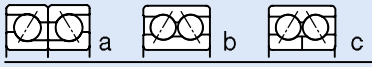
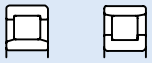
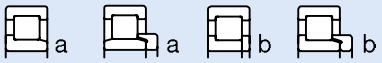
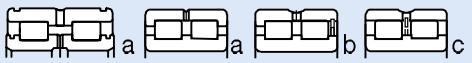
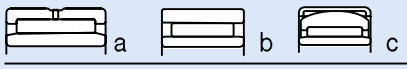
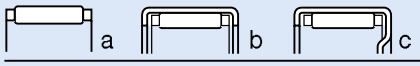
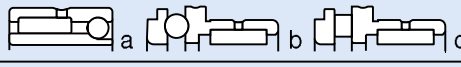
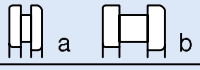
Selection of bearing type

The matrix can only provide a rough guide so that in each individual case it is necessary to make a more qualified selection referring to the information given on the preceding pages or the detailed information in the text preceding each table section. If several designs of the bearing type are shown adjacent to each other, the relevant information is indicated by the same small letter used to identify the individual design.

Symbols:

+++ excellent	– poor
++ good	– – unsuitable
+ fair	← single direction
	← → double direction

Bearing type	Bearing types – design and characteristics Design tapered bore	shields or seals	self-aligning	non-seperable	separable
Deep groove ball bearings 		a			
Angular contact ball bearings, single row 					
matched single row, double row 		b		a, b	c
four-point contact 					
Self-aligning ball bearings 					
Cylindrical roller bearings, with cage 					
					
full complement, single row 				a	b
full complement, double row 		a			
Needle roller bearings, with steel rings 		a	c		
assemblies/drawn cups 		b, c			
combined bearings 		b, c			
Taper roller bearings, single row 					
matched single row 					
Spherical roller bearings 					
CARB toroidal roller bearings, with cage 					
full complement 					
Thrust ball bearings 					
with sphered housing washer 					
Needle roller thrust bearings Cylindrical roller thrust bearings 					
Spherical roller thrust bearings 					

Characteristics
Suitability of bearings for

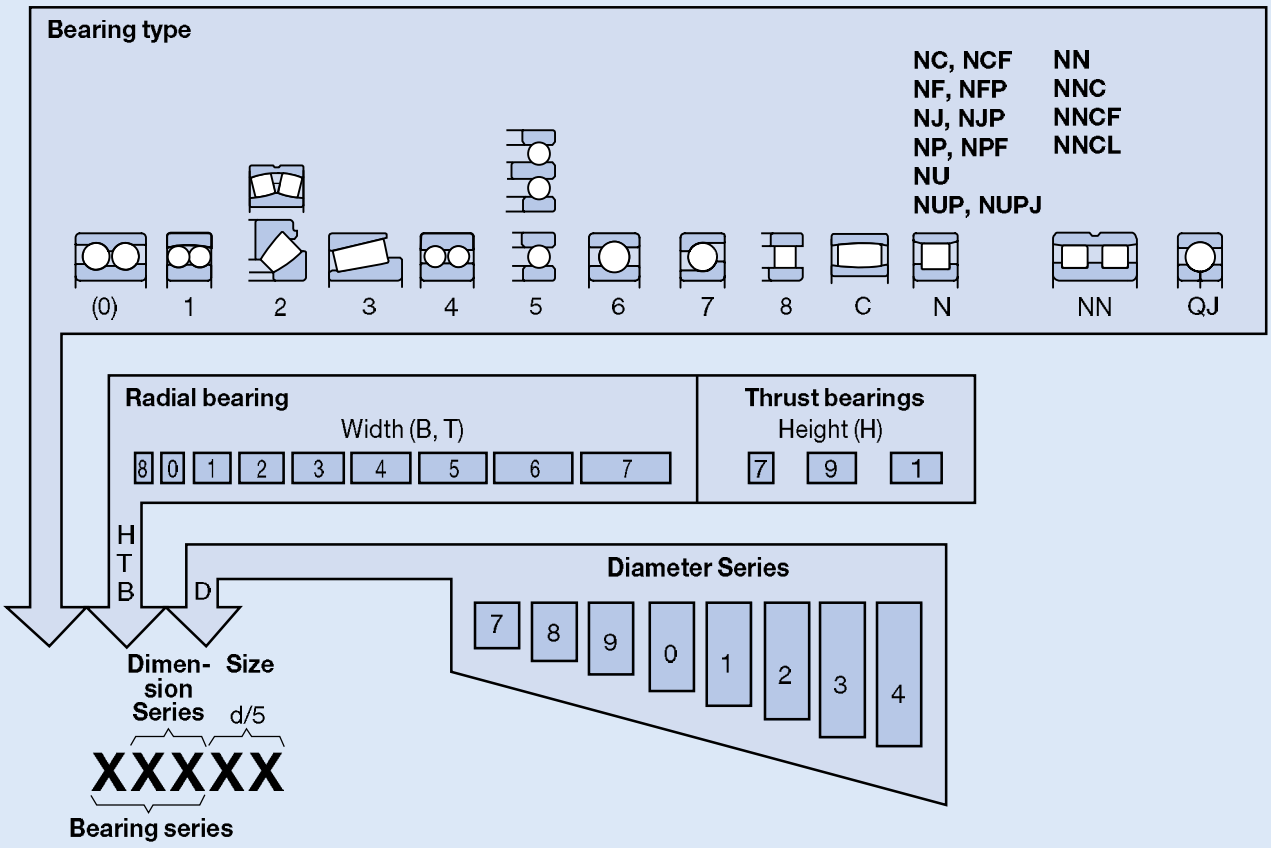
purely radial load	purely axial load	combined load	moment load	high speed	high running accuracy	high stiffness	quiet running	low friction	compensation for misalignment in operation	compensation for errors of alignment (initial)	locating bearing arrangements	non-locating bearing arrangements	axial displacement possible in bearing
+	+ ←→	+ ←→	− b+	+++ b+	+++ b+	+	+++	+++	−	−	++ ←→	+	−−
+	+ ←	++ ←	−	++	+++	+	++	++	−	−	++ ←	−−	−−
++	+ ←→	++ ←→	+	+	++	++	+	+	−−	−−	++ ←→	+	−−
−	++ ←→	+ ←→	+	++	+	+	+	+	−−	−−	++ ←→	−	−−
+	−	−	−−	+++	++	−	++	+++	+++	+++	+ ←→	+	−−
++	−−	−−	−−	++	++	++	++	++	−	−	−−	+++	+++
++	+ a← b←→	+ a← b←→	−−	++	++	++	+	++	−	−	++ a← b←→	+ a←	+ a←
+++	−	+ ←	−−	−	+	+++	−	−	−	−	+ ←	+	+
+++	−	+ a←→ b←	+	−	+	+++	−	−	−−	−−	+ a←→ b←	+ c	+ b← c←→
++	−−	−−	−−	+	+ a++	a++ b++	+	−	−−	−− c++	−−	+++	+++
++	−−	−−	−−	+	+	++	+	−	−−	−−	−−	+++	+++
+	+ c++ ←	+ ←	−	+	+	++	+	−	−−	−−	+ ←	−−	−−
++	++ ←	+++ ←	−	+	+	++	+	+	−	−	+++ ←	−−	−−
+++	++ ←→	+++ ←→	+	+	+	+++	+	+	−	−−	+++ ←→	−	−−
+++	+ ←→	+++ ←→	−−	+	+	++	+	+	+++	+++	++ ←→	+	−−
+++	−−	−−	−−	+	+	++	+	+	+++	+++	−−	+++	+++
+++	−−	−−	−−	−	+	+++	+	+	+++	+++	−−	+++	+++
−−	+ a← b←→	−−	−−	−	++ a	+	−	+	−	−−	++ a← b←→	−−	−−
−−	+ a← b←→	−−	−−	−	+	+	−	+	−	++	++ a← b←→	−−	−−
−−	++ ←	−−	−−	−	a+ b++	++	−	−	−−	−−	++ ←	−−	−−
−−	+++ ←	+ ←	−−	−	+	++	−	+	+++	+++	+++ ←	−−	−−

Diagram 2

Designation system for SKF standard metric ball and roller bearings

Bearing series

						6(0)4						
						623						
					544	6(0)3				(0)4		
		223			524	622				33		
		213			543	6(0)2				23		
		232			523	630			23	(0)3		
		222			542	6(1)0			32	22		
		241			522	16(0)0			22	12		
		231				639			41	(0)2		
		240	323		534	619			31	31	41	
		230	313		514	609			60	30	31	
		249	303		533	638			50	20	60	
	139	239	332		513	628	7(0)4	814	40	10	50	
	130	248	322		532	618	7(0)3	894	30	39	40	23
	(1)23	238	302		512	608	7(0)2	874	69	29	30	(0)3
	1(0)3		331		511	637	7(1)0	813	59	19	69	12
	(1)22	294	330		510	627	719	893	49	38	49	(0)2
(0)33	1(0)2	293	320	4(2)3	591	617	718	812	39	28	39	10
(0)32	1(1)0	292	329	4(2)2	590	607	708	811	29	18	48	19



Code	Bearing type	Code	Bearing type	Code	Bearing type
0	Double row angular contact ball bearings	**7**	Single row angular contact ball bearings	**QJ**	Four-point contact ball bearings
1	Self-aligning ball bearings	**8**	Cylindrical roller thrust bearings	**T**	Taper roller bearings according to ISO 355-1977
2	Spherical roller bearings, spherical roller thrust bearings	**C**	CARB toroidal roller bearings		
3	Taper roller bearings	**N**	Cylindrical roller bearings. A second and sometimes a third letter are used to identify the number of the rows or the configuration of the flanges, e.g. NJ, NU, NUP, NN, NNU, NNCF etc.		
4	Double row deep groove ball bearings				
5	Thrust ball bearings				
6	Single row deep groove ball bearings				

Bearing arrangements

The bearing arrangement of a rotating machine component, e.g. a shaft, generally requires two bearings to support and locate the component radially and axially relative to the stationary part of the machine, such as a housing. Depending on the application, load, requisite running accuracy and cost considerations the arrangement may consist of

- locating and non-locating bearing arrangements,
- adjusted bearing arrangements, or
- “floating” bearing arrangements.

Bearing arrangements consisting of a single bearing which can support radial, axial and moment loads, e.g. for an articulated joint, are not dealt with in this catalogue. If such arrangements are required it is advisable to contact the SKF application engineering service.

Locating and non-locating bearing arrangements

The locating bearing at one end of the shaft provides radial support and at the same time locates the shaft axially in both directions. It must, therefore, be fixed in position both on the shaft and in the housing. Suitable bearings are radial bearings which can accommodate combined loads, e.g. deep groove ball bearings, double row or paired single row angular contact ball bearings, self-aligning ball bearings, spherical roller bearings or matched taper roller bearings. Combinations of a radial bearing that can accommodate purely radial load, e.g. a cylindrical roller bearing having one ring without flanges, with a deep groove ball bearing, four-point contact ball bearing or a double direction thrust bearing can also be used as the locating bearing. The second bearing then provides axial location in both directions but must be mounted with radial freedom (i.e. have a clearance fit) in the housing.

