

MIL-S-12515C  
31 August 1983  

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SUPERSEDING  
MIL-S-12515B(MR)  
20 April 1972

MILITARY SPECIFICATION

SURFACE HARDENING: FLAME AND INDUCTION  
(FOR FERROUS ALLOYS)

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 surface hardening of ferrous alloys by gas flame or electromagnetic induction heating followed by a quenching or relatively rapid cooling operation (see 6.1 and 3.3 and 3.5).

1.2 Classification. Surface hardening shall be classified according to the following heating methods:

Method I - Flame hardening  
Method II - Induction hardening

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. Unless otherwise specified, the following specifications, standards, and handbooks of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this specification to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-I-6868 - Inspection Process, Magnetic Particle

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Director, US Army Materials and Mechanics Research Center, ATTN: DRXMP-SMS, Watertown, MA 02172 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

NO DELIVERABLE DATA REQUIRED BY THIS DOCUMENT

/ AREA MFFP /

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STANDARDS

FEDERAL

Fed. Test Method Std. No. 151 - Metals; Test Methods

MILITARY

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

(Copies of specifications, standards, handbooks, drawings, and publications required by manufacturers 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. The issues of the documents which are indicated as DoD adopted shall be the issue listed in the current DoDISS and the supplement thereto, if applicable.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 10 - Brinell Hardness of Metallic Materials, Test for

ASTM E 18 - Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials, Tests for

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

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

3.1 Preproduction. Unless otherwise specified in the invitation for bids, contract or order, prior to the surface hardening of any parts, the contractor shall submit sample parts or approved control specimens processed by the procedure to be used in production (see 6.2). A processing procedure for each individual part shall be prepared including the factors shown in table I for the applicable method of processing. The submitted procedures shall be considered acceptable if the sample parts or control specimens meet all the requirements of the drawing and this specification.

3.2 Procedural changes. Unless otherwise specified by the procuring activity any major change in any one of the procedure factors listed in table I, without the approval of the procuring activity, shall require a resubmittal of sample parts reflecting the new processing procedure as well as a record of the new processing procedure.

3.3 Surface Preparation. Surfaces to be hardened shall be clean and free of any decarburization to assure proper response to the surface hardening operation.

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Table I. Procedure factors

Factor	Method I	Method II
a	Size, weight, shape of part	Same
b	Composition of material	Same
c	Condition, mechanical properties previous heat treatment (see 3.3 and 3.5)	Same
d	Required hardness range	Same
e	Required depth of hardness	Same
f	Method of supporting and holding or clamping part	Same
g	Method of moving part or flame	Method of moving work or induction head (heating coil)
h	Fuel gas used	Induction frequency (c.p.s of heating current)
i	Pressures and regulator and gauge settings	Energy requirement (k.v.a)
j	Type(s) and size(s) of heating tip(s)	Induction head (heating coil) design
k	Flame characteristics and flame inner-cone-to-work distance	Distance between induction head(s) and work (flux air gap)
l	Rate of travel of heating tip(s) or work	Rate of travel of work or induction head(s)
m	Quenching method and medium	Same
n	Coolant temperature, volume, tem- perature control arrangement (if any)	Same
o	Gas (fuel) and oxygen consumption per part or per unit of surface treated	Energy (k.w.h) requirement per part or per unit of surface treated

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Factor	Method I	Method II
p	Heating time required per part surface hardened	Same
q	Time between end of heating cycle and start of quenching cycle	Same
r	Temperature and time of stress relieving	Same
s	Design of work Holding Fixture	Same

3.4 Hardness. The parts shall meet the hardness requirements of the applicable drawing after the surface hardening operation. If hardness values are not specified, the minimum hardness number shall be, after tempering, (72HRA or 43HRC).

3.4.1 Depth of hardening. The depth of hardening is the "effective case depth". Unless otherwise specified, the hardness value to measure the effective case depth should be per the following table:

Table II.

Material Carbon Content (%)	Effective Case Depth Hardness (Rc)
0.28 to 0.32	35
0.33 to 0.42	40
0.43 to 0.52	45
0.53 and over	50

3.4.2 Area of hardening. When only localized areas are to be hardened, the areas shall be so designated on the applicable drawing by dimensionally indicating the basic area to be hardened as well as the allowable overlap.

3.4.3 Core hardness. Core hardness shall be as specified on the applicable drawing. Areas that are not surface hardened shall have a surface hardness equal to the core hardness requirement.

