



the specifications.  
Kindly note that CDA is only a reference book for academic purpose and it indicates typical values only. Its not reference manual for manufacture.  
It may please be noted that CDA indicates the corresponding ASTM standard reference and also the application of the material. In case of C15100, CDA refers ASTM B 747, while there are no standards indicated in case of C15000. Manufacturing is done as per national and International standards. Mitsubishi follows JIS and ASTM standards. Hence reference to ASTM B 747 (or JIS) may please be retained.  
It may please be note that LUVATA had informed RDSO in Nov 2018 that they cant meet even ASTM B 747 requirement and in order to meet the Conductivity of 90%, they had committed lower tensile Strength to 330 MPa (or Alternately Conductivity of 86% and tensile Strength of 400 MPa).  
Temper : There are two different heat treatments that can alter the strength/ properties of a material-solution heat treating (TDO4) and precipitation heat treatment (THO4).  
  
THO4: In this process –percipitation heat treatment – involves the addition of impurity particles to increase a materials strength- and the material is solution heat treated and quenched and the process is known as Precipitation Hardening and its resorted to increase the Yield strength of the material and further cold worked to increase the Hardness (Tensile strength ). In this process there is no increase in the conductivity of the material.  
This temper is not recommended for rotor bar application and this precipitation hardening has no specified requirement of conductivity. This and higher grade temper are used for resistance welding application and hence NO conductivity requirement is mentioned in CDA 15000.  
  
TD04: Solid solution heat treatment (annealing) involves formation of a single phase solid solution via quenching and resorted to increase the conductivity of the material without affecting the hardness of the material and further cold drawn to increase the hardness.  
However TDO4(Solution treated and cold worked to HARD) Temper can be used in Electrical Application as solution treatment increases the conductivity and cold working improves the hardness (and tensile) . Conductivity specified is 90% and has lower tensile than THO4.  
As per ASTM B 601 Table x 1.1 (Page 5) TD is denoted by H (Hard).

	<p>Equivalent to TD04 Temper is HO4 of ASTM (copy enclosed) and you may specify ASTM B 747 HO4 Temper with minimum conductivity of 93%.</p> <p>It may please be noted that CDA indicates the value of conductivity of 95% under Annealed condition for C 15100 alloy and corresponding ASTM Standard as ASTM B 747.</p>								
<b>RDSO's Remarks</b>	<p>It is learnt that for THO4 and TDO4 tempers conductivity shall not be 93%. Thus in the specification no change is envisaged with respect to temper for maintaining 93% conductivity.HO4 is being kept in the specification for maintaining high conductivity.</p>								
<b>SNo.3</b>									
<b>Clause No 5 of RDSO specification</b>	<p>Chemical composition of Zr-Cu is given in Table-2 and tenderer must provide test result by spectrograph or any other suitable method at the time of prototype inspection for each lot of finished as well as raw material from which bar is drawn. The test report shall have clear tractability of raw material from which it is manufactured.</p> <p style="text-align: center;">Table-2</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Element</th> <th>In Percent/PPM</th> </tr> </thead> <tbody> <tr> <td>Cu+Ag</td> <td>99.80%</td> </tr> <tr> <td>Zr</td> <td>0.05 0.1-0.2%</td> </tr> <tr> <td>O2</td> <td>10PPMMax)</td> </tr> </tbody> </table>	Element	In Percent/PPM	Cu+Ag	99.80%	Zr	0.05 0.1-0.2%	O2	10PPMMax)
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<b>M/s Selvoc Eng Company Private Limited.</b>	<p>In Rev 3 you have changed Zr Content (from 0.05%-0.2% to 0.1%-0.2% ). Mitsubishi always follow this range (0.1%-0.2%). You have also changed the temper of material, which is also appreciated.</p>								
<b>M/s Radhika Industries comments</b>	<p>Chemical Composition: The oxygen content in the material needs to be reported in the test certificate of raw material procedure. It should be less than 10PPM.It is important since less oxygen in material signifies the purity of the melting process. This in turn ensures that the quality of the finished product is superior. Also it is to be noted that presence of oxygen leads to Hydrogen Embrittlement at the time of brazing, leading to cracks. It is suggested that the oxygen content may be made mandatory to report by raw material producer, it may not however, be necessary to be checked at time of inspection.</p>								
<b>M/s India Metal alloys</b>	<p>Chemical composition as per your table-2 is OK. But again, in some cases we have seen while testing from M/s CLW lab that their finding is below than 0.1% against the RM mill TC of 1.3% from Mitsubishi/Japan. We don't know whether CLW/lab has proper CRM for Zirconium copper . Recently they are in process to get the NABL approval the same and may get this within Dec-20. If so alternate testing by NABL lab should be allowed in case of</p>								

