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SURFACE VEHICLE RECOMMENDED PRACTICE

An American National Standard

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MICROSCOPIC DETERMINATION OF INCLUSIONS IN STEELS

Foreword—This Document has not changed other than to put it into the new SAE Technical Standards Board Format.

1. ***Scope***—This recommended microscopic practice for evaluating the inclusion content in steel has been developed as a practical method of quantitatively determining the degree of cleanliness of steel. This method has been established as a reasonable control for steel mill operations and acceptance for production manufacturing. It has been widely accepted for carbon and alloy steel bars, billets, and slabs. Exceptions are resulfurized grades which are outside the limits of these photomicrographs and the high carbon bearing quality steels which are generally classified using ASTM E 45-60T, Method A, Jernkontoret Charts.

2. ***References***—There are no referenced publications specified herein.

3. ***Preparation of Samples***—This microscopic method is based on examination of specimens approximately 160 mm^2 (1/4 in^2) in area [10 x 19 mm (3/8 x 3/4 in)]. The exact dimensions are not of prime importance since the area examined represents an extremely small part of the bar, billet, or heat being evaluated. For bars 40 mm (1-1/2 in) and smaller, the face obtained by cutting from surface to center with the short dimension parallel to the rolling direction is polished and examined. If one-half the diameter is more than 25 mm (1 in), the specimen shall be taken midway between the outside and center. The manner of cutting a specimen from a 38 mm (1-1/2 in) round bar is shown in Fig. 1. A disk, 10 mm (3/8 in) in thickness should be sliced from the bar, the section indicated in Fig. 1 cut out of the disk and the shaded area polished parallel to the direction of rolling.

   Bars and billets over 100–150 mm (4–6 in) are normally forged to 100 mm (4 in) square before specimens are obtained from a midway position as described above for bars over 50 mm (2 in). This is illustrated in Fig. 2. The area that shall be polished is shown shaded and extends 10 mm (3/8 in) parallel to the length of the bar or billet and 19 mm (3/4 in) in the longitudinal center plane normal to the longitudinal axis, so that the polished face is midway between the outside and center of the bar or billet.

   It is generally desirable to facilitate polishing by hardening the specimen. Polishing may be done by any desired technique. One generally followed is:

   Step 1—Grind.

   Step 2—Rough polish, going successively from Nos. 240, 320, 400 grits and Nos. 0, 00, and 000 emery papers.

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Step 3—Fine polish, employing some medium such as alumina or other powders having a uniform particle size of 0.3 μm to less than 0.1 μm.

Step 4—Wash in hot water and follow by rinsing in alcohol.

Polishing scratches in the direction of rolling tends to confuse the appearance of the specimen. It is of utmost importance that the polished surface not be pitted or the inclusions distorted.

The entire polished surface of the prepared specimen is examined at 100 diameters. The examination may be made using the eyepiece or by projecting the field on a ground glass screen. In practice, visual observation of the prepared sample is often used to locate critical areas for microscopic examination.

