

INCH-POUND

MIL-DTL-87161A
15 August 1997
SUPERSEDING
MIL-W-87161
6 September 1982
(See 6.5)

DETAIL SPECIFICATION

WIRE STRAND, NONFLEXIBLE, FOR AIRCRAFT APPLICATION

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

1. SCOPE

1.1 Scope. This specification covers the requirements for carbon steel and corrosion-resistant steel wire strand used in aircraft application other than over sheaves. (CAUTION: See application limitations in 6.1).

1.2 Classification. The wire strand covered by this specification should be of the following types and composition:

Type I - Non-Flexible 1x7 class: Construction 1 - Right Lay
Construction 2 - Left Lay

Type II - Non-Flexible 1x19 class: Construction 1 - Right Lay
Construction 2 - Left Lay

Composition A: Carbon Steel, Zinc Coated
Composition B: Corrosion-Resistant Steel

2. APPLICABLE DOCUMENTS

2.1 Government documents

2.1.1 Specifications and standards. Unless otherwise specified, the following specifications and standards of the issues listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS), and supplement thereto, in effect on the date the qualifying activity authorizes the conduct of the qualification tests, form a part of this specification to the extent specified herein.

2.1.2 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification should take precedence.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Industrial Supply Center, attn.: DISC-EED, 700 Robbins Avenue, Philadelphia, PA 19111-5096, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 4010

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SPECIFICATIONS

MILITARY

MIL-DTL-83420 Wire Rope, Flexible, for Aircraft Control

STANDARDS

MILITARY

MIL-STD-129 Marking for Shipment and Storage

(Copies of specifications, standards, handbooks, drawings and publications required by manufacturers in connection with specific acquisition 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. The issues of the documents which are indicated as DoD adopted should be the issues listed in the current DoDISS and the supplement thereto, if applicable.

American Society for Testing and Materials

ASTM A 90 Weight of Coating on Zinc Coated (Galvanized) Iron or Steel Articles, Test for

ASTM E 8 Tension Testing of Metallic Materials

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

Uniform Freight Classification Committee

Uniform Freight Classification Rules

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

3. REQUIREMENTS

3.1 Qualification. Wire strand furnished under this specification shall be products that are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.2, 6.4). Products must be qualified by a test facility located in the continental United States or Canada.

3.2 Materials and protective coating.

3.2.1 Steel for composition A. Carbon steel shall be used for composition A wire rope and shall be of one type. The carbon steel shall be capable of meeting the requirements of this specification.

3.2.2 Steel for composition B. Corrosion resistant steel S30200 or S30400 in accordance with SAE HS-1086 shall be used for composition B, types I and II wire rope.

3.2.3 Protective coating. Composition A wires shall be thoroughly and uniformly coated by the methods specified in 3.2.3.1.

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3.2.3.1 Zinc coating for composition A. Zinc coating of composition A wires shall be by the hot dipped or electroplated process and shall conform to the following:

<u>Wire Diameter</u>	Min Weight of Zinc Coating <u>Oz/Sq Ft</u>
.005 to .010 inch	.03
Over .010 to .015 inch	.05
Over .015 to .028 inch	.10
Over .028 to .060 inch	.20
Over .060 to .090 inch	.30

3.2.4 Lubricant. The wire rope shall be coated with a friction-preventative noncorrosive lubricant. The lubricant shall be applied so that each wire is coated. As a minimum the lubricant shall be capable of operating at temperatures from -54°C (-65° F) to +121°C (+250°F).

3.3 Construction

3.3.1 Wire. The wire (see 6.3.1) used in steel wire rope shall be cylindrical, smooth and of uniformly high quality. It shall be free from splits, cold shuts, and other defects.

3.3.1.1 Wire properties. Tensile strengths of wire and wire sizes shall be such that wire rope will be capable of meeting the requirements of this specification.

3.3.1.2 Preforming of wires. The individual wires composing each type of steel wire strand shall be shaped into the exact helical position they will have in the finished strand, so that if the strand is cut or severed, the measured diameter of the strand at the unseized cut ends shall not increase by more than the amount specified in table I.

3.3.1.3 Splicing and joining. All wire splices shall be brazed or welded. In a type I, 1 x 7 wire strand, there shall be no more than 1 wire splice or joint in any 150-ft. section of a completed strand. In a type II 1 x 19 wire strand, joints and splices in individual wires shall be well spaced and not less than 20 feet apart.

