INTERNATIONAL STANDARD ISO 3290

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up has the right to be represented on that Committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

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 3290 was drawn up by Technical Committee ISO/TC 4, *Rolling bearings*, and circulated to the Member Bodies in April 1974.

It has been approved by the Member Bodies of the following countries :

Australia	Italy	Switzerland
Austria	Japan	Thailand
Bulgaria	Netherlands	Turkey
Canada	Poland	U.S.A.
France	Romania	U.S.S.R.
Germany	South Africa, Rep. of	Yugoslavia
Hungary	Spain	
India	Sweden	

This International Standard has also been approved by the International Union of Railways (UIC).

The Member Body of the following country expressed disapproval of the document on technical grounds :

United Kingdom

Printed in Switzerland

Rolling bearings — Bearing parts — Balls for rolling bearings

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies requirements for finished steel balls for rolling bearings.

2 DEFINITIONS, SYMBOLS AND EXPLANATIONS

2.1 nominal ball diameter, D_w : The diameter value which is used for the purpose of general identification of a ball size.

2.2 single diameter of a ball, D_{ws} : The distance between two parallel planes tangent to the surface of the ball.

2.3 mean diameter of a ball, D_{wm} : The arithmetic mean of the largest and the smallest actual single diameters of the ball.

2.4 ball diameter variation, $V_{D_{ws}}$: The difference between the largest and smallest actual single diameters of one ball.

2.5 deviation from spherical form : The greatest radial distance in any radial plane between a sphere circumscribed around the ball surface and any point on the ball surface.

Information regarding the measurement of the deviation from spherical form is given in annex B.

2.6 lot : A definite quantity of balls manufactured under conditions which are presumed uniform and which is considered as an entity.

2.7 lot mean diameter, D_{wmL} : The arithmetic mean of the mean diameter of the largest ball and that of the smallest ball in the lot.

2.8 lot diameter variation, $V_{D_{wL}}$: The difference between the mean diameter of the largest ball and that of the smallest ball in the lot.

2.9 ball grade : A specific combination of dimensional, form, surface roughness, and sorting tolerances.

A ball grade is identified by a number.

2.10 ball gauge, S : The amount by which a lot mean diameter should differ from the nominal ball diameter, this amount being one of an established series.

Each ball gauge is a whole multiple of the ball gauge interval established for the ball grade in question. See also annex A.

A ball gauge, in combination with the ball grade and nominal diameter, should be considered as the most exact ball size specification to be used by a customer for ordering purposes.

2.11 deviation from ball gauge, ΔS : The difference between the lot mean diameter and the sum of the nominal diameter and the ball gauge. See also annex A.

$$\Delta S = D_{wmL} - (D_w + S)$$

2.12 ball subgauge : The amount, of an established series of amounts, which is nearest to the actual deviation from a ball gauge.

Each ball subgauge is a whole multiple of the ball subgauge interval established for the ball grade in question. See also annex A.

The ball subgauge, in combination with the nominal ball diameter and the ball gauge, is used by ball manufacturers to denote the lot mean diameter and should not be used by customers for ordering purposes.

2.13 surface roughness : All those irregularities of the surface which are conventionally defined within a section of the area where deviations of form and waviness are eliminated.

The surface roughness tolerance values given in table 2 refer to the arithmetical mean deviation, R_a, from the mean line of the profile, evaluated according to the method specified in ISO/R 468, *Surface roughness.*

2.14 hardness : *The measure of resistance to penetration* as determined by specific methods.

3 REQUIREMENTS

3.1 Ball size

The preferred nominal ball diameters are given in table 1.

3.2 Quality of geometry and surface

Table 2 comprises the applicable tolerances for :

- ball diameter variation;
- deviation from spherical form;
- surface roughness.

It is recognized that other characteristics, such as waviness and surface appearance, are also essential for the quality of balls for rolling bearings. In the absence of internationally established practice in this field, the specifications and tolerances for such characteristics are subject to agreement between customer and supplier.

3.3 Sorting accuracy and ball gauges

Table 3 comprises the applicable values for :

- maximum lot diameter variation;
- gauge interval;
- preferred gauges;
- subgauge interval;
- subgauges.

3.4 Ball grade application

The preferred range of ball sizes to which the different ball grades should be applied is given in table 4.

