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(See 6.4)

FEDERAL SPECIFICATION

WIRE, MAGNET, ELECTRICAL

This specification was approved by the Commissioner, Federal Supply Service, General Services Administration, for use of all Federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers electrical magnet wire of various classes and types (see 1.2.1) used for fabricating armature coils, field coils, solenoid coils, transformer coils, and other such windings for use in electrical and electronic equipment (see 6.1).

1.1.1 Federal specification coverage. Federal specifications do not include all types, classes, and styles of the commodity indicated by the titles of the specifications, but are intended to cover only those used by the Federal Government.

1.2 Classification. Electrical magnet wire shall be of the following classes, types, shapes, and sizes, as specified (see 6.2):

1.2.1 Classes and types. The class of the magnet wire indicates the temperature index for the material (see 4.7.18.1). (The numeral following the type designator indicates the thickness of coating of film insulations, or the number of wraps of tape or fibers, as applicable.)

1.2.1.1 Film-coated round magnet wire.

Class 105		
	Type E.....	Oleoresinous-enamel-coated
	Type U, U2.....	Polyurethane-coated
	Type N, N2.....	Nylon-coated
	Type T, T2, T3.....	Polyvinyl-formal-coated
	Type TN, TN2.....	Polyvinyl-formal-nylon-coated
	Type TB, T2B, T3B.....	Polyvinyl-formal-coated, self bonding
	Type SA, SA2.....	Solderable-acrylic-coated
	Type SAN, SAN2.....	Solderable-acrylic-nylon-coated
Class 130		
	Type UN, UN2.....	Polyurethane-nylon-coated
Class 155		
	Type L, L2, L3.....	Polyester-coated
	Type LN, LN2, LN3.....	Polyester-nylon-coated
Class 180		
	Type H, H2, H3.....	Polyester-imide or polyester-amide-imide coated
Class 200		
	Type K, K2.....	Modified polyester, polyester-imide or polyester-amide-imide overcoated with polyamide-imide
Class 220		
	Type M, M2, M3.....	Aromatic polyimide-coated

1.2.1.2 Film-coated rectangular magnet wire.

Class 105		
	Type T2, T4.....	Polyvinyl-formal-coated
Class 200		
	Type K2, K4	Modified polyester, polyester-imide or polyester-amide-imide overcoated with polyamide-imide
Class 220		
	Type M2, M4.....	Aromatic polyimide-coated

1.2.1.3 Fibrous-covered round magnet wire.

Class 155		
	Type GV, G2V.....	Bare with single or double varnished glass
	BGV, BG2V.....	Single film, single or double glass varnished
	B2GV, B2G2V.....	Heavy film, single or double glass varnished

Class 155 (Continued)

Type	Dg, Dg2.....	Bare with single or double polyester-glass-fiber unvarnished
	DgV, Dg2V.....	Bare with single or double polyester-glass-fiber varnished
	BDg, BDg2.....	Single film, single or double polyester-glass fiber unvarnished
	BDgV, BDg2V.....	Single film, single or double polyester-glass fiber varnished
	B2Dg, B2Dg2.....	Double film, single or double polyester-glass fiber unvarnished
	B2DgV, B2Dg2V.....	Double film, single or double polyester-glass fiber varnished

Class 180

Type	DgH, Dg2H.....	Bare with single or double polyester-glass-fiber silicone varnished
	LDgH, LDg2H.....	Single film, single or double polyester-glass-fiber silicone varnished
	L2DgH, L2Dg2H.....	Heavy film, single or double polyester-glass-fiber silicone varnished

Class 200

Type	GK, G2K.....	Bare with single or double glass, silicone varnished
	LGK, LG2K.....	Single film, single or double glass, silicone varnished
	L2GK, L2G2K.....	Double film, single or double glass, silicone varnished

1.2.1.4 Fibrous-covered rectangular magnet wire.

Class 155

Type	G2V.....	Bare with double glass-fiber covered, varnished
	B2GV, B2G2V.....	Double film, single or double glass, varnished
	Dg2.....	Bare with double polyester-glass fiber, unvarnished
	Dg2V.....	Bare with double polyester-glass fiber, varnished
	B2Dg, B2Dg2.....	Double film, single or double polyester-glass fiber, unvarnished
	B2DgV, B2Dg2V.....	Double film, single or double polyester-glass fiber varnished

Class 180

Type	Dg2H.....	Bare with double polyester-glass-fiber, silicone varnished
	L2DgH, L2Dg2H.....	Heavy film, single or double polyester-glass-fiber, silicone varnished

Class 200

Type	G2K.....	Bare with double glass fiber covering, silicone varnished
	L2GK, L2G2K.....	Double film, single or double glass, silicone varnished

Class 220

Type	M2DgGM.....	Heavy film, single-polyester-glass-fiber and single-glass-fiber covering, varnished

1.2.2 Shapes. The wire shall be round, square, or rectangular as specified on the individual specification sheet. For the purpose of this specification, square and rectangular wire are hereinafter referred to as rectangular wire, and the smaller dimension as the thickness dimension.

1.2.3 Sizes. Wire sizes shall be specified in bare-wire dimensions: that is, in specifying wire sizes (and in referring to them herein), the effect of the addition of the insulation in increasing the dimensions of the bare wire is disregarded. For round wire, American Wire Gage (AWG) sizes shall be used; and for rectangular wire, dimension in inches.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal form a part of this specification to the extent specified herein.

Federal Specifications:

QQ-S-781 - Strapping, Steel and Seals.
QQ-W-343 - Wire, Electrical (Uninsulated).
LLL-R-626 - Rosins: Gum, Wood, and Tall Oil.
PPP-B-566 - Boxes, Folding, Paperboard.
PPP-B-576 - Box, Wood, Cleated, Veneer, Paper Overlaid.
PPP-B-585 - Boxes, Wood, Wirebound.
PPP-B-591 - Boxes, Fiberboard, Wood-Cleated.
PPP-B-601 - Boxes, Wood, Cleated-Plywood.
PPP-B-621 - Boxes, Wood, Nailed and Lock-Corner.
PPP-B-636 - Box, Shipping, Fiberboard.
PPP-B-640 - Boxes, Fiberboard, Corrugated, Triple-Wall.
PPP-B-665 - Boxes, Paperboard, Metal Edged and Components.
PPP-B-676 - Boxes, Set-Up.
PPP-T-76 - Tape, Pressure-Sensitive Adhesive Paper, (for Carton Sealing).
PPP-T-97 - Tape: Pressure-Sensitive Adhesive, Filament Reinforced.

(Activities outside the Federal Government may obtain copies of Federal Specifications, Standards, and Handbooks as outlined under General Information in the Index of Federal Specifications and Standards and at the prices indicated in the Index. The Index, which includes cumulative monthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

(Single copies of this specification and other Federal specifications required by activities outside the Federal Government for bidding purposes are available without charge from Business Service Centers at the General Services Administration Regional Offices in Boston, New York, Washington, DC, Atlanta, Chicago, Kansas City, MO, Fort Worth, Denver, San Francisco, Los Angeles, and Seattle, WA.

(Federal Government activities may obtain copies of Federal Specifications, Standards, and Handbooks and the Index of Federal Specifications and Standards from established distribution points in their agencies.)

Military Specifications:

MIL-P-116 - Preservation, Methods of.
MIL-Y-1140 - Yarn, Cord, Sleeving, Cloth, and Tape-Glass.
MIL-I-24092 - Insulating Varnish, Electrical, Impregnating.
MIL-I-45208 - Inspection System Requirements.

Federal Standards:

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

Military Standards:

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-147 - Palletized and Containerized Unit Loads, 40" x 48" Pallets, Skids, Runners, or Pallet Type Base.

(Copies of Military Specifications and Standards required by suppliers in connection with the specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

American National Standards Institute (ANSI) Standards:
C7.4 - Tinned Soft or Annealed Copper Wire for Electrical Purposes.
C7.9 - Soft Rectangular and Square Bare Copper Wire for Electrical Conductors.

(Application for copies should be addressed to the American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018.)

American Society for Testing and Materials (ASTM) Standards:

B193 - Method of Test for Resistivity of Electrical Conductor Materials
B298 - Silver-Coated Soft or Annealed Copper Wire.
B324 - Rectangular and Square Bare Aluminum Wire for Electrical Purposes.
B355 - Nickel-Coated Soft or Annealed Copper Wire.
D374 - Thickness of Solid Electrical Insulation, Tests for.
D1676 - Standard Method for Testing Film-Insulated Magnet Wire.
D2307 - Test for Relative Thermal Endurance of Film-Insulated Round Magnet Wire.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103.)

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)
101 - Guide for Statistical Analysis of Test Data (Formerly AIEE 1P)

(Application for copies should be addressed to the Institute of Electrical and Electronic Engineers, 345 East 47th Street, New York, N.Y. 10017.)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)
MW1000 - Magnet Wire.

(Application for copies should be addressed to the National Electrical Manufacturer's Association, 155 East 44th Street, New York, N.Y. 10017.)

National Motor Freight Traffic Association, Inc., Agent:
National Motor Freight Classification

(Application for copies should be addressed to the National Motor Freight Traffic Association, Inc., 1616 "P" Street, N.W., Washington, DC 20036.)

UNIFORM CLASSIFICATION COMMITTEE, AGENT
Uniform Freight Classification

(Application for copies should be addressed to the Uniform Classification Committee, Room 1106, 222 South Riverside Drive, Chicago, Illinois 60606.)

3. REQUIREMENTS

3.1 Qualification. All classes 105, 130, 155, 180, 200, and 220 magnet wire, furnished under this specification shall be a product which is qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.5 and 6.3).

3.2 Materials and shapes. The materials and shapes for the magnet wire shall be in accordance with NEMA-MW-1000 and as specified herein; however, when a definite material is not specified, a material shall be used which will enable the wire to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product. The material shall be new. There shall be no evidence of used, reclaimed, repaired or salvaged materials.

3.2.1 Conductors. Unless otherwise specified (see 6.2), conductors shall be of copper.

3.2.1.1 Copper.

3.2.1.1.1 Round wire, AWG sizes 50 and larger in diameter. The bare copper wire, after insulating, shall comply with type S of QQ-W-343, where applicable. All splices shall be of the butt type. Annealing may be done before, during or after insulating.

3.2.1.1.2 Rectangular wire. Conductors for rectangular wire shall be type B wire conforming to ANSI Standard C7.9; however, in all film types and glass insulated wire, the copper conductors may be medium-hard drawn, and annealed during or after insulating.

3.2.1.2 Silver-coated wire. When specified (see 6.2), silver-coated copper wire shall conform to ASTM Publication B298. The coating thickness shall be not less than 40 micro-inches (μ in).

3.2.1.3 Nickel-coated wire. When specified (see 6.2), nickel-coated copper wire shall conform to ASTM Publication B355. The coating thickness shall be not less than 50 µ in.

3.2.1.4 Aluminum wire. Film-coated aluminum round wire, sizes 10 through 25 AWG, shall have a yield strength not less than 7000 gage pressure of pounds per square inch (lb/in^2) and a tensile strength not less than 13000 gage pressure of pounds-force per square inch (lbf/in^2). Larger round sizes, all rectangular film-coated, and all fibrous-covered wire shall have a yield strength not less than 5000 gage pressure of lb/in^2 and shall have a tensile strength not less than 9000 gage pressure of lbf/in^2.

3.2.1.5 Joints, copper conductors. Magnet wire shall be furnished in one continuous length for each spool, reel, or container. Necessary joints shall be brazed with silver solder or welded. The number of joints shall be held to a minimum. The surface of the wire at the joint shall be smooth and insulated. The dimensions of the wire at the joints shall be substantially the same as at any other point on the wire. For 30 AWG and heavier wire, the tensile strength of the point shall be at least 80 percent of the tensile strength of the wire 3 feet from the joint. For 31 AWG and finer wire, the tensile strength of the joint shall be at least 20,000 lbf/in^2.

