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MILITARY SPECIFICATION

SPRINGS, TORSION-BAR, SUSPENSION

This specification is approved by Army Tank-Automotive Command, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers straight, solid, circular cross-section, torsion-bar springs.

2. APPLICABLE DOCUMENTS

2.1 Issues of documents. 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

TT-C-490	- Cleaning Methods and Pretreatment of Ferrous Surfaces for Organic Coatings.
TT-P-636	- Primer Coating, Alkyds Wood and Ferrous Metal.
TT-P-1757	- Primer Coating, Zinc Chromate, Low-Moisture-Sensitivity.

* Military

MIL-I-6866	- Inspection, Penetrant Method of.
MIL-M-11472	- Magnetic-Particle Inspection; Process, for Ferromagnetic Materials.
MIL-S-13165	- Shot Peening of Metal Parts.
MIL-I-15126	- Insulation Tape, Electrical, Pressure Sensitive Adhesive and Pressure Sensitive Thermosetting Adhesive.

FSC-2530

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: U.S. Army Tank-Automotive Materiel Readiness Command by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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

DRAWINGS
Inspection Equipment
K-8668989 - Supplementary Quality Assurance Provisions (SQAP's).

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

* 3.1 Preproduction sample(s). Prior to the manufacture of torsion bar springs in quantities a preproduction sample(s) shall be submitted for examination and tests specified herein (see 4.4.11.3), to determine conformance to requirements of this specification. The bars submitted shall be fully representative of the bars proposed to be furnished under the production contract.

3.2 Workmanship and endurance. The workmanship shall be of a quality to assure that the torsion bars are free from any defects that compromise, limit, or reduce the bar capabilities herein expressed resulting from improper manufacturing practices. Torsion bars made in accordance with this specification shall be subjected to examinations and tests to prove torsion bar capabilities to meet endurance requirements.

* 3.2.1 Endurance life. Springs shall have an endurance life of not less than 45,000 cycles (see 4.4.11). Unless otherwise specified, each cycle shall be such that it imposes a deflection range from five (5) to one hundred (100) percent of the maximum wind up angle.

3.3 Material. Material shall be free from pipes, flakes, and heat checks and shall not contain any other defects which, due to their nature, degree, or extent, may effect suitability of the material for the intended use.

3.3.1 Continuous lengths. Material used for the torsion bar springs shall be of one continuous piece as cut from the full length bar as rolled.

* 3.3.2 Chemical composition. The chemical composition of the material shall provide the hardenability specified herein or on the applicable drawing. Where the material is steel, the phosphorous and sulfur content shall be limited to a maximum of 0.040 percent each.

* 3.3.3 Hardenability. The material shall have sufficient hardenability at half radius of finished bar body to obtain the minimum hardness as specified herein or on applicable drawing. Unless otherwise specified, when the material is steel, the hardenability shall be such as to obtain an

as-quench minimum hardness of Rockwell C55 at the half-radius of the finished bar body when processed in accordance with the torsion bar manufacturers actual production procedure

* 3.4 Construction. The spring construction shall conform to the requirements specified on applicable drawings.

3.5 Processing.

3.5.1 Forming. Ends of springs shall be formed by upsetting to provide a continuous, uniform grain flow that conforms to the blend surfaces of the finished spring. Grain flow shall not terminate into blend radii. The serrated ends shall be either cold formed, hobbed or form ground.

* 3.5.2 Heat treatment. The treatment selected shall be capable of meeting the hardness specified herein or on applicable drawing. Unless otherwise specified, when the material is steel, the springs shall be quenched and tempered to a hardness of Rockwell C47-51 from the half radius to the outside of the finished bar body. The hardness may be as low as Rockwell C45 from the half radius to the center, provided that the total spread of hardness in any one cross section shall not exceed five (5) points Rockwell C. Microscopic examination of polished and/or etched cross section of springs shall verify absence of abnormal surface condition that may result from heat treatment. Decarburization and retained austenite, as determined by microscopic examination at a magnification of 250 diameters shall not be permissible on steel springs.

