Designation: B694 – 13

Standard Specification for Copper, Copper-Alloy, Copper-Clad Bronze (CCB), Copper-Clad Stainless Steel (CCS), and Copper-Clad Alloy Steel (CAS) Sheet and Strip for Electrical Cable Shielding[1]

This standard is issued under the fixed designation B694; 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.

1. Scope*

1.1 This specification establishes the requirements for copper, copper alloy, copper-clad bronze (CCB), copper-clad stainless steel (CCS), and copper-clad alloy steel (CAS) materials, sheet, and strip, in various thicknesses, for use as electrostatic or electromagnetic shielding for insulated power, control, instrumentation, and communication cables.

NOTE 1—See Specification B736, for related standards for aluminum-based shielding materials.

1.2 The products covered are the following:

Copper or Copper Alloy UNS No.	Type of Products
C11000	copper
C19400	copper-iron alloy
C22000	copper-zinc alloy (commercial bronze)
C23000	copper-zinc alloy (red brass)
C66400	copper-zinc-iron-cobalt alloy
C66410	copper-zinc-iron alloy
C66430	copper-zinc-iron-tin alloy
C71000	cupro-nickel 20 %
...	copper-clad bronze (CCB)
...	copper-clad stainless steel (CCS)
...	copper-clad alloy steel (CAS)

1.3 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.

1.3.1 The only exception is grain size, which is reported in SI (mm) units.

1.4 *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:*[2]

A176 Specification for Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip

A505 Specification for Steel, Sheet and Strip, Alloy, Hot-Rolled and Cold-Rolled, General Requirements for

B152/B152M Specification for Copper Sheet, Strip, Plate, and Rolled Bar

B193 Test Method for Resistivity of Electrical Conductor Materials

B248 Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar

B601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast

B736 Specification for Aluminum, Aluminum Alloy and Aluminum-Clad Steel Cable Shielding Stock

B846 Terminology for Copper and Copper Alloys

E3 Guide for Preparation of Metallographic Specimens

E8 Test Methods for Tension Testing of Metallic Materials

E54 Test Methods for Chemical Analysis of Special Brasses and Bronzes (Withdrawn 2002)[3]

E62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods) (Withdrawn 2010)[3]

E75 Test Methods for Chemical Analysis of Copper-Nickel and Copper-Nickel-Zinc Alloys (Withdrawn 2010)[3]

E112 Test Methods for Determining Average Grain Size

E255 Practice for Sampling Copper and Copper Alloys for

[1] This specification is under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.01 on Plate, Sheet, and Strip.

Current edition approved April 1, 2013. Published April 2013. Originally approved in 1981. Last previous edition approved in 2010 as B694 – 10. DOI: 10.1520/B0694-13.

[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.

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

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

the Determination of Chemical Composition
E478 Test Methods for Chemical Analysis of Copper Alloys

2.2 *International Standards Organization (ISO) Standards:*
ISO 3110/2 Determination of Aluminum; Flame Atomic Absorption Spectrometric Method (TC/26 Ref. No. N698 E/F)[4]

3. General Requirements

3.1 The following sections of Specification B248 constitute a part of this specification:
3.1.1 Terminology,
3.1.2 Materials and Manufacture,
3.1.3 Workmanship, Finish, and Appearance,
3.1.4 Sampling—except for chemical analysis,
3.1.5 Number of Tests and Retests,
3.1.6 Specimen Preparation,
3.1.7 Test Methods—except for chemical analysis,
3.1.8 Significance of Numerical Limits,
3.1.9 Inspection,
3.1.10 Rejection and Rehearing,
3.1.11 Certification,
3.1.12 Test Reports,
3.1.13 Packaging and Package Marking, and
3.1.14 Supplementary Requirements.

3.2 In addition, when a section with a title identical to that referenced in 3.1 above, appears in this specification, it contains additional requirements, which supplement those appearing in Specification B248.

