Flat Cable Shielding

1. Introduction

1.1 Scope. This specification covers the design, performance and qualification requirements for flat cable shielding to be used with the Tyco Electronics, Raychem Integrated Interconnection System (I^2S). This specification forms a part of I^2S Master Specification C-6100.

1.2 Description. The shielding covered by this specification consists of copper foil coated on one or both surfaces with an insulating film and, where specified, pressure sensitive adhesive. The shielding is supplied in two basic configurations: planar, for covering or separating individual layers of flat cable; and wraparound, for surrounding one or more layers of flat cable. When installed with the appropriate Raychem connector accessories in accordance with the applicable instructions, flat cable shielding provides circuit isolation for crosstalk reduction and electromagnetic effects (EME) shielding.

1.3 Classification. Shielding materials covered by this specification are classified in accordance with 1.3.1, 1.3.2 and 1.3.3.

1.3.1 Type.

I Planar shielding with adhesive on one surface
II Planar shielding without adhesive
III Wraparound shielding, standard
IV Wraparound shielding, environment resistant

1.3.2 Thickness of Shielding Foil.

1.0 ounce nominal copper (0.0014 inch thickness)
1.0 mil nominal copper (0.0010 inch thickness)
0.5 ounce nominal copper (0.0007 inch thickness)

1.3.3 Nominal Cable Width.

0.5 inch.
1.0 inch.
1.5 inch.
2.0 inch.

1.4 Grade

1.4.1 Environmental Grade, see paragraph 4.3.3

1.4.2 Non-Environmental Grade (Mod -001), see paragraph 4.3.3

1.5 Temperature Range. Shielding covered by this specification is suitable for use over the temperature range of -65 to 125°C unless otherwise specified in 3.1.

2.0 Applicable Documents

2.1 Issues of Documents. The following documents, of the issue in effect on date of order or request for proposal, form a part of this specification to the extent specified herein. However, this specification takes precedence over referenced documents.

2.2 Department of Defense

Specifications

Military

MIL-PRF-5606	Hydraulic Fluid, Petroleum Base; Aircraft, Missile, and Ordnance
MIL-T-5624	Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-PRF-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, NATO Code Number 0-148
SAE-AMS1424	Anti-Icing and Deicing-Defrosting fluids
J-STD-004 and J-STD-006	Flux, Soldering, Liquid (Rosin Base)
MIL-C-43616	Cleaning Compounds, Aircraft Surface
SAE-AS85485	Cable, Electric, Filter Line, Radio Frequency Absorptive

Federal

MIL-PRF-680	Dry Cleaning Solvent
J-STD-006	Solder; Tin Alloy, Tin Lead Alloy, and Lead Alloy
TT-I-735	Isopropyl Alcohol

Standards

ANSI/ASQ Z1.4	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
MIL-HDBK-454	Standard General Requirements for Electronic Equipment
ISO-10012-1 and ANSI-Z540-1	Calibration Systems Requirements

(Copies of Department of Defense documents may be obtained from the Naval Publications and Forms center, 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.3 American Society for Testing and Materials (ASTM).

D3032	Standard Test Method for Resistance of Electrical Wire Insulation Materials to Flame at 60°

(Copies of ASTM publications may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

2.4 National Aeronautics and Space Administration (NASA).

SP-R-022A General Specification Vacuum Stability Requirements of Polymeric Material for Spacecraft Application

(Copies of NASA documents may be obtained from National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Mail Code: JM62, Houston, TX 77058.)

2.5 Tyco Electronics Corporation

C-6100 System Overview and General Requirements for Integrated Interconnection System (I^2S) Components

(Copies of Tyco Electronics documents may be obtained from Tyco Electronics Corporation, 300 Constitution Drive, Menlo Park, CA 94025.)

3.0 Requirements

3.1 Specification Control Drawings. The requirements for shielding furnished under this specification shall be as specified herein and on the applicable specification control drawings. In the event of conflict between the requirements of this specification and those of the specification control drawing, the latter shall govern.

