



Standard Specification for High Conductivity Tough-Pitch Copper Refinery Shapes¹

This standard is issued under the fixed designation B 5; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope *

1.1 This specification establishes the requirements for high conductivity, tough-pitch, copper wire bars, cakes, slabs, billets, ingots, and ingot bars.

1.2 Copper under this specification corresponds to the designations “ETP” (UNS C11000) and “FRHC” (UNS C11020) as shown in Classification B 224. These coppers may also be used to produce coppers corresponding to the following:

Copper UNS No.	Classification B 224 Designation
C11300, C11400, C11500, and C11600	STP
C12000	DLP
C12200	DHP
C12300	DHPS
C14500	DPTE

1.3 Although this specification includes certain UNS designations as described in Practice E 527, these designations are for cross reference only and are not specification requirements. Therefore, in case of conflict, this ASTM specification shall govern.

1.4 *Units*—The values stated in inch-pound units are the standard, except for electrical resistivity, which is expressed in SI units. The values given in parentheses are mathematical conversions to SI units, which are provided for information only, and are not considered the standard.

2. Referenced Documents

2.1 ASTM Standards:

- B 193 Test Method for Resistivity of Electrical Conductor Materials²
- B 224 Classification of Coppers³
- B 846 Terminology for Copper and Copper Alloys³
- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications⁴
- E 53 Test Method for Determination of Copper in Unalloyed Copper by Gravimetry⁵

¹ This specification is under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.07 on Refined Copper.

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² *Annual Book of ASTM Standards*, Vol 02.03.

³ *Annual Book of ASTM Standards*, Vol 02.01.

⁴ *Annual Book of ASTM Standards*, Vol 14.02.

⁵ *Annual Book of ASTM Standards*, Vol 03.05.

E 255 Practice for Sampling Copper and Copper Alloys for Determination of Chemical Composition⁵

E 478 Test Methods for Chemical Analysis of Copper Alloys⁵

E 527 Practice for Numbering Metals and Alloys (UNS)⁶

3. Terminology

3.1 For definitions of terms related to this specification, refer to Classification B 224 and Terminology B 846.

4. Ordering Information

4.1 Include the following information, as applicable:

4.1.1 ASTM Specification Designation and year of issue,

4.1.2 Copper UNS No. Designation,

4.1.3 Quantity, shape, and dimension of each piece, and weight,

4.1.4 Should cakes, slabs, or billets be ordered for electrical use, it must be stated in the contract or purchase order, and

4.1.5 Silver content in silver-bearing shapes when required, in troy oz per short ton.

5. Chemical Composition

5.1 The copper in all shapes shall meet the minimum requirement for copper, including silver, of 99.90 %.

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

5.2 For the STP (silver-bearing) coppers, the addition of silver up to an average of 30 troy oz per short ton (0.10 %) will be considered within the specification, with no individual silver analysis to exceed 35 troy oz per short ton (0.12 %).

6. Physical Property Requirements

6.1 Electrical Resistivity:

6.1.1 The maximum mass resistivity for wire bars, cakes, slabs, and billets for electrical use shall be 0.153 28 Ω·g/m² (conductivity 100.0 % minimum, International Annealed Copper Standard, (IACS)), at 68°F (20°C), annealed.

6.1.2 The maximum mass resistivity for other uses shall be 0.156 94 Ω·g/m² (conductivity 97.66 % minimum IACS), at 68°F (20°C), annealed.

⁶ *Annual Book of ASTM Standards*, Vol 01.01.

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

6.1.3 The maximum mass resistivity for ingots and ingot bars shall be $0.15694 \Omega \cdot \text{g}/\text{m}^2$ (conductivity 97.66 % minimum IACS), at 68°F (20°C), annealed.

7. Dimensions, Mass, and Permissible Variations

7.1 Standard Sizes and Shapes of Wire Bars:

7.1.1 One size of mold shall be used for casting 200- to 230-lb (91- to 104-kg) wire bars, the bottom width of these bars to be 3½ in. (89 mm), the listed weights being 200 and 225 lbs (91 to 102 kg) (Fig. 1).

