SLOVENSKI STANDARD
oSIST prEN ISO 6507-1:2016

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Kovinski materiali - Preskus trdote po Vickersu - 1. del: Preskusni postopek (ISO/DIS 6507-1:2016)

Metallic materials - Vickers hardness test - Part 1: Test method (ISO/DIS 6507-1:2016)

Metallische Werkstoffe - Härteprüfung nach Vickers - Teil 1: Prüfverfahren (ISO/DIS 6507-1:2016)

Matériaux métalliques - Essai de dureté Vickers - Partie 1: Méthode d'essai (ISO/DIS 6507-1:2016)

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77.040.10 Mehansko preskušanje kovin Mechanical testing of metals

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Metallic materials — Vickers hardness test —

Part 1: Test method

Matériaux métalliques — Essai de dureté Vickers —

Partie 1: Méthode d'essai

ICS: 77.040.10

ISO/CEN PARALLEL PROCESSING

This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five month enquiry.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

ISO 6507-1 was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 3, *Hardness testing*.

This second edition cancels and replaces the first edition (ISO 6507-4:2005), which has been technically revised.

ISO 6507 consists of the following parts, under the general title *Metallic materials — Vickers hardness test*:

— *Part 1: Test method*

— *Part 2: Verification and calibration of testing machines*

— *Part 3: Calibration of reference blocks*

— *Part 4: Tables of hardness values*

Metallic materials — Vickers hardness test — Part 1: Test method

1 Scope

This part of ISO 6507 specifies the Vickers hardness test method, for the three different ranges of test force for metallic materials including hardmetals (see Table 1).

Table 1 — Ranges of test force

Ranges of test force, F N	Hardness symbol	Designation
$F \geq 49{,}03$	≥ HV 5	Vickers hardness test
$1{,}961 \leq F < 49{,}03$	HV 0,2 to < HV 5	Low-force Vickers hardness test
$0{,}009\ 807 \leq F < 1{,}961$	HV 0,001 to < HV 0,2	Vickers microhardness test

The Vickers hardness test is specified in this part of ISO 6507 for lengths of indentation diagonals between 0,020 mm and 1,400 mm.

For specific materials and/or products, particular International Standards exist.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6507-2, *Metallic materials — Vickers hardness test — Part 2: Verification and calibration of testing machines*

ISO 6507-3, *Metallic materials — Vickers hardness test — Part 3: Calibration of reference blocks*

ISO 6507-4, *Metallic materials — Vickers hardness test — Part 4: Tables of hardness values*

3 Principle

A diamond indenter, in the form of a right pyramid with a square base and with a specified angle between opposite faces at the vertex, is forced into the surface of a test piece followed by measurement of the diagonal length of the indentation left in the surface after removal of the test force, F (see Figure 1).

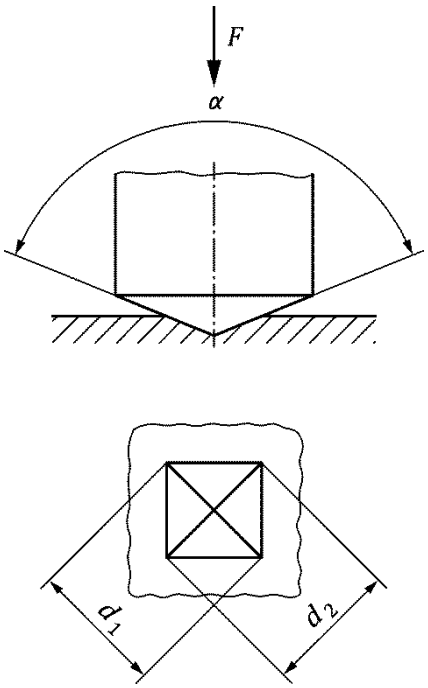


Figure 1 — Principle of the test, geometry of indenter and Vickers indentation

The Vickers hardness is proportional to the quotient obtained by dividing the test force by the area of the sloped surface of indentation, which is assumed to be a right pyramid with a square base, and having at the vertex the same angle as the indenter.