	discrepancy.
<b>RDSO's Remarks</b>	As per Mill TC of M/s Mitsubishi max 10 PPM of oxygen is specified, as its the limit specified by M/s MITSUBISHI.
<b>SNo.4</b>	
<b>Clause No.7 of RDSO specification</b>	<p>The tenderer shall use raw material of M/s Mitsubishi/Japan, M/s Luvata, M/s Buntmetall, Austria <del>or any other</del> only reputed source who can supply the raw material strictly as per specification as well as submit documentary proof regarding quality of raw materials, <del>along with quotations for manufacture of resistance ring/rotor bars/copper laminations.</del> The tenderer manufacturer of raw material shall be having experience of manufacturing Zr-Cu alloys and resistance ring/rotor bars/copper laminations manufactured with Zr-Cr-Cu alloys for induction motor applications. <del>The raw material manufacturer must have supplied Zr Cu/Zr Cr Cu alloys materials for more than 500 induction motors to more than two countries excluding country of origin.</del> The raw material to be suitably processed to meet the requirement of standard as mentioned in Table 2&amp; 3. It is obligatory to attach a copy of the documentary evidence of the same with inspection certificate.</p> <p>However introduction of new source of raw material should only be after successful prototype testing as well as successful prototype testing as well as successful field trial over specified period.</p>
<b>M/s Selvoc Engg company Pvt Ltd comments.</b>	We have seen your draft specification (Rev 3) previously there were limited sources to import. Now there is no restriction to import raw materials. From very beginning , each and every time we have imported raw materials from M/s Mitsubishi, Japan. From their raw materials we have manufactured Rotor Bar and have not faced any problem so far. So we are not sure whether other companies raw materials satisfy us or not. Generally Mitsubishi furnished oxygen content in their test certificate and the oxygen content is only 2 to 3 PPM, but we do not know other company can do it or not.
<b>M/s India Metal Alloys Co.Ltd Comments</b>	Refer Point 7, deletion of the name of M/s Mitsubishi /Japan is surprising for us. As its raw materials are not only the best but already proven and consistent since the supply of our last 12 years. We would like to share our experience during the early days of our development of above item. We had tried almost all RM from different manufacturers but not found as consistent as RM from M/s Mitsubishi/Japan as they are the only manufacturer who maintain oxygen content less than 5 PPM. (Mill TC attached for your kind evaluation).

	<p>Deletion of the name of M/s Buntmetall/Austria and M/s Luvata is okay. Though they are manufacturing Zr-Cu materials as per C15000 but again their consistency of RM is not so proven. In some cases, they have agreed that their RM does not confirm to Railway specification which is different than C15000 in many ways. Also they do not mention the oxygen contents in their Mill TC.</p> <p>In view of above, we are of opinion that the name of M/s Mitsubishi/Japan as source of raw material must be allowed and mentioned in the specification, till the others RM is not came in existence after successfully trial and up to your entire satisfaction.</p>
<p><b>M/s Applied Engg Services comments.</b></p>	<p>It has been notice that in CLause.7 Source of Raw Material: Name of Mitsubishi has been deleted. In this regard we wish to submit as under:</p> <p>Mitsubishi Shindoh Ltd (Presently known as Mitsubishi Materials ) is the first company to produce the Zr-Cu rotor bars to IR for traction motor application. No manufacturer of any repute was interested and shown the interest to develop these products. As you are aware , Mitsubishi were also reluctant to develop this in 2008 due to initial specified properties and also due to low and uneconomical volume. At your persistence and assurance that volume will increase after successful development and trials and performance over a period of 5 years, Mitsubishi agreed to develop the same.</p> <p>To start with Mitsubishi agreed to develop this with condition that they will meet the requiremen5ts as per ASTM B 747 (Tensile : 365 to 425 Mpa and conductivity: 90% min under H04 Temper ). After the initials trial Mitsubishi visited RDSO on 9<sup>th</sup> March 2009 and during the meeting for further technical discussion and Mitsubishi were asked to improve both conductivity and Tensile. Mitsubishi informed that technically its impossible to improve both properties under the give temper as conductivity is inversely proportional to tensile (and temper grade ). It was informed to Mitsubishi that Conductivity is of paramount importance and were asked to priorities this.</p> <p>Subsequently as suggested by then Director Mr.Ganesh, Mitsubishi tried and succeeded to improve the Conductivity to min 93% on regular basis under Temper HO4 with tensile of 365 to 430 MPa. We supplied prototype samples, manufactured by Mitsubishi in July 2009( Copy</p>

