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MILITARY SPECIFICATION

INSERTS, SCREW-THREAD, HELICAL COIL

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

1. SCOPE

1.1 Scope. This specification covers helical coil screw-thread inserts made from formed wire, the inner surfaces of which, after assembly, provide threads as specified on the applicable MS standard, drawing, or part descriptive document.

1.2 Classification. Inserts shall be of the following types and classes, as specified (see 6.2):

Type I - Coarse thread
Type II - Fine thread
  Class 1 - Free running
  Class 2 - Screw locking (self-locking)
Type III - Taper pipe thread
  Class 5 - NPT pipe thread
  Class 6 - ANPT pipe thread
Type IV - Metric - spark plug thread
  Class 3 - Staking (spark plug thread)

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

*PPP-H-1581	Hardware (Fasteners and Related Items), Packaging and Packing for Shipment and Storage of

Military

MIL-P-7105	Pipe Threads, Taper, Aeronautical National Form, Symbol ANPT, General Requirements for
MIL-S-8879	Screw Threads, Controlled Radius Root with Increased Minor Diameter, General Specification for

STANDARDS

Federal

FED-STD-66	Steel: Chemical Composition and Hardenability
Federal Test Method Standard No. 151	Metals; Test Methods

Military

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-1312	Fasteners, Test Methods
MS9018	Insert - 18-1.5MM Aviation Spark Plug Helical Coil
MS9071	Bosses, 18-1.50MM Spark Plug Thread Helical Insert, Standard Dimensions for
MS16997	Screw, Cap, Socket Head-Hexagon, Alloy Steel, Cadmium Plated, UNC-3A
MS21209	Insert, Screw Thread, Coarse and Fine, Screw Locking, Helical Coil, CRES
MS33537	Insert - Standard Dimensions for Coarse and Fine Thread Helical Coil, Assembly
MS122076 thru MS122115	Insert-CRES Helical Coil Coarse Thread, 1 Dia Nominal Length
MS122116 thru MS122155	Insert-CRES Helical Coil Coarse Thread, 1-1/2 Dia Nominal Length
MS122156 thru MS122195	Insert-CRES Helical Coil Coarse Thread, 2 Dia Nominal Length
MS122196 thru MS122235	Insert-CRES Helical Coil Coarse Thread, 2-1/2 Dia Nominal Length
MS122236 thru MS122275	Insert-CRES Helical Coil Coarse Thread, 3 Dia Nominal Length
MS124651 thru MS124690	Insert-CRES Helical Coil Fine Thread, 1 Dia Nominal Length
MS124691 thru MS124730	Insert-CRES Helical Coil Fine Thread, 1-1/2 Dia Nominal Length
MS124731 thru MS124770	Insert-CRES Helical Coil Fine Thread, 2 Dia Nominal Length
MS124771 thru MS124810	Insert-CRES Helical Coil Fine Thread, 2-1/2 Dia Nominal Length
MS124811 thru MS124850	Insert-CRES-Helical Coil Fine Thread, 3 Dia Nominal Length

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained form 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 shall apply.

National Bureau of Standards

Handbook H28	Screw-Thread Standards for Federal Services

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.)

American National Standards Institute

ANSI B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)

(Application for copies should be addressed to the American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018.)

National Aerospace Standards

NAS 1303 thru 1320	Bolt, Shear - Hexagon Head

(Application for copies should be addressed to the National Standards Association, Inc., 1321 Fourteenth Street, N.W., Washington, D. C. 20005.)

American Society for Testing and Materials

ASTM-E-8	Standard Methods of Tension Testing of Metallic Materials
ASTM-E-290	Standard Method for Semi-Guided Bend Test for Ductility of Metallic Materials

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

3. REQUIREMENTS

3.1 Material. Unless otherwise specified on the drawing, the wire shall be manufactured of induction furnace or electric arc furnace steel, cold drawn, and shaped by rolling to conform to this specification and the applicable MS standards.

3.1.1 Chemical composition. The chemical composition of the wire shall conform to table I or type 304 of FED-STD-66 (see 4.4.1).

