Designation: B747 – 11

Standard Specification for Copper-Zirconium Alloy Sheet and Strip [1]

This standard is issued under the fixed designation B747; 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 (ε) 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 *Units*—Values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units, which are provided for information only and are not considered standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B193 Test Method for Resistivity of Electrical Conductor Materials

B248 Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar

B601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast

B846 Terminology for Copper and Copper Alloys

E3 Guide for Preparation of Metallographic Specimens

E8/E8M Test Methods for Tension Testing of Metallic Materials

E53 Test Method for Determination of Copper in Unalloyed Copper by Gravimetry

E112 Test Methods for Determining Average Grain Size

E255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition

E478 Test Methods for Chemical Analysis of Copper Alloys

3. General Requirements

3.1 The following sections of Specification B248 constitute a part of this specification:

3.1.1 Terminology,
3.1.2 Workmanship, Finish, and Appearance,
3.1.3 Sampling,
3.1.4 Number of Tests and Retests,
3.1.5 Specimen Preparation,
3.1.6 Significance of Numerical Limits,
3.1.7 Inspection,
3.1.8 Rejection and 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 B846.

5. Ordering Information

5.1 Include the following specified choices when placing orders for product under this specification, as applicable:

5.1.1 ASTM designation number and year of issue,
5.1.2 Quantity (of each size),
5.1.3 Copper Alloy UNS No. designation (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),
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 B248 when specified in the contract or purchase order.

6. Material and Manufacture

6.1 *Material:*

6.1.1 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.

[1] This specification is under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.01 on Plate, Sheet, and Strip.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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

6.1.2 When specified in the contract or purchase order, that 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.

6.2 *Manufacture:*

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

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

6.3 *Edges:*

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

7. Chemical Composition

7.1 The material shall conform to the chemical composition prescribed in Table 1.

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

7.3 When all elements listed in Table 1 are analyzed, the sum of results shall be 99.9 % minimum.

8. Temper

8.1 The standard tempers for products described in this specification are given in Table 2.

8.1.1 Cold rolled tempers H01 to H08.

8.1.2 Annealed temper OS015.

9. Grain Size for Annealed Temper

9.1 Grain size shall be the standard requirement for all product in the annealed tempers.

9.2 Acceptance or rejection based upon grain size shall depend only on the average grain size of a test specimen taken from each of two sample portions, and each specimen shall be within the limits prescribed in Table 2 when determined in accordance with Test Method E112.

10. Physical Property Requirements

10.1 *Electrical Resistivity Requirements:*

10.1.1 The product furnished shall conform to the electrical mass Resistivity requirements in Table 3 by temper when tested in accordance with Test Method B193.

TABLE 1 Chemical Requirements

Element	Composition, %
	Copper Alloy UNS No. C15100
Copper (including Ag)	99.80 % min
Zirconium	0.05–0.15
Cu + sum of named elements	99.9 % min

TABLE 2 Tensile Strength and Grain Size Requirements

Temper Designation[A]		Tensile Strength, ksi[B] (MPa)[C]		Grain Size, mm[D]
Standard	Former	Min	Max	
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 (425)	...
H06	extra hard	59 (405)	65 (450)	...
H08	spring	64 (440)	71 (490)	...

[A] Standard designations defined in Practice B601.
[B] ksi = 1000 psi.
[C] See Appendix X1.
[D] Although no minimum grain size is required, this material must be fully recrystallized.

TABLE 3 Electrical Resistivity

Temper	Electrical Resistivity at 20°C (68°F), max, $\Omega \cdot g/m^2$	Equivalent Conductivity at 20°C (68°F), % IACS, min
Annealed (OS015)	0.16136	95
Rolled (H01, H02, H03, H04, H06, H08)	0.17031	90

11. Mechanical Property Requirements

11.1 *Tensile Strength Requirements :*

11.1.1 Product furnished under this specification shall conform to the tensile requirements prescribed in Table 2, when tested in accordance with Test Method E8/E8M.

11.1.2 Acceptance and rejection based upon mechanical properties shall depend only on tensile strength.

12. Dimensions, Mass, and Permissible Variations

12.1 The following titled sections and tables in Specification B248 are a part of this specification:

12.1.1 *Thickness.*

12.1.2 *Width*—Slit metal and slit metal with rolled edges.

12.1.3 *Square Sheared Metal; Sawed Metal.*

12.1.4 *Length:*

12.1.4.1 *Length Tolerances for Specific and Stock Lengths With and Without Ends.*

12.1.4.2 *Schedule of Lengths (Specific and Stock) With Ends.*

12.1.4.3 *Length Tolerances for Square Sheared Metal.*

12.1.4.4 *Length Tolerances for Sawed Metal.*

12.1.5 *Straightness:*

12.1.5.1 *Slit Metal or Slit Metal Either Straightness or Edge Rolled.*

12.1.5.2 *Square Sheared Metal.*

12.1.5.3 *Sawed Metal.*

12.1.6 *Edges:*

12.1.6.1 *Square Edges.*

12.1.6.2 *Rounded Corners.*

12.1.6.3 *Rounded Edges.*

12.1.6.4 *Full Rounded Edges.*

13. Workmanship, Finish, and Appearance

13.1 The product shall be free of defects, but blemishes of a nature that do not interfere with the intended application 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*—An inspection lot shall be 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*—A portion 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*—The sample for chemical analysis shall be taken in accordance with Practice E255 for product in its final form taken from the pieces selected in 14.1.2 and combined into one composite sample. The minimum weight of the composite sample shall be 150 g. Unless otherwise required by the purchaser, at the time the order is placed, the manufacturer shall have the option of determining conformance to chemical composition by analyzing samples taken at the time the castings are poured or samples taken from the semifinished product if heat identity can be maintained throughout all operations. If the manufacturer determines the chemical composition during manufacture, he shall not be required to sample and analyze the finished product.