3.2.2 Insulation.

3.2.2.1 Insulating materials. All insulating materials shall be homogeneous, free from blisters, wrinkles, bumps or impurities or defects which would deleteriously affect mechanical or electrical properties of the finished wire.

3.2.2.1.1 Glass fiber. Glass-fiber insulation shall conform to MIL-Y-1140.

3.2.2.1.2 Glass-and polyester fiber. Glass-and-polyester-fiber insulation shall consist of a mixture of glass fiber and polyester fiber, with the polyester fiber not exceeding 50 percent of the combination. The polyester-glass fibers may be either fused to the conductor, or fused and varnish treated as specified on the individual specification sheet.

3.2.2.1.3 Film insulation. Film insulation shall be a material which provides a magnet wire that meets the requirements specified for the applicable type and class.

3.2.2.1.4 Varnish. Varnish used in treating glass and glass-and-polyester-fiber magnet wire shall conform to MIL-I-24092, or an alternate selected on the basis of service experience or equivalent test data. The varnish used shall be identified in the qualification test report (see 6.3).

3.2.2.2 Crack in insulation. The insulation shall be free from cracks. A crack in the film coating shall be defined as an opening in the coating which exposes the bare conductors to view. Wire sizes AWG 30 and larger shall be examined with normal vision[1/]. Sizes 30 to 44 AWG, inclusive shall be examined under 6X-10X magnification and sizes 45 and finer shall be examined under 10X-15X magnification.

3.3 Increase in bare-wire dimensions. The maximum increase in dimensions due to insulation specified herein may be exceeded provided the overall diameter of the finished wire does not exceed the computed maximum overall dimensions of the finished wire determined by adding the maximum specified increase due to insulation and the maximum specified bare-wire dimensions.

3.3.1 Intermediate sizes. For wire sizes between AWG sizes, the increase in diameter due to the film coating shall be the same as for the next larger AWG size and the test values shall be the same as for the next smaller AWG size.

3.4 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheets. In the event of any conflict between the requirements of this specification and the specification sheets, the latter shall govern.

[1/] Normal vision shall be defined as 20/20 vision, after correction with eyeglasses, if necessary.

3.5 Workmanship. Varnish or resin used shall be cured, free from bubbles, soft spots and shall be evenly applied. No paraffin or other deleterious coating shall be applied to types Dg and Dg2 wire. The wire shall be free from dirt, grease, moisture, dust, and metallic particles in insulation.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Test equipment and inspection facilities. Test equipment and inspection facilities shall be of sufficient accuracy, quality, and quantity to permit performance of the required inspection. The contractor shall establish calibration of inspection equipment to the satisfaction of the Government.

4.1.2 Inspection system. The contractor shall provide and maintain an inspection system acceptable to the Government for supplies and services covered by this specification. The inspection system shall be in accordance with MIL-I-45208 (see 6.2.1).

4.2 Classification of inspection. The examination and testing of magnet wire shall be classified as follows:

(a) Component-materials inspection (see 4.3).
(b) Qualification inspection (see 4.5).
(c) Quality conformance (see 4.6).
    Inspection of product for delivery (see 4.6.1).
    Inspection of preparation for delivery (see 4.6.2).

4.3 Component-materials inspection. Component-materials inspection shall consist of verification that the component materials listed in table I used in fabricating the magnet wire, are in accordance with the applicable referenced documents or requirements prior to such fabrication.

TABLE I. Component-materials inspection.

Component materials[1/]	Requirement paragraph	Applicable documents
Conductors:		
Copper	3.2.1.1	
Round, AWG size 50 and larger in diameter	3.2.1.1.1	QQ-W-343[2/]
Rectangular	3.2.1.1.2	(ANSI C7.9)
Silver-coated copper	3.2.1.2	(ASTM B298)
Nickel-coated copper	3.2.1.3	(ASTM B355)
Aluminum, rectangular, round	3.2.1.4	
Glass fiber	3.2.2.1.1	MIL-Y-1140
Glass-and-polyester fiber	3.2.2.1.2	---
Varnish	3.2.2.1.4	MIL-I-24092

[1/] Testing may be performed either before or after insulating.

[2/] Samples shall be selected on the basis of 10 percent of any lot of spools and reels up to and including 100, and one additional spool or reel for every 24 spools or reels over 100.

4.4 Inspection conditions. Unless otherwise specified on the applicable specification sheet, all tests shall be made at room temperature, which shall be between 20 degrees Celsius (°C) and 45°C (113°F). In case of dispute arising out of inspection made under these inspection conditions, the wire samples shall be dried for 48 hours at 105°C ± 3°C, conditioned for 4 hours at 23°C ± 5°C and 50 ± 5 percent relative humidity, and reinspected after such conditioning. Temperatures shall be controlled within plus or minus 2°C, or 2 percent of that specified, whichever is larger, and relative humidities within plus or minus 5 percent of that specified.

4.5 Qualification inspection. Qualification inspection shall be conducted at a laboratory satisfactory to the Naval Ship Engineering Center. Qualification tests shall consist of the tests specified on the applicable specification sheet.

4.5.1 Qualification specimen. The manufacturers requesting qualified products listing shall manufacture and be responsible for testing at least one specimen of wire for each class and type for which qualification is sought. The specimen of wire subjected to qualification testing of round film coated wire shall be AWG No. 18 heavy film build, unless otherwise specified in 4.7 or as agreed between the manufacturers and NAVSEC shall be the basis for the qualification listing of all sizes and film thicknesses shown on the applicable individual specification sheet. The size of wire for qualification testing of film insulated rectangular wire shall be as agreed between the manufacturer and NAVSEC and have a heavy film build and shall be the basis for qualification listing of all sizes and thicknesses of film listed on the applicable specification sheet. The specimen of wire for qualification testing of fibrous-covered round or rectangular wire shall be as agreed between the manufacturer and NAVSEC, and have an underlying varnish covering and shall be the basis for qualification listing of all sizes and types of insulation combinations listed on the applicable specification sheet.

4.6 Quality conformance.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of component-materials inspection of 4.3 and of groups A, B, and C inspection of 4.6.1.2, 4.6.1.3 and 4.6.1.4.

4.6.1.1 Definitions.

4.6.1.1.1 Inspection lots. An inspection lot, shall consist of all the magnet wire of the same class, type, shape, and size or size range, produced under essentially the same conditions, and offered for inspection at one time. A range of sizes may be consolidated into one inspection lot, provided that the ratio of the largest conductor cross-section to the smallest conductor cross-section does not exceed five.

4.6.1.1.2 Unit of product. The unit of product shall be defined as a spool, reel, container or other package of magnet wire of any length.

4.6.1.1.3 Lot size. The lot size shall be the number of units of product in an inspection lot.

4.6.1.1.4 Sample. A sample shall be defined as one or more sample units selected from an inspection lot in accordance with the sampling plan for the lot size determined as in 4.6.1.1.3.

4.6.1.1.5 Sample unit. A sample unit shall be defined as a unit of product selected in an unbiased manner and is part of a sample from which specimens are taken.

4.6.1.1.6 Specimen. A specimen is an individual piece of wire taken from a sample unit and subjected to inspection.

4.6.1.1.7 Defective unit. Failure in any one test shall constitute a defect; however, if the sample unit fails more than one test in any test group, it shall be counted as only one defective unit.

4.6.1.1.8 Rejected lots. If an inspection lot is rejected, the contractor may withdraw the lot, rework it to correct the defects, or screen out the defective units and again reinspect it, as applicable. Such lots shall be kept separate from new lots, and shall be clearly identified as reinspected lots. Such lots shall be reinspected using tightened inspection.

4.6.1.2 Group A inspection. Group A inspection shall consist of the examinations and tests specified in table II, and shall be made on the same set of samples.

TABLE II. Group A inspection.

Examination or test	Specification sheet	Method paragraph	AQL (percent defective) Major
Visual and dimensional examination	1 thru 16, 18 thru 27	4.7.1	1.5
Increase in bare dimensions		---	
Insulation and workmanship		---	
Adhesion and flexibility	2 thru 16, 18 thru 27		4.0
Adhesion (only)	1	4.7.2	4.0
Elongation	1 thru 16, 18 thru 27	4.7.4	4.0
Springback	1 thru 12 incl 14, 15	4.7.6	4.0

4.6.1.2.1 Sampling plan. Statistical sampling and inspection shall be in accordance with MIL-STD-105 for ordinary inspection. The inspection level shall be I when the specified AQL is 4.0. The acceptable quality levels (AQL) shall be as specified in table II. Major defects shall be as defined in MIL-STD-105 and in table III.

TABLE III. Classification of defects in accordance with MIL-STD-105.

Categories	Defects
Critical:	None defined.
Major:	
101	Type and size not as specified.
102	Material nonconforming; evidence of unauthorized material used.
103	Material not new; evidence of used, reclaimed, repaired, or salvaged parts.
104	Material of conductors nonconforming; not in accordance with specifications.
105	Insulation not homogeneous; has blisters, wrinkles, cracks, bumps.
106	Fiber or filament insulation wrapping uneven; not firm and continuous.
107	Application method of synthetic resin not as specified. (Types T, T2, T3, and T4, synthetic-resin insulated.)
108	Increase in diameter of bare round wire, due to addition of synthetic-resin insulation, is not within specified limits (types T, T2, T3, and T4).
109	Increase in dimensions of bare rectangular wire, due to addition of synthetic-resin insulation, is not within specified limits (types T, T2, and T4).
110	Glass not in accordance with specification (types GK and G2K, glass insulated).
111	Glass wrap or wraps not completely coated and filled with specified varnish or resin (types GK and G2K).
112	Varnish or resin used is not cured; has bubbles, soft spots, uneven surface (types GK and G2K).
113	Increase in dimensions of bare round and rectangular wire, due to addition of glass insulation, single or double, is not within specified limits (types GK and G2K).
114	Glass fiber not as specified (types Dg and Dg2, glass-and-polyester-fiber insulated).
115	Polyester fiber in insulation greater than maximum percent allowed (types Dg and Dg2).
116	Varnish or bonding material used in insulation is not as specified; wrap or wraps not thoroughly coated and filled with varnish or bonding material (types Dg and Dg2).
117	Varnish or bonding material is rough, uneven, has bare spots, soft spots (types Dg and Dg2).
118	Paraffin or other deleterious coating applied to insulated wire (types Dg and Dg2).
119	Increase in dimensions of bare round and rectangular wire, due to addition of single or double insulation, is not within specified limits (types Dg and Dg2).

TABLE III. Classification of defects in accordance with MIL-STD-105. (Con.)

Categories	Defects
Major continued:	
120	Combination insulations: size limits not as specified.
121	Combination insulations: increase in dimensions of bare wire is not within specified limits.
122	All wire splices are not butt type; construction of splices is such that diameter, configuration, resistivity, flexibility, and mechanical strength are adversely affected.
123	Manufacture of magnet wire such that it is not free of dirt, grease, moisture, dust, metallic particles in insulation.
124	Round or rectangular magnet wire not wound on spools or reels; maximum weight or wire per spool or reel nonconforming.
Minor:	None defined.

4.6.1.2.2 Disposition of sample units. Sample units which have passed all the group A inspection may be delivered on the contract, if the lot is accepted.

4.6.1.3 Group B inspection. Group B inspection shall consist of the tests specified in table IV.

TABLE IV. Group B inspection.

