SAE Aerospace
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AEROSPACE STANDARD

SAE AS13572

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Springs, Helical, Compression and Extension

RATIONALE

This document has been reaffirmed to comply with the SAE 5-year Review policy.

NOTICE

This document has been taken directly from U.S. Military Specification MIL-S-13572C, Amendment 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-S-13572C, Amendment 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.

Under Department of Defense policies and procedures, any qualification requirements and associated qualified products lists are mandatory for DOD contracts. Any requirement relating to qualified products lists (QPL's) has not been adopted by SAE and is not part of this SAE technical document.

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1. SCOPE:

1.1 Scope:

This specification covers helical compression and extension springs, made from single wire or rod of either round or special cross-section (see 6.4).

1.2 Classification:

The springs shall be of the following types and grades (see 6.2).

1.2.1 Types:

Type I - Compression
Type II - Extension

Grades

Grade A - Highly stressed or critical applications (recoil springs and other special applications) (see 6.1).

Grade B - General applications (see 6.1).

2. APPLICABLE DOCUMENTS:

2.1 Government Documents:

2.1.1 Specifications and standards: The following specifications and standards form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto cited in the solicitation.

SPEFICICATIONS

FEDERAL

QQ-P-416 - Plating, Cadmium (Electrodeposited)

PPP-B-566 - Boxes, Folding, Paperboard

PPP-B-591 - Boxes, Fiberboard, Wood-Cleated

PPP-B-601 - Boxes, Wood, Cleated Plywood

PPP-B-621 - Box, Wood, Nailed and Lock-cornered

2.1.1 (Continued):

PPP-B-636 - Box, Shipping, Fiberboard

PPP-B-640 - Boxes, Fiberboard, Corrugated, Triple-Wall

PPP-B-676 - Boxes, Set-Up

PPP-T-76 - Tape, Pressure Sensitive Adhesive, packaging (For Carton Sealing)

MILITARY

MIL-P-116 - Preservation, Methods of

MIL-P-117 - Bags, Sleeve and Tubing-Interior Packaging

MIL-C-16173 - Corrosion Preventive Compound, Solvent Cutback, Cold Application

MIL-S-13165 - Shot Peening of Metal Parts

DOD-P-16232 - Phosphate Coatings, Heavy, Manganese or Zinc Base (For Ferrous Metals)

MIL-STD-1190 - Minimum Guidelines For Level C Preservation, Packing & Marking

MIL-STD-29 - Spring, mechanical, Drawing Requirements For

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes

MIL-STD-129 - Marking for Shipment and Storage

MIL-STD-147 - Palletized Unit Loads

MIL-STD-1186 - Cushioning, Anchoring, Bracing, Blocking, and Waterproofing with Appropriate Test Methods

MIL-STD-1189 - Standard Department of Defense Bar Code Symbology

MIL-STD-1949 - Inspection, Magnetic Particle

MIL-STD-6866 - Inspection, Penetrant Method of

(Copies of specifications, standards, drawings and publications required by contractors in connection with specific acquisition functions should be obtained from the contracting 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 specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the DoDISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS shall be the issue of the nongovernment documents which is current on the date of the solicitation.

ASTM

A380 - Cleaning and Descaling Stainless Steel Parts, Equipment and Systems

B633 - Electrodeposited Coatings of Zinc on Iron and Steel

D3951 - Commercial Packaging, Practice for

(Application for copies should be addressed to ASTM, 1916 Race Street, Philadelphia, Pennsylvania 19103)

2.3 Order of precedence:

In the event of a conflict between the test of this specification and the references cited herein (except for MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS:

3.1 Material:

Material shall be as specified on the spring drawing or the applicable Military Standards (MS) (see 6.3) and shall be selected from the specification list in 6.4 as applicable. When material is not covered by a Government specification or an approved non-Government document, the contractor shall furnish a certificate of chemical analysis and mechanical properties for the proposed material (see 4.4.1).

3.1.1 Decarburization in Springs: Unless otherwise specified, prior to being wound material for Grade A spring shall be centerless ground to remove all surface decarburization and produce a true circular cross section. When magnified to 100 diameters there shall be no free ferrite visible. When specified (see 6.2), springs which are heat treated after coiling shall conform to the following depths of decarburization:

TABLE 1-1. Maximum Decarburization in Grade A Springs [1]

	Hot Wound	Cold Wound
Complete[2]	0.000 in. (No complete Decarburization)	0.000 in. (No complete Decarburization)
Partial[3]	0.005 in.	1% Wire Diameter, not to exceed 0.0015 in.