14.2.1 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 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.

14.2.3 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 portion in 14.1.2 and be of a convenient size to accommodate the test and comply with the requirements of the appropriate ASTM product standard and test method.

15. Number of Tests and Retests

15.1 *Tests*

15.1.1 *Chemical Analysis*—Chemical composition shall be determined in accordance with the element mean of the results from the sample 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.

15.1.2 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 *Other Tests:*

15.2.1 *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.

15.2.2 *Electrical Resistivity*—Results shall be reported 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.

15.3 *Retests:*

15.3.1 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.

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

15.3.2 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.

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

16. Specimen Preparation

16.1 *Grain Size*—All specimens shall be prepared as specified in Method E3.

16.2 *Mechanical Tests*—All samples of strip less than ¾ in. wide shall be pulled in full size when practicable. Machined test specimens shall be as specified in Test Method E8/E8M, 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 E255.

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
Copper	E53
Silver	E478
Tensile Strength	E8/E8M
Grain Size	E3,E112
Electrical Resistivity	B193

17.1.1 The test method(s) used for determination of element(s) required by contractual or purchase order agreement shall be as agreed upon between the manufacturer and the purchaser.

17.1.2 Since no recognized test method is known to be published, the determination of zirconium shall be subject to the agreement between the manufacturer and purchaser.

18. Significance of Numerical Limits

18.1 For the purpose of determining compliance with the specified property limits for requirements of the properties listed in the following table, and for dimensional tolerances, an observed value of a calculated value shall be rounded as indicated in accordance with the rounding method of Practice E29:

Property	Rounded Unit for Observed or Calculated Value
Chemical composition	nearest unit in the last right-hand place
Hardness	of figures of the specified limits.
Tensile strength	nearest ksi (nearest 5 MPa)
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 manufacturer, or supplier, shall inspect and make test necessary to verify the furnished product conforms to specification requirements.

19.2 Source inspection of the product by the purchaser may be agreed upon by the manufacturer, or supplier, and the purchaser as part of the purchase order. In such case, the nature of the facilities needed to satisfy the inspector, representing the purchaser, that the product is being furnished in accordance with the specification, shall be included in the agreement. All testing and the inspection shall be conducted so as not to interfere unnecessarily with the operation of the works.

19.3 When mutually agreed upon, the manufacturer, or supplier, and the purchaser shall conduct the final inspection simultaneously.

20. Rejection and Rehearing

20.1 *Rejection:*

20.1.1 Product that fails to conform to the specification requirements when inspected or tested by the purchaser or purchaser's agent shall be subject to rejection.

20.1.2 Rejection shall be reported to the manufacturer or supplier promptly. In addition, a written notification of rejection shall follow.

20.1.3 In case of dissatisfaction with the results of the test upon which the rejection is based, the manufacturer or supplier shall have the option to make claim for a rehearing.

20.2 *Rehearing:*

20.2.1 As a result of product rejection, the manufacturer, or supplier, shall have the option to make a claim for a retest to be conducted by the manufacturer or supplier and the purchaser. Samples of the rejected product shall be taken in accordance with this product specification and subjected to test by both parties using the test method(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 method(s) specified in this product specification.

21. Certification

21.1 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been tested and 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. Packaging and Package Marking

23.1 *Packaging:*

23.1.1 The product shall be separated by size, composition, and temper, and prepared for shipment by common carrier, in such a manner to afford protection from the normal hazards of transportation.

23.2 *Package Marking:*

23.2.1 Each shipping unit shall be legibly marked with the purchase order number, alloy designation, temper, size, shape, gross and new weight, and name of shipper.

23.2.2 When specified in the contract or purchase order, the product specification number shall be shown.

24. Keywords

24.1 copper-zirconium; sheet and strip; UNS No. C15100

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 ($N = kg\ m/s^2$). The derived SI unit for pressure or stress is the newton per square metre (N/m^2), which has been named the pascal (Pa) by the General Conference on Weights and Measures. Since 1 ksi = 6 894 757 Pa the metric equivalents are expressed as megapascal (MPa), which is the same as MN/m^2 and N/mm^2.

SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue (B747 - 07) that may impact the use of this standard. (Approved Oct. 1, 2011.)

(1) Revised Test Methods (Section 17) to change from Tension to Tensile Strength, change from Grain to Grain Size, and add E3 to Grain Size as an ASTM Test Method.
(2) Moved section 17.1.1 to 17.1.2 (newly created) and made 17.1.1 state "The test method(s) used for determination of element(s) required by contractual or purchase order agreement shall be as agreed upon between the manufacturer and the purchaser."
(3) Added UNS No. C15100 to Keywords (Section 24).
(4) Changed Max Tensile Strength for H04 from 430 MPa to 425 MPa.
(5) Removed Supplementary Requirements as there are none for this standard.
(6) Made editorial corrections to the standard to ensure it conforms to proper form and style.