Designation: B972 – 10 (Reapproved 2014)

Standard Specification for Nickel-Coated Braid and Ribbon Flat Copper Wire Intended for use in Electronic Application[1]

This standard is issued under the fixed designation B972; 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 covers nickel-coated copper braid and ribbon flat wire intended for electronic application (Explanatory Note 1).

1.2 Two classes of nickel-coated braid and ribbon flat copper wire are covered as follows:

1.2.1 *Class A*—Annealed temper.

1.2.2 *Class H*—Hard-drawn.

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 *Exceptions*—The SI values for density, resistivity, and volume are to be regarded as standard.

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]

B1 Specification for Hard-Drawn Copper Wire

B3 Specification for Soft or Annealed Copper Wire

B49 Specification for Copper Rod Drawing Stock for Electrical Purposes

B193 Test Method for Resistivity of Electrical Conductor Materials

B258 Specification for Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors

2.2 *Other Standards:*[3]

NBS Handbook 100 Copper Wire Tables

3. Ordering Information

3.1 Orders for material under this specification shall include the following information:

3.1.1 Quantity of each size,

3.1.2 Wire size-thickness and width in inches (see 5.4),

3.1.3 Class of wire (see 1.2),

3.1.4 Type of copper, if special (see 4.2),

3.1.5 Package size (see 10.1),

3.1.6 Special packaging marking, if required, and

3.1.7 Place of inspection (see 7.1).

4. Material

4.1 The material shall be nickel-coated flat wire (Explanatory Note 1) of such quality and purity that the finished product shall meet the properties and characteristics prescribed in this specification.

4.2 *Copper-Base Metal*—The base metal shall be copper of such quality and purity that the finished product shall have properties and characteristics prescribed in this specification.

NOTE 1—Specifications B1, B3, or B49 defines copper suitable for use.

5. General Requirements (See Section 8)

5.1 *Temper*—The nickel-coated flat wire conductor shall be provided in either hard-drawn condition (Class H) or annealed condition (class A) as agreed upon between the manufacturer and purchaser.

5.2 *Tensile and Elongation (Explanatory Note 2):*

5.2.1 *Class A*—The nickel-coated copper flat wire in the annealed condition shall conform to the elongation requirements prescribed in Table 1. See Explanatory Note 3 for equivalent round diameter calculations based on given thickness and width dimensions for the flat wire. For flat wire whose nominal equivalent round diameter is more than 0.001 in. (0.025 mm) greater than a size listed in Table 1, but less than that of the next larger size, the requirements of the next larger size shall apply. No requirements for tensile strength are specified.

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[1] This specification is under the jurisdiction of ASTM Committee B01 on Electrical Conductors and is the direct responsibility of Subcommittee B01.04 on Conductors of Copper and Copper Alloys.

Current edition approved Oct. 1, 2014. Published October 2014. Originally approved in 2010. Last previous edition approved in 2010 as B972 – 10. DOI: 10.1520/B0972-10R14.

[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] Available from National Technical Information Service (NTIS), 5285 Port Royal Rd., Springfield, VA 22161, http://www.ntis.gov.

TABLE 1 Tensile Properties[A]

Equivalent Round Diameter, in.	Area at 20°C cmils	Area at 20°C in.^{2}	Elongation in 10 in., min, %
0.0641	4 110	0.00323	25
0.0571	3 260	0.00256	25
0.0508	2 580	0.00203	25
0.0453	2 050	0.00161	25
0.0403	1 620	0.00128	25
0.0359	1 290	0.00101	25
0.0320	1 020	0.000804	25
0.0285	812	0.000638	25
0.0253	640	0.000503	25
0.0226	511	0.000401	25
0.0201	404	0.00317	20
0.0179	320	0.000252	20
0.0159	253	0.000199	20
0.0142	202	0.000158	20
0.0126	159	0.000125	20
0.0113	128	0.000100	20
0.0100	100	0.0000785	20
0.0089	79.2	0.0000622	15
0.0080	64.0	0.0000503	15
0.0071	50.4	0.0000396	15
0.0063	39.7	0.0000312	15
0.0056	31.4	0.0000246	15
0.0050	25.0	0.0000196	15
0.0045	20.2	0.0000159	15
0.0040	16.0	0.0000126	15

[A] See Explanatory Note 3 for equivalent round calculation.