Test	Specification sheet	Method paragraph	Shapes, sizes and types of wire
Heat shock	2 thru 16 and 18	4.7.3	Film coated round and rectangular wire
Dielectric strength	1 thru 16,	4.7.8	
Layer to layer (round wire)	18 thru 27		Round in AWG sizes 0000 to 30 incl. in all types GV, Dg, GK
Twist			Round in AWG sizes 10 to 40 incl. in all types E, U, N, T, TN, TB, SA, SAN, UN, L, LN, H, K, M.
Wrapped foil			Rectangular in all sizes and types Round in AWG sizes 4/0 to 9 incl. in all types GV, Dg, GK Round in AWG sizes 4/0 to 9 incl. in all types E, U, N, T, TN, TB, SA, SAN, UN, L, LN, H, K, M.
Continuity: High voltage or Low voltage	4 thru 12 incl., 14 and 15	4.7.10 or 4.7.9	Round in all types and sizes
Completeness of cure	4-6-15-18	4.7.12	Round in AWG sizes 4 to 44 incl. in all types T, TB, M. Rectangular type M.
Solderability	2-3-7-8-9	4.7.13	Round in AWG sizes 4 to 44 incl. in all types U, N, SA, SAN, UN
Helical coil bond	6	4.7.15	Round in AWG sizes 4 to 44 incl. in all types TB

4.6.1.3.1 Sampling plan. The sampling plan shall be in accordance with MIL-STD-105 for small-sample inspection. Unless otherwise specified herein, normal inspection shall be used at the start of the contract. The AQL shall be 6.5 (percent defective), and the inspection level shall be S4 for normal and tightened inspection, and S3 for reduced inspection.

4.6.1.3.2 Disposition of sample units. Sample units which have passed all the group B inspection may be delivered on the contract, if the lot is accepted.

4.6.1.4 Group C inspection. Group C inspection shall consist of the tests specified in table V. Shipment shall not be held up pending results of the inspection.

TABLE V. Group C inspection.

Test	Specification sheet	Method paragraph
Scrape resistance Unidirectional scrape	2, 4, 5, 7 thru 12 incl. 14, 15	4.7.5.1
Thermoplastic flow	1 thru 16, 18	4.7.7
Solubility	1 thru 16, 18	4.7.11
Alcohol tack	6	4.7.15
Dielectric strength at rated temperature	2 thru 16, 18	4.7.17
Thermal evaluation	1 thru 12 incl; 14 thru 16, 18	4.7.18.2
Overload	3 thru 12 incl. 14 thru 16, 18	4.7.14

4.6.1.4.1 Sampling plan. Three sample units of magnet wire shall be selected from the first lot and thence from each 3-month production or 5,000 units, whichever is less.

4.6.1.4.2 Noncompliance. If a sample fails to pass group C inspection, the contractor shall take corrective action on the materials or process, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same conditions, with essentially the same materials, processes, and so forth, and which are considered subject to the same failure. Acceptance of the product shall be discontinued until corrective action, acceptable to the Government, has been taken. After the corrective action has been taken, group C inspection shall be repeated on additional sample units (all inspection, or the inspection which the original sample failed, at the option of the Government). Groups A and B inspection may be reinstituted; however, final acceptance shall be withheld until the group C reinspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure and the corrective action taken shall be furnished to the contracting officer.

4.6.1.4.3 Disposition of sample units. Sample units which have passed all the group C inspection may be delivered on the contract, if the lot is accepted.

4.7 Test methods.

4.7.1 Visual and dimensional examination. Each of the finished samples of magnet wire selected in accordance with 4.6.1.2 shall be visually and dimensionally examined to verify that materials and construction conform to this specification.

4.7.1.1 Materials and construction. Examination shall be made of conductors, insulation coverings and processing to determine that the magnet wire conforms to this specification.

4.7.1.2 Dimensions.

4.7.1.2.1 Film-coated round wire AWG 44 and larger. The diameter over the insulation shall be measured using a hand or bench micrometer having a spindle pressure not greater than 6 ounces per 1/4-inch diameter anvil for wire sizes AWG 40 and larger and not greater than 2.5 ounces per 1/2-inch diameter anvil for wire sizes smaller than AWG 40. The micrometer shall be checked with wire standards at least daily. For micrometer methods of use, specifications and calibrations, refer to ASTM publication D-374. The test specimens shall consist of 4 to 6 inch straight length of wire free from kinks or obvious defects. The

sample shall be carefully removed from the spool or container to avoid damaging or stretching. The diameter of the film coated wire shall be measured at four points spaced approximately 45 degrees apart around the circumference of the wire. The largest and smallest readings shall be recorded, and the average of these two readings shall be taken as the overall diameter of the specimen. The film coating shall then be removed at approximately the same position on the wire by means not injurious to the bare wire and the measurements repeated around the bare wire. If removing only a bonding overcoat, a solvent shall be used that will remove the bond coat but not swell or change dimensions of the base coat. The average diameter of the conductor shall be subtracted from the overall diameter. This shall be reported as the average film addition (also known as increase in diameter or as film build).

4.7.1.2.2 Film-coated round wire smaller than AWG 44. The micrometer method specified in 4.7.1.2.1 shall be used for measuring the diameter over the insulation for wire sizes AWG 56 and larger. The conductor diameter may be measured either by the method of 4.7.1.2.1 or by the resistance method. Resistance measurements shall be made in accordance with the procedures of ASTM Publication B-193. The test specimens shall consist of 5 feet or longer lengths of wires.

4.7.1.2.3 Film-coated rectangular wire. The thickness of the film-coated rectangular wire shall be measured using the micrometer method specified in 4.7.1.2.1 and on three carefully straightened specimens each at least 3 inches long taken from a reel or spool at 1-foot intervals. Straightening may be accomplished by stretching the wire not more than 1 percent to remove bends or kinks. One measurement of the thickness shall be made over the coating of each specimen. The coating shall then be removed at these points without injury to the bare wire and the thickness of the bare wire measured at each point. The average of these readings shall be the conductor thickness. The average thickness over the bare wire shall be subtracted from the average thickness over the film coating. This shall be reported as the average film addition or increase in thicknesss due to film coating. The increase in width shall be determined in the same manner as the increase in thickness.

4.7.1.2.4 Fibrous-covered round wire. The thickness of the fibrous-covered round wire shall be measured using the micrometer method specified in 4.7.1.2.1 and at three points, spaced approximately 1 foot apart. The average of these readings is the overall diameter of the wire. The covering shall then be removed at these points without injury to the wire and the diameter of the bare wire measured at each point. In the case of fibrous coverings over film-coated wire, the film coating as well as the fibrous covering shall be removed and the diameter of the bare wire measured. In each set of measurements, the diameter shall be measured at two points on the circumference approximately 90 degrees apart. The average diameter after removal of the coverings shall be subtracted from the average diameter over the fibrous covering. This shall be reported as the increase in diameter due to fibrous or film-fibrous covering.

4.7.1.2.5 Fibrous-covered rectangular wire. The thickness of the fibrous-covered rectangular wire shall be measured at three points spaced approximately 1 foot apart on a carefully straightened specimen using a pressure type micrometer having a 0.250-inch diameter spindle and a 250-inch diameter anvil. The spindle shall have an effective weight of three pounds, including the weight of the spindle. Straightening may be accomplished by stretching the wire not more than 1 percent to remove bends or kinks. The fibrous covering or film and fibrous covering shall then be removed and the thickness of the bare wire measured at each point. The average thickness over the bare wire shall be subtracted from the average thickness over the fibrous covering. This shall be reported as the increase in thickness due to fibrous or film/fibrous covering. The increase in width shall be determined in the same manner.

4.7.2 Adhesion and flexibility.

4.7.2.1 Film-coated round wire.

4.7.2.1.1 Adhesion. A specimen of film-coated wire having an effective length of 10 inches shall be elongated (a) at the rate of 12 inches, ± 1 inch, per minute for sizes 13 AWG and heavier, inclusive and (b) by a sudden jerk (12 to 16 feet per second) for sizes 14 AWG and finer. The specimen shall then be examined for cracks in the film coating as follows:

(a) Size AWG 30 and heavier - Examine with normal vision
(b) Size AWG 31-44, inclusive - Examine with 6X-10X magnification
(c) Size AWG 45 and finer - Examine with 10X-15X magnification

4.7.2.1.2 Flexibility. A specimen of film-coated wire having an effective length of 10 inches shall be wound not more than ten turns around a mandrel having the diameter specified on the applicable specification sheet. The specimen shall then be examined for cracks in the film coating as follows:

(a) Size AWG 30 and heavier - Examine with normal vision
(b) Size AWG 31-44, inclusive - Examine with 6X-10X magnification
(c) Size AWG 45 and finer - Examine with 10X-15X magnification

4.7.2.1.3 Adhesion and flexibility. A specimen of film-coated wire having an effective length of 10 inches shall be elongated, wound not more than ten turns around a mandrel, and examined in accordance with table VI.

TABLE VI. Adhesion and flexibility.

AWG size	Elongation rate	Minimum elongation, percent	Mandrel diameter	Examined with
4-9	12 ± 1 inches per minute	30	None	Normal vision
10-13	12 ± 1 inches per minute	25	5X	Normal vision
14-20	Sudden jerk	20	3X	Normal vision
21-30	Sudden jerk	15	1X	Normal vision
31-44	Sudden jerk	20	3X	6X-10X magnification
45-56	Sudden jerk	Breaking point	None	10X-15X magnification

1/ Or to its breaking point, whichever is less.

4.7.2.2 Film-coated, rectangular.

4.7.2.2.1 Adhesion. A specimen of film-coated wire having an effective length of 10 inches shall be elongated 30-percent at a rate of 12 inches ± 1 inch, per minute. The wire shall be visually examined for cracks in the film coating.

4.7.2.2.2 Bend test - edgewise and flatwise. Two undamaged 10-inch specimens of wire shall be elongated 10 percent and bent approximately four inches from each end, one flatwise and one edgewise, on a 90-degree angle over a mandrel as outlined in table VII in the form of a "Z". During the bending operation, extreme caution shall be observed to prevent external damage to the film coating such as may occur due to scraping, cutting, and so forth. A strip of 1/4-inch wide conductive adhesive foil tape shall be tightly wrapped around the wire at the center of each bend and a dielectric breakdown test made in accordance with 4.7.8.3(c).

TABLE VII. Mandrel size for bend test.

Flatwise (wire thickness)	Edgewise (wire width)	Mandrel diameter
Inch	Inch	Inches
0.031 to 0.036		0.152
.037 to .041		.170
.042 to .050		.200
.051 to .063		.250
.064 to .075		.300
.076 to .088	0.076 to 0.088	.350
.089 to .100	.089 to .100	.400
.101 to .125	.101 to .125	.500
.126 to .150	.126 to .150	.600
.151 to .187	.151 to .187	.750
.188 to .219	.188 to .219	.900
.220 to .250	.220 to .250	1.00
.251 to .310	.251 to .310	1.25
	.311 to .375	1.50
	.376 to .435	1.70
	.436 to .500	2.00

4.7.2.3 Fibrous-covered round wire.

4.7.2.3.1 Adhesion. A specimen of fibrous covered round wire having an effective length of 10 inches shall be elongated 25 percent or to the breaking point, whichever is less, at a rate of 12 inches ± 1 inch, per minute. There shall be no loosening, fraying, or loss of adherence of the covering except at the point of rupture.

4.7.2.3.2 Flexibility. A specimen of fibrous covered round wire shall be wound three times around a mandrel of the diameter shown in table VIII and examined for cracks in the fibrous covering.

TABLE VIII. Mandrel size for flexibility test.

AWG size	Mandrel diameter
30-1	10X
0 and larger	15X

4.7.2.4 Fibrous-covered, rectangular wire.

4.7.2.4.1 Adhesion.

4.7.2.4.1.1 Fibrous-covered wire without underlying film coatings. A specimen of fibrous-covered wire without an underlying film coating, shall be wound flatwise 180 degrees around a mandrel having a diameter 10 times the thickness of the bare wire, and the bent portion shall be buried in No. 6 lead shot (0.080 to 0.100 inch in diameter). A source of 60-Hertz (Hz) voltage, of a substantially sinusoidal wave form shall be applied between the conductor and the lead shot.