3.5 Hardness

Hardness values and the measuring method shall be agreed upon between customer and supplier.

TABLE 1 — **Preferred ball sizes**

Nominal ball diameter D_w		Diameter for subgauge 0 of gauge 0	
mm	in	mm	in
0,3		0,300 00	0.011 810
	1/64	0,396 88	0.015 625
0,4		0,400 00	0.015 750
0,5		0,500 00	0.019 680
	0.020	0,508 00	0.020 000
0,6		0,600 00	0.023 620
	0.025	0,635 00	0.025 000
0,7		0,700 00	0.027 560
	1/32	0,793 75	0,031 250
0,8		0,800 00	0.031 496
1		1,000 00	0.039 370
	3/64	1,190 63	0.046 875
1,2		1,200 00	0.047 240
1,5		1,500 00	0.059 060
	1/16	1,587 50	0.062 500
	5/64	1,984 38	0.078 125
2		2,000 00	0.078 740
	3/32	2,381 25	0.093 750
2,5		2,500 00	0.098 420
	7/64	2,778 00	0.109 375
3		3,000 00	0.118 110
	1/8	3,175 00	0.125 000
3,5		3,500 00	0.137 800
	9/64	3,571 87	0.140 625
	5/32	3,968 75	0.156 250
4		4,000 00	0.157 480
	11/64	4,365 63	0.171 875
4,5		4,500 00	0.177 160
	3/16	4,762 50	0.187 500
5		5,000 00	0.196 850
5,5		5,500 00	0.216 540
	7/32	5,556 25	0,218 750
	15/64	5,953 12	0.234 375
6		6,000 00	0.236 220
	1/4	6,350 00	0.250 000
6,5		6,500 00	0.255 900
	17/64	6,746 88	0.265 625
7		7,000 00	0.275 590
	9/32	7,143 75	0.281 250
7,5		7,500 00	0.295 280
	19/64	7,540 63	0.296 875
	5/16	7,937 50	0.312 500
8		8,000 00	0.314 960
8,5		8,500 00	0.334 640
	11/32	8,731 25	0.343 750

Nominal ball diameter D_w		Diameter for subgauge 0 of gauge 0	
mm	in	mm	in
9		9,000 00	0.354 330
	23/64	9,128 12	0.359 375
	3/8	9,525 00	0.375 000
	25/64	9,921 87	0.390 625
10		10,000 00	0.393 700
	13/32	10,318 75	0.406 250
11		11,000 00	0.433 070
	7/16	11,112 50	0.437 500
11,5		11,500 00	0.452 756
	29/64	11,509 38	0.453 125
	15/32	11,906 25	0.468 750
12		12,000 00	0.472 440
	31/64	12,303 12	0.484 375
	1/2	12,700 00	0.500 000
13		13,000 00	0.511 810
	17/32	13,493 75	0.531 250
14		14,000 00	0.551 180
	9/16	14,287 50	0.562 500
15		15,000 00	0.590 550
	19/32	15,081 25	0.593 750
	5/8	15,875 00	0.625 000
16		16,000 00	0.629 920
	21/32	16,668 75	0.656 250
17		17,000 00	0.669 290
	11/16	17,462 50	0.687 500
18		18,000 00	0.708 660
	23/32	18,256 25	0.718 750
19		19,000 00	0.748 030
	3/4	19,050 00	0.750 000
	25/32	19,843 75	0.781 250
20		20,000 00	0.787 400
	13/16	20,637 50	0.812 500
21		21,000 00	0.826 770
	27/32	21,431 25	0.843 750
22		22,000 00	0.866 140
	7/8	22,225 00	0.875 000
23		23,000 00	0.905 510
	29/32	23,018 75	0.906 250
	15/16	23,812 50	0.937 500
24		24,000 00	0.944 880
	31/32	24,606 25	0.968 750
25		25,000 00	0.984 250
	1	25,400 00	1,000 000
26		26,000 00	1.023 620

TABLE 1 (*concluded*)