4. Terminology

4.1 For definitions of terms related to copper and copper alloys, refer to Terminology B846.

5. Ordering Information

5.1 Include the following information when placing orders for product under this specification, as applicable:
5.1.1 ASTM designation and year of issue,
5.1.2 Quantity: total for each item, pounds (or kilograms),
5.1.3 Name of material: cable shielding (or “cable wrap”),
5.1.4 Form of material: strip,
5.1.5 Type of product: (or abbreviation, in the case of clad materials) as listed in section 1.2,
5.1.6 Alloy number when appropriate (see 1.2),
5.1.7 Temper,
5.1.8 Dimensions: thickness and width (see Section 12),
5.1.9 How furnished: coils (rolls), traverse wound on reels or spools, etc.,

5.2 The following options are available and should be specified at the time of placing of the order when required:
5.2.1 Whether electrical resistivity test is required for any item,
5.2.2 Coil dimension: inner or outer coil diameter limitation, or both, if required,
5.2.3 Weight of coils: coil weights or coil size limitations, if required,
5.2.4 Cladding ratio when appropriate (see 7.5.4),
5.2.5 Certification, if required,
5.2.6 Test Report, if required, and
5.2.7 Special tests or exceptions, if any.

6. Materials and Manufacture

6.1 *Material*—The material of manufacture shall be of such purity and soundness as to be suitable for processing into the products prescribed herein.

6.2 *Manufacture:*

6.2.1 The copper and copper alloy product shall be manufactured by such hot working, cold working, and annealing processes as to produce a uniform wrought structure in the finished product, and conform to the properties and characteristics prescribed in the specification.

6.2.2 Cladding metals as appropriate may be bonded to the specified base metal by any method that will produce a clad material that will conform to this specification.

7. Chemical Composition

7.1 The copper and copper-alloy materials shall conform to the chemical composition requirements in Table 1 for the copper [alloy] UNS No. designation specified in the ordering information.

7.2 Copper cladding shall be, unless otherwise specified, a copper conforming in chemical composition to that covered by Specification B152/B152M. The grade provided shall be one of the following coppers, such that the final strip meets the conductivity and mechanical properties of this specification. These are:

C10920
C11000
C11020
C12000

7.3 These composition limits do not preclude the presence of other elements. By agreement between the manufacturer and purchaser, limits may be established and analysis required for unnamed elements.

7.4 Except for copper C11000, copper may be taken as the difference between all the elements analyzed and 100 %.

7.4.1 *Alloys C19400, C22000, and C23000*—When all elements specified in Table 1 are determined, the sum of the results shall be 99.8 % min.

7.4.2 *Alloys C66400, C66410, C66430, C64785, and C71000*—When all elements specified in Table 1 are determined, the sum of the results shall be 99.5 % min.

7.5 *Clad Metal:*

7.5.1 For stainless steel clad cores, the stainless steel shall conform in chemical composition to one established by Specification A176. If not specified on the purchase order, stainless steel in accordance with UNS No. S43000 (Type 430) shall be supplied as the core material.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

TABLE 1 Chemical Requirements

Element	Composition, %								
	Copper or Copper Alloy UNS No.								
	C11000	C19400	C22000	C23000	C66400	C66410	C66430	C71000	C64785 core of Copper-Clad Bronze
Copper (incl silver)	99.90 min	97.0 min	89.0–91.0	84.0–86.0	remainder	remainder	remainder	remainder	remainder
Iron	...	2.1–2.6	0.05 max	0.05 max	1.3–1.7	1.8–2.3	0.6–0.9	1.0 max	0.02 max
Lead, max	...	0.03	0.05	0.05	0.015	0.015	0.05	0.05	0.015
Tin	...	...	...	...	0.05 max	0.05 max	0.6–0.9	...	0.50–2.0
Zinc	...	0.05–0.20	remainder	remainder	11.0–12.0	11.0–12.0	13.0–15.0	1.0 max	3.0–6.0
Nickel (incl cobalt)	...	...	...	...	...	...	...	19.0–23.0	0.4–1.6
Manganese	...	...	...	...	...	...	...	1.0 max	0.20–1.0
Phosphorus	...	0.015–0.15	...	...	...	...	0.10 max	...	0.015 max
Cobalt	...	...	...	...	0.30–0.7	...	...	...	...
Iron and cobalt	...	...	...	...	1.8–2.3	...	...	...	...
Silicon	...	...	...	...	...	...	...	...	0.15 max
Aluminum	...	...	...	...	...	...	...	...	3.0–6.0

7.5.2 For alloy steel clad cores, the steel shall conform in chemical composition to an alloy steel established by Specification A505. If not specified on the purchase order, alloy steel UNS No. G41300 shall be supplied.