Table I. Chemical Composition

Element	Analysis (percent)	Check analysis	
		Under (minimum)	Over (maximum)
Carbon	0.15 max	----	0.01
Manganese	2.00 max	----	0.04
Silicon	1.00 max	----	0.05
Phosphorus	0.045 max	----	0.01
Sulfur	0.035 max	----	0.01
Chromium	17.00 to 20.00	0.20	0.20
Nickel	7.00 to 11.00	0.15	0.15
Molybdenum	0.60 max	----	0.03
Selenium	0.35 max	----	0.03
Copper	0.30 max	----	0.03

3.1.2 Tensile strength. Before coiling into parts, the wire shall have a tensile strength not lower than 150,000 pounds per square inch (psi) (see 4.4.2).

3.1.3 Cold-bending. Wire from which the inserts are made shall withstand, without cracking, bending at room temperature through an angle of 180 degrees around a diameter equal to twice the cross-sectional dimension of the wire in the plane of bend (see 4.4.3).

3.2 Design. The detail design and dimensions of the inserts shall conform to the applicable MS standard, drawing, or part descriptive document.

3.2.1 Surface texture. When the design or application makes it necessary to control the surface roughness of the insert, the allowable roughness shall be 32 microinches AA or as specified in the detail specification or the product drawing. Roughness shall be specified in accordance with the method outlined in ANSI B46.1.

3.3 Threads. Class 1 inserts (MS122076 thru MS122275, and MS124651 thru MS124850) and class 2 inserts (MS21209), when assembled in accordance with MS33537, shall accept threads which conform to MIL-S-8879. After assembly, class 1 and class 2 inserts shall conform to the minimum and maximum lengths specified on MS33537. Class 3 inserts (MS9018), when assembled, shall form threads in accordance with MS9071. Class 5 and class 6 inserts, when assembled in accordance with the applicable design standard or drawing, shall form threads conforming to Handbook H28 and MIL-P-7105, respectively.

3.4 Screw-locking-torque. The class 2 insert, when assembled in accordance with MS33537 and tested in accordance with 4.4.4, shall produce torque in accordance with the values specified in table II.

* Table II. Pound-inches Torque at Room Temperature

Fine thread series			Coarse thread series		
Bolt size	Maximum locking torque, installation or removal	Minimum breakway torque	Bolt size	Maximum locking torque, installation or removal	Minimum breakway torque
0.099-56	2	7. 1/	0.086-56	1.25	3. 1/
0.112-48	3	10. 1/	0.099-48	2	7. 1/
0.138-40	6	1.0	0.112-40	3	10. 1/
0.164-36	9	1.5	0.125-40	4.7	13. 1/
0.190-32	13	2.0	0.138-32	6	1.0
0.250-28	30	3.5	0.164-32	9	1.5
0.3125-24	60	6.5	0.190-24	13	2.0
0.375-24	80	9.5	0.250-20	30	4.5
0.4375-20	100	14.0	0.3125-18	60	7.5
0.500-20	150	18.0	0.375-16	80	12.0
0.5625-18	200	24.0	0.4375-14	100	16.5
0.625-18	300	32.0	0.500-13	150	24.0
0.750-16	400	50.0	0.5625-12	200	30.0
0.875-14	600	70.0	0.625-11	300	40.0
1.000-12	800	90.0	0.750-10	400	60.0
1.125-12	900	117.0	0.875-9	600	82.0
1.250-12	1,000	143.0	1.000-8	800	110.0
1.375-12	1,150	165.0	1.125-7	900	137.0
1.500-12	1,350	190.0	1.250-7	1,000	165.0
			1.375-6	1,150	185.0
			1.500-6	1,350	210.0

1/ Ounce-inches.

3.5 Vibration. The class 2 insert shall withstand the vibration test specified in 4.4.5.

* 3.6 Identification of product. Unplated class 1 inserts shall be furnished in bright stainless steel finish. Cadmium plated class 1 inserts shall be gold to yellow iridescent in color. Unplated class 2 inserts shall be coated with a red dye. Cadmium plated class 2 inserts shall be olive drab to dark brown in color. Class 1 and 2 inserts coated with a dry film lubricant shall be dark gray to black in color. On inserts that are cadmium plated the cadmium shall be 0.0001 inch nominal thickness.

3.7 Workmanship. The formed wire shall be of uniform quality and temper; smooth; clean; and free from kinks, waviness, splits, cracks, laps, seams, scale, segregation, and other defects which may impair the serviceability of the insert.

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 in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by 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 the prescribed requirements.

4.2 Classification of inspection. The examination and testing of inserts shall be classified as quality conformance inspection.

