



Designation: ~~B115-00 (Reapproved 2004)~~ Designation: B115 – 10

## Standard Specification for Electrolytic Copper Cathode<sup>1</sup>

This standard is issued under the fixed designation B115; 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 electrolytic copper cathode; electrorefined and electrowon.

1.2 *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.

NOTE 1—Cathode produced to this specification corresponds to the designation “Cath” as defined in Classification B224 and may be used to produce all other coppers listed in Classification B224 that are normally produced from “Cath” copper.

NOTE 2—Grade 1 cathode conforms to the chemical compositional requirements of Copper UNS No. C11040, except for oxygen, and is suitable for the manufacture of wire rod as designated in Specification B49.

1.3 The following hazard caveat applies to the test methods described in Annex A2 of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

### 2. Referenced Documents

2.1 *ASTM Standards*:<sup>2</sup>

B49 Specification for Copper Rod Drawing Stock for Electrical Purposes

B193 Test Method for Resistivity of Electrical Conductor Materials

B224 Classification of Coppers

B846 Terminology for Copper and Copper Alloys

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E50 Practices for Apparatus, Reagents, and Safety Considerations for Chemical Analysis of Metals, Ores, and Related Materials

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

### 3. Terminology

3.1 For definition of general terms related to copper and copper alloys, refer to the current editions of Classification B224 and Terminology B846.

### 4. Ordering Information

4.1 Orders for product shall include the following information, as applicable:

4.1.1 ASTM designation and year of issue (for example, B115 – XX),

4.1.2 Cathode grade (Table 1),

4.1.3 Size; full cathode or cut,

4.1.4 Total weight of each size.

### 5. Chemical Composition

5.1 The cathode furnished shall conform to the requirements of Table 1 for the grade specified in the contract or purchase order.

5.2 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 supplier and the purchaser and such agreement shall be part of the contract or purchase order.

<sup>1</sup> 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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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto: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.

**TABLE 1 Chemical Composition**

Element	Grade 1 <sup>A</sup>	Grade 2 <sup>A</sup>
	Percent, %	
Copper		99.95, min <sup>B</sup>
		ppm <sup>C</sup>
Selenium, max	2	10
Tellurium, max	2	5
Bismuth, max	1.0	3
Group total, max	3	...
Antimony, max	4	15
Lead, max	5	40
Arsenic, max	5	15
Iron, max	10	25
Nickel, max	10	20
Tin, max	5	10
Sulfur, max	15	25
Silver, max	25	70
Maximum allowable total	65	...

<sup>A</sup> Measurement error is not incorporated in the maximum limits, refer to 10.1.1.

<sup>B</sup> Including silver.

<sup>C</sup> Determined from a melted sample.

## 6. Physical Property Requirements

### 6.1 Electrical Resistivity:

6.1.1 The maximum electrical resistivity for product produced from Grade 2 cathode shall be  $0.153\ 28\ \Omega\cdot\text{g}/\text{m}^2$  (conductivity 100.0 % minimum IACS) at 20°C (68°F) annealed<sup>3</sup> when tested in accordance with Test Method B193. Measurement error is not included in the maximum/minimum limit.

## 7. Dimensions, Mass, and Permissible Variations

7.1 Full-size cathodes or cathodes cut to size may be supplied as agreed upon between supplier and purchaser.

## 8. Workmanship, Finish, and Appearance

8.1 Cathodes shall withstand ordinary handling without breakage or excessive separation of nodules. They shall be substantially free of all foreign material; for example, copper sulfate, dirt, grease, and oil.

## 9. Sampling

9.1 For routine sampling of cathodes for analysis, the method of sampling shall be at the discretion of the sampler.

9.2 In case of dispute concerning sampling for chemical composition, or electrical resistivity, or both, the method of sampling shall be in accordance with Annex A1.

9.3 In case of special requirements specified in the purchase order or contract, the method of sampling shall be as agreed between the supplier and the purchaser.

## 10. Number of Tests and Retests

### 10.1 Tests:

10.1.1 Chemical composition shall be determined as the per element mean of at least two replicate analyses of each sample.