3.2 Classification of Requirements. The requirements for the shielding materials are classified herein as follows:

Requirements	Paragraph
Qualification	3.3
Materials	3.4
Design and Construction	3.5
Performance Requirements	3.6
Identification	3.7
Workmanship	3.8

3.3 Qualification. Shielding furnished under this specification or listed on Qualified Products List C-6119-QPL shall be products which are qualified to this specification in accordance with the requirements of Specification C-6100.

3.4 Materials. All materials used in the manufacture of this shielding shall be of the quality and form best suited for the purpose intended.

3.4.1 Fungus Resistance. Insulation materials shall fungus-inert in accordance with MIL-HDBK-454 Requirement 4, and encompassing the fungus species listed in MIL-STD-810, Method 508.

3.4.2 Hydrolytic Stability. All nonmetallic materials shall be selected to meet the hydrolytic reversion resistance requirements specified in Requirement 47 of MIL-HDBK-454.

3.4.3 Vacuum Stability. Shielding shall meet the vacuum stability requirements of NASA Specification SP-R-0022A.

3.4.4 Component Materials. Materials for specific components of the shielding shall be as follows:

3.4.4.1 Shielding Element. Material for the shielding element shall be copper foil that is of consistent thickness and essentially free from cracks, lumps and foreign materials.

3.4.4.2 Insulation Film. The insulation film shall be of consistent thickness, homogeneous and essentially free from cracks, lumps, foreign materials and porosity.

3.4.4.3 Pressure-Sensitive Adhesive. Pressure sensitive adhesive, when present, shall be nonhazardous, homogeneous and essentially free from defects, lumps and foreign materials.

3.5 Design and Construction. Design and construction shall be in accordance with the applicable specification control drawing.

3.5.1 System Compatibility. Shielding shall be compatible with the applicable connectors, components and cables of the I^2S system when installed in accordance with the applicable Engineering Standard (ES). Insulation film shall be removable to permit termination.

3.6 Performance Requirements. Shielding shall conform to the requirements specified herein and on the applicable specification control drawing.

3.6.1 Insulation Resistance When shielding is tested as specified in 4.5.4, the insulation resistance of the polyester film insulation between the shield element and the test electrode shall be 5000 megohms, minimum.

3.6.2 Dielectric Withstand Voltage. When shielding is tested as specified in 4.5.5, there shall be no evidence of breakdown or flashover. The leakage current shall be 1.0 mA maximum.

3.6.3 Solderability. When shielding is tested as specified in 4.5.6, the stripped termination surfaces of the shielding shall be at least 95 percent covered with a continuous new solder coating.

3.6.4 Life Cycle. (Type IV Only) When shielding is tested as specified in 4.5.7, there shall be no cracking of the insulation and no dielectric breakdown after conditioning at 200°C for 192 hours.

3.6.5 Flexure Endurance. (Types I and II only; when specified on the applicable specification control drawing) When shielded cable assemblies are subjected to flexure conditioning as specified in 4.5.8, the shield insulation shall not show evidence of cracks or delamination detrimental to performance.

3.6.6 Mandrel Bend Endurance. (Type IV only) When shielded cable assemblies are subjected to mandrel bend conditioning as specified in 4.5.9, the shield insulation shall not show evidence of cracks or delamination detrimental to performance.

3.6.7 Fold Endurance. When shielded cable assemblies are subjected to two folding cycles as specified in 4.5.10, the shield insulation shall not show evidence of cracks or delamination detrimental to performance.

