



Designation: B 747 – 9602

## Standard Specification for Copper-Zirconium Alloy Sheet and Strip <sup>1</sup>

This standard is issued under the fixed designation B 747; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope\*

- 1.1 This specification establishes the requirements for sheet and strip of Copper Alloy UNS C15100.
- 1.2 Values stated in inch-pound units are the standard. SI values given in parentheses are for information only.

### 2. Referenced Documents

- 2.1 *ASTM Standards:*  
B 193 Test Method for Resistivity of Electrical Conductor Materials<sup>2</sup>

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<sup>1</sup> This specification is under the jurisdiction of ASTM Committee B-5 B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.01 on Plate, Sheet, and Strip.

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\*A Summary of Changes section appears at the end of this standard.

- B 248 Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar<sup>3</sup>  
B 601 Practice for Temper Designations for Copper and Copper Alloys—Wrought and Cast<sup>3</sup>  
B 846 Terminology for Copper and Copper Alloys<sup>3</sup>  
~~E 8 Test Methods 3 Guide for Tension Testing Preparation of Metallic Materials Metallographic Specimens<sup>4</sup>~~  
E 8 Test Methods for Tension Testing of Metallic Materials<sup>4</sup>  
E 53 Test Methods for Chemical Analysis of Copper<sup>5</sup>  
E 62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods)<sup>5</sup>  
E 112 Test Methods for Determining Average Grain Size<sup>4</sup>  
E 255 Practice for Sampling of Copper and Copper Alloys for Determination of Chemical Composition<sup>5</sup>  
E 478 Test Methods for Chemical Analysis of Copper Alloys<sup>5</sup>  
E 527 Practice for Numbering Metals and Alloys (UNS)<sup>6</sup>

### 3. **Ordering Information**

- ~~3.1 Orders for product under this specification should include the General Requirements~~  
~~3.1 The following information:~~  
~~3.1.1 ASTM designation number and year sections of issue,~~  
~~3.1.2 Quantity (of each size),~~  
~~3.1.3 Copper Alloy UNS No. (see 1.1),~~  
~~3.1.4 Form Specification B 248 constitute a part of material (sheet or strip),~~  
~~3.1.5 Temper (see 6.1),~~  
~~3.1.6 Dimensions (thickness, width, length, if applicable),~~  
~~3.1.7 How furnished (rolls, specific lengths with or without ends, stock lengths with or without ends),~~  
~~3.1.8 Type this specification:~~  
~~3.1.1 Terminology,~~  
~~3.1.2 Workmanship, Finish, and Appearance,~~  
~~3.1.3 Sampling,~~  
~~3.1.4 Number of edge, if required (slit, sheared, sawed, square corners, rounded corners, rounded edges, or full-rounded edges, see 10.1.6),~~  
~~3.1.9 Type Tests and Retests,~~  
~~3.1.5 Specimen Preparation,~~  
~~3.1.6 Significance of width Numerical Limits,~~  
~~3.1.7 Inspection,~~  
~~3.1.8 Rejection and straightness tolerances, if required (slit metal tolerances, square sheared metal tolerances, sawed metal tolerances, straightened or edge-rolled metal tolerances, see Section 10), and~~  
~~3.2 When product is purchased for agencies of the U.S. Government. Rehearing,~~  
~~3.1.9 Certification,~~  
~~3.1.10 Test Reports,~~  
~~3.1.11 Packaging and Package Marking, and~~  
~~3.1.12 Supplementary Requirements.~~

### 4. **Terminology**

- 4.1 For definition of terms related to copper and copper alloys, refer to Terminology B 846.

### 5. **Ordering Information**

- 5.1 Orders for product under this specification should include the following information:  
5.1.1 ASTM designation number and year of issue,  
5.1.2 Quantity (of each size),  
5.1.3 Copper Alloy UNS No. (see 1.1),  
5.1.4 Form of material (sheet or strip),  
5.1.5 Temper (see 8.1),  
5.1.6 Dimensions (thickness, width, length, if applicable),  
5.1.7 How furnished (rolls, specific lengths with or without ends, stock lengths with or without ends),  
5.1.8 Type of edge, if required (slit, sheared, sawed, square corners, rounded corners, rounded edges, or full-rounded edges),

<sup>2</sup> Annual Book of ASTM Standards, Vol 02.03.