The non-locating bearing at the other end of the shaft provides radial support only. It must also allow axial displacement so that the bearings do not mutually stress each other, e.g. when the shaft length changes as a result of thermal expansion. Axial displace-

Fig 1

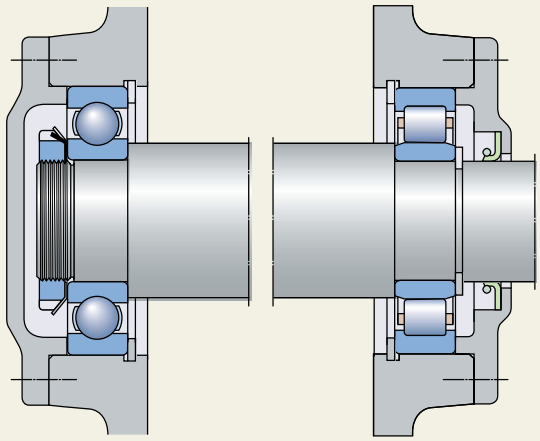


Fig 2

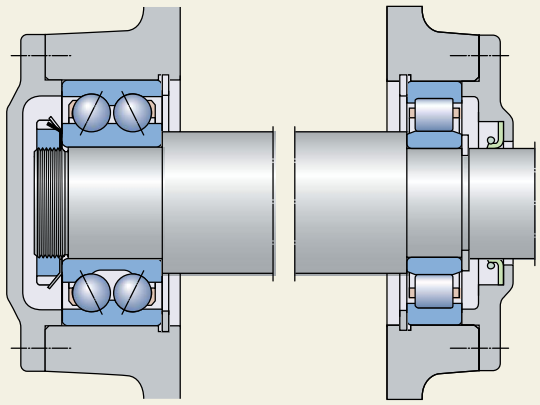


Fig 3

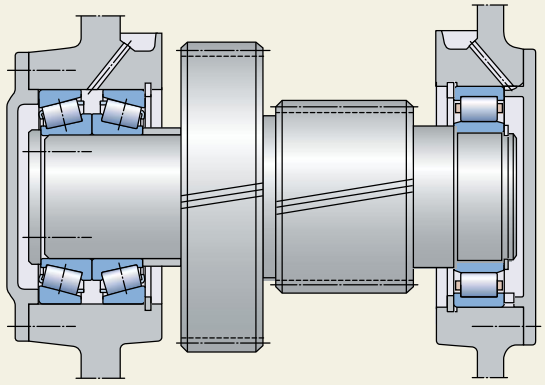


Fig 4

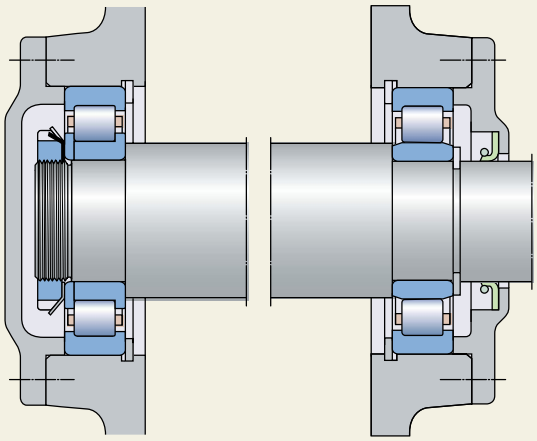


Fig 5

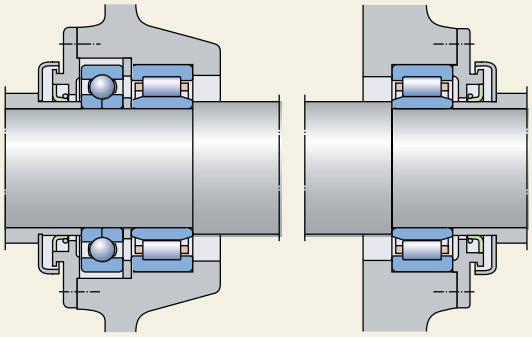
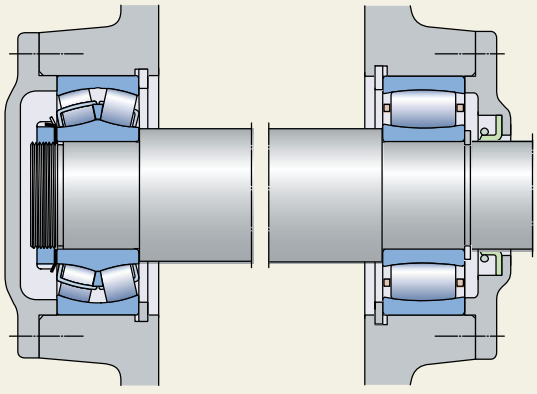


Fig 6



ment can take place within the bearing in the case of needle roller bearings, NU- and N-design cylindrical roller bearings and CARB toroidal roller bearings, or between one of the bearing rings and its seating, preferably between the outer ring and its seating in the housing bore.

From the large number of locating/non-locating bearing combinations the popular combinations are described in the following.

For stiff bearing arrangements where “frictionless” axial displacements should take place within the bearing the following combinations may be used:

- deep groove ball bearing/cylindrical roller bearing (→ **fig** 1),
- double row angular contact ball bearing/cylindrical roller bearing (→ **fig** 2),
- matched single row taper roller bearings/cylindrical roller bearing (→ **fig** 3),
- NUP-design cylindrical roller bearing/NU-design cylindrical roller bearing (→ **fig** 4), or
- NU-design cylindrical roller bearing and four-point contact ball bearing/NU-design cylindrical roller bearing (→ **fig** 5).

For the above combinations, angular misalignment of the shaft must be kept to a minimum. If this is not possible it is advisable to use combinations of self-aligning bearings to allow for misalignment, viz.

- self-aligning ball bearing/CARB toroidal roller bearing or
- spherical roller bearing/CARB toroidal roller bearing (→ **fig** 6).

The abillity of these arrangements to accommodate angular misalignments as well as axial displacements avoids generating internal axial forces in the bearing system.

For bearing arrangements with rotating inner ring load, where changes in the shaft length are to be accommodated between the bearing and its seating, axial displacement should take place between the outer ring of the bearing and the housing. The most usual combinations are

- deep groove ball bearing/deep groove ball bearing (→ **fig** 7),
- self-aligning ball or spherical roller bearing/self-aligning ball or spherical roller bearing (→ **fig** 8) and
- matched single row angular contact ball bearings/deep groove ball bearing (→ **fig** 9).

Adjusted bearing arrangements

In adjusted bearing arrangements the shaft is axially located in one direction by the one bearing and in the opposite direction by the other bearing. This type of arrangement is referred to as "cross located" and is generally used for short shafts. Suitable bearings include all types of radial bearings that can accommodate axial loads in at least one direction, including

- angular contact ball bearings (→ **fig** 10) and
- taper roller bearings (→ **fig** 11).

In certain cases where single row angular contact ball bearings or taper roller bearings are used for cross-located arrangements, preload may be necessary (→ **page 206**).

"Floating" bearing arrangements

Floating bearing arrangements are also cross located and are suitable where demands regarding axial location are moderate or where other components on the shaft serve to locate it axially.

Suitable bearings for this type of arrangement are:

- deep groove ball bearings (→ **fig** 12),
- self-aligning ball bearings or
- spherical roller bearings.

In these types of arrangements it is important that one ring of each bearing should be able to move on or in its seating, preferably the outer ring in the housing. A floating bearing arrangement can also be obtained with two NJ-design cylindrical roller bearings, with offset inner rings (→ **fig** 13). In this case the axial movement can take place within the bearing.