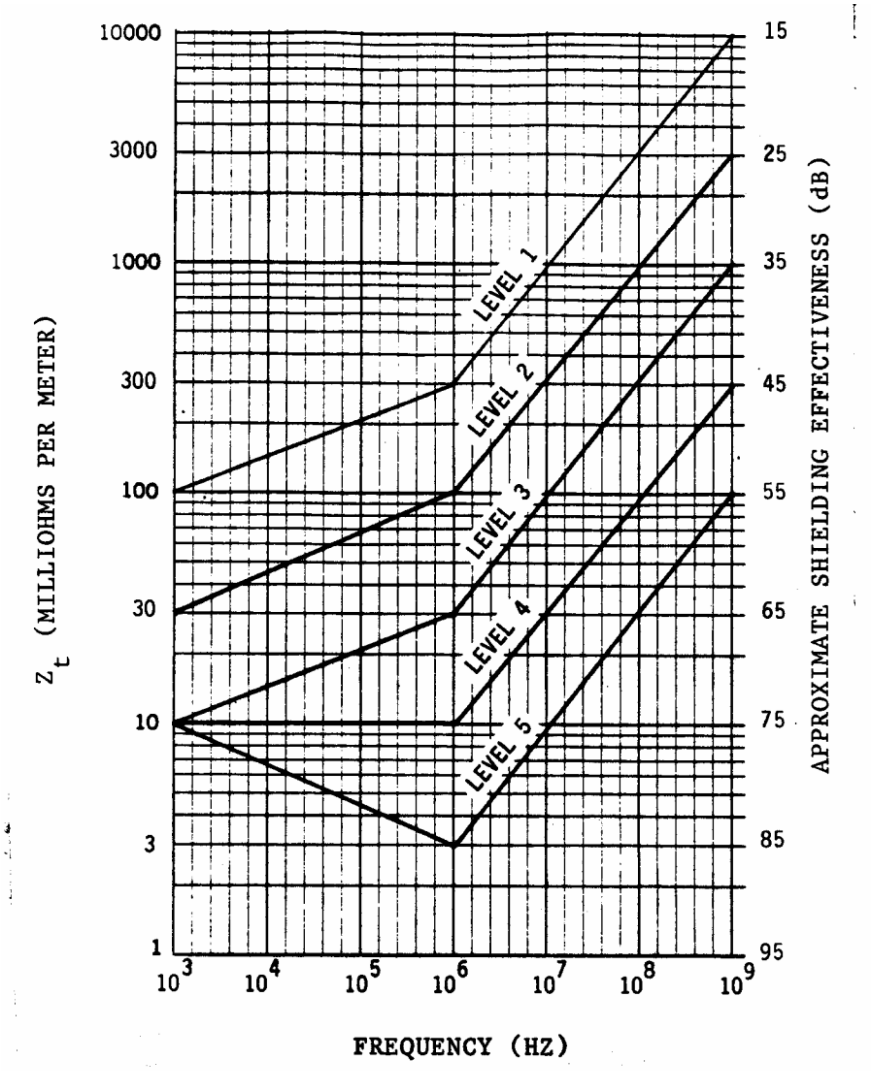

Figure 1. Surface Transfer Impedance Requirement

3.6.8 EME Shielding. (Types III and IV only) When shielded cable assemblies are tested as specified in 4.5.11, the surface transfer impedance (Z_t) of the test assembly at each frequency shall not exceed the level 5 limit as shown in Figure 1.

3.6.9 Flammability. When shielded cable assemblies are subjected to the 60-degree flammability testing of D3032 as specified in 4.5.12, the distance of flame travel shall be 3.0 inch maximum, the after burn time shall be 30 seconds maximum, and there shall be no flaming, dripping particles that continue to flame after striking the floor of the enclosure.

3.6.10 Moisture Resistance. When shielded cable assemblies are subjected to 10-day cyclic humidity testing as specified in 4.5.13, the insulating film shall not become delaminated from the copper shielding, and portions of shielding attached by pressure sensitive adhesive shall not lose adhesion.

