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AEROSPACE STANDARD

SAE AS6136

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Submitted for recognition as an American National Standard

Conduit, Electrical, Flexible, Shielded, Aluminum Alloy for Aircraft Installations

FSC 5975

NOTICE

This document has been taken directly from U.S. Military Specification MIL-C-6136A, Amendment 2, Notice 1 and contains only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE technical standards. The initial release of this document is intended to replace MIL-C-6136A, Amendment 2, Notice 1. Any part numbers established by the original specification remain unchanged.

The original Military Specification was adopted as an SAE standard under the provisions of the SAE Technical Standards Board (TSB) Rules and Regulations (TSB 001) pertaining to accelerated adoption of government specifications and standards. TSB rules provide for (a) the publication of portions of unrevised government specifications and standards without consensus voting at the SAE Committee level, and (b) the use of the existing government specification or standard format.

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1. SCOPE:

1.1 Scope:

This specification covers the requirements for shielded electrical conduit for aircraft installations.

1.2 Classification:

Flexible shielded conduit shall be furnished in two types, as specified (see 6.2):

Type I - Without outer synthetic compounded covering
Type II - With outer synthetic compounded covering

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:

SPECIFICATIONS

Federal

QQ-A-225/2	Aluminum Alloy Bar, Rod, and Wire; Rolled, Drawn, or Cold Finished, 3003
QQ-A-250/2	Aluminum Alloy 3003, Plate and Sheet
QQ-A-430	Aluminum Alloy Rod and Wire; for Rivets and Cold Heading

Military

MIL-P-116	Preservation, Methods of
MIL-S-6855	Synthetic Rubber Sheets, Strips, Molded or Extruded Shapes
MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-129	Marking of Shipments

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with 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 Society for Testing and Materials

ASTM D 149-64	Dielectric Breakdown Voltage and Dielectric Strength of Electrical Insulating Materials at Commercial Power Frequencies
ASTM D 412-68	Tension Testing of Vulcanized Rubber
ASTM D 568-61	Flammability of Plastics 0.127 CM (0.050 inch) and Under in Thickness
ASTM D 570-63	Water Absorption of Plastics
ASTM D 624(c)-54	Test for Tear Resistance of Vulcanized Rubber
ASTM D 746-64T	Test for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D 792-66	Test for Specific Gravity and Density of Plastics by Displacement
ASTM D 2240-64T	Test for Indentation Hardness of Rubber and Plastics by means of a Durometer

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

3. REQUIREMENTS:

3.1 Materials:

Materials shall conform to applicable specifications and be as specified herein and on applicable drawings. Materials which are not covered by specifications or which are not specifically described herein shall be of the best quality, of the lightest practicable weight, and suitable for the purpose intended.

3.1.1 Tubing material: The tubing shall be formed from aluminum alloy sheet conforming to QQ-A-250/2 or from flattened wire conforming to QQ-A-225/2.

3.1.2 Packing material: The packing material used shall be such as not to cause corrosion when the tubing is exposed to salt atmosphere. If cotton packing is used it shall be impregnated with bituminous paint or other acceptable compound.

3.1.3 Braid material: The wire from which the braid is made shall be aluminum alloy conforming to QQ-A-430, temper O.

3.1.4 Outer covering material (Type II): The outer cover of Type II conduit shall be either synthetic rubber or nitrile rubber plasticized polyvinyl chloride or nitrile rubber plasticized polyvinyl chloride - acetate.

3.1.4.1 Synthetic rubber: The synthetic rubber shall conform to Class 2 of MIL-S-6855 and shall be of uniform thickness and free from pits and pinholes.

3.1.4.2 Nitrile rubber plasticized polyvinyl chloride or nitrile rubber plasticized polyvinyl chloride - acetate: The nitrile rubber plasticized polyvinyl chloride or nitrile rubber plasticized polyvinyl chloride-acetate shall be of uniform thickness and free from pitting and shall conform to Table I.

TABLE I

PROPERTY	VALUE	APPLICABLE ASTM OR FEDERAL TEST PROCEDURE
Tensile strength (psi, min.)	1800	ASTM D 412
Elongation (%) Min.	350	ASTM D 412
Modulus at 100% elongation (psi)	900	ASTM D 412
Tear strength (lbs/inch) Min.	350	ASTM D 624 Die (c)
Water absorption (gram/sq. in.)	.04 max.	ASTM D 624
Hardness (Durometer ±3)	82	ASTM D 2240
Specific gravity	1.20 max.	ASTM D 792
Low temperature flexibility(° F)	-70	Fed. Test Method Std. No. 601, Method 5211
Flammability	Self-extinguishing	ASTM D 568
Dielectric strength (volts/mil) Minimum	600	ASTM D 149 (Short time in air-0.30 mil sheet) 2-inch diameter electrodes

3.2 Design and construction:

3.2.1 Complete conduit: Type I complete conduit shall consist of flexible aluminum alloy tubing covered with a woven aluminum alloy wire braid (see figure 1). Type II complete conduit shall be identical to type I, except that it shall be provided with an outer protective synthetic rubber covering.