5.2.2 *Class H*—The nickel-coated copper flat wire in the hard drawn condition shall conform to elongation requirements of 1 % minimum to 5 % maximum. The tensile strength shall be 55 000 psi (379 MPa) minimum.

5.3 *Resistivity (Explanatory Note 4)*—The electrical resistivity of the coated wire at a temperature of 20°C shall not exceed the values prescribed in Table 2.

5.4 *Dimensions and Permissible Variations*—The flat wire sizes shall be expressed as the thickness and width of the wire in decimal fractions of an inch to the nearest 0.0001 in. (0.0025 mm). The nickel-coated flat wire shall not vary from the specified thickness and width by more than the amounts specified in Table 3 and Table 4, respectively.

5.5 *Continuity of Coating*—The nickel coating shall be continuous. The continuity of coating on the flat wire shall be determined on representative samples taken before braiding applications or insulating. The continuity of coating shall be determined by the hydrochloric acid-sodium polysulfide test in accordance with 6.4. Wire whose coating weight corresponds to a thickness less than 50 µin. (0.00005 in.) (0.0013 mm) shall not be subject to this test (Explanatory Note 5). The thickness of coating shall be determined in accordance with Test Method A as prescribed in Appendix X1.

5.6 *Joints*—Necessary joints in the wire and rods prior to final coating and drawing shall be made in accordance with the best commercial practice. There shall be no uncoated joints in the final product.

5.7 *Finish*—The coating shall consist of a smooth continuous layer, firmly adherent to the surface of the copper. The wire shall be free of all imperfections not consistent with the best commercial practice.

TABLE 2 Electrical Resistivity Requirements

Class A	Thickness Range, Inch (mm)	Resistivity at 20°C Ω·lb/mile^2
	0.0008 to 0.0010 (0.020 to 0.025), incl	1029.7
	0.0011 to 0.0013 (0.028 to 0.033), incl	994.55
	0.0014 to 0.0018 (0.037 to 0.046), incl	972.45
	0.0019 to 0.0028 (0.048 to 0.071), incl	951.31
	0.0029 to 0.0039 (0.074 to 0.099), incl	931.07
	0.0040 to 0.0065 (0.102 to 0.165), incl	921.27
	0.0065 to 0.0100 (0.165 to 0.254), incl	911.67
Class H	**Thickness Range, Inch (mm)**	**Resistivity at 20°C Ω·lb/mile^2**
	0.0008 to 0.0010 (0.020 to 0.025), incl	1067.3
	0.0011 to 0.0013 (0.028 to 0.033), incl	1029.7
	0.0014 to 0.0018 (0.037 to 0.046), incl	1006.0
	0.0019 to 0.0028 (0.048 to 0.071), incl	983.38
	0.0029 to 0.0039 (0.074 to 0.099), incl	961.76
	0.0040 to 0.0065 (0.102 to 0.165), incl	951.31
	0.0065 to 0.0100 (0.165 to 0.254), incl	941.08

TABLE 3 Permissible Variations in Thickness

Nominal Thickness Range, Inch (mm)	Tolerance, Inch (mm)
0.0010 to 0.0014 (0.025 to 0.036)	+/- 0.0002 (0.005)
0.0015 to 0.0019 (0.038 to 0.048)	+/- 0.0003 (0.008)
0.0020 to 0.0049 (0.051 to 0.124)	+/- 0.0004 (0.010)
0.0050 to 0.0100 (0.127 to 0.254)	+/- 0.0005 (0.013)

TABLE 4 Permissible Variations in Width

Nominal Width Range, Inch (mm)	Tolerance, Inch (mm)
0.0100 to 0.0499 (0.254 to 1.27)	+/- 0.0013 (0.033)
0.0500 to 0.0699 (1.27 to 1.78)	+/- 0.0015 (0.038)
0.0700 to 0.0999 (1.78 to 2.54)	+/- 0.0020 (0.051)
0.1000 to 0.1249 (2.54 to 3.17)	+/- 0.0030 (0.076)
0.1250 to 0.1500 (3.18 to 3.81)	+/- 0.0040 (0.102)

6. Test Methods

6.1 *Tensile Strength and Elongation (Explanatory Note 6):*

6.1.1 The tensile strength, expressed in pounds per square inch, shall be obtained by dividing the maximum load carried by the specimen during the tension test by the original cross-sectional area of the specimen. Tensile strength and elongation may be determined simultaneously on the same specimen.

