



AEROSPACE RECOMMENDED PRACTICE

ARP1820™**REV. C**

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Superseding ARP1820B

Chord Method of Evaluating Surface Microstructural Characteristics

RATIONALE

ARP1820C results from a Five-Year Review and update of this specification with rewritten Introduction and Scope to add clarity, disc surface texture changed from 32 to 18 as it was more desirable but that higher texture may be needed for smaller diameters (3.1), added ASTM E385 for determining Knoop microhardness and allowed for staggered indentations (3.5), changed hardness for Depth of Decarburization to be consistent with AMS2759 (3.6), added clarifying wording for Inadvertent Carburization and Nitriding (3.7.2), and Figures 2, 3, and 4 were replaced with more accurate figures.

INTRODUCTION

The chord method enables evaluation of microhardness and microstructures close (0.002 inch [0.051 mm] or less) to the surface of a disk specimen. It is useful for evaluating process control in heat treatment of steel parts, decarburization, excessive intergranular oxidation, and detecting inadvertent nitriding and carburization. It also may be used to evaluate platings and other surface, and near-surface, features.

The chord method enables the magnification of near-subsurface zones of a specimen by cutting across the zone of interest at an angle much greater than 90 degrees followed by metallurgical sample preparations and microstructural examination techniques.

The chord method utilizes an easy-to-fabricate specimen (a round disc or a sector thereof), mounted with the circumferential surface ready for grinding. The specimen is then ground and polished for evaluation, providing a chordal surface that intersects the circumferential surface at approximately 165 degrees and producing approximately 4X magnification. The support provided by the circumferential surface enables evaluation of the carburization and decarburization at a depth of 0.0005 inch (0.012 mm) or more, as it permits 500 gram load microhardness testing of hardened steel within 0.0005 inch (0.012 mm) of the intersection. The magnification also facilitates detection and measurement of other metallurgically significant near surface layers such as thin layers of total decarburization and intergranular oxidation.

1. SCOPE

This practice provides a method for evaluating microhardness and microstructure very close (0.002 inch (0.051 mm) or less) to the surface of a disk specimen. Specific accept/reject criteria for partial decarburization (3.7.1), inadvertent carburization/nitriding (3.7.3), total decarburization/intergranular oxidation (3.8), and other characteristics evaluated are to be found in the applicable specification where this ARP is referenced.

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2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9598, www.astm.org.

ASTM E384 Standard Test Method for Microindentation Hardness of Materials

3. PROCESS CONTROL AND QUALITY ASSURANCE PROVISIONS FOR HEAT TREATMENT OF STEEL PARTS

- 3.1 Fabricate disc or disc-sector specimens 1/8 to 1/4 inch (3 to 6 mm) thick, with a 1/4 to 1/2 inch (6 to 12 mm) radius, small central hole permissible, of the same alloy as the parts with texture of circumferential surface 18 μ in Ra (0.5 μ m) or finer. Note that for a small diameter, for example 0.5 inch (13 mm), higher surface finish may be necessary to assure accuracy of results.
- 3.2 Unless otherwise specified in the specification where the method is called out, heat treat specimens with parts but do not temper specimens made from carbon, low-alloy, and martensitic corrosion-resistant steels. If testing is conducted on a periodic basis, then appropriate quality assurance activities may be required on work run since the last prior successful test.

EXCEPTION: Temper specimens made from steels exhibiting secondary hardening characteristics, e.g., H-11.

- 3.3 Metallographically mount specimens so that circumferential surface is ready for grinding and polishing.
- 3.4 Grind and polish specimens to produce a magnification of 3 to 5X near the intersections (I) of the chordal and circumferential surfaces (see Figure 1). The magnification is D/c , where "D" is the disc diameter and "c" is the length of the chordal surface.
- 3.5 Determine Knoop microhardness, using 500 gram load, in accordance with ASTM E384 on a traverse from an intersection (I) at the mid thickness of the disk. Make the first impression 0.002 inch (0.052 mm) from the intersection "I". Parallel, staggered indentations may be used to obtain more accurate results with tighter spacing. Make subsequent impressions to produce a smooth curve when depth versus hardness is plotted (see Figure 1).
 - 3.5.1 Continue testing microhardness at increasing depths approximately 0.001 inch (0.025 mm) apart until there is no significant difference in microhardness at adjacent locations. The final microhardness reading shall be designated as the base hardness.
 - 3.5.1.1 It may not be possible to accurately measure the core hardness on the sample if the chord is shallow or if the sample is a thin disk. In that case, the chord can be ground further to obtain the core hardness, or the core hardness can be determined by a different technique such as the use of a transverse specimen.
- 3.6 Determine depth (d) beneath surface using Equation 1, the approximate formula of Equation 2, or nomographs like Figure 2, 3, or 4 (for measurements in inches).

$$d = r - \sqrt{r^2 - \Delta(c - \Delta)} \text{ or the approximate formula}$$

$$d = \frac{c\Delta - \Delta^2}{2r} \quad (\text{Eq. 1})$$

(Eq. 2)

where:

r = radius of disc

Δ = distance from intersection

c = length of chordal surface

3.7 Plot Hardness Versus Depth Curve

3.7.1 Depth of Partial Decarburization

The depth of partial decarburization is the depth, d , in thousandths of an inch or multiples of 0.025 mm, determined as in 3.5 and 3.6, at the location where the Knoop hardness is within 25 points (or equivalent) of the core Knoop hardness.