7.5.3 For bronze clad cores, the bronze shall conform in chemical composition to the requirements of UNS No. C64785 listed in Table 1.

7.5.4 Unless otherwise stated (see 5.2.4), the cladding ratio shall be one of the standard ratios listed in Table 2 and Table 3, and shall be expressed as XX/XX/XX, copper/bronze/copper, copper/stainless steel/copper, or copper/alloy steel/copper as appropriate.

8. Temper

8.1 As described in Classification B601, tempers furnished to this specification shall be:

8.1.1 Copper C11000—H00, H01, H02, and O61.

8.1.2 Copper alloy C19400—H02, O61, and O50.

8.1.3 Copper alloy C22000—H01, H02, and O81.

8.1.4 Copper alloy C23000—H01, H02, and O81.

8.1.5 Copper alloy C66400, C66410, and C66430—O60.

8.1.6 Copper alloy C71000—H01, H02, OS035, and OS015.

8.1.7 Copper-Clad Steel—O61.

8.1.8 Copper-Clad Bronze—O61 and O81.

9. Grain Size for Annealed Tempers

9.1 There are no minimum or maximum grain size requirements for product in annealed tempers O50, O61, and O81; however, the metal shall be fully recrystallized.

9.2 For copper alloy UNS No. C71000 in annealed tempers OS035 and OS015, acceptance or rejection based upon grain size shall depend only on the average grain size of a test specimen taken from each of two sample portions, and each specimen shall be within the limits prescribed in Table 2 when determined in accordance with Test Method E112.

10. Physical Property Requirements

10.1 *Electrical Conductivity Requirement:*

10.2 The annealed product furnished shall conform to the electrical conductivity prescribed in Table 3 and Table 4.

10.3 The electrical resistivity of the material shall be determined in accordance with Test Method B193; the conductivity shall be calculated in accordance with Explanatory notes 3 and 4 of Test Method B193.

11. Mechanical Property Requirements

11.1 *Tensile Strength Requirements :*

11.1.1 Product furnished under this specification shall conform to the tensile requirements prescribed in Table 2, when tested in accordance with Test Method E 8 [or E 8M].

11.1.2 Acceptance or rejection based upon mechanical properties shall depend only on tensile strength.

11.2 *Rockwell Hardness Requirement :*

11.2.1 The hardness test is a quick and convenient method for estimating tensile strength and grain size. Approximate hardness values are given in Table 2. For copper-clad materials, copper is etched off with a suitable reagent before testing the steel. This test is not required and shall not be used as a basis of rejection.

12. Dimensions, Mass, and Permissible Variations

12.1 *General*—For the purpose of determining conformance with the dimensional requirements prescribed in this specification, any measured value outside the specified limiting values for any dimension may be cause for rejection.

12.2 *Thickness*—The standard method of specifying thickness shall be in decimal fractions of an inch. For material 0.021 in. (0.53 mm) and under in thickness, it is recommended that the nominal thickness be stated not closer than the nearest half-thousandth. (For example, specify 0.006 or 0.0065 in. (0.15 or 0.165 mm), but not 0.0063 in. (0.160 mm).) A list of

TABLE 2 Tensile Strength Requirements and Approximate Hardness Values for Shielding Materials in Commonly Ordered Tempers