Fig 7

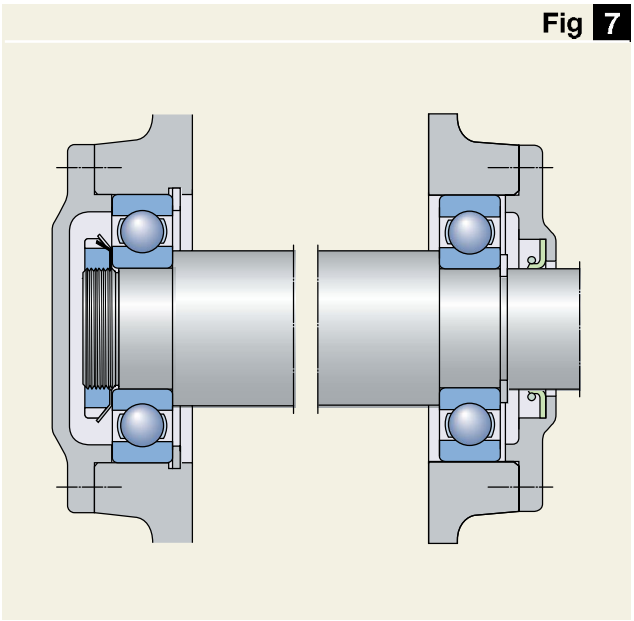


Fig 8

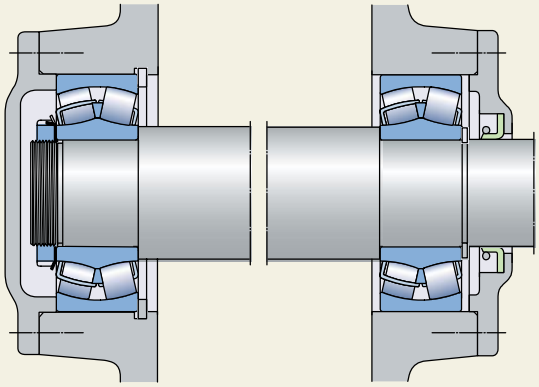


Fig 9

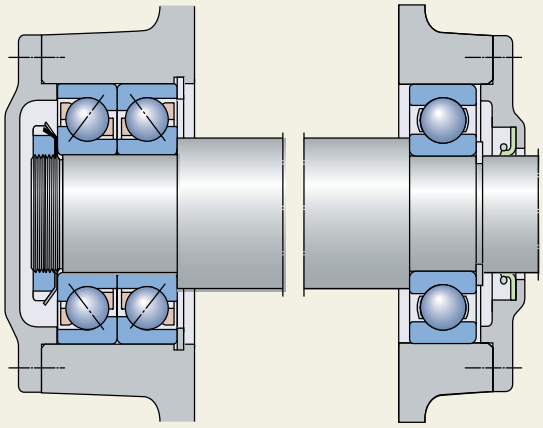


Fig 10

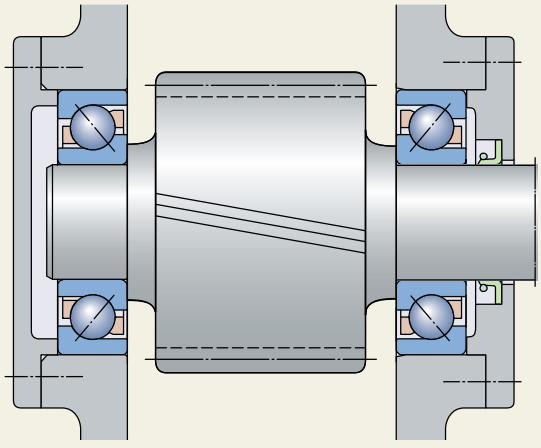


Fig 11

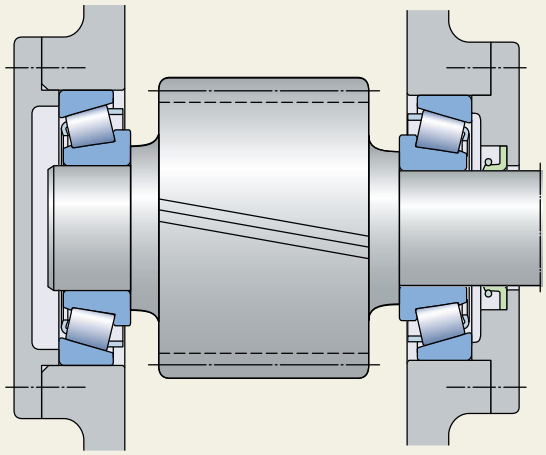


Fig 12

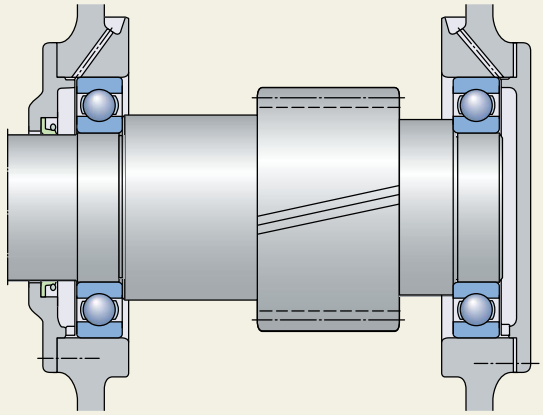


Fig 13

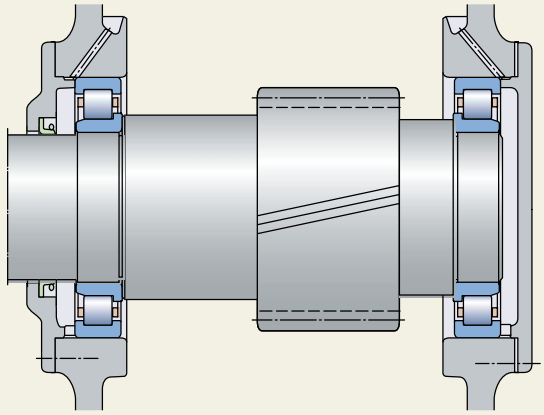


Table 2

Fits for solid steel shafts

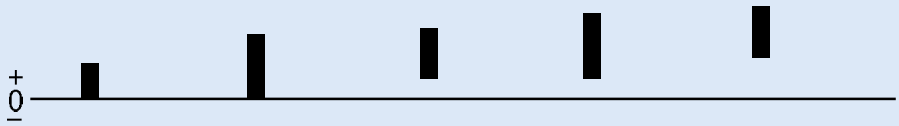
Radial bearings with cylindrical bore

Conditions	Examples	Shaft diameter, mm			Tolerance
		Ball bearings	Cylindrical and taper roller bearings	CARB and spherical roller bearings	
Rotating inner ring load or direction of load indeterminate					
Light and variable loads ($P \leq 0,06\ C$)	Conveyors, lightly loaded gearbox bearings	(18) to 100 (100) to 140	≤ 40 (40) to 100	–	j6 k6
Normal and heavy loads ($P > 0,06\ C$)	Bearing applications generally, electric motors, turbines, pumps, internal combustion engines, gearing, woodworking machines	≤ 18 (18) to 100 (100) to 140 (140) to 200 (200) to 280 – – –	– ≤ 40 (40) to 100 (100) to 140 (140) to 200 (200) to 400 – –	– ≤ 40 (40) to 65 (65) to 100 (100) to 140 (140) to 280 (280) to 500 > 500	j5 k5 (k6)[1] m5 (m6)[1] m6 n6 p6 r6[2] r7[2]
Very heavy loads and shock loads with difficult working conditions ($P > 0,12\ C$)	Axleboxes for heavy railway vehicles, traction motors, rolling mills	– – –	(50) to 140 (140) to 200 > 200	(50) to 100 (100) to 140 > 140	n6[2] p6[2] r6[2]
High demands on running accuracy with light loads ($P \leq 0,06\ C$)	Machine tools	8 to 240 – – – –	– 25 to 40 (40) to 140 (140) to 200 (200) to 500	– – – – –	js4 js4 (j5)[3] k4 (k5)[3] m5[3] n5[3]
Stationary inner ring load					
Easy axial displacement of inner ring on shaft desirable	Wheels on non-rotating axles				g6[4]
Easy axial displacement of inner ring on shaft unnecessary	Tension pulleys, rope sheaves				h6
Axial loads only					
	Bearing applications of all kinds	≤ 250 > 250	≤250 > 250	≤ 250 > 250	j6 js6

[1] The tolerances in brackets are generally used for taper roller bearings and single row angular contact ball bearings, they can also be used for other types of bearing where speeds are moderate and the effect of bearing internal clearance variation is not significant
[2] Bearings with radial internal clearance greater than Normal may be necessary
[3] The tolerances in brackets apply to taper roller bearings. For lightly loaded taper roller bearings adjusted via the inner ring, js5 or js6 should be used
[4] Tolerance f6 can be selected for large bearings to provide easy displacement

Table 7d

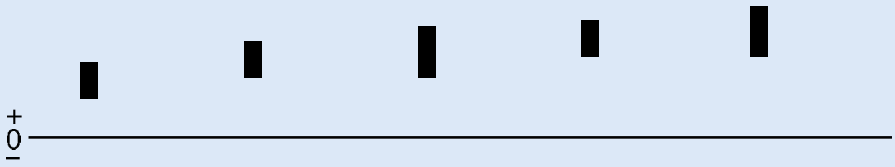
Shaft tolerances and resultant fits



Shaft Nominal diameter d		Bearing Bore diameter tolerance Δ_{dmp}		Deviations of shaft diameter, resultant fits Tolerances									
				k5		k6		m5		m6		n5	
				Deviations (shaft diameter) Theoretical interference (+)/clearance (–) Probable interference (+)/clearance (–)									
over	incl.	low	high										
mm		µm		µm									
1	**3**	–8	0	+4 +12 +11	0 0 +1	+6 +14 +12	0 0 +2	+6 +14 +13	+2 +2 +3	+8 +16 +14	+2 +2 +4	+8 +16 +15	+4 +4 +5
3	**6**	–8	0	+6 +14 +13	+1 +1 +2	+9 +17 +15	+1 +1 +3	+9 +17 +16	+4 +4 +5	+12 +20 +18	+4 +4 +6	+13 +21 +20	+8 +8 +9
6	**10**	–8	0	+7 +15 +13	+1 +1 +3	+10 +18 +16	+1 +1 +3	+12 +20 +18	+6 +6 +8	+15 +23 +21	+6 +6 +8	+16 +24 +22	+10 +10 +12
10	**18**	–8	0	+9 +17 +15	+1 +1 +3	+12 +20 +18	+1 +1 +3	+15 +23 +21	+7 +7 +9	+18 +26 +24	+7 +7 +9	+20 +28 +26	+12 +12 +14
18	**30**	–10	0	+11 +21 +19	+2 +2 +4	+15 +25 +22	+2 +2 +5	+17 +27 +25	+8 +8 +10	+21 +31 +28	+8 +8 +11	+24 +34 +32	+15 +15 +17
30	**50**	–12	0	+13 +25 +22	+2 +2 +5	+18 +30 +26	+2 +2 +6	+20 +32 +29	+9 +9 +12	+25 +37 +33	+9 +9 +13	+28 +40 +37	+17 +17 +20
50	**80**	–15	0	+15 +30 +26	+2 +2 +6	+21 +36 +32	+2 +2 +6	+24 +39 +35	+11 +11 +15	+30 +45 +41	+11 +11 +15	+33 +48 +44	+20 +20 +24
80	**120**	–20	0	+18 +38 +33	+3 +3 +8	+25 +45 +39	+3 +3 +9	+28 +48 +43	+13 +13 +18	+35 +55 +49	+13 +13 +19	+38 +58 +53	+23 +23 +28
120	**180**	–25	0	+21 +46 +40	+3 +3 +9	+28 +53 +46	+3 +3 +10	+33 +58 +52	+15 +15 +21	+40 +65 +58	+15 +15 +22	+45 +70 +64	+27 +27 +33
180	**250**	–30	0	+24 +54 +48	+4 +4 +10	+33 +63 +55	+4 +4 +12	+37 +67 +61	+17 +17 +23	+46 +76 +68	+17 +17 +25	+51 +81 +75	+31 +31 +37
250	**315**	–35	0	+27 +62 +54	+4 +4 +12	+36 +71 +62	+4 +4 +13	+43 +78 +70	+20 +20 +28	+52 +87 +78	+20 +20 +29	+57 +92 +84	+34 +34 +42
315	**400**	–40	0	+29 +69 +61	+4 +4 +12	+40 +80 +69	+4 +4 +15	+46 +86 +78	+21 +21 +29	+57 +97 +86	+21 +21 +32	+62 +102 +94	+37 +37 +45
400	**500**	–45	0	+32 +77 +68	+5 +5 +14	+45 +90 +78	+5 +5 +17	+50 +95 +86	+23 +23 +32	+63 +108 +96	+23 +23 +35	+67 +112 +103	+40 +40 +49

