DC.: 620.178.152.42 : 620.1.08 March 1975

Calibration of the Reference Blocks for use with Rockwell Hardness Testing Machines (B, C, N and T Scales)

EURONORM
117 - 75

Previous edition:

EUROPEAN COAL AND STEEL COMMUNITY
COMMISSION OF THE EUROPEAN COMMUNITIES
IRON AND STEEL NOMENCLATURE COORDINATION COMMITTEE

CONTENTS

1 SCOPE

This EURONORM concerns the calibration of reference blocks intended for the indirect verification of Rockwell hardness testing machines (B, C, N and T scales). It does not necessarily apply to the calibration of test blocks which are used in the routine checking of the testing machine by the user, but it is not intended to preclude the use of blocks calibrated in accordance with the conditions of this EURONORM for the routine checking of a machine.

Note

In the case of N & T scales, the reference blocks used for the routine checking of the testing machine may be calibrated using the loading time indicated by clause 5.3 of EURONORM 109 : 'Conventional Rockwell hardness tests — Rockwell scales HRN and HRT — scales HRB' and HR 30 T' for thin walled products'.

2 MANUFACTURE

2.1

Each metal block to be calibrated shall have a thickness of not less than 6 mm.

2.2

The block shall be specially prepared and the attention of the manufacturer is drawn to the need to use a manufacturing process which will give the necessary homogeneity, stability of structure and uniformity of surface hardness. It is recommended that the fineness and regularity of grain and the uniformity of the metallurgical structure be verified by micrographic examination. A micrographic examination may also be made by the body which carries out the calibration of the blocks.

Amendment:

FB 150.– Dkr. 23,50 DM 10,10 £ 1,70 FF 18,50 Lit 2550.– Fl 10,40 $ 3,60

2.3

The reference blocks shall not be magnetized. If therefore they are made of ferro-magnetic materials, the manufacturer shall guarantee that they have been de-magnetized. Moreover the blocks shall not be subject to ageing.

2.4

The upper and lower surfaces of the reference block shall be flat to within 0.005 mm, and their parallelism shall be such that the thickness does not vary by more than 0.010 mm per 50 mm.

2.5

The lower surface of the reference block shall be finished by fine grinding giving a roughness characterized by $R_t \leq 5$ µm (*).

(*) R_t = total depth or total deviation of roughness (distance between the highest point of the projections and the lowest point of the hollows).

2.6

The test surface (upper surface) shall be such that its roughness is characterized by $R_t \leq 1.5$ µm.

It shall be noted that the surface of the reference block is necessarily work-hardened by any machining process. It is necessary to ensure that the machining processes are such that the work-hardening effects are uniform over the whole surface and penetrate only to a minimum depth.

2.7

To permit checking that no material is subsequently removed from the reference block after calibration, each block shall have on the test face at least one of the marks defined in section 13.

3 PROCEDURE

The reference blocks shall be calibrated on a calibrating machine complying with the requirements of sections 4 to 8. The operations will be carried out at a temperature of 20 ± 2 degrees C in accordance with the general method described in EURONORM 4 and EURONORM 109 respectively.

4 CALIBRATION MACHINE

The calibration machine used is a machine in which the load, the form of the indentor and the measuring device can be verified by fundamental measurements. The load shall be applied by means of weights.

5 LOADS

The loads shall be correct to within ± 0.1 %.

6 FORM OF THE INDENTOR

6.1 C and N Scales

6.1.1

The surface of the diamond shall be highly polished and be free from flaws or cavities.

6.1.2

The diamond cone shall have an included angle of 120 ± 0.1°. The tip of the cone shall be spherical with a radius of 0.200 ± 0.005 mm. The surface of the cone shall blend in a truly tangential manner

with the surface of the spherical tip. The angle between the axis of the indentor cone and the support surface of the indentor shall be 90° ± 0.3°. Locally, the deviation between the profile of the spherical tip of the indentor and the theoretical profile shall be less than or equal to 0.002 mm. The verification of the indentor shall be carried out on not less than four diametral sections.

Note

The hardness values given by the testing machine do not depend only on the dimensions given in clause 6.1.2 but also on the roundness of sections perpendicular to the axis, the position of the crystallographic axes of the diamond and the seating of the diamond in its holder.

For this reason, it may be necessary to carry out a performance test in which the indentor is compared, in a calibration machine, with other indentors already accepted for standardized tests.

6.2 B and T Scales

6.2.1

The diameter of the steel ball shall not differ from the nominal diameter by more than ± 0.001 mm.