Description		Temper Designation		Tensile Strength, ksi[A] (Mpa[B])		Approximate Rockwell Hardness[C]	
Copper or Copper Alloy UNS No.	Type of Material	Code	Name	Min	Max	Other Scales Thicknesses >0.020 in.	Superficial 30T Thicknesses >0.012 in.
			Cold-Rolled Tempers:				
C11000	Copper	H00	eighth hard	32 (220)	40 (275)	F54–82	up to 49
		H01	quarter hard	34 (235)	42 (290)	F60–84	18–51
		H02	half hard	37 (255)	46 (315)	F77–89	43–57
			Annealed Tempers:				
		O61	annealed	...	34 (235)	...	...
			Annealed Tempers:				
C19400	Copper-iron alloy	O61	annealed[D]	45 (310)	55 (380)	...	...
		O50	light annealed[D]	50 (345)	60 (415)	...	...
			Cold-Rolled Tempers:				
		H02	half hard	53 (365)	63 (435)	B49–69	52–63
			Cold-Rolled Tempers:				
C22000	Commercial bronze	H01	quarter hard	40 (275)	50 (345)	B27–52	38–53
		H02	half hard	47 (325)	57 (395)	B50–63	52–61
			Annealed Tempers:				
		O81	quarter hard	39 (270)	46 (315)	...	...
			Cold-Rolled Tempers:				
C23000	Red brass	H01	quarter hard	44 (305)	54 (375)	B33–58	45–60
		H02	half hard	51 (350)	61 (420)	B56–68	58–66
			Annealed Tempers:				
		O81	quarter hard	44 (305)	54 (375)	...	...
			Annealed Tempers:				
C66400	Copper-zinc-iron-cobalt alloy	O60	soft[D]	53 (365)	60 (415)	...	...
C66410	Copper-zinc-iron alloy	O60	soft[D]	53 (365)	60 (415)	...	...
C66430	Copper-zinc-iron-tin alloy	O60	soft[D]	59 (405)	69 (475)	...	59–69
			Cold-Rolled Tempers:				
C71000	Cupro-nickel 20 %	H01	quarter hard	47 (325)	63 (435)	B45–72	46–65
		H02	half hard	56 (385)	70 (485)	B64–78	59–69
			Annealed Tempers:				
		OS035	0.025–0.050 mm	52 (355)	...	B18–35	28–40
		OS015	0.010–0.020 mm	53 (365)	...	B35–88	40–58
Copper-Clad Stainless (CCS) and Copper-Clad Alloy Steel (CAS)							
Cladding Ratio	Total Thickness						
	in. (mm)		Annealed Tempers				
16/68/16	0.005 (0.13)	O61	annealed[D]	55 (380)	68 (470)	15T 89 max	...
33.3/33.3/33.3	0.006 (0.15)	O61	annealed[D]	44 (305)		15T 89 max	...
Copper-Clad Bronze (CCB)							
Cladding Ratio	Total Thickness						
	in. (mm)		Annealed Tempers				
12.5/75/12.5	[E]	O61	annealed[D]	55 (380)	68 (470)	15T 89 max	...
		O81	annealed to temper—quarter hard	62 (425)	75 (515)	15T 92 max	...
16/68/16	[E]	O61	annealed[D]	55 (380)	68 (470)	15T 89 max	...
		O81	annealed to temper—quarter hard	62 (425)	75 (515)	15T 92 max	...

[A] ksi = 1000 psi.
[B] See Appendix X3.
[C] Rockwell values normally apply as follows: The B and F scales apply to metal 0.020 to 0.036 in. (0.5 to 0.91 mm) in thickness. The Superficial 30-T scale applies to metal 0.012 to 0.028 in. (0.30 to 0.71 mm) in thickness.
[D] There is no grain size requirement but all annealed metal shall be fully recrystallized.
[E] See Appendix X2, Table X2.1.

TABLE 3 Preferred Cladding Ratios—Copper-Clad Materials

Clad Material	Nominal Total Thickness of Strip		Cladding Ratio	Nominal Thickness, in. (mm)			Conductivity, % IACS	
	in.	mm		Copper	Core	Copper	Nominal	Minimum
CCS or CAS	0.005	0.13	16/68/16	0.0008 (0.02)	0.0034 (0.09)	0.0008 (0.02)	30	28
CCS or CAS	0.006	0.15	33.3/33.3/33.3	0.002 (0.05)	0.002 (0.05)	0.002 (0.05)	61	60
CCB	0.005	0.13	16/68/16	0.0008 (0.02)	0.0034 (0.09)	0.0008 (0.02)	32	30
CCB	0.005	0.13	12.5/75/12.5	0.0006 (0.016)	0.0038 (0.1)	0.0006 (0.016)	30	28

preferred thicknesses is shown in Appendix X2. The thickness tolerance shall be those shown in Table 5 and Table 6.

