



## Standard Specification for Copper Alloy Addition Agents<sup>1</sup>

This standard is issued under the fixed designation B 644; 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.

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

### 1. Scope\*

1.1 This specification establishes the requirements for copper nickel, ferro copper, phosphor copper, and silicon copper master alloys in ingot, shot, and waffle form to be used as addition agents for cast and wrought alloys.

1.2 Inch-pound units are the standard. SI units given in parenthesis are for information only.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

E 29 Practice for Using Significant Digits in Test Data to Determine Conformation With Specification<sup>2</sup>

E 255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition<sup>3</sup>

E 62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods)<sup>3</sup>

E 76 Test Methods for Chemical Analysis of Nickel-Copper Alloys<sup>3</sup>

E 478 Test Methods for Chemical Analysis of Copper Alloys<sup>3</sup>

E 1371 Test Method for Gravimetric Determination of Phosphorus in Phosphorus-Copper Alloys and Phosphorus-Copper-Silver Alloys<sup>3</sup>

#### 2.2 ISO Standard:

No. 4748 Determination of Iron Content; Na<sub>2</sub>EDTA Titrimetric Method<sup>4</sup>

### 3. Ordering Information

3.1 Orders for materials should include the following information:

3.1.1 ASTM designation and year of issue (for example B 644-XX).

3.1.2 Alloy number and letter; generic name (Table 1),

3.1.3 Form; size, weight, screen distribution,

3.1.4 Quantity or total weight; each form, size, weight, screen distribution.

### 4. Material and Manufacture

#### 4.1 Material:

4.1.1 Any material may be used which, when melted, will form an alloy of the required composition.

#### 4.2 Manufacture:

4.2.1 Any manufacturing process may be used that will yield a product uniform in composition and free of defects of a nature that would render the product unsuitable for the intended application.

### 5. Chemical Composition

5.1 The product in final form shall conform to the requirements prescribed in Table 1 for the specified alloy.

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

### 6. Sampling

6.1 The inspection lot size, portion size, and selection of portion pieces shall be as follows:

6.1.1 *Lot Size*—An inspection lot shall consist of all product from a single heat.

#### 6.1.2 Portion Size:

6.1.2.1 *Ingot and Shot*—The portion size shall be not less than 1 ingot.

6.1.2.2 *Shot and Waffle*—The portion size for product in shot or waffle form shall be not less than 1 lb (0.453 kg) and shall be selected to consist of an average of all sizes of product in the lot.

6.1.3 *Selection of Portion Pieces*—The individual pieces shall be randomly selected.

#### 6.2 Chemical Analysis:

<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 B05.05 on Castings and Ingots for Remelting.

Current edition approved Apr. 10, 2003. Published June 2003. Originally approved in 1982. Last previous edition approved in 1995 as B 644 - 95.

<sup>2</sup> *Annual Book of ASTM Standards*, Vol 14.02.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 03.05.

<sup>4</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

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

**TABLE 1 Chemical Requirements**

Composition, max, % (unless shown as a range or minimum)

| Element                 | Copper-Nickel |          | Ferro Copper |           | Phosphor Copper |          |           | Silicon Copper |           |  |
|-------------------------|---------------|----------|--------------|-----------|-----------------|----------|-----------|----------------|-----------|--|
|                         | Alloy 1A      | Alloy 2A | Alloy 2B     | Alloy 3A  | Alloy 3B        | Alloy 4A | Alloy 4B  | Alloy 4C       | Alloy 4D  |  |
| Copper, min             | 46.5          | 88.7     | 48.2         |           |                 |          |           |                |           |  |
| Nickel (incl. cobalt)   | 48.0–51.0     | 0.10     | 0.10         |           |                 |          |           |                |           |  |
| Silicon                 | 0.05          |          |              |           |                 | 9.0–11.0 | 13.5–16.5 | 18.5–21.5      | 28.5–31.5 |  |
| Copper + silicon + iron |               |          |              |           |                 | 99.4 min | 99.4 min  | 99.4 min       | 99.4 min  |  |
| Phosphorus              |               |          |              | 14.0 min  | 8.0–8.8         |          |           |                |           |  |
| Phosphorus + copper     |               |          |              | 99.75 min | 99.75 min       |          |           |                |           |  |
| Iron                    | 1.20          | 9.0–11.0 | 48.5–51.5    | 0.15      | 0.15            | 0.50     | 0.50      | 0.50           | 0.50      |  |
| Aluminum                |               |          |              |           |                 | 0.25     | 0.25      | 0.25           | 0.25      |  |
| Tin                     | 0.10          |          |              |           |                 | 0.25     | 0.25      | 0.25           | 0.25      |  |
| Calcium                 |               |          |              |           |                 | 0.15     | 0.15      | 0.15           | 0.15      |  |
| Carbon                  | 0.05          | 0.05     | 0.05         |           |                 |          |           |                |           |  |
| Sulfur                  | 0.02          |          |              |           |                 |          |           |                |           |  |
| Lead                    | 0.05          |          |              |           |                 |          |           |                |           |  |
| Zinc                    | 0.10          |          |              |           |                 | 0.10     | 0.10      | 0.10           | 0.10      |  |
| Manganese               | 0.7           | 0.10     | 0.10         |           |                 |          |           |                |           |  |