3.3.2 Strand lengths. The steel wire strand shall be furnished on reels in lengths specified by the procuring activity. There shall be no more than two pieces of wire strand on the reel. The shortest piece shall be not less than 20 percent of the reel length. The reel length shall be marked on the reel and package. In addition, when two pieces are supplied, both lengths shall be marked on the reel and package.

3.3.3 Types of construction. Steel wire strand shall be either type I, 1 x 7 class, construction 1 or 2, or type II, 1 x 19 class, construction 1 or 2. The type of strand for the respective diameters, the dimensional tolerances, and the physical properties shall be as specified in table I.

3.3.3.1 Type I, 1 x 7 class, construction 1. Strand of this type, class and construction shall consist of a layer of 6 wires laid around a center wire in a right-hand direction. The length of lay shall be not more than 11 nor less than 9 times the respective nominal strand diameters.

3.3.3.2 Type I, 1 x 7 class, construction 2. Strand of this type, class, and construction shall consist of a layer of 6 wires laid around a center wire in a left-hand direction. The length of lay shall be not more than 11 nor less than 9 times the respective nominal strand diameters.

3.3.3.3 Type II, 1 x 19 class, construction 1. Strand of this type shall consist of a layer of 6 wires laid around a center wire in a left-hand direction and a layer of 12 wires laid over the 7-wire strand in a right-hand direction. The length of lay of the first operation 7-wire strand shall not exceed 60 percent of the lay of the second operation 12-wire outside layer. The length of lay of the second operation 12-wire outside layer shall not be more than 11 nor less than 9 times the respective nominal strand diameter.

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TABLE I. Construction, physical properties of type I and II, composition A and B wire strand.

STRAND TYPE	NOMINAL DIAMETER OF WIRE STRAND	TOLERANCE ON DIAMETER (Plus Only)	ALLOWABLE INCREASE IN DIAMETER AT THE END (see 4.4.8)	MINIMUM BREAK STRENGTH COMP A & B	APPROXIMATE WEIGHT PER 100 FT. (30.5 m)
	In.	In.	In.	Lbs.	Lbs.
I	1/32	.003	.006	185	.25
I	3/64	.005	.008	375	.55
II	3/64	.005	.008	375	.55
I	1/16	.006	.009	500	.85
II	1/16	.006	.009	500	.85
II	5/64	.008	.009	800	1.40
II	3/32	.009	.010	1200	2.00
II	7/64	.009	.010	1600	2.70
II	1/8	.013	.011	2100	3.50
II	5/32	.013	.016	3300	5.5
II	3/16	.013	.019	4700	7.7
II	7/32	.015	.020	6300	10.2
II	1/4	.018	.021	8200	13.5
II	5/16	.022	.024	12,500	21.0
II	3/8	.026	.027	17,500	30.0

3.3.3.4 Type II, 1 x 19 class, construction 2. Strand of this type shall consist of a layer of 6 wires laid around a center wire in a right-hand direction and a layer of 12 wires laid over the 7-wire strand in a left-hand direction. The length of lay of the first operation 7-wire strand shall not exceed 60 percent of the lay of the second operation (outside) layer of 12 wires. The length of lay of the second operation 12-wire outside layer shall not be more than 11 nor less than 9 times the respective nominal strand diameter.

3.4 Performance

3.4.1 Breaking strength. When tested in accordance with 4.4.2, the steel wire strand shall have the minimum breaking strength as shown in table I.

3.4.2 Stretch limits. When tested in accordance with 4.4.3, the stretch in the steel wire strand shall not exceed 1 percent when it is loaded to 60 percent of the minimum breaking strength as shown in table I.

3.4.3 Adherence of coating. The zinc coating shall not crack or flake when tested in accordance with 4.4.5. Loosening or detachment during the adhesion test of superficial, small particles of zinc formed by mechanical polishing of the surface of zinc-coated wire shall not be cause for rejection.

3.4.4 Ductility of steel. Composition A or B wire shall not fracture when tested in accordance with 4.4.6.

3.4.5 Test load. Each wire strand shall carry 85 percent of its respective minimum breaking strength load, as shown in table I, without any failures.

