

INCH-POUND

MIL-DTL-87161F

1 April 2005

SUPERSEDING

MIL-DTL-87161E

5 December 2002

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 will be of the following types and compositions, as specified (see [6.2](#)).

1.2.1 Types. The types of wire strand are as follows:

Type I - Non-flexible 1 x 7 class Construction 1 - Right Lay

Construction 2 - Left Lay

Type II - Non-flexible 1 x 19 class Construction 1 - Right Lay

Construction 2 - Left Lay

1.2.2 Compositions. The compositions of the wire strand are as follows:

Composition A - Carbon steel, zinc coated

Composition B - Corrosion resistant steel

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2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of the documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications and standards. The following specification and standard form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATION

MIL-DTL-83420 - Wire Rope, Flexible, for Aircraft Control, General Specification for.

DEPARTMENT OF DEFENSE STANDARD

MIL-STD-129 - Military Marking for Shipment and Storage.

(Copies of these documents are available online at <http://assist.daps.dla.mil/> or from the Standardization Documents Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL

ASTM A 90/A 90M - Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
ASTM E 8 - Standard Test Methods for Tension Testing of Metallic Materials.

(Copies of these documents are available from <http://www.astm.org/> or from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

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SAE INTERNATIONAL

- SAE HS-1086 - Metals and Alloys in the Unified Number System (DoD adopted).
- SAE AMS-STD-66 - Steel: Chemical Composition and Hardenability (DoD adopted).

(Copies of these documents are available from <http://www.sae.org/> or from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. Wire strand furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.2 and 6.3). Products must be qualified by a test facility located in the continental United States or Canada (see 4.1). The qualifying activity will be advised of any plant relocation, changes in key personnel, or major process change(s) (e.g. changes in lubricant and/or jacketing material, changes in the lubricant application process, etc.) for requalification testing determinations.

3.2 Materials and protective coating.

3.2.1 Steel for composition A. High carbon steel in accordance with SAE AMS-STD-66 shall be used for composition A wire strand 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 UNS S30200 or UNS S30400 in accordance with SAE HS-1086 shall be used for composition B, types I and II wire strand.

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

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:

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<u>Wire diameter</u>	<u>Minimum weight of zinc coating (oz./sq. ft.)</u>
0.005 to 0.010 inch	0.03
Over 0.010 to 0.015 inch	0.05
Over 0.015 to 0.028 inch	0.10
Over 0.028 to 0.060 inch	0.20
Over 0.060 to 0.090 inch	0.30

3.2.4 Lubricant. The wire strand shall be coated with a friction-preventive, non-corrosive lubricant. The lubricant shall be applied so that each wire is coated. As a minimum, the lubricant shall operate at temperatures from -65 °F to +250 °F (-54 °C to +121 °C). Any change in lubricant is considered a major process change and may require requalification testing (see 3.1).

3.3 Construction.

3.3.1 Wire. The wire (see 6.4.10) used in steel wire strand (see 6.4.9) shall be cylindrical, smooth, and of uniformly high quality.

3.3.1.1 Wire properties. Tensile strengths of wire and wire sizes shall be such that it will meet 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 (see 6.4.2) 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 Wire rope 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

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of lay (see 6.4.4) 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, class, and construction shall consist of a layer of 6 wires laid around a center wire (see 6.4.1) 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.

3.3.3.4 Type II, 1 x 19 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 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 (MBS) (see 6.4.6) 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 MBS 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 MBS load, as shown in table I, without any failures.

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

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(see 6.4.8), 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 filaments manufactured into the wire strand. The specification preparing activity will assign a combination of colors to each manufacturer desiring qualification. The inclusion of color tracing filaments alone does not designate that the steel wire strand is in full conformance with this specification or has met qualification requirements, but only serves to identify the manufacturer. Color tracer filaments are not mandatory in type I construction.

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. ^{1/}
- b. Nominal diameter, type, class, construction, composition, and specification number (MIL-DTL-87161).
- 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.

^{1/} The contractor shall enter the National Stock Number (NSN) specified in the contract or as furnished by the procuring activity. Space shall be left for the NSN when not available.

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. 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](#).

