



Designation: B456 – 03

# Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium<sup>1</sup>

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 ( $\epsilon$ ) 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 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.*

## 2. Referenced Documents

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

- [B183 Practice for Preparation of Low-Carbon Steel for Electroplating](#)<sup>2</sup>
- [B242 Guide for Preparation of High-Carbon Steel for Electroplating](#)<sup>2</sup>
- [B252 Guide for Preparation of Zinc Alloy Die Castings for](#)

### [Electroplating and Conversion Coatings](#)<sup>2</sup>

- [B253 Guide for Preparation of Aluminum Alloys for Electroplating](#)<sup>2</sup>
- [B254 Practice for Preparation of and Electroplating on Stainless Steel](#)<sup>2</sup>
- [B281 Practice for Preparation of Copper and Copper-Base Alloys for Electroplating and Conversion Coatings](#)<sup>2</sup>
- [B320 Practice for Preparation of Iron Castings for Electroplating](#)<sup>2</sup>
- [B368 Test Method for Copper-Accelerated Acetic Acid-Salt Spray \(Fog\) Testing \(CASS Test\)](#)<sup>2</sup>
- [B380 Test Method for Corrosion Testing of Decorative Electrodeposited Coatings by the CorrodKote Procedure](#)<sup>2</sup>
- [B487 Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of Cross Section](#)<sup>2</sup>
- [B489 Practice for Bend Test for Ductility of Electrodeposited and Autocatalytically Deposited Metal Coatings on Metals](#)<sup>2</sup>
- [B490 Practice for Micrometer Bend Test for Ductility of Electrodeposits](#)<sup>2</sup>
- [B499 Test Method for Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals](#)<sup>2</sup>
- [B504 Test Method for Measurement of Thickness of Metallic Coatings by the Coulometric Method](#)<sup>2</sup>
- [B530 Test Method for Measurement of Coating Thicknesses by the Magnetic Method: Electrodeposited Nickel Coatings on Magnetic and Nonmagnetic Substrates](#)<sup>2</sup>
- [B537 Practice for Rating of Electroplated Panels Subjected to Atmospheric Exposure](#)<sup>2</sup>
- [B568 Test Method for Measurement of Coating Thickness by X-Ray Spectrometry](#)<sup>2</sup>
- [B571 Practice for Qualitative Adhesion Testing of Metallic Coatings](#)<sup>2</sup>
- [B602 Test Method for Attribute Sampling of Metallic and Inorganic Coatings](#)<sup>2</sup>
- [B604 Specification for Decorative Electroplated Coatings of Copper Plus Nickel Plus Chromium on Plastics](#)<sup>2</sup>

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 02.05.

- [B659 Guide for Measuring Thickness of Metallic and Inorganic Coatings](#) <sup>2</sup>
- [B697 Guide for Selection of Sampling Plans for Inspection of Electrodeposited Metallic and Inorganic Coatings](#) <sup>2</sup>
- [B762 Test Method of Variables Sampling of Metallic and Inorganic Coatings](#) <sup>2</sup>
- [B764 Test Method for Simultaneous Thickness and Electrode Potential Determination of Individual Layers in Multilayer Nickel Deposit \(STEP Test\)](#) <sup>3</sup>
- [D1193 Specification for Reagent Water](#) <sup>4</sup>
- [D3951 Practice for Commercial Packaging](#) <sup>5</sup>
- [E50 Practices for Apparatus, Reagents, and Safety Considerations for Chemical Analysis of Metals, Ores, and Related Materials](#) <sup>3</sup>
- [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 chromium<sup>6</sup>

## 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.

## 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 micrometres (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 micrometres,

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 micrometres (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 0.25µ m 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 classification numbers corresponding to the specified service condition number, as given in [Table 1](#), [Table 2](#), [Table 3](#), [Table](#)

**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.

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

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 11.01.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 15.09.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 03.05.

<sup>6</sup> Available from International Standards Organization, 1 Rue de Varembe, Geneva 20, Switzerland.

**TABLE 2 Copper Plus Nickel Plus Chromium Coatings on Steel**

Service Condition No.	Classification No.	Nickel Thickness, $\mu\text{m}$
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, $\mu\text{m}$
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

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 6.7.3).