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3.5 Identification of product.

3.5.1 Identification by number. Each manufacturer shall assign a significant identification number on each manufacturing reel or steel wire strand. When the steel wire strand on the manufacturing reel is cut to specified lengths for transfer to the shipping reel, each shipping reel shall be marked with the identification number of the manufacturing reel, and a sequential transfer number.

3.5.2 Identification by color tracer filaments. Each manufacturer shall identify every wire strand made to this specification by the use of color tracer filaments manufactured into the wire strand. The specification preparing activity shall assign a combination of two or three colors to each manufacturer desiring qualification. The inclusion of color-tracer filaments does not assure that the steel wire strand is in full conformance, but only serves to identify the manufacturer.

3.5.3 Marking of reels and shipping containers. Each shipping reel and shipping container shall be marked in accordance with the requirements of MIL-STD-129. The following information shall be included.

- a. Stock No. or identification as specified in the contract (see 6.2).

NOTE: The contractor shall enter the NSN (National Stock Number) specified in the contract or as furnished by the procuring activity. Space shall be left for the NSN when not available.

- b. Nominal diameter, type, class, construction, composition, and specification number (example: MIL-DTL-XXXXX).

- c. Name of wire strand manufacturer.

- d. Name of contractor.

- e. Contract order number.

- f. Length of wire strand on the reel. For reels of two lengths, indicate both lengths.

3.6 Workmanship and finish. All details of workmanship and finish shall be in accordance with the best practice for high quality aircraft steel wire strand consistent with the requirements of this specification. The finished wire strand shall be uniform in construction and securely laid, free from kinks, broken wires, loose or protruding wire or other defects (see 4.4.1).

4. VERIFICATION

4.1 Classification of inspection. The inspection and testing of the wire strand shall be classified as follows:

- a. Qualification inspection (see 4.2)

- b. Quality conformance inspection (see 4.3)

4.2 Qualification inspection

4.2.1 Qualification inspection samples. When conducting qualification tests specified herein, one sample lot for each size and construction wire strand submitted for qualification shall be taken after any discard has been removed from the head or starting end of the first manufacturing reel for each lot of wire strand.

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4.2.1.1 Lot. A qualification inspection lot shall consist of 50 feet of wire strand of the same construction and diameter produced continuously by one machine or by one series of progressive processing machines.

4.2.2 Qualification testing. The qualification tests shall include all of the examinations and tests as specified in table II.

TABLE II. Qualification tests and quality conformance tests and inspection

TESTS	REQUIREMENT PARA	QUALIFICATION PARA	QUALITY CONFORMANCE TEST PARA
Examination of Product	3.6	4.4.1	4.4.1
Weight of zinc coating test, Comp. A	3.2.3.1	4.4.7	4.4.7
Preforming check	3.3.1.2	4.4.8	4.4.8
Breaking strength	3.4.1	4.4.2	4.4.2
Stretch test	3.4.2	4.4.3	4.4.3
Adherence of coating	3.4.3	4.4.5	4.4.5
Ductility of steel	3.4.4	4.4.6	4.4.6
Test loading	3.4.5	4.4.4 - 4.4.4.1	4.4.4 - 4.4.4.1
Identification of product	3.5 - 3.5.3	4.4.1.1	4.4.1.1

4.2.3 Retention of qualifications. To retain qualification, the manufacturer must be able to demonstrate that the company still has the capabilities and facilities necessary to produce the items. The qualifying activity will request appropriate documentation demonstrating this capability at the time qualification retention is required (at least 2 year intervals).

4.3 Quality conformance inspection. Quality conformance inspection shall consist of individual tests (4.3.1) and sampling tests (4.3.3).

4.3.1 Individual tests. Each wire strand of each construction furnished under each government order or contract shall be subject to the following test as described under 4.4 (see table II).

4.3.2 Sampling plan.

4.3.2.1 Samples. When conducting the tests specified herein, with the exception of examination of product, one sample not less than 15 feet in length shall be taken after any discard has been removed from the head or starting end of the manufacturing reel for each lot of wire strand.

4.3.2.2 Lot. A lot shall consist of not more than 30,000 feet of wire strand of the same construction and diameter produced continuously by one machine or by one series of progressive processing machines.

