Specification No. RDSO/2008/EL/SPEC/0063(Rev'~~2~~'3)

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Government of India
Ministry of Railways

Technical Specification for ZrCu Rotor Bars for Traction Motor type 6 FRA6068 for WAG9/WAP7 locos.

Specification No. RDSO/2008/EL/SPEC/0063(Rev'~~2~~'3)

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SPECIFICATION FOR ZIRCONIUM COPPER ROTOR BARS FOR ROTORS OF THREE PHASE TRACION MOTORS TYPE 6FRA 6068 USED IN WAG9/WAP7 LOCOMOTIVES

1. SCOPE:

This specification covers the requirement of Zirconium Copper (C15000) rotor bars 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
Copper development Association Inc.(Annexure-A)	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 zirconium copper rotor bars 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 rotor bars shall be made from Zirconium Copper alloys conforming to UNS no. C15000 – ~~H04~~ THO4 Temper ~~(Hard).~~ 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 spectrograph or any another suitable method at the time of prototype inspection for each lot both of finished as well as raw material from which bar 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	~~0.05~~ 0.1–0.2 %

6. PHYSICAL MECHANICAL AND ELECTRICAL PROPERTIES :

Table-3

Properties	Zirconium Copper of C15000
Temper	~~H04 (Hard)~~ THO4
Composition	Cu+Ag 99.80% min and Zr ~~0.05–~~0.1-0.2 %
Electrical Conductivity	93% IACS min at 20^{0}C
Resistivity in	0.16481 Ω-g/m2 (Maximum)
Tensile Strength in	400 MPa (Minimum)
Yield Strength	380 MPa (Minimum)
Elongation in 50 mm gauge length	11 % minimum
Hardness	90 HRF (minimum)
Sp gravity	8.89

7. SOURCE OF RAW MATERIAL:

The tenderer shall use raw material of ~~M/s Mitsubishi/Japan, M/s, M/s Luvata , Ms Buntmetall ,Austria or any other~~ only reputed source who can supply the raw material strictly as per specification as well as submit documentary proof regarding quality of raw materials , ~~along with quotations for manufacture of resistance ring/rotor bars/copper laminations~~ . The ~~tenderer~~ 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 manufacturer must have supplied zirconium copper/ zirconium chromium copper alloys materials for more than 500 induction motors to more than two countries excluding country of origin~~. 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 ROTOR BARS:

The various size, shapes and dimensions for the rotor bars shall be as per rotor specifications given below:

Scheme I: Shaft Mounted Zirconium Copper Stamping Resistance Ring Design as per RDSO/2007/EL/SPEC/0060((Latest Rev)
Scheme 2: Resistance Ring Mechanically Interlocked to Endplate Design as per Specification No. RDSO/2007/EL/SPEC/0061(Latest Rev)

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 rotor bars is concerned.
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8.1. JOINTS

There shall be no joint in the rotor bar.

8.2. FREEDOM FROM DEFECTS

8.2.1. The rotor bars shall be clean, smooth and free from all surface defects, such as scales, peelings, sharp edges and other defects .There shall be no die marks

8.2.2. To check on this, suitable means shall be employed by the manufacturer by way of provision of a mirror or other suitable means and monitor the drawing out of the rotor bars.

8.2.3. The tenderer shall submit the process of drawing in the form of QAP.

9. QAP

The tenderer shall submit the process of manufacturing in the form of 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 rotor bars, the internal test results for all the tests specified in Causes 9 & 14 shall be furnished by the successful tenderer to the Director General (Elect)/Research Designs & Standards Organisation, Manak Nagar, Lucknow – 226011, within the period stipulated for prototype approval in the order.

10.1. Any change required in the process of manufacture or the prototype as desired by the Director General (Elect)/Research Designs & Standards Organisation, Manak Nagar, Lucknow-226011 (RDSO) 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 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, reserves the right to conduct any additional tests(s) besides those specified herein on rotor bars so as to test the rotor bars 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, 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, 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, to the manufacturer, shall he take up bulk manufacture of the rotor bars 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 rotor bars. The guaranteed values shall have to be proved by tests.