3.5 Prior heat treatment. All parts shall be properly heat treated to the specified core hardness prior to surface hardening.

3.6 Stress relief. Stress relief shall be as specified on the applicable drawings or as authorized by the procuring activity. However, if no stress relief is specified, all surface hardened parts shall, after hardening, be tempered at a minimum tempering temperature of 400°F. for at least one hour per each inch of part thickness. In order to avoid temper embrittlement, the contractor should exercise proper discretion in the selection of a tempering temperature for the steel involved.

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### 3.7 Workmanship.

3.7.1 Surface defects. Surface hardened parts shall be free of cracks, excessive scaling, blisters or other detrimental defects. Unless otherwise specified in the contract or purchase order, preproduction sample parts shall be subject to magnetic particle inspection for workmanship defects prior to approval of the surface hardening process.

3.7.2 Warpage. The surface hardening process shall cause no warpage or dimensional changes, not in conformance with the applicable drawings. Straightening or other corrective measures shall not be permitted unless approved by the procuring activity.

## 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.

4.2 Classification of inspection. The inspection requirements specified herein are classified as follows:

1. Preproduction inspection (see 4.3).
2. Acceptance inspection (see 4.7).

4.3 Preproduction inspection. Preproduction inspection, except as otherwise indicated in this specification, shall utilize the same requirements and test methods as the production acceptance inspection.

4.4 Lot for acceptance inspection. A lot shall consist of all parts of the same drawing or part number, surface hardened by the same process, and presented for inspection at one time.

### 4.5 Sampling.

4.5.1 Preproduction. The number of samples shall be specified by the procuring activity (see 6.2).

### 4.5.2 Acceptance.

4.5.2.1 Hardness. Unless otherwise specified by the procuring activity, sampling for hardness shall be Level II, MIL-STD-105. The Acceptable Quality Level (AQL) shall be 4.0 percent defective.

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4.5.2.2 Depth of hardening. Sampling for depth of hardening shall be as specified by the procuring activity (see 6.2).

4.6 Examination.

4.6.1 Visual. The samples shall be examined in accordance with the sampling procedures specified by the procuring activity for compliance with the surface requirements of 3.7.1 (see 6.2).

4.6.2 Warpage. The samples selected for visual examination in 4.5.1 shall also be measured for compliance with the warpage requirements of 3.7.2.

4.7 Tests.

4.7.1 Test specimens.

4.7.1.1 Hardness. Specimens shall be prepared in accordance with ASTM E 10 or E 18 as applicable.

4.7.1.2 Depth of hardening. The sample parts or control specimens shall be sectioned perpendicular to the hardened surface and the resulting cut face shall be metallographically polished.

4.7.2. Test procedure.

4.7.2.1 Hardness. Hardness tests shall be conducted in accordance with ASTM E 10 or E18 as applicable.

4.7.2.2 Depth of hardening. Depth of hardness shall be determined by etching the polished face and measuring by conducting a hardness traverse through the hardened zone perpendicular to the surface.

4.7.2.3 Magnetic particle inspection. Unless otherwise specified in the contract or purchase order, magnetic particle inspection in accordance with MIL-I-6868 shall be used to check preproduction samples for surface defects.

4.8 Rejection and retests.

4.8.1 Preproduction. The failure of preproduction samples to comply with any of the requirements of this specification shall be cause for rejection of the surface hardening process. Retesting shall not be conducted until it is shown, to the satisfaction of the procuring activity, that the process procedure has been corrected.

4.8.2 Acceptance. Unless otherwise specified in the contract or order, rejection and retest shall be conducted in accordance with the general section of Fed. Test Method Std. No. 151 (see 6.2).

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5. PACKAGING

5.1 Packaging requirements. Not applicable

6. NOTES

6.1 Intended use. The procedures covered in this specification are intended for use in surface hardening ferrous parts, such as, shafts, pinions, worms, bearing components, spur or bevel gears, etc.

6.2 Ordering data. Procurement documents should specify the following:

- (a) Title, number and date of this specification
- (b) Method of surface hardening, if only one method is allowable (see 1.2).
- (c) Number and destination of preproduction samples, if required (see 3.1 and 4.5.1).
- (d) Number of acceptance samples (see 4.5.2.1, 4.5.2.2, and 4.6.1).

Custodian:

Army - MR  
Navy - SH  
Air Force - 20

Preparing activity:

Army - MR

Project No. MFFP-0211

Review Activities:

Army - AT, AR

User activities:

Army - MI

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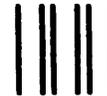
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