INTERNATIONAL STANDARD 4967

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Steel — Determination of content of non-metallic inclusions — Micrographic method using standard diagrams

Aciers — Détermination de la teneur en inclusions non métalliques — Méthode micrographique à l'aide d'images types

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FOREWORD

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4967 was developed by Technical Committee ISO/TC 17, *Steel*, and was circulated to the member bodies in September 1976.

It has been approved by the member bodies of the following countries :

Australia	France	Philippines
Austria	India	Romania
Belgium	Iran	South Africa, Rep. of
Brazil	Ireland	Spain
Bulgaria	Italy	Sweden
Canada	Korea, Rep. of	United Kingdom
Chile	Mexico	USA
Czechoslovakia	Netherlands	USSR
Egypt, Arab Rep. of	New Zealand	Yugoslavia
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The member bodies of the following countries expressed disapproval of the document on technical grounds :

Germany, F.R.
Hungary
Switzerland

Printed in Switzerland

Steel — Determination of content of non-metallic inclusions — Micrographic method using standard diagrams

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies a micrographic method of determining the non-metallic inclusions in rolled or forged steel products, using standard diagrams. This method is widely used to assess the suitability of a steel for a given use. However, since it is difficult to achieve reproducible results owing to the influence of the test operator, even with a large number of samples, precautions should be taken when using the method.

2 PRINCIPLE

Non-metallic inclusions in rolled or forged steels are assessed by comparison with standard diagrams which form the Jernkontoret chart (or JK chart). These diagrams correspond to fields of view of 0,8 mm taken from a longitudinal section and observed with a magnification of 100 X. According to the shape and distribution of the inclusions, the standard diagrams are divided into four main groups, bearing the reference A, B, C and D. The method of designation is not based on the constitution of the inclusions, but on their morphology.

Group A : sulphide type

Group B : alumina type

Group C : silicate type

Group D : globular oxide type

Each main group on the JK chart consists of two sub-groups, each made up of five diagrams representing increasing contents of inclusions. This division into sub-groups is merely intended to give examples of different thicknesses of non-metallic particles.

The diagrams on the Jernkontoret chart are given in annex A. Plate 1 is taken from the Jerkontoret method and plate 2 from the American Society for Testing and Materials (ASTM) method. These two plates shall not be used simultaneously for the same examination.

These diagrams are numbered 1 to 5 in plate I and 0,5 to 2,5 in plate II, the numbers increasing with the surface area of inclusions; for example, the diagram A2 indicates that the shape of the inclusions observed under the microscope is in accordance with group A and that their distribution and quantity are in accordance with number 2.

This method has been selected for international standardization as being the most widely known using standard diagrams JK or ASTM. By agreement, other tables of standard diagrams (BS4 S100, Diergarten, PN 64 H 04510, Gost 1778-70, VDEh/Stahl-Eisen Prüfblatt 1570-71) may be used. In case of dispute only the method detailed in this International Standard (JK standard diagrams or ASTM standard diagrams) shall be used.

3 SAMPLING

The shape of the inclusion depends to a large extent on the degree of reduction of the steel; therefore, comparative measurements may only be carried out on prepared sections taken from similar samples.

The polished surface of the sample used to determine the content of inclusions shall be approximately 200 mm^2 (20 mm × 10 mm). It shall be parallel to the longitudinal axis of the product and shall be located halfway between the outer surface and the centre (see figure 1).

In the case of bars and billets with diameters of 40 mm or less, the method of sampling shall be subject to agreement between the parties. In the absence of an agreement, the sampling procedure shall be as follows :

— bar or billet with a diameter greater than 25 mm and less than or equal to 40 mm : the surface to be examined consists of half the diametral section (from the centre to the edge of the sample) (see figure 2);

— bar with a diameter less than or equal to 25 mm : the surface to examined consists of the full diametral section of sufficient length to obtain a surface of about 200 mm^2 (see figure 3).

The number of samples to be taken is defined in the product standard or by special agreement.

For any other product, the sampling procedures shall be subject to agreement between the parties.

4 PREPARATION OF SAMPLES

The sample shall be cut so as to obtain a surface for examination. In order to achieve a flat surface and to avoid rounding the edges of the sample when polishing, the sample may be held mechanically or may be mounted.

When polishing samples, it is important to avoid any tearing out or deformation of the inclusions, or contamination of the polished surface, so that the surface is as clean as possible and the shape of the inclusions is not affected. These precautions are of particular importance when the inclusions are small. It is advisable to use diamond paste for polishing. In certain cases it may be necessary for the sample to be heat treated before polishing in order to give it the maximum possible hardness.

5 DETERMINATION OF THE CONTENT OF INCLUSIONS

5.1 Method of observation

Examination under the microscope may be by one of two methods :

— either by projection onto a ground glass;

— or by observation by means of an eyepiece.

The method of observation chosen shall be maintained throughout the test.

For the first method, care must be taken to ensure that the magnification is 100 × and that the actual diameter of the field is 0,8 mm; the size of the image on the ground glass is thus 80 mm. This image is then compared with the JK chart.