6.1.2 The elongation of the flat wire may be determined by measurements made between the jaws of the tensile testing machine. The zero length shall be the distance between the jaws at the start of the tension test and be as near 10 in. (254 mm) as practicable. The final length shall be the distance between the jaws at the time of rupture. The fracture shall be between the jaws of the testing machine and not closer than 1 in. (25.4 mm) to the jaw.

6.2 *Resistivity (Explanatory Note 4)*—The electrical resistivity of the material shall be determined in accordance with Test Method B193. The purchaser may accept certification that the wire was drawn from rod stock meeting the international standard for annealed copper instead of resistivity tests on the finished wire.

6.3 *Dimensional Measurements*—Dimensional measurements for width and thickness shall be made with a micrometer caliper equipped with a vernier graduated in 0.0001 in. (0.0025 mm). Measurements shall be made on at least three places on each unit selected for this test. Any measurement taken exceeding the dimensions and permissible variation requirements in 5.4 shall constitute failure to meet the dimensional conformance criterion.

6.4 *Continuity of Coating:*

6.4.1 *Length of Specimens*—Test specimens shall each have a length of about 6 in. (152 mm). They shall be tagged or marked to correspond with the coil, spool, or reel from which they were cut.

6.4.2 *Treatment of Specimens*—The specimens shall be thoroughly cleaned by immersion in a suitable organic solvent for at least 3 min, then removed and wiped dry with a clean, soft cloth or tissue (**Caution:** Explanatory Note 7). The specimens thus cleaned shall be kept wrapped in a clean, dry cloth or tissue until tested. That part of the specimen to be immersed in the test solution shall not be handled. Care shall be taken to avoid abrasion by the cut ends.

6.4.3 *Special Solution (sp gr 1.142)*—A concentrated solution shall be made by dissolving sodium sulfide crystals (cp) in distilled water until the solution is saturated at about 21°C, and adding sufficient flowers of sulfur (in excess of 250 g/L of solution) to provide complete saturation, as shown by the presence in the solution of an excess of sulfur after the solution has been allowed to stand for at least 24 h. The test solution shall be made by diluting a portion of the concentrated solution with distilled water to a specific gravity of 1.135 to 1.145 at ambient temperature of 15.6 °C. The sodium polysulfide test solution should have sufficient strength to thoroughly blacken a piece of clean uncoated copper wire in 5 s. A portion of the test solution used for testing samples shall not be considered to be exhausted until it fails to blacken a piece of clean copper as described above (Explanatory Note 8).

6.4.4 *Procedure*—Immerse a length of at least 4.5 in. (114 mm) from each of the clean specimens for 30 s in the sodium polysulfide solution (see 6.4.3) maintained at a temperature between 15.6 and 21°C. After the immersion, immediately wash the specimens in clean water and wipe dry with a clean, soft cloth or tissue. After immersion and washing, examine the specimens to ascertain if copper exposed through openings in the nickel coating has been blackened by action of the sodium polysulfide. Examine the specimen with the normal eye against a white background. Consider the specimens to have failed if, by such blackening, exposed copper is revealed. No attention shall be paid to blackening within 0.5 in. (12.7 mm) of the cut end.

6.5 *Finish*—Surface-finish inspection shall be made with the unaided eye (normal spectacles excepted).

7. Inspection

7.1 *General (Explanatory Note 9)*—Unless otherwise specified in the contract or purchaser order, the manufacturer shall be responsible for the performance of all inspection and test requirements specified.

7.1.1 All inspections and tests shall be made at the place of manufacture unless otherwise especially agreed upon between the manufacturer and the purchaser at the time of purchase.

7.1.2 The manufacturer shall afford the inspector representing the purchaser all reasonable manufacturer's facilities to satisfy him that the material is being furnished in accordance with this specification.

7.1.3 Unless otherwise agreed upon between the purchaser and the manufacturer, conformance of the wire to the various requirements listed in Section 5 shall be determined on samples taken from each lot of wire presented for acceptance.

7.1.4 The manufacturer shall, if requested prior to inspection, certify that all wire in the lot was made under such conditions that the product as a whole conforms to the requirements of this specification as determined by regularly made and recorded tests.