12.3 *Width*—The width tolerances shall be those required by Specification B248, unless otherwise stated in the purchase order.

12.4 *Straightness*—The straightness tolerances shall be those required by Specification B248, unless otherwise stated in the purchase order.

12.5 *Cladding Ratio*—Cladding ratios shall be within ±10 % of the outer clad layer percentage (for example, the

TABLE 4 Electrical Resistivity and Conductivity

UNS Alloy No.	Mass Resistivity, Ω·g/m ^{2} (Ref. only)	Conductivity %, IACS min
A. Copper Alloy Materials		
C11000	0.153 28	100.00
C19400	0.256 03	60
C22000	0.379 30	40
C23000	0.407 73	37
C66400	0.504 01	30
C66410	0.504 01	30
C66430	0.540 63	28
C71000	2.568 91	6

B. Copper-Clad Bronze Material

Total Thickness, in.	Cladding Ratio	Mass Resistivity, Ohm·g/m ^{2}	Conductivity %, IACS
all	12.5/75/12.5	...	28 min
all	16/68/16	...	30 min

C. Copper-Clad Steel Material

Total Thickness, in.	Cladding Ratio	Mass Resistivity, Ohm·g/m^2	Conductivity %, IACS
0.005	16/68/16	...	28 min
0.006	33.3/33.3/33.3	...	60 min

outer layers of a 16/68/16 clad product can have an outer layer clad thickness of 16% +/- 1.6%). The thickness percentage of the core shall not be used for basis of rejection. The test method shall be metallurgical microsection of at least three samples per lot.

13. Workmanship, Finish, and Appearance

13.1 All material shall be uniform in quality and condition, sound and free of internal and external defects of a nature that interferes with normal fabrication or the performance of the cable shielding. It shall be well cleaned and free of dirt. A superficial film of residual light lubricant is permissible, unless otherwise specified.

13.2 Copper-clad material shall be free of defects including unbond delamination or separation of layers of a nature that interferes with normal commercial operations.

14. Sampling

14.1 *Chemical Composition for Copper and Copper Alloys:*

14.1.1 Instead of sampling in accordance with Practice E255, the manufacturer shall have the option of sampling at the time castings are poured or from the semifinished or finished product.

14.1.1.1 When sampled at the time castings are poured, at least one sample shall be taken for each group of castings poured simultaneously from the same source of molten metal.

14.1.1.2 When sampled from a semifinished or finished product, at least one sample representative of the product of each cast bar from a single melt charge continuously processed with heat identity maintained shall be taken.

14.1.1.3 When sampled from semifinished or finished product when heat identity has not been maintained, a single sample representative of each 10 000-lb lot, or fraction thereof, shall be taken. When the product piece is greater than 10 000 lb, one sample to be representative of the product piece shall be taken.

14.2 *Clad Metal:*

14.2.1 When materials of fabrication have been certified to meet the requirements of the specification to which they were ordered, sampling by the fabricator is not required unless specified otherwise in the contract or purchase order. Proof of certification of the materials of fabrication to their associated Standard Specification shall be provided to the purchaser upon request.

14.2.2 When sampling of the fabricating materials is specified in the contract or purchase order, sampling shall be as prescribed in the specification to which the material was ordered.

15. Number of Tests and Retests

15.1 *Tests:*

15.1.1 *Chemical Analysis*—Chemical composition shall be determined as per element mean of the results from at least two replicate analyses of the sample.

15.1.2 *Grain Size and Tensile Strength*—Determine as the average of results from two test specimens.

15.2 *Retests:*

15.2.1 *Chemical Composition*—Should one or more of the determinations fail to conform with the requirements of Table 1, a retest may be made on a new composite made up from the pieces originally selected.

15.2.2 *Grain Size and Tensile Strength*—Should the test results fail to conform with the requirements, a retest shall be permitted on two specimens made up from the pieces originally selected.

15.2.3 All test specimens shall conform to the product specification requirement (s) in retest. Failure to conform shall be cause for rejection.

16. Specimen Preparation

16.1 *Chemical Composition*—Preparation of the analytical specimens shall be the responsibility of the reporting laboratory.