4.3 Quality conformance inspection. Quality conformance inspection shall consist of the sampling tests and examinations.

4.3.1 Lot. Unless otherwise specified in the contract or order, a lot shall consist of inserts which are of the same type, class, thread size and length, fabricated by the same process, and produced as one continuous run or order, or part thereof, and submitted for acceptance inspection at the same time.

4.3.2 Sampling tests and examinations

4.3.2.1 Sampling for tests. Sampling for the material composition test (4.4.1), tensile strength test (4.4.2), and cold-bending test (4.4.3) shall be in accordance with the applicable test paragraph, and any one failure shall be cause for rejection of the represented lot. Sampling for the torque test (4.4.4) shall be in accordance with MIL-STD-105, inspection level S-1, with an AQL of 4.0 percent. Sampling and acceptance procedures for the vibration test (4.4.5) shall be as specified in 4.4.5.

4.3.2.2 Sampling for examination. Samples shall be selected in accordance with MIL-STD-105, inspection level II, and examined for defects as specified in table III. The AQL shall be 1.0 percent for major defects and 4.0 percent for minor defects.

4.4 Test methods

4.4.1 Material composition. It shall be ascertained that the material complies with 3.1.1. The manufacturer's certificate of chemical composition may be accepted. At the discretion of the procuring activity, the material shall be tested in accordance with method 111 of Federal Test Method Standard No. 151. If the material does not pass these tests, the entire lot shall be rejected.

Table III. Classification of Defects

Defects	Requirement paragraph	Classification of Defects	Method of Inspection
Incorrect thread dimensions	3.3	Major	Standard measuring instruments
Incorrect surface roughness	3.2.1	Minor	Standard measuring instruments or visual comparison specimens
Incorrect dimensions	3.2	Minor	Standard measuring instruments
Incorrect design	3.2	Minor	Visual
Incorrect identification	3.6	Minor	Visual
Poor workmanship	3.7	Minor	Visual

4.4.2 Tensile strength. Two samples representative of the insert material shall be tested in accordance with test method ASTM-E-8 for compliance with 3.1.2.

4.4.3 Cold-bending. Two samples representative of the insert material shall be tested in accordance with test method ASTM-E-290 for compliance with 3.1.3.

* 4.4.4 Screw-locking torque (class 2 inserts). The torque test shall consist of a 15-cycle, room-temperature torque test, using cadmium-plated bolts or screws in accordance with table IV, and with thread lengths greater than the nut thicknesses of table IV. The bolt or screw pitch diameter, after plating, shall be class 3A. A new bolt or screw and a new tapped hole shall be used for each complete 15-cycle test. The insert shall be assembled in a nut in accordance with table IV. Bolts and screws must assemble freely, with the fingers, up to the locking coil or coils. The bolt or screw shall be engaged and disengaged from the assembled insert for 15 full installation and removal cycles without axial load on the insert. The test shall be run at a rate slow enough to yield a dependable measure of torque and avoid heating of the bolt. A bolt shall be considered fully installed when three threads extend past the end of the locking coils of the insert; the removal cycle shall be considered complete when the locking coils are disengaged.

4.4.4.1 Maximum locking torque. Maximum locking torque shall be the maximum torque value encountered on any installation or removal cycle and shall not exceed the values specified in table II. Maximum locking torque readings shall be taken on the first and seventh installation cycles and on the fifteenth removal cycle.

4.4.4.2 Minimum breakway torque. Minimum breakway torque shall be the minimum torque required to start removal of the screw or bolt from the installed position and shall be recorded at the start of the fifteenth removal cycle. The torque value for any cycle shall be not less than the applicable value shown on table II.

* 4.4.5 Vibration (class 2 inserts). The vibration test is waived for inserts sizes below 0.190-32 and sizes larger than 0.500-20 thread size, provided the insert of 0.500-20 thread size with the same type and design locking element has satisfactorily passed the vibration test. The vibration test is also waived for inserts of nominal lengths other than 1-1/2 diameters, provided the 1-1/2 diameter inserts have the same type and design locking elements as the inserts of other lengths and have satisfactorily passed the vibration test.