<sup>3</sup> Annual Book of ASTM Standards, Vol 02.01.

<sup>4</sup> Annual Book of ASTM Standards, Vol 03.01.

<sup>5</sup> Annual Book of ASTM Standards, Vol 03.05.

<sup>6</sup> Annual Book of ASTM Standards, Vol 01.01.

5.1.9 Type of width and straightness tolerances, if required (slit metal tolerances, square sheared metal tolerances, sawed metal tolerances, straightened or edge-rolled metal tolerances), and

5.2 In addition, when material is purchased for the U.S. Government, it shall conform to the Supplemental requirements as defined in Specification B 248 when specified in the contract or purchase order.

**6. Material and Manufacture**

46.1 *Material:*

46.1.1 The material of manufacture shall be a cast bar, slab, cake, billet, etc. of Copper Alloy UNS No. C15100 of such purity and soundness as to be suitable for processing in to the products prescribed herein.

46.1.2 In the event heat identification or traceability is required, the purchaser shall specify the details desired.

NOTE 1—Due to the discontinuous nature of the processing of castings into wrought products, it is not always practical to identify a specific casting analysis with a specific quantity of finished material.

46.2 *Manufacture:*

46.2.1 The product shall be manufactured by such hotworking, cold-working, and annealing processes as to produce a uniform wrought structure in the finished product.

46.2.2 The product shall be hot- or cold-worked to the finished size and subsequently annealed, when required, to meet the temper properties specified.

46.3 *Edges:*

46.3.1 Slit edges shall be furnished unless otherwise specified in the contract or purchase order.

**57. Chemical Composition**

57.1 The product shall conform to the chemical composition prescribed in Table 1.

~~5.1.1~~ These

7.2 These composition limits do not preclude the presence of other elements. Limits may be established and analysis required for unnamed elements by agreement between the manufacturer or supplier and the purchaser.

~~5.2~~ Copper, given as the remainder, is the difference between the sum of results for

~~7.3~~ When all elements analyzed and 100%.

~~5.3~~ When all elements listed in Table 1 are analyzed, the sum of results shall be 99.94 % minimum.

**68. Temper**

68.1 The tempers, as defined in Practice B 601, available under this specification are as designated in Table 2.

**79. Grain Size for Annealed Temper**

79.1 Grain size for OS015 temper product shall be as given in Table 2 when tested in accordance with Test Methods E 112.

**810. Physical Property Requirements**

810.1 *Electrical Resistivity Requirements:*

810.1.1 The product shall conform to the requirements of Table 3 by temper when tested in accordance with Test Method B 193.

**911. Mechanical Property Requirements**

911.1 *Tensile Strength Requirements:*

911.1.1 Tempers H01, H02, H03, H04, ~~H05~~, H06, and H08 shall conform to the requirements prescribed in Table 2 when tested in accordance with Test Methods E 8. Tensile strength shall be the basis for acceptance or rejection of product in these tempers.

**102. Dimensions, Mass, and Permissible Variations**

102.1 The following titled sections and tables in Specification B 248 are a part of this specification:

**TABLE 1 Chemical Requirements**

Element	Composition, %
	Copper Alloy UNS No. C15100
Copper	re-remainder
Copper (including Ag)	99.8 % min
Zirconium	0.05–0.15
Fe-n, max	0.005
Cu + sum of named elements	99.005
Manganese, max	0.005
Aluminum, max	0.005
Aluminum + manganese + iron, max	0.04
Aluminum 9 % min, max	0.04

**TABLE 2 Tensile Strength and Grain Size Requirements**

Standard <sup>E</sup>	Temper Designation <sup>A</sup>	Tensile Strength, ksi <sup>B</sup> (MPa) <sup>C</sup>		Grain Size, mm <sup>D</sup>
		Former	Min	
OS015	annealed	...	...	0.030 max
H01	quarter hard	40 (275)	45 (310)	...
H02	half hard	43 (295)	51 (350)	...
H03	three-quarter hard	47 (325)	56 (385)	...
H04	hard	53 (365)	62 (430)	...
H06	extra hard	59 (405)	65 (450)	...
H08	spring	64 (445)	71 (490)	...

