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SUPERSEDING
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MILITARY SPECIFICATION

CONDUIT, METAL, FLEXIBLE: ELECTRICAL, SHIELDED

This specification is approved for use by all Departments and agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers shielded, electrical, flexible metal conduit. The conduit consists of a core of flexible metal tubing with a covering of wire braid for use in military applications (see 6.1).

1.2 Classification.

1.2.1 Types. Conduit shall be furnished in the following types, as specified (see 6.2):

- Type I - Waterproof.
- Type II - Nonwaterproof.

1.2.2 Grades. Conduit shall be furnished in the following grades, as specified (see 6.2):

- Grade A - Double wire braid.
- Grade B - Single wire braid.

2. APPLICABLE DOCUMENTS

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

FSC-5975

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STANDARDS

Military

- MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
- MIL-STD-129 - Marking for Shipment and Storage.
- MIL-STD-130 - Identification Marking of U.S. Military Property.
- MIL-STD-202 - Test Methods for Electronic and Electric Component Parts.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer. Copies of packaging documentation may be obtained from the preparing activity.)

3. REQUIREMENTS

3.1 First article. A first article shall be procured and furnished for testing prior to the manufacture of conduit in production quantities. The First Article(s) shall pass testing specified herein (see 4.2). All items furnished to the Government under this specification shall be representative of those which have passed First Article Testing and inspection. Approval of the first article samples shall not relieve the contractor of this responsibility to provide conduit in production quantities that are fully representative of the first article samples. Changes or deviations of the production units from the first article sample shall be subject to approval of the contracting officer.

3.2 Materials. Materials used in the construction of conduit shall be as specified herein, on the applicable drawings, and in applicable specifications.

3.3 Design and construction.

3.3.1 Dimensions. Conduit shall be furnished in the nominal sizes specified by the procuring activity (see 6.2), and shall conform to all dimensions shown on the applicable drawings (see 3.6).

3.3.2 Lengths. Conduit shall be furnished in the lengths specified by the procuring activity (see 6.2). When random lengths are specified, no less than 80 percent of the lengths shall be a minimum of 10 feet and no lengths shall be less than 6 feet. All lengths shall be continuous and unspliced.

3.3.3 Ends.

3.3.3.1 Assemblies. When furnished with fittings, (see table V) the ends of each length of conduit shall be cut squarely and shall be free of burrs and sharp edges. Fittings shall be soldered to the conduit as indicated on the assembly drawing.

3.3.3.2 Bulk. When not furnished with fittings, the ends of each length shall be cut squarely and shall be protected with a removable spot-soldered ferrule, or flushed with soft solder to a length of not more than 1/2 inch and covered with seizing or tape to prevent unraveling of the braid.

3.3.4 Tubing. Tubing of type I conduit shall be of a corrugated or convoluted interlocking construction. Tubing of type II conduit shall be of a strip-wound, interlocked construction.

3.3.4.1 Interior. Interior of the tubing shall be free of any obstructions, protruding sharp edges, or burs.

3.3.5 Braid. Grade A conduit shall have double wire braid covering and grade B conduit shall have single wire braid covering the tubing. The under layer of braid for grade A conduit may be constructed of flat ribbon wire. The outer layer of Grade A conduit braid shall provide no less than 95 percent coverage, and the outer layer of Grade B conduit braid shall provide no less than 85 percent coverage of the underlying components (6.3).

3.3.5.1 Carriers and wires. Each carrier of the outer layer of braid shall have no less than 4 parallel copper alloy or tinned copper wires, from .0075 to .016 O.D., with a minimum carrier width of 1/16 inch. Carrier shall be continuous throughout the entire length of the braid with no breaks and no splices other than splicing of individual wires. Splices shall cause no rough or sharp projection in the braid, and there shall be no more than 1 such splice in any 2 foot length of conduit. All loose ends of braid wire shall be trimmed.