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4.3.2.3 Specimen. A specimen is a section of wire strand cut from a sample for the performance of a testing method. All specimens shall be taken from the lot furnished under that specific order.

4.3.3 Sampling tests. The quality conformance sampling tests shall be performed in accordance with the following paragraphs:

- Examination of Product (4.4.1)
- Breaking strength (4.4.2)
- Stretch test (4.4.3)
- Test loading (4.4.4, 4.4.4.1)
- Adherence of coating (4.4.5)
- Ductility of steel (4.4.6)
- Weight of zinc coating, composition A (4.4.7)
- Conformance test to preforming of strand (4.4.8)

4.3.5 Certification. For each government order or contract, the wire rope manufacturer shall certify that the product satisfactorily passed the quality conformance inspections (see 4.3.1, 4.3.3) of this specification. The certification shall include, as a minimum, actual results of the tests specified herein (see 6.4) and shall be retained on file at the manufacturer's facility for a minimum of 7 years.

4.4 Test methods

4.4.1 Examination of product. Each sample of wire strand shall be visually examined for workmanship and finish to determine compliance with 3.6.

4.4.1.1 Identification. Each wire strand shall be inspected for proper identification as specified in 3.5.

4.4.2 Breaking strength. The wire strand specimen shall be selected from the sample from each lot. The specimen may be gripped in the jaws of the testing machine or held in suitable swaged or socketed terminals. In case of failure in grips or terminal, the test may be disregarded and a new test conducted. The length of strand in the clear between grips or terminals shall be no less than 10 inches (25 cm) or 10 strand lay lengths, whichever is larger. The breaking strength shall be determined by use of a tensile testing machine in accordance with applicable requirements of ASTM E-8. The breaking strength shall conform to the requirements of table I for qualification and acceptance.

4.4.3 Stretch test. One specimen from each sample of wire strand selected as specified in 4.3.2.3 shall be tested to determine the percent stretch. The total length of the wire strand specimen to be tested shall not be less than 24 inches (60.9 cm). Where necessary, swaged terminals and accompanying hardware may be used to facilitate installation of the specimen in the jaws of the test machine. The amount of stretch shall be determined on a tension testing machine in accordance with ASTM E-8. The specimen shall be loaded to one percent minimum breaking strength shown in table I to straighten the wire strand. While the specimen is under tension, an adequate gauge length not less than 10 inches should be marked on the wire strand between the end fittings of the testing specimen. The specimen shall then be loaded to 60 percent of minimum breaking strength and measured for elongation under load.

$$\text{Percent stretch} = \frac{\text{Elongation of gauge length under load} \times 100}{\text{Original gauge length}} = 1.0\%$$

Results of the stretch test shall not exceed 1 percent change in length.

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4.4.4 Test loading. The following test loading shall be made using the same wire strand specimen used in the stretch test, or similarly prepared specimen. Load the specimen to one percent of breaking strength, then increase the loading to 85 percent of the minimum required breaking strength of the wire strand specimen test, the wire strand fittings shall be removed and the entire wire strand shall be completely unwound and every wire inspected. A suitable acoustic, electronic device capable of detecting the breaking of individual wires during test loading may be used instead of unwinding the wire strand. The failure of any wire shall be cause for rejection (see 4.4.4.1 and 6.3.8).

4.4.4.1 Use of acoustic, electronic device for test loading. The load shall be increased to 85 percent on the test specimen. If no ping is heard, the specimen has passed the test (see 6.3.8). If one or more pings are heard, the wire strand specimen shall be unraveled and the broken wires shall confirm failure of the specimen. If no wire breaks are found, the specimen has passed the test.

4.4.5 Adherence of coating. The zinc coated wire shall be capable of being wrapped at a rate not exceeding fifteen turns per minute in close helix of at least two turns around a cylindrical mandrel equal to two times the nominal diameter of the wire under tests without cracking or flaking the zinc coating to such an extent that any zinc can be removed by rubbing with the bare finger.

4.4.6 Ductility of steel. The wire shall be wrapped in a way which does not cause indenting. The wire shall be wrapped around a cylindrical mandrel for two complete turns in a close helix at a rate not exceeding fifteen turns per minute. The cylindrical mandrel diameter shall be equal to the nominal wire diameter being tested for composition B and two times the nominal diameter being tested for composition A.