3.6.11 Fluid Immersion. When shielded cable specimens are subjected to fluid immersion as specified in 4.5.14, the insulating film shall not become delaminated from the copper shielding or damaged so as to adversely affect performance. Portions of shielding attached by pressure sensitive adhesive shall not lose adhesion so as to adversely affect shielding performance.

3.7 Identification. Marking shall be on the package or container only. The marking shall include the number of linear feet of product and the Raychem part number.

3.8 Workmanship. Shielding shall be processed in such a manner as to be uniform in quality and shall be free of defects that would adversely affect life or serviceability.

4. Quality Assurance Provisions

4.1 Responsibility for Inspection. The supplier is responsible for the performance of all inspection tests specified herein. The supplier may utilize his own or any other suitable testing facility. Inspection records of the tests shall be kept complete and available to the buyer as specified in the contract or order.

4.1.1. Test Equipment and Inspection Facilities. Test and measuring equipment and inspection facilities shall be established and maintained by the supplier. They shall be of sufficient accuracy, quality, and quantity to permit performance of the required inspections. A calibration system to control the accuracy of the measuring and test equipment shall be maintained in accordance with ISO-10012-1 AND ANSI-Z540-1.

4.2 Classification of Inspection. The examination and testing of shielding covered by this specification shall be classified as follows:

a. Qualification inspection (see para 4.3)
b. Acceptance inspection (see para 4.4)

4.3 Qualification Inspection. Qualification inspection shall consist of all the tests in Table I conducted upon the samples defined in 4.3.1. Separate samples shall be used for each test in Table I.

4.3.1 Test Samples for Qualification Test. Test samples for each type of shielding to be qualified shall be selected in compliance with the qualification requirements of Specification C-6100. Shielded cable assemblies shall be tested using the particular type of cable contained in the shielded cable assembly to be qualified.

4.3.2 Failures. One or more failures of the tests listed in Table I shall constitute failure of qualification of the parts under test. The exception to this is visual examination, where occurrence of one major defect or two minor defects shall constitute failure. Major and minor defects shall be as defined in ANSI/ASQ Z1.4.

4.3.3 Qualification Report. Qualification shall be documented in a report which shall be available to the buyer.

Table I. Qualification Inspection

Test	Environmental	Non-Environmental	Requirement Paragraph	Procedure Paragraph
Visual examination	X	X	3.1, 3.4, 3.5, 3.7, 3.8	4.5.3
Insulation resistance	X	X	3.6.1	4.5.4
Dielectric withstand voltage	X	X	3.6.2	4.5.5
Solderability	X		3.6.3	4.5.6
Life cycle (Type IV only)	X		3.6.4	4.5.7
Flexure endurance (Types I and II only)	X		3.6.5	4.5.8
Mandrel bend endurance (Type IV only)	X		3.6.6	4.5.9
Fold endurance	X		3.6.7	4.5.10
EME shielding (Types III and IV only)	X		3.6.8	4.5.11
Flammabilty	X		3.6.9	4.5.12
Moisture resistance	X		3.6.10	4.5.13
Fluid immersion	X		3.6.11	4.5.14

4.4 Acceptance Inspection. Lot acceptance inspection shall consist of the tests listed in Table II. Acceptance inspection shall be performed on every lot of shielding supplied under this specification. The sample units may be shipped against orders. In-process examination may be used for acceptance inspection.

Table II. Acceptance Inspection

Test	Requirement Paragraph	Inspection Level	AQL*
Visual examination	3.1, 3.4, 3.5, 3.7, 3.8	I	4.0

*AQL shall apply to individual defects in accordance with ANSI/ASQ Z1.4, Paragraph 4.5

4.4.1 Sampling for Acceptance Inspection. ANSI/ASQ Z1.4 shall apply for definitions of inspection terms used herein. For purposes of this specification, the following shall apply:

4.4.1.1 Inspection Lot. The inspection lot shall consist of all components of one part number offered for inspection at the same time.