10.1.2 Electrical resistivity shall be determined as the mean of results from four specimens.

### 10.2 Retests:

10.2.1 In the case of compositional or resistivity dispute, retests may be made under the conditions of 9.2.

### 10.3 Umpire Test:

10.3.1 In the case in which retest does not settle the dispute, further retest may be made by a qualified third-party laboratory agreeable to both parties. This provision does not preclude other contractual agreements.

## 11. Specimen Preparation

11.1 For routine testing, specimen preparation shall be at the discretion of the preparer.

11.2 In the case of special requirements specified in the purchaser order or contract, specimen preparation shall be as agreed between the supplier and the purchaser.

<sup>3</sup> NBS Notebook 100 available from National Technical Information Service, 528 Port Royal Rd., Springfield, VA 22161-available from National Technical Information Service (NTIS), 5301 Shawnee Rd, Alexandria, VA 22312, <http://www.ntis.gov>.

11.3 In the case of dispute concerning specimen preparation for chemical composition specified in Table 1 or electrical resistivity, specimen preparation shall be in accordance with Annex A1.

## **12. Test Methods**

### *12.1 Chemical Composition:*

12.1.1 For routine analysis of Grade 1 and Grade 2 cathode, the methods of analysis used shall be at the discretion of the analyst.

12.1.2 In the case of dispute concerning the chemical composition, the methods of analysis shall be in accordance with Annex A2, except for copper in Grade 2 cathode.

12.1.3 In the case of dispute concerning copper content of Grade 2 cathode, the method of analysis shall be in accordance with Test Methods E53.

12.1.4 In the case of dispute concerning special requirements stated in the purchase order or contract, the methods of analysis used shall be as agreed between the supplier and the purchaser.

### *12.2 Electrical Resistivity:*

12.2.1 In the case of dispute concerning electrical resistivity, the method of testing shall be in accordance with Test Method B193.

## **13. Significance of Numerical Limits**

13.1 Calculated values shall be rounded to the desired number of places as directed in Practice E29.

## **14. Inspection**

14.1 The producer shall inspect the product and conduct such tests as are necessary to verify that the requirements of this specification are met.

## **15. Rejection and Rehearing**

### *15.1 Rejection:*

15.1.1 Product that fails to conform to the requirements of this specification may be rejected.

15.1.2 Rejection shall be reported to the producer or supplier promptly and in writing.

15.1.3 In the case of disagreement or dissatisfaction with the results of the test upon which rejection was based, the producer or supplier may make claim for a rehearing.

### *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 and tested by both parties as directed in this specification, or, alternatively, upon agreement between both parties, an independent laboratory may be selected for the tests using the test methods prescribed in this specification.

## **16. Packaging and Package Marking**

### *16.1 Packaging:*

16.1.1 Cathodes, whether full size or cut, shall be assembled in bundles or containers of suitable weight for handling and shall be prepared for shipment in such a manner as to ensure acceptance by common carrier for transportation and to afford protection from normal hazards of transportation.

### *16.2 Package Marking:*

16.2.1 Each cathode bundle or container shall be marked to identify source and grade.

16.2.2 When used, metallic identifying markers shall be firmly attached only to the strapping or shipping container.

## **17. Keywords**

17.1 cathode; copper; electrolytic copper; electrorefined copper; electrowon copper

## **ANNEXES**

### **(Mandatory Information)**

#### **A1. SAMPLING AND SPECIMEN PREPARATION OF ELECTROLYTIC CATHODE COPPER FOR DETERMINATION OF COMPLIANCE WITH SPECIFICATION REQUIREMENTS**

##### **A1.1 Scope**

A1.1.1 This practice establishes a procedure for the sampling and specimen preparation of electrolytic copper cathodes, Grades 1 and 2, for the determination of conformance with specification requirements.

A1.1.2 *Units*—The values stated in inch-pound units are the standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

A1.1.3 *This standard does not purport to address the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## **A1.2 Terminology**

### *A1.2.1 Definitions of Terms Specific to This Standard:*

A1.2.1.1 *lot*—One shipment, or part of one shipment, produced by one refiner. For use other than continuous cast rod production, shipments greater than 200 tons short shall be subdivided into lots not exceeding 200 tons each for sampling purposes.

A1.2.1.2 *gross sample*—The total number of test pieces selected from a lot and considered representative of the lot.

A1.2.1.3 *test piece*—An individual cathode, or cathode part, randomly selected from the lot.