4.7.2.4.1.2 Fibrous-covered wire with an underlying film coating. A specimen of fibrous-covered wire with an underlying film coating, having an effective length of 10 inches shall be elongated at least 20 percent at a rate not greater than 12 inches, ± 1 inch, per minute. The wire shall be visibly examined for cracks in the film coating.

4.7.2.4.2 Flexibility. A specimen of fibrous-covered wire shall be bent on its flat side 180 degrees around a mandrel having a diameter 10 times the thickness and then examined with normal vision for cracks in the fibrous covering. The outer diameter of the insulation shall determine the mandrel diameter.

4.7.3 Heat shock.

4.7.3.1 Film-coated round wire. A specimen of coated wire having an effective length of 10 inches shall be elongated at a rate shown in table IX and wound not more than 10 times around a mandrel having the diameter specified on the applicable specification sheet. The specimen shall be removed from the mandrel and placed in a circulating air oven for 1/2 hour at the temperature specified on the applicable specification sheet. The specimen shall then be examined in accordance with table IX for cracks in the film coating.

TABLE IX. Heat shock.

AWG size	Elongation rate	Examine with
4-13	12 ± 1 inches per minute	Normal vision
14-30	Sudden jerk	Normal vision
31-44	Sudden jerk	6X-10X magnification

4.7.3.2 Film-coated rectangular wire. A specimen of film-coated wire having an effective length of 10 inches shall be elongated at a rate of 12 inches, ± 1 inch, per minute to the percent specified on the applicable specification sheet and placed in a circulating air oven at the temperature specified on the specification sheet for 1/2 hour. The specimen shall be allowed to cool to room temperature and shall then be examined with normal vision for cracks in the film coating.

4.7.4 Elongation.

4.7.4.1 Film-coated round and rectangular wire. A specimen of film-coated wire having an effective length of 10 inches shall be elongated to its breaking point at a rate of 12 inches, ± 1 inch, per minute. The gripping jaws shall be such that a break will not occur within 1/4 inch of either jaw. The travel distance of the jaw at the instant of break shall be noted and the percentage of elongation calculated.

than the maximum value specified on the applicable

4.7.4.2 Fibrous-covered round wire. A specimen of wire size 30 AWG and larger shall be elongated to its breaking point at a rate of 12 inches, ± 1 inch, per minute. The gripping jaws shall be such that a break will not occur within 1/4-inch of either jaw. In case of failure of glass-fiber-covered wire, the fibrous covering shall be removed from another specimen and the wire tested. The travel distance of the jaw at the instant of break shall be noted and the percentage of elongation calculated. On fibrous covered wire sizes 22 AWG and smaller, the fibrous covering shall be removed from the specimen prior to testing.

4.7.4.3 Fibrous-covered rectangular wire. A specimen of fibrous-covered wire, with or without silicone, having an effective length of 10 inches shall be elongated to the breaking point at a rate of 12 inches, ± 1 inch, per minute. The gripping jaws shall be such that a break will not occur within 1/4-inch of either jaw. The travel distance of the jaw at the instant of break shall be noted and the percentage of elongation calculated.

4.7.5 Scrape resistance.

4.7.5.1 Unidirectional scrape resistance - sizes 10 to 30 AWG, inclusive. Scrape resistance shall be measured on a device which scrapes the surface of the coated wire longitudinally by means of a weighted scraping fixture.

4.7.5.1.1 Test procedure. A specimen of film-coated wire shall be wiped with a clean, dry, bleached, and unsized cheese-cloth, placed in the device, and straightened by elongating it not more than 1 percent to remove kinks. The specimen shall then be secured in the clamping jaws, and the supporting anvil adjusted to contact the underside of the specimen.

4.7.5.1.1.1 Approximately 90 percent of the minimum grams-to-fail load specified on the applicable specification sheet shall be applied to the scraping device. This initial load shall be recorded. The weighted scraping device shall be lowered gently onto the surface of the film coating and the scraping action started.

4.7.5.1.1.2 Weight shall be added until the conductor is exposed and the device stops. The value at which the device is shut off shall be read on the graduated scale on the lower edge of the beam. The product of this value and the initial load applied shall be recorded as the "grams-to-fail" load.

4.7.5.1.1.3 The test procedure shall be repeated twice, indexing around the periphery of the wire, once at 120 degrees and once at 240 degrees from the original position and the same information recorded. The three "grams-to-fail" figures shall then be averaged.

4.7.5.1.2 Scraping device. The device shall provide a scraping action in one direction only at a rate of 16 inches (± 10 percent) per minute. The weighted scraping fixture shall contain a polished 0.009-inch-diameter steel piano wire or needle located between two jaws which support the steel piano wire or needle rigidly, without sagging or curvature, at right angles to the direction of stroke. The stroke shall be in one direction along the longitudinal axis of the film-coated wire to be tested. The film-coated wire to be tested shall be held securely between two clamping jaws over a supporting anvil which shall be lowered while the specimen is inserted into the jaws and straightened. It shall then be raised to contact the under surface and support the specimen. The scraping device shall be equipped with an electrical circuit which limits the current to 20.0 milliamperes at 7.5 ± 1.5 volts (V) between the conductor and the piano wire or needle scraper. The circuit shall be so designed that failure of the film coating is detected and the scraping device stopped when the film coating is removed and the bare conductor exposed for approximately 1/8 inch. The scraping device shall be equipped with a graduated scale on the lower edge of the beam which indicates the factor by which the initial load is multiplied to determine the "grams-to-fail".

4.7.6 Springback - sizes 14 to 30 AWG, inclusive. A specimen of film-coated wire shall be wound three turns at a rate of 5 to 10 rpm around a mandrel having the diameter shown in table X, under the tension indicated. One end of the coil so formed shall be held and the other allowed to unwind slowly.

TABLE X. Springback.

AWG size	Mandrel diameter, inches	Tension ounces
14	3 1/4	16
15	3 1/4	16
16	3 1/4	16
17	3 1/4	16
18	3 1/4	16
19	3 1/4	16
20	3 1/4	16
21	1 7/8	4
22	1 7/8	4
23	1 7/8	4
24	1 7/8	4
25	1 7/8	2
26	1 7/8	2
27	3/4	2
28	3/4	2
29	3/4	2
30	3/4	2

The springback tester (see figure 1) shall be operated in accordance with the following procedure:

(a) The instrument shall be mounted with the shaft of the mandrel horizontal at a height approximately 4.5 feet above the floor.

(b) The mandrel shall be locked in position so that the hole for fastening the wire is in a vertical position to correspond with zero on the dials.

(c) The wire to be tested shall be removed carefully from the package in such a way that the wire will not be subjected to extra bends or tension and shall be wound onto the mandrel in the same direction as originally coiled.

(d) The wire shall be inserted in the hole using the size of mandrel and weight specified in table X.

(e) The wire shall be layer-wound by turning the mandrel counterclockwise with the number of turns as specified.

(f) A mark with a crayon, pencil, or ink shall be made on the last turn opposite the zero mark on the dial.

(g) The wire shall be held in place with the left hand on the mandrel and then the weight shall be removed.

(h) The wire shall be cut, leaving approximately 1/2 inch of wire past the mark previously scribed on the last turn. This 1/2-inch length shall be bent in a vertical position.

(i) By placing a pencil to the left of the vertical piece of wire, the coil of wire shall be allowed to unwind slowly, without jerking. If the wire is permitted to spring back suddenly, erroneous results are obtained.

(j) Note the angle through which the mark on the last turn has moved as shown on the dial mounted behind the mandrel specified.

(k) The indicating point on the free end of the coil should come to rest on the curve shown on each dial.

NOTE: A soft wire will exhibit less tendency to spring back; hence the figure representing the degrees per turn will be less than that for a harder wire.

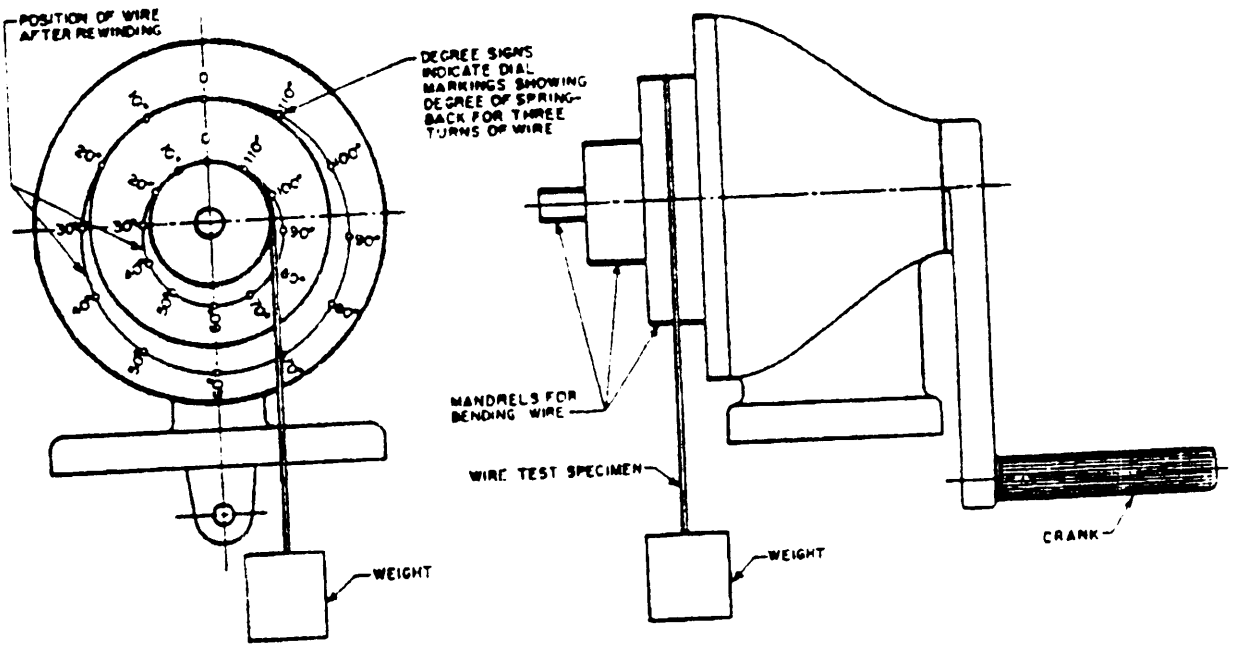

FIGURE 1. Machine for springback.

4.7.7 Thermoplastic flow.

4.7.7.1 Procedure. The specimen shall be comprised of two lengths of wire positioned at right angles to each other in the apparatus as required. The specimen shall be carefully loaded with 2000 grams for size 18 AWG or 100 grams for size 36 AWG wire. The temperature shall be increased at 10°C to 45°C per minute to not less than 50°C below the thermoplastic flow temperature specified in the applicable specification sheet, and then raised 5°C per minute until failure occurs. The indicated temperature, corrected in accordance with 4.7.7.2, shall be taken as the thermoplastic flow temperature of that specimen. For 18 AWG wire, five specimens shall be tested and the average shall be the thermoplastic flow temperature. For size 36 AWG wire, ten specimens shall be tested and the average shall be the thermoplastic flow temperature.

4.7.7.2 Apparatus. The thermoplastic flow tester shall be capable of exerting a constant load perpendicular to, and directly over, the right-angle crossover of the specimen. The tester shall include a control thermocouple with a temperature range and a pyrometer to indicate the temperature measured by the control thermocouple. The actual specimen temperature at each test position under the load at the crossover position shall be measured throughout the expected temperature range by a calibrated thermocouple-pyrometer and compared to the control or indicated temperature. The resulting temperature difference shall be used to appropriately correct the indicated thermoplastic flow temperature. The testing chamber shall be of a size to maintain a temperature rise of 10°C to 45°C per minute to not less than 50°C below the temperature specified in the applicable specification sheet and 5°C per minute temperature rise from that point to failure. The failure detector shall be so constructed that a current flow of 0.50 to 0.100 ampere at 115 V alternating current, 60 Hz, between the crossed wires of the specimen will indicate failure.