1 Measurements are made from the spring surface

2 Complete Decarburization - loss of carbon content at the surface of a steel specimen to a level below the solubility limit of carbon in ferrite so that only ferrite is present.

3 Partial Decarburization - loss of carbon content at the surface of a steel specimen to a level less than the bulk carbon content of the unaffected interior but greater than the room temperature solubility limit of carbon in ferrite."

3.1.2 Heat treatment: Unless otherwise specified on the drawing, heat treating methods may be determined by the manufacturer. Hot-wound, grade A springs that are coiled at a temperature above 1700 degrees Fahrenheit (F) shall be cooled in air to a distinct black heat, or below the transformation temperature, before they receive further heat treatment.

3.1.3 Stress relief: Unless otherwise specified (see 6.2), cold-wound springs just formed shall be given a suitable stress relief treatment conforming to 3.1.3.1 through 3.1.3.4. The specific time and temperature shall be determined by the manufacturer from the range of times and temperatures listed. The temperature used will normally be the maximum which will leave the original hardness of the wire essentially unchanged.

3.1.3.1 Alloy steel springs: Thermally treat for 20-60 minutes at 500-800 degrees F.

3.1.3.2 Carbon steel springs: Thermally treat for 20-60 minutes at 450-750 degrees F.

3.1.3.3 Copper-base alloy springs: Thermally treat for 20-60 minutes at 250-400 degrees F.

3.1.3.4 Corrosion-resistant steel springs: Thermally treat for 20-60 minutes at 450-900 degrees F.

3.2 Shot peening:

When specified (see 6.2), open-wound springs shall be shot peened in accordance with MIL-S-13165.

3.3 Dimensions and design:

Dimensions, tolerances, direction of helix, and construction of ends shall be as specified on the applicable drawing or the applicable MS (see 6.3) or by using MIL-STD-29.

3.3.1 Squared and ground ends: Unless otherwise specified on the drawing or (MS), squared and ground ends of compressions springs shall have a bearing surface not less than three-quarters of the mean circumference of the spring for grade A springs, and two-thirds for grade B springs. The ends shall be squared by closing down the end coil and subsequently grinding to obtain the bearing surface; or by one of the following methods followed by closing down the end coil and subsequently grinding:

a. By tapering both sides of the material to the shape of a wedge having a developed length equal to the bearing surface of the spring end. The width of the wedge tip shall be not less than three quarters, or more than the original diameter of the material.

b. By tapering uniformly on the side away from the adjoining coil for a developed length equal to the bearing surface of the spring.

The thickness of the tip of the end coil after grinding shall not exceed one-half of the original diameter of the material. Unless otherwise specified, the thickness of the tip shall not be reduced to less than one-eighth of the wire diameter. The sides and corners of the tip shall be broken with all sharp edges removed.

3.4 Protective finishes:

3.4.1 Passivation: All helical springs manufactured from corrosion resistant steel shall be cleaned, descaled and passivated in accordance with ASTM A380.

3.4.2 Grade A springs: Unless otherwise specified, steel springs shall be supplementary coated with a corrosion preventive compound conforming to MIL-C-16173 Grade 3 (P-3), or when specified on the drawing, phosphate coated in accordance with DOD-P-16232, Type M or Z, Class 1.

3.4.3 Grade B springs: Unless otherwise specified, carbon or alloy steel springs shall be cadmium plated in accordance with QQ-P-416, Type II, Class 2 or zinc coated in accordance with ASTM B633, Service Condition 3, Type II, except that the embrittlement relief requirements shall be in accordance with 3.4.4. When specified on the drawing, Type M or Z, class 1, phosphate coating per DOD-P-16232, and treated with corrosion preventive compound conforming to MIL-C-16173 Grade 3 (P-3), shall be used.

