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**Vickers hardness test — Verification and
calibration of testing machines**

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Contents

	Page
Introduction	1
1 Scope	1
2 Normative references	2
3 Terms and definitions	2
4 Symbols and their definitions	3
5 General conditions	3
6 Direct verification	4
6.1 General	4
6.2 Calibration of the test force	4
6.3 Verification of the indenter	5
6.4 Calibration and verification of the diagonal measuring system	6
6.5 Verification of the testing cycle	7
6.6 Uncertainty of calibration/verification	7
7 Indirect verification	7
7.1 General	7
7.2 Test force and hardness levels	7
7.3 Measurement of reference indentation	8
7.4 Number of indentations	8
7.5 Verification result	8
7.6 Repeatability	8
7.7 Bias	9
7.8 Uncertainty of calibration/verification	9
8 Intervals between verifications	9
9 Verification report/calibration certificate	10
9.1 Vickers testing machine	10
9.2 Vickers indenter	10
Annex A (informative) Uncertainty of the calibration results of the hardness testing system	12
Annex JA (informative) Maximum permissible values of bias for indirect verification	22
Bibliography	23
Annex JB (informative) Comparison table between JIS and corresponding International Standard	24

Foreword

This Japanese Industrial Standard has been revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by The Japan Testing Machine Association (JTM)/Japanese Standards Association (JSA) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act applied mutatis mutandis pursuant to the provision of Article 16 of the said Act. This edition replaces the previous edition (**JIS B 7725**:2010), which has been technically revised.

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Vickers hardness test — Verification and calibration of testing machines

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 6507-2** : 2018, Edition 4, with some modifications of the technical contents.

The dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JB. Annex JA is unique to **JIS** and not given in the corresponding International Standard.

1 Scope

This Standard specifies a method of verification and calibration of testing machines for determining Vickers hardness (hereafter referred to as testing machines) in accordance with **JIS Z 2244-1**.

A direct method of verification and calibration is specified for the testing machine, indenter and the diagonal length measuring system. An indirect verification method using reference blocks is specified for the overall checking of the machine.

If a testing machine is also to be used for other methods of hardness testing, it shall be verified independently for each method.

This Standard is also applicable to portable Vickers hardness testing machines, but not applicable to hardness testing machines based on different measurement principles, e.g. ultrasonic impedance method.

It should be noted that using the method specified in this Standard for determination from indentations <20 µm in diagonal length may cause large uncertainties in the results.

NOTE The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 6507-2 : 2018 *Metallic materials — Vickers hardness test — Part 2 : Verification and calibration of testing machines* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

WARNING Persons carrying out tests based on this Standard should be familiar with normal laboratory practice. This Standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this Standard to establish appropriate safety and health practices.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 7728 *Calibration of force-proving instruments used for the verification of uniaxial testing machines*

NOTE Corresponding International Standard : ISO 376 *Metallic materials — Calibration of force-proving instruments used for the verification of uniaxial testing machines*

JIS B 7735 *Vickers hardness test — Calibration of reference blocks*

NOTE Corresponding International Standard : ISO 6507-3 *Metallic materials — Vickers hardness test — Part 3 : Calibration of reference blocks*

JIS Z 2244-1 *Vickers hardness test — Part 1 : Test method*

NOTE Corresponding International Standard : ISO 6507-1 *Metallic materials — Vickers hardness test — Part 1 : Test method*

JIS Z 8103 *Glossary of terms used in measurement*

3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in JIS Z 2244-1 and JIS Z 8103, and the following apply.

3.1

Vickers hardness testing machine

equipment consisting of a test force loading system, a diagonal measuring system, and an indenter

3.2

diagonal measuring system

system for measuring the diagonal length of indentations

3.3

direct verification

verification where main components of a testing machine (test forces, indenter, diagonal measuring system, etc.) are verified individually

3.4

indirect verification

verification where the overall performance of a testing machine is verified by means of a hardness test using hardness reference blocks

3.5

reference indentation

indentation, among those given for hardness determination on a hardness reference block, whose position and diagonal length are certified

4 Symbols and their definitions

The symbols used in this Standard and their definitions are provided in Table 1.

