INTERNATIONAL STANDARD

ISO 6506-1

Third edition
2014-10-01

Metallic materials — Brinell hardness test —

Part 1:
Test method

Matériaux métalliques — Essai de dureté Brinell —

Partie 1: Méthode d'essai

Reference number
ISO 6506-1:2014(E)

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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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The committee responsible for this document is ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 3, *Hardness testing*.

This third edition cancels and replaces the second edition (ISO 6506-1:2005), which has been technically revised.

ISO 6506 consists of the following parts, under the general title *Metallic materials — Brinell hardness test*:

— *Part 1: Test method*

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

— *Part 3: Calibration of reference blocks*

— *Part 4: Table of hardness values*

Metallic materials — Brinell hardness test —

Part 1:
Test method

1 Scope

This part of ISO 6506 specifies the method for the Brinell hardness test for metallic materials. It is applicable to both fixed location and portable hardness testing machines.

For some specific materials and/or products, particular International Standards exist (e.g. ISO 4498) and make reference to this International Standard.

2 Normative references

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

ISO 4498, *Sintered metal materials, excluding hardmetals — Determination of apparent hardness and microhardness*

ISO 6506-2:2014, *Metallic materials — Brinell hardness test — Part 2: Verification and calibration of testing machines*

ISO 6506-3:2014, *Metallic materials — Brinell hardness test — Part 3: Calibration of reference blocks*

ISO 6506-4, *Metallic materials — Brinell hardness test — Part 4: Table of hardness values*

3 Principle

An indenter (tungsten carbide composite ball with diameter, D) is forced into the surface of a test piece and, after removal of the force, F, the diameter of the indentation, d, left in the surface is measured.

The Brinell hardness is proportional to the quotient obtained by dividing the test force by the curved surface area of the indentation. The indentation is assumed to take the shape of the unloaded ball indenter, and its surface area is calculated from the mean indentation diameter and the ball diameter, using the formula given in Table 1.

4 Symbols and abbreviated terms

4.1 See Figure 1 and Table 1.

Table 1 — Symbols and abbreviated terms

Symbol/ abbreviated term	Definition	Unit
D	Diameter of the ball	mm
F	Test force	N
d	Mean diameter of the indentation $d=\frac{d_1+d_2}{2}$	mm
d_1, d_2	Indentation diameters measured at approximately 90°	mm
h	Depth of indentation $h=\frac{D}{2}\left(1-\sqrt{1-\frac{d^2}{D^2}}\right)$	mm
HBW	Brinell hardness $=\text{constant (see Note)}\times\frac{\text{Test force}}{\text{idealized surface area of indentation}}$ $\text{HBW}=0{,}102\times\frac{2F}{\pi D^2\left(1-\sqrt{1-\frac{d^2}{D^2}}\right)}$	
$0{,}102\times F/D^2$	Force-diameter index	
NOTE constant $=0{,}102\approx\frac{1}{9{,}806\,65}$, where 9,806 65 is the conversion factor from kgf to N.		

4.2 The following is an example of the designation of Brinell hardness, HBW.

EXAMPLE

600 HBW 1 / 30 / 20

- 20: duration time of test force (20 s), if not within the specified range (10 s to 15 s)
- 30: approximate kgf equivalent of applied test force, where 30 kgf = 294,2 N
- 1: ball diameter in mm
- HBW: hardness symbol
- 600: Brinell hardness value

NOTE In former editions of this International Standard, when use of a steel ball was permitted, the Brinell hardness was denoted by HB or HBS.

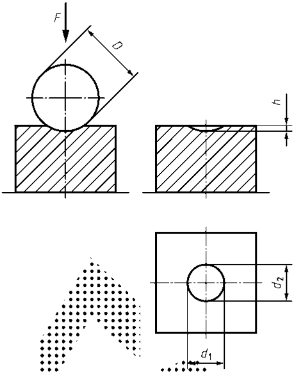

Figure 1 — Principle of test

For symbols, see Table 1.

5 Apparatus

5.1 Testing machine, capable of applying a predetermined test force or test forces within the range of 9,807 N to 29,42 kN, in accordance with ISO 6506-2.

5.2 Indenter, a polished tungsten carbide composite ball, as specified in ISO 6506-2.

5.3 Indentation diameter measuring system, as specified in ISO 6506-2.

6 Test piece

6.1 The test shall be carried out on a surface which is smooth and even; free from oxide scale, foreign matter, and, in particular, free from lubricants. The test piece shall have a surface finish that will allow an accurate measurement of the diameter of the indentation.