Table 7e

Shaft tolerances and resultant fits



Shaft Nominal diameter d		Bearing Bore diameter tolerance Δ_{dmp}		Deviations of shaft diameter, resultant fits Tolerances									
				n6		p6		p7		r6		r7	
				Deviations (shaft diameter) Theoretical interference (+)/clearance (–) Probable interference (+)/clearance (–)									
over	incl.	low	high										
mm		µm		µm									
80	**100**	–20	0	+45 +65 +59	+23 +23 +29	+59 +79 +73	+37 +37 +43	+72 +92 +85	+37 +37 +44	+73 +93 +87	+51 +51 +57	+86 +106 +99	+51 +51 +58
100	**120**	–20	0	+45 +65 +59	+23 +23 +29	+59 +79 +73	+37 +37 +43	+72 +92 +85	+37 +37 +44	+76 +96 +90	+54 +54 +60	+89 +109 +102	+54 +54 +61
120	**140**	–25	0	+52 +77 +70	+27 +27 +34	+68 +93 +86	+43 +43 +50	+83 +108 +100	+43 +43 +51	+88 +113 +106	+63 +63 +70	+103 +128 +120	+63 +63 +71
140	**160**	–25	0	+52 +77 +70	+27 +27 +34	+68 +93 +86	+43 +43 +50	+83 +108 +100	+43 +43 +51	+90 +115 +108	+65 +65 +72	+105 +130 +122	+65 +65 +73
160	**180**	–25	0	+52 +77 +70	+27 +27 +34	+68 +93 +86	+43 +43 +50	+83 +108 +100	+43 +43 +51	+93 +118 +111	+68 +68 +75	+108 +133 +125	+68 +68 +76
180	**200**	–30	0	+60 +90 +82	+31 +31 +39	+79 +109 +101	+50 +50 +58	+96 +126 +116	+50 +50 +60	+106 +136 +128	+77 +77 +85	+123 +153 +143	+77 +77 +87
200	**225**	–30	0	+60 +90 +82	+31 +31 +39	+79 +109 +101	+50 +50 +58	+96 +126 +116	+50 +50 +60	+109 +139 +131	+80 +80 +88	+126 +156 +146	+80 +80 +90
225	**250**	–30	0	+60 +90 +82	+31 +31 +39	+79 +109 +101	+50 +50 +58	+96 +126 +116	+50 +50 +60	+113 +143 +135	+84 +84 +92	+130 +160 +150	+84 +84 +94
250	**280**	–35	0	+66 +101 +92	+34 +34 +43	+88 +123 +114	+56 +56 +65	+108 +143 +131	+56 +56 +68	+126 +161 +152	+94 +94 +103	+146 +181 +169	+94 +94 +106
280	**315**	–35	0	+66 +101 +92	+34 +34 +43	+88 +123 +114	+56 +56 +65	+108 +143 +131	+56 +56 +68	+130 +165 +156	+98 +98 +107	+150 +185 +173	+98 +98 +110
315	**355**	–40	0	+73 +113 +102	+37 +37 +48	+98 +138 +127	+62 +62 +73	+119 +159 +146	+62 +62 +75	+144 +184 +173	+108 +108 +119	+165 +205 +192	+108 +108 +121
355	**400**	–40	0	+73 +113 +102	+37 +37 +48	+98 +138 +127	+62 +62 +73	+119 +159 +146	+62 +62 +75	+150 +190 +179	+114 +114 +125	+171 +211 +198	+114 +114 +127
400	**450**	–45	0	+80 +125 +113	+40 +40 +52	+108 +153 +141	+68 +68 +80	+131 +176 +161	+68 +68 +83	+166 +211 +199	+126 +126 +138	+189 +234 +219	+126 +126 +141

Mounting bearings with tapered bore

Self-aligning ball bearings with a tapered bore are always mounted with an interference fit on a tapered shaft seating or an adapter or withdrawal sleeve. As a measure of the degree of interference of the fit, either the reduction in radial internal clearance of the bearing or the axial displacement of the inner ring on its tapered seating is used.

Suitable methods for mounting self-aligning ball bearings with tapered bore are:

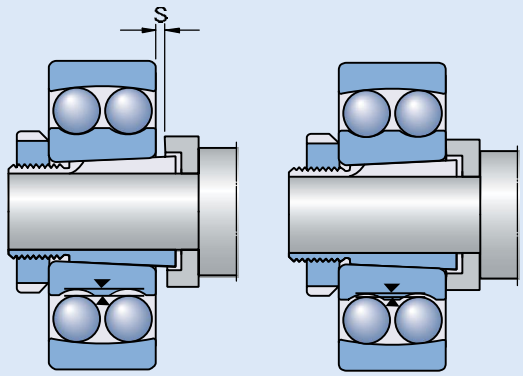
- measuring the clearance reduction,
- measuring the lock nut tightening angle,
- measuring the axial drive-up.

Measuring the clearance reduction

When mounting basic design self-aligning ball bearings with the relatively small Normal radial internal clearance, it is generally sufficient to check clearance during the drive-up by turning and swivelling out the outer ring. When the bearing is properly mounted the outer ring can be easily turned but there should be a slight resistance when the outer ring is swivelled out. The bearing will then have the requisite interference fit. In some cases the residual internal clearance may be too small for the application, and a bearing with C3 radial internal clearance should be used instead.

Table 6

Mounting self-aligning ball bearings with a tapered bore

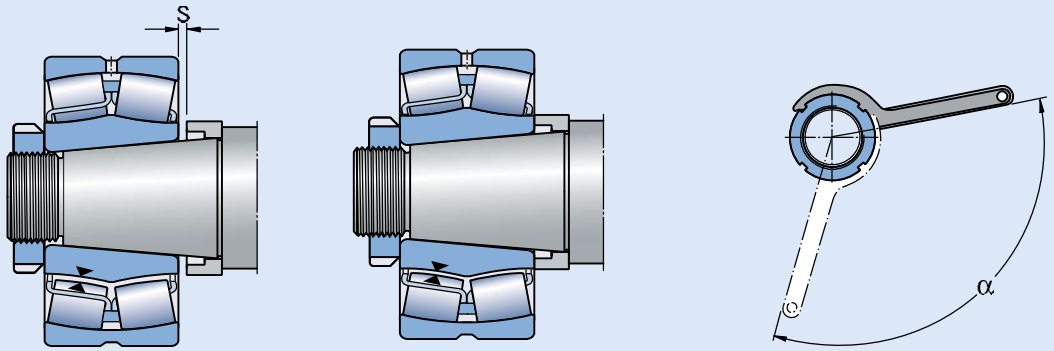


Bore diameter d	Tightening angle[1] α	Axial drive-up s
mm	degrees	mm
20	80	0,22
25	55	0,22
30	55	0,22
35	70	0,30
40	70	0,30
45	80	0,35
50	80	0,35
55	75	0,40
60	75	0,40
65	80	0,40
70	80	0,40
75	85	0,45
80	85	0,45
85	110	0,60
90	110	0,60
95	110	0,60
100	110	0,60
110	125	0,70
120	125	0,70

[1] Valid for bearings with Normal radial clearance. For bearings with C3 radial clearance the guideline values can be increased by approximately 15 to 20°

Table 6

Guideline values for reduction of radial internal clearance, axial drive-up and lock nut tightening angle

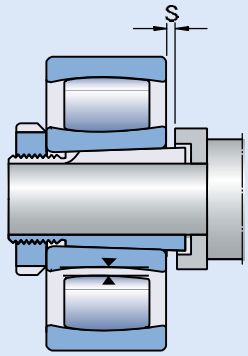


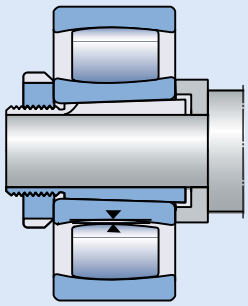
Bore diameter d		Reduction of radial internal clearance		Axial drive-up[1] s				Permissible residual[2] radial clearance after mounting bearings with initial clearance			Lock nut tightening angle α
				Taper 1:12		Taper 1:30					
over	incl.	min	max	min	max	min	max	Normal	C3	C4	
mm		mm		mm				mm			degrees
24	**30**	0,015	0,020	0,3	0,35	–	–	0,015	0,020	0,035	110
30	**40**	0,020	0,025	0,35	0,4	–	–	0,015	0,025	0,040	120
40	**50**	0,025	0,030	0,4	0,45	–	–	0,020	0,030	0,050	130
50	**65**	0,030	0,040	0,45	0,6	3	4	0,025	0,035	0,055	110
65	**80**	0,040	0,050	0,6	0,7	3,2	4,2	0,025	0,040	0,070	130
80	**100**	0,045	0,060	0,7	0,9	1,7	2,2	0,035	0,050	0,080	150
100	**120**	0,050	0,070	0,75	1,1	1,9	2,7	0,050	0,065	0,100	–
120	**140**	0,065	0,090	1,1	1,4	2,7	3,5	0,055	0,080	0,110	–
140	**160**	0,075	0,100	1,2	1,6	3	4	0,055	0,090	0,130	–
160	**180**	0,080	0,110	1,3	1,7	3,2	4,2	0,060	0,100	0,150	–
180	**200**	0,090	0,130	1,4	2	3,5	5	0,070	0,100	0,160	–
200	**225**	0,100	0,140	1,6	2,2	4	5,5	0,080	0,120	0,180	–
225	**250**	0,110	0,150	1,7	2,4	4,2	6	0,090	0,130	0,200	–
250	**280**	0,120	0,170	1,9	2,7	4,7	6,7	0,100	0,140	0,220	–
280	**315**	0,130	0,190	2	3	5	7,5	0,110	0,150	0,240	–
315	**355**	0,150	0,210	2,4	3,3	6	8,2	0,120	0,170	0,260	–
355	**400**	0,170	0,230	2,6	3,6	6,5	9	0,130	0,190	0,290	–
400	**450**	0,200	0,260	3,1	4	7,7	10	0,130	0,200	0,310	–
450	**500**	0,210	0,280	3,3	4,4	8,2	11	0,160	0,230	0,350	–
500	**560**	0,240	0,320	3,7	5	9,2	12,5	0,170	0,250	0,360	–
560	**630**	0,260	0,350	4	5,4	10	13,5	0,200	0,290	0,410	–
630	**710**	0,300	0,400	4,6	6,2	11,5	15,5	0,210	0,310	0,450	–
710	**800**	0,340	0,450	5,3	7	13,3	17,5	0,230	0,350	0,510	–
800	**900**	0,370	0,500	5,7	7,8	14,3	19,5	0,270	0,390	0,570	–
900	**1 000**	0,410	0,550	6,3	8,5	15,8	21	0,300	0,430	0,640	–
1 000	**1 120**	0,450	0,600	6,8	9	17	23	0,320	0,480	0,700	–
1 120	**1 250**	0,490	0,650	7,4	9,8	18,5	25	0,340	0,540	0,770	–
1 250	**1 400**	0,550	0,720	8,3	10,8	21	27	0,360	0,590	0,840	–
1 400	**1 600**	0,600	0,800	9,1	11,9	22,7	29,8	0,400	0,650	0,920	–
1 600	**1 800**	0,670	0,900	10,2	13,4	25,4	33,6	0,440	0,720	1,020	–

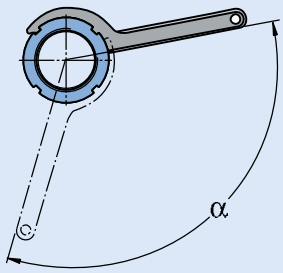
[1] Valid only for solid steel shafts and general application. Not valid for the SKF Drive-up Method
[2] The residual clearance must be checked in cases where the initial radial internal clearance is in the lower half of the tolerance range, and where large temperature differentials between the bearing rings can arise in operation. The residual clearance must not be less than the minimum values quoted above