6.2.2

The Vickers hardness of the ball, measured in conformity with EURONORM 5' Vickers hardness test for steel' shall not be less than 850 HV 10.

Note

The maximum value of the mean diagonal obtained with a Vickers indentor under 98.1 N (10 kgf) is 0.141 mm for a ball 1.5875 mm in diameter.

6.2.3

The ball shall be polished and free from surface defects.

7 APPLICATION OF THE LOAD

7.1

The load shall be applied and removed without shock.

Note

External vibrations may affect the results of the calibration.

7.2

The mechanism which controls the application of the load shall include :

(a) Either a system, with a spring for example, to reduce the velocity of penetration of the indentor during the period of penetration.

(b) Or an adjustment system to maintain this velocity constant.

7.3

In calibration machines of the first type (see clause 7.2 a), the initial velocity (i.e. the velocity of the indentor prior to penetration of the block to be calibrated) shall not exceed 1 mm/s. In machines of the second type (see clause 7.2 b), the initial velocity shall be between 0.003 mm/s and 0.012 mm/s.

Note

When making an indentation, the load-applying mechanism becomes clear of the load before the indentor has come to rest, so that the last stage in the indenting process is under the control of the load and the reference block alone.

It has been established experimentally that the depth of indentation, and therefore the hardness value obtained, is dependent on the velocity of penetration and that variable hardness values are obtained if excessively slow velocities of penetration are used.

8 DURATION OF THE APPLICATION OF THE LOADS

The initial load shall be applied for 10 seconds and the additional load for 30 to 35 seconds. The indexing of the pointer of the measuring apparatus, or the taking of the first reading, shall be carried out as soon as possible after the 10 seconds duration of the initial load and the taking of the final reading shall be carried out 10 seconds after the additional load has been removed.

9 NUMBER OF INDENTATIONS

On each block five indendations shall be made, widely distributed over the test surface.

10 MEASURING APPARATUS

The measuring apparatus shall be capable of measuring vertical displacements to within :

± 0.1 of a scale unit in the case of HRB and HRC
and
± 0.2 of a scale unit in the case of HRN and HRT.

11 REPEATABILITY

Let e_1, e_2, ... e_5, be the values in scale units of the increase in depth of indention, arranged in increasing order of magnitude.

The repeatability of the reference block is defined as

$$e_5 - e_1 \quad \text{ie.} \quad e_{max} - e_{min}$$

12 UNIFORMITY OF THE HARDNESS

The uniformity of the reference block can only be considered as satisfactory for standardization purposes if the repeatability of the block satisfies the conditions in the table below

Hardness	$\frac{e_{max} - e_{min}}{\bar{e}}$
HRB	$\leq$ 3 %
HRC	$\leq$ 1.5 %
HRN	$\leq$ 2 % or $e_{max} - e_{min}$ $\leq$ 0.6 hardness units (*)
HRT	$\leq$ 3 % or $e_{max} - e_{min}$ $\leq$ 1.2 hardness units (*)
(*) see figure 1	

$\bar{e}$ being the mean value of the increase in depth.

The hardness of the block is that corresponding to this mean value of the increase in depth.

13 MARKING

13.1

Each reference block shall be marked with the following :

(a) The hardness symbol and the arithmetic mean of the hardness values obtained during the calibration operations

(b) The serial number

(c) The name or reference of the calibration department

(d) The last two figures of the number indicate the calibration year of the block

(e) The name or mark of the supplier.

13.2

At least one of these marks shall be on the test surface. The others may be on the side of the block, the marks being upright when the test surface is the upper face.

13.3

A calibration certificate shall be attached to the block. It will include :

(I) The name or mark of the supplier

(II) The thickness of the reference block

(III) The tolerance permitted for the mean hardness value or the hardness values taken as a basis for the calculation and,

(IV) Any other information considered useful.