<sup>A</sup> Standard designations defined in Practice B 601.

<sup>B</sup> ksi = 1000 psi.

<sup>C</sup> See Appendix X1.

<sup>D</sup> Although no minimum grain size is required, this material must be fully recrystallized.

<sup>E</sup> The Rockwell B scale applies to metal 0.020 in. and over in thickness. The Superficial 30T scale applies to metal 0.012 in. and over in thickness.

**TABLE 3 Electrical Resistivity**

Temper	Electrical Resistivity at 20°C (68°F), max, Ω·g/m <sup>2</sup>	Equivalent Conductivity at 20°C (68°F), % IACS, min
Annealed (OS015)	0.16136	95
Rolled (H01, H02, H03, H04, H06, H08)	0.17031	90
Rolled (H01, H02, H03, H04, H06, H08)	0.17031	90

~~102.1.1 Thickness—See 5.2, Table 1.~~

~~10.1.2 Width: Slit.~~

~~12.1.2 Width—Slit metal and slit metal with rolled edges—See 5.3, Table 4.~~

~~10.1.3 edges.~~

~~12.1.3 Square Sheared Metal; Sawed Metal—See 5.3, Table 5; Sawed Metal—See 5.3, Table 6.~~

~~10.1.4~~

~~12.1.4 Length:~~

~~102.1.4.1 Length Tolerances for Specific and Stock Lengths With and Without Ends—See 5.4, Table 7.~~

~~10.1.4.2~~

~~12.1.4.2 Schedule of Lengths (Specific and Stock) With Ends—See 5.4, Table 8.~~

~~10.1.4.3~~

~~12.1.4.3 Length Tolerances for Square Sheared Metal—See 5.4, Table 9.~~

~~10.1.4.4~~

~~12.1.4.4 Length Tolerances for Sawed Metal—See 5.4, Table 10.~~

~~10.1.5~~

~~12.1.5 Straightness:~~

~~102.1.5.1 Slit Metal or Slit Metal Either Straightness or Edge Rolled—See 5.5, Table 11.~~

~~10.1.5.2~~

~~12.1.5.2 Square Sheared Metal—See 5.5, Table 12.~~

~~10.1.5.3~~

~~12.1.5.3 Sawed Metal—See 5.5, Table 13.~~

~~10.1.6~~

~~12.1.6 Edges—See 5.6:~~

~~10.1.6.1~~

~~12.1.6.1 Square Edges—See 5.6.1, Table 15.~~

~~10.1.6.2~~

~~12.1.6.2 Rounded Corners—See 5.6.2, Table 16.~~

~~10.1.6.3~~

~~12.1.6.3 Rounded Edges—See 5.6.3, Table 17.~~

~~10.1.6.4~~

~~12.1.6.4 Full Rounded Edges.~~

### **13. Workmanship, Finish and Appearance**

13.1 The material shall be free of defects, but blemishes of a nature that do not interfere with normal commercial operations are acceptable. It shall be well-cleaned and free of dirt. A superficial film or residual light lubricant is normally present and is acceptable unless otherwise specified.

13.2 The surface finish and appearance shall be the normal commercial quality for the alloy, thickness, and temper ordered. When application information is provided with purchase order, the surface shall be that commercially producible for the application. Superficial films of discoloration, or lubricants, or tarnish inhibitors are permissible unless otherwise specified.

### **14. Sampling**

14.1 Sampling—The lot size, portion size, and selection of sample pieces shall be as follows:

14.1.1 Lot Size—40 000 lb (18 144 kg) or less material of the same mill form, temper, and thickness, subject to inspection at one time.