14. TESTS ON ROTOR BARS

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 ZrCu rotor bars

14.1.1.1. Visual Examination
14.1.1.2. Measurement of dimensions
14.1.1.3. Electrical Conductivity
14.1.1.4. Tensile & yield strength/elongation test
14.1.1.5. Hardness
14.1.1.6. Chemical composition
14.1.1.7. Ultrasonic/eddy current testing

14.2. ~~ACCEPTANCE 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 acceptance tests shall be carried out on the samples of the ZrCu rotor bars~~

14.2.1.1. ~~Visual Examination~~
14.2.1.2. ~~Measurement of dimensions~~
14.2.1.3. ~~Electrical Conductivity~~
14.2.1.4. ~~Tensile & yield strength/elongation test~~
14.2.1.5. ~~Hardness~~
14.2.1.6. ~~Chemical composition~~
14.2.1.7. ~~Ultrasonic/eddy current testing~~

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 ZrCu rotor bars

14.2.1.1 Visual Examination
14.2.1.2 Measurement of dimensions
14.2.1.3 Electrical Conductivity
14.2.1.4 Tensile & yield strength/elongation test
14.2.1.5 Hardness
14.2.1.6 Ultrasonic/eddy current testing
14.2.1.7 Chemical composition

The manufacturer shall test every lot of rotor bars for chemical composition, if extrusion has been done by another agency. The results shall be checked by the Inspector.

14.3 MANUFACTURER'S TESTS:

14.3.1 The manufacturer shall test all the rotor bars for visual examination and measurement of dimensions. All the rotor bars 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 rotor bars for tensile/elongation .

14.3.3 The manufacturer shall test every lot of rotor bars for chemical composition of finish material

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

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

14.4 CRITERIA FOR ACCEPTANCE

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

15 METHODS OF TESTS

15.1 VISUAL EXAMINATION:

The surface of rotor bar shall be fairly smooth, free from inclusions or foreign particles, indentation, surface defects, scales, twists, entanglements etc. The rotor bars shall have no twists ,kinks or any mark of die.

15.2 MEASUREMENT OF DIMENSIONS

Dimension of rotor bars shall be measured with the help of duly calibrated vernier calipers & micrometers and values shall be as per Clause 8 for respective drawings

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 and elongation, the material shall have a tensile strength of 400 MPa (min) , Yield Strength of 380 MPa(Min) and a minimum of 11 % elongation on a gauge length of 50 mm.

15.4 CHEMICAL COMPOSTION

The material shall have the chemical composition as given in Table-2. The copper shall be determined in accordance with IS: 440-2006. For oxygen content, certificate from the manufacturer of copper shall be furnished. At least one sample from finished material from each lot/ batch of extrusion shall be tested for chemical analysis.

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. If not specified in PO, the sample size shall be 10% of the quantity of a batch.

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 after confirming validity of calibration certificates of the ultrasonic test equipment, test certificate of the operator. The operator shall be valid 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 rotor bars shall be determined on Rockwell hardness in F scale with 1.587mm ball dia and 60 kg load in accordance with IS:1586:2000

15.7 ELECTRICAL CONDUCTIVITY TEST

Conductivity of the bar shall be measured with help of calibrated Conductivity meters. Calculated value of resistivity is 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 Table 6 of clause no.12 of IS: 613: 2000 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 Govt. approved independent NABL approved test laboratories shall be utilised for carrying out these tests. The cost of such tests shall be borne by the supplier.