Nominal ball diameter D_w		Diameter for subgauge 0 of gauge 0	
mm	in	mm	in
	1 1/16	26,987 50	1.062 500
28		28,000 00	1.102 360
	1 1/8	28,575 00	1.125 000
30		30,000 00	1.181 100
	1 3/16	30,162 50	1.187 500
	1 1/4	31,750 00	1.250 000
32		32,000 00	1.259 840
	1 5/16	33,337 50	1.312 500
34		34,000 00	1.338 580
	1 3/8	34,925 00	1.375 000
35		35,000 00	1.377 950
36		36,000 00	1.417 320
	1 7/16	36,512 50	1.437 500
38		38,000 00	1.496 060
	1 1/2	38,100 00	1.500 000
	1 9/16	39,687 50	1.562 500
40		40,000 00	1.574 800
	1 5/8	41,275 00	1.625 000
	1 11/16	42,862 50	1.687 500
	1 3/4	44,450 00	1.750 000
45		45,000 00	1.771 650
	1 13/16	46,037 50	1.812 500
	1 7/8	47,625 00	1.875 000
	1 15/16	49,212 50	1.937 500
50		50,000 00	1.968 500
	2	50,800 00	2.000 000
	2 1/8	53,975 00	2.125 000
55		55,000 00	2.165 354
	2 1/4	57,150 00	2.250 000
60		60,000 00	2.362 205
	2 3/8	60,325 00	2.375 000
	2 1/2	63,500 00	2.500 000
65		65,000 00	2.559 055
	2 5/8	66,675 00	2.625 000
	2 3/4	69,850 00	2.750 000
	2 7/8	73,025 00	2.875 000
	3	76,200 00	3.000 000
	3 1/8	79,375 00	3.125 000
	3 1/4	82,550 00	3.250 000
	3 3/8	85,725 00	3.375 000
	3 1/2	88,900 00	3.500 000
	3 5/8	92,075 00	3.625 000
	3 3/4	95,250 00	3.750 000
	3 7/8	98,425 00	3.875 000
	4	101,600 00	4.000 000
	4 1/8	104,775 00	4.125 000
	4 1/4	107,950 00	4.250 000
	4 3/8	111,125 00	4.375 000
	4 1/2	114,300 00	4.500 000

TABLE 2 — **Form and surface roughness tolerances**

Grade	Ball diameter variation V_{Dws}	Deviation from spherical form	Surface roughness R_a
	Maximum values in micrometres		
3	0,08	0,08	0,012
5	0,13	0,13	0,02
10	0.25	0,25	0,025
16	0,4	0,4	0,032
20	0,5	0,5	0,04
28	0,7	0,7	0,05
40	1	1	0,08
100	2,5	2,5	0,125
200	5	5	0,2
	Maximum values in microinches		
3	3	3	0.5
5	5	5	0.8
10	10	10	1
16	16	16	1.25
20	20	20	1.6
28	28	28	2
40	40	40	3 2
100	100	100	5
200	200	200	8

TABLE 3 – **Sorting tolerances and gauges**

Grade	Lot diameter variation V_{DwL} max.	Gauge interval	Preferred gauges	Subgauge interval	Subgauges
	Values in micrometres				
3	0,13	0,5	− 5, . . . − 0,5, 0, + 0,5, . . . + 5	0,1	− 0,2, − 0,1, 0, + 0,1, + 0,2
5	0,25	1	− 5, . . . − 1, 0, + 1, ... + 5	0,2	− 0,4, − 0,2, 0, + 0,2, + 0,4
10	0,5	1	− 9, . . . − 1, 0, + 1, ... + 9	0,2	− 0,4, − 0,2, 0, + 0,2, + 0,4
* 16	0,8	2	− 10, . . . − 2, 0, + 2, ... + 10	0,4	− 0,8, − 0,4, 0, + 0,4, + 0,8
* 20	1	2	− 10, . . . − 2, 0, + 2, ... + 10	0,4	− 0,8, − 0,4, 0, + 0,4, + 0,8
* 28	1,4	2	− 12, . . . − 2, 0, + 2, ... + 12	0,4	− 0,8, − 0,4, 0, + 0,4, + 0,8
40	2	4	− 16, . . . − 4, 0, + 4, ... + 16	0,8	− 1,6, − 0,8, 0, + 0,8, + 1,6
100	5	10	− 40, . . − 10, 0, + 10, . . . + 40	2	− 4, − 2, 0, + 2, + 4
200	10	15	− 60, . . − 15, 0, + 15, . . . + 60	3	− 6, − 3, 0, + 3, + 6
	Values in microinches				
3	5	20	− 200, . . . − 20, 0, + 20, . . . + 200	4	− 8, − 4, 0, + 4, + 8
5	10	40	− 200, . . . − 40, 0, + 40, . . . + 200	8	− 16, − 8, 0, + 8, + 16
10	20	40	− 360, . . . − 40, 0, + 40, . . . + 360	8	− 16, − 8, 0, + 8, + 16
* 16	32	80	− 400, . . . − 80, 0, + 80, . . . + 400	16	− 32, − 16, 0, + 16, + 32
* 20	40	80	− 400, . . . − 80, 0, + 80, . . . + 400	16	− 32, − 16, 0, + 16, + 32
* 28	56	80	− 480, . . . − 80, 0, + 80, . . . + 480	16	− 32, − 16, 0, + 16, + 32
40	80	160	− 640, . . − 160, 0, + 160, . . . + 640	32	− 64, − 32, 0, + 32, + 64
100	200	400	− 1 600, . . − 400, 0, + 400, . . + 1 600	80	− 160, − 80, 0, + 80, + 160
200	400	600	− 2 400, . . − 600, 0, + 600, . . + 2 400	120	− 240, − 120, 0, + 120, + 240