4.7.8 Dielectric strength.

4.7.8.1 Layer to layer (round wire). Two layers of insulated wire shall be close wound, turn-to-turn, one on top of the other, around a smooth, cylindrical insulating mandrel without reversing the direction of rotation of the mandrel. The maximum tension and the mandrel diameter shall be as specified in table XI. The length of the winding along the mandrel shall be 1 inch, but not less than six turns. Voltage at 60-Hz of a wave shape substantially sinusoidal, starting at zero and increasing uniformly at 500 V per second, shall be applied between the two layers until the insulation is punctured, the voltage at puncture being measured with a voltmeter calibrated in volts root-mean-square (rms). In the event, that breakdown occurs in less than 5 seconds, the test shall be repeated and the rate of increase in voltage shall be reduced sufficiently so that breakdown will not occur in less than 5 seconds. The breakdown voltage shall be not less than the values given in the applicable specification sheet.

TABLE XI. Mandrel diameters for dielectric-strength test on round wire, sizes 10 to 30 AWG (layer-to-layer).

Wire size (AWG), Incl	Mandrel diameter, inch
10 to 23	1.00
24 to 30	.25

4.7.8.2 Twist (round wire). Two pieces of wire shall be twisted together for a distance of 4.75 inches. The tension on the wires while being twisted and the number of twists shall be as specified in table XII. Voltage at 60-Hz frequency of a wave shape substantially sinusoidal, starting at zero and increasing uniformly at 500 V per second, shall be applied between the two wires until the insulation is punctured, the voltage at puncture being measured with a voltmeter calibrated in volts rms. The testing transformer shall have a rating of 500 voltamperes or more. In the event that breakdown occurs in less than 5 seconds, the test shall be repeated and the rate of increase in voltage shall be reduced sufficiently so that breakdown will not occur in less than 5 seconds. The breakdown voltage shall be not less than the values given in the applicable specification sheet.

sufficient to give adequate performance under

TABLE XII. Tension and number of twists for dielectric-strength of round wire (twist).

AWG size	Total tension on wire	Number of twists
10 to 11	24 lbs.	3
12 to 14	12 lbs.	4
15 to 17	6 lbs.	6
18 to 20	3 lbs.	8
21 to 23	1.5 lbs.	12
24 to 26	340 grams	16
27 to 29	170 grams	20
30 to 32	85 grams	25
33 to 35	40 grams	31
36 to 38	20 grams	36
39 to 41	10 grams	41
42 to 44	5 grams	46

4.7.8.3 Wrapped foil. This test applies to rectangular wire of all sizes, and to round wire AWG size 9 and larger in diameter. The wrapped-foil test shall be performed as follows:

(a) Apply a strip of thin metallic foil, 1/4-inch wide, to the center of a 1/2-inch wide pressure-sensitive tape. Cut the tape into strips about 3-inches long, in such a manner that the tape does not extend beyond the end of the metallic foil. These strips are the electrodes.

(b) Cut a specimen of wire of such length that four electrodes may be applied at intervals of about 2 inches. Starting 2 inches minimum from the exposed end, apply the electrodes to the wire with the tape at right angles to the wire, and the foil in contact with the wire. Wrap the tape smoothly and firmly around the wire a minimum of one and one-half complete turns.

(c) Apply a 60 + 1 Hz voltage of sinusoidal waveform between the metallic foil and the conductor, one electrode at a time. Start the voltage at zero, and increase it uniformly at a rate of 500 V per second until breakdown occurs. In the event that breakdown occurs in less than 5 seconds, the test shall be repeated and the rate of increase in voltage shall be reduced sufficiently so that breakdown will not occur in less than 5 seconds.

(d) The breakdown voltage in at least three of the four locations where the electrodes are applied shall be not less than the values given in the applicable specification sheet

4.7.9 Low voltage continuity - sizes 25 to 56 AWG inclusive. A 100-foot specimen of wire shall be passed through a mercury bath at a speed of 100 feet per minute, + 10 percent. The length of the bath shall be 1 + 1/16 inch and the height of the mercury sufficient to cover the wire for the entire length of the bath. A direct-current potential shall be applied between the bath and the wire conductor of magnitude as shown in table XIII. The test circuit shall be so arranged that the discontinuity indicating device will operate when the resistance between the bath and the wire conductor is less than 5,000 ohms, but will not operate when the resistance is 10,000 ohms or more. It shall be arranged so that a minimum of 600 faults per minute, + 10 percent, will be counted when a bare wire is passed through the bath. Any automatic counter conforming to the conditions specified herein may be used.

TABLE XIII. Low voltage continuity.

Wire sizes (AWG), inclusive	Volts
25 to 29	75
30 to 34	60
35 to 40	30
41 to 56	20

4.7.10 High voltage direct current continuity, bench test, sizes 14 to 30 AWG, inclusive.

4.7.10.1 Test procedure. One hundred feet of film-coated wire shall be passed over an energized corrosion resistant (stainless steel) V-grooved insulated sheave (contact) at a speed of 60 + 2.5 feet per minute. Two grounded metallic guide sheaves shall be used (one before and the other after contact). All three sheaves shall be of the same diameter and construction and shall be arranged so that the amount of wire in contact with the energized

e for a short

are quickly replaceable, or in guided missiles which operate one

sheave (center) will be 1.0 ± 0.2 inch. The conductor of the magnet wire under test shall be electrically grounded by means of either a ground terminal or a grounded take-up drum. Pay-off equipment shall be designed to eliminate damage to the wire under test.

4.7.10.2 Equipment. The high-voltage power supply shall be regulated and shall provide to the contact sheave a smooth filtered direct-current voltage free of transient overvoltage "spikes" (see 4.7.10.2.2). The open circuit test voltages, available by adjustment shall be 500, 750, 1000, 1500, 2000, 2500 and 3000 V and shall have a positive polarity with respect to the grounded test wire. The steady-state short-circuit current shall be limited internally to a maximum of 50 microamperes at any test voltage setting. A 50-megohm fault resistance at the contact sheave shall not cause more than a 70 percent drop in voltage on the high-voltage sheave at any voltage setting. The sensitivity (see 4.7.10.2.3) of the fault detection circuit (see 4.7.10.2.3) shall be such that the circuit will be capable of detecting any fault (see 4.7.10.2.1) having a resistance of less than 30 megohm but will not operate when the insulation resistance of the test wire exceeds 180 megohms. The fault detection current shall have a range not greater than 14 ± 5, microamperes at the 3000 V setting. The speed of response of the fault detection circuit shall be not greater than 100 milliseconds ± 10 percent. The fault counting circuit shall be designed to repeat at the rate of 600 ± 60, counts per minute when bare wire is passed over the contact sheave. The fault counter shall be a digital readout device such as an electromechanical counter or its electronic equivalent. Means for resetting the counter to zero shall be included. Additional recorder equipment for making records of fault patterns is optional. The high-voltage contact sheave shall be a 2-inch-outside-diameter corrosion resistant (stainless-steel) sheave with a V-shaped groove such that the included angle will be 45 ± 3, degrees and the root diameter will be 1.5 ± 0.1 inches. The bottom of the groove shall have a maximum radius of 0.005 ± 0.001 inch. The ground insulation for the contact sheave shall be a high resistivity material, nonhygroscopic, nontracking, easily cleaned, and shall have clearances for maintaining a maximum voltage of 3000 V indefinitely. All edges of the sheave shall be well rounded to minimize corona. The two grounded guide sheaves shall be of the same dimensions and material and shall be spaced 2.72 ± 0.005 inches between centers of the contact sheave and either guide sheave and on the same horizontal line, leaving approximately a 3/4-inch space between sheave edges on either side of the contact sheave. This arrangement, when threaded with wire for testing in an alternate wrap manner (that is, over-under-over or vice versa), shall provide a contact length of wire on the charged center sheave of 1.0 ± 0.2 inch. A surge damping resistor of 4.7 megohms ± 10 percent, shall be installed in the high-voltage line at the contact sheave connection. No shielding shall be used on the high-voltage lead since a minimum capacitance to ground is sought during switching and counting events. The test device shall include such wire handling equipment as will provide the wire speed stipulated in 4.7.10.1 and shall be capable of handling wire sizes 14 to 30 AWG, inclusive. A footage counter with a preset cut-off feature shall be included so that exact lengths can be monitored. The drive motor shall be of the brushless type and shall have sufficient power to maintain speed under the heaviest load.

4.7.10.2.1 Fault. Any defect or series of defects with reduced electrical properties such that, under voltage, a sufficient current will flow to activate the fault detection circuit and indicate one fault per inch of wire tested.

4.7.10.2.2 Test voltage. The open-circuit voltage applied to the contact sheave shall be as specified in table XIV. All voltage settings shall be checked with a high-impedance device such as an electrostatic voltmeter. Sufficient internal resistance shall be provided so that rapid collapse of the applied test voltage occurs when a fault is detected. Rapid recovery of the voltage to the test level is also required.

TABLE XIV. High voltage continuity.

AWG size	DC voltage		
	Single	Heavy	Triple
14 - 24	1000	1500	2000
25 - 30	500	750	1000

4.7.10.2.3 Fault detection current. The current flowing from the contact sheave through the fault to ground (see 4.7.10.2).

4.7.10.2.4 Sensitivity. The maximum resistance which will positively operate the detection circuit when inserted between the contact sheave and ground (see 4.7.10.2). Resistances above this value may also operate the circuit on occasion in a statistical manner but are not considered at the sensitivity "threshold".

4.7.11 Solubility.

4.7.11.1 Film coated round wire (sizes 18 or 36 AWG).

4.7.11.1.1 Preparation of specimens. Specimens of unstretched and unbent film-coated wire, each 12 inches long, which have been stress annealed and prepared in accordance with the applicable specification sheet, shall be immersed at least 6 inches, without bending, for 30 minutes in the liquids specified in the specification sheet and maintained at 60°C ± 2°C. Each specimen shall be immersed in one liquid only.

4.7.11.1.2 Cheesecloth wipe. The specimens shall then be removed from the liquid and within 2 minutes but not less than 1 minute, drawn once between the folds of a thickness of dry, bleached and unsized cheesecloth pressed firmly between the fore-finger and the ball of the thumb. Any removal of the coating caused by knicks or mechanical injury shall not be considered as failure to meet the requirements of the applicable specification sheet.

4.7.11.1.3 Needle scrape. The specimens shall then be removed from the solvent and tested within 2 minutes, but not less than 1 minute, on a device which scrapes the surface of the film coating at 2 inches per second and at right angles to the lengths of the wire with a 0.016-inch steel needle loaded with 580 grams when testing copper wire and 340 grams when testing aluminum wire (see figure 2). The specimens shall be wiped with a clean cloth to remove any liquid and shall be straightened by hand, without stretching, to remove kinks. After the wire is inserted in the test apparatus, the weighted needle shall be lowered gently to the surface of the film coating. Exposure of the bare conductor shall be indicated by an electrical circuit having a potential of 7.5 ± 1.5 V between the needle and the conductor.

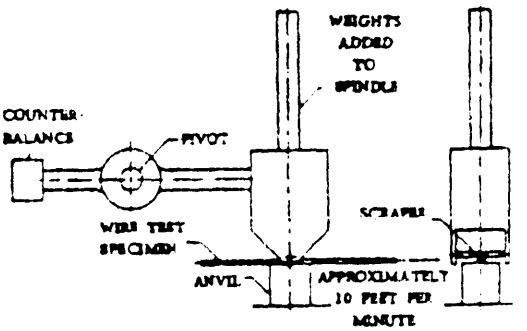

FIGURE 2. Machine for solubility scrape.