7.1.2 One size of mold shall be used for casting 240- to 300-lb (109- to 136-kg) wire bars, the bottom width of these bars to be 4 in. (102 mm), the listed weights being 250, 265, 275, and 300 lbs (113, 120, 125, and 136 kg) (Fig. 2).

7.1.3 All bars shall be 54 in. (1.372 m) in length. The side draft or taper shall be 3/8 in. (9.5 mm) in 4 in. (3/16 in. (4.8 mm) in 4 in. on each side of the bar). The radius of the corners at the bottom of the bars shall be 5/8 in. (15.9 mm). The end taper at the bottom shall be 6 in. (152.4 mm) in overall length and approximately 2 in. (50.8 mm)/ft (304.8 mm). The end taper of the side shall be approximately 2¼ in. (57.1 mm)/ft and the end of the bar shall be approximately 3¾ in. (85.7 mm) in depth at the point.

7.1.4 Wire bars not conforming to the requirements of Fig. 1 or Fig. 2, but otherwise meeting the requirements of this specification, may be supplied by agreement between manufacturer and the purchaser.

7.2 Permissible Variations in Weight and Dimensions—A permissible variation of ±5 % in weight or ±¼ in. (6.3 mm)

in any dimension from the manufacturer’s published list or the purchaser’s specified size shall be considered good delivery; provided, however, that wire bars may vary in length ±1 % from the listed or specified length, and cakes may vary ±3 % from the listed or specified size in any dimension greater than 8 in. (203.2 mm). The weight of copper in ingots and ingot bars shall not exceed that specified by more than 10 %, but otherwise its variation is not important.

8. Workmanship, Finish, and Appearance

8.1 Wire bars, cakes, slabs, and billets shall be substantially free of shrink holes, cold sets, pits, sloppy edges, concave tops, and similar defects in set or casting. This requirement shall not apply to ingots or ingot bars, in which physical defects are of no consequence.

8.2 Blemishes of a nature that do not interfere with the intended application are acceptable.

9. Sampling

9.1 For routine sampling, the sampling practice shall be at the discretion of the sampler.

9.2 In case of dispute, a lot shall consist of all pieces the same shape and size bearing a common single identifying number.

9.3 Chemical Composition—In case of dispute concerning chemical composition, sampling shall be in accordance with Practice E 255.