Table 1 Symbols and their definitions

Symbol	Unit	Definition
F	N	Test force
F_{RS}	N	Nominal test force
ΔF_{rel}	%	Percent relative error of each measurement of the force F
r_{rel}	%	Repeatability of hardness values expressed as a percentage of $\bar{H}$
H_i	(HV)	Measured Vickers hardness
$\bar{H}$	(HV)	Mean measured hardness
d_i	mm, μm	Mean measured diagonal length
H_{CRM}	(HV)	Hardness value of reference block
b	(HV)	Bias (mean measured hardness – hardness value of reference block)
b_{rel}	%	Bias expressed as a percentage of H_{CRM}

5 General conditions

Before a Vickers hardness testing machine is verified and calibrated, the machine shall be checked to ensure that it is properly set up in accordance with the manufacturer's instructions. Especially, it should be checked that :

- the plunger holding the indenter is capable of sliding in its guide without any friction or excessive side play;
- the indenter-holder is firmly mounted in the plunger;
- the test force can be applied and removed without shock, vibration or overshoot and in such a manner that the readings are not influenced;
- the diagonal measuring system :
 - if integral with the machine, the change from removing the test force to measuring mode does not influence the readings;
 - the illumination device of the measuring microscope produces uniform lighting of the whole observed field with enough contrast between the indentation and the surrounding surface to determine the boundary clearly;
 - the centre of the indentation is in the centre of the field of view, if necessary.

NOTE When determining a specific tolerance that the machine needs to meet, the uncertainty associated with the use of measuring equipment and/or reference standards has been incorporated within this

tolerance and it would therefore be inappropriate to make any further allowance for this uncertainty by, for example, reducing the tolerance by the measurement uncertainty. This applies to all measurements made when performing a direct or indirect verification of the machine.

6 Direct verification

6.1 General

6.1.1 Direct verification shall be conducted in accordance with the schedule given in Clause 8.

6.1.2 Direct verification involves :

- a) calibration of the test force;
- b) verification of the indenter;
- c) calibration and verification of the diagonal measuring system;
- d) verification of the testing cycle.

6.1.3 Direct verification should be carried out at a temperature of $(23 \pm 5) ^\circ\text{C}$. If the verification is made outside this temperature range, this shall be stated in the verification report.

6.1.4 The instruments used for verification and calibration shall be traceable to national standards.

6.2 Calibration of the test force

6.2.1 Each test force shall be measured at three positions of the plunger uniformly spaced throughout its range of movement during testing. The positions should be such that they at least cover the depth of the indentations. For testing machines whose test force is shown not to be influenced by the position of the plunger, e.g. closed-loop controlled loading system, or whose plunger position during loading is approximately constant, the test force can be calibrated in one position.

6.2.2 The test force shall be measured by one of the following methods :

- a) by means of a force-proving instrument in accordance with **JIS B 7728**, class 1 or better;
- b) by means of a device accurate to 0.2 %. Evidence should be available to demonstrate that the output of the device does not vary by more than 0.2 % in the period of 1 s to 30 s following a stepped change in force.

6.2.3 Three readings shall be taken for each test force, F , at each position of the plunger. Immediately before each reading is taken, the indenter shall be moved in the same direction as during testing. All readings shall be within the maximum permissible percent relative error, ΔF_{rel} , defined in Table 2.

The percent relative error, ΔF_{rel} , of each measurement of the force, F , is calculated according to Formula (1) :

$$\Delta F_{\text{rel}} = 100 \times \frac{F - F_{\text{RS}}}{F_{\text{RS}}} \dots\dots\dots (1)$$

where, F : test force (N)
 F_{RS} : nominal test force (N)

Table 2 Test force tolerances

Ranges of the nominal test force, F_{RS} N	Maximum permissible relative error, ΔF_{rel} %
$0.009\ 807 \leq F_{\text{RS}} < 0.098\ 07$	± 2.0
$0.098\ 07 \leq F_{\text{RS}} < 1.961$	± 1.5
$F_{\text{RS}} \geq 1.961$	± 1.0

6.3 Verification of the indenter

6.3.1 The four faces of the square-based diamond pyramid shall be polished and free from surface defects.

6.3.2 The verification of the shape of the indenter can be made by direct measurement or optical measurement. The device used for the verification should have an accuracy of $\pm 0.07^\circ$.

