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(C) FINAL PRODUCT:

S N	Material/ Process	Characteristics to be checked	Process of Checking	Quantum of Checking	Reference documents/ Recording	Acceptance Norms	Inspection agency			Remarks, if any
							P	W	V	
1.0	Non destructive testing	Surface and Inherent defect.	Eddy current	100%	T.C. of vendor	Vendor's requirement	2	-	1	
2.0	Final Inspection	Verification of complete T.Cs & Identification	By Record checking	100%	T.C. of vendor	Specification No. RDSO/2008/EL/SPEC/0064(Rev-2)	2	-	1	
3.0	Packing	Protection		100%	T.C. of vendor	-	2	-	-	

Legends :

1- Stands for inspecting agency(RDSO/CLW)
2- Stands for manufacturer
P- Perform
W- Witness
V- Verify

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