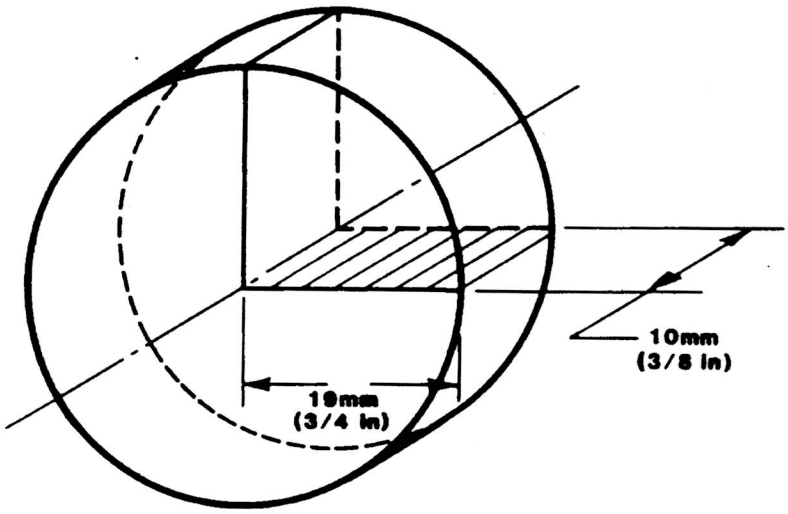


FIGURE 1—SPECIMEN FROM 33 mm (1-1/2 in) ROUND SECTION FOR