16.2 *Grain Size*—In case of disagreement, test specimens shall be prepared in accordance with Guide E3.

16.3 *Tensile Strength*—In case of disagreement, test specimens shall be prepared in accordance with Test Methods E8.

17. Test Methods

17.1 Test methods for quality control shall be discretionary.

17.2 *Chemical Analysis*—In case of disagreement, determine the composition using the following methods:

Element	Test Method
Aluminum	ISO 3110 (AA)
Cobalt	E75
Copper	E478
Iron	E478
High iron	E54
Lead	E478 (AA)
Manganese	E62
Nickel	E478 (photometric)
Phosphorus	E62
Silicon	E62
Silver	E478
Tin	E478 (photometric)
Zinc	E478 (titrimetric)

TABLE 5 Thickness Tolerances

Material	Thickness, in. (mm)	Tolerance, Plus and Minus in. (mm)	
		12 in. (305 mm) and Under in Width	Over 12 in. (305 mm)
Copper and copper alloys	0.004 (0.102) and under	0.0003 (0.0076)	0.0006 (0.015)
	Over 0.004 to 0.005 (0.102 to 0.127), incl	0.0004 (0.010)	0.0008 (0.020)
	Over 0.005 to 0.009 (0.127 to 0.229), incl	0.0005 (0.013)	0.001 (0.025)
	Over 0.009 to 0.013 (0.229 to 0.330), incl	0.0008 (0.020)	0.0015 (0.038)
Copper-clad bronze (CCB)	0.004 (0.102) and under	0.0003 (0.0076)	0.0006 (0.015)
	Over 0.004 to 0.005 (0.102 to 0.127), incl	0.0004 (0.010)	0.0008 (0.020)
	Over 0.005 to 0.009 (0.127 to 0.229), incl	0.0005 (0.013)	0.001 (0.025)
	Over 0.009 to 0.013 (0.229 to 0.330), incl	0.0008 (0.020)	0.0015 (0.038)
Copper-clad stainless steel (CCS)	Over 0.004 to 0.005 (0.102 to 0.127), incl	0.0005 (0.013)	...
	Over 0.005 to 0.009 (0.127 to 0.229), incl	0.0006 (0.015)	...
Copper-clad alloy steel (CAS)	Over 0.004 to 0.005 (0.102 to 0.127), incl	0.0005 (0.013)	...
	Over 0.005 to 0.009 (0.127 to 0.229), incl	0.0006 (0.015)	...

TABLE 6 Width Tolerances for Slit Metal and Slit Metal with Rolled Edges (applicable to all materials listed in 1.2)

Width, in. (mm)	Width Tolerances,[A] Plus and Minus For All Thicknesses	
	in.	(mm)
2 (50.8) and under	0.005	(0.13)
Over 2 to 12 (50.8 to 305), incl	0.008	(0.20)
Over 12 to 24 (305 to 610), incl	0.015	(0.38)

[A] If tolerances are specified as all plus or all minus, double the values given.

18. Rejection and Rehearing

18.1 *Rejection:*

18.1.1 Product that fails to conform to the specification requirements when tested by the purchaser, or purchaser's agent, shall be subject to rejection.

18.1.2 Rejection shall be reported to the manufacturer, or supplier, promptly. In addition, a written notification of rejection shall follow.

18.1.3 In case of dissatisfaction with results of the test upon which rejection is based, the manufacturer, or supplier, shall have the option to make claim for a rehearing.

18.2 *Rehearing:*

18.2.1 As a result of product rejection, the manufacturer or supplier shall have the option to make claim for a retest to be conducted by the manufacturer, or supplier, and the purchaser. Samples of the rejected product shall be taken in accordance with the product specification and subjected to test by both parties using the test method(s) specified in the product specification, or alternatively, upon agreement of both parties, an independent laboratory may be selected for the test(s) using the test method(s) specified in the product specification.

19. Certification

19.1 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been tested or inspected as directed in this specification and the requirements have been met.

20. Test Report

20.1 When specified in the purchase order or contract, a report of the test results shall be furnished.

21. Packaging and Package Marking

21.1 *Packaging:*

21.1.1 The product shall be separated by size, composition, and temper, and prepared for shipment by common carrier, in such a manner to afford protection from the normal hazards of transportation.