7.2 *Definitions Applicable to Inspection:*

7.2.1 *lot*—any amount of wire of one type and size presented for acceptance at one time.

7.2.2 *sample*—a quantity of production units (coils, reels, and so forth) selected at random from the lot for the purpose of determining conformance of the lot to the requirements of this specification.

7.2.3 *specimen*—a length of wire removed for test purposes from any individual production unit of the sample.

7.3 *Sample Size (Explanatory Note 9)*—The number of production units in a sample shall be as follows:

7.3.1 A full (100 % inspection) will be completed at every set-up prior to running the order.

7.3.2 For elongation, resistivity, dimensional measurements, continuity of coating, and thickness of coating determinations, the sample shall consist of sequential production units from the lot.

7.3.3 For surface-finish inspection and for packaging inspection (when specified by the purchaser at the time of placing the order) the sample shall consist of sequential production units from the lot.

8. Conformance Criteria (Explanatory Note 9)

8.1 Any lot of wire, the samples of which comply with the conformance criteria of Section 5, shall be considered as complying with the requirements of this standard. Individual production units that fail to meet one or more of the requirements shall be rejected. If a failure of an individual production unit occurs, material which was made between the non-conforming unit and the last production unit which passed the conformance criteria must be inspected for the non-conforming characteristic.

9. Density (Explanatory Note 10)

9.1 For the purpose of calculating linear densities, cross sections, etc., the density of the copper shall be taken as 8.89 g/cm^3(0.32117 $lb/in.^3$) at 20°C.

10. Packaging and Shipping

10.1 Package sizes shall be agreed upon by the manufacturer and the purchaser in the placing of individual orders.

10.2 The flat wire shall be protected against damage in ordinary handling and shipping.

11. Keywords

11.1 copper flat wire nickel-coated; nickel-coated annealed copper flat wire; nickel-coated copper electrical equipment flat wire; nickel-coated soft copper flat wire

EXPLANATORY NOTES

NOTE 1—Nickel coatings on copper wire provide for a barrier between the copper and insulation whose curing temperature in the process of fabricating is too high for the use of tin-coated wires. The manufacturer and user of the standard should also give consideration to any agreed upon cast and camber requirements for ribbon wire applications.

NOTE 2—The equivalent round diameter or size for a flat conductor is calculated from the cross sectional area of the flat conductor, which is based on thickness and width. The values of the equivalent diameter sizes in Table 1 are given to the nearest 0.0001 in. and correspond to the standard sizes given in Specification B258. The use of gage numbers to specify wire sizes is not recognized in this specification because of the possibility of confusion. An excellent discussion of wire gages and related subjects is contained in NBS Handbook 100 of the National Bureau of Standards.

NOTE 3—The nominal equivalent round diameter for a flat conductor is:

$$\textit{Nominal Equivalent round diameter} = \sqrt{((T \times W \times 4)/3.1416)}$$

where:

T = nominal thickness specification
W = nominal width specification

NOTE 4—Resistivity units are based on the International Annealed Copper Standard (IACS) adopted by IEC in 1913, which is 1/58 $\Omega \cdot mm^2/m$ at 20°C for 100 % conductivity. The value of 0.017241 $\Omega \cdot mm^2/m$ and the value of 0.15328 $\Omega \cdot g/m^2$ at 20°C are respectively the international equivalent of volume and weight resistivity of annealed copper equal (to 5 significant figures) to 100 % conductivity. The latter term means that a copper wire 1 m in length and weighing 1 g would have a resistance of 0.15328 Ω. This is equivalent to a resistivity value of 875.20 $\Omega \cdot lb/mile^2$, which signifies the resistance of a copper wire 1 mile in length weighing 1 lb. It is also equivalent, for example, to 1.7241 µΩ/cm of length of a copper bar 1 cm^2 in cross section. A complete discussion of this subject is contained in NBS Handbook 100 of the National Institute of Standards and Technology.[3] The use of five significant figures in expressing resistivity does not imply the need for greater accuracy of measurement than that specified in Test Method B193. The use of five significant figures is required for reasonably accurate reversible conversion from one set of resistivity units to another. The equivalent resistivity values in Table 5 were derived from the fundamental IEC value (1/58 $\Omega \cdot mm^2/m$) computed to 7 significant figures and then rounded to 5 significant figures.