14.1.2 Portion Size—Sample pieces shall be selected from eight individual pieces, and shall be taken so as to be representative of those pieces. If the lot consists of less than eight pieces, a sample shall be taken from each individual piece.

14.2 Chemical Analysis:

14.2.1 The sample for chemical analysis shall be taken in accordance with Practice E 255 for product in its final form taken from the pieces selected in 14.61.2 and combined into one composite sample. The minimum weight of the composite sample shall be 150 g.

14.2.2 Instead of sampling as directed in 14.2.1, the manufacturer shall have the option of sampling at the time the castings are poured or samples taken from the semifinished product. If the manufacturer determines the chemical composition of the material during the course of manufacture, he shall not be required to sample and analyze the finished product.

14.2.2.1 When samples are taken at the time the castings are poured, at least one sample shall be taken from each group of castings poured from the same source of molten metal.

14.2.2.2 When samples are taken from semifinished product, a sample shall be taken to represent each 10 000 lbs (5 000 kg) or fraction thereof, except that no more than one sample shall be required per piece.

14.2.2.3 Only one sample need be taken from the semifinished product of one cast bar from a single melt charge continuously processed.

14.3 Samples for all Other Tests—Samples for all other tests shall be taken from the sample portions selected in 14.1.2 and be of an convenient size to accomodated the test and comply with the requirements of the appropriate product specifiication and test method.

### **15. Number of Tests and Retests**

15.1 Tests

15.1.1 Chemical Requirements:

15.1.2 When samples are taken at the time the castings are poured, at least one sample shall be analyzed for each group of castings poured simultaneously from the same source of molten metal.

15.1.3 When samples are taken from the semifinished or finished product, at least one sample representative of the product of each cast bar from a single melt charge continuously processed with heat identity maintained shall be analyzed.

15.2 Mechanical Properties and Grain Size—Unless otherwise provided in the product specification, test specimens shall be taken from two of the sample pieces selected in accordance with 14.1.2. The required tests shall be made on each of the specimens so selected.

15.3 Other Tests—For other tests, test specimens shall be taken from four of the sample pieces selected in accordance with 14.1.2. The required tests shall be made on each of the specimens so selected.

15.4 Retests:

15.4.1 If the chemical analysis of the specimens prepared from samples selected in accordance with 14.1.2 fails to conform to the specified limits, analysis shall be made on a new composite sample prepared from the pieces selected in accordance with 14.1.2.

15.4.2 If one of the two tests made to determine any of the mechanical or grain size requirements fails to meet a specified limit, this test shall be repeated on the remaining pieces, maximum of two, selected in accordance with 14.1.2, and the results of both of these tests shall comply with the specified requirements.

15.4.3 If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

15.5 Chemical Analysis, shall be determined as the average of at least two replicate determinations for each element specified.

### **16. Specimen Preparation**

16.1 In the grain size test, all specimens shall be prepared as specified in Method E 3.

16.2 In the tension test, all strip less than ¾ in. wide shall be pulled in full size when practicable. Machined test specimens shall be as specified in Test Method E 8, Fig. 1 for sheet type specimens.

16.3 Chemical Composition—The composite sample for laboratory analysis shall, in case of disagreement, be prepared in accordance with Practice E 255.

## 17. Test Methods

17.1 The properties and chemical compositions enumerated in the specifications shall, in case of disagreement, be determined in accordance with the following ASTM test methods:

Test	ASTM Designation
Chemical Analysis	E 53, E 62, E 478
Tension	E 8
Grain	E 112
Electrical Resistivity	B 193

## 12. General Requirements

12.1 The

## 18. Significance of Numerical Limits

18.1 For purposes of determining compliance with the specified property limits for the properties listed in the following sections table, an observed value of Specification B 248 constitute a calculated value shall be rounded as indicated in accordance with the rounding method of Practice E 29:

Property	Rounded Unit for Observed or Calculated Value
Chemical composition	nearest unit in the last right-hand place of figures of the specified limits.
Hardness	nearest ksi (nearest 5 MPa)
Tensile strength	
Grain size:	
Up to 0.055 mm, incl	nearest multiple of 0.005 mm
Over 0.055 to 0.160 mm, incl	nearest 0.01 mm
Elongation:	
5 % and over	nearest 1 %

## 19. Inspection

19.1 The manufacture shall inspect and make the test necessary to verify that the product furnished conforms to the requirements of this specification.