4.7.11.2 Film-coated rectangular wire. Specimens of unstretched and unbent film-coated wire, each 12 inches long, which have been prepared in accordance with the applicable specification sheet shall be immersed without bending for 30 minutes in the liquids specified on the applicable specification sheet and maintained at 60°C ± 2°C. Each specimen shall be immersed in one liquid only. The specimens shall be removed from the solvent and, within 2 minutes, but not less than 1 minute, each pair of surfaces shall be drawn once between the folds of four thicknesses of cheesecloth pressed firmly between the forefinger and the ball of the thumb and then examined with normal vision. Any removal of the coating caused by kinks or mechanical injury shall not be considered a failure to meet the requirements of the applicable specification sheet.

4.7.12 Completeness of cure.

4.7.12.1 Film-coated round.

4.7.12.1.1 Chemical - sizes 4 to 44 AWG, inclusive. A specimen of coated wire which has been annealed by baking for 10 minutes at 175° ± 3°C shall be immersed without bending for 5 minutes in a boiling mixture initially containing 30 percent commercial-grade 3-degree toluene and 70 percent denatured ethyl alcohol by volume. Four inches immersed in the liquid shall be sufficient for this test. After removal from the mixture, sizes 4 to 29 AWG, inclusive, shall be examined with normal vision; sizes 30 to 44 AWG, inclusive, shall be examined by 6X to 10X magnification. Swelling of the film within 1/2 inch of the immersed end shall not constitute failure. When testing type TB wire, removal of the thermoplastic outer coating after the completeness of cure test shall not be considered as failure.

4.7.12.1.2 Dissipation factor. A minimum length of 12 inches of wire shall be wiped with a soft clean cloth or tissue and very carefully formed into an approximate "U" shape. The radius of any bend shall be not less than twice the diameter of the bare wire. The bent section shall be immersed in mercury so that a minimum length of 5 inches is below the surface, with no portion of the specimen touching any other portion of the specimen. The specimen shall be held by an insulated holder, such as a cork. The dissipation factor shall be measured at 60-1000 Hz by means of a General Radio Bridge, or its equivalent, connected to the conductor of the specimen and the mercury. In case of failure, another specimen shall be wiped with a soft clean cloth or tissue and conditioned by drying in a circulating air oven for 1 hour at 125°C ± 3°C. The wire shall be removed from the oven, cooled to room temperature, and tested as specified herein.

4.7.12.2 Film-coated, rectangular.

4.7.12.2.1 Chemical method. A specimen of wire which has been annealed by baking for 10 minutes at 125°C ± 3°C shall be immersed without bending for 5 minutes in a boiling mixture initially containing 30 percent commercial-grade 3-degree toluene and 70 percent denatured ethyl alcoholby volume. Four inches immersed in the liquid shall be sufficient for this test. The specimen shall then be removed from the mixture and examined with normal vision for swelling of the film coating. Swelling of the film coating within 1/2-inch of the immersed end shall not constitute failure.

4.7.12.2.2 Solvent method. A specimen shall be elongated 30 percent and wound for at least two complete turns on a 1-inch-diameter mandrel. The specimen shall be slipped from the mandrel and immersed in N-Methyl-2-Pyrrolidone(NMP) for 1 minute. No cracks, crazing or swelling shall be visible in the coating when the specimen is removed from the NMP and examined with normal vision. Swelling of the film coating within 1/2-inch of the immersed end shall not constitute failure.

4.7.12.2.3 Dissipation factor method. A minimum length of 12 inches of wire shall be wiped with a soft clean cloth or tissue and very carefully formed into an approximate "U" shape. The radius of any bend shall be not less than five times the thickness of the bare wire or 1/2 inch, whichever is larger. The bent section shall be immersed in mercury so that a minimum length of 5 inches is below the surface. The specimen shall be held by an insulated holder. The dissipation factor shall be measured at 60-1000 Hz by means of a General Radio Bridge, or equivalent, connected to the conductor of the specimen and the mercury. In case of failure, another specimen shall be wiped with a soft clean cloth or tissue and conditioned by drying in a circulating air oven for 1 hour at 125°C ± 3°C. The wire shall be removed from the oven, cooled to room temperature, and tested as specified herein.

4.7.13 Solderability.

4.7.13.1 Sizes 14 to 23 AWG, inclusive. Soldering tests shall be made by forming a loop of a 12-inch of insulated wire and twisting the ends together for a distance of 3/4 to 1 inch, with a minimum of five turns and a maximum of ten turns. The very end of the twist shall then be trimmed off with a pair of wire cutters. The specimen so prepared shall be immersed in a rosin-alcohol flux (10 parts of water white rosin conforming to grade WW of LLL-R-626 mixed with 90 parts of denatured ethyl alcohol by weight), and then immersed to a depth of at least 1-1/4 inches in a soldering pot of 50/50 tin-lead solder maintained at the specified temperature. The temperature shall be measured within 1/4 inch from the immersed end of the specimen which shall be dipped on approximately the vertical centerline of the pot. The immersion time shall be in accordance with table XV after which the specimen shall be removed from the pot and examined with normal vision.

TABLE XV. Solderability.

AWG size	Maximum immersion time, seconds	Temperature of solder, °C
14-19	10	430
20-23	8	430
24-29	6	360
30-36	5	360
37-46	4	360

4.7.13.2 Sizes 24 to 46 AWG, inclusive. A specimen of film-coated wire shall be wound for a distance of 1/2 to 3/4 inch around the end of a 6-inch length of 20 AWG (0.0320 inch) clean, tinned copper wire, hot-dipped in accordance with ANSI Standard size C7.4. There shall be a minimum of five turns and a maximum of ten turns, with a slight spacing between each turn. The specimens so prepared shall be immersed in a rosin-alcohol flux (see 4.7.13.1) and then immersed to a depth of at least 1 inch in a soldering pot of 50/50 tin-lead solder maintained at a temperature of 360°C + 5°C. The immersion time shall be in accordance with table XV after which the specimen shall be removed from the pot and examined. Visual examination of sizes 24 to 36 AWG shall be made with normal vision and of sizes 37 to 46 AWG shall be made under 6X to 10X magnification.

4.7.14 Overload test procedure.

4.7.14.1 Preparation of specimens. Five sets of twisted pair specimens shall be prepared in accordance with 4.7.6.2. Each specimen shall be prepared with all four ends bared and shaped by use of a forming jig (see figure 3) for standardizing the length of wire in the samples.

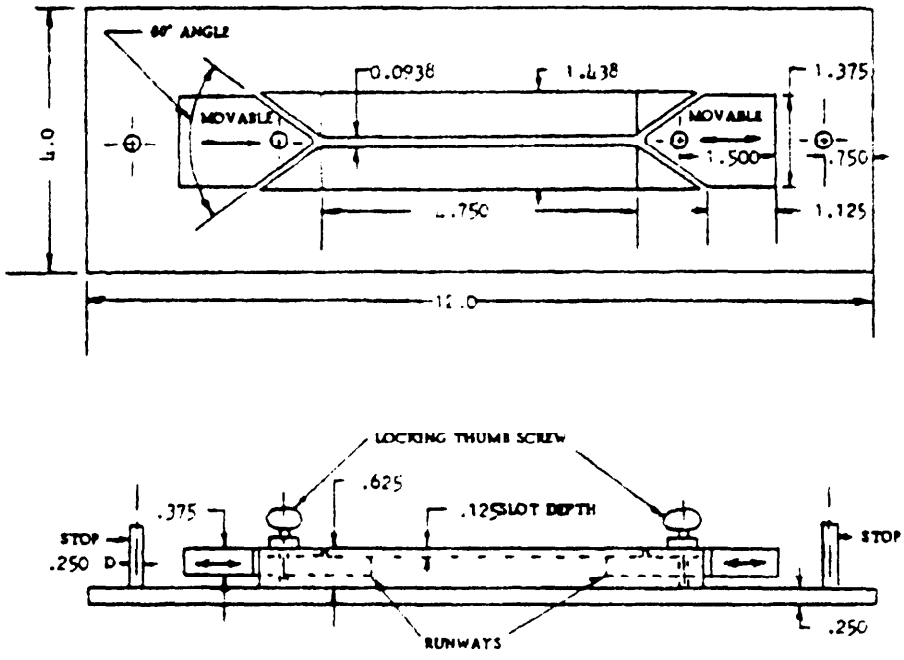

FIGURE 3. Forming jig, overload test specimen.

4.7.14.2 Current selection. The initial current and current steps shall be calculated by the following formulae:

For copper -

Initial current: $I_i = 7200\ d^{1.65}$ (Eq.1)

Step size: $\Delta I = 400\ d^{1.65}$ (Eq.2)

For aluminum -

Initial current: $I_1 = 867\ d^{1.08}$ (Eq.3) 1/

Step size: $\triangle I = 48\ d^{1.08}$ (Eq.4)

In which -

I_1 = current of first step in amperes

$\triangle I$ = current advance to each succeeding step in amperes

d = bare wire diameter in inches

(Tables can be prepared so currents can be selected without computation. Nominal size 18 AWG copper wire calls for an initial current of 36 amperes and a step size of 2 amperes. Nominal size 18 AWG aluminum wire calls for an initial current of 27.1 amperes and a step size of 1.5 amperes.)

1/ Equation 3 yields 14.3 for the five complete steps of 3 minutes each. Certain materials exceed this time and for overtime conversion use the following:

$$OFM = 14.3 + 0.01936\ t_o$$

t_o = overtime in seconds (Eq.6)

4.7.14.3 General operation. The test is based on passing specified currents through the two arms of a standard twisted pair specimen for 3 minutes in each of five successive steps of current, such as 36, 38, 40, 42, and 44 amperes. Temperatures from 345°C to 570°C shall be attained. A 115 V source is applied between arms of the specimen while heating currents are operating. Failure is exhibited by a visual alarm (red light) and by the stopping of the timing read-out device. The seconds of burnout time are converted to the overload figure of merit by the following formula:

$$OFM = 0.01225\ t + 4.00 \times 10^{-6}\ t^2 \quad \text{(Eq.5)}$$

Tables can be prepared to facilitate the conversion from time in seconds (t) to figure of merit units.

4.7.14.4 Test procedure. Following the preparation described in 4.7.14.1, the specimen shall be inserted in the four terminals with sufficient lateral force to maintain a straight but not elongated specimen throughout the test and the lid shall be closed. Prior to the start of the first testing period, a warm-up step shall be run with parallel wires. The temperature of the right rear electrode shall be 135°F ± 1°F prior to each test. (During the warm-up period, calculated currents and steps can be set in readiness for the actual test.) Consecutive tests shall be spaced by waiting periods required for the right rear electrode to return to the 135°F condition. The timer shall be reset to zero. The initial current shall be applied and adjusted to the calculated value. At each step, the current shall be adjusted to the predetermined value for that step. The time at the failure point shall be recorded and converted to a figure-of-merit value.

4.7.15 Alcohol tack. A specimen of film-coated self-bonding wire shall be wound into a coil by passing the wire over a felt pad which is saturated with denatured ethyl alcohol, using sufficient tension to produce a compact winding. The coil shall be heated at approximately 80°C until all of the alcohol has evaporated from the coil (minimum of 1/2 hour).

4.7.16 Helical coil, bond.

4.7.16.1 Preparation of specimen.

4.7.16.1.1 Sizes 18 and 26 AWG. The appropriate mandrel shall be selected from table XV and sprayed with a release agent (such as fluorocarbon spray, or silicone spray). The wire shall be dereeled over the end of the spool as a 3-inch single layer coil is wound onto the prepared mandrel, using a winding tension not to exceed that of table XVI. The coil and mandrel shall be vertically mounted in a holder with the free end of the coil at the top. The specified bonding weight, from table XV shall be placed on the vertically mounted coil providing a downward force during bonding. Three coils shall be prepared.

TABLE XVI. Helical coil bond test.

AWG size	Mandrel size, inches 1/	Maximum winding tension	Bonding weight 1/	Test weight 1/ After heat bonding	Test weight 1/ After solvent bond
18	0.2500	1220 grams	408 grams	9 Kg	4.5 Kg
26	0.1570	200 grams	76 grams	1.6 Kg	0.8 Kg
36	0.0394	12.2 grams	15.25 grams	0.025 Kg	0.0122 Kg

1/ Tolerance limits ± 2 percent.