4.2.3 Maintenance of qualification. To maintain 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 Conformance inspection. Conformance inspection shall consist of individual tests (see [4.3.1](#)) and sampling tests (see [4.3.3](#)).

4.3.1 Individual tests. Each wire strand of each construction furnished under each contract or order 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, 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.

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 conformance sampling tests shall be performed in accordance with the following paragraphs:

- a. Examination of product ([4.4.1](#)).
- b. Breaking strength ([4.4.2](#)).
- c. Stretch test ([4.4.3](#)).
- d. Test loading ([4.4.4](#) and [4.4.4.1](#)).
- e. Adherence of coating ([4.4.5](#)).
- f. Ductility of steel ([4.4.6](#)).
- g. Weight of zinc coating, composition A ([4.4.7](#)).
- h. Conformance test to preforming of strand ([4.4.8](#)).

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4.3.4 Certification. For each contract or order, the wire rope manufacturer shall certify that the product satisfactorily passed the conformance inspections (see 4.3.1 and 4.3.3) of this specification. The certification shall include, as a minimum, actual results of the tests specified herein 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 MBS 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 MBS and measured for elongation under load.

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

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

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

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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).

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 (see 6.4.7) is heard, the specimen has passed the test. 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 15 turns per minute in close helix of at least 2 turns around a cylindrical mandrel equal to 2 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 that 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 15 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/A 90M.

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, the wire strand shall be measured by passing the wire strand through a hole drilled to a diameter increased as shown in [table I](#) under "Allowable increase in diameter at cut end" or by using a shadowgraph with suitable magnification. The allowable increase in diameter shall be applied to the actual diameter of the wire strand being tested.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of material is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. 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.

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6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

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.

6.2 Acquisition requirements. 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 (see 1.2).
- c. Packaging requirements (see 5.1).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products that are, at the time of award of contract, qualified for inclusion in 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 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. Information pertaining to qualification of products may be obtained from Defense Supply Center Richmond, ATTN: DSCR-VEB, 8000 Jefferson Davis Highway, Richmond, VA 23297-5616.

6.4 Definitions.

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

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

6.4.3 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.

6.4.4 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.

6.4.5 Master reel. The master reel is the large manufacturing reel that is used to hold the wire strand as it is continuously manufactured.

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6.4.6 Minimum breaking strength. The minimum tension load that a wire rope must support.

6.4.7 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.

6.4.8 Shipping reel. The shipping reels are cut from the master reel (see 6.4.5) as needed.

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

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

6.5 Subject term (key word) listing.

Airplane
Nonpliable
Steel cable

6.6 Changes from previous issue. The margins of this specification are marked with vertical lines to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

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

Strand type	Diameter of wire strand		Tolerance on diameter (plus only)	Allowable increase in diameter at the end ^{1/}	MBS composition A & B	Approximate weight per 100 ft. (30.5 m)
	Nominal reference	Minimum				
	in.	in.	in.	in.	lbs.	lbs.
I	1/32	0.031	0.003	0.006	185	0.25
I	3/64	0.046	0.005	0.008	375	0.55
II	3/64	0.046	0.005	0.008	375	0.55
I	1/16	0.062	0.006	0.009	500	0.85
II	1/16	0.062	0.006	0.009	500	0.85
II	5/64	0.078	0.008	0.009	800	1.40
II	3/32	0.093	0.009	0.010	1,200	2.00
II	7/64	0.109	0.009	0.010	1,600	2.70
II	1/8	0.125	0.013	0.011	2,100	3.50
II	5/32	0.156	0.013	0.016	3,300	5.50
II	3/16	0.187	0.013	0.019	4,700	7.70
II	7/32	0.218	0.015	0.020	6,300	10.20
II	1/4	0.250	0.018	0.021	8,200	13.50
II	5/16	0.312	0.022	0.024	12,500	21.00
II	3/8	0.375	0.026	0.027	17,500	30.00

^{1/} The allowable increase in diameter shall be applied to the actual diameter of the wire strand being tested.

TABLE II. Qualification and conformance tests and inspections.

Tests	Requirement paragraph	Qualification paragraph	Conformance paragraph
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

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Custodians:

Army - AV

Navy - AS

Air Force - 99

Preparing Activity:

DLA - GS5

(Project 1640-0004)

Review Activity:

Air Force - 71

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