MICROSCOPIC TEST

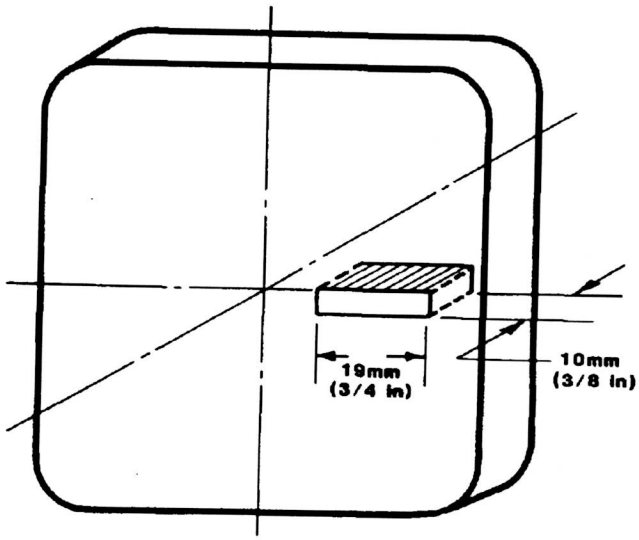
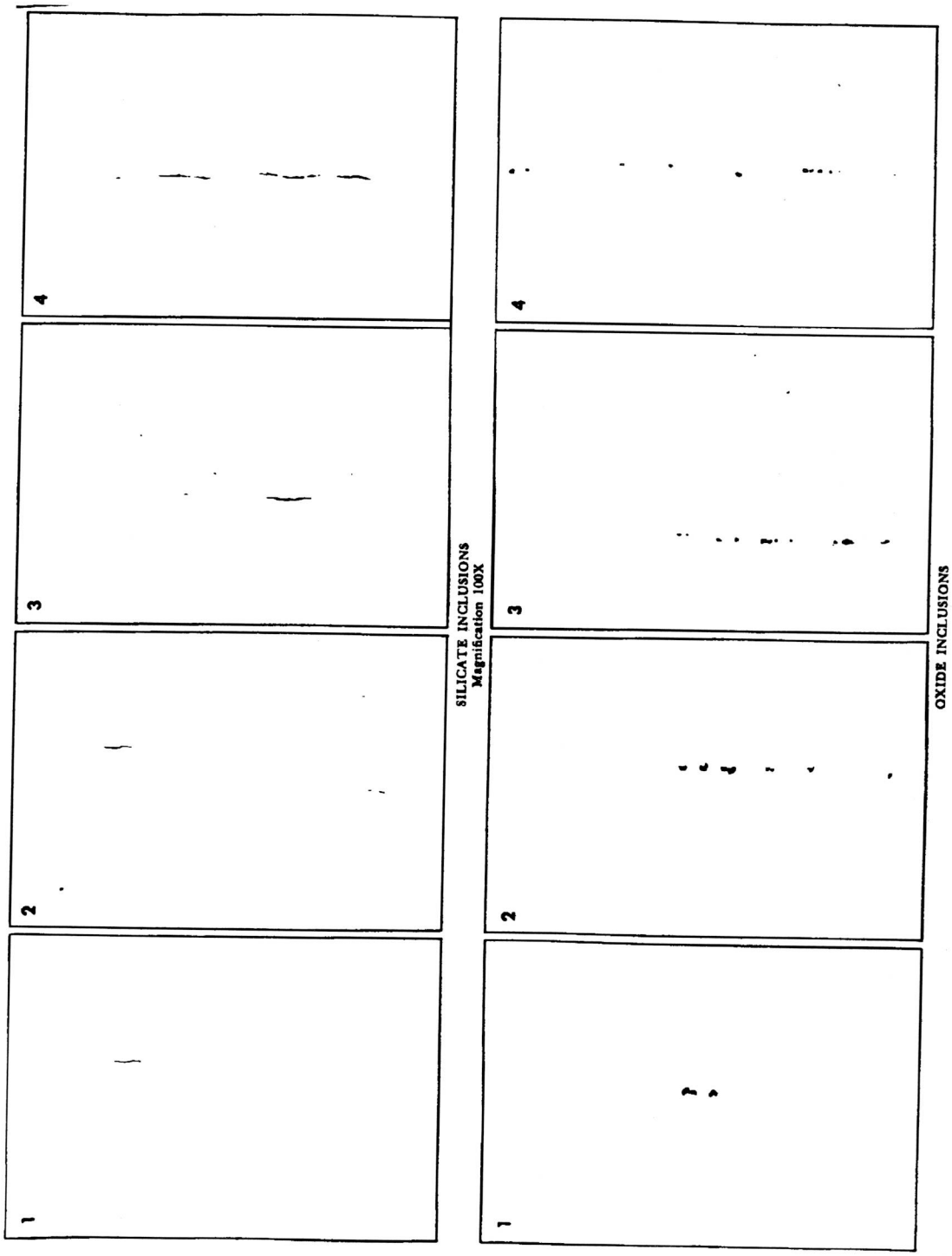