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

**TABLE 4 Nickel Plus Chromium Coatings on Copper or Copper Alloy**

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

**TABLE 5 Nickel Plus Chromium<sup>A</sup> on Stainless Steels, AISI Designated Type 300 and 400 Series,<sup>B</sup> and Copper Plus Nickel Plus Chromium on Aluminum and Its Alloys**

NOTE 1—Before nickel-chromium plating, the stainless steel surface and the aluminum substrate shall be prepared by a pretreatment from Practice B254,<sup>C</sup> Guide B253,<sup>D</sup> or equivalent, which is agreed upon between the supplier and the user.

Service Condition No.	Classification No.	Nickel Thickness, $\mu\text{m}$
SC 4	SS-3XX <sup>E</sup> /Ni20b/Cr mp	20
SC 4	SS-4xx <sup>E</sup> /Ni25b/Cr mp	25
SC 5	Al/Cu15a/Ni40d/Cr mp	40

<sup>A</sup> Data in Table 5 were obtained using only microporous chromium systems. No data are available for the use of standard or microcracked systems.

<sup>B</sup> The stainless steel alloy numbers used in this specification are based on the AISI system. They may not be interchangeable with other numbering systems such as the United Numbering System (UNS) or foreign designations.

<sup>C</sup> Preplate for stainless steel substrates.

<sup>D</sup> Preplate for aluminum substrates.

<sup>E</sup> Insert number for specific 300 or 400 alloy.

5.1.11 The minimum values of the electrode potential differences between individual nickel layers as measured in accordance with Test Method B764 within the limits given in 6.8.

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.

6.1.2 Defects in the surface of the basis metal, such as scratches, porosity, nonconducting inclusions, roll and die marks, cold shuts, 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.

### 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 as required to produce the types of deposits described by the specific coating classification numbers or one of the coating

classification numbers listed in [Table 1](#), [Table 2](#), [Table 3](#), [Table 4](#), or [Table 5](#) appropriate for the specified service condition number.

### 6.2.3 Type of Copper and Deposit Thickness:

6.2.3.1 *Type of Copper*—The type of copper is designated by the following symbols that are placed after the thickness value:

a for ductile copper deposited from acid-type baths containing additives that promote leveling by the copper deposit and that have an elongation not less than 8 %.

No symbol is placed after the thickness value if a minimum elongation is not required or if a deposit from a non-leveling bath is permitted.

6.2.3.2 *Thickness of Copper Deposits*—The number following the chemical symbol for copper (Cu) indicates in micrometres the minimum thickness of the copper deposit at points on significant surfaces (see [3.1](#)).

### 6.2.4 Type of Nickel and Deposit Thickness:

6.2.4.1 *Type of Nickel*—The type of nickel is designated by the following symbols, which are placed after the thickness value ([Note 5](#)):

b for nickel deposited in the fully bright condition.

d for a double-layer or triple-layer nickel coating.

The bottom layer of this coating system shall contain less than 0.005 mass % sulfur ([Note 3](#)), and a minimum ductility of 67 % (see [Practice B490](#)). The top layer of this system shall contain more than 0.04 mass % sulfur ([Note 2](#) and [Note 3](#)), and have a minimum ductility of 11 %. Its thickness shall be not less than 20 % nor more than 40 % (see [Table 6](#)) of the total nickel thickness. The thickness of the bottom layer in double-layer coatings shall not be less than 60 % nor more than 80 % of the total nickel thickness. In triple-layer coatings, the bottom layer shall be not less than 50 % nor more than 70 %. If there are three layers, the intermediate layer shall contain not less than 0.15 mass % sulfur and shall not exceed 10 % of the total nickel thickness. These requirements for multilayer nickel coatings are summarized in [Table 6](#).

**NOTE 2**—The sulfur contents are specified in order to indicate which type of nickel electroplating solution must be used. Although at present, no simple method is available for determining the sulfur content of a nickel deposit on a coated article, chemical determinations are possible using specially prepared test specimens (see [Appendix X3](#)).

**NOTE 3**—It will usually be possible to identify the type of nickel by microscopical examination of the polished and etched section of an article prepared in accordance with [Test Method B487](#). The thickness of the individual nickel layers in double-layer and triple-layer coatings, as well

as the electrochemical relationships between the individual layers, can also be measured by the STEP test,<sup>7</sup> in accordance with [Test Method B764](#).

6.2.4.2 *Thickness of Nickel Deposit*—The number following the chemical symbol Ni indicates, in micrometres, the minimum thickness of the nickel electrodeposit at points on the significant surface (see [3.1](#)).