	of prototype test results enclosed) and were approved.
<b>RDSO's Remarks</b>	<p>Name of firms are being deleted based on instructions from vigilance Directorate. Which are provided below:-</p> <p>(i) SDG/VD RDSO vide note No.Spl.DG/VD/Mom dated 31.08.2020, clause 2 (vi) specifies “ All the provisions/conditions/clauses restricting wider vendor participation, any restrictions to indigeneous vendors , coming in the way of preference to make in India policy and to other extant policies of the government of Indian should be removed/Modified.</p> <p>(ii) Vigilance Directorate vide Its note No.CVO/RDSO/Confdl/2020 dated 23.06.2020 at clause 2(b) states following “ Very restrictive narrow eligibility criteria by specifying experience of same item has been stipulated in some of the STRs.Eligibility criteria to be broad based.</p> <p>In view of above and to make the specification vendor neutral. Names of likely suppliers of raw material have been delete from the spec.</p>
<b>SNo.5</b>	
<b>Clause No.8.2.1 of RDSO specification</b>	<p>FREEDOM FROM DEFECTS</p> <p>The rotor bars shall be clean , smooth and free from all surface defects, such as scales , peeling , sharp edges and other defects . there shall be no die marks.</p>
<b>M/s Radhika Industries comments</b>	We request you to clarify “ other defects” since this leads to ambiguity at time of inspection . Also the defect in clause 14.3.1 need to be same in as mentioned in this clause.
<b>RDSO's Remarks</b>	It is proposed to change the term “ other defects” as “other visual defects “.
<b>SNo.6</b>	
<b>Clause No.14.2.1.7 of RDSO specification</b>	Chemical Composition
<b>M/s Applied Engg Services comments.</b>	<p>Chemical Composition under routine test:</p> <p>In Chemical Composition testing , copper content is determined by reducing the Alloy element (in this case Zirconium) and all other impurities .Since Zirconium cant be determined , it will not be possible to determine the copper Content.</p> <p>1. There is no protocol specified in ASTM B 478 nor in JIS nor in any international standards for testing the zirconium content in copper alloy and hence and there are no NABL accredited laboratories available to test the</p>

	<p>same.</p> <p>2. Certified reference material for determine the Zirconium content by Spectrometer is not Available.</p> <p>3. As per minutes of meeting at RDSO held on 17.07.2019, CLW also does not have any certified reference material to determine Zirconium content.</p> <p>4. As per clause 14.2.2 of ASTM B 747 specifies that manufacturers (OEM) test report to be accepted for chemical analysis as when samples are taken during the course of manufacture, sampling of the finished product by the manufacturer is not required. And hence is OEM test report is accepted (RDSO letter No.EL/3.2,182 dated 14.05.2013). This letter was issued to resolve the issue of one sample tested at 3 different places had 3 different readings not matching with OEM report.</p> <p>In view of this OEM test report for chemical composition may be accepted.</p>
<b>RDSO's Remarks</b>	CLW carry out this test as per their protocol. In reference to RDSO's Specification No.RDSO/2008/EL/SPEC/0062, Rev 23.CLW vide their letter No.CLW/TM/9160 dated 10.09.2020 has confirmed about the testing of Zr-Cu content in copper alloy. Thus Chemical composition test for Zirconium has been retained in the specification in reference with the availability of the testing facility at CLW.
<b>SNo.7</b>	
<b>Clause No.15.4 of RDSO specification</b>	<p>CHEMICAL COMPOSITION</p> <p>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.</p>
<b>M/s Radhika Industries comments</b>	The quality of material is very much dependent on the oxygen content in material as it signifies how clean and melting process is , while casting, presence of oxygen leads to hydrogen embrittlement at time of brazing, thereby leading to cracks. Therefore oxygen content must be reported by the supplier of raw material in their test certificate and must be less than 10 PPM. The same must be mentioned in the table-3 of clause 6 as well. It may be only for purpose of reporting in the raw material test certificate of raw material supplier.
<b>M/s Applied Engg Services comments.</b>	Rotor bars are brazed to end rings/stamping rings and hence this brazing requirement necessitates that rotor bars shall be oxygen free and therefore oxygen content not more than 5PPM to be specified to avoid Hydrogen