3.3.5.2 Identification. Conduit, other than assembled lengths of conduit that are readily identified as parts of an assembly, shall be marked with the Federal stock number in accordance with MIL-STD-130. Tracer wires, as approved by the procuring activity (see 6.2), shall be used with the regular wire of the braid to identify the manufacturer, distinguish the conduit from similar fuel and oil hose, and show the pitch of the braid.

3.4 Performance requirements.

3.4.1 Leakage resistance. When tested as specified in 4.6.1 conduit shall have no evidence of internal obstructions, or damage of any kind to the tubing or the braid as a result of the test. Type I conduit shall evidence no leakage.

3.4.2 Flexibility. When tested as specified in 4.6.2 conduit shall have no evidence of internal obstructions, or damage of any kind to the tubing or the braid as a result of the test. Type I conduit shall evidence no leakage.

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Table I. Mandrel diameters for flexibility tests

Nominal inside diameter of conduit, inches	Diameter of mandrel, inches
1/4	4
9/32	4
5/16	4
3/8	6
1/2	6
5/8	8
3/4	10
1 inch and over	12

3.5 Environmental requirements.

3.5.1 Resistance to temperature extremes and temperature shock. When tested as specified in 4.7.1, conduit shall evidence no damage resulting from the test. Type I conduit shall subsequently conform to 3.4.1.

3.5.2 Corrosion resistance. After testing in accordance with 4.7.2, conduit shall evidence no corrosion affecting mechanical or electrical properties and shall subsequently conform to 3.4.2 and 3.4.1.

3.6 Drawings. The drawings shall be complete; showing all dimensions, materials, marking, tracer information and shall reference this specification unless otherwise specified by the procuring activity.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to 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.

4.2 First Article Testing. A first article sample of 12 pieces of conduit of each type, grade, and size specified by the procuring activity shall be furnished for testing in order to conform to 3.1. Samples shall be furnished complete with fittings as specified in table V, and shall be representative of the units to be furnished under the contract. First Article testing shall be conducted by the contractor under government surveillance, at a place acceptable to the Government, and shall consist of examination for the defects specified in 4.4.2.2, and testing as specified in table II.

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4.3 Order of test. Six specimens shall be used for each series of tests. All types I specimens shall be subjected to the leakage and flexibility test. If no failures occur, three specimens from each series shall be selected and complete the tests in the order listed (see table II). Five of the remaining six will be used as spares to provide extra specimens in the event of damage. The other will be destroyed performing the braid coverage test specified in 3.3.5.

4.3.1 Failure. Failure of any sample to pass the inspection specified herein may be cause for the government to refuse to witness additional testing of the product. New samples may be submitted when it has been proved to the satisfaction of the Government that the faults revealed by such testing have been corrected.

Table II. Applicability of first article tests

Grade	Test	Type
A	4.6.1 Leakage	I
	4.6.2 Flexibility	I, II
	4.7.1 Extreme temperature	I, II
B	4.6.1 Leakage	I
	4.6.2 Flexibility	I, II
	4.7.2 Corrosion resistance	I, II
	4.6.2 Flexibility	I, II
	4.6.1 Leakage	I

4.4 Acceptance inspection.

4.4.1.1 Lot formation. Unless otherwise specified, a lot shall consist of all conduit of type, grade, and size, from an identifiable production period, from manufacturer, submitted at 1 time for acceptance.

4.4.1.2 Sampling for acceptance examination. Samples for acceptance examination shall be selected in accordance with Standard MIL-STD-105.

4.4.1.3 Sampling for acceptance testing. Samples for acceptance testing shall be selected in accordance with inspection level L6 of Standard MIL-STD-105.

4.4.1.3.1 Reduced sampling for acceptance testing. Reduced sampling for acceptance tests may be instituted provided that the conditions for reduced inspection procedure of Standard MIL-STD-105, have been met. The inspection level for reduced sampling shall be in accordance with inspection level L3.