* 4.4.5.1 Method

a. Five samples of each size shall be tested. The inserts shall be installed in the test nuts listed in table V, and then assembled on the test fixture shown in MIL-STD-1312, test No. 7.

b. The insert-nut assembly shall be screwed onto the test bolt and tightened to the torque specified in table V. The maximum prevailing torque before clamping shall be recorded.

c. Reference lines shall be scribed on the bolts and insert-nut assemblies to determine relative motion or loosening of the assembly. Also the sliding surfaces of the test fixture under the cylinder flanges and washers should be lightly lubricated with SAE 20 oil so that the cylinder assembly will freely traverse the slots of the fixture.

d. The fixture shall then be vibrated with an essentially sinusoidal wave form at a frequency of 1750 to 1800 cycles per minute and double amplitude of 0.450 $\pm$0.015 inch. The test shall be run for 30,000 cycles. If, prior to the completion of 30,000 cycles, an insert-nut assembly rotates completely off a bolt, the test shall be stopped.

e. Breakway torque after vibration shall also be measured after the insert-nut assembly has been unseated from the clamped position.

* Table IV. Dimensions of Insert Nuts and Bolts Required for Test Assemblies

	Tests	Test Nuts 1/		Bolts for Torque and Vibration Tests
		Across Flats (Maximum)	Thickness 2/ +0.010 -0.000	Basic MS or NAS Part Number
FINE THREAD SERIES	0.099-56 UNF-3B	0.250	0.170	
	0.112-48 UNF-3B	0.312	0.190	
	0.138-40 UNF-3B	0.344	0.240	
	0.164-36 UNF-3B	0.375	0.280	
	0.190-32 UNJF-3B	0.437	0.320	NAS1303
	0.250-28 UNJF-3B	0.500	0.410	NAS1304
	0.3125-24 UNJF-3B	0.562	0.510	NAS1305
	0.375-24 UNJF-3B	0.688	0.600	NAS1306
	0.4375-20 UNJF-3B	0.750	0.710	NAS1307
	0.500-20 UNJF-3B	0.875	0.800	NAS1308
	0.5625-18 UNJF-3B	0.937	0.900	NAS1309
	0.625-18 UNJF-3B	1.062	0.990	NAS1310
	0.750-16 UNJF-3B	1.250	1.190	NAS1312
	0.875-14 UNJF-3B	1.437	1.380	NAS1314
	1.000-12 UNJF-3B	1.625	1.625	NAS1316
	1.125-12 UNJF-3B	1.812	1.770	NAS1318
	1.250-12 UNJF-3B	2.000	1.960	NAS1320
	1.375-12 UNJF-3B	2.187	2.150	----
	1.500-12 UNJF-3B	2.187	2.330	----
COARSE THREAD SERIES	0.086-56 UNC-3B	0.188	0.150	MS16997
	0.099-48 UNC-3B	0.250	0.170	
	0.112-40 UNC-3B	0.312	0.190	MS16997
	0.125-40 UNC-3B	0.344	0.210	
	0.138-32 UNC-3B	0.344	0.240	MS16997
	0.164-32 UNC-3B	0.375	0.280	MS16997
	0.190-24 UNC-3B	0.437	0.320	MS16997
	0.250-20 UNC-3B	0.500	0.410	MS16997
	0.3125-18 UNC-3B	0.562	0.510	MS16997
	0.375-16 UNC-3B	0.688	0.600	MS16997
	0.4375-14 UNC-3B	0.750	0.710	MS16997
	0.500-13 UNC-3B	0.875	0.800	MS16997
	0.5625-12 UNC-3B	0.937	0.900	
	0.625-11 UNC-3B	1.062	0.990	MS16997
	0.750-10 UNC-3B	1.250	1.190	MS16997
	0.875-9 UNC-3B	1.437	1.380	MS16997
	1.000-8 UNC-3B	1.625	1.625	MS16997
	1.125-7 UNC-3B	1.812	1.770	
	1.250-7 UNC-3B	2.000	1.960	
	1.375-6 UNC-3B	2.187	2.150	
	1.500-6 UNC-3B	2.187	2.330	

1/ Material: Aluminum alloy 2024-T4 or T351.
2/ Nut thickness is equal to dimension "H" minimum of MS33537.

