



Designation: **B5—16 B5 – 22**

Standard Specification for High Conductivity Tough-Pitch Copper Refinery Shapes¹

This standard is issued under the fixed designation B5; 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 U.S. 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 **B224**. These coppers may also be used to produce coppers corresponding to the following:

| Copper UNS No. | Classification B224 Designation |
|------------------------------------|--|
| C11300, C11400, C11500, and C11600 | STP |
| C12000 | DLP |
| C12200 | DHP |
| C12300 | DHPS |
| C14520 | DPTE |

1.3 Although this specification includes certain UNS designations as described in Practice **E527**, 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 to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4.1 *Exception*—Electrical resistivity is expressed in SI units.

1.5 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 *ASTM Standards*:²

B193 Test Method for Resistivity of Electrical Conductor Materials

B224 Classification of Coppers

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 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**

[B846 Terminology for Copper and Copper Alloys](#)

~~[B950 Guide for Editorial Procedures and Form of Product Specifications for Copper and Copper Alloys](#)~~

[E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications](#)

[E53 Test Method for Determination of Copper in Unalloyed Copper by Gravimetry \(Withdrawn 2022\)³](#)

[E255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition](#)

[E478 Test Methods for Chemical Analysis of Copper Alloys](#)

[E527 Practice for Numbering Metals and Alloys in the Unified Numbering System \(UNS\)](#)

3. Terminology

3.1 For definitions of terms related to copper and copper alloys, refer to Terminology [B846](#). For definitions of terms related to standard classification of coppers, refer to Classification [B224](#).

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.

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

5. Materials and Manufacture

5.1 *Materials:*

5.1.1 The material of manufacture shall be a form (copper wire bar, cake, slabs, billets, ingots, and ingot bars) of Copper Alloy “ETP” (UNS C11000) or “FRHC” (UNS C11020) of such purity and soundness as to be suitable for processing into the prescribed herein.

5.1.2 When specified in the contract or purchase order that heat identification or traceability is required, the purchaser shall specify the details desired.

³ The last approved version of this historical standard is referenced on www.astm.org.

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.

5.2 *Manufacture:*

5.2.1 The product shall be hot- or cold-worked as to produce a uniform wrought structure in the finished product.

6. Chemical Composition

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

6.1.1 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.

6.2 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 %).

7. Physical Property Requirements

7.1 *Electrical Resistivity:*

7.1.1 The maximum mass resistivity for wire bars, cakes, slabs, and billets for electrical use shall be 0.153 28 $\Omega \cdot \text{g}/\text{m}^2$ (conductivity 100.00 % minimum, International Annealed Copper Standard, (IACS)), at ~~68°F (20°C)~~, 68 °F (20 °C), annealed.

7.1.2 The maximum mass resistivity for other uses shall be 0.156 94 $\Omega \cdot \text{g}/\text{m}^2$ (conductivity 97.66 % minimum IACS), at ~~68°F (20°C)~~, 68 °F (20 °C), annealed.

7.1.3 The maximum mass resistivity for ingots and ingot bars shall be 0.156 94 $\Omega \cdot \text{g}/\text{m}^2$ (conductivity 97.66 % minimum IACS), at ~~68°F (20°C)~~, 68 °F (20 °C), annealed.

8. Dimensions, Mass, and Permissible Variations

[ASTM B5-22](https://standards.iteh.ai/catalog/standards/sist/90afc16a-7927-4048-a967-00033118dc93/astm-b5-22)

<https://standards.iteh.ai/catalog/standards/sist/90afc16a-7927-4048-a967-00033118dc93/astm-b5-22>

8.1 *Standard Sizes and Shapes of Wire Bars:*

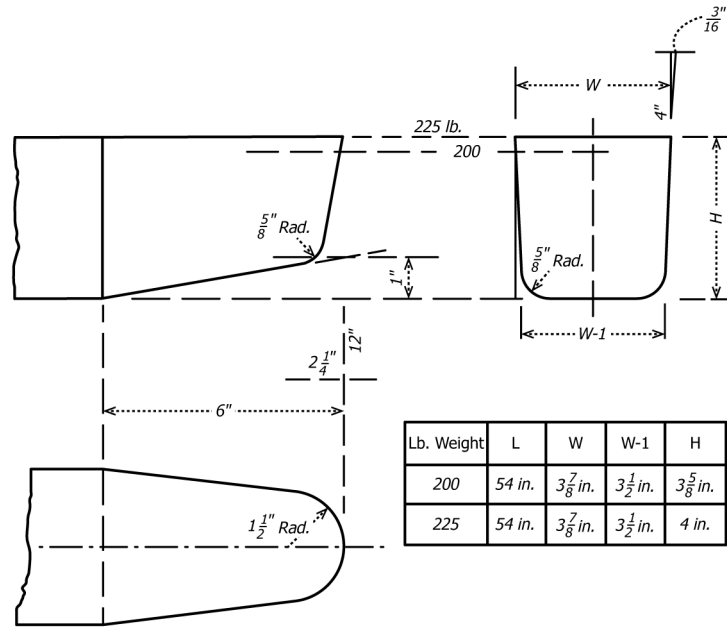
8.1.1 One size of mold shall be used for casting ~~200-200 lb to 230-lb (91-230 lb (91 kg to 104-kg)104 kg)~~ wire bars, the bottom width of these bars to be 3½ in. (89 mm), the listed weights being ~~200 and 225 lbs (91-200 lb and 225 lb (91 kg and 102 kg)~~ (Fig. 1).