NOTE For indentations made with the smaller ball indenters, it might be necessary to polish or lap the surface prior to making the indentation.

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

6.3 The thickness of the test piece shall be at least eight times the depth of indentation. Values for the minimum thickness of the test piece in relation to the mean diameter of indentation are given in Annex B.

Visible deformation at the back of the test piece can indicate that the test piece is too thin.

7 Procedure

7.1 In general, the test should be carried out at ambient temperature within the limits of 10 °C to 35 °C. However, because temperature variation can affect the results, users of the Brinell test can choose to control the temperature within a tighter range, such as 23 °C ± 5 °C.

7.2 Before performing any tests, confirm that verification has been performed in accordance with Annex A.

7.3 The test forces given in Table 2 shall be used. Other test forces and force-diameter indices can be used by special agreement.

Table 2 — Test forces for the different testing conditions

Hardness symbol	Ball diameter D mm	Force-diameter index $0{,}102 \times F/D^2$	Test force value F N
HBW 10/3 000	10	30	29 420
HBW 10/1 500	10	15	14 710
HBW 10/1 000	10	10	9 807
HBW 10/500	10	5	4 903
HBW 10/250	10	2,5	2 452
HBW 10/100	10	1	980,7
HBW 5/750	5	30	7 355
HBW 5/250	5	10	2 452
HBW 5/125	5	5	1 226
HBW 5/62,5	5	2,5	612,9
HBW 5/25	5	1	245,2
HBW 2,5/187,5	2,5	30	1 839
HBW 2,5/62,5	2,5	10	612,9
HBW 2,5/31,25	2,5	5	306,5
HBW 2,5/15,625	2,5	2,5	153,2
HBW 2,5/6,25	2,5	1	61,29
HBW 1/30	1	30	294,2
HBW 1/10	1	10	98,07
HBW 1/5	1	5	49,03
HBW 1/2,5	1	2,5	24,52
HBW 1/1	1	1	9,807

7.4 The test force should be chosen so that the diameter of the indentation, d, lies between the values 0,24 D and 0,6 D. If the diameter of the indentation lies outside these limits, the ratio of indentation diameter to indenter diameter (d/D) shall be stated in the test report. Table 3 indicates recommended force-diameter indices ($0{,}102 \times F/D^2$) that are appropriate for use when testing certain materials and hardness levels. In order to test the largest representative area of the test piece, the diameter of the indenter ball should be chosen to be as large as possible.

Table 3 — Recommended force-diameter indices for different metallic materials

Material	Brinell hardness HBW	Force-diameter index $0{,}102 \times F/D^2$
Steel, nickel alloys, titanium alloys		30
Cast iron[a]	<140	10
	≥140	30
Copper and copper alloys	< 35	5
	35 to 200	10
	>200	30
Light metals and their alloys	<35	2,5
	35 to 80	5 10 15
	>80	10 15
Lead, tin		1
Sintered metal	According to ISO 4498	

[a] For the testing of cast iron, the nominal diameter of the ball shall be 2,5 mm, 5 mm, or 10 mm.

7.5 The test piece shall be placed on a rigid support. The contact 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.

7.6 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 overrun, until the applied force attains the specified value. The time from the initial application of force to the time the full test force is reached shall be 7^{+1}_{-5} s. Maintain the test force for 14^{+1}_{-4} s. For certain materials, where a longer duration of the test force is required, this time shall be applied with a tolerance of ±2 s.

NOTE 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).

7.7 Throughout the test, the testing machine shall be protected from significant shock or vibration, which can influence the test result.

7.8 The distance from the edge of the test piece to the centre of each indentation shall be a minimum of two and a half times the mean indentation diameter. The distance between the centres of two adjacent indentations shall be at least three times the mean indentation diameter.

7.9 The optical measurement of the indentation diameter can be performed with either a manual or an automatic measuring system. The visual field for the optical device should be evenly illuminated, and the type of illumination shall be unchanged from that used during the machine's direct and indirect verifications and its daily verification.

For manual measuring systems, measure the diameter of each indentation in two directions approximately perpendicular to each other. The arithmetic mean of the two readings shall be taken for the calculation of the Brinell hardness.

For test pieces with a ground surface, it is recommended that the direction of the indentation measurements be at approximately 45° to the direction of grinding.