6.3.3 The measured angles between the opposite faces at the vertex of the diamond pyramid shall be within the range $136^\circ \pm 0.5^\circ$ (see Figure 1). The angles between the opposite faces may also be verified by measuring the angle between the opposite edges. To meet the requirements, the angles between the opposite edges shall be $148.11^\circ \pm 0.38^\circ$.

6.3.4 The angle between the axis of the diamond pyramid and the axis of the indenter-holder shall be not more than 0.5° .

6.3.5 The four faces should ideally meet at a common point, however, there is usually a line of junction between opposite faces as shown in Figure 2. The length of the line of junction shall be determined by directly measuring the indenter tip or by measuring the tip impression in an indentation. The maximum permissible length of the line of junction, a , between opposite faces is given in Table 3 (see Figure 2).

6.3.6 A valid calibration certificate which confirms the geometrical deviations of the indenter shall be attached to the indenter.

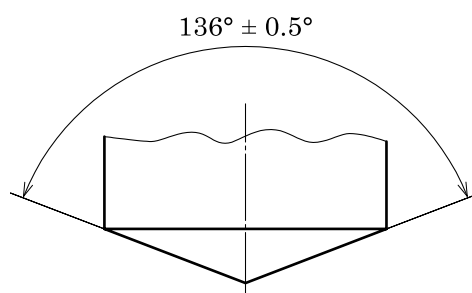
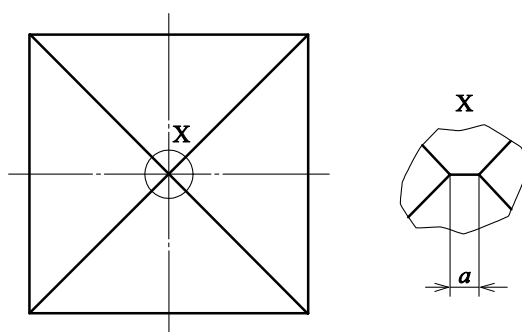


Figure 1 Angle between opposite faces of the diamond indenter



a : length of line of injection

Figure 2 Length of line of junction, a , on the top of the diamond indenter

Table 3 Tolerance on length of line of junction, a , on the top of the indenter

Ranges of the nominal test force, F_{RS} N	Maximum permissible length of the line of junction, a μm
$0.009\,807 \leq F_{RS} < 1.961$	0.5
$1.961 \leq F_{RS} < 49.03$	1
$F_{RS} \geq 49.03$	2

6.4 Calibration and verification of the diagonal measuring system

6.4.1 The system for measuring the diagonal of the indentation shall be verified at each magnification using a calibrated stage micrometer. When an individual scale is used in two perpendicular axes, it shall be calibrated in both orientations. The maximum expanded uncertainty of the distances between the line intervals on the stage micrometer should be as indicated in Table 4.

6.4.2 Measurements shall be made at a minimum of four evenly spaced intervals, arranged centrally in the field of view, covering each working range. Three measurements shall be made at each of the evenly spaced intervals. Requirements for stage micrometer and permissible error of measurements of the diagonal measuring system shall be as indicated in Table 4.

Table 4 Calibration and verification requirements of the diagonal measuring system

Measurement parameters	Requirements
Maximum expanded uncertainty of the distances between the line intervals on the stage micrometer (see 6.4.1)	Greater of $0.4\,\mu\text{m}$ or $0.2\,\%$ of the measurement interval
Maximum permissible error of the measurements of the diagonal measuring system (see 6.4.2)	Greater of $0.8\,\mu\text{m}$ or $1.0\,\%$ of the measurement interval