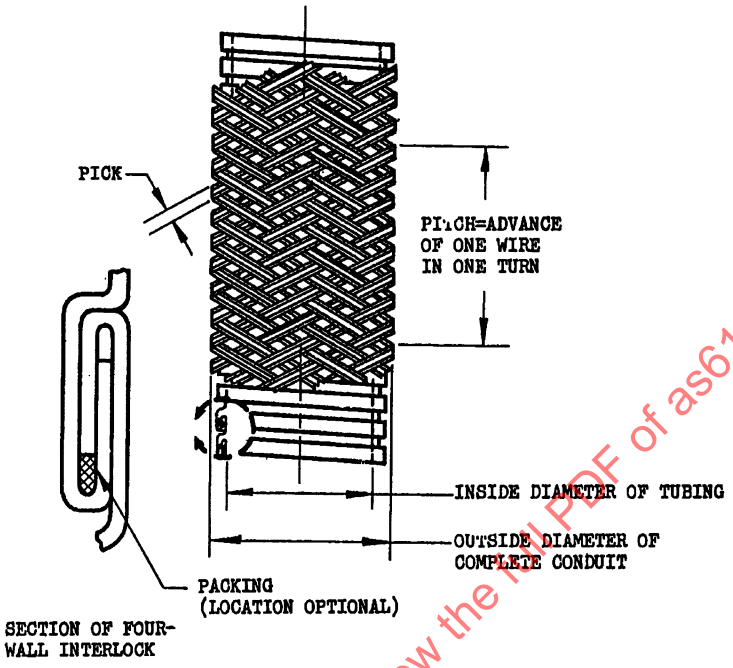

FIGURE 1. Shielded conduit type I and type II
(before outer covering is applied)

3.2.1.1 Sizes and dimensions: The nominal sizes and inside and outside diameters of the complete conduit shall be as specified in Table II.

3.2.1.2 Bending radius: All conduit (minus the outer synthetic rubber covering of type II) shall withstand bending in a loop, with the inside radius as specified in Table II, without damage.

3.2.2 Tubing: The tubing shall be of a rugged, full four-wall inter locking type, suitably packed to provide the specified watertightness (see 3.2.2.3). The tubing shall be made by helically coiling a formed aluminum alloy strip in such manner that it will not unravel or show loose ends when cut. The width of the strip and pitch of the helix shall be designed to provide for the required bending radius (see 3.2.1.2).

3.2.2.1 Tubing dimensions: The dimensions of the tubing and the thickness of the strip used in its forming shall be as specified in Table II.

3.2.2.2 Tubing yield load: The yield load of the tubing (conduit with outer covering and braid removed) shall be as specified in Table II.

TABLE II. Sizes and dimensions

Nom. size (ID)	Complete conduit							Tubing		Shielding braid				
	Inside diameter		Outside diameter type I		Outside diameter type II	Bending radius (inside)	Load for bending test	Thickness of strip	Yield load	Wires per pick (max.)		Wire diameter		Minimum coverage
	Inches		Inches		Inches	Inches	Lb.	Inch	Lb.	2/2 weave	1/1 weave	Inch		Percent
Inches	Min	Max	Min	Max	Max	Max	Max	Nom	Min			Min	Max	
3/16	0.183	0.193	0.318	0.338	0.386	2 1/4	1	0.010	50	6	8	0.0075	0.0085	85
1/4	.245	.255	.380	.400	.448	2 3/4	1	.010	75	6	8	.0075	.0085	85
3/8	.370	.380	.505	.525	.573	3 3/4	1	.010	85	6	8	.0075	.0085	85
1/2	.495	.505	.630	.650	.698	3 3/4	2	.010	100	6	8	.0075	.0085	85
5/8	.620	.630	.755	.775	.823	3 3/4	2	.010	105	6	8	.0075	.0085	85
3/4	.745	.755	.910	.930	.983	4 1/4	2	.010	110	7	14	.0095	.0105	90
1	.995	1.005	1.200	1.220	1.345	5 3/4	2	.012	120	7	14	.0095	.0105	90
1 1/4	1.245	1.255	1.450	1.475	1.600	8	2	.012	160	7	14	.0095	.0105	90
1 1/2	1.495	1.505	1.703	1.728	1.853	8 1/4	7 1/2	.012	190	7	15	.0095	.0105	90
1 3/4	1.745	1.755	1.953	1.978	2.103	9	7 1/2	.012	225	8	15	.0095	.0105	90
2	1.995	2.005	2.208	2.233	2.353	9 3/4	7 1/2	.012	265	8	16	.0121	.0131	90
2 1/2	2.495	2.505	2.720	2.745	2.870	10	7 1/2	.012	335	8	16	.0121	.0131	90

3.2.2.3 Water tightness: Class I tubing from which the shielding braid has been removed, or class II tubing from which the outer covering and the shielding braid have been removed and which has been flexed to the bending radius specified in Table II, shall not leak more than one-third of its interior volume per hour when tested as specified in 4.5.2.