4.7.16.1.2 Size 36 AWG. The appropriate mandrel shall be selected from table XV and sprayed with a release agent (see 4.7.15.1.1). The wire shall be dereeled over the end of the spool as a coil of fifty continuous turns are wound onto the prepared mandrel. The coil and mandrel shall be vertically mounted in a holder. The specified bonding weight, from table XV shall be placed on the vertically mounted coil (see 4.7.16.1.1). Three coils shall be prepared.

4.7.16.2 Heat bonding, sizes 18, 26, and 36 AWG. The holder assembly shall be placed in a forced air oven for 1 hour at 150°C unless otherwise specified on the applicable specification sheet. The assembly shall be removed from the oven and cooled to room temperature. The coil shall be removed from the mandrel and inspected for breaks or physical damage.

4.7.16.3 Solvent bonding, sizes 18, 26, and 36 AWG. The specimen shall be dipped into the solvent specified on the applicable specification sheet for approximately 5 seconds. The bonded coil shall be immediately placed in the holder with the specified bonding weight from table XVI and allowed to dry for 1 hour at room temperature, unless otherwise specified on the applicable specification sheet. The coil shall be removed from the mandrel and inspected for breaks or physical damage and dried for 15 minutes at 100°C.

4.7.16.4 Bond.

4.7.16.4.1 Sizes 18 and 26 AWG. The three inch test coil shall be placed in a test fixture identical to all dimensions and radii shown on figure 4. The appropriate test weight, specified in table XVI shall be the total load to be applied to the center of the coil, which includes the knife edge, support, and added weight. The load shall be lowered gently and allowed to hang for 5 seconds. A stress-strain analyzer may be used instead to apply an increasing load. The cross-head speed shall be between 1/2 and 1 inch per minute.

4.7.16.4.2 Size 36 AWG. The coil shall be hung by one of the ends and loaded with the weight specified in table XVI. When attaching the load, any additional shock must be avoided. The weight shall be allowed to hang for 5 seconds.

4.7.17 Dielectric strength at rated temperature.

4.7.17.1 Preparation of specimens. Five sets of specimens of size 18 or 36 AWG heavy film-coated wire shall be prepared in accordance with 4.7.8.2.

4.7.17.2 Test procedure. The temperature of a circulating air oven shall be raised to the temperature equivalent to the thermal class rating of the specimen ± 2°C, each specimen shall be placed in a holder, and the specimen and holder shall then be placed in the oven and connected to a high voltage feed-through connector. Fifteen minutes, but not more than 30 minutes, after the oven again reaches the temperature equivalent to the thermal class rating of the specimen ± 2°C, a source of 60-Hz voltage as described in 4.7.8.2 shall be applied to the specimen through the feed-through connector at the oven. The values of the five specimens shall be averaged. The voltage rise and the breakdown voltage shall be measured in accordance with 4.7.8.2.

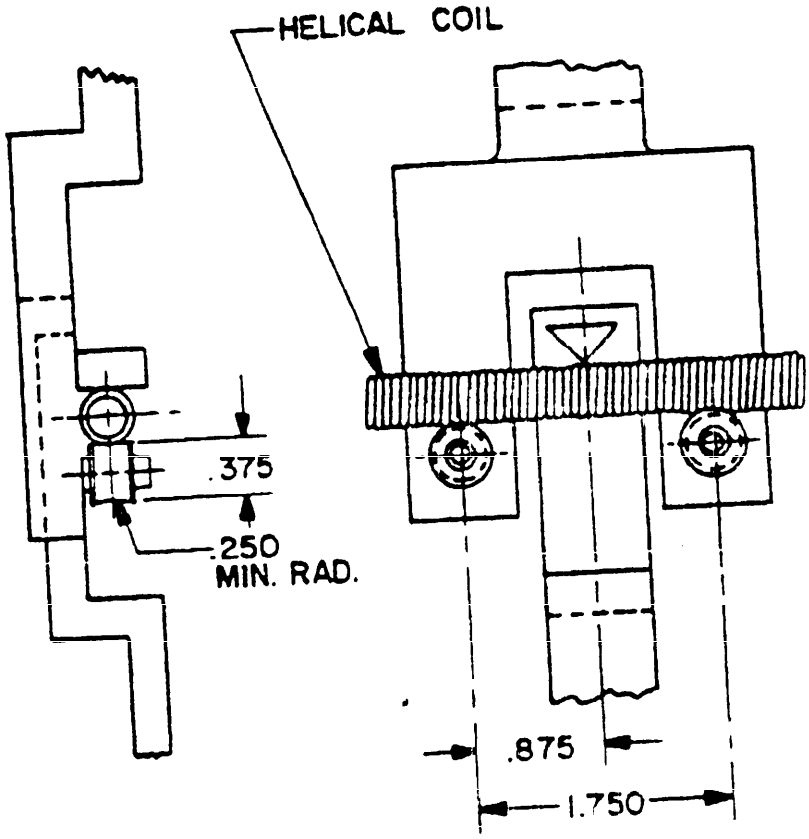

FIGURE 4. Test fixture for bond strength test.

4.7.18 Thermal evaluation.

4.7.18.1 For qualification (temperature index). The temperature index test for qualification shall consist of the dielectric-twist test as specified in Publication ASTM D2307. Heavy grade, size 18 AWG magnet wire shall be used. The test voltage shall be regulated within 5 percent. Tests shall be made on both unvarnished and varnished specimens. The varnished specimens shall be single dipped. The varnish shall be in accordance with MIL-I-24092 and shall be the same class as the magnet wire. The lowest temperature test point shall have an average life of not less than 5,000 hours. The highest temperature test point shall have an average life of not less than 100 hours. The spread between successive temperature points shall be not less than 20°C. If the highest temperature point obtained yields less than 100 hours average life, an additional temperature point 10°C lower may be ta .. Extrapolation, to determine the classifying temperature, shall be based on the regression line of the three lowest temperature points.[1/] This regression line shall be calculated in accordance with the methods outlined in Publication IEEE 101. Temperature index will be based on the extrapolation of the data to at least 20,000 hours for unvarnished, varnished or bondable wire at the claimed temperature rating.

4.7.18.2 For quality conformance inspection. Specimens shall be twisted together as specified for the dielectric-strength (twist) test (see 4.7.8.2) and coated with an insulating varnish in accordance with MIL-I-24092 of the types used to impregnate coils for an insulation system of the same class in which the wire is rated to operate. The varnish shall then be dried to a nontacky finish at a temperature below that which will have any appreciable effect on the insulation under test. The dried, coated specimens shall then be conditioned for 168 hours in a circulating-air oven at the temperature specified on the applicable specification sheet. As a result of this test, the minimum dielectric breakdown strength shall be not less than the value specified on the applicable specification sheet. At the conclusion of this conditioning, the specimens shall be cooled to room temperature and subjected to the dielectric-strength (twist) test specified in 4.7.8.2.

4.8 Inspection of preparation for delivery. Sample packages and packs and the inspection of the preservation and packaging, packing and marking for shipment and storage shall be in accordance with the requirements of section 5.

5. PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government procurements. For the extent of applicability of the preparation for delivery requirements of referenced documents listed in section 2, see 6.5.)

5.1 Preservation and packaging. Preservation and packaging shall be level A or C as specified (see 6.2).

5.1.1 Level A. Magnet wire shall be uniformly and compactly wound on spools or reels. The ends shall be secured to prevent unwinding of the wire. The net weight of a reel of rectangular wire shall be 200 ± 20 pounds. The net weight of a spool or reel of round wire shall be as specified in table XVII (see 6.2).

1/ When the data points do not fall on a straight line the permissible departure will be gauged by the difference between the extrapolation of the two lowest temperature points and the regression line of the three lowest temperature-points. These differences are measured based on a reference line of 20,000 hours. When the extrapolation of the regression line of the three lowest temperature points intercepts the reference line at a point which exceeds both 20,000 hours (measured vertically downward from the intercept point) and 15°C over that obtained by extrapolating from the two lowest temperature points, an additional temperature point shall be obtained. This point shall be located at least 10°C below the lowest existing temperature point when that point represents an average life of less than 6,000 hours, and shall be located 10°C above the lowest existing temperature point when that point represents an average life of 6,000 hours or more. Extrapolation shall then be based on the regression line of the three lowest temperature points and this line shall then be used to determine the classifying temperature. If only one of the above two conditions is exceeded then the original three-point regression line shall be used to determine the classifying temperature, however, a cooler temperature point may be run at any time at the discretion of the contractor to support his data.

TABLE XVII. Weights of round wire per spool or reel.

Wire (AWG) sizes	Film build[1/]	Reel, Wt, lbs		Minimum flange clearance inches	Reel sizes inches
		Nominal	Min		
13 and larger	1, 2, 3	200	175	1-1/2	24
14 - 20	1, 2	80	70	1/2	12
14 - 20	3	75	65	1/2	12
21 - 23	1, 2	75	65	1/2	12
21 - 23	3	65	55	1/2	12
24 - 26	1, 2	70	60	1/2	12
24 - 26	3	60	50	1/2	12
27 - 30	1, 2	65	55	1/2	12
27 - 30	3	50	40	1/2	12
31 - 41	1, 2	8	6	1/4	6
31 - 41	3	6	4	1/4	6
42 - 46	1, 2, 3	1.25	1	3/16	3

[1/] 1-single, 2 heavy, 3 triple film thickness.

5.1.1.1 Spools. Magnet wire on spools in the quantity specified shall be individually packaged in accordance with Method III of MIL-P-116. Each spool of wire shall be wrapped with non-corrosive Kraft paper (60-pound base weight) and secured with a pressure-sensitive tape conforming to PPP-T-76. The paper shall be cut to the inside width of the spool. Each spool of wire shall then be placed in an individual fiberboard box conforming to the domestic class of PPP-B-636, or in a paperboard box conforming to PPP-B-566, PPP-B-665, or PPP-B-676. Fiberboard boxes shall be sealed with tape 1-1/2 inches wide, minimum, in accordance with PPP-T-76.

5.1.1.2 Reels. Magnet wire on reels shall be individually packaged in accordance with Method III of MIL-P-116. Reels of wire, with approximate net weights greater than 50 pounds, shall be wrapped with water-resistent fiberboard and securely fastened with tape conforming to PPP-T-97 or two 8-gage high tensile round wires or two 5/8-inch by 0.020-inch minimum zinc-coated steel strapping conforming to QQ-S-781, respectively. The fiberboard shall be cut to the inside width of each reel.

5.1.2 Level C. Magnet wire shall be preserved-packaged in such a manner that will afford adequate protection against corrosion, deterioration, and physical damage during shipment from supply source to the first receiving activity for immediate use. The contractor's normal preservation-packaging methods may be utilized when such meet the requirements of this level.

5.2 Packing. Packing shall be level A, B, or C as specified (see 6.2).

5.2.1 Level A. Spools of wire (except weights greater than 50 pounds), packaged as specified (see 6.2) shall be packed in containers conforming to any of the following specifications at the option of the supplier:

Specification	Container	Class or style
PPP-B-576	Wood, Cleated, Veneer, Paper Overlaid	Class 2
PPP-B-585	Wood, Wirebound	Class 2 or 3
PPP-B-591	Fiberboard, Wood-cleated	Style A or B
PPP-B-601	Wood, Cleated-Plywood	Class II - Overseas type, style A or B
PPP-B-621	Wood, Nailed and Lock-corner	Class 2
PPP-B-636	Fiberboard	Class (weather resistant)
PPP-B-640	Fiberboard, Corrugated Triple Wall	Class 2

Box closures and strapping shall be as specified in the applicable box specification or appendix thereto. Fiberboard boxes conforming to PPP-B-636 may be banded with tape conforming to type IV of PPP-T-97 and appendix thereto in lieu of steel straps. The gross weight of wood boxes shall not exceed 200 pounds; contents of fiberboard boxes shall not exceed the weight limitations of the applicable box specification. Reels of wire of 250 pounds shall be completely enclosed with wooden lagging, with boards touching adjacent boards, and shipped unboxed. Reels of wire weighing 50 to 100 pounds shall be palletized in accordance with MIL-STD-147.