4.4.2 Examination inspection for conduit.

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4.4.2.1 Visual, dimensional, and primary functional examination. Each sample selected in accordance with 4.4.1.2 shall be examined for conformance to the following acceptable quality levels (AQL), on the basis of percent defective:

<u>Classification</u>	<u>AQL</u>
Major	1.0
Minor	2.5

4.4.2.2 Classification of defects. Examination shall be conducted as specified in table III. Any conduit in the sample containing one or more defects shall be rejected, and if the number of defects in any one sample exceeds the acceptance number for that sample, the lot represented by One sample shall be rejected.

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

<u>Categories</u>	<u>Defects</u>	<u>Method of inspection</u>
Critical	None defined	
Major:		
101	OD, ID and length (of finished lengths) not within tolerance (see 3.3.1)	Visual, gage.
102	Nonconformance of tubing (see 3.3.2)	Visual.
103	Nonconformance of braid (see 3.3.3)	Visual.
Minor:		
201	Length (of bulk or random lengths) not within tolerance (see 3.3.1)	Visual.
202	Nonconformance of ends (see 3.3.3)	Visual.
203	Improper identification (see 3.3.5.2)	Visual.

4.4.3 Testing inspection for conduit. Samples selected in accordance with 4.4.1.3 shall be subjected to the tests specified in 4.6.1, (type I only) and 4.6.2 using an AQL of 6.5 on the basis of percent defective.

4.4.4 Sampling for packaging and packing.

4.4.4.1 Lot formation. A lot consists of all packs, packed in accordance with 1 level (see 5.1) from an identifiable production period, from 1 manufacturer, submitted at 1 time for acceptance.

4.4.4.2 Sampling for acceptance and examination. Sampling for acceptance examination shall be performed in the manner specified in 4.4.1.2.

4.4.5 Examination inspection for packaging and packing.

4.4.5.1 Visual, dimensional and primary functional examination. Each sample selected in accordance with 4.4.4.2 shall be examined for conformance to the following acceptable quality levels (AQL), on the percent defective:

<u>Classification</u>	<u>AQL</u>
Major	1.0
Minor	2.5

4.4.5.2 Classification of defects. Examination shall be conducted as specified in table IV. Any pack in the sample containing one or more defects shall be rejected, and if the number of defects in any one sample exceeds the acceptance number for that sample, the lot represented by the sample shall be rejected.

Table IV. Classification of defects in accordance with Standard MIL-STD-105

<u>Categories</u>	<u>Defects</u>	<u>Method of inspection</u>
Critical	None defined	
Major:		
101	Illegible marking	Visual.
102	Incorrect marking	Visual.
Minor:		
201	Improper closure and strapping of exterior container	Visual.

4.5 Control tests.

4.5.1 Sampling for control tests. Control test samples shall be selected at the rate of 5 of each 500 units produced, except that not more than 10 nor less than 5 units shall be selected in any 30 day period.

4.5.2 For conduit. Conduit selected in accordance with 4.5.1 shall be examined for the defects specified in 4.4.2.2.

4.5.3 Failure. Failure of a control test sample to pass any specified examination or test may be cause for the Government to refuse to accept subsequent lots until it has been proved to the satisfaction of the Government that the faults revealed by the test have been corrected.

4.6 Performance tests.

4.6.1 Leakage test. To determine conformance to 3.4.1, the specimen shall be sealed at one end to prevent leakage and the other end connected to equipment

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designed to produce the specified pressure and vacuum. The specimen shall then be immersed in a bath of fresh water and subjected to an internal air pressure of 15 psi for 5 minutes and subsequently to an internal vacuum of 6 psi for 30 minutes. During and after this test the specimen shall be examined for evidence of leakage as indicated by the escape of air bubbles, by loss of volume of the bath or by the presence of water in the specimen.

4.6.2 Flexibility test. To determine conformance to 3.4.2, specimens shall be cooled to a stabilized temperature of minus $65^{\circ} \pm 2^{\circ}\text{F}$. for a period not less than 1 hour. Specimens shall then be bent through an angle of 180° around a mandrel of the applicable diameter specified in table 1 in approximately 10 seconds. While bent around mandrel, specimens shall be allowed to warm to ambient air temperature of $77^{\circ} \pm 15^{\circ}\text{F}$. Type 1 conduit shall then be subjected to an internal hydraulic pressure of 15 psi for five minutes and examined for leakage. After the test, specimens shall be returned to a straight condition and examined internally and external for evidence of damage resulting from the test.

