



Designation: B456 – 17

Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium¹

This standard is issued under the fixed designation B456; 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 covers requirements for several types and grades of electrodeposited copper plus nickel plus chromium or nickel plus chromium coatings on steel, nickel plus chromium coatings on copper and copper alloys, nickel plus chromium coatings on Type 300 and 400 series stainless steel and copper plus nickel plus chromium coatings on aluminum and its alloys and zinc alloys for applications where both appearance and protection of the basis metal against corrosion are important. Five grades of coatings are provided to correspond with the service conditions under which each is expected to provide satisfactory performance: namely, extended very severe, very severe, severe, moderate, and mild. Definitions and typical examples of these service conditions are provided in [Appendix X1](#).

1.2 This specification does not cover the requirements for the plating on plastics, see Specification [B604](#).

1.3 The following hazards caveat pertains only to the test methods portions, [Appendix X2](#), [Appendix X3](#), [Appendix X4](#), and [Appendix X5](#) of this specification: *This standard does not purport to address all of 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.*

1.4 *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

- [B183 Practice for Preparation of Low-Carbon Steel for Electroplating](#)
- [B242 Guide for Preparation of High-Carbon Steel for Electroplating](#)
- [B252 Guide for Preparation of Zinc Alloy Die Castings for Electroplating and Conversion Coatings](#)
- [B253 Guide for Preparation of Aluminum Alloys for Electroplating](#)
- [B254 Practice for Preparation of and Electroplating on Stainless Steel](#)
- [B281 Practice for Preparation of Copper and Copper-Base Alloys for Electroplating and Conversion Coatings](#)
- [B320 Practice for Preparation of Iron Castings for Electroplating](#)
- [B368 Test Method for Copper-Accelerated Acetic Acid-Salt Spray \(Fog\) Testing \(CASS Test\)](#)
- [B380 Test Method for Corrosion Testing of Decorative Electrodeposited Coatings by the Corrodokote Procedure](#)
- [B487 Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of Cross Section](#)
- [B489 Practice for Bend Test for Ductility of Electrodeposited and Autocatalytically Deposited Metal Coatings on Metals](#)
- [B490 Practice for Micrometer Bend Test for Ductility of Electrodeposits](#)
- [B499 Test Method for Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals](#)
- [B504 Test Method for Measurement of Thickness of Metallic Coatings by the Coulometric Method](#)
- [B530 Test Method for Measurement of Coating Thicknesses by the Magnetic Method: Electrodeposited Nickel Coatings on Magnetic and Nonmagnetic Substrates](#)

¹ This specification is under the jurisdiction of ASTM Committee [B08](#) on Metallic and Inorganic Coatings and is the direct responsibility of Subcommittee [B08.05](#) on Decorative Coatings.

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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.

- B537 Practice for Rating of Electroplated Panels Subjected to Atmospheric Exposure
- B568 Test Method for Measurement of Coating Thickness by X-Ray Spectrometry
- B571 Practice for Qualitative Adhesion Testing of Metallic Coatings
- B602 Test Method for Attribute Sampling of Metallic and Inorganic Coatings
- B604 Specification for Decorative Electroplated Coatings of Copper Plus Nickel Plus Chromium on Plastics
- B659 Guide for Measuring Thickness of Metallic and Inorganic Coatings
- B697 Guide for Selection of Sampling Plans for Inspection of Electrodeposited Metallic and Inorganic Coatings
- B762 Test Method of Variables Sampling of Metallic and Inorganic Coatings
- B764 Test Method for Simultaneous Thickness and Electrode Potential Determination of Individual Layers in Multilayer Nickel Deposit (STEP Test)
- B995 Test Method for Chloride Resistance Test for Chromium Electroplated Parts (Russian Mud Test)
- D1193 Specification for Reagent Water
- D3951 Practice for Commercial Packaging
- E50 Practices for Apparatus, Reagents, and Safety Considerations for Chemical Analysis of Metals, Ores, and Related Materials
- G85 Practice for Modified Salt Spray (Fog) Testing
- 2.2 ISO Standards:
- ISO 1456 Metallic coatings—Electrodeposited coatings of nickel plus chromium and of copper plus nickel plus chromium³

3. Terminology

3.1 Definitions:

3.1.1 *significant surfaces*—those surfaces normally visible (directly or by reflection) that are essential to the appearance or serviceability of the article, or both, when assembled in normal position; or that can be the source of corrosion products that deface visible surfaces on the assembled article. When necessary, the significant surfaces shall be specified by the purchaser and shall be indicated on the drawings of the parts, or by the provision of suitably marked samples.