4 Symbols, abbreviated terms, and designations

4.1 Symbols and abbreviated terms used in this document

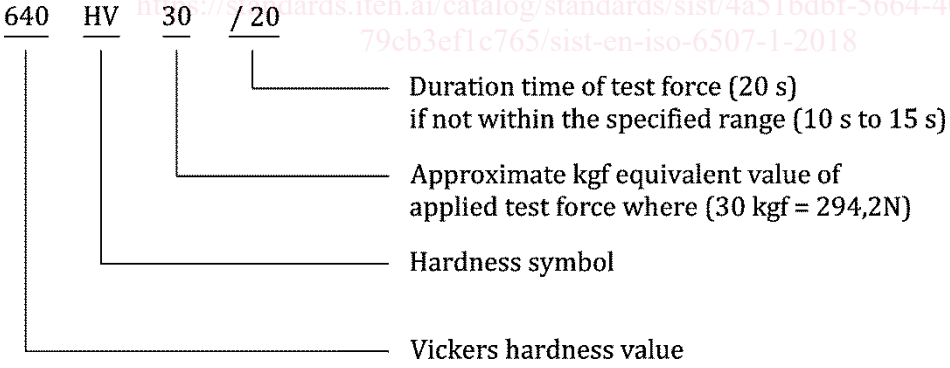
See Table 2 and Figure 1.

Table 2 — Symbols and abbreviated terms

Symbol/ Abbreviated term	Designation
α	Angle between the opposite faces at the vertex of the pyramidal indenter (nominally 136°) (see Figure 1)
F	Test force, in newtons (N)
d	Arithmetic mean, in millimetres, of the two diagonal lengths d_1 and d_2 (see Figure 1)
V	Magnification of the measuring system
HV	Vickers hardness $= \frac{\text{Test Force (kgf)}}{\text{Surface area of indentation (mm}^2\text{)}}$ $= \frac{1}{g_n} \times \frac{\text{Test Force (N)}}{\text{Surface area of indentation (mm}^2\text{)}}$ $= \frac{1}{g_n} \times \frac{F}{d^2/\left(2\sin\frac{\alpha}{2}\right)} = \frac{1}{g_n} \times \frac{2F\sin\frac{\alpha}{2}}{d^2}$ For the nominal angle α = 136°, Vickers hardness $\approx 0{,}1891 \times \frac{F}{d^2}$
NOTE 1 Standard acceleration due to gravity, g_n = 9,806 65 m/s^2 which is the conversion factor from kgf to N NOTE 2 To reduce uncertainty, the Vickers hardness may be calculated using the actual indenter angle α	

4.2 Designation of hardness number

Vickers hardness, HV, is designated as shown in the following example.



5 Testing machine

5.1 Testing machine

The testing machine shall be capable of applying a predetermined force or forces within the desired range of test forces, in accordance with ISO 6507-2.

5.2 Indenter

The indenter shall be a diamond in the shape of a right pyramid with a square base, as specified in ISO 6507-2.

5.3 Diagonal measuring system

The diagonal measuring system shall satisfy the specifications in ISO 6507-2.

Many older objectives lenses are non-linear towards the edge of the field of view. Therefore, magnifications should be provided so that the diagonal can be enlarged to greater than 25 % but less than 75 % of the maximum possible optical field of view.

NOTE Systems using a camera for measurement may use 100% of the camera's field of view provided they are designed to consider the 75% and any other field of view limitations of the optical system.

The resolution required of the diagonal measuring system depends on the size of the smallest indentation to be measured.

The scale of the measuring system shall be graduated to permit estimation of the diagonals of the indentation in accordance with Table 3.

Table 3 – Resolution of the measuring system

Diagonal length, d mm	**Resolution of the measuring system**
$d < 0{,}080$	0,000 4 mm
$0{,}080 \leq d$	0,5 % of d
NOTE The diagonal length of the indentation determines the necessary magnification V of the measuring system according to the following condition: $V \times d \geq 14$ mm For indentation diagonals $d < 0{,}035$ mm this condition may not be fulfilled, but the magnification should be at least $\times 400$.	

The resolution of the measuring system for Vickers hardness testing of hardmetals is specified in ISO 3878 [11].

6 Test piece

6.1 Test surface

The test shall be carried out on a surface which is smooth and even, free from oxide scale, foreign matter and, in particular, completely free from lubricants, unless otherwise specified in product standards. The finish of the surface shall permit accurate determination of the diagonal length of the indentation.

6.2 Preparation

Surface preparation shall be carried out in such a way that any pull out of materials, or alteration of the surface hardness due to excessive heating or cold-working, for example, is minimized.

Due to the small depth of Vickers microhardness indentations, it is essential that special precautions be taken during preparation. It is recommended to use a polishing/electropolishing process which is suitable for the material to be measured.

6.3 Thickness

The thickness of the test piece, or of the layer under test, shall be at least 1,5 times the diagonal length of the indentation (see Annex A). No deformation shall be visible at the back of the test piece after the test.

NOTE The depth of the indentation is approximately 1/7 of the diagonal length (0,143 *d*).

6.4 Tests on curved surfaces

For tests on curved surfaces, the corrections given in Annex B, Tables B.1 to B.6 shall be applied.