3.7.2 Inadvertent Carburization and Nitriding

The presence of inadvertent carburization and nitriding is determined as in 3.5 and 3.6 with the accept/reject criteria as specified in the applicable processing specification. Carburization and/or nitriding is indicated by Knoop hardness at 0.0005 inch (0.0127 mm) depth, or any other location, in excess of 25 Knoop hardness (or equivalent) of core.

3.8 Metallographically determine the presence of any complete (total) decarburization and the depth of any intergranular oxidation present on the circumferential surface. Use approximately 250X and appropriate etchant, as necessary.

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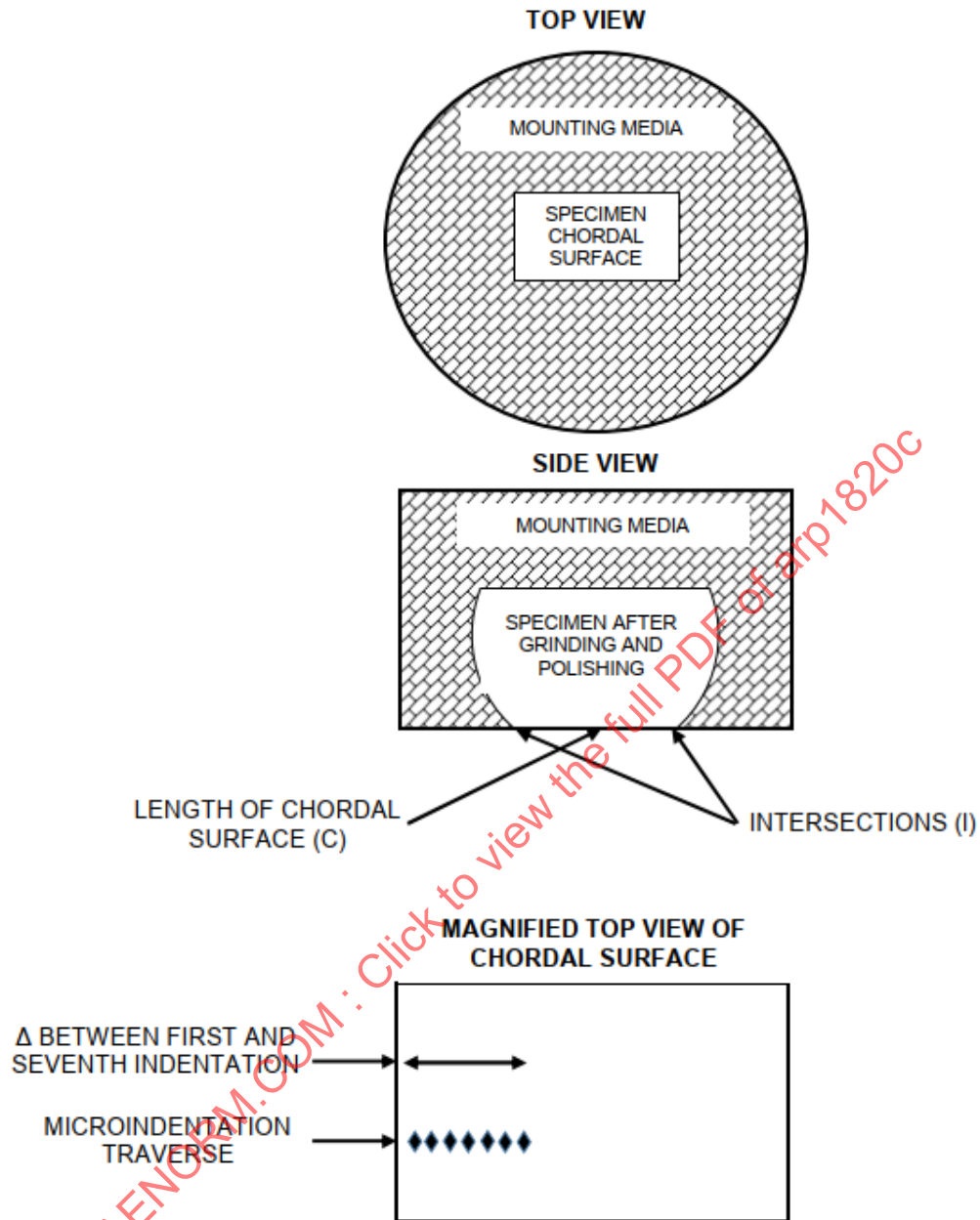