* Table V. Vibration Requirements

Thread Size Fine or Coarse	Across Flats	Nut Thickness	Assembly Torque Pound-inches
0.190	0.437	0.285	30
0.250	0.500	0.375	60
0.3125	0.562	0.469	120
0.375	0.688	0.562	160
0.4375	0.750	0.656	200
0.500	0.875	0.750	300

* 4.4.5.1.1 The inserts shall be considered to have failed the vibration test under any of the following conditions:

a. Any structural failure occurs during vibration, such as a break or crack.

b. After vibration, the relative rotation between any insert-nut assembly and the bolt exceeds 360°.

c. The prevailing or breakaway torques exceed the maximum or fall below the minimum specified values.

d. Any insert-nut assembly comes completely off the bolt during vibration.

e. Any insert turns out of the nut upon removal of the bolt.

4.4.6 Preservation, packaging, packing, and marking. Preparation for delivery shall be inspected for conformance to section 5.

5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging, packing, and marking. Preservation, packaging, packing, and marking shall conform to PPP-H-1581, packaging standards, or packaging data sheets.

6. NOTES

6.1 Intended use. The inserts covered by this specification are intended for use in original design application, especially in soft materials, to provide protection against thread failures caused by stripping, fatigue, wear, corrosion, and seizing. They are also intended for use in the repair of damaged or worn threads not originally protected. The class 2 insert which has prevailing torque capabilities provides protection to the joint against loosening caused by vibration and impact loading, thus obviating the use of lockwashers, lock wires, or other means of locking.

6.2 Ordering data. Procurement documents should specify the following:

a. Title, number, and date of this specification

b. Part number in accordance with the applicable MS standard, drawing, or other descriptive document (see 3.2).

c. Type class, nominal length, thread size, and series (see 1.2)

d. Applicable levels of preservation, packaging, and packing (see 5.1)

e. Identification of product (see 3.6)

f. Package quantities, if other than standard.

*6.3 Design and isntallation guidance

6.3.1 Insert lengths. Type I and type II inserts are available in five standard lengths, 1, 1-1/2, 2, 2-1/2 and 3 times the nominal thread diameter. For specific sizes and part numbers see 2.1.

6.3.2 Installation. Inserts are installed in accordance with the dimensional requirements contained in MS33537.

6.3.3 Insert length selection. The standard engineering practice of balancing the tensile strength of the bolt material against the shear strength of the parent or boss material applies to helical coil inserts. Table VI will aid the designer in developing the full load value of the bolt rather than stripping the parent or tapped material.

In using this table these factors must be considered:

6.3.3.1 Actual bolt tensile strength, particularly in the lower bolt tensile ranges may be significantly higher than the nominal values. This should be considered in insert length selection.

6.3.3.2 The parent material shear strengths are for room temperature. Elevated temperatures call for significant shear value reductions; compensation should be made when required. Shear values are appropriate because the parent material is subject to shearing stress at the major diameter of the tapped threads.

6.3.3.3 When parent material shear strength falls between two tabulated values, use the lower of the two.

6.3.3.4 Bolt thread length, overall length, insert length, and full tapped thread depth must be adequate to insure full thread engagement when assembled in order to comply with its design function. Refer to MS33537.

6.4 Tools. Tools for inserting and extracting helical coil wire screw thread inserts are covered by MIL-T-21309.

Table VI. Length of Thread Engagement in Bolt Nominal Diameters

Shear Strength of Material (psi) (Alum., Mag., Steel)	Bolt Material Minimum Ultimate Tensile Strength (psi)								
	54,000	75,000	96,000	108,000	125,000	132,000	160,000	180,000	220,000
10,000	2	2-1/2	3	3	-	-	-	-	-
15,000	1-1/2	1-1/2	2	2-1/2	2-1/2	3	3	-	-
20,000	1	1-1/2	1-1/2	2	2	2	2-1/2	3	3
25,000	1	1	1-1/2	1-1/2	1-1/2	2	2	2-1/2	2-1/2
30,000	1	1	1	1-1/2	1-1/2	1-1/2	2	2	2-1/2
40,000	1	1	1	1	1	1-1/2	1-1/2	1-1/2	2
50,000	1	1	1	1	1	1	1	1-1/2	1-1/2

6.5 The margins of this specification are marked with an asterisk to indicate where changes (additions, modifications, corrections, deletions) 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.

Custodians:
Army - AV
Navy - AS
Air Force - 11

Review activities:
Army - AV, WC, MI, MU
Navy - AS
Air Force - 82
DSA - IS

User activities:
Army - EL, ME, AT, GL
Navy - SH

Preparing activities:
Air Force - 11

Project No. 5340-0991

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

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