A1.2.1.4 *sample*—A portion prepared from the gross sample and considered representative of the gross sample.

A1.2.1.5 *specimen*—Representative fraction taken from the sample for test.

## **A1.3 Selection of Cathode**

A1.3.1 Nodules shall not be considered a sample representative of the lot.

### *A1.3.2 Cathodes for Continuous Rod Casting:*

A1.3.2.1 The cathodes shall be available in the original packing for examination.

A1.3.2.2 The quantity of cathodes required shall be that necessary to flush the system plus 1 hour of melting furnace operation.

A1.3.2.3 All cathode bundles shall be numbered and a random number generator shall be used to determine which bundles shall be selected for the gross sample.

A1.3.2.4 Should there be an insufficient quantity of cathodes to comply with A1.3.2.2, then the procedure described in A1.3.3 shall apply.

### *A1.3.3 Cathodes for Other Uses:*

A1.3.3.1 Not less than 25 % of the original lot weight or 25 tons, whichever is the larger, shall be available in the original packing for examination.

A1.3.3.2 A gross sample of 24 cathodes, or the equivalent in sheared cathode pieces, shall be selected from a lot. To guarantee random selection, all cathodes, or sheared cathode pieces, of the lot shall be individually numbered, and a random number generator shall be used to select the individual test pieces.

A1.3.3.3 In the case of sheared cathodes, 24 full cathodes; 48 half-plate cathodes, 24 each of tops and bottoms; 96 quarter-plate cathodes, and 24 each of the four quarters, shall be selected.

A1.3.3.4 The selection of test pieces of cathode sheared smaller than quarter plate shall be by agreement between the producer, or the supplier, and the purchaser.

A1.3.3.5 Alternatively, to avoid individual numbering of cathodes, or sheared cathode pieces, in the case of large lots, provided both parties agree, individual bundles, or containers, may be selected on a random basis, and then individual cathodes, or sheared cathode pieces, within each bundle, or container, shall be numbered and test pieces selected, using a random number generator as just described.

## **A1.4 Sample Preparation**

### *A1.4.1 Cathode for Continuous Rod Casting:*

A1.4.1.1 The portion used for flushing the system shall not be used for sampling.

A1.4.1.2 The remaining gross sample, minimum of one hour's cast, shall be charged to the melting furnace. The rod coils produced from the caster shall be sequentially numbered, excluding any coils with obvious defects normally attributed to the rod casting process.