19.2 If, in addition, source inspection of the material by the purchaser is agreed upon by the manufacturer and the purchaser as part of the purchase contract, the nature of the facilities needed to satisfy the inspector representing the purchaser that the product is being furnished in accordance with this specification:

12.1.1 Terminology;

12.1.2 Workmanship, Finish, specification shall be included in the agreement. All tests and Appearance;

12.1.3 Sampling;

12.1.4 Number the inspection shall be conducted so as not to interfere unnecessarily with the operation of Tests the works.

19.3 The manufacturer and Retests;

12.1.5 Specimen Preparation;

12.1.6 Significance the purchaser, by mutual agreement, may accomplish the final inspection simultaneously.

## 20. Rejection and Rehearing

20.1 Rejection:

20.1.1 Product that fails to conform to the specified requirements when inspected or tested by the purchaser or his agent may be rejected.

20.1.2 Rejection should be reported to the manufacturer or supplier promptly and in writing.

20.1.3 In case of Numerical Limits;

12.1.7 Inspection;

12.1.8 Rejection dissatisfaction with the results of the test, the manufacturer or supplier may make claim for a rehearing.

20.2 Rehearing—A a result of product rejection, the manufacturer or supplier may make a claim for a retest to be conducted by the manufacturer or supplier and Rehearing;

12.1.9 Certification;

12.1.10 Test Reports;

12.1.11 Packaging the purchaser. Samples of the rejected product shall be taken in accordance with this product specification and Package subjected to test by both parties using the test methods (s) specified in this product specification, or alternatively, upon agreement of both parties, an independent laboratory may be selected for the test(s) using the test methods(s) specified in this product specification.

## 21. Certification

21.1 When specified in the purchase order or contract, the purchaser shall be furnished certifications that samples representing each lot have been tested or inspected as directed in this specification and the requirements have been met.

## **22. Test Report**

22.1 When specified in the purchase order or contract, a report of the test results shall be furnished.

## **23. Packing, Marking, Shipping, and Preservation**

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23.1.12 *SPackaging*—The product shall be separated by size, composition, and temper, and prepared for shipment in such a manner as to ensure acceptance by common carrier for transportation and to afford protection from the normal hazards of transportation.

## **24. Keywords**

24.1 copper-zirconium; sheet and strip

## **SUPPLEMENTARY REQUIREMENTS**

An extensive five-year review was conducted. Most sections were revised in order to conform to Society requirements and to improve clarity of product requirements.

## **APPENDIX**

### **(Nonmandatory Information)**

#### **X1. METRIC EQUIVALENTS**

X1.1 The SI unit for strength properties now shown is in accordance with the International System of Units (SI). The derived SI unit for force is the newton (N), which is defined as that force which when applied to a body having a mass of one kilogram gives it an acceleration of one metre per second squared ( $N = \text{kg m/s}^2$ ). The derived SI unit for pressure or stress is the newton per square metre ( $\text{N/m}^2$ ), which has been named the pascal (Pa) by the General Conference on Weights and Measures. Since  $1 \text{ ksi} = 6\,894\,757 \text{ Pa}$  the metric equivalents are expressed as megapascal (MPa), which is the same as  $\text{MN/m}^2$  and  $\text{N/mm}^2$ .

## **SUMMARY OF CHANGES**

Committee B05 has identified the location of selected changes to this standard since the last issue (B 747 – 96) that may impact the use of this standard.

- (1) Added many sections to this specification to meet current outline of form.
- (2) Table 1 was changed to match CDA chemical composition.

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