3.2.3 Braid: The braid shall be applied in such manner that the finished conduit may be bent to the specified radius without damage (see 3.2.1.2). The braid shall fit the tubing closely enough to prevent appreciable bunching or undue slipping.

3.2.3.1 Braid design: The weave of the braid shall be either of the basket types, over two and under two, or over one and under one. The diameter of the wire used for the braid and the number of wires per pick shall be as specified in Table II. Each pick shall contain the same number of wires.

3.2.3.2 Braid coverage: The total number of wires in the complete braid and the number of parallel wires per inch length of conduit shall be such as to provide the percentage of coverage specified in Table II, when calculated by the method specified in 4.5.4.

3.2.4 Physical properties of outer cover: The physical properties of the outer synthetic rubber covering, both before and after testing, shall conform to class 2 of MIL-S-6855.

3.3 Marking:

Types I and II conduit shall be marked by either of the following methods:

(a) Continuous or intermittent lengths of waterproof tape marked with the manufacturer's name or trademark at intervals of not more than 1 foot shall be incorporated between the metal tubing and the braid.

(b) Manufacturer's identification shall be placed at not more than 3-inch intervals on the inner side of the spiral convolutions of the conduit.

3.4 Length of cut:

The maximum permissible length of a single piece within any quantity ordered is limited only by manufacturing and handling facilities. Not less than 85 percent of the total quantity of each size on order shall be furnished in lengths equal to or greater than the nominal lengths specified in Table III. Pieces shorter than the minimum acceptable lengths specified in Table III will not be accepted. All lengths shall be continuous, unspliced, and shall be measured when the conduit is fully extended under a tension of approximately 10 percent of the yield load specified in Table II.

TABLE III. Piece lengths

Nominal size (ID) Inches	Nominal Extended length Feet	Minimum acceptable extended length Feet
3/16	50	25
1/4	50	20
3/8	50	20
1/2	40	15
5/8	40	14
3/4	40	10
1	30	10
1 1/4	20	10
1 1/2	17	10
1 3/4	15	10
2	13	10
2 1/2	10	10

3.4.1 End protection: Each end of each length of type I conduit shall be provided with a removable ferrule or with suitable seizing or tape, which will prevent unraveling of the braid and cover the ends of the braided wires.

3.5 Workmanship:

All details of manufacture shall be in accordance with the best practice for aircraft flexible conduit. The conduit shall be free from all defects which would adversely affect its serviceability.

3.5.1 Interior: The interior surface of the conduit shall be free from burrs or sharp edges which might cause abrasion of cable insulation, and shall be free from obstructions.

3.5.2 Splices: Splices in braids shall be neatly made, and shall cause no sharp or rought projections on the conduit. There shall be not more than one spliced pick in any 2-foot length of conduit. All loose ends shall be trimmed closely.

3.5.3 Ends: The ends of each length of conduit shall be cut square, and shall be free from burrs or sharp edges which would interfere with the assembly of the conduit with parts with which it is intended to be used.

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 Sampling:

Unless otherwise specified, sampling for examinations and tests shall be in accordance with MIL-STD-105.

4.3 Inspection lot:

Conduit of one type and size presented at one time shall be considered a lot. The inspection lot size shall be determined by the number of coils or reels presented. The sample unit for examination shall consist of 4 consecutive feet of conduit.

4.3.1 Visual examination: The conduit shall be examined for defects in material, design, construction, marking, and workmanship. Any area of nonconformance with specified requirements shall be classified a defect. The inspection level shall be Level II with an AQL of 4.0 defects per 100 units.

4.3.2 Dimensional examination: An examination shall be made to determine compliance with dimensional requirements. Any dimension that is not within the specified tolerances shall be classified a defect. The inspection level shall be S-3 with an AQL of 6.5 defects per 100 units.

4.3.3 Testing of the end item: Testing shall be performed on each sample unit in accordance with 4.5.1, 4.5.2, 4.5.3, and 4.5.4. The inspection level shall be S-2 and any failure to meet the specified requirements shall be cause for rejection of the lot.

4.4 Test reports:

When required by the contract or order (see 6.2), test reports shall be furnished in duplicate showing quantitative results for all tests and analyses required by this specification.