4.4.1.2 Inspection Level and Acceptance Quality Level (AQL). The inspection levels and acceptance quality levels shall be in accordance with ANSI/ASQ Z1.4 and shall be as specified in Table II.

4.4.2 Rejected Lots. If an inspection lot is rejected, the lot shall be replaced, or the defective units shall be reworked to correct the defect or screened out. If the lot is reworked or the defective units are screened out, the lot shall be resubmitted for inspection. Resubmitted lots shall be inspected using tightened inspection in accordance with ANSI/ASQ Z1.4.

4.4.3 Examination of Preparation for Delivery. Preparation for delivery of material ready for shipment shall be examined to determine compliance with the requirements of Section 5.

4.5 Test Procedures

4.5.1 Test Conditions. Unless otherwise specified, all tests shall be performed at ambient pressure and ambient relative humidity as specified in the general requirements of MIL-STD-202.

4.5.2 Specimen Preparation. Specimens for test procedures using installed shielding shall be prepared as follows. Lengths of shield/cable assemblies shall be as specified in the applicable procedure paragraph. The width of the flat cable shall be appropriate for the width of shielding being tested.

a. Planar shield without adhesive: Test specimen shall consist of a length of flat cable with one layer of shielding attached to each surface by suitable means.

b. Planar shield with adhesive: Test specimen shall consist of a length of flat cable with one layer of shielding attached to each surface by means of the adhesive.

c. Wraparound shield: Test specimen shall consist of a length of flat cable with wraparound shielding installed as specified for the assembly to be qualified. When required for testing, the ends of the wraparound shielding shall be attached to the flat cable by suitable means.

4.5.3 Visual Examination (See 3.1, 3.4, 3.5, 3.7, 3.8). Shielding shall be examined at 4X magnification.

4.5.4 Insulation Resistance (See 3.6.1). Shielding shall be tested in accordance with MIL-STD-202, Method 302, Test condition B (500 V). Insulation resistance shall be measured on a 2 foot length of shielding between the copper shielding element and a flat copper electrode with an area of 1.0 ± 0.25 inch^2. The shielding under test shall be laid flat on a flat surface with the insulation layer to be tested facing upward and one test lead connected to the copper shielding element. The electrode, connected to the other test lead, shall be positioned on the area to be tested and weighted with a mass of 1.0 ± 0.25 lb. Measurements shall be taken at five different locations on each insulated surface of the test specimen.

4.5.5 Dielectric Withstand Voltage (See 3.6.2). Shielding shall be tested in accordance with MIL-STD-202, Method 301, using a test voltage of 1000 Vrms. Test voltage shall be applied on a 2-foot length of shielding between the copper shielding element and a flat copper electrode with an area of 1.0 ± 0.25 inch^{2}'. The shielding under test shall be laid flat on a flat surface with the insulation layer to be tested facing upward and one test lead connected to the copper shielding element. The electrode, connected to the other test lead, shall be positioned on the area to be tested and weighted with a mass of 1.0 ± 0.25 lb. Testing shall be done at five different locations on each insulated surface of the test specimen.

4.5.6 Solderability (See 3.6.3). Shield samples of suitable length shall be prepared by removal of 0.25 ± 0.05 inch of insulation from one end. Within 30 minutes of insulation removal, prepared samples shall be tested in accordance with MIL-STD-202, Method 208, using Sn63 solder per J-STD-006. Flux shall be type RMA per J-STD-004 and J-STD-006 and solder temperature shall be 245 ± 5°C. Aging and application of standard copper wrapping wire are not required.