NOTE 1 It should be noted that for anisotropic materials, for example those which have been heavily cold-worked, there might be a difference between the lengths of the two diameters of the indentation. The specification for the product might indicate limits for such differences.

For automatic measuring systems, other validated algorithms to compute the mean diameter are allowed. These algorithms include

— the average of a greater number of measurements, and

— an assessment of the projected area of the indentation.

7.10 Calculate the Brinell hardness value for tests on flat surfaces using the formula given in Table 1, rounding the result to three significant figures. The Brinell hardness value can also be determined using the calculation table given in ISO 6506-4.

8 Uncertainty of the results

A complete evaluation of the uncertainty should be done according to Reference [1].

For hardness, independent of the type of sources, there are two possibilities for the determination of the uncertainty.

— One possibility is based on the evaluation of all relevant sources appearing during a direct calibration. As a reference, a EURAMET guideline[2] is available.

— The other possibility is based on indirect calibration using a hardness reference block, see References [2] to [5]. A guideline for the determination is given in Annex C.

It may not always be possible to quantify all the identified contributions to the uncertainty. In this case, an estimate of type A standard uncertainty can be obtained from the statistical analysis of repeated indentations into the test piece. Care should be taken, if standard uncertainties of type A and B are summarized, that the contributions are not counted twice (see 4.3.10 of Reference [1]).

9 Test report

At least the following information shall be recorded and included in the report, unless otherwise agreed by the parties involved:

a) a reference to this part of ISO 6506 (i.e. ISO 6506-1);

b) all details necessary for the complete identification of the test piece;

c) the date of the test;

d) the test temperature if it is not within the limits 10 °C to 35 °C;

e) the ratio of indentation diameter to indenter diameter, if it falls outside the limits of 0,24 to 0,60;

f) the result obtained, in HBW, reported in accordance with the designation specified in 4.2;

g) where conversion to another hardness scale is also performed, the basis and method of this conversion shall be specified (see Reference [6]);

NOTE There is no general process of accurately converting Brinell hardness into other scales of hardness or into tensile strength.

h) additional requirements outside the scope of this part of ISO 6506;

i) details of any occurrence which may have affected the result.

Annex A
(normative)

Procedure for periodic checking of the testing machine by the user

A check of the machine shall be carried out on each day that the machine is used, for each scale that is to be used at approximately the hardness level of the material to be tested.

The check involves at least one indentation being made on a hardness reference block, calibrated in accordance with ISO 6506-3. If the difference between the mean measured hardness and the block's certified value is within the permissible error limits given in ISO 6506-2:2014, Tables 2 and 3, the machine can be regarded as satisfactory. If not, verify that the indenter, specimen holder, and tester are in good condition and repeat the test. If the machine continues to fail the daily test, an indirect verification as specified in ISO 6506-2:2014, Clause 5, shall be performed.

NOTE It is good metrological practice to maintain a record of these results over a period of time and to use this record to measure reproducibility and monitor drift of the machine.

Annex B
(normative)

Minimum thickness of the test piece in relation to the mean diameter of indentation

Table B.1 — Minimum test piece thickness values, see 6.3

Dimensions in millimetres

Mean diameter of the indentation *d*	Minimum thickness of the test piece			
	D = 1	*D* = 2,5	*D* = 5	*D* = 10
0,24	0,12			
0,3	0,18			
0,4	0,33			
0,5	0,54			
0,6	0,80	0,29		
0,7		0,40		
0,8		0,53		
0,9		0,67		
1,0		0,83		
1,1		1,02		
1,2		1,23	0,58	
1,3		1,46	0,69	
1,4		1,72	0,80	
1,5		2,00	0,92	
1,6			1,05	
1,7			1,19	
1,8			1,34	
1,9			1,50	
2,0			1,67	
2,2			2,04	
2,4			2,45	1,17
2,6			2,92	1,38
2,8			3,43	1,60
3,0			4,00	1,84
3,2				2,10
3,4				2,38
3,6				2,68
3,8				3,00
4,0				3,34
4,2				3,70

Table B.1 *(continued)*

Mean diameter of the indentation *d*	**Minimum thickness of the test piece**			
	D = 1	*D* = 2,5	*D* = 5	*D* = 10
4,4				4,08
4,6				4,48
4,8				4,91
5,0				5,36
5,2				5,83
5,4				6,33
5,6				6,86
5,8				7,42
6,0				8,00

Annex C
(informative)

Uncertainty of the measured hardness values

C.1 General requirements

The approach for determining uncertainty, presented in this annex, considers only those uncertainties associated with the overall measurement performance of the hardness testing machine with respect to the hardness reference blocks. These performance uncertainties reflect the combined effect of all the separate uncertainties (indirect verification). Because of this approach, it is important that the individual machine components are operating within the tolerances. It is strongly recommended that this procedure be applied for a maximum of one year after the successful passing of a direct verification.