3.4.4 Embrittlement relief: Within 30 minutes after plating, cadmium or zinc plated springs, having a tensile strength greater than 210,000 psi, or a hardness greater than 45HRC, shall be baked for 23 hours at 375 ± 25 degrees F. Steel springs having tensile strength of 210,000 psi or less, or hardness of 45HRC or less shall be baked for three hours at 375 ± 25 degrees F. Phosphate coated springs shall be treated in accordance with DOD-P-16232.

3.5 Performance and product characteristics:

3.5.1 Pitch: The pitch of the active coils shall be as specified on the drawing or MS Standard. Unless otherwise specified on the drawing or standard, end coils of compression springs with square and ground ends shall decrease uniformly from full pitch to a pitch of one wire diameter.

3.5.1.1 Uniformity: The pitch of the active coils of springs shall be sufficiently uniform so that when compressed, unsupported laterally to a length equal to 80 percent of deflection calculated in accordance with Figure 1, paragraph 4.4.5, none of the active coils shall be in contact. When the design of the spring is such that it cannot be compressed without support, this requirement shall be waived.

3.5.2 Load: The springs shall support the required load at the lengths specified on the drawing or MS Standard. Unless otherwise specified on the drawing or standard, set shall be removed before testing (see 4.4.4.1).

3.5.3 Spring rate: When given as a functional requirement the spring rate calculated in accordance with 4.4.5 shall be within the limits specified on the drawing or standard.

3.5.4 Initial tension: Unless otherwise specified, close-wound extension springs that are coiled cold, with no subsequent heat treatment, shall support not less than five percent of the load required to extend the spring 75 percent of total theoretical deflection, as initial tension. (Total theoretical deflection is defined as that calculated load which, if exceeded, will cause the spring to take a set.)

3.5.5 Squareness of ends: Unless otherwise specified on the drawing or standard, squared and ground ends shall be square with the spring axis within one and one-half degrees for Grade A springs, and three degrees for Grade B springs.

3.5.6 Solid height: The solid height of a helical compression spring shall be the perpendicular distance between the plates of the testing machine, when the spring is compressed with a test load to bring all coils in contact. In no case shall this test load exceed by more than 50 percent the load beyond which no appreciable deflection takes place, nor shall the test load be held for any appreciable length of time.

3.6 Cracks, seams and laps:

Springs having any cracks, seams or laps shall not be acceptable (see 4.4.7).