### 6.2.5 Type of Chromium and Deposit Thickness:

6.2.5.1 *Type of Chromium*—The type of chromium deposit is designated by the following symbols placed after the chemical symbol Cr:

r for “regular” (that is, conventional) chromium.

mc for microcracked chromium, having more than 30 cracks/mm in any direction over the whole of the significant surface. The cracks shall be invisible to the unaided eye (see [6.10](#)).

mp for microporous chromium containing a minimum of 10 000 pores/10 mm by 10 mm square (10 000/cm<sup>2</sup>). The pores shall be invisible to the unaided eye (see [6.10](#)).

**NOTE 4**—A specially formulated nickel strike in between the bright nickel and the chromium deposits may be used to induce micropores or microcracks in the chromium deposits. Controlled particle impingement of the plated standard chromium deposit may also be used to induce microporous chromium. Trivalent chromium deposits, as plated, may be microporous, microcracked, or both.

6.2.5.2 *Thickness of Chromium Deposit*—The minimum thickness of the chromium deposit shall be 0.25 μm on significant surfaces (see [3.1](#)), except that for service condition SC 1 (see [4.2.1](#)) the minimum thickness may be reduced to 0.13 μm. The thickness of chromium is designated by the same symbol as the type instead of by numerals as in the case of copper and nickel.

6.2.5.3 When plating chromium over a nickel strike containing micro-particles used to induce microporosity in the subsequent chromium deposit, excess chromium thickness will bridge the nonconductive particles within the nickel layer. A maximum of 0.5 μm is recommended.

6.3 *Adhesion*—The coating shall be sufficiently adherent to the basis metal, and the separate layers of multilayer coatings shall be sufficiently adherent to each other, to pass the appropriate tests detailed in [Test Methods B571](#). The particular test or tests to be used shall be specified by the purchaser.

6.4 *Elongation*—The elongation of copper shall be such that it will not be less than stated in [6.2.3.1](#) when tested by the method given in [Appendix X2](#). Greater elongation may be requested but shall be subject to agreement between the purchaser and the manufacturer.

6.5 *Ductility*—The ductility of the composite nickel deposit on a finished part is considered acceptable when foils plated out of the individual nickel processes meet or exceed the values listed in [Table 6](#). See test details in [Test Method B490](#).

### 6.6 Coating Thickness:

6.6.1 The minimum coating thickness shall be as designated by the coating classification number.

<sup>7</sup> Harbulak, E. P., “Simultaneous Thickness and Electrochemical Potential Determination of Individual Layers in Multilayer Nickel Deposits,” *Plating and Surface Finishing*, Vol 67, No. 49, February 1980.

**TABLE 6 Summary of the Requirements for Double- and Triple-Layer Nickel Coatings**

Type of Nickel Layer	Ductility	Sulfur Content	Thickness Relative to Total Nickel Thickness	
			Double Layer	Triple Layer
Bottom	67 %	<0.005 mass %	60 to 80 %	50 to 70 %
Middle (high-sulfur)	...	>0.15 mass %	...	≤10 %
Top (bright)	11 %	>0.04 mass %	20 to 40 %	≥30 %
Test Method	See <a href="#">B490</a>	See <a href="#">Note 2</a> <sup>4</sup>	...	<a href="#">Note 3</a> <sup>4</sup>

<sup>4</sup> For [Note 2](#) and [Note 3](#), see [Section 6](#).



**TABLE 7 Corrosion Tests Appropriate for Each Service Condition Number**

Basis Metals	Service Condition No.	Corrosion Test and Duration h		
		CASS Method B368	Corrodokote Method B380	Acetic-salt Method G85
Steel, zinc alloy, or copper and copper alloy, stainless steel and aluminum alloys	SC 5	66	...	...
	SC 4	22	Two 16-h cycles	144
	SC 3	16	16	96
	SC 2	8	4	24
	SC 1	...	...	8

6.6.2 It is recognized that requirements may exist for thicker coatings than are covered by this specification.

6.6.3 The thickness of a coating and its various layers shall be measured at points on the significant surfaces (See 3.1.1 and Note 5).

NOTE 5—When significant surfaces are involved on which the specified thickness of deposit cannot readily be controlled, such as threads, holes, deep recesses, bases of angles, and similar areas, the purchaser and the manufacturer should recognize the necessity for either thicker deposits on the more accessible surfaces or for special racking. Special racks may involve the use of conforming, auxiliary, or bipolar electrodes or nonconducting shields.