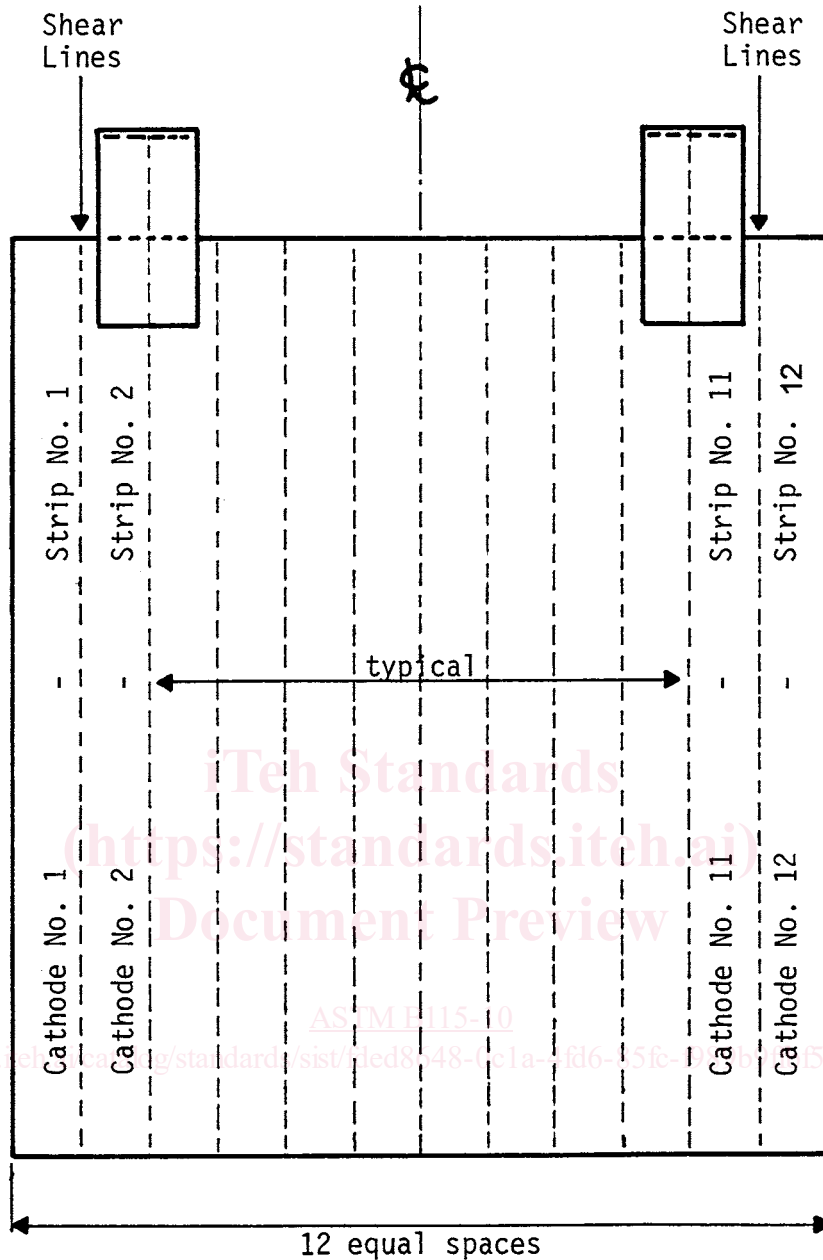
A1.4.1.3 *Chemical Composition*—Each party shall select 2 coils from which a segment of rod approximately 16 in. (406 mm) in length shall be cut at the trailing ends of the coils. Each rod segment shall be cut into 4 portions of approximate equal lengths. The 16 portions shall be divided into 4 groups; each group shall contain one portion from each of the 4 original rod segments. The 4 groups of rod portions shall be placed in separate noncontaminating containers, then sealed and identified for the supplier, the purchaser, contingency, and umpire if necessary.

A1.4.1.4 *Electrical Resistivity*—Each party shall select 2 coils from which a rod segment of sufficient length for test shall be taken from the trailing ends of the coils. Each rod segment shall be cold drawn into a wire about 0.080 in. diameter (2.0 mm) and at least 160 in. in length (4 m). Each wire coil shall be cut into 4 portions of approximately equal length, and the 16 portions shall be individually identified. The 16 wires shall be divided into 4 groups of 4 wires each, one from each of the 4 original rod segments; one group each for the producer, the purchaser, and the umpire, if necessary.

### *A1.4.2 Cathodes for Other Uses:*

#### *A1.4.2.1 Chemical Composition:*

(a) From each cathode, or sheared cathode piece, of the gross sample a vertical strip shall be cut in such a position (see Fig. A1.1) that the collection of the strips so cut represents all points of the cathode, or sheared cathode piece, including the loops (hangers) for full cathode. All vertical sections shall be approximately the same width and cut sequentially from left to right in the same order as that in which the cathodes were selected.



NOTE 1—Repeat for second set of twelve cathodes.

FIG. A1.1 Vertical Strip Sampling Pattern (Refer to A1.4.2.1(a) of text)

(b) The strips selected shall be immersed in 10 % volume/volume (v/v) hydrochloric acid at approximately 20°C for 15 min and then removed and washed in distilled or deionized water until all visible extraneous contamination has been removed.

(c) Where excessive copper sulfate surface contamination is evident, the parties shall confer to determine the extent of washing.

(d) An electric induction or resistance furnace equipped with a graphite, or other noncontaminating crucible and a close-fitting lid of the same material with provision for an inert atmosphere within the crucible shall be used for melting the selected strips.

(e) The crucible shall first be cleaned by melting in it a quantity of copper from the lot in question. The melt shall be discarded.

(f) The prepared cathode strips shall be melted in the cleaned crucible under an inert atmosphere. The molten metal shall be thoroughly stirred with a clean graphite or other noncontaminating rod.

(g) Where the available crucible is not large enough to melt the composite sample, the 24 strips shall be grouped into 2 or more batches of approximately equal weight for melting. In such cases, the metal from each melt shall be separately sampled.