4.5.7 Life Cycle (See 3.6.4). An 18 inch length of shield shall be folded over a horizontal, 0.25 inch diameter, stainless steel mandrel, with the insulated surface against the mandrel. The ends of the shield specimen shall be evenly clamped together between two stainless steel or aluminum strips, and the specimen shall be weighted so that the combined weight of the clamps and load mass totals 2.0 lbs. The specimen, so prepared on the mandrel, shall be conditioned in an air circulating oven for 192 hours at 200°C. The velocity of air past the specimen (measured at room temperature) shall be between 100 and 200 feet per minute. After the specified conditioning time, the oven shall be turned off, the door opened, and the specimen allowed to cool for at least 1 hour. When cool, the specimen shall be freed from tension, the strips removed, and the specimen removed from the mandrel. The shield shall then be folded over the mandrel so that the portion which was outside during conditioning is now next to the mandrel. The shield shall be loaded with the mass for 1 hour ± 10 minutes at room temperature.

The specimen shall then be removed from the mandrel and examined for cracking of the insulation. The specimen shall then be subjected to the dielectric withstand voltage test of paragraph 4.5.5.

4.5.8 Flexure Endurance (See 3.6.5). The shielded cable assembly shall be installed in a fixture as shown in Figure 2. One end of the f lat cable shall be held in the fixed clamping device and other end fastened in the movable clamping device, allowing a free length of 3.00 to 3.05 inches between clamping devices. The movable clamping device shall be driven in reciprocating linear motion for 5.4 to 5.5 inches from one extreme position to the other. One cycle shall consist of travel from one extreme position to the other and return. The specimen shall be subjected to 30 cycles per minute for 400 cycles. The shielding insulation shall then be visually examined for signs of cracks or delamination from the copper shielding element.

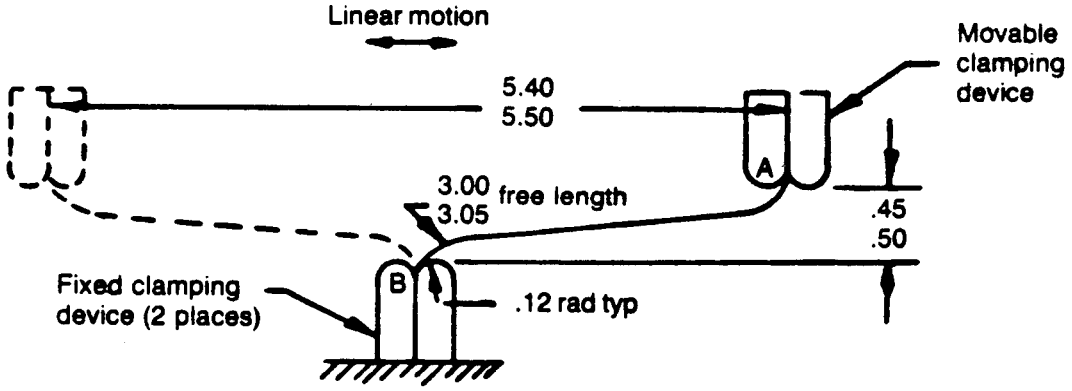

Figure 2. Flexure Endurance Test Setup

4.5.9 Mandrel Bend Endurance (See 3.6.6). The shielded cable assembly shall be installed in a fixture as shown in Figure 3. One cycle shall consist of movement from vertical to 90 degrees in one direction, then to the 90 degree extreme in the other direction and return to vertical. The specimen shall b subjected to 30 cycles per minute for 400 cycles. The shielding insulation shall then be visually examined for signs of cracks or delamination.

4.5.10 Fold Endurance (See 3.6.7). A shielded cable assembly of 6-inch minimum length shall be folded at a right angle as shown in Figure 4 and placed on a horizontal surface between two smooth surfaced flat metal plates. A load of 30 ± 1 lbf/in^2 over the triangular area of the fold shall then be applied to the upper plate for 15 minute duration. The specimen shall then be unfolded and the equivalent load applied to the unfolded, creased portion of the specimen f or 15 minutes. This cycle of folding and unfolding shall be repeated, with the fold at the same place and in the same direction. The shielding insulation shall then be visually examined for signs of cracks or delamination from the copper shielding element.