6.5 Support of unstable test pieces

For test pieces of small cross-section or of irregular shape, it may be necessary to provide some form of additional mounting in plastic material. The test piece shall be adequately supported by the mounting medium so that the test piece does not move during the force application.

7 Procedure

7.1 Test temperature

In general, the test is carried out at ambient temperature within the limits of 10 °C to 35 °C. If the test is carried out at a temperature outside this range, it shall be noted in the test report. Tests carried out under controlled conditions shall be made at a temperature of (23 ± 5) °C.

7.2 Test force

The test forces given in Table 4 are typical. Other test forces may be used. Test forces should be chosen that result in indentations with diagonals greater than 0,020 mm.

Table 4 — Typical Test forces

Hardness test [a]		Low-force hardness test		Microhardness test	
Hardness symbol	Nominal value of the test force F N	Hardness symbol	Nominal value of the test force F N	Hardness symbol	Nominal value of the test force F N
---	---	---	---	HV 0,001	0,009 807[a]
---	---	---	---	HV 0,002	0,019 61
---	---	---	---	HV 0,003	0,029 42
---	---	---	---	HV 0,005	0.049 03
HV 5	49,03	HV 0,2	1,961	HV 0,01	0,098 07
HV 10	98,07	HV 0,3	2,942	HV 0,015	0,147
HV 20	196,1	HV 0,5	4,903	HV 0,02	0,196 1
HV 30	294,2	HV 1	9,807	HV 0,025	0,245 2
HV 50	490,3	HV 2	19,61	HV 0,05	0,490 3
HV 100[a]	980,7	HV 3	29,42	HV 0,1	0,980 7

[a] Nominal test forces greater than 980,7 N or smaller than 0,009 807 N may be applied.

7.3 Daily verification

The daily verification defined in Annex C shall be performed before the first test of each week for each test force used but is recommended daily. The daily verification is recommended whenever the test force is changed. The daily verification shall be done whenever the indenter is changed. The daily verification should be done within 200 HV of the expected hardness level to be tested.

7.4 Test piece support

The test piece shall be placed on a rigid support. The support surfaces shall be clean and free from foreign matter (scale, oil, dirt, etc.). It is important that the test piece lies firmly on the support so that displacement cannot occur during the test.

7.5 Focus on test surface

Focus the diagonal measuring system microscope so that the specimen surface and the desired test location can be observed.

NOTE Some testers do not require that the microscope be focused on the specimen surface.

7.6 Test force application

Bring the indenter into contact with the test surface and apply the test force in a direction perpendicular to the surface, without shock, vibration or overload, until the applied force attains the specified value. The time from the initial application of the force until the full test force is reached shall be 7^{+1}_{-5} s.

NOTE 1 The requirements for the time durations are given with asymmetric limits. For example, 7^{+1}_{-5} s indicates that 7 s is the nominal time duration, with an acceptable range of not less than 2 s (7 s – 5 s) to not more than 8 s (7 s + 1 s).

For the Vickers hardness range and low-force Vickers hardness range tests, the approach speed of the indenter shall not exceed 0,2 mm/s. For micro-hardness tests, the indenter shall contact the test piece at a velocity between 0,015 and 0,070 mm/s.

The duration of the test force shall be 14^{+1}_{-4} s , except for tests on materials whose time-dependent properties would make this an unsuitable range. For these tests, this duration shall be specified as part of the hardness designation (see EXAMPLE in 4.2).

NOTE 2 It should be noted that for anisotropic materials, for example those which have been heavily cold-worked, there could be a difference between the lengths of the two diagonals of the indentation. Therefore, where possible, the indentation should be made so that the diagonals are oriented in plane at approximately 45° to the direction of cold-working. The specification for the product may indicate limits for the differences between the lengths of the two diagonals.

NOTE 3 There is evidence that some materials may be sensitive to the rate of straining which causes changes in the value of the yield strength. The corresponding effect on the termination of the formation of an indentation can make alterations in the hardness value.

7.7 Prevention of the effect of shock or vibration

Throughout the test, the testing machine shall be protected from shock or vibration [5].

7.8 Minimum distance between adjacent indentations

The minimum distance between adjacent indentations and the minimum distance between an indentation and the edge of the test piece are shown in Figure 2.

The distance between the centre of any indentation and the edge of the test piece shall be at least 2,5 times the mean diagonal length of the indentation in the case of steel, copper and copper alloys, and at least three times the mean diagonal length of the indentation in the case of light metals, lead and tin and their alloys.

The distance between the centres of two adjacent indentations shall be at least three times the mean diagonal length of the indentation in the case of steel, copper and copper alloys, and at least six times the mean diagonal length in the case of light metals, lead and tin and their alloys. If two adjacent indentations differ in size, the spacing shall be based on the mean diagonal length of the larger indentation.