3.1.2 *p-points*—specific points of measurement that are encouraged to be determined and agreed upon with the customer early in the contract review process. These are used for measurement of critical characteristics that vary with current density such as thickness, STEP, active sites, etc. and may be designated at multiple locations per part.

4. Classification

4.1 Five grades of coatings designated by service condition numbers and several types of coatings defined by classification numbers are covered by this specification.

4.2 Service Condition Number:

4.2.1 The service condition number indicates the severity of exposure for which the grade of coating is intended:

- SC 5 extended severe service
- SC 4 very severe service,
- SC 3 severe service,
- SC 2 moderate service, and
- SC 1 mild service.

4.2.2 Typical service conditions for which the various service condition numbers are appropriate are given in **Appendix X1**.

4.3 *Coating Classification Number*—The coating classification number comprises:

4.3.1 The chemical symbol for the basis metal (or for the principal metal if an alloy) followed by a slash mark, except in the case of stainless steel. In this case, the designation shall be SS followed by the designated AISI number followed by a slash, that is, SS463/.

4.3.2 The chemical symbol for copper (Cu) (if copper is used),

4.3.3 A number indicating the minimum thickness of the copper coating in micrometers (if copper is used),

4.3.4 A lower-case letter designating the type of copper deposit (if copper is used) (see 4.4 and 6.2.3),

4.3.5 The chemical symbol for nickel (Ni),

4.3.6 A number indicating the minimum thickness of the nickel coating, in micrometers,

4.3.7 A lower-case letter designating the type of nickel deposit (see 4.4 and 6.2.4),

4.3.8 The chemical symbol for chromium (Cr), and

4.3.9 A letter (or letters) designating the type of chromium deposit and its minimum thickness in micrometers (see 4.4 and 6.2.5).

4.4 *Symbols for Expressing Classification*—The following lower-case letters shall be used in coating classification numbers to describe the types of coatings:

- a —ductile copper deposited from acid-type baths
- b —single-layer nickel deposited in the fully-bright condition
- d —double- or triple-layer nickel coatings
- r —regular (that is, conventional) chromium
- mc —microcracked chromium
- mp —microporous chromium

4.5 *Example of Complete Classification Numbers*—A coating on steel comprising 15 µm minimum (ductile acid) copper plus 25 µm minimum (duplex) nickel plus 0.25 µm minimum (micro-cracked) chromium has the classification number: Fe/Cu15aNi25d Cr mc (see 4.3 and 6.2 for explanation of symbols).

5. Ordering Information

5.1 When ordering articles to be electroplated in conformance with this standard, the purchaser shall state the following:

5.1.1 The ASTM designation number of this standard.

5.1.2 Either the classification number of the specific coating required (see 4.3) or the substrate material and the service condition number denoting the severity of the conditions it is required to withstand (see 4.2). If the service condition number is quoted and not the classification number, the manufacturer is free to supply any of the types of coatings designated by the

³ Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, <http://www.iso.ch>.

classification numbers corresponding to the specified service condition number, as given in [Table 1](#), [Table 2](#), [Table 3](#), [Table 4](#), or [Table 5](#). On request, the manufacturer shall inform the purchaser of the classification number of the coating applied.

5.1.3 The appearance required, for example, bright, dull, or satin. Alternatively, samples showing the required finish or range of finish shall be supplied or approved by the purchaser.

5.1.4 The significant surfaces, to be indicated on drawings of the parts, or by the provision of suitably marked specimens (see [3.1](#)).

5.1.5 The positions on significant surfaces for rack or contact marks, where such marks are unavoidable (see [6.1.1](#)).

5.1.6 The extent to which defects shall be tolerated on nonsignificant surfaces.

5.1.7 The elongation of copper if other than the standard value (see [6.4](#)).

5.1.8 The ductility of the nickel if other than the standard value (see [6.5](#)).

5.1.9 The extent of tolerable surface deterioration after corrosion testing (see [6.8.3](#)).

5.1.10 Sampling methods and acceptance levels (see [Section 7](#)).

5.1.11 The minimum and maximum values of the electrode potential differences between individual nickel layers as measured in accordance with Test Method [B764](#) within the limits given in [6.9](#).

5.1.12 *Adhesion Test*—The adhesion test to be used (see [6.3](#)).