Figure C.1 shows the four-level structure of the metrological chain necessary to define and disseminate hardness scales. The chain starts at the international level, using international definitions of the various hardness scales to carry out international intercomparisons. A number of primary hardness standard machines at the national level "produce" primary hardness reference blocks for the calibration laboratory level. Naturally, direct calibration and the verification of these machines should be at the highest possible accuracy.

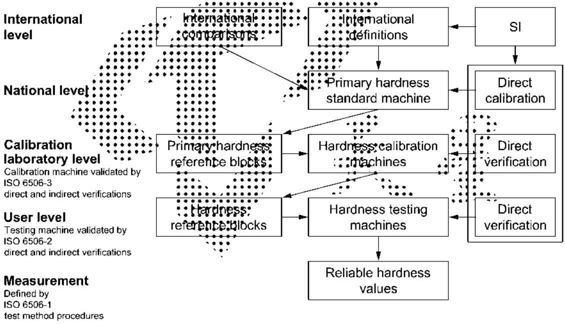

Figure C.1 — Structure of the metrological chain for the definition and dissemination of hardness scales

Measurement uncertainty analysis is a useful tool to help determine sources of error and to understand differences in test results. This annex gives guidance on uncertainty estimation, but the values derived are for information only, unless specifically instructed otherwise by the customer.

Most product specifications have tolerances that have been developed over the past years based mainly on the requirements of the product, but also, in part, on the performance of the machine used to make the hardness measurement. These tolerances, therefore, incorporate a contribution due to the uncertainty of the hardness measurement and it would be inappropriate to make any further allowance for this uncertainty by, for example, reducing the specified tolerance by the estimated uncertainty of the hardness measurement. In other words, where a product specification states that the hardness of an item shall be higher or lower than a certain value, this should be interpreted as simply specifying that the measured and calculated hardness value(s) shall meet this requirement, unless specifically stated otherwise in the product standard.

C.2 General procedure

This procedure calculates an expanded uncertainty, U, associated with the measured hardness value. Two different approaches to this calculation are given in Tables C.1 and C.2, together with details of the symbols used. In both cases, a number of uncorrelated standard uncertainty sources are combined by the Root-Sum-Square (RSS) method, and then multiplied by the coverage factor, $k = 2$.

NOTE This uncertainty approach makes no allowance for any possible drift in the machine performance subsequent to its last calibration, as it assumes that any such changes will be insignificant in magnitude. As such, most of this analysis could be performed immediately after the machine's calibration and the results included in the machine's calibration certificate.

C.3 Bias of the machine

The bias, b, of a hardness testing machine (also termed "error") is derived, during an indirect verification, from the difference between

— the certified calibration value of the hardness reference block used, and

— the mean hardness value of the five indentations made in this block during verification of the machine,

and can be implemented in different ways into the determination of uncertainty.

C.4 Procedures for calculating uncertainty: Hardness measurement values

NOTE In this annex, the abbreviation "CRM" stands for "certified reference material". In hardness testing standards, certified reference material is equivalent to the hardness reference block, i.e. a piece of material with a certified value and associated uncertainty.

C.4.1 Procedure without consideration of bias (method M1)

Method M1 is a simplified method which can be used without needing to consider the magnitude of any systematic error of the hardness testing machine.

In M1, the error limit (the amount by which the machine's reading is allowed to differ from the reference block's value) is used to define one component, U_{mpe}, of the uncertainty. There is no correction of the hardness values with respect to the measured error.

The procedure for the determination of U is explained in Table C.1 (see References [1] and [2] in the Bibliography).

$$U = k \times \sqrt{u_{CRM}^2 + u_H^2 + u_{ms}^2 + \left(\frac{U_{mpe}}{\sqrt{3}}\right)^2} \quad \text{(C.1)}$$

where the result of the measurement is given by

$$X = x \pm U \quad \text{(C.2)}$$

C.4.2 Procedure with consideration of bias (method M2)

As an alternative to method M1, method M2 can be used. This is correlated with the conduct of a control chart. Method M2 can lead to smaller values of uncertainty than method M1.