6.2.1 The sample for chemical analysis shall be taken from the pieces selected in 6.1.2 in accordance with Practice E 255. The minimum weight of the composite sample shall be 150 g.

6.2.2 Instead of sampling in accordance with Practice E 255, the manufacturer shall have the option of sampling during the pouring of the product. At least two samples shall be taken for each lot poured from the same source of molten metal.

6.2.2.1 When the manufacturer determines chemical composition during the course of manufacture, sampling of the finished product is not required.

## 7. Number of Tests and Retests

### 7.1 Tests:

7.1.1 *Chemical Analysis*—Composition shall be determined as the average of results from at least two replicate determinations for each element specified in Table 1 for the specified alloy.

### 7.2 Retests:

#### 7.2.1 *Chemical Analysis*:

7.2.1.1 When requested by the manufacturer or supplier, a retest shall be permitted should test results obtained by the purchaser fail to conform with the requirements of Table 1 for the specified alloy.

7.2.1.2 The retest shall be as directed in 7.1 except the number of replicate determinations shall be twice that normally required by this specification. All determinations shall conform to specification requirements. Failure to comply shall be cause for lot rejection.

## 8. Specimen Preparation

### 8.1 *Chemical Composition*:

8.1.1 Preparation of the analytical specimen shall be the responsibility of the reporting laboratory.

## 9. Test Methods

9.1 Test methods used for quality control or production control, or both, for the determination of conformance to chemical compositional requirements are discretionary.

9.1.1 Test methods used for obtaining data for the preparation of certification or test report shall be made available to the purchaser on request.

### 9.2 *Chemical Composition*:

9.2.1 In case of disagreement, the test method to be followed for a specific element and concentration shall be as indicated in the following table:

| Element     | Range or Max % | Method                            |
|-------------|----------------|-----------------------------------|
| Aluminum    | 0.25           | E 478                             |
| Carbon      | 0.05           | E 76                              |
| Copper      | 99.75          | E 478                             |
| Iron        | 1.25           | E 478                             |
|             | 9.0–11.0       | ISO 4748; Titrimetric             |
|             | 48.5–51.5      | ISO 4748; Titrimetric             |
| Lead        | 0.05           | E 478; Atomic Absorption          |
| Manganese   | 0.10–0.7       | E 62                              |
| Nickel      | 0.10           | E 478; Photometric                |
| incl Cobalt | 48–51          | E 76                              |
| Phosphorus  | 0.01–1.0       | E 62                              |
|             | 8.0–14.0       | E 1371                            |
| Silicon     | 0.05–32        | E 54; Perchloric Acid Dehydration |
| Sulfur      | 0.05–0.08      | E 76; Direct Combustion           |
| Tin         | 0.01–1         | E 478 Photometric                 |
| Zinc        | 0.10           | E 478; Atomic Absorption          |

9.2.2 The determination of calcium and magnesium, for which no recognized test method is known to be published, shall be subject to agreement between the manufacturer or supplier and the purchaser.

9.2.3 Test method(s) for the determination of elements required by contractual or purchase order agreement shall be as agreed upon between the manufacturer and the purchaser.

## 10. Significance of Numerical Limits

10.1 For purposes of determining compliance with the specified limits for chemical composition an observed or calculated value shall be rounded as indicated in accordance with the Rounding-Off method of Practice E 29.

| Property             | Rounded Limit for Observed or Calculated Value                                              |
|----------------------|---------------------------------------------------------------------------------------------|
| Chemical Composition | nearest unit in the last right-hand significant digit used in expressing the limiting value |

## 11. Inspection

11.1 The manufacturer shall inspect and make tests necessary to verify that the product furnished conforms to the specified requirements.

## 12. Rejection and Rehearing

### 12.1 *Rejection:*

12.1.1 Product which fails to conform to the requirements of this specification when inspected or tested by the purchaser or purchaser's agent may be rejected.