For the second method, it is essential that the diameter of the field of view be 0,8 mm. Slight variations in the magnification are not important, since the assessment is only an estimate of the size of the inclusions in proportion to the field of view.

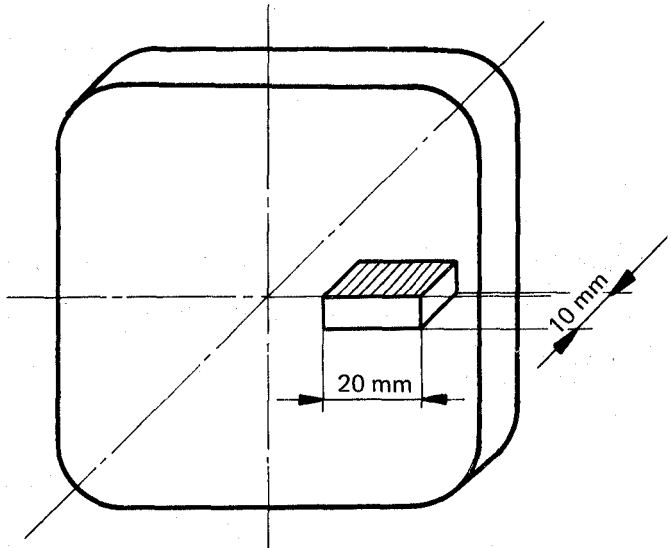

FIGURE 1 — **Sample from bar or billet with a diameter or length of side > 40 mm**

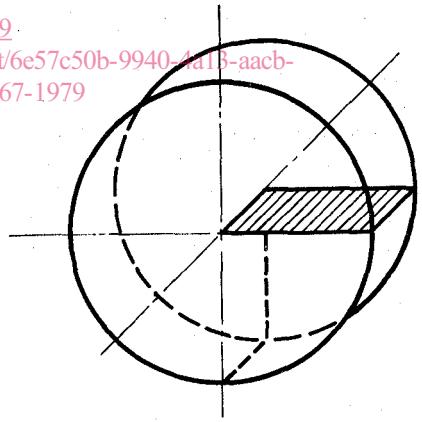

FIGURE 2 — **Sample from bar or billet with a diameter or length of side > 25 mm and ⩽ 40 mm**

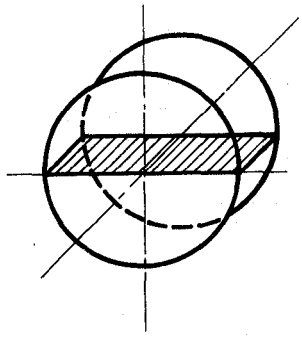

FIGURE 3 — **Sample from bar with a diameter ⩽ 25 mm**

5.2 Actual examination

Two methods are possible : 5.2.1 and 5.2.2.

5.2.1 *Method A*

The entire polished surface is examined and, for each type of inclusion, a note is made of the reference number which lies to the side of the standard diagram which corresponds to the worst field examined, in the fine or thick series.

5.2.2 *Method B*

The entire polished surface is examined and each field of the sample is compared with the standard diagrams. The reference number of the field (indicated to the side of the standard diagrams) which best corresponds to the field examined for each type of inclusion is noted, in the fine and thick series.

When making the comparison, one plate only shall be used : either plate I or plate II, but in no case both at the same time.

In order to minimize the cost of examination, it may be agreed to make a partial examination of the sample by studying a reduced number of fields, distributed in accordance with a fixed scheme. Both the number of fields examined and their distribution shall be arranged by prior agreement.

NOTE – For comparative testing it is necessary to make provision for a system of stops on the microscope stage so that the same fields are always examined.

5.2.3 *Methods A and B*

Inclusions which are longer than the diameter of the field shall be noted separately; the same is true of inclusions thicker than those of the standard diagrams.

6 EXPRESSION OF RESULTS

Unless otherwise stated in the product standard, the results may be expressed in the following ways.

6.1 Indication of the reference number corresponding to the worst field for each type of inclusion (see annex B).

The reference symbol for the group of inclusions is followed by the reference number of the worst field, the presence of thick inclusions being indicated by the letter e [= *épaisse*].

Examples : A2, B1e, C3, D1.

NOTE – This procedure is currently used with the method defined in 5.2.1.

6.2 Indication of the total number of fields for a given index, per group of inclusions, for a given number of fields observed (N).

NOTE – This procedure is generally usable with the method defined in 5.2.2.

The full set of total numbers of fields for a given index relative to the various types of inclusion may be used in special methods for expressing results, such as total index or mean index, subject to agreement between the parties.

Example : for type A inclusions in accordance with plate I :

taking n_1 as the number of fields of index 1

n_2 as the number of fields of index 2

n_3 as the number of fields of index 3

n_4 as the number of fields of index 4

n_5 as the number of fields of index 5

$$\text{total index} \quad (n_1 \times 1) + (n_2 \times 2) + (n_3 \times 3) + (n_4 \times 4) + (n_5 \times 5)$$

$$\text{mean index} = \frac{\text{total index}}{N}$$

where N is the total number of fields observed.

