SAE Aerospace
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AEROSPACE RECOMMENDED PRACTICE

SAE ARP1820 | REV. B

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Superseding ARP1820A

Chord Method of Evaluating Surface Microstructural Characteristics

RATIONALE

ARP1820B has been reaffirmed to comply with the SAE five-year review policy.

INTRODUCTION

The chord method is based on magnifying the near-subsurface zone of a specimen by cutting across the zone at an angle much greater than 90 degrees. It utilizes an easy-to-fabricate specimen, a round disc or a sector thereof, that is mounted with the circumferential surface ready for grinding. It is then ground and polished to provide, for evaluation, a chordal surface that intersects the circumferential surface at approximately 165 degrees, producing approximately 4X magnification. The support provided by the circumferential surface permits 500 g load microhardness testing of hardened steel within 0.0005 in (0.012 mm) of the intersection, and thus allows evaluation of the severity of carburization and decarburization at a depth of 0.00015 in (0.0038 mm) or more. The magnification also facilitates detection and measurement of thin layers of total decarburization and intergranular oxidation.

1. SCOPE

This practice provides a method of evaluating microhardness and microstructure very close to the surface of a disk specimen. It is useful for process control in heat treatment of steel parts to detect nitriding and carburization as well as decarburization and excessive intergranular oxidation. It also may be valuable for other evaluations, e.g., plated coatings and other materials.

2. REFERENCES

There are no referenced publications specified herein.

3. PROCESS CONTROL FOR HEAT TREATMENT OF STEEL PARTS

3.1 Fabricate disc or disc-sector specimens 1/8 to 1/4 in (3 to 6 mm) thick, with a 1/4 to 1/2 in (6 to 12 mm) radius, small central hole permissible, of the same alloy as the parts with texture of circumferential surface approximately 32 µin (0.8 µm) (see 4.4).

3.2 Heat treat specimens with parts but do not temper specimens made from carbon, low-alloy, and martensitic corrosion-resistant steels.

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

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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 g load, on a traverse from an intersection (I) at the mid thickness of the disk. Make the first impression 0.0005 in (0.012 mm), and the second 0.0005 in (0.012 mm) further from the intersection. Make subsequent impressions so as to produce a smooth curve when depth versus hardness is plotted.

3.5.1 Continue testing microhardness at increasing depths approximately 0.001 in (0.025 mm) apart until core hardness is determined, i.e., until there is no significant difference in microhardness at adjacent locations. Convert microhardness at 0.0003 in (0.008 mm) depth and at core microhardness from Knoop to HRC (see 3.7.2).

3.5.1.1 Inability to obtain core hardness, i.e., consistent microhardness, may be due to small disc diameter or short chord length. In such a case, grind the specimen further to lengthen the chord.

3.6 Determine depth (d) beneath surface using Equation 1, the approximate formula of Equation 2, or nomographs similar to Figure 2 (for measurements in inches) and Figure 3 (for measurements in millimeters).

$$d = r - \sqrt{r^2 - \Delta\,(c - \Delta)} \text{ or the approximate formula} \quad \text{(Eq. 1)}$$

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

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 20 points of the core Knoop hardness.

3.7.2 Severity of Partial Decarburization

The severity of partial decarburization is the difference between the HRC hardness (converted from Knoop) at 0.0003 in (0.008 mm) depth and that of the core.

3.7.3 Carburization and Nitriding

The presence is indicated by Knoop hardness at 0.0005 in (0.0127 mm) depth, or any other location, in excess of Knoop hardness of core.