6.6.3.1 The coulometric method described in Test Method B504 may be used to measure thickness of the chromium, the total thickness of the nickel, and the thickness of the copper. The STEP test, Test Method B764, which is similar to the coulometric method, may be used to closely estimate the thicknesses of individual layers of nickel in a multilayer coating.

6.6.3.2 The microscopical method described in Test Method B487 may be used to measure the thickness of each nickel layer and of the copper layer.

6.6.3.3 The X-ray method described in Test Method B568 may be used when the total thickness of a copper/nickel/chromium composite coating is to be measured, without any indication of the thickness of each individual layer.

6.6.3.4 Other methods may be used if it can be demonstrated that the uncertainty of the measurement is less than 10 %, or less than that of any applicable method mentioned in 6.6.3. Other methods such as B499 and B530, as outlined in Guide B659, may be used if agreed upon between the purchaser and manufacturer.

### 6.7 Corrosion Testing:

6.7.1 Coated articles shall be subjected to the corrosion test for a period of time that is appropriate for the particular service condition number (or for the service condition number corresponding to a specified classification number) as shown in Table 5. The test is described in detail in the referenced ASTM designation.

NOTE 6—There is no direct relation between the results of an accelerated corrosion test and the resistance to corrosion in other media, because several factors, such as the formation of protective films, influence the progress of corrosion and vary greatly with the conditions encountered. The results obtained in the test should, therefore, not be regarded as a direct guide to the corrosion resistance of the tested materials in all environments where these materials may be used. Also, performance of different materials in the test cannot always be taken as a direct guide to the relative resistance of these materials in service.

6.7.2 After the article has been subjected to the treatment described in the relevant corrosion test method, it shall be examined for corrosion of the basis metal or blistering of the coating. Any basis metal corrosion or blistering of the coating shall be cause for rejection. It is to be understood that occasional widely scattered, small corrosion defects such as surface pits may be observed after the testing period. In general, “acceptable resistance” shall mean that such defects are not, when viewed critically, significantly defacing or otherwise deleterious to the function of the electroplated part. A method of rating corrosion is given in Practice B537.

6.7.3 Surface deterioration of the coating itself is expected to occur during the testing of some types of coatings. The extent to which such surface deterioration will be tolerated shall be specified by the purchaser.

### 6.8 STEP Test Requirements:

6.8.1 The electrode potential differences between individual nickel layers shall be measured for multilayer coatings corresponding to SC5, SC4, and SC3 in accordance with Test Method B764 (STEP Test).

NOTE 7—Universally accepted STEP values have not been established but some agreement in the value of ranges has been obtained. The STEP values depend upon which two nickel layers are being measured.

The STEP potential difference between the semi-bright nickel layer and the bright nickel layer has an accepted range of 100 to 200 mV with a typical range of 110 to 140 mV. For all combinations of nickel layers, the semi-bright nickel layer is more noble (cathodic) than the bright nickel layer.

The STEP potential difference between the high-activity nickel layer and the bright nickel layer in triple-layer coatings has an accepted potential range of 15 to 35 mV. The high-activity nickel layer is more active (anodic) than the bright nickel layer.

The STEP potential difference between the bright nickel layer and a nickel (particle nickel) layer between the bright nickel layer and the chromium layer has an accepted potential range of 0 to 30 mV. The bright nickel layer is more active (anodic) than the particle nickel layer prior to chromium.

### 6.9 Sulfur Content:

6.9.1 The sulfur content of the nickel deposit shall meet the maximum or minimum values as stated in 6.2.4.1 and Table 6.

6.9.2 A method to determine sulfur is presented in Appendix X3. Any reliable method may be used.

### 6.10 Density and Measurement of the Discontinuities in Chromium:

6.10.1 The density of cracks or pores in microcracked or microporous chromium deposits shall meet minimum values. Microcracked chromium shall have more than 30 cracks/mm (300 cracks/cm) in any direction over the whole of the significant surface. Microporous chromium shall contain a

minimum of 10 000 pores/10 by 10 mm square (10 000 pores/cm<sup>2</sup>) in any location over the whole of the significant surface. The cracks and pores shall be invisible to the unaided eye.

6.10.2 A method for measuring the discontinuities, referred to as Dubpernell sites, is given in [Appendix X4](#). A method for measuring the number of corrosion sites formed during corrosion, referred to as active sites, is given in [Appendix X5](#).