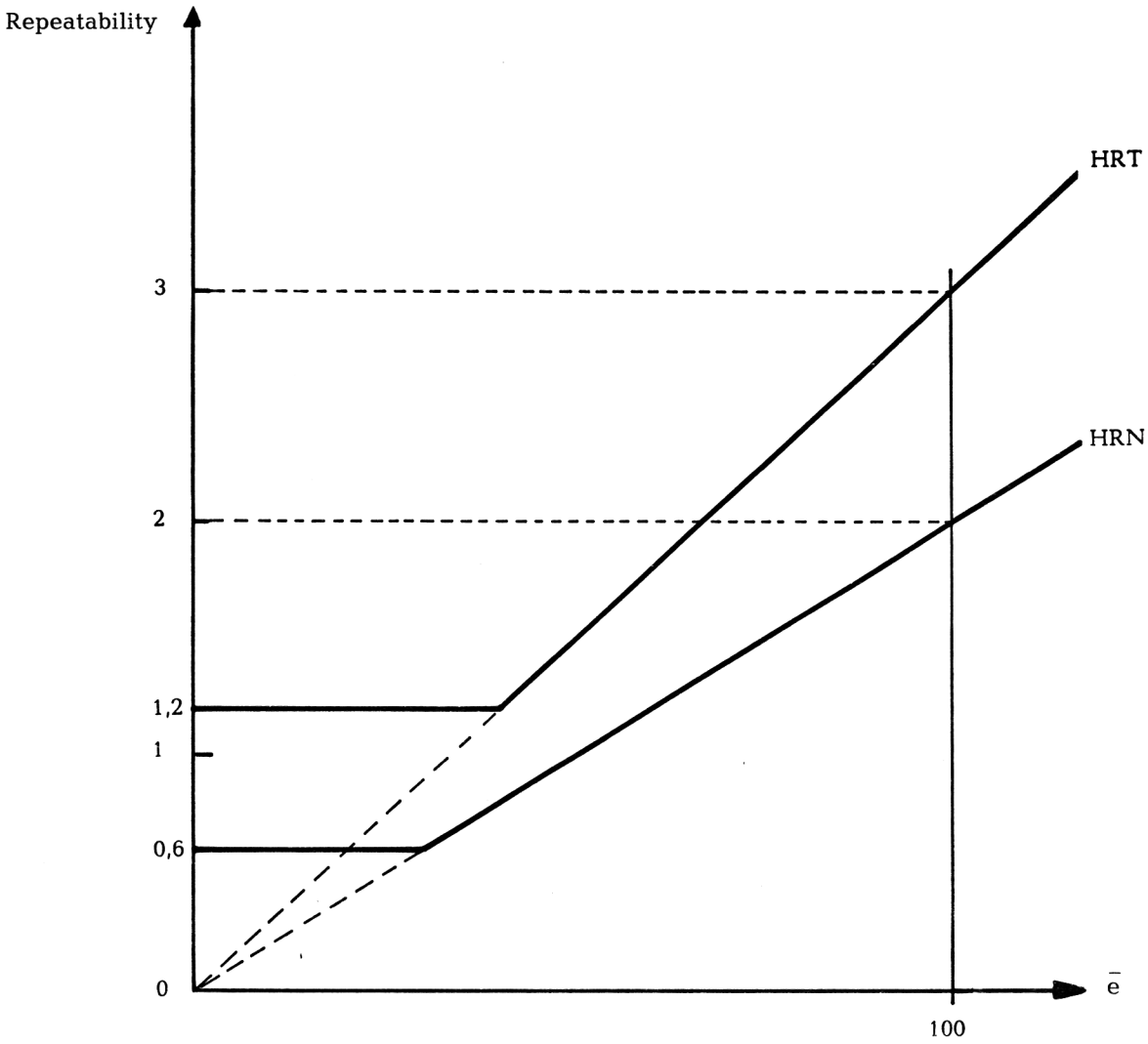

Figure 1 — Repeatability

APPENDIX 1

Examples of the repeatability required when using HRB Rockwell Hardness Reference Blocks

Hardness of the Reference Block, HRB	Increase in depth e measured in HRB units	Repeatability maximum in HRB units	Hardness of the Reference Block, HRB	Increase in depth e measured in HRB units	Repeatability maximum in HRB units
40	90	2,7	70	60	1,8
41	89	2,7	71	59	1,8
42	88	2,6	72	58	1,7
43	87	2,6	73	57	1,7
44	86	2,6	74	56	1,7
45	85	2,6	75	55	1,7
46	84	2,5	76	54	1,6
47	83	2,5	77	53	1,6
48	82	2,5	78	52	1,6
49	81	2,4	79	51	1,5
50	80	2,4	80	50	1,5
51	79	2,4	81	49	1,5
52	78	2,3	82	48	1,4
53	77	2,3	83	47	1,4
54	76	2,3	84	46	1,4
55	75	2,3	85	45	1,4
56	74	2,2	86	44	1,3
57	73	2,2	87	43	1,3
58	72	2,2	88	42	1,3
59	71	2,1	89	41	1,2
60	70	2,1	90	40	1,2
61	69	2,1	91	39	1,2
62	68	2,0	92	38	1,1
63	67	2,0	93	37	1,1
64	66	2,0	94	36	1,1
65	65	2,0	95	35	1,1
66	64	1,9	96	34	1,0
67	63	1,9	97	33	1,0
68	62	1,9	98	32	1,0
69	61	1,8	99	31	0,9
			100	30	0,9