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

8.1.3 All bars shall be 54 in. (1.372 m) in length. The side draft or taper shall be ⅜ in. (9.5 mm) in 4 in. (⅜ 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 ⅝ 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 3⅜ in. (85.7 mm) in depth at the point.

8.1.4 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 the manufacturer and the purchaser.

8.2 *Permissible Variations in Weight and Dimensions*—A permissible variation of ± 5 % in weight or $\pm ¼$ 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.



| Inch-Pound Units | SI Units | Inch-Pound Units | SI Units |
|------------------|-----------|------------------|----------|
| 3/16 in. | 4.763 mm | 3/8 in. | 98 mm |
| 5/8 in. | 15.875 mm | 4 in. | 102 mm |
| 1 in. | 25.4 mm | 6 in. | 152.4 mm |
| 1 1/2 in. | 38.1 mm | 12 in. | 304.8 mm |
| 2 1/4 in. | 57.15 mm | 54 in. | 1.372 m |
| 3 1/2 in. | 89 mm | 200 lbs | 91 kg |
| 3 3/2 in. | 89 mm | 200 lb | 91 kg |
| 3 5/8 in. | 92 mm | 225 lbs | 102 kg |
| 3 5/8 in. | 92 mm | 225 lb | 102 kg |

FIG. 1 Copper Wire Bars, 200 lb and 225 lb

9. Workmanship, Finish, and Appearance

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<https://standards.iteh.ai/catalog/standards/sist/90afc16a-7927-4048-a967-00033118dc93/astm-b5-22>

9.1 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.

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

10. Sampling

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

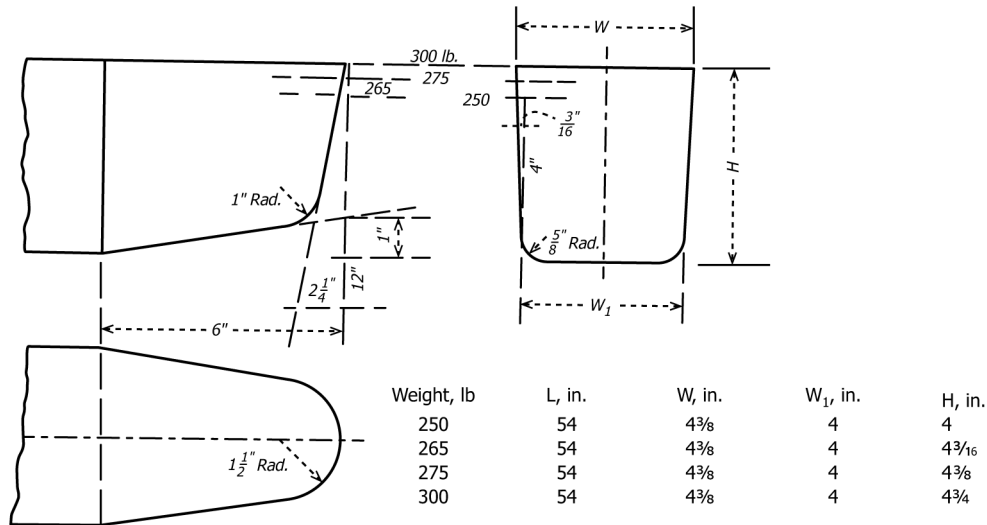
10.2 In case of dispute, a lot shall consist of all pieces the same shape and size bearing a common single identifying number.

10.3 *Chemical Composition*—In case of dispute concerning chemical composition, sampling shall be in accordance with Practice E255.

10.4 *Electrical Resistivity*—In case of dispute concerning the electrical resistivity, 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. See 12.2 for subsequent specimen preparation.

11. Number of Tests and Retest

11.1 *Tests*:



| Inch-Pound Units | SI Units | Inch-Pound Units | SI Units |
|------------------|-----------|------------------|----------|
| 3/16 in. | 4.763 mm | 4 3/8 in. | 121 mm |
| 5/8 in. | 15.875 mm | 6 in. | 152.4 mm |
| 1 in. | 25.4 mm | 12 in. | 304.8 mm |
| 1 1/2 in. | 38.1 mm | 54 in. | 1.372 m |
| 2 1/4 in. | 57.15 mm | 250 lbs | 113 kg |
| 2 3/4 in. | 57.15 mm | 250 lb | 113 kg |
| 4 in. | 102 mm | 265 lbs | 120 kg |
| 4 in. | 102 mm | 265 lb | 120 kg |
| 4 3/8 in. | 107 mm | 275 lbs | 125 kg |
| 4 3/8 in. | 107 mm | 275 lb | 125 kg |
| 4 3/8 in. | 111 mm | 300 lbs | 136 kg |
| 4 3/8 in. | 111 mm | 300 lb | 136 kg |

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

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11.1.1 *Chemical Analysis*—Chemical composition shall be determined as per the element mean of the results from at least three replicate analyses of the sample(s).

11.2 *Other Tests:*

11.2.1 *Electrical Resistivity*—The mass resistivity shall be determined as the mean of the observations from the test on the four wires.

11.3 *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, 10.4 and 12.2 shall apply.

11.4 *Umpire Test:*

11.4.1 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.

11.4.2 The umpire provision does not preclude other contractual agreements.

12. **Specimen Preparation**

12.1 *Chemical Analysis*—The analytical specimen preparation shall be the responsibility of the reporting laboratory.

12.2 *Electrical Resistivity:*