3.5.2.1 Reprocessing. The torsion bar springs represented by the bar failing to meet endurance requirements may be reheat treated providing the material and dimensional requirements specified herein are complied with. The bars shall be reprocessed in accordance with the process used in production (see 6.2). Reprocessed bars shall be from an identifiable heat. Under no circumstance shall any bars from another heat of steel previously rejected be reprocessed and resubmitted as part of any other heat.

3.5.3 Straightening. All straightening operations after final heat treating shall be performed with the spring held at a temperature of not less than 600°F.

* 3.5.4 Surface indications and discontinuities. Springs shall show no evidence of circumferential or longitudinal indications of cracks or heavy seams except that light longitudinal indications less than four (4) inches in length, which can be completely polished and blended with surface by the removal of 0.010 inch or less material are permissible.

* 3.5.5 Shot peening. Springs shall be shot peened in accordance with MIL-S-13165 to a minimum peening intensity of 0.010C for the body and 0.007C for the serrations and to a minimum visual surface coverage of one hundred (100) percent. Diameter of shot used on body shall be 0.035 to 0.064 inch and on the serrations 0.017 to 0.033 inch. Body and serrations may be peened

simultaneously with a mixture of 60 percent 0.035 to 0.064 inch diameter shot and 40 percent 0.017 to 0.033 inch diameter shot provided the required peening intensity and dimensional requirement shall be maintained.

* 3.5.6 Presetting. Unless otherwise specified, the spring shall be preset by holding one end and twisting and releasing the other end a minimum of 3 times. The degree of twist for the spring shall be as shown on the applicable drawing.

3.6 Protective coating.

3.6.1 Cleaning. Prior to application of any coating, the spring shall be cleaned in accordance with method II, of Specification TT-C-490.

* 3.6.2 Priming. The spring body shall be primed with primer coating conforming to Specification TT-P-636 or TT-P-1757.

* 3.6.3 Tape covering. Body of the spring shall be covered with tape conforming to type EF-9 or MIL-I-15126. Tape shall be 1 1/4 to 3 inches wide and shall be spirally wound with a 50 percent overlap. Free ends shall have an additional winding to prevent peelback.

3.6.4 Serration protection. Springs not intended to be immediately packaged shall be suitably protected from transportation and handling damage.

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 specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Contractor quality control system. Unless otherwise specified by the procuring activity, the contractor shall provide and maintain an effective Inspection and Quality Control System acceptable to the Government covering the supplies under contract. A current written description of the system shall be submitted to the contracting officer prior to initiation of production. The contractor will not be restricted to the inspection station or to the method of inspection listed provided that an equivalent limitation is included in the approved quality control procedure. The contractor shall notify the Government and obtain approval for any change to the written procedure that might affect the degree of control required by this specification or other applicable documents referenced therein.

4.1.2 Government verification. All quality assurance operations performed by the contractor will be subject to Government verification at unscheduled intervals. Verification will consist of (a) surveillance of the operations to determine that practices, methods, and procedures of the of the written inspection plan are being properly applied, and (b) Government product inspection to measure quality of product offered for acceptance. Deviation from the prescribed or agreed-upon procedures, or instances of poor practices which might have an effect upon the quality of the product, will be immediately called to the attention of the contractor. Failure of the contractor to promptly correct deficiencies discovered shall be cause for suspension of acceptance until corrective action has been made or until conformance of product to prescribed criteria has been demonstrated.

4.2 Preproduction test. Unless otherwise specified (see 6.1), a minimum of 3 torsion bar springs of the material to be furnished shall be selected for preproduction testing (see 4.4.11.3). Preproduction inspection and testing shall be conducted by the contractor under Government surveillance at the place approved by the Government.

4.2.1 Failure. Failure of the samples to pass the inspection and testing shall be cause for refusal of the Government to conduct retest until corrective measures satisfactory to the Government have been taken.

4.3 Production inspection.

4.3.1 Lot by lot inspection. Lot by lot inspection shall be performed by the contractor in accordance with the following procedures.

4.3.2 Inspection lot formation. Unless otherwise specified, a lot shall consist of any quantity of springs of the same size, from the same heat produced by one manufacturer, under essentially the same conditions.

4.3.3 Sampling inspection.

4.3.3.1 Visual and dimensional inspection. Sampling shall be in accordance with MIL-STD-105. The classification of characteristics and acceptable quality level (AQL) shall be as specified in tables I and II.