## 7. Sampling Requirements

7.1 The sampling plan used for the inspection of a quantity of coated articles shall be as agreed upon by the purchaser and supplier.

NOTE 8—Usually, when a collection of coated articles, the inspection lot, is examined for compliance with the requirements placed on the coating, a relatively small number of the articles, the sample, is selected at random and is inspected. The inspection lot is then classified as complying or not complying with the requirements based on the results of the inspection of the sample. The size of the sample and the criteria of compliance are determined by the application of statistics. The procedure is known as sampling inspection. Three standards, Test Method [B602](#), Guide [B697](#), and Method [B762](#) contain sampling plans that are designed for the sampling inspection of coatings.

Test Method [B602](#) contains four sampling plans, three for use with tests that are non-destructive and one when they are destructive. The buyer and seller may agree on the plan or plans to be used. If they do not, Test Method [B602](#) identifies the plan to be used.

Guide [B697](#) provides a large number of plans and also gives guidance on the selection of a plan. When Guide [B697](#) is specified, the buyer and seller need to agree on the plan to be used.

Method [B762](#) can be used only for coating requirements that have a numerical limit, such as coating thickness. The test must yield a numerical value and certain statistical requirements must be met. Method [B762](#) contains several plans and also gives instructions for calculating plans to meet special needs. The buyer and the seller may agree on the plan or

plans to be used. If they do not, Test Method [B762](#) identifies the plan to be used.

NOTE 9—When both destructive and nondestructive tests exist for the measurement of a characteristic, the purchaser needs to state which is to be used so the proper sampling plan is selected. A test may destroy the coating but in a noncritical area; or, although it may destroy the coating, a tested part may be reclaimed by stripping and recoating. The purchaser needs to state whether the test is to be considered destructive or nondestructive.

7.2 An inspection lot shall be defined as a collection of coated articles that are of the same kind, that have been produced to the same specifications, that have been coated by a single supplier at one time or approximately the same time under essentially identical conditions, and that are submitted for acceptance or rejection as a group.

7.3 If separate test specimens are used to represent the coated articles in a test, the specimens shall be of the nature, size, and number and be processed as required in [Appendix X2](#), [Appendix X3](#), [Appendix X4](#), and [Appendix X5](#). Unless a need can be demonstrated, separately prepared specimens shall not be used in place of production items for nondestructive tests and visual examination. For destructive tests including determination of adhesion, ductility, sulfur contents, the number of discontinuities, and corrosion testing, separately prepared specimens may be used.

## 8. Packaging

8.1 Parts plated for the U.S. Government and military, including subcontracts, shall be packaged in accordance with Practice [D3951](#).

## 9. Keywords

9.1 corrosion; decorative; electrodeposited chromium; electrodeposited copper; electrodeposited nickel

<https://standards.iteh.ai/catalog/standards/sist/16d8de15-5401-483d-bec5-dbc1be69ceb7/astm-b456-03>

<https://standards.iteh.ai/catalog/standards/sist/16d8de15-5401-483d-bec5-dbc1be69ceb7/astm-b456-03>

## APPENDIXES

(Nonmandatory Information)

### X1. DEFINITIONS AND EXAMPLES OF SERVICE CONDITIONS FOR WHICH THE VARIOUS SERVICE CONDITION NUMBERS ARE APPROPRIATE

X1.1 *Service Condition No. SC 5 (Extended Very Severe)*—Service conditions that include likely damage from denting, scratching, and abrasive wear in addition to exposure to corrosive environments where *long-time protection* of the substrate is required; for example, conditions encountered by some exterior components of automobiles.

X1.2 *Condition No. SC 4 (Very Severe)*—Service conditions that include likely damage from denting, scratching, and abrasive wear in addition to exposure to corrosive environments; for example, conditions encountered by exterior components of automobiles and by boat fittings in salt water service.

X1.3 *Service Condition No. SC 3 (Severe)*—Exposure that is likely to include occasional or frequent wetting by rain or dew or possibly strong cleaners and saline solutions; for example, conditions encountered by porch and lawn furniture; bicycle and perambulator parts; hospital furniture and fixtures.

X1.4 *Service Condition No. SC 2 (Moderate)*—Exposure indoors in places where condensation of moisture may occur; for example, in kitchens and bathrooms.

X1.5 *Service Condition No. SC 1 (Mild)*—Exposure indoors in normally warm, dry atmospheres with coating subject to minimum wear or abrasion.