12.1.2 Rejection shall be reported to the manufacturer, or supplier, promptly and in writing.

12.1.3 When dissatisfied with test results upon which rejection was based, the manufacturer, or supplier, may make claim for a rehearing.

### 12.2 *Rehearing:*

12.2.1 As a result of product rejection, the manufacturer or supplier may make claim for a retest to be conducted by the manufacturer or supplier and the purchaser.

12.2.2 The portion selected for sampling shall be twice that required in 6.1.2. Sampling of the rejected product shall be in accordance with this specification and the composite sample shall be tested by both parties using the test methods prescribed in this specification, or, alternatively, upon agreement by both parties, an independent laboratory may be selected for the test(s) using the test methods prescribed in this specification.

## 13. Certification

13.1 The purchaser shall be furnished certification that samples representing each lot have been either tested or inspected as directed in this specification and the requirements have been met.

## 14. Test Report (Foundry)

14.1 A report of the test results shall be furnished.

## 15. Packaging and Package Marking

15.1 The material shall be packaged in sound containers, or shipped in bulk, in such a manner that none of the product is lost or contaminated in shipment.

15.2 When the shipment is made in bulk, it shall be accompanied by appropriate identification showing the material, grade designation, ASTM designation, size, lot number, and the name, brand, or trademark of the manufacturer.

15.3 When the shipment is made in containers, each shall be marked either on the container or on a label or on a tag attached thereto. The marking shall show the material, grade designation, ASTM designation, size, heat identification, gross, tare, and net weight, and the name, brand, or trademark of the manufacturer.

## 16. Keywords

16.1 copper alloys; copper alloy addition agents; copper base alloys

## SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall apply only when specified by the purchaser in the inquiry, contract or order, for agencies of the U.S. government.

## S1. Referenced Documents

S1.1 The following documents of the issue in effect on date of material purchase form a part of this specification to the extent referenced herein:

### S1.1.1 *Federal Standards:*<sup>5</sup>

Fed. Std. No. 102 Preservation, Packaging, and Packing Levels

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

Fed. Std. 185 Identification Marking of Copper and Copper-Base Alloy Mill Products

### S1.1.2 *Military Standard:*<sup>5</sup>

MIL-STD-129 Marking for Shipment and Storage

### S1.1.3 *Military Specification:*<sup>5</sup>

MIL-C-3993 Packaging of Copper and Copper-Base Alloy Mill Products

## S2. Quality Assurance

### S2.1 *Responsibility for Inspection:*

S2.1.1 Unless otherwise specified in the contract or purchase order, the manufacturer is responsible for the performance of all inspection and test requirements specified. Except as otherwise specified in the contract or purchase order, the manufacturer may use his own or any other suitable facilities for the performance of the inspection and test requirements unless disapproved by the purchaser at the time the order is placed. The purchaser shall have the right to perform any of the inspections or tests set forth when such inspections and tests are deemed necessary to assure that the material conforms to prescribed requirements.

## S3. Identification Marking

S3.1 All material shall be properly marked for identification in accordance with Fed. Std. No. 185 except that the ASTM specification number and the alloy number shall be used.

## S4. Preparation for Delivery

### S4.1 *Preservation, Packaging, Packing:*

S4.1.1 *Military Agencies*—The material shall be separated by size, composition, grade or class, and shall be preserved and packaged, level A or C, packed level A, B, or C as specified in

<sup>5</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, ATTN: NPODS.

the contract or purchase order, in accordance with the requirements of MIL-C-3993.

S4.1.2 *Civil Agencies*—The requirements of Fed. Std. No. 102 shall be referenced for definitions of the various levels of packaging protection.

S4.2 *Marking*:

S4.2.1 *Military Agencies*—In addition to any special marking required by the contract or purchase order, marking for shipment shall be in accordance with MIL-STD-129.

S4.2.2 *Civil Agencies*—In addition to any special marking required by the contract or purchase order, marking for shipment shall be in accordance with Fed. Std. No. 123.

## SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue (B 644 – 88) that may impact the use of this standard.

(1) New sections with this revision are Terminology, Specimen Preparation, Significance of Numerical Limits, and Test Report (Foundry).

(2) Sections that have been revised are: Scope, Materials and Manufacturing, Chemical Composition, Tests and Retests, Sampling, Inspection, Certification, Test Reports, Rejection

and Rehearing, and Packaging and Package Marking.

(3) Minimum limits have been established for copper in the Copper-Nickel Alloy and the two Ferro Copper Alloys.

(4) Analytical test methods are identified for each element and concentration.

(5) Certification is now mandatory with this revision.

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