APPENDIX 2

Examples of the repeatability required when using HRC Rockwell Hardness Reference Blocks

Hardness of the Reference Block, HRC	Increase in depth e measured in HRC units	Repeatability maximum in HRC units	Hardness of the Reference Block, HRC	Increase in depth e measured in HRC units	Repeatability maximum in HRC units
20	80	1,2	45	55	0,8
21	79	1,2	46	54	0,8
22	78	1,2	47	53	0,8
23	77	1,2	48	52	0,8
24	76	1,1	49	51	0,8
25	75	1,1	50	50	0,8
26	74	1,1	51	49	0,7
27	73	1,1	52	48	0,7
28	72	1,1	53	47	0,7
29	71	1,1	54	46	0,7
30	70	1,0	55	45	0,7
31	69	1,0	56	44	0,7
32	68	1,0	57	43	0,6
33	67	1,0	58	42	0,6
34	66	1,0	59	41	0,6
35	65	1,0	60	40	0,6
36	64	1,0	61	39	0,6
37	63	0,9	62	38	0,6
38	62	0,9	63	37	0,6
39	61	0,9	64	36	0,5
40	60	0,9	65	35	0,5
41	59	0,9			
42	58	0,9			
43	57	0,9			
44	56	0,8			

APPENDIX 3

Examples of the repeatability required when using HRN Rockwell Hardness Reference Blocks

Hardness of the Reference Block, HRN	Increase in depth e measured in HRN units	Repeatability maximum in HRN units	Hardness of the Reference Block, HRN	Increase in depth e measured in HRN units	Repeatability maximum in HRN units
17	83	1,7	47	53	1,1
18	82	1,6	48	52	1,0
19	81	1,6	49	51	1,0
20	80	1,6	50	50	1,0
21	79	1,6	51	49	1,0
22	78	1,6	52	48	1,0
23	77	1,5	53	47	0,9
24	76	1,5	54	46	0,9
25	75	1,5	55	45	0,9
26	74	1,5	56	44	0,9
27	73	1,5	57	43	0,9
28	72	1,4	58	42	0,8
29	71	1,4	59	41	0,8
30	70	1,4	60	40	0,8
31	69	1,4	61	39	0,8
32	68	1,4	62	38	0,8
33	67	1,3	63	37	0,7
34	66	1,3	64	36	0,7
35	65	1,3	65	35	0,7
36	64	1,3	66	34	0,7
37	63	1,3	67	33	0,7
38	62	1,2	68	32	0,6
39	61	1,2	69	31	0,6
40	60	1,2	70	30	0,6
41	59	1,2	71	29	0,6
42	58	1,2	72	28	0,6
43	57	1,1	73	27	0,6
44	56	1,1	⋮	⋮	⋮
45	55	1,1	⋮	⋮	⋮
46	54	1,1	91	9	0,6

APPENDIX 4

Examples of the repeatability required when using HRT Rockwell Hardness Reference Blocks

Hardness of the Reference Block, HRT	Increase in depth e measured in HRT units	Repeatability maximum in HRT units	Hardness of the Reference Block, HRT	Increase in depth e measured in HRT units	Repeatability maximum in HRT units
12	88	2,6	41	59	1,8
13	87	2,6	42	58	1,7
14	86	2,6	43	57	1,7
15	85	2,6	44	56	1,7
16	84	2,5	45	55	1,7
17	83	2,5	46	54	1,6
18	82	2,5	47	53	1,6
19	81	2,4	48	52	1,6
20	80	2,4	49	51	1,5
21	79	2,4	50	50	1,5
22	78	2,3	51	49	1,5
23	77	2,3	52	48	1,4
24	76	2,3	53	47	1,4
25	75	2,3	54	46	1,4
26	74	2,2	55	45	1,4
27	73	2,2	56	44	1,3
28	72	2,2	57	43	1,3
29	71	2,1	58	42	1,3
30	70	2,1	59	41	1,2
31	69	2,1	60	40	1,2
32	68	2,0	61	39	1,2
33	67	2,0	62	38	1,2
34	66	2,0	63	37	1,2
35	65	2,0	64	36	1,2
36	64	1,9	65	35	1,2
37	63	1,9	66	34	1,2
38	62	1,9	⋮	⋮	⋮
39	61	1,8	⋮	⋮	⋮
40	60	1,8	93	7	1,2

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