5.2.2 Level B. Spools of wire (except weights greater than 50 pounds) packaged as specified (see 6.2) shall be packed in containers conforming to any of the following specifications at the option of the contractor.

Specification	Container	Class or Style
PPP-B-576	Wood, Cleated, Veneer, Paper Overlaid	Class 1
PPP-B-585	Wood, Wirebound	Class 1
PPP-B-591	Fiberboard, Wood-cleated	Class 1, style optional
PPP-B-601	Wood, Cleated-plywood	Domestic type style optional
PPP-B-621	Wood, Nailed and Lock-corner	Class 1
PPP-B-636	Fiberboard	Class domestic
PPP-B-640	Fiberboard, Corrugated Triple Wall	Class 1

Box closures shall be as specified in the applicable box specification or appendix thereto. The gross weight of wood boxes shall not exceed 250 pounds; contents of fiberboard boxes shall not exceed the weight limitations of the applicable box specification. Reels of wire of 250 pounds shall be completely enclosed with wooden lagging, with boards touching adjacent boards, and shipped unboxed. Reels of wire weighing 50 to 100 pounds shall be palletized in accordance with MIL-STD-147.

5.2.3 Level C. Magnet wire packaged as specified (see 6.2) shall be packed in containers of the type, size, and kind commonly used for the purpose, in a manner that will insure acceptance by common carrier and safe delivery at destination. Containers, packing or method of shipment shall comply with Uniform Freight Classification Rules or National Motor Freight Classification Rules, or other carrier rules as applicable to the mode of transportation.

5.2.4 Exterior containers shall be uniform in shape and size, shall be of minimum cube and tare consistent with the protection required, and shall contain similar quantities of identical items.

5.3 Marking. Marking shall include the date of manufacture. Marking shall be located on the flange of spools and reels in a manner to preclude the possibility of the marking's being illegible during its use, and the wrapper of spools shall be marked by the use of a pressure-sensitive label. In addition to any special marking required by the contract or herein, interior and exterior shipping containers, including spools or reels, shall be marked in accordance with MIL-STD-129 or FED-STD-123 as applicable.

6. NOTES

6.1 Intended use.

6.1.1 Temperature limitations. The maximum or hotspot temperatures to which equipments or apparatus wound with various classes of insulated magnet wire covered by this specification may be subjected continuously, with normal life expectancy, are 105°, 130°, 155°, 180°, 200°, and 220°C.

6.1.1.1 Insulation.

6.1.1.1.1 105°C. Insulation for a 105°C. equipment consists of materials or combinations of materials, when impregnated or coated, or when immersed in a dielectric liquid. Other materials or combinations of materials may be included in this class if by experience or accepted tests they can be shown to be capable of operation at 105°C.

6.1.1.1.2 130°C. Insulation for a 130°C. equipment consists of materials or combinations of materials such as mica, glass fiber, and so forth, with bonding substances. Other materials or combinations of materials, not necessarily inorganic, may be included in this class if by experience or accepted tests they can be shown to be capable of operation at 130°C.

6.1.1.1.3 155°C. Insulation for a 155°C. equipment consists of materials or combinations of materials such as mica, glass fiber, and so forth, with bonding substances. Other materials or combinations of materials, not necessarily inorganic, may be included in this class if by experience or accepted tests they can be shown to be capable of operation at 155°C.

6.1.1.1.4 180°C. Insulation for 180°C. equipment consists of materials or combinations of materials such as silicone elastomer, mica, glass fiber, and so forth, with bonding substances (such as appropriate silicone resins). Other materials or combinations of materials may be included in this class if by experience or accepted tests they can be shown to be capable of operation at 180°C.

6.1.1.1.5 200°C. Insulation for a 200°C. equipment consists of materials or combinations of materials which by experience or by accepted tests can be shown to be capable of operation at 200°C.

6.1.1.1.6 220°C. Insulation for a 220°C. equipment consists of materials or combinations of materials which by experience or by accepted tests can be shown to be capable of operation at 220°C.

6.1.2 Definitions.

6.1.2.1 Impregnated. Insulation is considered to be "impregnated" when a substance provides a bond between components of the structure and also a degree of filling and surface coverage sufficient to give adequate performance under the extremes of temperature, surface contamination (moisture, dirt, and so forth), and mechanical stress expected in service. The impregnant must not flow or deteriorate enough at the operating temperature so as to seriously affect performance in service.

6.1.2.2 Impaired. The electrical and mechanical properties of the insulation must not be impaired by the prolonged application of the limiting insulation temperature permitted for the specific insulation class. The word "impaired" is used in the sense of causing any change which could disqualify the insulating material for continuously performing its intended function.

6.1.2.3 Accepted tests. The words "accepted tests" are intended to refer to recognized test procedure established by the IEEE, NEMA, ASTM, or Government for the thermal evaluation of materials themselves or in simple combinations.

6.1.3 Wire with single or multiple insulation.

6.1.3.1 Film insulated.

6.1.3.1.1 Thickness of insulation. The thickness of insulation for film-insulated wires with the same numeral designator (see 1.2.1.1) is the same for all wires no matter what the insulation. Thus, as far as space considerations are concerned, any film-insulated magnet wire can be replaced with any other with the same numeral designator, and coils can be rewound with the desired type of wire for most class equipment without change in dimensions.

6.1.3.1.2 Marine service. For severe marine-service conditions of moisture and steam condensate and where glass fiber or glass-synthetic fibers are used, a combination insulation should be used such as the following:

Types	Insulation system temperature, °C
BDg, BDg2, BDgV, BDg2V, B2Dg, B2Dg2	155
H2GK, H2G2K	200
LDgK, LDg2K, L2DgK, L2Dg2K	180
M2DgGM	220

6.1.3.2 Self bonding wire. Film type of magnet wire may be treated with overcoating resins to impart self-bonding characteristics to coils and windings using such wire. The self-bonding resins may be activated by either solvent or heat. Separate qualification inspection approval is not required for the overcoat materials; however, qualification approval provisions apply to the basic wire insulation and in all cases the properties (including dimension) of the basic insulation must conform to the requirements of this specification. For example, an approved L2 magnet wire may be overcoated so as to meet the dimensions of an L3 magnet wire. In order to be considered as complying with this specification, the performance requirements for an L2 magnet wire must be met.

6.1.4 Thermal stability. The entire insulation system should be designed to withstand the temperatures indicated in 1.2.1. At these maximum or hotspot temperatures, the magnet wire will not be the weakest link in a properly designed system, and a service life of 10 years or more should be expected. These temperatures may be exceeded in specific applications where a shorter life expectancy can be tolerated, for instance, in miniaturized electronic equipments where burned-out parts are quickly replaceable, or in guided missiles which operate once for a short time. Equipment contractors should consult wire suppliers for recommendations on the relation of life expectancy versus temperatures in excess of those indicated in 1.2.1.1.

6.1.4.1 Conductor. The conductor normally specified is bare, annealed copper. The copper will oxidize at an increasing rate at temperatures of 200°C. and above, and will also tarnish and become brittle at such temperatures when fluorocarbon-resin insulated. This oxidation will eventually damage the insulating film, and coil failure will result. The oxidation problem is overcome largely by using a silver-coated, or more preferably, a nickel-coated copper or an aluminum conductor.

6.2 Ordering data. Procurement documents should specify the following:

(a) Title, number, and date of this specification.
(b) Class, type, shape, and size of wire (see 1.2).
(c) Specific resin for synthetic-resin-film-insulated magnet wire, when required (see 1.2.1).
(d) Quantity of wire required, in pounds (see 5.1.1).
(e) Conductor, if other than copper (see 3.2.1, 3.2.1.2 to 3.2.1.4, incl.).
(f) Levels of preservation and packaging, packing, and applicable marking (see 5.1, 5.2 and 5.3).

6.2.1 Contract data requirements. When this specification is used in a procurement which incorporates a DD Form 1423 and invokes the provisions of 7-104.9(n) of the Armed Services Procurement Regulations, the data requirements identified below will be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved Contract Data Requirements List (DD Form 1423) incorporated into the contract. When the Provisions of ASPR-7-104.9(n) are not invoked, the data specified below will be delivered by the contractor in accordance with the contract requirements. Deliverable data required by this specification is cited in the following paragraph:

Specification paragraph	Data requirement	Applicable DID
4.1.2	Inspection system	DI-R-4803

(Copies of data item descriptions required by the contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

6.3 With respect to products requiring qualification, awards will be made only for products which are at the time set for opening of bids, qualified for inclusion in applicable Qualified Products List QPL-J-W-1177, whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Ship Engineering Center, Prince George's Center, Center Building, Hyattsville, Maryland 20782, and information pertaining to qualification of products may be obtained from that activity. Application for qualification tests shall be made in accordance with "Provisions Governing Qualification SD-6" (see 6.3.1).

6.3.1 Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

6.4 Supersession data. This specification supersedes specification MIL-W-583C of 6 March 1963. Table XVIII lists the superseded types of MIL-W-583C cross-referenced to the new type designations with applicable specification sheet number.

TABLE XVIII. Supersession data.

Previous types of wire covered in MIL-W-583C	Present type and applicable specification sheet number
E	Type E.....J-W-1177/1
C	Type C.....J-W-1177/2
N	Type N.....J-W-1177/3
T	Type T.....J-W-1177/4 (Round)
T	Type TN.....J-W-1177/5
T	Type TB.....J-W-1177/6
T	Type SA.....J-W-1177/7
T	Type SAN.....J-W-1177/8
B	Type UN.....J-W-1177/9
L	Type L.....J-W-1177/10
L	Type LN.....J-W-1177/11
H	Type H.....J-W-1177/12
K	Type K.....J-W-1177/13 (Rectangular)
K	Type K.....J-W-1177/14 (Round)
M	Type M.....J-W-1177/15
T	Type T.....J-W-1177/16 (Rectangular)
M	Type M.....J-W-1177/18 (Rectangular)
GV	Type GV.....J-W-1177/19 (Round)
DgV	Type DgV.....J-W-1177/20 (Round)
GH	Type GK.....J-W-1177/21 (Round)
GV	Type GV.....J-W-1177/22
GH	Type GK.....J-W-1177/23 (Rectangular)
None	Type DgH.....J-W-1177/24 (Round)
LDg	Type DgV.....J-W-1177/25 (Rectangular)
none	Type DgH.....J-W-1177/26 (Rectangular)
M_2DgGM	Type M_2DgGM.....J-W-1177/27

6.5 Sub-contracted material and parts. The preparation for delivery requirements of referenced documents listed in section 2 do not apply when material and parts are procured by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

Military Custodians:

Army - EL
Navy - SH
Air Force - 80

Review activities:

Army - EL, MI, MU

User activities:

Army - ME
Navy - AS, CG, MC

Preparing activity:

Navy - SH

Civil Agency Coordinating Activities:

COMMERCE-NBS
DC GOVT.-DCG
DOT-ACO, FIS, RDS
GSA-PSS, PBO, PCD
HEW-FEC, FDA
INTERIOR-BPA
NASA-JPK

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Orders for this publication are to be placed with General Services Administration, acting as an agent for the Superintendent of Documents. See section 2 of this specification to obtain extra copies and other documents referenced herein. Price 65 cents each.

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- ☐ VENDOR
- ☐ USER
- ☐ MANUFACTURER
- ☐ OTHER *(Specify)*: _____

5 PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording

c. Reason/Rationale for Recommendation

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional

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