* In exceptional cases and after agreement between customer and manufacturer, half the gauge and subgauge interval values may be used for grades 16, 20 and 28.

TABLE 4 – **Applicability of ball grades**

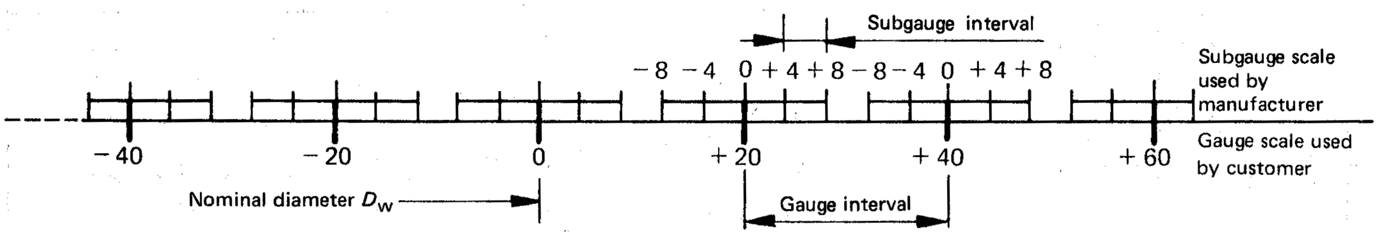
Grade	Preferred range of nominal ball diameters to which the grade is applicable			
	mm		in	
	over	incl.	over	incl.
3	–	12	–	1/2
5	–	12	–	1/2
10	–	25	–	1
16	–	25	–	1
20	–	38	–	1 1/2
28	–	38	–	1 1/2
40	–	50	–	2
100	–	all	–	all
200	–	all	–	all