Table 3

Guideline values for reduction of radial internal clearance, axial drive-up and lock nut tightening angle







Bore diameter d		Reduction of radial internal clearance		Axial drive-up[1] s Taper 1:12		Taper 1:30		Permissible residual[2] radial clearance after mounting bearings with initial clearance			Lock nut tightening angle α
over	incl.	min	max	min	max	min	max	Normal	C3	C4	
mm		mm		mm				mm			degrees
24	**30**	0,012	0,018	0,25	0,34	0,64	0,85	0,025	0,033	0,047	100
30	**40**	0,015	0,024	0,30	0,42	0,74	1,06	0,031	0,038	0,056	115
40	**50**	0,020	0,030	0,37	0,51	0,92	1,27	0,033	0,043	0,063	130
50	**65**	0,025	0,039	0,44	0,64	1,09	1,59	0,038	0,049	0,074	115
65	**80**	0,033	0,048	0,54	0,76	1,36	1,91	0,041	0,055	0,088	135
80	**100**	0,040	0,060	0,65	0,93	1,62	2,33	0,056	0,072	0,112	150
100	**120**	0,050	0,072	0,79	1,10	1,98	2,75	0,065	0,083	0,129	–
120	**140**	0,060	0,084	0,93	1,27	2,33	3,18	0,075	0,106	0,147	–
140	**160**	0,070	0,096	1,07	1,44	2,68	3,60	0,085	0,126	0,173	–
160	**180**	0,080	0,108	1,21	1,61	3,04	4,02	0,093	0,140	0,193	–
180	**200**	0,090	0,120	1,36	1,78	3,39	4,45	0,100	0,150	0,210	–
200	**225**	0,100	0,135	1,50	1,99	3,74	4,98	0,113	0,163	0,230	–
225	**250**	0,115	0,150	1,67	2,20	4,18	5,51	0,123	0,175	0,250	–
250	**280**	0,125	0,170	1,85	2,46	4,62	6,14	0,133	0,186	0,275	–
280	**315**	0,140	0,190	2,06	2,75	5,15	6,88	0,143	0,200	0,290	–
315	**355**	0,160	0,215	2,31	3,09	5,77	7,73	0,161	0,225	0,330	–
355	**400**	0,175	0,240	2,59	3,47	6,48	8,68	0,173	0,250	0,360	–
400	**450**	0,200	0,270	2,91	3,90	7,27	9,74	0,183	0,275	0,385	–
450	**500**	0,225	0,300	3,26	4,32	8,15	10,8	0,210	0,295	0,435	–
500	**560**	0,250	0,335	3,61	4,83	9,04	12,1	0,225	0,325	0,465	–
560	**630**	0,280	0,380	4,04	5,42	10,1	13,6	0,250	0,365	0,510	–
630	**710**	0,315	0,425	4,53	6,10	11,3	15,3	0,275	0,385	0,560	–
710	**800**	0,355	0,480	5,10	6,86	12,7	17,2	0,320	0,430	0,620	–
800	**900**	0,400	0,540	5,73	7,71	14,3	19,3	0,335	0,465	0,675	–
900	**1 000**	0,450	0,600	6,44	8,56	16,1	21,4	0,365	0,490	0,740	–
1 000	**1 120**	0,500	0,670	7,14	9,57	17,9	23,9	0,395	0,545	0,825	–
1 120	**1 250**	0,560	0,750	8	10,7	20	26,7	0,415	0,595	0,885	–

[1] Valid only for solid steel shafts and general application. Not valid for the SKF Drive-up Method
[2] The residual clearance must be checked in cases where the initial radial internal clearance is in the lower half of the tolerance range, and where large temperature differentials between the bearing rings can arise in operation. The residual clearance must not be less than the minimum values quoted above. When measuring, make sure that the rings and roller assembly are aligned and centred

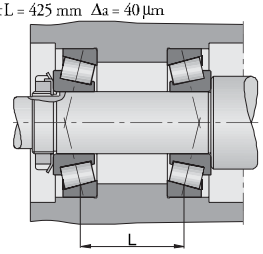
Adjusting the axial clearance - you just have to know how to do it !

Adjusting the axial clearance of tapered roller bearings

FAG

The diagram is valid for a temperature gradient of 10 K from the inner ring to the outer ring.
Convert proportionally in the case of other temperature differences.

Example 1: 2 bearings 32034X in **O arrangement**
At L = 425 mm Δa = 40 µm



Example 2: 2 bearings 30313A in **X arrangement**
At L = 285 mm Δa = 95 µm

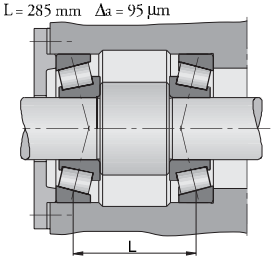
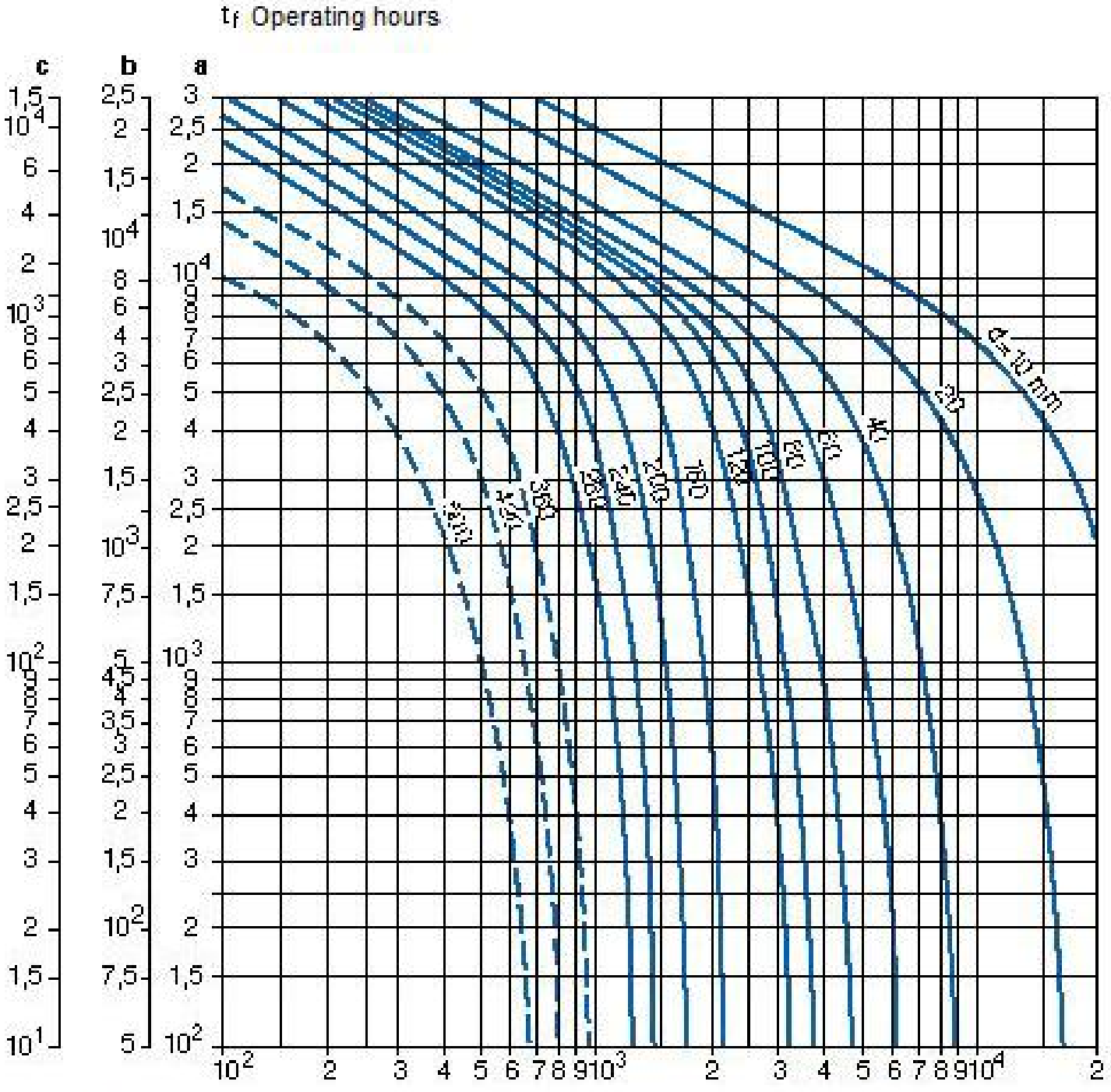
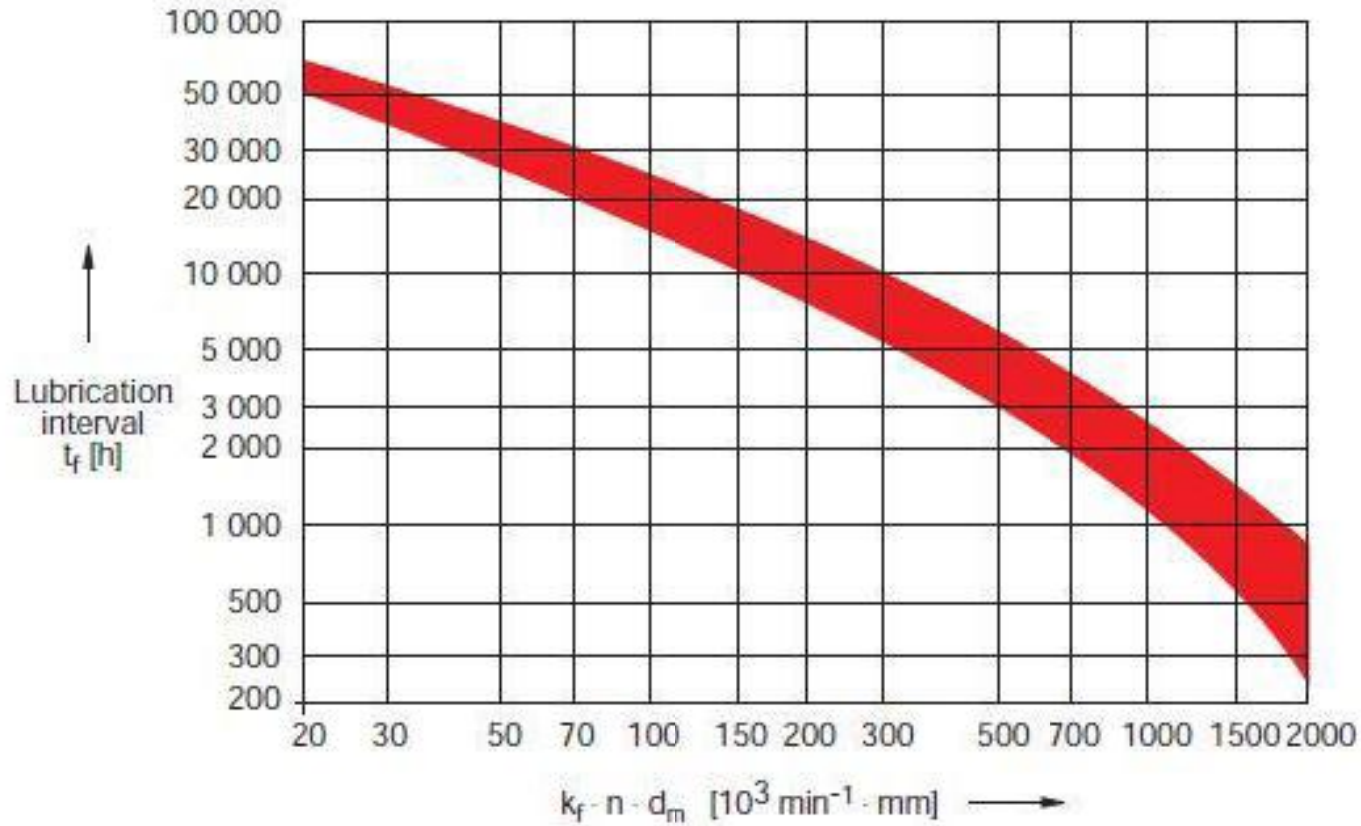