4.3.3.2 Classification of characteristics.

Table I. Classification of defects.

Categories	Major AQL 1.5 Percent Defective	Method of Inspection
Critical	None defined	
100. Hardness		Hardness tester
101. Major diameter serrations	See 4.3.3.3	See 4.3.3.3
102. Minor diameter serrations	See 4.3.3.3	See 4.3.3.3
103. Minimum diameter tooth thickness	See 4.3.3.3	See 4.3.3.3
104. (a) Tooth profile error (b) Lead error (c) Comulative tooth spacing error (d) Out of roundness (e) True involute form diameter	See 4.3.3.3	See 4.3.3.3
105. Depth and location of removed tooth (both ends)	See 4.3.3.3	See 4.3.3.3
106. Parallelism of serrations with centerline of bar	See 4.3.3.3	See 4.3.3.3
107. Location of (2) in-line teeth	See 4.3.3.3	See 4.3.3.3
108. Body diameter		SIE
109. Blend radii (both ends)		SIE
110. Nicks, scratches, tool marks	……..	Visual
111. Shot peening intensity	……..	Visual Almen strip
112. Priming	……..	Visual
113. Protective tape omitted	……..	Visual

Table II. Classification of defects.

Categories	Minor AQL 4.0 Percent Defective	Method of Inspection
200. Length of teeth	……	SIE
201. Chamfer (both ends)	……	SIE
202. Overall length	……	SIE
203. Threads requirements	……	Go thread plug Gage, not go thread plug gage
204. Removed tooth mark (both ends)	……	Visual
205. Incomplete coverage	……	Visual
206. Printing incomplete	……	Visual
207. Damaged	……	Visual

* 4.3.3.3 Inspection equipment. The inspection equipment for various characteristics specified in 4.3.3.2 are referenced in the method of Inspection on the representative Supplementary Quality Assurance Provisions (SQAP's) developed for each of the torsion bars tabulated on K8668989 spring torsion bar suspension or other applicable drawings.

4.4 Inspection procedure.

4.4.1 Material check. To determine conformance to 3.3 and 3.3.1, prior to processing the torsion bar springs the material shall be checked for specified defects and lengths.

4.4.2 Chemical composition and hardenability check. Unless otherwise specified chemical analysis shall be performed to determine conformance to 3.3.2 and 3.3.3.

4.4.3 Forming check. To determine conformance to 3.5.1, the formed ends shall be checked for proper lengths, diameter, and radius. After the serrations have been completed a dimensional check shall be made of the serrations.

4.4.4 Heat treatment test. To determine conformance to 3.5.2 and 3.5.2.1, the torsion bar springs shall be checked for Rockwell C hardness and the procedure shall be observed for conformance.

4.4.5 Straightening operations check. To determine conformance to 3.5.3, the straightening operation shall be checked for proper temperature.

* 4.4.6 Surface indications and discontinuities check. To determine conformance to 3.5.4, the torsion bar springs shall be checked for discontinuities in accordance with Specification MIL-M-11472, 100 percent. If springs are fabricated from non-magnetic material, they shall be inspected by the dye penetrant method of MIL-I-6866, or by an approved alternate method.

4.4.7 Spot peening check. To determine conformance to 3.5.5, the shot peening operation shall be observed for proper shot size intensity and control.

4.4.8 Presetting check. To determine conformance to 3.5.6, the presetting operation shall be observed for proper application of procedure.

4.4.9 Cleaning, priming, and tape covering check. To determine conformance to 3.6.1, 3.6.2, and 3.6.3, each torsion bar spring shall be checked for proper cleaning, priming and tape covering.

4.4.10 Serration protection check. To determine conformance to 3.6.4, all serrated ends shall be checked for proper protection.

* 4.4.11 Control tests. Control tests for maintaining control of these requirements where inspection would be of the long durations to be included under acceptance tests shall be conducted by the contractor as specified herein.

4.4.11.1 Frequency. For this test, one sample from the first produced of each size shall be selected from each identifiable heat, and subjected to endurance test (see 4.4.11.3).