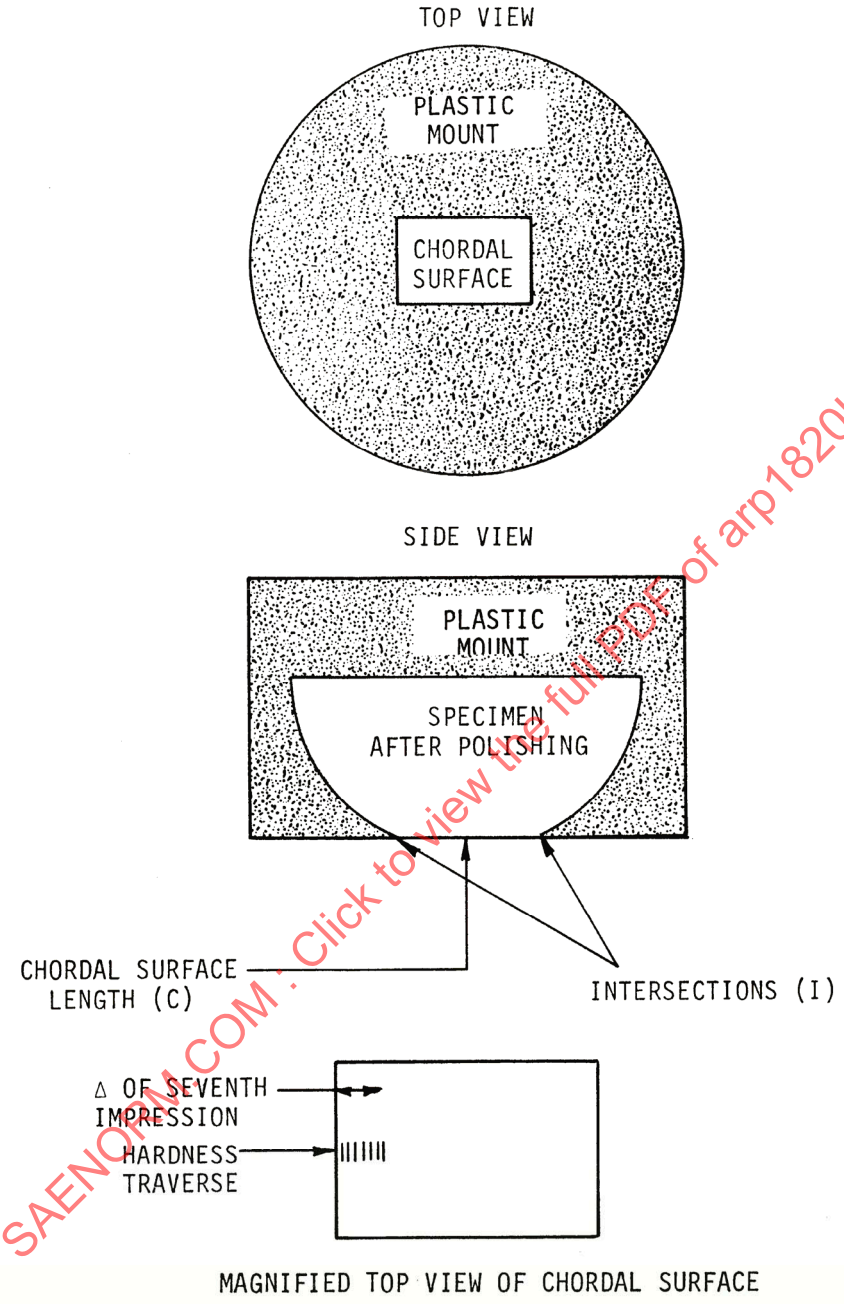

FIGURE 1 - MOUNTED AND POLISHED SPECIMEN

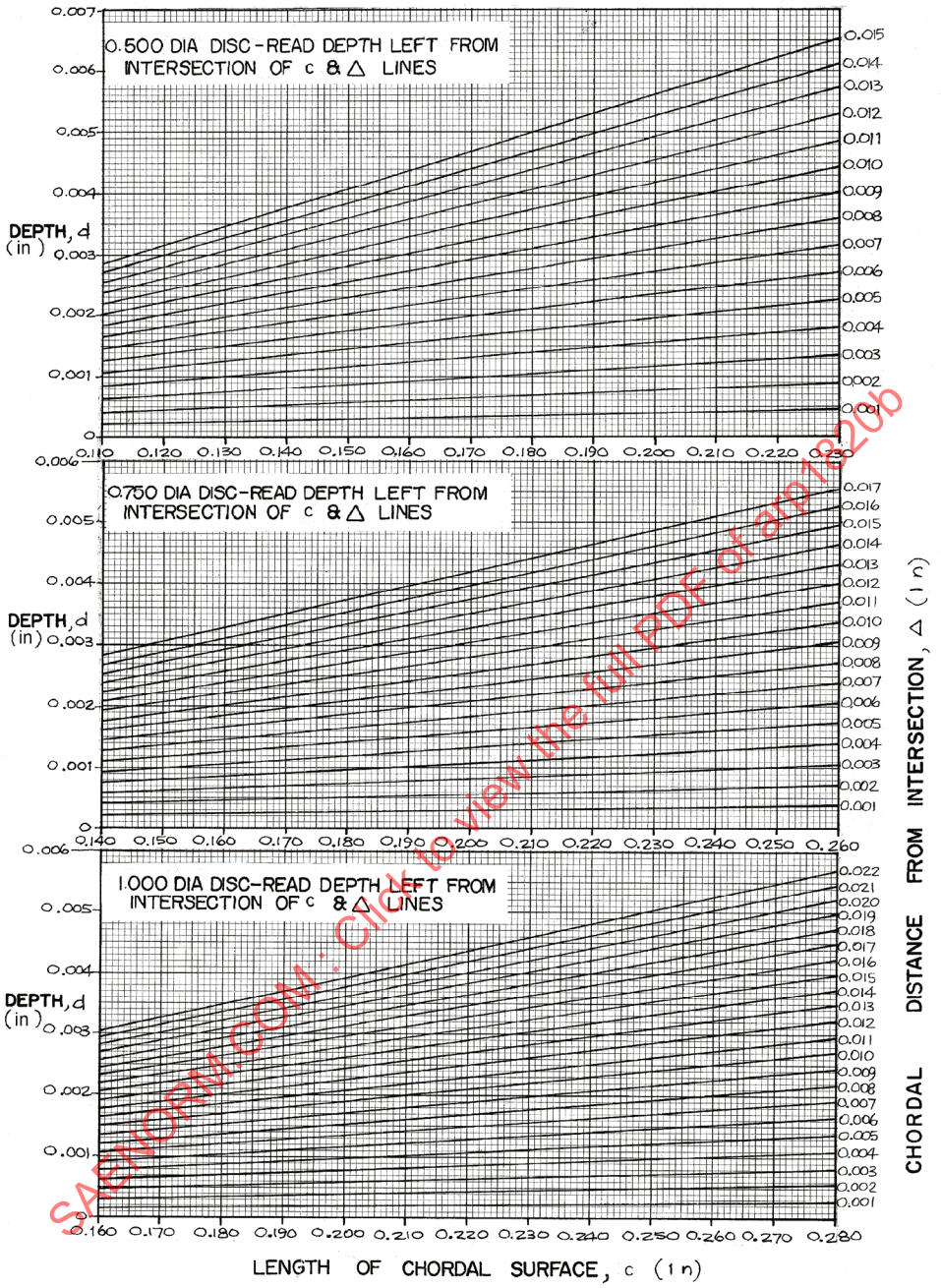

FIGURE 2 - CHORDAL LENGTH AND DISTANCE VERSUS DEPTH FOR 1/2, 3/4, AND 1 in DIAMETER DISCS