The bias, b, (step 5 in Table C.2) can be expected to be a systematic effect. In GUM,[1] it is recommended that a correction be used to compensate for systematic effects, and this is the basis of M2. The error limit term, U_{mpe}, is no longer a component in the uncertainty calculation, but either all determined hardness values have to be reduced by b or U_{corr} has to be increased by b. The procedure for the determination of U_{corr} is explained in Table C.2 (see References [4] and [5] in the Bibliography).

$$U_{\text{corr}} = k \times \sqrt{u_{\text{CRM}}^2 + u_{\text{H}}^2 + u_{\text{ms}}^2} \tag{C.3}$$

where the result of the measurement is given by

$$X_{\text{corr}} = (x - b) \pm U_{\text{corr}} \tag{C.4}$$

or by

$$X_{\text{ucorr}} = x \pm (U_{\text{corr}} + |b|) \tag{C.5}$$

depending on whether the bias (error), b, is considered to be part of the mean value or of the uncertainty.

When method M2 is used, it is also necessary to include an additional uncertainty component within the RSS term relating to the value of b employed. This will particularly be the case when

— the measured hardness is significantly different from the hardness levels of the blocks used during the machine's calibration,

— the machine's bias value varies significantly throughout its calibrated range, and

— the material being measured is different from the material of the hardness reference blocks used during the machine's calibration.

In all circumstances, a robust method for estimating the uncertainty associated with b is required.

C.5 Expression of the result of measurement

When reporting the measurement result, the method (M1 or M2) used to estimate the uncertainty should also be specified.

Table C.1 — Determination of the measurement result according to method M1

Step	Sources of uncertainty	Symbols	Formula	Literature/Certificate	Example [..] = HBW 2,5/187,5
1	Expanded uncertainty derived from maximum permissible error	U_{mpe}	$U_{mpe} = E_{rel} \times \bar{x}_{CRM}$	Permissible error, E_{rel}, for X = 258,8 HBW 2,5/187,5 from Table 2, ISO 6506-2:2014, $\bar{x}_{CRM}$ according to CRM calibration certificate	$U_{mpe} = 0{,}025 \times 258{,}8 = 6{,}17$
2	Standard uncertainty of hardness of CRM (for detailed calculation see ISO 6506-3:2014, Table A.4)	u_{CRM}	$u_{CRM} = \frac{U_{CRM}}{2}$	U_{CRM} according to CRM calibration certificate (See Note)	$u_{CRM} = \frac{2{,}2}{2} = 1{,}10$
3	Mean value ($\bar{H}$) and standard deviation (s_H) of the measurement on CRM	$\bar{H}$, s_H	$\bar{H} = \frac{1}{n} \times \sum_{i=1}^{n} H_i$ $s_H = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (H_i - \bar{H})^2}$	H_i according to 5.7, ISO 6506-2:2014	Single values H_i: 258, 257, 258, 258, and 259 $\bar{H} = 258{,}0$ $s_H = 0{,}71$
4	Standard uncertainty of hardness testing machine when measuring CRM	u_H	$u_H = t \times s_H$	t = 1,14 for n = 5 (see G.3 and Table G.2, Reference [1])	$u_H = 1{,}14 \times 0{,}71 = 0{,}81$
5	Standard uncertainty due to resolution of the indentation diameter measuring system	u_{ms}	$u_{ms} = \frac{\delta_{ms}}{2\sqrt{3}} \times \frac{HBW}{d} \times \frac{D + \sqrt{D^2 - d^2}}{\sqrt{D^2 - d^2}}$	D = 2,5 mm δ_{ms} = 0,002 5 mm d = 0,947 5 mm, HBW = 256	$u_{ms} = 0{,}41$
6	Determination of the expanded uncertainty	U	$U = k \times \sqrt{u_{CRM}^2 + u_H^2 + u_{ms}^2 + \left(\frac{U_{mpe}}{\sqrt{3}}\right)^2}$	Steps 1, 2, 4, and 5 k = 2	$U = 2 \times \sqrt{1{,}10^2 + 0{,}81^2 + 0{,}41^2 + \left(6{,}17/\sqrt{3}\right)^2}$ U = 7,7 HBW
7	Measurement result	X	$X = x \pm U$		$X = (256{,}0 \pm 7{,}7)$ HBW 2,5/187,5

NOTE If necessary, the hardness change of the CRM has to be considered.