9.4 Electrical Resistivity:

9.4.1 In case of dispute concerning the electrical resistivity,

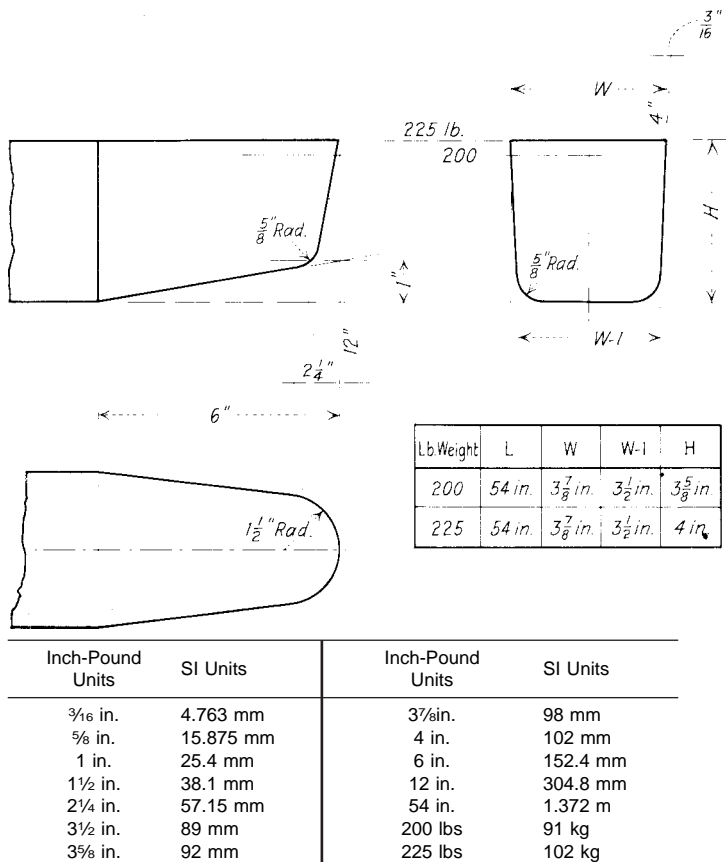


FIG. 1 Copper Wire Bars, 200 and 225 lbs

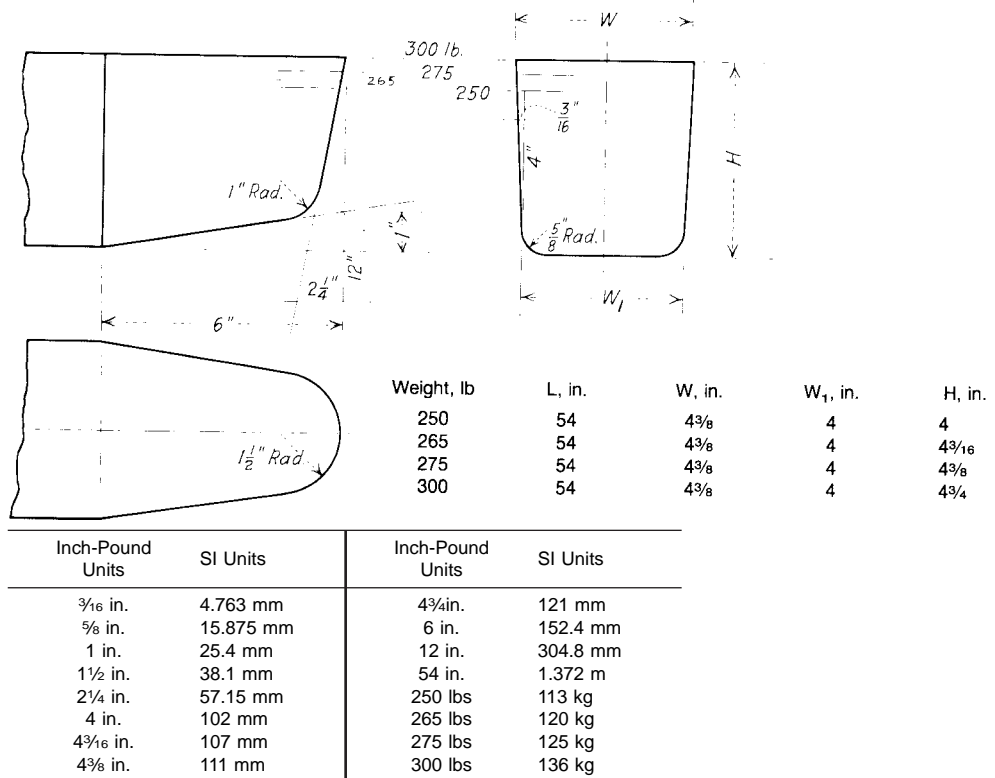


FIG. 2 Copper Wire Bars, 250, 265, 275, and 300 lbs

each party shall select two pieces from the lot. In the presence of both parties, and by means mutually agreeable, a single sample of adequate size shall be cut from each of the four pieces and fabricated into a wire.

10. Number of Tests and Retest

10.1 *Number of Tests:*

10.1.1 The chemical composition shall be determined as the mean of the results from at least three replicate analyses.

10.1.2 The mass resistivity shall be determined as the mean of the observations from the test on the four wires.

10.2 *Retest*—In case of dispute, one retest may be made for chemical composition determined as the mean of the results from replicate analyses. In case of dispute concerning electrical resistivity, 9.4 and 11.2 shall apply.

10.3 *Umpire Test:*

10.3.1 In the case in which the retest does not settle the dispute, further retest may be made by a qualified third-party laboratory agreeable to the producer and the purchaser. The retest shall be made on the sample set aside for that purpose.