17 PACKING

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

18 MARKING OF ROTOR BAR

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 rolling agency
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 Zirconium Copper Rotor Bar

(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 strip~~	~~Dimension~~	~~By meter scale/tape/Vernier/micrometer~~	~~Per strip~~	~~T.C. of vendor~~	~~Specification No. RDSO/2008/EL/SPEC/0063(Rev-2)~~	~~2~~	~~-~~	~~1~~	
		~~Chemical composition~~	~~By Spectrometer/ weight analysis~~	~~Per cast~~	~~T.C. of vendor~~	~~Specification No. RDSO/2008/EL/SPEC/0063(Rev-2)~~	~~2~~	~~-~~	~~1~~	
		~~Temper condition~~	~~By Hardness measurement~~	~~Per cast~~	~~T.C. of vendor~~	~~Specification No. RDSO/2008/EL/SPEC/0063(Rev-2)~~	~~2~~	~~-~~	~~1~~	
		~~Mechanical testing~~	~~By making test pieces as per IS:1608~~	~~Per cast~~	~~T.C. of vendor~~	~~Specification No. RDSO/2008/EL/SPEC/0063(Rev-2)~~	~~2~~	~~-~~	~~1~~	
		~~Chemical composition~~	~~Spectrometer/ weight analysis~~	~~Per cast~~	~~T.C. of vendor~~	~~Specification No. RDSO/2008/EL/SPEC/0063(Rev-2)~~	~~2~~	~~-~~	~~1~~	
		~~Electrical conductivity~~	~~Electrical conductivity measuring equipment~~	~~Per cast~~	~~T.C. of vendor~~	~~Specification No. RDSO/2008/EL/SPEC/0063(Rev-2)~~	~~2~~	~~-~~	~~1~~	

(B) IN PROCESS:

1.0	Rolling	Roller characteristics	Visual	100%	-	Vendor's requirement	2	-	-	
		Temperature of rolling	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 pass	By vernier scale	100%	T.C. of vendor	Process requirement	2	-	-	

		No. of passes	By counting	100%	T.C. of vendor	Process requirement	2	-	-	
2.0	Drawing	Die characteristics	Visual	100%	-	Vendor's requirement	2	-	-	
		Lubricants		100%	T.C. of vendor	Process requirement	2	-	-	
		Pulling force	By force measuring scale	100%	T.C. of vendor	Process requirement	2	-	-	
		Reduction	By vernier scale	100%	T.C. of vendor	Process requirement	2	-	-	
3.0	Pickling	Strength of H2SO4.	By analysis	100%	T.C. of vendor	Process requirement	2	-	-	
		Time of Pickling	By stop watch	100%	T.C. of vendor	Process requirement	2	-	-	
		Straightness	By Gauge	100%	T.C. of vendor	Process requirement	2	-	-	
4.0	Testing	Mechanical properties	By making test pieces as per IS:1608	Per Cast	T.C. of vendor	Specification No. RDSO/2008/EL/SPEC/0063(Rev-~~2~~ 3)	2	-	1	
		Internal defects	Ultrasonic testing and Liquid penetrant test	100%	T.C. of vendor	Specification No. RDSO/2008/EL/SPEC/0063(Rev-~~2~~ 3)	2	-	1	
		Electrical properties	Electrical conductivity measuring equipment	100%	T.C. of vendor	Specification No. RDSO/2008/EL/SPEC/0063(Rev-~~2~~ 3)	2	-	1	

(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	
5.0	Machining	Dimension	By Micro meter & Vernier	20%	T.C. of vendor	Specification No. RDSO/2008/EL/S	2	-	1	

						PEC/0063(Rev-~~2~~ 3)				
		Surface defect	Visual	100%	T.C. of vendor	Specification No. RDSO/2008/EL/SPEC/0063(Rev-~~2~~ 3~~)~~	2	-	1	
6.0	Final Inspection	Verification of complete T.Cs & Identification	By Record checking	100%	T.C. of vendor	Specification No. RDSO/2008/EL/SPEC/0063(Rev-~~2~~ 3)	2	-	1	
7.0	Packing	Protection		100%	T.C. of vendor	-	2	-	-	

Legends:

1- Stands for RDSO/CLW
2- Stands for manufacturer
P- Perform
W- Witness
V- Verify