4.4.7 Weight of zinc coating, composition A. Three specimens not less than 12 inches long shall be cut from the wire before or after the wire strand is fabricated. These specimens shall be cut from each size of wire to be used in making each lot of wire strand. The weight of zinc coating on the specimens shall be determined in accordance with ASTM A 90.

4.4.8 Conformance test to preforming of strand. To test strand for conformity to values shown in table I for increase in diameter, strand shall be mechanically cut with a cutter having constricting jaws. A plain shear with straight blades distorts the product and may void the test. After cutting, one of the following methods of measurements shall be used:

- a. Pass the strand through a hole drilled to a diameter shown in table I under "Allowable increase in diameter at cut end".
- b. A shadow graph with a suitable magnification.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of material is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

6.1 Intended use. The wire strand covered by this specification is intended for use in aircraft control systems applications where high resistance is needed against corrosion and abrasion. Wire strand to this specification should not be used for applications subject to bending fatigue.

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6.2 Ordering data

6.2.1 Acquisition documents. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Type, class, construction, composition, nominal diameter, and length of wire strand to be furnished.
- c. Selection of applicable levels of packaging and packing required (see section 5).

6.3 Definitions

6.3.1 Wire. Each individual cylindrical element is designated as a wire.

6.3.2 Strand. Each group of wires helically twisted is designated as a strand.

6.3.3 Diameter. The diameter of wire strand is the diameter of the circumscribing circle, or the distance across opposite wires.

6.3.4 Lay (or twist). The helical form taken by the wires in the strand and by the strand in the wire rope is characterized as the lay (or twist) of the strands or wire rope, respectively. In a right-hand lay, the wires of the strand are the same direction as the thread on a right-hand screw, and for a left-hand lay the strands of wires lay in opposite direction.

6.3.5 Length of lay (or pitch). The distance parallel to the axis of the strand, in which a wire makes one complete turn about the axis, is designated as the length of lay (or pitch) of the strand.

6.3.6 Center wire. The center of all strand is an individual wire and is designated as a center wire.

6.3.7 Master reel. The master reel is the large manufacturing reel that is used to hold the wire strand as it is continuously manufactured. The shipping reels are cut from the master reel as needed.

6.3.8 Ping. Ping is an audible sound given off as a result of an individual wire breaking in the wire strand. The sound is amplified and fed into a speaker system to a level distinctly detectable by the human ear.

6.4 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Product List QPL-87161 whether or not such products have actually been so listed by that date. The attention of contractors is called to these requirements, and manufacturers are urged to arrange to contact the activity responsible for the Qualified Products List to determine the specific requirements that must be met for qualification. The activity responsible for the Qualified Products List is Defense Industrial Supply Center, 700 Robbins Avenue, Philadelphia, PA 19111-5096 and information pertaining to qualification of products may be obtained from that activity.

6.5 Superseding specifications. MIL-DTL-87161 supersedes MIL-W-5693 dated 6 December 1965 and MIL-W-6940 dated 31 August 1969 .

6.6 Subject term (keyword) listing.

Airplane
Nonpliable
Steel cable

6.7 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

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Custodians:

Army - AV
Navy - AS
Air Force - 99

Preparing activity:
DLA-IS

(Project 4010-0225)

Review activity:

Air Force - 11

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER
MIL-DTL-87161A

2. DOCUMENT DATE (YYMMDD)
970815

WIRE STRAND, NONFLEXIBLE, FOR AIRCRAFT APPLICATION

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle Initial)

b. ORGANIZATION

c. ADDRESS (Include Zip Code)

d. TELEPHONE (Include Area Code)
(1) Commercial
(2) AUTOVON
(if applicable)

7. DATE SUBMITTED
(YYMMDD)

8. PREPARING ACTIVITY

a. NAME

DEFENSE INDUSTRIAL SUPPLY CENTER

b. TELEPHONE (Include Area Code)
(1) Commercial (2) AUTOVON

ATTN: DISC-EED
700 ROBBINS AVENUE
PHILADELPHIA, PA 19111-5096

IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:
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5203 Leesburg Pike, Suite 1403, Falls Church, VA 22401-3466
Telephone (703) 756-2340 AUTOVON 289-2340