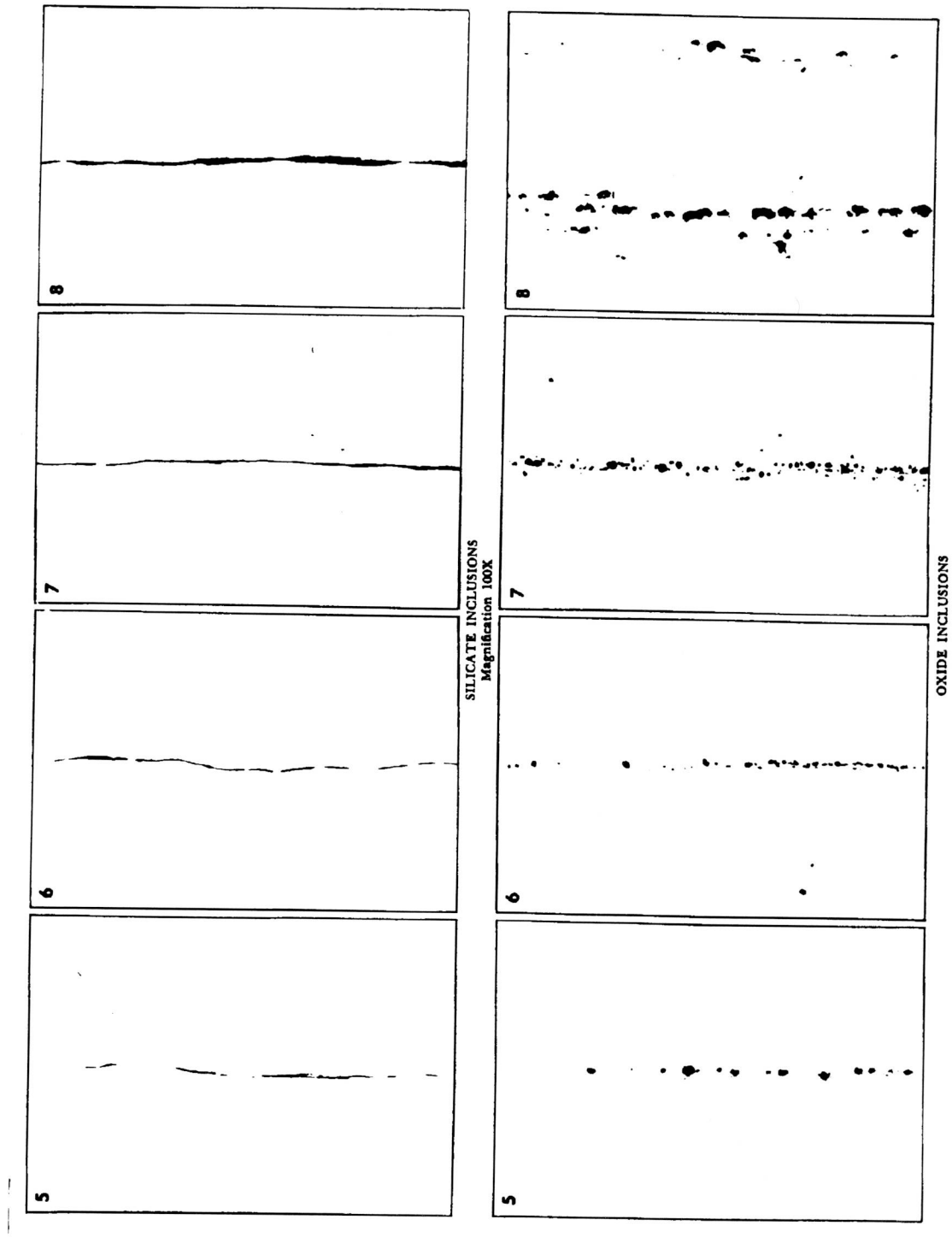
FIGURE 2—SPECIMEN FROM LARGE BAR OR BILLET FOR MICROSCOPIC TEST

4. ***Classification***—The inclusions observed are compared with the accompanying series of photomicrographs of oxides and silicates classified from 1 to 8 inclusive. The length of the field shown is represented as 1.1 mm (0.045 in), and the classification is based on length with consideration given to width in the photomicrographs over class 6. The maximum length of each type of inclusion oxide or silicate, is generally used to evaluate a specimen. The silicate photomicrographs are used for all slag or fluid type inclusions and the oxide photomicrographs for all oxide or hard type inclusions. For example, a specimen may be classified 5-0 (oxide) 4-S (silicate) to indicate that the longest oxide inclusion noted was comparable to photomicrograph 5 and the longest silicate inclusion noted was comparable to photomicrograph 4.

Modifications may be used such as suffix numerals to indicate the number of long inclusions noted or the exact length of a particular inclusion in thousandths of an inch when over the maximum length indicated by the photomicrographs.

In evaluating steel cleanliness it is important to recognize that the value obtained applies directly to that area being examined. For proper inclusion determination, adequate sampling is of prime importance. Inclusions vary from heat to heat, ingot to ingot, and in different portions of the same ingot product. The accompanying standard series of photomicrographs is designed for use in evaluating the severity of the most common types of inclusions and it should be recognized that they do not represent a complete metallographic study of steel cleanliness.





5. *Notes*

5.1 Marginal Indicia—The change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.

PREPARED BY THE SAE IRON AND STEEL TECHNICAL COMMITTEE

Rationale—Not applicable.

Relationship of SAE Standard to ISO Standard—Not applicable.

Application—This recommended microscopic practice for evaluating the inclusion content in steel has been developed as a practical method of quantitatively determining the degree of cleanliness of steel. This method has been established as a reasonable control for steel mill operations and acceptance for production manufacturing. It has been widely accepted for carbon and alloy steel bars, billets, and slabs. Exceptions are resulfurized grades which are outside the limits of these photomicrographs and the high carbon bearing quality steels which are generally classified using ASTM E 45-60T, Method A, Jernkontoret Charts.

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