MIL-STD- 1867(AT)
13 January 1983

MILITARY STANDARD

SHAFTS, STEEL, SAE 5140, 5145, and 5150
HEAT TREATMENT OF

NO INFORMATION REQUIREMENTS

FSC 9510

Department of Defense
Washington, D.C. 20301

Shafts, Steel, SAE 5140, 5145, and 5150,
Heat Treatment of.

MIL-STD-1867(AT)

1. This Military Standard is approved for use by U.S. Army Tank-Automotive Command, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: US Army Tank-Automotive Command, ATTN: DRSTA-GSS, Warren, MI 48090, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FOREWORD

This standard establishes requirements and procedures for heat treatment of shafts produced from SAE 5140, 5145, and 5150 steel.

1. SCOPE

1.1 Scope. This standard establishes processes for heat treatment of shafts made from SAE 5140, 5145, and 5150 steel.

1.2 Classification. The heat treatment processes covered by this standard for shafts produced from SAE 5140, 5145 and 5150 steel shall be classified as follows:

1.2.1 Method I - Induction hardening and tempering (see 5.1.1).

1.2.2 Method II - Hardening and tempering (see 5.1.4).

1.2.3 Method III - Hardening, tempering and induction hardening (see 5.1.7).

2. REFERENCED 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 standard to the extent specified herein.

SPECIFICATIONS
MILITARY

MIL-I-6868	- Inspection Process, Magnetic Particle.
MIL-S-12515	- Surface Hardening: Flame Induction (for Ferrous Alloys).

(Copies of specification, standards, drawings, and publications required by contractors in accordance with specific acquisition functions should be obtained from the acquiring activity or as directed by the contracting officer.)

3. DEFINITIONS (Not applicable).

4. GENERAL REQUIREMENTS

4.1 Processing procedures. Processing procedures for heat treatment of individual types of shafts shall meet all requirements of the applicable drawing, and this standard.

4.1.1 Approved procedures. Shaft processing procedures shall not be changed unless the proposed procedure has been submitted to, and accepted by the Government. A revised processing procedure shall include a sample shaft specimen submitted to the Government for acceptance or approval after heat treatment.

4.2 Conditioning heat treatments. Annealing and normalization are conditioning heat treatments required for shafts made from hot rolled bar stock and forgings. Purpose of treatments is to provide structural uniformity, minimum distortion, and to promote consistent response to subsequent shaft heat treatments.

4.2.1 Hot rolled annealed bar stock. Shafts made from hot rolled annealed bar stock are to be processed in accordance with method I (see 5.1.1). Unless otherwise specified on the applicable shaft drawing, bar stock shall be in the hot rolled annealed condition having a minimum hardness of BHN217.

4.2.2 Normalization. Forged shafts shall be normalized as specified on the applicable shaft drawing or as a processing requirement.

4.3 Hardness. An applicable shaft drawing shall indicate final hardness of a shaft. Shafts requiring only hardening and tempering (see method II 5.1.4) shall have their hardness determined on the base material following the removal of superficial surface or case. Shaft surface hardness shall be equal or greater than the core hardness.

4.3.1 Surface hardness. Surface hardness of an induction hardened area on a shaft shall be referenced in the drawing requirements of the applicable shaft drawing. If numerical hardness values are not specified, a minimum hardness shall be determined in accordance with MIL-S-12515.

4.3.2 Depth of hardening. Induction hardened areas on a shaft shall have a depth of hardening determined by measuring the width of a discolored band on a ground and etched cross section of the shaft.

Depth of hardening requirement shall be specified on the applicable shaft drawing. When hardening depth is not specified, measurement shall be in accordance with MIL-S-12515.

4.4 Surface defects. Hardened shafts shall be free of cracks, excessive scaling, blisters, or other defects. Shafts may be subjected to magnetic particle inspection in accordance with MIL-I-6868 for location of defects prior to Government approval of the shaft hardening process.

4.4.1 Warpage. A shaft hardening process shall not cause warpage or dimensional deviation from an applicable shaft drawing. Straightening or other corrective measures for elimination of these defects shall not be permitted without approval of the Government.

4.5 Recycled, virgin and reclaimed materials. The use of recycled materials which meet the requirements of the applicable item or part without jeopardizing the intended use shall be encouraged.

5. DETAILED REQUIREMENTS

5.1 Hardening and tempering treatments.

5.1.1 Method I (see 1.2.1).

5.1.2 Induction hardening. Bar stock in a heat treat condition as specified in 4.2.1 shall be heated in the areas indicated by the drawing to approximately 1550 degrees Fahrenheit (°F) using an appropriate induction heating facility, and to a depth necessary to meet drawing requirements. The shaft shall be quenched in an appropriate circulating oil maintained at a temperature of 110-140°F. Shafts shall remain in the quench medium until their temperature reaches 200°F or less.

5.1.3 Tempering. Heat shafts in a circulating air furnace for not less than two hours at a temperature required to produce a case hardness of R_c 50-56 or as specified on the shaft drawing. Cool in air. Case depth shall be in accordance with drawing requirements.

5.1.4 Method II (see 1.2.2 and 4.3).

5.1.5 Hardening. Heat to a temperature within the range of 1500-1550 $\pm$ 25°F depending upon length, diameter, and chemistry of shafts being treated. Use controlled atmosphere at a potential in equilibrium with 0.9 percent carbon and hold at temperature for one to one and one-half hours. Quench in an appropriate circulating oil maintained at a temperature of 110-400°F depending upon length, diameter and chemistry of the shafts being quenched. Shafts shall remain in the quench medium until their temperature reaches that of the medium unless the quench is maintained at temperature less than 200°F. In the latter event, shafts may be removed from the quench medium when they reach a temperature of 200°F or less. Cool in air. When specified, shafts may be die quenched in an appropriate quench oil.

5.1.6 Tempering. Heat shafts in a circulating air furnace for not less than two hours at a temperature producing the hardness specified on the shaft drawing.

5.1.7 Method III (see 1.2.3).

5.1.8 Hardening and tempering. Shafts made from bar stock or forgings, and in a heat treat condition as specified in 4.2 shall be hardened in accordance with 5.1.5 and tempered in accordance with 5.1.6.

5.1.9 Induction hardening. Induction harden areas indicated on the shaft drawing in accordance with 5.1.2.

5.1.10 Tempering. Heat shafts in a circulating air furnace to a minimum of 300°F for one hour minimum per inch of thickness of the largest section, and then cool in air. Resulting hardness shall be R_C 58 minimum, or as specified on the shaft drawing.

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