4.7 Environmental tests.

4.7.1 Extreme temperature test. To determine conformance to 3.5.1, all specimens shall be subjected to 12 cycles of cooling and heating as specified in 4.7.1.1 and 4.7.1.2. Following each cycle of cooling and heating, type I specimens shall be immediately immersed as specified in 4.7.1.3.

4.7.1.1 Cooling. Specimens shall be cooled to a stabilized temperature of minus $65^{\circ} \pm 2^{\circ}\text{F}$. and maintained at minus $65^{\circ} \pm 2^{\circ}\text{F}$. specimens shall be bent around a mandrel in the manner specified in 4.6.2.

4.7.1.2 Heating. Each cooled specimen (see 4.7.1.1) shall be heated to a stabilized temperature of $200^{\circ} \pm 2^{\circ}\text{F}$. and maintained at that temperature for a period of not less than 1 hour.

4.7.1.3 Immersion. Each heated type 1 specimen (see 4.7.1.2) shall be immersed in a fresh water bath maintained at a temperature of $77^{\circ} \pm 15^{\circ}\text{F}$. and allowed to remain under water for a period of 15 minutes. The specimen shall then be dried prior to the next test cycle.

4.7.1.4 Inspection. At the end of the 4th, 8th, and 12th cycles, and while still immersed in the fresh water bath, each specimen of type 1 conduit shall be subjected to the leakage test specified on 4.6.1.

4.7.2 Corrosion resistance test. To determine conformance to 3.5.2, conduit shall be subjected to the 100-hour salt spray test specified in Standard MIL-STD-202. The ends of the specimen shall be plugged and sealed prior to

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the test to prevent entry of the salt spray solution. Specimens shall then be tested in accordance with 4.6.2. Type 1 specimens shall then be tested in accordance with 4.6.1.

5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging and packing. Preservation, packaging and pack-ing shall be in accordance with the applicable packaging standards or data sheets as specified by the preparing activity (see 6.2).

6. NOTES

6.1 Intended use. The conduit covered by this specification is intended for use as protection of wiring in military vehicles from mechanical injury and, when properly installed and grounded, to prevent radiation which may cause interference with radio and other electronic equipment. Type 1 conduit also affords protection against water. Sheathing may be applied over the conduit at the time of harness assembly as an additional abrasion protection.

6.2 Ordering data. Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Type and grade of conduit to be furnished (see 1.2).
- (c) Dimensional requirements (see 3.3.1).
- (d) Lengths required (see 3.3.2).
- (e) Tracer wires required for identification (see 3.3.5.2).
- (f) Applicable drawings (see 3.6).
- (g) Selection of packaging standards or data sheets (see 5.1).
- (h) Thread size of fittings for hose over 1 inch (see table V).
- (i) Special marking, if required.

Table V. Thread sizes of conduit fittings

Conduit nominal id - inches	Fittings and thread size
1/4	3/4 - 20
9/32	3/4 - 20
5/16	3/4 - 20
3/8	3/4 - 20
1/2	3/4 - 20
5/8	1 3/16 - 18
3/4	1 3/16 - 18
1	1 3/16 - 18
above 1	

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6.3 Braid coverage. Coverage of the shielding (see 3.3.5) will be calculated as follows:

$$\text{Percent coverage} = (2F - F^2) \times 100$$

When F =

$$\frac{N \times D}{P \times \text{Cos angle of advance}}$$

N = Number of parallel wires between successive turns of a selected marker wire plus the selected wire.

D = Diameter of a single wire.

Angle of advance = Angle whose tangent is P/C.

P = Pitch of braid measured along the axis of the conduit.

C = (Outside diameter of conduit - 2D) X 3.1416.

Custodians:

Army - AT
Navy - AS
Air Force - 85

Preparing activity:

Army - AT

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Review:

Army - MU
Air Force - 80

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