Diagram 1



Scale a: Radial ball bearings
Scale b: Cylindrical roller bearings, needle roller bearings
Scale c: Spherical roller bearings, taper roller bearings, thrust ball bearings, CARB
Full complement cylindrical roller bearings (0,2 t_f of scale c)
Roller thrust bearings (0,5t_f of scale c)

33: Lubrication intervals under favourable environmental conditions. Grease service life F_{10} for standard lithium soap base greases according to DIN 51825, at 70 °C; failure probability 10 %.



Bearing type		k_f
Deep groove ball bearing	single row	0.9...1.1
	double row	1.5
Angular contact ball bearing	single row	1.6
	double row	2
Spindle bearing	$\alpha = 15°$	0.75
	$\alpha = 25°$	0.9
Four-point bearing		1.6
Self-aligning ball bearing		1.3...1.6
Thrust ball bearing		5...6
Angular contact thrust ball bearing	double row	1.4

Bearing type		k_f
Cylindrical roller bearing	single row	3...3.5*)
	double row	2
	full complement	25
Cylindrical roller thrust bearing		90
Needle roller bearing		3.5
Tapered roller bearing		4
Barrel roller bearing		10
Spherical roller bearing without lips (E design)		7...9
Spherical roller bearing with centre lip		9...12

*) for bearings which are loaded radially and constantly axially; for varying axial loads $k_f = 2$

Diagram 2:

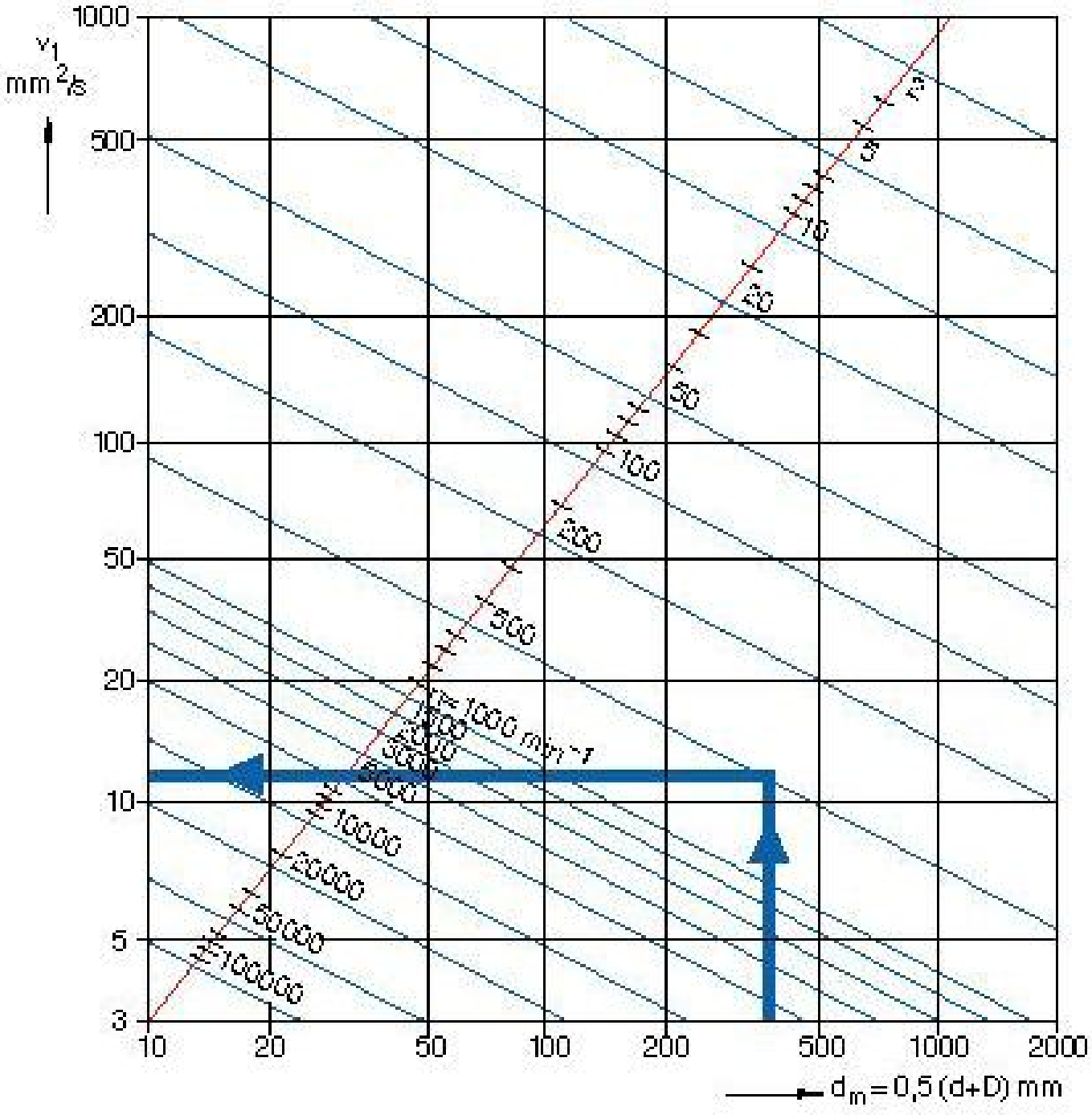
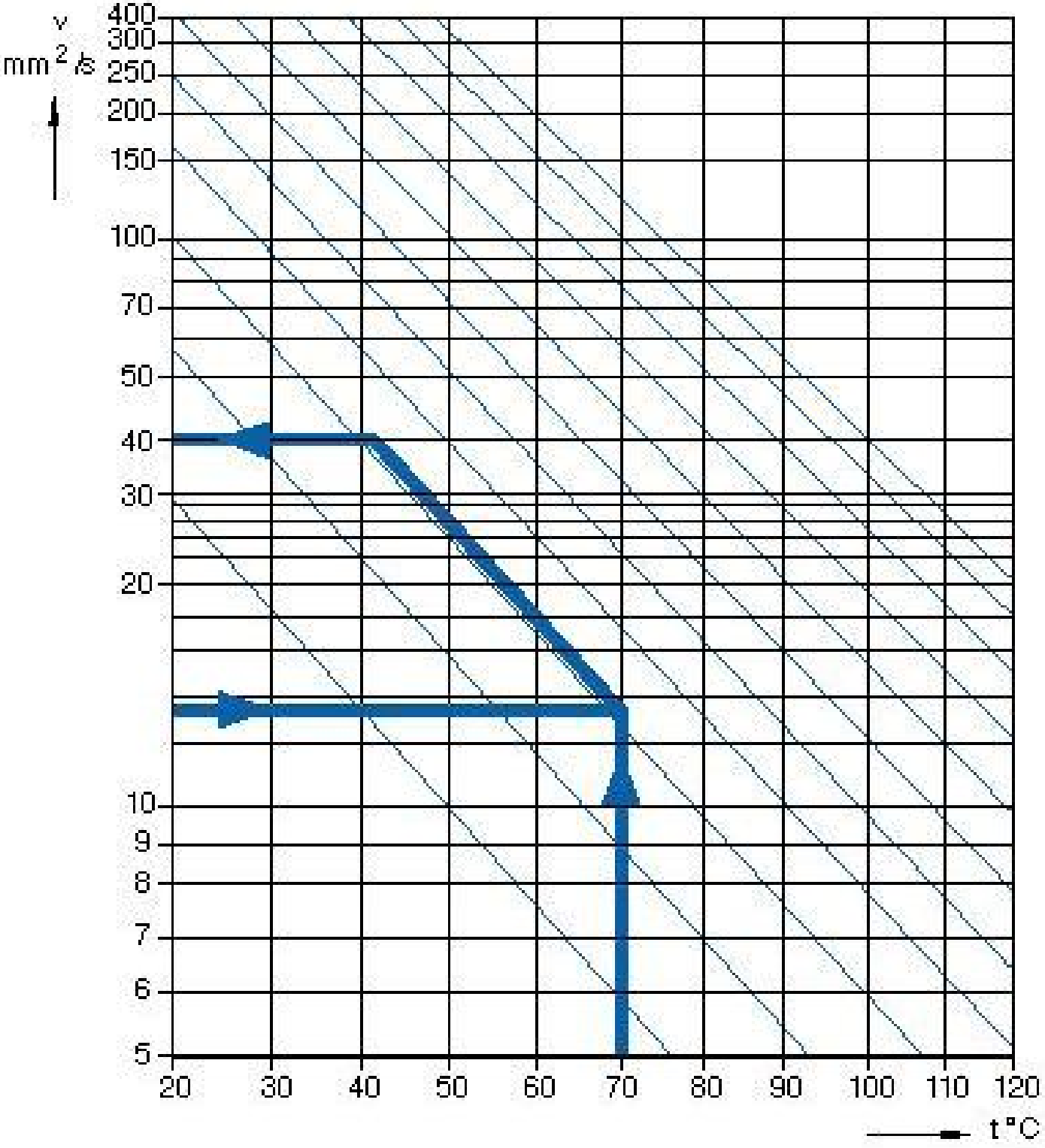

1000
500
200
100
50
20
10
5
3
ν_1
mm²/s
10
20
50
100
200
500
1000
2000
$d_m = 0,5\,(d+D)$ mm
n=1000 min⁻¹
n=10000
n=20000
n=50000
n=100000