A typical result is given in annex C.

6.3 The results are expressed with the reference numbers for each sample and on their basis the arithmetic mean is assessed per cast for each type of inclusion. This method is used in combination with the method described in 5.2.1.

7 TEST REPORT

The test report shall contain the following particulars :

a) reference to this International Standard;

b) the steel grade and the cast number;

c) the type of sampling and position of the surface examined;

d) the method selected (method of observation, method of examination, standard diagram plates, method of expressing results);

e) the results of the examination (with an indication of those cases where the size of the inclusion exceeds that of the standard diagrams);

f) report number and date.

ANNEX A

JERNKONTORET AND ASTM STANDARD DIAGRAMS

NOTE – The standard diagrams in the following plates are drawn to half scale and may not be used to determine the amount of inclusions. The plates used shall be of actual size.

PLATE I – Jernkontoret standard diagrams

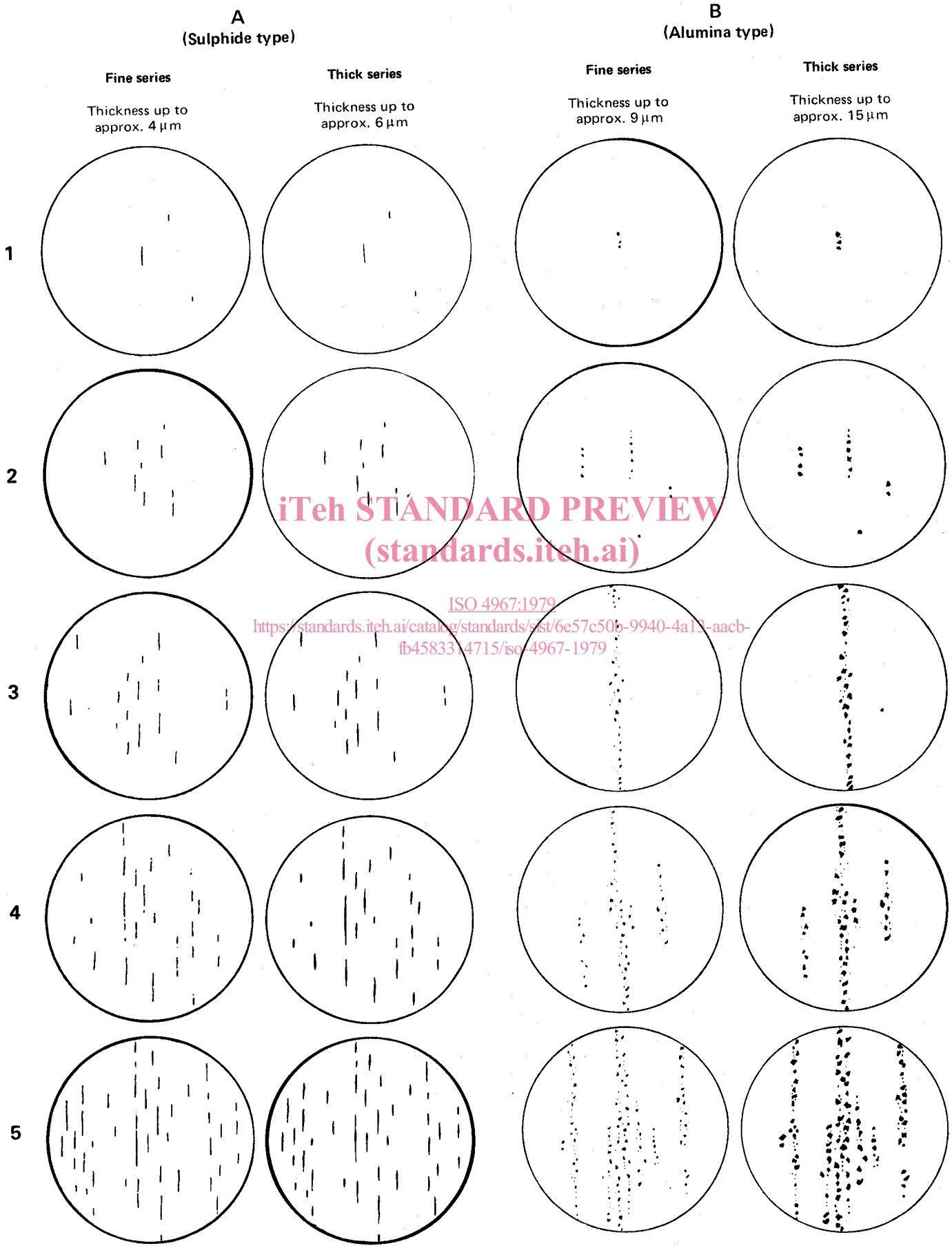

PLATE I – Jernkontoret standard diagrams (*concluded*)