Table C.2 — Determination of the measurement result according to method M2

Step	Sources of uncertainty	Symbols	Formula	Literature/Certificate	Example ([..] = HBW 2,5/187,5)
1	Standard uncertainty of hardness of CRM (for detailed calculation see ISO 6506-3:2014, Table A.4)	u_{CRM}	$u_{CRM} = \frac{U_{CRM}}{2}$	U_{CRM} according to calibration certificate of CRM (See Note 1)	$u_{CRM} = \frac{2,2}{2} = 1,10$
2	Mean value ($\bar{H}$) and standard deviation (s_H) of the measurement on CRM	$\bar{H}$, s_H	$\bar{H} = \frac{1}{n} \times \sum_{i=1}^{n} H_i$ $s_H = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (H_i - \bar{H})^2}$	H_i according to 5.7, ISO 6506-2:2014	Single values H_i: 258, 257, 258, 258 and 259 $\bar{H} = 258,0$ $s_H = 0,71$
3	Standard uncertainty of hardness testing machine when measuring CRM	u_H	$u_H = t \times s_H$	$t = 1,14$ for $n = 5$ (see C.3 and Table C.2, Reference [1])	$u_H = 1,14 \times 0,71 = 0,81$
4	Standard uncertainty due to resolution of the indentation diameter measuring system	u_{ms}	$u_{ms} = \frac{\delta_{ms}}{2\sqrt{3}} \times \frac{HBW}{d} \times \frac{D + \sqrt{D^2 - d^2}}{\sqrt{D^2 - d^2}}$	$D = 2,5$ mm $\delta_{ms} = 0,002\,5$ mm $d = 0,947\,5$ mm, HBW = 256	$u_{ms} = 0,41$
5	Deviation of hardness testing machine from calibration value	b	$b = \bar{H} - X_{CRM}$	Step 2 (See Note 2)	$b = 258,0 - 258,8 = -0,8$
6	Determination of the corrected expanded uncertainty	U_{corr}	$U_{corr} = k \times \sqrt{u_{CRM}^2 + u_H^2 + u_{ms}^2}$	Steps 1, 3 and 4 $k = 2$	$U_{corr} = 2 \times \sqrt{1,10^2 + 0,81^2 + 0,41^2}$ $U_{corr} = 2,9$ HBW
7	Measurement result with modified hardness	X_{corr}	$X_{corr} = (x - b) \pm U_{corr}$	Steps 5 and 6	$X_{corr} = (256,8 \pm 2,9)$ HBW 2,5/187,5
8	Measurement result with modified uncertainty	X_{ucorr}	$X_{ucorr} = x \pm (U_{corr} + \|b\|)$	Steps 5 and 6	$X_{ucorr} = (256,0 \pm 3,7)$ HBW 2,5/187,5

NOTE 1 If necessary, the hardness change of the CRM has to be considered.

NOTE 2 If $0,8\ U_{mpe} < |b| < 1,0\ U_{mpe}$, where U_{mpe} is as defined in Step 1 of Table C.1, the relationship of hardness values between CRM and sample should be considered.

Bibliography

[1] JCGM 100. *(GUM 1995 with minor corrections), Evaluation of measurement data - Guide to the expression of uncertainty in measurement.* BIPM/IEC/IFCC/ILAC/ISO/IUPAC/IUPAP/OIML, 2008

[2] EURAMET/cg-16/v.01, Guidelines on the Estimation of Uncertainty in Hardness Measurements, 2007

[3] GABAUER W. *Manual of Codes of Practice for the Determination of Uncertainties in Mechanical Tests on Metallic Materials, The Estimation of Uncertainties in Hardness Measurements,* Project, No. SMT4-CT97-2165, UNCERT COP 14:2000

[4] GABAUER W., & BINDER O. *Abschätzung der Messunsicherheit in der Härteprüfung unter Verwendung der indirekten Kalibriermethode, DVM Werkstoffprüfung.* Tagungsband, 2000, pp. 255–261.

[5] POLZIN T., & SCHWENK D. Method for Uncertainty Determination of Hardness Testing; PC file for the Determination. *Materialprüfung,* 2002, 44 pp. 64–71

[6] ISO 18265, *Metallic materials — Conversion of hardness values*

ICS 77.040.10
Price based on 16 pages