21.2 *Package Marking:*

21.2.1 Each shipping unit shall be legibly marked with the purchase order number, metal or alloy designation (or clad product designation, as applicable), temper, size, shape, gross and net weight, and name of supplier. The specification number shall be shown, when specified.

22. Keywords

22.1 bimetallic; cladding ratio; copper; copper alloy; copper-clad bronze; copper-clad alloy steel; copper-clad stainless steel; electric cable shielding; electrical conductivity; grain size; Rockwell Hardness; sheet; strip; tensile; UNS No. C11000; UNS No. C19400; UNS No. C22000; UNS No. C23000; UNS No. C64785; UNS No. C66400; UNS No. C66410; UNS No. C66430; UNS No. C71000; UNS No. G41300; UNS No. S43000

APPENDIXES

(Nonmandatory Information)

X1. EXPLANATORY NOTE—CABLE SHIELDING

X1.1 Cable shielding or "cable wrap" is normally used by manufacturers of electrical insulated wire and cable in strips of various widths. The material is wrapped around an insulated wire or group of wires, and may be applied over an intervening layer of wrapping material or over a jacket. The material may be applied in various configurations depending upon the requirements of the finished cable:

X1.1.1 *Helical wrap*—overlapped, butted, or gapped.

X1.1.2 *Longitudinal application*—corrugated or smooth, overlapped, butted, gapped, or welded/soldered.

X1.2 The selection of the particular material and of the thickness of the material to be used is dependent largely upon the specification requirements for the finished wire or cable. Military and Federal Specifications, Rural Utilities Services (RUS) specifications, ICEA (Insulated Cable Engineers Association) specifications, among others, typically apply.

X1.3 Electrical conductivity of the material is an important characteristic considered in the selection process and is affected by the material, its thickness, and the method of application. Corrosion resistance is important for various environments. Physical strength requirements may include such features as resistance to tensile stress, resistance to bending stress (including repeated bending), resistance to gopher attack, and so forth.

X2. PREFERRED THICKNESSES

X2.1 It is recommended that whenever possible, material purchased to this specification be ordered in a thickness as listed in Table X2.1.

TABLE X2.1 Preferred Thickness, Nominal

Material or UNS No.	Thickness, in. (mm)
C11000	0.005 (0.13)
	0.010 (0.25)
C19400	0.006 (0.15)
	0.007 (0.18)
C22000 and C23000	0.005 (0.13)
	0.007 (0.18)
	0.010 (0.25)
C66400	0.0055 (0.14)
C66410	0.0055 (0.14)
C66430	0.005 (0.13)
	0.007 (0.18)
	0.010 (0.25)
C71000	0.005 (0.13)
Copper-clad bronze (CCB)	0.0048 (0.122)[A]
	0.005 (0.13)[A]
	0.0055 (0.14)[A]
	0.006 (0.15)[A]
	0.007 (0.18)[A]
	0.010 (0.25)[A]
Copper-clad stainless steel (CCS)	0.005 (0.13)[A]
	0.006 (0.15)[A]
Copper-clad alloy steel (CAS)	0.005 (0.13)[A]
	0.006 (0.15)[A]

[A] Total thickness of strip.

X3. METRIC EQUIVALENTS

X3.1 The SI unit for strength properties now shown is in accordance with the International System of Units (SI). The derived SI unit for force is the newton (N), which is defined as that force which when applied to a body having a mass of one kilogram gives it an acceleration of one metre per second squared ($N = kg \cdot m/s^2$). The derived SI unit for pressure or stress is the newton per square metre (N/m^2), which has been named the pascal (Pa) by the General Conference on Weights and Measures. Since 1 ksi = 6 894 757 Pa, the metric equivalents are expressed as megapascal (MPa), which is the same as MN/m^2 and N/mm^2.

SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue (B694 – 10) that may impact the use of this standard. (Approved April 1, 2013.)

(1) Added B193 to Reference Documents in Section 2.
(2) Added 10.3 to indicate that electrical conductivity shall be used.
(3) Since the resistivity and conductivities don't exactly match returned to original values of conductivity for acceptance criteria and listed resistivity as a Reference only.