Figure 1 - Mounted and polished specimen

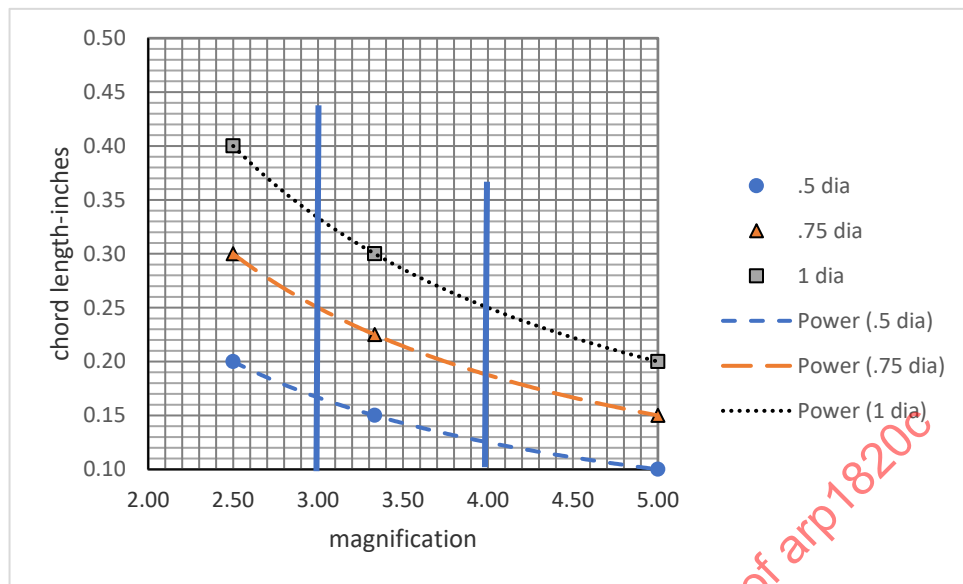


Figure 2 - Chordal length versus magnification for diameters

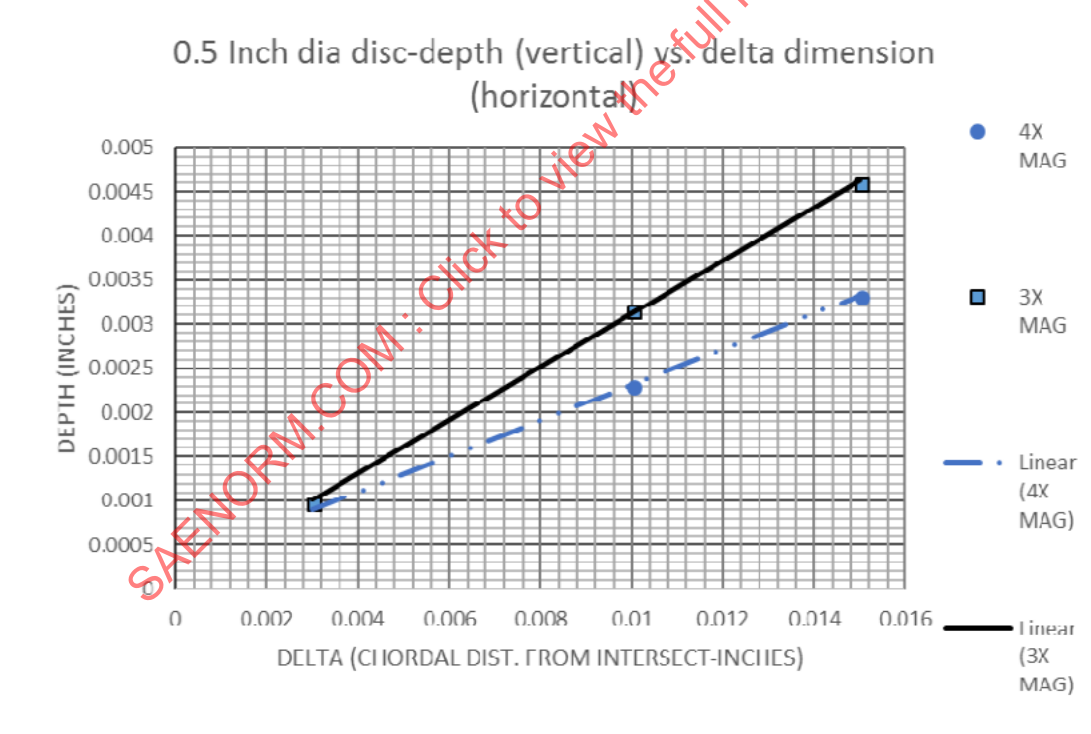


Figure 3 - Perpendicular depth below surface versus chordal length at selected magnification for a 0.5 inch diameter disc