	Embrittlement. It may please be noted that as per Cl.3.1 : Chemical composition of CLW Specs: 4TMS.096.060: Spec for Rotor bar of oxygen free copper oxygen content: 5PPM max (copy enclosed).
<b>RDSO's Remarks</b>	As per Mill TC of M/s MITSUBISHI for this material, maximum limit for oxygen content is specified as 10PPM.Thus maximum oxygen content has been accepted as 10PPM.
<b>SNo.8</b>	
<b>Clause No.15.5 of RDSO specification</b>	ULTRASONIC TEST Ultra sonic test should be carried out from NABL approved laboratory on number of samples as stipulated in the specification mentioned in P.O. If not specified in P.O sample size shall be 10% of 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 certificated 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.
<b>M/s Radhika Industries comments</b>	Please add ASNT level II certified operator, after govt approved operator in this clause. It does not come out clearly that ASTN level II operator is also acceptable.
<b>RDSO's Remarks</b>	Level II certified operator ASNT and ISNT is specified in the specification.
<b>SNo.9</b>	
<b>Clause No.16 of RDSO specification</b>	SELECTION OF SAMPLE 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 reporters of the test mentioned in these clauses shall be annexed to inspection certificates. Only Govt approved independent NABL approved test laboratories shall be utilized for carrying out these tests. The cost of such tests shall be borne by the supplier.
<b>M/s Radhika Industries comments</b>	As per IS: 613 the lot is defined as what is offered for inspection , the same should be clearly mentioned in the selection of samples, clause 16, so there is no ambiguity while drawing the samples for testing of electrical and mechanical properties.
<b>RDSO's Remarks</b>	LOT quantity shall be guided by relevant IS, Hence no change is proposed in the specification.
<b>SNo.10</b>	
<b>Annexure I</b>	Manufacturing Quality plan of Zirconium Copper Rotor bar
<b>M/s Radhika Industries</b>	(A) RAW MATERIAL The testing of raw material in form of Strip or billet

<b>comments</b>	needs to be maintained in Quality plan. It is crucial since that is what ensures testing at first point of entry of the raw material in the manufacturers factory. So in this (A) raw material section. Dimension and chemical composition need to be retained, rest points are properties that will be measured in finished product.
<b>M/s India Metal Alloys Co.Ltd Comments</b>	You have deleted the raw material as part from Annexure-I of QAP, while we suggest that Mill TC from approved RM source must be available with oxygen contents as this should be basic requirements before the manufacturing of finished products for better quality.
<b>M/s Applied Engg Services comments</b>	<p>ANNUXERE (A)</p> <p>Manufacturing quality plan, raw material (input) (copper strip is deleted. However extruded copper flat/BAR/ROD may please be specified as Raw material since strip is defined as flat product of thickness not exceeding the thickness of 5.0mm, (ASTM B 846 Page 15) which cant be used as intermediary shape of product to manufacture 7.5mm thick rotor bars. Copper Flats /bars/rods may be confirm process are not permitted (Please refer Siemens Specs Cl.7 on page 9).</p> <p>Further billet may also be specified as raw material input to process the rotor bars, provided that the container capacity of the extruder is 50% more than the size of the input billet. Forging process either before extrusion for sizing the billet or after extrusion to increase the yield strength is Not permitted.(Pease refer Cl3.3.1 of GE Spec No. operation of cold working cold forging is permitted after Forging and heat treatment).</p>
<b>RDSO's remarks</b>	In manufacturing quality plan strip has been omitted. Against the material extruded copper flat/bar/rod is being specified. Billets too is being specified as raw material.