Diagram 3:


v
mm²/s
400
300
250
200
150
100
70
50
40
30
20
10
9
8
7
6
5
20
30
40
50
60
70
80
90
100
110
120
t °C

14 صفحه

پلان اندازه یاتاقانهای شعاعی (به جز یاتاقان غلتکی مخروطی)

DIN 616 (3 صفحه)

سری قطر خارجی 8											سری قطر خارجی 9									
		سری پهنا							برای سری اندازه 8	برای سری اندازه 18 تا 68		سری پهنا							برای سری اندازه 09	برای سری اندازه 19 تا 69
		0	1	2	3	4	5	6				0	1	2	3	4	5	6		
		سری اندازه										سری اندازه								
		08	18	28	38	48	58	68				09	19	29	39	49	59	69		
d	D	B							r		D	B							r	
0,6	2,5	–	1	–	1,4	–	–	–	–	0,15	–	–	–	–	–	–	–	–	–	–
1	3	–	1	–	1,5	–	–	–	–	0,15	4	–	1,6	–	2,3	–	–	–	–	0,2
1,5	4	–	2	–	2	–	–	–	–	0,2	5	–	2	–	2,6	–	–	–	–	0,3
2	5	–	1,5	–	2,3	–	–	–	–	0,2	6	–	2,3	–	3	–	–	–	–	0,3
2,5	6	–	1,8	–	2,6	–	–	–	–	0,3	7	–	2,5	–	3,5	–	–	–	–	0,3
3	7	–	2	–	3	–	–	–	–	0,3	8	–	3	–	4	–	–	–	–	0,3
4	9	–	2,5	3,5	4	–	–	–	–	0,3	11	–	4	–	5	–	–	–	–	0,3
5	11	–	3	4	5	–	–	–	–	0,3	13	–	4	–	6	10	–	–	–	0,3
6	13	–	3,5	5	6	–	–	–	–	0,3	15	–	5	–	7	10	–	–	–	0,3
7	14	–	3,5	5	6	–	–	–	–	0,3	17	–	5	–	7	10	–	–	–	0,3
8	16	–	4	5	6	8	–	–	–	0,4	19	–	6	–	9	11	–	–	–	0,3
9	17	–	4	5	6	8	–	–	–	0,4	20	–	6	–	9	11	–	–	–	0,5
10	19	–	5	6	7	9	–	–	–	0,5	22	–	6	8	10	13	16	22	–	0,5
12	21	–	5	6	7	9	–	–	–	0,5	24	–	6	8	10	13	16	22	–	0,5
15	24	–	5	6	7	9	–	–	–	0,5	28	–	7	8,5	10	13	18	23	–	0,5
17	26	–	5	6	7	9	–	–	–	0,5	30	–	7	8,5	10	13	18	23	–	0,5
20	32	4	7	8	10	12	16	22	0,5	0,5	37	7	9	11	13	17	23	30	0,5	0,5
22	34	4	7	–	10	–	16	22	0,5	0,5	39	7	9	11	13	17	23	30	0,5	0,5
25	37	4	7	8	10	12	16	22	0,5	0,5	42	7	9	11	13	17	23	30	0,5	0,5
28	40	4	7	–	10	–	16	22	0,5	0,5	45	7	9	11	13	17	23	30	0,5	0,5
30	42	4	7	8	10	12	16	22	0,5	0,5	47	7	9	11	13	17	23	30	0,5	0,5
32	44	4	7	–	10	–	16	22	0,5	0,5	52	7	10	13	15	20	27	36	0,5	1
35	47	4	7	8	10	12	16	22	0,5	0,5	55	7	10	13	15	20	27	36	0,5	1
40	52	4	7	8	10	12	16	22	0,5	0,5	62	8	12	14	16	22	30	40	0,5	1
45	58	4	7	8	10	13	18	23	0,5	0,5	68	8	12	14	16	22	30	40	0,5	1
50	65	5	7	10	12	15	20	27	0,5	0,5	72	8	12	14	16	22	30	40	0,5	1
55	72	7	9	11	13	17	23	30	0,5	0,5	80	9	13	16	19	25	34	45	0,5	1,5
60	78	7	10	12	14	18	24	32	0,5	0,5	85	9	13	16	19	25	34	45	0,5	1,5
65	85	7	10	13	15	20	27	36	0,5	1	90	9	13	16	19	25	34	45	0,5	1,5
70	90	8	10	13	15	20	27	36	0,5	1	100	10	16	19	23	30	40	54	1	1,5
75	95	8	10	13	15	20	27	36	0,5	1	105	10	16	19	23	30	40	54	1	1,5
80	100	8	10	13	15	20	27	36	0,5	1	110	10	16	19	23	30	40	54	1	1,5
85	110	9	13	16	19	25	34	45	0,5	1,5	120	11	18	22	26	35	46	63	1	2
90	115	9	13	16	19	25	34	45	0,5	1,5	125	11	18	22	26	35	46	63	1	2
95	120	9	13	16	19	25	34	45	0,5	1,5	130	11	18	22	26	35	46	63	1	2
100	125	9	13	16	19	25	34	45	0,5	1,5	140	13	20	24	30	40	54	71	1	2
105	130	9	13	16	19	25	34	45	0,5	1,5	145	13	20	24	30	40	54	71	1	2
110	140	10	16	19	23	30	40	54	1	1,5	150	13	20	24	30	40	54	71	1	2
120	150	10	16	19	23	30	40	54	1	1,5	165	14	22	27	34	45	60	80	1	2
130	165	11	18	22	26	35	46	63	1	2	180	16	24	30	37	50	67	90	1,5	2,5
140	175	11	18	22	26	35	46	63	1	2	190	16	24	30	37	50	67	90	1,5	2,5
150	190	13	20	24	30	40	54	71	1	2	210	19	28	36	45	60	80	109	1,5	3
160	200	13	20	24	30	40	54	71	1	2	220	19	28	36	45	60	80	109	1,5	3
170	215	14	22	27	34	45	60	80	1	2	230	19	28	36	45	60	80	109	1,5	3
180	225	14	22	27	34	45	60	80	1	2	250	22	33	42	52	69	95	125	2	3
190	240	16	24	30	37	50	67	90	1,5	2,5	260	22	33	42	52	69	95	125	2	3
200	250	16	24	30	37	50	67	90	1,5	2,5	280	25	38	48	60	80	109	145	2,5	3,5
220	270	16	24	30	37	50	67	90	1,5	2,5	300	25	38	48	60	80	109	145	2,5	3,5
240	300	19	28	36	45	60	80	109	1,5	3	320	25	38	48	60	80	109	145	2,5	3,5
260	320	19	28	36	45	60	80	109	1,5	3	360	31	46	60	75	100	136	180	3	3,5
280	350	22	33	42	52	69	95	125	2	3	380	31	46	60	75	100	136	180	3	3,5
300	380	25	28	48	60	80	109	145	2,5	3,5	420	37	56	72	90	118	160	218	3,5	4
320	400	25	38	48	60	80	109	145	2,5	3,5	440	37	56	72	90	118	160	218	3,5	4
340	420	25	38	48	60	80	109	145	2,5	3,5	460	37	56	72	90	118	160	218	3,5	4
360	440	25	38	48	60	80	109	145	2,5	3,5	480	37	56	72	90	118	160	218	3,5	4
380	480	31	46	60	75	100	136	180	3	3,5	520	44	65	82	106	140	190	250	4	5
400	500	31	46	60	75	100	136	180	3	3,5	540	44	65	82	106	140	190	250	4	5
420	520	31	46	60	75	100	136	180	3	3,5	560	44	65	82	106	140	190	250	4	5
440	540	31	46	60	75	100	136	180	3	3,5	600	50	74	95	118	160	218	290	5	5
460	580	37	56	72	90	118	160	218	3,5	4	620	50	74	95	118	160	218	290	5	5
480	600	37	56	72	90	118	160	218	3,5	4	650	54	78	100	128	170	230	308	5	6
500	620	37	56	72	90	118	160	218	3,5	4	670	54	78	100	128	170	230	308	5	6
530	650	37	56	72	90	118	160	218	3,5	4	710	57	82	106	136	180	243	325	5	6
560	680	37	56	72	90	118	160	218	3,5	4	750	60	85	112	140	190	258	345	6	6
600	730	42	60	78	98	128	175	236	4	4	800	63	90	118	150	200	272	355	6	6
630	780	48	69	88	112	150	200	272	4	5	850	71	100	128	165	218	300	400	6	8
670	820	48	69	88	112	150	200	272	4	5	900	73	103	136	170	230	308	412	6	8
710	870	50	74	95	118	160	218	290	5	5	950	78	106	140	180	243	325	438	6	8
750	920	54	78	100	128	170	230	308	5	6	1000	80	112	145	185	250	335	450	8	8
800	980	57	82	106	136	180	243	325	5	6	1060	82	115	150	195	258	355	462	8	8
850	1030	57	82	106	136	180	243	325	5	6	1120	85	118	155	200	272	365	488	8	8
900	1090	60	85	112	140	190	258	345	6	6	1180	88	122	165	206	280	375	500	3	8
950	1150	63	90	118	150	200	272	355	6	6	1250	95	132	175	224	300	400	545	8	10
1000	1220	71	100	128	165	218	300	400	6	8	1320	103	140	185	236	315	438	580	8	10
1040	1280	71	100	128	165	218	300	400	6	8	1400	109	150	195	250	335	462	615	10	10

5

ضمیمه 15

سری اندازه یاتاقانهای شعاعی (به جز یاتاقان غلتکی مخروطی) DIN 616 (صفحه4)

سری قطر خارجی

سری پهنا		
	1	3
سری اندازه		
	17	37
D	B		r
2	0,8	–	0,1
2,5	1	–	0,1
3	1	1,8	0,1
4	1,2	2	0,1
5	1,5	2,3	0,15
6	2	3	0,15
7	2	3	0,15
8	2	3	0,15
10	2,5	3,5	0,2
11	2,5	3,5	0,2
12	2,5	3,5	0,2
14	3	4,5	0,2
15	3	4,5	0,2