4.5.11 EME Shielding (See 3.6.8). A shielded cable assembly of suitable length shall be prepared and surface transfer impedance (Z_t) measured in accordance with SAE-AS85485, Paragraph 4.7.24.

4.5.12 Flammability (See 3.6.9). A shielded assembly shall be tested in accordance with D3032. The specimen shall be mounted in clamps as shown in Figure 5. The duration of flame application shall be 30 seconds.

4.5.13 Moisture Resistance (See 3.6.10). Shielded cable assemblies of 12 inch minimum length shall be conditioned in accordance with MIL-STD-202, Method 106, except that electrical loading and Step 7B (vibration) shall not be required. After completion of the humidity exposure, specimens shall be removed from the humidity chamber and visually examined.

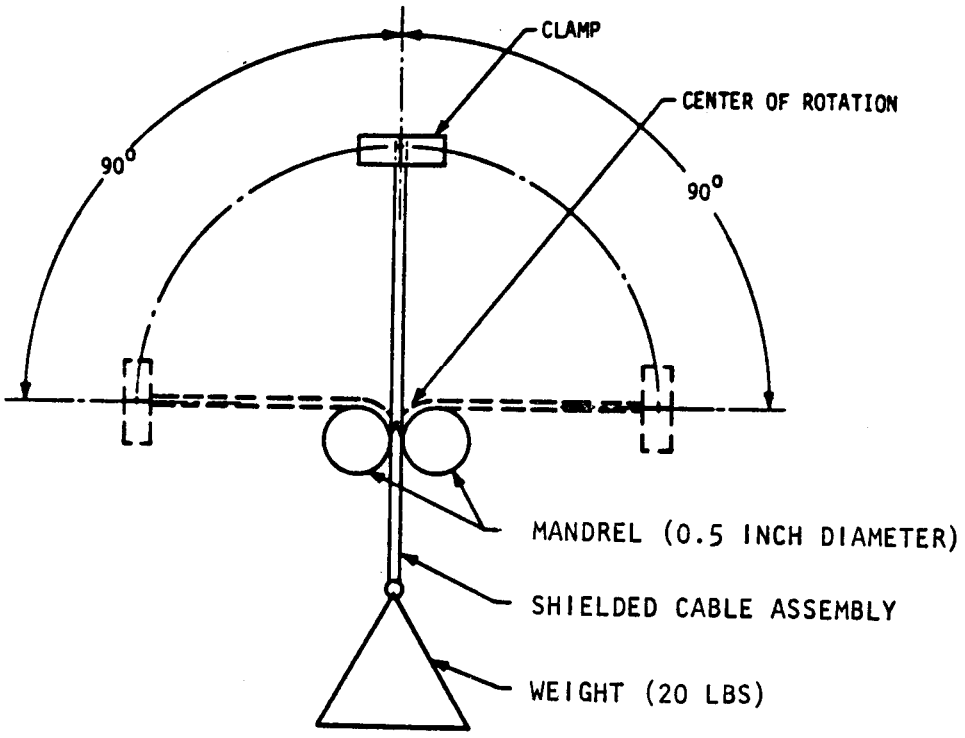

Figure 3. Mandrel Bend Endurance Test Setup

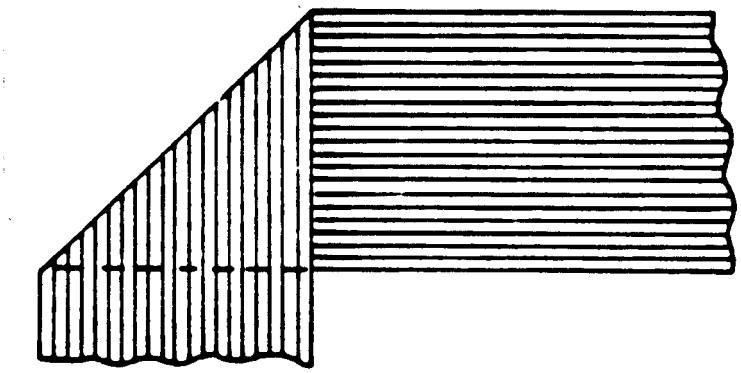

Figure 4. Fold Endurance Test