ANNEX A

ILLUSTRATION OF GAUGES AND SORTING PRINCIPLES

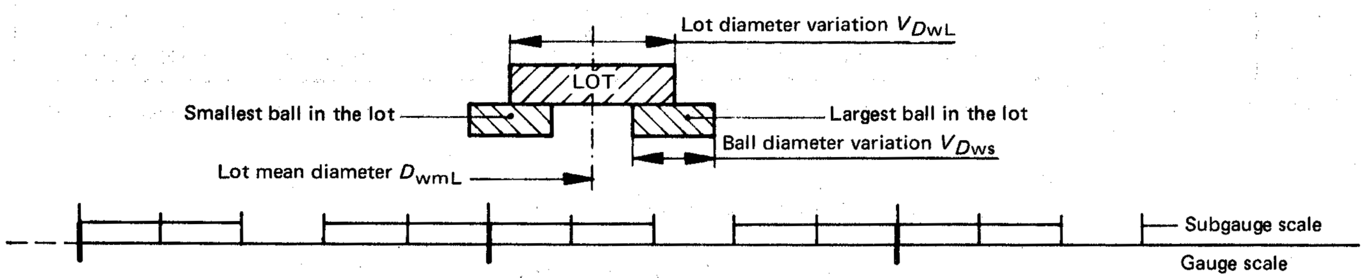
A.1 GAUGE AND SUBGAUGE

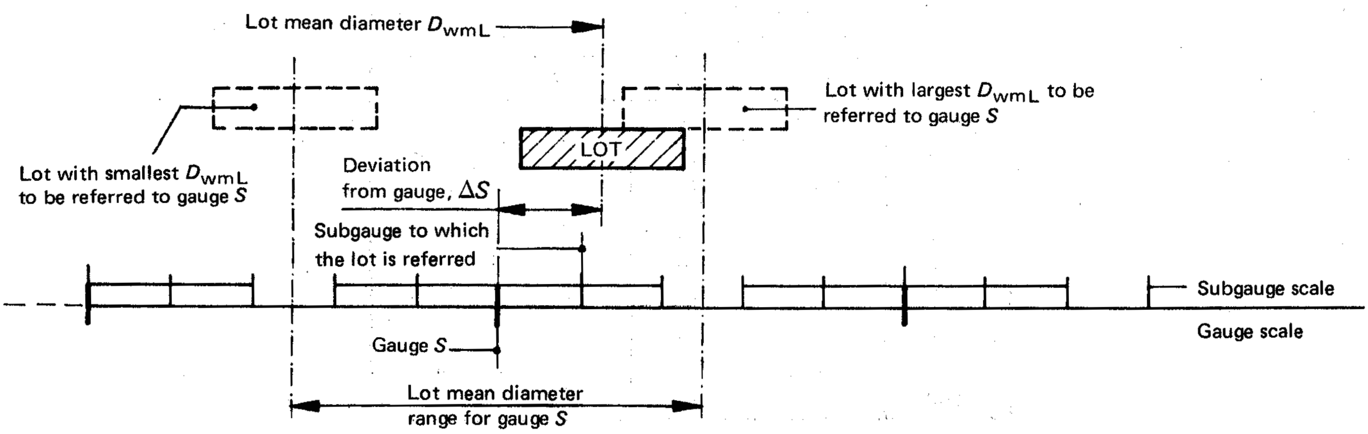
Example 1 : Grade 3, values in microinches



Example 2 : Grade 5, values in micrometres

A.2 LOT AND GAUGE DEVIATION





ANNEX B

MEASUREMENT OF DEVIATION FROM SPHERICAL FORM

B.1 METHOD USING ROUNDNESS MEASURING INSTRUMENT

Considering the wide range of sizes of steel balls for rolling bearings, from 0,3 mm to 114,3 mm (4 1/2 in), the measurement of deviation from spherical form may be a difficult and slow process requiring special equipment. In practice it is usually measured by a numerical evaluation of the ball profile, in two or three equatorial planes at 90° to each other, as recorded on a polar chart which shows the measured profiles. The measured profile is a graphical representation of the ball's radial deviations, highly magnified, which are recorded as either the ball or a contacting stylus is precisely rotated about the ball axis. The accuracy of spindle rotation and the sensitivity of the transducer should be within 0,025 µm (10^{-6} in). Because of the high radial magnification, some care must be taken in interpreting the polar charts, and there are several commonly used procedures for finding the radial separation of the measured profile from a perfect circle. The minimum circumscribed circle method is relatively simple and is generally satisfactory for ball profiles, as is also the assumption that two or three equatorial profiles at 90° to each other are a good indication of deviation from spherical form.

B.2 METHOD USING VEE-BLOCK MEASUREMENTS

Deviation from spherical form in steel balls for rolling bearings may result in equatorial profiles having two or more waves or radial deviations from a perfect circle. Measuring single diameters of a ball will give a good indication of out-of-roundness for two waves or even numbers of waves but may fail to detect or properly measure out-of-roundness having odd numbers of waves. For medium and large balls it is practical to use a Vee-block measuring device, arranged as shown in the figure, to measure the out-of-roundness of the profile having odd numbers of waves. The angle of the Vee has a pronounced influence on the indicator reading and no one angle is adequate for all waviness. The most practical Vee angles appear to be 90° and 120° and the magnification factor for the ratio of the indicator reading to the actual wave height or deviation from spherical form is shown in the table below the sketch. To determine the deviation from spherical form, divide the indicator reading by this factor.

When the number of waves in the profile is unknown, which is most usual, readings in three planes at 90° to each other should be taken on a single diameter (two-point) measuring device and on both the 90° and 120° Vee-block (three-point) measuring devices. Dividing the highest reading obtained with either Vee-block measuring device by a factor of 2 to determine the deviation from spherical form for odd numbers of waves is considered acceptable.