NOTE 5—Whether the nickel is applied by electroplating or by mechanical cladding, coatings less than 50 µin. (0.00005 in.) in thickness will not pass the "Continuity of Coating" test.

NOTE 6—In general, tested values of tensile strength are increased and tested values of elongation are reduced with increase of speed of the moving head of the testing machine in the tension testing of copper wire. In the case of tests on soft or annealed copper wire, however, the effects of speed of testing are not pronounced. Tests of soft wire made at speeds of moving head, which under no-load conditions are not greater than 12 in./min, do not alter the final results of tensile strength and elongation determinations to any practical extent.

NOTE 7—**Caution:** Consideration should be given to toxicity and flammability when selecting solvent cleaners.

NOTE 8—It is important that the polysulfide solution be of proper composition and strength at the time of test. A solution that is not saturated with sulfur or that has been made from decomposed sodium sulfide crystals may give a false indication of failure. Therefore, the requirement that the solution be tested by observing its blackening effect on a bright copper wire is significant. Significant also is the requirement that the solution be saturated with sulfur by allowing the solution to stand at least 24 h after preparation. Attention is called also to the necessity for the use of sodium sulfide that has not deteriorated through exposure to air; and if exposure has occurred, the crystals should be tested for purity. The "Standard Reagents Tests" of the American Chemical Society are useful in this connection.

NOTE 9—Cumulative results secured on the product of a single manufacturer, indicating continued conformance to the criteria, are necessary to ensure an over-all product meeting the requirements of this specification. The sample sizes and conformance criteria given for the various characteristics are applicable only to lots produced under these conditions.

NOTE 10—The value of density of copper is in accordance with the International Annealed Copper Standard. The corresponding value at 0°C is 8.90 g/cm^3 (0.32150 $lb/in.^3$). In calculations involving density it must be borne in mind that the apparent density of coated wire is not a constant but a variable function of wire diameters or size. The smaller the diameter or size, the greater the percentage of coating present and hence the greater

TABLE 5 Resistivity Relations

Class A	Conductivity at 20°C %	100.0	96.0	95.0	94.0	92.0	90.0	88.0	85.0
	$\Omega \cdot lb/mile^2$	875.20	911.67	921.27	931.07	951.31	972.45	994.55	1029.7
	$\Omega \cdot g/m^2$	0.15328	0.15966	0.16134	0.16306	0.16660	0.17031	0.17418	0.18032
	Ω·cmil/ft	10.371	10.803	10.917	11.033	11.273	11.523	11.785	12.201
	$\Omega \cdot mm^2/m$	0.017241	0.017960	0.018149	0.018342	0.018741	0.019157	0.019592	0.020284
	µΩ·in.	0.67879	0.70708	0.71452	0.72212	0.73782	0.75421	0.77136	0.79858
	µΩ·cm	1.7241	1.7960	1.8149	1.8342	1.8741	1.9157	1.9592	2.0284
Class H	Conductivity at 20°C %	100.0	93.0	92.0	91.0	89.0	87.0	85.0	82.0
	$\Omega \cdot lb/mile^2$	875.20	941.08	951.31	961.76	983.38	1006.0	1029.7	1067.3
	$\Omega \cdot g/m^2$	0.15328	0.16481	0.16660	0.16844	0.17222	0.17618	0.18032	0.18692
	Ω·cmil/ft	10.371	11.152	11.273	11.397	11.653	11.921	12.201	12.648
	$\Omega \cdot mm^2/m$	0.017241	0.018539	0.018741	0.018947	0.019372	0.019818	0.020284	0.021026
	µΩ·in	0.67879	0.72989	0.73782	0.74593	0.76269	0.78022	0.79858	0.82780
	µΩ·cm	1.7241	1.8539	1.8741	1.8947	1.9372	1.9818	2.0284	2.1026

departure from the density of copper.

NOTE 11—*Principle of Operation of the Electronic Thickness Tester*—The unit operates by anodically deplating a small surface area of the specimen in a cell containing the test solution. The cell serves as cathode and the piece to be tested is the anode.