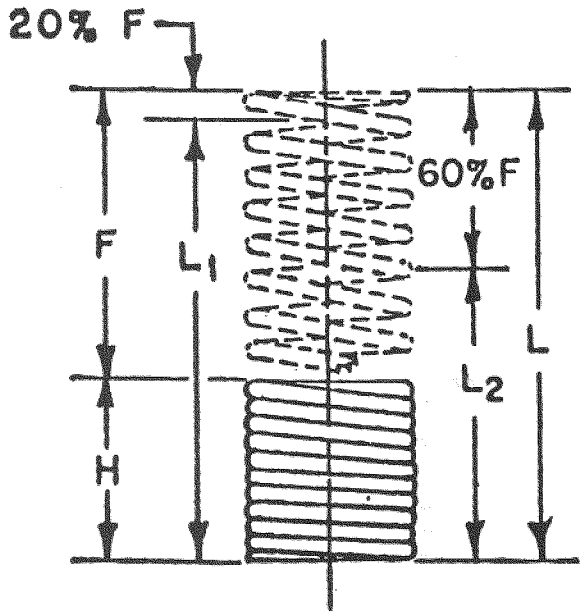

FIGURE 1. Compression springs

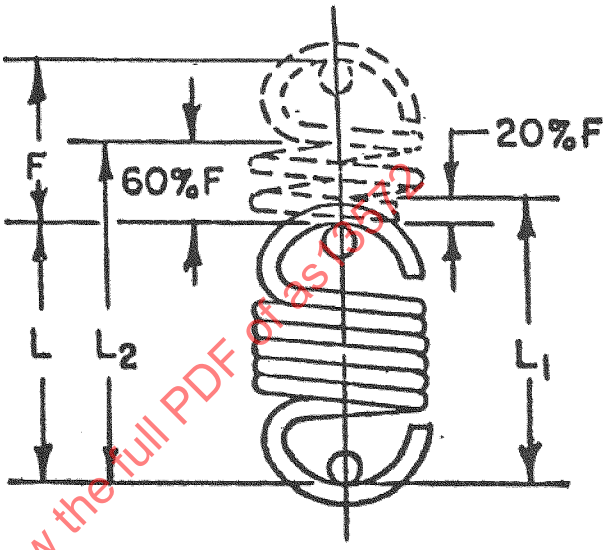

FIGURE 2. Extension springs

L = Free length
H = Solid height
F = Theoretical total deflection

Test dimensions

L_1 = First test length
L_2 = Second test length

3.7 Identification:

A metal tag of sufficient size to be legible, bearing the following information, shall be firmly attached to each spring shipped individually, or to at least one spring in each container for springs shipped in quantity.

CAGE Code (Commercial and Government Entity Code).

Piece mark (when specified on the drawing).

Purchase order number.

National stock number

When a serial number applies, each individual spring shall be tagged and the number shall be shown in addition to the above. When approved by the contracting officer, this information may be stamped or etched on the spring, at a place not detrimental to its serviceability. Springs individually marked by stamping or etching shall be sub-lotted by the heat treat batch.

3.8 Workmanship:

Workmanship shall be such as to produce springs, free from grit, scale, sharp edges, fins, burrs, nicks or other defects that would impair the usefulness of these springs. Protective coatings shall be applied to properly prepared surfaces in a uniform manner.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for inspection:

Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor 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 prescribed requirements.

4.1.1 Responsibility for compliance: All items must meet all requirements of Sections 3 and 5. The inspections set forth in the specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility for assuring that all supplies and services submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorized submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

4.2 Sampling:

4.2.1 Inspection lots: Unless otherwise specified in the contract or order, a lot shall consist of all springs of one type, grade, size and protective coatings, produced from material of the same composition and presented for inspection at one time.

4.2.2 Sampling for examination: A random sample of springs shall be taken from each lot in accordance with MIL-STD-105, Inspection level II. The acceptable quality level (AQL) shall be as specified in TABLE I.

4.2.3 Sampling for protective finish test: Sampling for test of protective finish shall be in accordance with the applicable specification shown in 3.4 or as specified on the drawing or standard.

4.2.4 Sampling for performance tests: A random sample of springs shall be taken from each lot in accordance with MIL-STD-105, inspection level S-3, with an AQL of 0.065% defective for Grade A springs, and an AQL of 1.5% defective for Grade B springs. These AQL levels shall apply to tests of load, spring rate and initial tension, in accordance with 4.4.4 through 4.4.6.

4.2.5 Sampling for packaging and packing: Sampling for preservation, packaging and packing shall be in accordance with the applicable inspection levels of MIL-STD-105, as specified in MIL-P-116.

4.2.6 Sampling for test of cracks, seams and laps: Samples for Grade A springs shall be taken from each lot in accordance with MIL-STD-105, Inspection level S3, with an AQL of .065% defective. When testing of Grade B springs is specified, samples of Grade B springs shall be taken from each lot in accordance with MIL-STD-105, Inspection Level S-3, with an AQL of 1.5% defective.

4.3 Examination:

Each spring taken as specified in 4.2.2 shall be examined to verify compliance with this specification. Examination shall be conducted in accordance with TABLE I.

TABLE I. Classification of Defects

Categories	Defects	Inspection Method
Critical	None defined	
Major	AQL = 0.065% defective for Grade A springs	
	AQL = 1.5% defective for Grade B springs	
101	Outside diameter -incorrect (3.3)	CIE 1/
102	Inside diameter -incorrect (3.3)	CIE
103	Wire diameter -incorrect (3.3)	CIE
104	Free length -not as specified (3.3)	CIE
105	Solid height - for compression springs (3.5.6)	CIE
106	End construction-incorrect (3.3, 3.3.1, 3.3.5)	CIE
107	Direction of helix - not as specified (3.3)	Visual
108	Pitch -incorrect, or not uniform, (3.5.1, 3.5.1.1)	CIE
109	Protective finish (3.4) -absence or discontinuity	Visual
Minor	AQL = 0.25% defective for Grade A springs	
	AQL = 2.5% defective for Grade B springs	
201	Identification -incorrect or missing (3.7)	Visual
202	Workmanship - (3.8)	Visual