4.5 Inspection methods:

4.5.1 Bending radius: The specimens for the bending test shall be of a length approximately four times the required bending radius. One end of the specimen shall be fastened tangentially to the surface of a cylindrical form so as to hang vertically, in a plane normal to the axis of the form, and the weight specified in Table II shall be attached to the lower end. The radius of the form shall be as specified in Table II. The form shall be slowly rotated 225 degrees to the position shown on figure 2. Failure of the conduit to come within 1/8 inch of the form, at any point along its curvature between the point of attachment and a point diametrically opposite shall constitute cause for rejection.

4.5.2 Watertightness: Specimens for this test shall be taken from the flexed portion of specimens previously subjected to the bending radius test and shall be of a length approximately 15 times the nominal inside diameter. After removing the shielding braid, both ends shall be taped with friction or masking tape over a distance equal to the nominal inside diameter. Corks shall be fitted snugly in each end and the ends shall then be dipped in molten paraffin or wax as ar back as the inner edge of the tape to insure watertightness.

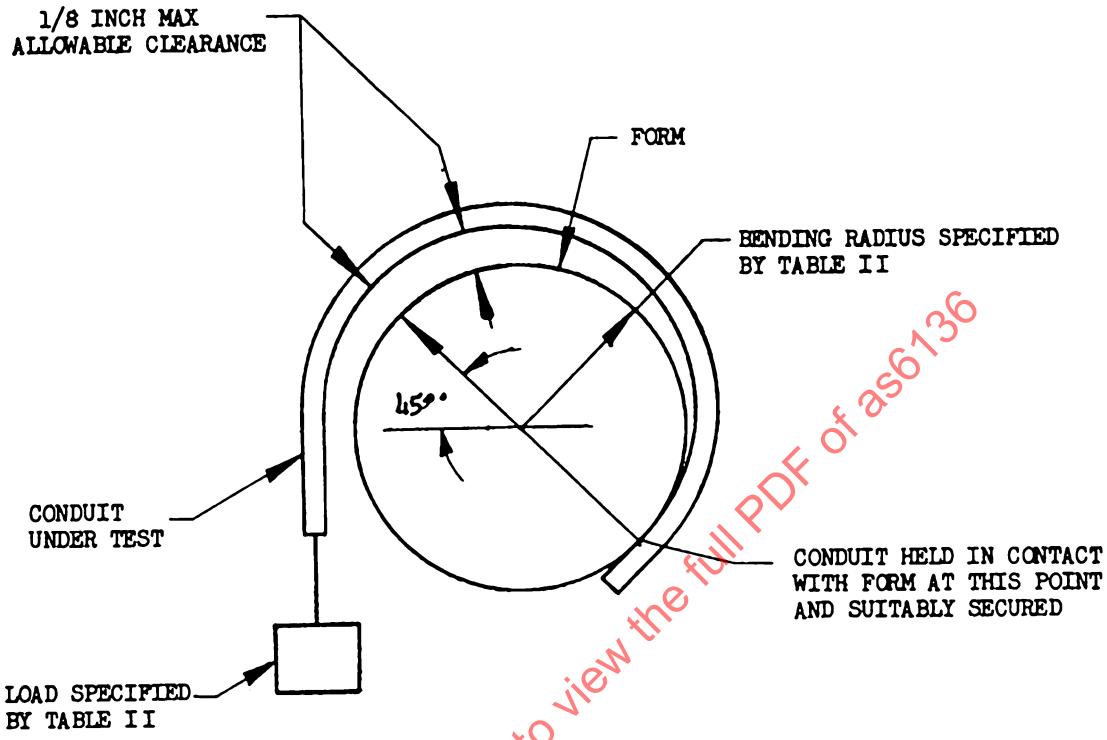

FIGURE 2. Bending radius test setup (diagrammatic)

4.5.2.1 Specimens prepared as noted above and in an axially straight position, shall be submerged horizontally in water so that the top of the conduit is at least 2 inches below the surface of the water. After submersion as specified in 3.2.2.3 the specimen shall be quickly and carefully removed. The contents (admitted water) shall be drained into a suitable receptacle, and weighed for calculation of amount of leakage. For the purpose of this test, the interior volume of the specimen shall be taken as the volume of a cylinder with a diameter equal to the minimum inside diameter permitted for the conduit under test, and with a length equal to the extended length of the specimen.

4.5.3 Yield load of tubing: Specimens for this test shall be at least 7½ inches long and the shielding braid shall be removed. Gripping of the specimen in the testing machine shall be accomplished by means of plugs inserted at least 1½ inches with clamps over the plugged portion or by means of suitable jaws which do not deform the tubing. The testing machine shall be operated so that the movable head travels at a rate not exceeding 0.022 inch per minute. The drop of the beam of the testing machine, and subsequent failure of the specimen to sustain increased loading, shall be taken as the indication of yield. The final value of the yield load shall be the average of not less than two tests. Failure to meet minimum yield load requirements specified in Table II shall be cause for rejection of the lot.