At the start of the test and until the base metal is exposed, a voltage characteristic of the plating exists across the cell; when all the plating has been removed from the test spot, this voltage changes sharply and assumes a new value which is now characteristic of the base metal. This rapid voltage change is the "end point" of the test, and is amplified and caused to operate a relay which turns off the instrument. The time required to dissolve the plating on the test spot is proportional to the thickness of the deposit; by correlating the area of the test spot with the current used to strip the plating, the counter is made to read directly in units of thickness.

Essentially, therefore, the electronic thickness tester embodies a miniature reverse-current plating cell in which the piece to be tested is the anode and the cell itself is the cathode.

The test solution used is specifically designed to give 100 % anodic current efficiency. It does not attack the plating unless current is flowing through the test cell. The anode efficiency is further maintained by providing agitation of the solution in the test cell.

NOTE 12—Kocour K5000 or K6000 model thickness testers display reading in mil × 100 equates to the "counter readings" for K1000 models. The user of this standard should also refer to operation manual for the particular model being used.

APPENDIX

(Nonmandatory Information)

X1. DETERMINATION OF THE WEIGHT OF NICKEL ON NICKEL-COATED COPPER FLAT WIRE METHOD A—ELECTRONIC DETERMINATION (Explanatory Note 11)

X1.1 Apparatus and Reagent

X1.1.1 Electronic Thickness Tester with Accessory Unit "WT."[4]

X1.1.2 Solution R-54.[4]

X1.2 Limitations of Method A

X1.2.1 This method is suitable for the determination of the thickness of coatings as follows:

Wire Size	Sample Length, in.
Less than or equal to 0.0114	2.00
Greater than or equal to 0.0115	1.00

NOTE X1.1—Wire size reflects the diameter of the incoming round wire, prior to flattening process.

X1.3 Procedure

X1.3.1 Connect the tester to 110-V, 60Hz, ac. Insert the jack plug on accessory unit lead wire into the jack marked "WT" on the left side of the thickness tester. Turn "Plate" selector to setting marked "Nickel." Turn power on and allow a 5 min warm-up period. Set K5000 or K6000 model thickness testers to read in MIL (Explanatory Note 12).

X1.3.2 Fill the stainless steel beaker to within 0.50 to 0.25 in. from the top with Solution R-54. Maintain the temperature of the solution at 20 to 25°C.

X1.3.3 Cut a straight length of the wire to be tested, approximately 4 in. longer than the required sample length. Lay the wire sample on a flat surface along a ruler and, using a crayon, mark off the appropriate sample length from one end of the wire. Make this measurement as accurately as possible.

X1.3.4 Insert the wire sample into the terminal on the horizontal arm of the accessory unit; then tighten the terminal so that the wire is held firmly in a vertical position. Lower the wire into the beaker until the liquid level is exactly at the crayon mark. Adjust the arm so that the wire is in the approximate center of the beaker.

X1.3.5 Press the "Test Button" to start the test. When the test is complete the instrument will turn off. The micro-inches for the flat wire may be calculated as follows:

$$MI\,(1 \text{ inch test length}) = K \times (.072)/(T+W)$$

or

$$MI\,(2 \text{ inch test length}) = K \times (.036)/(T+W)$$

where:

MI = Miro Inches
K = K5000 or K6000 display reading in mil X 100 (Explanatory Note 12), or
K = Counter reading for K1000 model
T = thickness, inches
W = width, inches

X1.4 Precautions

X1.4.1 Make no adjustments of the specimen while instrument is in operation. If an adjustment is necessary, stop the test by pressing the "Stop" button, make the adjustment, and repeat the test with a new sample.

X1.4.2 Avoid spilling test solutions into the accessory unit.

X1.4.3 Wire samples must be clean. If the wire is lacquered, remove the lacquer with a solvent before testing.

X1.4.4 Do not store test solutions in the stainless steel beaker. After daily use or after a series of tests have been completed, return the test solution to a re-usable storage bottle, and rinse the beaker thoroughly with water and dry it. Do not return used solutions to the original stock solution. Use a separate bottle for the used solution.

X1.4.5 Test solutions may be re-used. The extent to which the solutions become exhausted depends upon the number and size of the parts tested, as well as upon the thickness of the deposits which are stripped. In general, solutions may be

[4] The above named apparatus and reagent is the product of Kocour Company, 4800 So. St. Louis Ave., Chicago, IL 60632. http://www.kocour.net/

re-used approximately eight or ten times, or until erratic results are obtained, before discarding.