1/ Commercial Inspection Equipment

4.4 Tests:

4.4.1 Material and processes: Materials and processes shall be tested in accordance with the applicable specifications or requirements referenced on the drawing and this specification. When the contractor's certification of chemical analysis or certification of tests is available, they will be accepted for the following:

4.4.1.1 Materials: Certification that the materials used conform to the requirements of 3.1.

4.4.1.2 Heat treatment: Certification that the heat treatment used conforms to the requirements of 3.1.2.

4.4.1.3 Stress relief: Certification that the stress relief methods used conforms to requirement of 3.1.3.

4.4.1.4 Shot peening: Certification that the peening conforms with the requirements of 3.2.

4.4.1.5 Embrittlement relief: Certification that the method used for embrittlement relief conforms with that specified in 3.4.4.

4.4.2 Decarburization: When centerless ground material grade A springs are required (see 3.1.1), one spring from each sample of springs, or two representative samples each 12 inches in length of the spring material that have been heat treated (samples of hot wound spring material have been heated prior to heat treatment) at the same time as the sample springs shall be examined for compliance with 3.1.1 by the following method: Samples of the material shall be cross sectioned, mounted in plastic, polished and etched with nitric acid and alcohol. In grade A springs, using a magnification of 100 diameters no free ferrite shall be visible. Failure to pass this test shall be cause for rejection of the lot represented by the sample.

4.4.3 Protective finish test: Test of protective finishes shall be conducted in accordance with the applicable specifications specified in 3.4 or as specified on the drawing or standard.

4.4.4 Load test: Springs shall be tested for required loads at the lengths specified on the drawing or standard. Testing equipment shall be capable of meeting commercial standards of accuracy. Readings shall be taken as the spring is being loaded. Unless otherwise specified, set shall be removed in accordance with 4.4.4.1 before load testing. Removal of set before load testing may be certified as such upon certification by the manufacturer that this operation was performed during manufacture.

4.4.4.1 Procedure for removing set: Unless otherwise specified on the drawing or standard, springs shall be compressed solid and released, (a maximum of 30 cycles is allowed to determine compliance), until the total decrease in free length for any five consecutive cycles shall not exceed 0.002 inch per inch of free length for Grade A springs or shall not exceed 0.006 inch per inch of free length for Grade B springs. Failure to accomplish this shall be cause for rejection.

4.4.5 Spring rate: When specified, the spring rate shall be tested (see 3.5.3) at 20 and 60 percent of the total theoretical deflection, by establishing two test lengths in accordance with Figures 1 or 2 as applicable and recording the load at these lengths. The spring rate shall be determined by dividing the difference between these loads (in pounds) by the difference (in inches) between the test lengths.

4.4.6 Initial tension: Initial tension as determined by the method described below shall be equal to the load specified on the drawing or standard or to the load determined in 3.5.4, whichever is applicable.

a. Record the load required to deflect the spring by any deflection.

b. Record the load required to deflect the spring by twice the deflection used in (a).

c. Initial tensions will then be equal to twice the first load, minus the second load.

4.4.7 Cracks seams and laps: Springs taken as specified in 4.2.6 shall be tested for cracks, seams, and laps (see 3.6). Magnetic particle inspections shall be made on Grade A sample springs of ferrous material, using the continuous method in accordance with MIL-STD-1949. Non-magnetic springs shall be penetrant inspected when specified in accordance with MIL-STD-6866. Grade B springs shall be tested when specified on the drawing.

4.4.8 Examination and tests for packaging and packing: Examination and tests for cleaning, preservation, packaging, and packing for military procurement shall be in accordance with MIL-P-116.

5. PACKING:

5.1 Cleaning, drying, and preservation:

5.1.1 Cleaning: Prior to preservation, springs requiring a preservative shall be cleaned in accordance with process C-1 and dried in accordance with MIL-P-116.

5.1.2 Preservation: Application of a preservative is required only for alloy and carbon steel springs which do not have a permanent type coating such as paint, epoxy and platings, but including phosphate or black oxide. Unless otherwise specified, springs not exceeding three inches each in length or one pound each in weight shall receive an application of P-3 preservative of MIL-P-116. Unless otherwise specified, springs exceeding three inches each in length or one pound each in weight shall receive an application of P-1 or P-19 preservative specified in MIL-P-116.