6. Product Requirements

6.1 Visual Defects:

6.1.1 The significant surfaces of the electroplated article shall be free of clearly visible plating defects, such as blisters, pits, roughness, cracks, and uncoated areas and shall not be stained or discolored. On articles where a visible contact mark is unavoidable, its position shall be agreed upon by the purchaser and the plater. The electroplated article shall be clean and free of damage.

TABLE 1 Nickel Plus Chromium Coatings on Steel

NOTE 1—When permitted by the purchaser, copper may be used as an undercoat for nickel but is not substitutable for any part of the nickel thickness specified. If the use of copper is permitted, [Table 2](#) may be used to obtain the same service conditions.

NOTE 2—Satin nickel may replace or be deposited over the bright nickel layer per supplier recommendations.

NOTE 3—Substrate condition can have a significant impact on corrosion performance.

Service Condition No.	Classification No.	Nickel Thickness, μm
SC 5	Fe/Ni35d Cr mc	35
	Fe/Ni35d Cr mp	35
SC 4	Fe/Ni30d Cr mc	30
	Fe/Ni30d Cr mp	30
SC 3	Fe/Ni25d Cr mc	25
	Fe/Ni25d Cr mp	25
SC 2	Fe/Ni20b Cr r	20
	Fe/Ni15b Cr mc	15
SC 1	Fe/Ni15b Cr mp	15
	Fe/Ni10b Cr r	10

TABLE 2 Copper Plus Nickel Plus Chromium Coatings on Steel

Service Condition No.	Classification No.	Nickel Thickness, μm
SC 5	Fe/Cu15a Ni30d Cr mc	30
	Fe/Cu15a Ni30d Cr mp	30
SC 4	Fe/Cu15a Ni25d Cr mc	25
	Fe/Cu15a Ni25d Cr mp	25
SC 3	Fe/Cu12a Ni20d Cr mc	20
	Fe/Cu12a Ni20d Cr mp	20

TABLE 3 Copper Plus Nickel Plus Chromium Coatings on Zinc Alloy

Service Condition No.	Classification No.	Nickel Thickness, μm
SC 5	Zn/Cu5 Ni35d Cr mc	35
	Zn/Cu5 Ni35d Cr mp	35
SC 4	Zn/Cu5 Ni30d Cr mc	30
	Zn/Cu5 Ni30d Cr mp	30
SC 3	Zn/Cu5 Ni20d Cr mc	20
	Zn/Cu5 Ni20d Cr mp	20
SC 2	Zn/Cu5 Ni20b Cr r	20
	Zn/Cu5 Ni15b Cr mc	15
SC 1	Zn/Cu5 Ni15b Cr mp	15
	Zn/Cu5 Ni10b Cr r	10

TABLE 4 Nickel Plus Chromium Coatings on Copper or Copper Alloy

Service Condition No.	Classification No.	Nickel Thickness, μm
SC 4	Cu/Ni25d Cr mc	25
	Cu/Ni25d Cr mp	25
SC 3	Cu/Ni20d Cr mc	20
	Cu/Ni20d Cr mp	20
SC 2	Cu/Ni30b Cr r	30
	Cu/Ni25b Cr mc	25
SC 1	Cu/Ni25b Cr mp	25
	Cu/Ni15b Cr r	15
SC 1	Cu/Ni10b Cr mc	10
	Cu/Ni10b Cr mp	10
SC 1	Cu/Ni5b Cr r	5

6.1.2 Defects in the surface of the basis metal, such as scratches, porosity, nonconducting inclusions, roll and die marks, cold shuts, weld imperfections, and cracks, may adversely affect the appearance and the performance of coatings applied thereto despite the observance of the best electroplating practices. Accordingly, the plater's responsibility for defects in the coating resulting from such conditions shall be waived.

NOTE 1—To minimize problems of this type, the specifications covering the basis material or the item to be electroplated should contain appropriate limitations on such basis metal conditions. Furthermore, areas such as welds may be excluded from certain performance criteria based upon mutual agreement of purchaser and supplier.

6.2 Process and Coating Requirements:

6.2.1 Proper preparatory procedures and thorough cleaning of the basis metal surface are essential for satisfactory adhesion and corrosion performance of the coating. Accordingly, the applicable practices for the preparation of various basis metals for electroplating shall be followed. Practices [B183](#), [B242](#), [B252](#), [B281](#), and [B320](#) are examples of practices that may be used for the preparation of basis metals.

6.2.2 Following the preparatory operations, the parts (articles) to be electroplated are introduced in such plating baths