(h) The metal shall be sampled by one of the following methods:

(1) *Ingots:* Equal portions of the molten metal shall be cast into graphite ingot moulds at the beginning, middle, and end of the casting operation. The moulds shall provide ingots that are at least  $\frac{3}{4}$  by  $\frac{3}{4}$  in. (20 by 20 mm) in cross section and 4 to 8 in. (100 to 200 mm) in length. A sufficient number of ingots shall be cast to provide in excess of 28 oz (800 g) of small chips when

drilled, milled, or sawn, using carbide-tipped tools. The surplus metal not cast into ingots may be discharged by any convenient means.

(2) *Shot*: Remove a portion of the molten metal using a ladle coated with a noncontaminating mould wash. The molten metal shall be poured into a container of deionized or distilled water until shot in excess of 28 oz (800 g) has been produced. The depth of the water shall be such that the metal will not adhere to the container. Before sampling, the ladle shall be brought to the molten metal temperature, and the pouring rate shall be such that no metal will solidify in the ladle. The surplus metal may be discharged by any convenient means.

(3) *Pin Samples*—~~Take in excess of 28 oz (800 g) from the molten metal by using either commercially available evacuated glass tubes of several millimetres in diameter and 100 to 120 mm in length, or the equipment shown in Fig. A1.2. The latter equipment can be made by attaching a copper tube approximately 9.5-mm diameter and 400- to 500-mm length, to a spring-loaded vacuum pump. The pin may be removed by cutting away that portion of the tube that obviously had been under the molten metal surface, then splitting the tube using a small, sharp, chisel and a light hammer.~~—Take in excess of 28 oz (800 g) from the molten metal by using either commercially available evacuated glass tubes of several millimetres in diameter and 100 to 120 mm in length.

NOTE A1.1—If the vacuum pump method is elected, it is recommended that the user ensure the cleanliness of the copper tube, and the level of the impurities, if any, in the tube metal be determined to avoid potential specimen contamination.

(4) Divide the sample taken into 4 portions of approximately 7 oz (200 g) each and sealed in a noncontaminating package and individually identified; one each for the producer, the purchaser, contingencies, and the umpire, if necessary.

#### A1.4.2.2 *Electrical Resistivity*:

(a) A minimum of 4 castings shall be made by pouring the molten metal from (f) in A1.4.2.1 into a chill cast mould of sufficient size to produce a wire approximately 0.080 in. in diameter (2.0 mm) and at least 160 in. (approximately 4 m) in length.

(b) Alternatively, the disputing parties may agree to obtain a sample by drilling selected cathodes along the diagonals to obtain a total of about 140-oz (4000-g) drillings. The drillings shall be melted as described in (d) through (f) of A1.4.2.1 and chill cast as described in the preceding paragraph.

(c) The cast form may be hot worked initially, provided care is taken to avoid contamination, or excessive oxidation, or both. The external oxide shall be removed and the sample cold drawn. Each wire coil shall be cut into 4 portions of approximately equal lengths, the 16 portions thus obtained shall be divided into 4 groups of 4 wires each, one from each of the 4 original castings; one group each for the producer, the purchaser, contingencies, and the umpire if necessary.

### A1.5 Specimen Preparation

A1.5.1 *Continuous Cast Rod: Chemical Composition*—Chips, clippings, or drillings shall be taken from the rod sample using a noncontaminating tool.

A1.5.2 *Continuous Cast Rod: Electrical Resistivity*—The wire specimens shall be annealed in an inert atmosphere at approximately 500°C (932°F) for 30 min and cooled to ambient temperature under inert atmosphere. When cool, the wires are removed and cut to test length.

#### A1.5.3 *Cathodes for Others Uses: Chemical Composition*:

A1.5.3.1 Drillings from A1.4.2.1 (see *Ingots*: (1)) shall be etched in 50 % (v/v) nitric acid until the reaction is clearly visible, then washed four times with distilled or deionized water, once with alcohol or acetone, and air dried.

A1.5.3.2 Clean the shot (see *Shot*: (2)), as described in A1.5.3.1.

A1.5.3.3 Extreme care must be exercised in the removal of all glass from samples taken with evacuated glass tubes to avoid contamination from the glass.

A1.5.4 *Cathodes for Other Uses: Electrical Resistivity*—Prepare as described in A1.5.2.