10.3.2 The umpire provision does not preclude other contractual agreements.

11. Specimen Preparation

11.1 *Chemical Analysis*—The preparation of the analytical specimen is the responsibility of the reporting laboratory.

11.2 *Electrical Resistivity:*

11.2.1 Each test sample shall be fabricated into a rod.

11.2.2 The external oxide shall be removed and the rod cold drawn into a wire approximately 0.080 in. (2 mm) in diameter.

11.2.3 Each wire coil shall be cut into four wires of approximately the same length, and the sixteen wires thus obtained shall be individually identified. The sixteen wires shall be divided into four groups of four wires each, one wire from each of the four originally selected pieces; one group each for the producer, the purchaser, contingencies, and the umpire.

11.2.4 The resulting specimen shall be annealed in an inert atmosphere at approximately 932°F (500°C) for 30 min and quickly cooled to ambient temperature in the same inert atmosphere.

12. Test Methods

12.1 For routine testing, the methods of test shall be at the discretion of the reporting laboratory.

12.1.1 The test method(s) to be followed for determination of element(s) resulting from contractual or purchase-order agreement shall be as agreed upon between the supplier and purchaser.

12.2 In case of dispute concerning the minimum copper content, the method of analysis shall be in accordance with Test Method E 53.

12.3 In case of dispute concerning silver content of silver-bearing shapes, the method of analysis shall be in accordance with Test Methods E 478.

12.4 In case of dispute concerning the electrical resistivity, the method of test shall be in accordance with Test Method B 193.

13. Significance of Numerical Limits

13.1 Calculated values shall be rounded to the specified

number of places in accordance with Practice E 29.

14. Inspection

14.1 The manufacturer or supplier shall inspect and make tests necessary to verify the product furnished conforms to specification requirements.

15. Rejection and Rehearing

15.1 *Rejection*—Product that fails to conform to the requirements of this specification is subject to rejection. Rejection is to be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the reasons for rejection, the producer or supplier may make claim for a rehearing.

15.1.1 Rejection shall be considered as follows:

15.1.1.1 Chemical composition and electrical resistivity by lots.

15.1.1.2 Physical defects by individual pieces.

15.1.1.3 Variations in weight or dimension by individual pieces.

15.2 *Rehearing*:

15.2.1 As a result of product rejection, the supplier may make claim for retest to be conducted by the producer or supplier and the purchaser. Samples of the rejected product shall be taken in accordance with this specification, or alter-

nately, upon agreement by both parties, an independent laboratory may be selected for the tests using this specification prescribed test methods.

16. Product Marking

16.1 Each wire bar, cake, slab, and billet shall be stamped, or otherwise identified, with the producer's brand and lot.

16.2 Ingots and ingot bars shall have the producer's brand stamped, or cast in, but need have no other number.

17. Packaging and Package Marking

17.1 The manufacturer shall arrange rail-car loads, truck loads, or other shipping units so that, as far as possible, each shipping unit shall contain pieces bearing a single identifying lot number.

17.2 In case of dispute, a lot shall consist of all pieces of the same shape and size bearing the same identifying number.

18. Keywords

18.1 billets; cakes; electrolytic copper; electrorefined copper; electrowon copper; fire-refined copper; high-conductivity copper; ingots; ingot bars; refinery shapes; slabs; tough-pitch copper; wire bars

SUMMARY OF CHANGES

This section identifies changes to this specification that have been incorporated since the 1995 approval date:

(1) The Referenced Documents section has been expanded to include Terminology B 846.

(2) The Terminology, Ordering Information, Workmanship, Finish, and Appearance, Number of Tests and Retests, Specimen Preparation, Significance of Numerical Limits, Rejection and Rehearing, and Keywords sections have been modified,

have had items removed, and/or have been expanded.

(3) The Inspection section has been replaced with recommended ASTM Form and Style Book language.

(4) The Purchase for U.S. Government section and Supplementary Requirements have been deleted.

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