4.5.14 Fluid Immersion (See 3.6.11). Separate shielded cable specimens 3 ± 1 inch in length shall be immersed in each of the fluids listed in Table III for the specified time and at the specified temperature. After completion of the specified immersion, the specimens shall be removed, allowed to drain, and visually examined.

Table III. Fluid Immersion

Test Fluid	Test Temperature (°C)	Immersion Time (hours)
MIL-PRF-5606 hydraulic fluid	68 - 72	24
MIL-DTL-5624 JP-4 turbine fuel	20 - 25	24
MIL-PRF-7808 lubricating oil *	118 - 123	24
P-D-680, type II engine wash fluid	20 - 25	24
SAE-AMS1424 anti-icing fluid	20 - 25	24
MIL-C-43616 alkaline detergent	20 - 25	24
TT-I-735 isopropyl alcohol	20 - 25	24

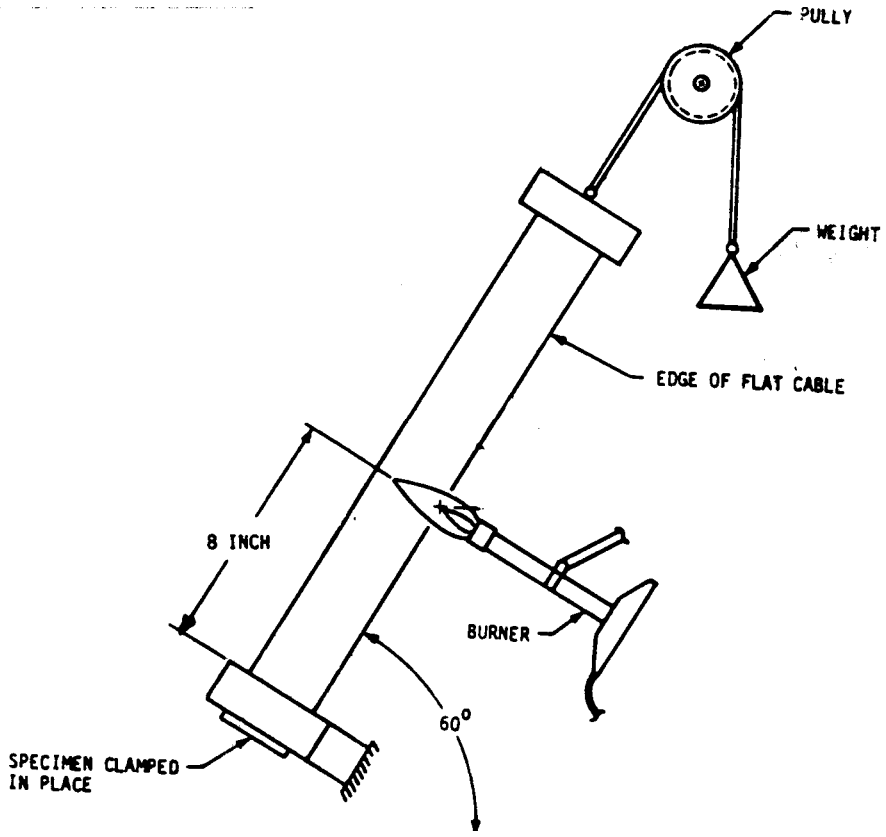

Figure 5. Flammability Test Setup

5. Preparation for Delivery

5.1 Packaging and Packing. Unless otherwise specified in the procurement document, packaging and packing shall be in accordance with commercial practice

5.2 Marking. Unless otherwise specified, packages shall be marked in accordance with commercial practice.