4.4.11.2 Test failure. If a torsion bar spring fails to pass any control test specified herein, this shall be cause for retest of two. Failure of either of the springs to pass the test shall be cause for the Government Inspector to stop acceptance of subsequent springs until evidence has been provided by the contractor that corrective action has been taken.

* 4.4.11.3 Endurance test. To determine conformance to 3.2.1, the angular deflection required shall be as shown on the applicable drawing. The test shall be continuous, constant load test with automatic or manual compensation for set after 5,000 cycles and every 5,000 cycles thereafter. The total angle of set during test for particular spring shall not exceed that specified on the drawings. Rate of loading shall be between ten (10) and one hundred (100) cycles per minute and the temperature shall not exceed 250°F. Anchors used in the testing machine shall be of the same serration configuration and hardness of those specified for use in operation of the vehicle.

4.5 Inspection of preparation for delivery.

4.5.1 Materials and processing. The Government inspection shall be unscheduled intervals, inspect all materials and processes involved in the preparation for delivery to determine conformance to the requirements of Section 5 and specifications referenced therein. Any evidence of deviation from specified requirements shall be cause for refusal to conduct further inspection until objective evidence has been provided by the contractor that corrective action has been taken.

5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging, packing and marking. Preservation and packaging for shipment and storage shall conform to the requirements of the packaging sheets (see 6.1).

6. NOTES

* 6.1 Ordering data. Procurement documents should specify the following:

(a) Title, number, and date of this specification.
(b) Number of samples required for preproduction testing (see 4.2).
(c) Levels of packaging and packing is required (see 5.1).

6.2 Recommended processing. The responsibility of furnishing spring to finished dimensions within tolerances shown on drawings, and that will conform to requirements of section 3 rests with the contractor. The means and methods of executing the work will therefore be determined by the contractor. In this connection, it is called to the contractor's attention that processing of springs in steps as indicated below has resulted in acceptable springs.

(a) Upset ends.
(b) Cycle anneal (Brinell hardness 207-262).
(c) Straighten hot (from step b).
(d) Clean (abrasive blast).
(e) Center.
(f) Face ends.
(g) Drill and tap holes.
(h) Finish all surfaces of spring to drawing tolerances.
(i) Cold form, hob or form grind splines.

NOTE: If splines are hobbed, the operation may be performed after step "m".

(j) Heat treat as follows (see step n):

(1) Heat in a controlled atmosphere furnace, neutral salt both or by electric means to control decarburization and quench in oil held at 110° to 117°F.
(2) Temper immediately before cooling to room temperature to hardness specified in 3.5.2 (800°F., minimum).

(k) Straighten hot off tempering heat (see 3.5.3). (No straightening to be done below 600°F.).
(l) After final heat treatment and before forming serrations, check final hardness on surface of upset diameter.

(m) Magnetic inspections:

(1) Magnetize spring between terminal posts and apply indicating solution while magnetizing current is flowing.
(2) Demagnetize.
(3) Electric etch or stamp letter "M" on outer end of acceptable springs.

(n) Shot peen.

NOTE: Step "r" may be performed simultaneously with stem "n" if splines have been made in step "i".

(o) Pre-set (see 3.5.6).
(p) Machine one serration from each end as per drawing; machined area shall then be peened as specified in 3.5.5.
(q) Mark, in a permanent manner, indexing notch on trailing end.
(r) Shot peen serrations (see step "n").
(s) When necessary, demagnetize to remove any residual magnetism remaining from pre-setting or shot peening.
(t) Clean (see 3.6.1).
(u) Prime (3.6.1).
(v) Tape (see 3.6.3).

* 6.2.1 Recommended means of assessment of effectiveness of shot peening. Surface residual stress measurements have proven to be an excellent means of determining the effectiveness of shot peening intensity and coverage. It has been found that average compressive residual stress for a correctly processed steel bar will be in the range of 45,000 to 60,000 psi and the standard deviation (one sigma) of the reading will be less than or equal to 8,000 psi. A minimum of two hundred (200) readings are generally taken utilizing an automated residual stress instrument. Readings are taken randomly from one (1) by one (1) inch square grids that have been superimposed longitudinally and radially on the spring surface.

* 6.3 Changes from previous issue. 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.

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