سری قطر خارجی

سری پهنا								برای سری اندازه 00	برای سری اندازه 10 تا 60
	0	1	2	3	4	5	6		
سری اندازه									
	00	10	20	30	40	50	60		
d	D	B						r	
0,6	–	–	–	–	–	–	–	–	–
1	–	–	–	–	–	–	–	–	–
1,5	6	–	2,5	–	3	–	–	–	0,3
2	7	–	2,8	–	3,5	–	–	–	0,3
2,5	8	–	2,8	–	4	–	–	–	0,3
3	9	–	3	–	5	–	–	–	0,3
4	12	–	4	–	6	–	–	–	0,4
5	14	–	5	–	7	–	–	–	0,4
6	17	–	6	–	9	–	–	–	0,5
7	19	–	6	8	10	–	–	–	0,5
8	22	–	7	9	11	14	19	25	–	0,5
9	24	–	7	10	12	14	20	27	–	0,5
10	26	–	8	10	12	16	21	29	–	0,5
12	28	7	8	10	12	16	21	29	0,5	0,5
15	32	8	9	11	13	17	23	30	0,5	0,5
17	35	8	10	12	14	18	24	32	0,5	0,5
20	42	8	12	14	16	22	30	40	0,5	1
22	44	8	12	14	16	22	30	40	0,5	1
25	47	8	12	14	16	22	30	40	0,5	1
28	52	8	12	15	18	24	32	43	0,5	1
30	55	9	13	16	19	25	34	45	0,5	1,5
32	58	9	13	16	20	26	35	47	0,5	1,5
35	62	9	14	17	20	27	36	48	0,5	1,5
40	68	9	15	18	21	28	38	50	0,5	1,5
45	75	10	16	19	23	30	40	54	1	1,5
50	80	10	16	19	23	30	40	54	1	1,5
55	90	11	18	22	26	35	46	63	1	2
60	95	11	18	22	26	35	46	63	1	2
65	100	11	18	22	26	35	46	63	1	2
70	110	13	20	24	30	40	54	71	1	2
75	115	13	20	24	30	40	54	71	1	2
80	125	14	22	27	34	45	60	80	1	2
85	130	14	22	27	34	45	60	80	1	2
90	140	16	24	30	37	50	67	90	1,5	2,5
95	145	16	24	30	37	50	67	90	1,5	2,5
100	150	16	24	30	37	50	67	90	1,5	2,5
105	160	18	26	33	41	56	75	100	1,5	3
110	170	19	28	36	45	60	80	109	1,5	3
120	180	19	28	36	46	60	80	109	1,5	3
130	200	22	33	42	52	69	95	125	2	3
140	210	22	33	42	53	69	95	125	2	3
150	225	24	35	45	56	75	100	136	2	3,5
160	240	25	38	48	60	80	109	145	2,5	3,5
170	260	28	42	54	67	90	122	160	2,5	3,5
180	280	31	46	60	74	100	136	180	3	3,5
190	290	31	46	60	75	100	136	180	3	3,5
200	310	34	51	66	82	109	150	200	3	3,5
220	340	37	56	72	90	118	160	218	3,5	4
240	360	37	56	72	92	118	160	218	3,5	4
260	400	44	65	82	104	140	190	250	4	5
280	420	44	65	82	106	140	190	250	4	5
300	460	50	74	95	118	160	218	290	5	5
320	480	50	74	95	121	160	218	290	5	5
340	520	57	82	106	133	180	243	325	5	6
360	540	57	82	106	134	180	243	325	5	6
380	560	57	82	106	135	180	243	325	5	6
400	600	63	90	118	148	200	272	355	6	6
420	620	63	90	118	150	200	272	355	6	6
440	650	67	94	122	157	212	280	375	6	8
460	680	71	100	128	163	218	300	400	6	8
480	700	71	100	128	165	218	300	400	6	8
500	720	71	100	128	167	218	300	400	6	8
530	780	80	112	145	185	250	335	450	8	8
560	820	82	115	150	195	258	355	462	8	8
600	870	85	118	155	200	272	365	488	8	8
630	920	92	128	170	212	290	388	515	8	10
670	980	100	136	180	230	308	425	560	8	10
710	1030	103	140	185	236	315	438	580	8	10
750	1090	109	150	195	250	335	462	615	10	10
800	1150	112	155	200	258	345	475	630	10	10
850	1220	118	165	212	272	365	500	670	10	10
900	1280	122	170	218	280	375	515	690	10	10
950	1360	132	180	236	300	412	560	730	10	10
1000	1420	136	185	243	308	412	560	750	10	10
1060	1500	140	195	250	325	438	600	800	12	12

سری قطر خارجی 1

سری پهنا					برای سری اندازه 01	برای سری اندازه 11 تا 41
0	1	2	3	4		
سری اندازه						
01	11	21	31	41		
D	B				r	
165	21	30	39	52	65	2	3
175	22	33	42	56	69	2	3
180	22	33	42	56	69	2	3
200	25	38	48	62	80	2,5	3
210	25	38	48	64	80	2,5	3
225	27	40	50	68	85	2,5	3
250	31	46	60	80	100	3	3
270	34	51	66	86	109	3	3
280	34	51	66	88	109	3	3
300	37	56	72	96	118	3,5	4
320	42	60	78	104	128	4	4
340	44	65	82	112	140	4	4
370	48	69	88	120	150	4	5
400	50	74	95	128	160	5	5
440	57	82	106	144	180	5	5
460	57	82	106	146	180	5	6
500	63	90	118	160	200	6	6
540	71	100	128	176	218	6	6
580	78	106	140	190	243	6	6
600	78	106	140	192	243	6	6
620	78	106	140	194	243	6	6
650	80	112	145	200	250	8	8
700	88	122	165	224	280	8	8
720	88	122	165	226	280	8	8
760	95	132	175	240	300	8	10
790	100	136	180	248	308	8	10
830	106	145	190	264	325	10	10
870	109	150	195	272	335	10	10
920	115	160	206	280	355	10	10
980	122	170	218	300	375	10	10
1030	128	175	230	315	400	10	10
1090	136	185	243	336	412	10	10
1150	140	195	250	345	438	12	12
1220	150	206	272	365	475	12	12
1280	155	212	272	375	475	12	12
1360	165	224	290	400	500	15	15
1420	165	230	300	412	515	15	15
1500	175	243	315	438	545	15	15
1580	185	258	335	462	580	15	15
1660	190	265	345	475	600	15	18

16 صفحه

سری اندازه یاتاقانهای شعاعی (به جز یاتاقان غلتکی مخروطی)

DIN 616 (صفحه 5)

سری اندازه 42 تا 94	سری پهنا 0	سری پهنا 2	سری اندازه 04	سری اندازه 24	r	D	B	برای سری اندازه 33 تا 03	برای سری اندازه 83	سری پهنا 8	سری پهنا 0	سری پهنا 1	سری پهنا 2	سری پهنا 3	سری اندازه 83	سری اندازه 03	سری اندازه 13	سری اندازه 23	سری اندازه 33	برای سری اندازه 42 تا 02	برای سری اندازه 82	سری پهنا 8	سری پهنا 0	سری پهنا 1	سری پهنا 2	سری پهنا 3	سری پهنا 4	سری اندازه 82	سری اندازه 02	سری اندازه 12	سری اندازه 22	سری اندازه 32	سری اندازه 42	r	D	d
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0,6
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,5
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,5
–	–	–	–	–	0,3	13	–	0,5	–	–	–	–	–	7	0,5	–	–	–	0,3	0,2	0,3	–	–	–	–	5	–	–	–	5	–	0,3	10	3
–	–	–	–	–	0,4	16	–	0,5	–	–	–	–	–	9	0,5	–	–	–	0,4	0,3	0,4	–	–	–	–	5	–	–	–	7	–	0,3	13	4
–	–	–	–	–	0,5	19	–	0,5	–	–	–	–	–	10	0,5	–	–	–	0,5	0,4	0,5	–	–	–	–	6	–	–	–	8	–	0,3	16	5
–	–	–	–	–	0,5	22	–	0,5	–	–	–	–	11	13	0,5	–	–	–	0,5	0,4	0,5	–	–	–	–	7	–	–	–	10	–	0,4	19	6
–	–	–	–	–	0,5	26	–	0,5	–	–	–	–	13	15	0,5	–	–	–	0,5	0,5	0,5	–	–	–	–	9	–	–	–	11	–	0,5	22	7
14	1	30	10	14	1	28	9	0,5	–	–	13	15	–	0,5	0,5	0,5	–	–	0,5	0,5	0,5	–	–	–	–	9	–	–	–	12	–	0,5	24	8
15	1	32	11	15	1	30	10	1	–	–	14	16	–	1	0,5	0,5	–	–	1	0,5	1	–	–	–	–	10	–	–	14	14,3	–	0,5	26	9
16	1	37	12	16	1	35	11	1	0,5	9	17	19	–	1	0,5	0,5	–	–	1	0,5	1	–	–	–	14	11	–	–	15,9	–	0,5	30	10
19	1,5	42	13	19	1,5	37	12	1,5	0,5	9	17	19	–	1	0,5	0,5	–	–	1	0,5	1	–	–	–	14	12	–	–	15,9	–	0,5	32	12
24	2	52	15	24	2	42	13	1,5	0,5	9	17	19	–	1	0,5	0,5	–	–	1	0,5	1	–	–	–	14	13	–	–	15,9	20	0,5	35	15
22	2	62	17	29	2	47	10	1,5	1	14	19	22,2	1	1,5	0,5	0,5	–	–	1	0,5	1	–	–	–	16	14	–	–	17,5	22	0,5	40	17
25	2	72	19	33	2	52	10	2	1	15	21	22,2	1	2	0,5	0,5	–	–	1,5	0,5	1,5	–	–	–	18	14	–	–	20,6	27	0,5	47	20
–	–	–	–	–	2,5	56	11	2	1	16	21	25	1	2	0,5	0,5	–	–	1,5	0,5	1,5	–	–	–	18	15	–	–	20,6	27	0,5	50	22
36	2,5	80	21	36	2,5	62	12	2	1	17	24	25,4	1	2	0,5	0,5	–	–	1,5	0,5	1,5	–	–	–	18	15	–	–	20,6	27	0,5	52	25
–	–	–	–	–	2,5	68	13	2	1	18	24	30	1	2	1	1	–	–	2	1	1,5	–	–	–	19	16	–	–	23	30	1	58	28
40	2,5	90	23	40	2,5	72	13	2	1,5	19	27	30,2	1	2	1	1	–	–	2	1	1,5	–	–	–	20	16	–	–	23,8	32	1	62	30
–	–	–	–	–	2,5	75	14	2	1,5	20	28	32	1	2	1	1	–	–	2	1	1,5	–	–	–	21	17	–	–	25	33	1	65	32
45	2,5	100	25	43	2,5	80	14	2,5	1,5	21	31	34,9	1	2,5	1	1	–	–	2	1	1,5	–	–	–	23	17	–	–	27	37	1	72	35
46	3	110	27	46	3	90	16	2,5	1,5	23	33	36,5	1,5	2,5	1	1	–	–	2	1	1,5	–	–	–	23	17	–	–	30,2	40	1	80	40
46	3	120	29	50	3	100	17	2,5	1,5	25	36	39,7	1,5	2,5	1	1	–	–	2	1	1,5	–	–	–	23	19	–	–	30,2	40	1	90	45
53	3,5	130	31	53	3,5	110	19	3	1,5	27	40	44,4	1,5	3	1	1	–	–	2	1	1,5	–	–	–	25	20	–	–	33,3	45	1	100	50
57	3,5	140	33	57	3,5	120	21	3	2	29	43	49,2	2	3	1,5	1,5	–	–	2,5	1,5	2	–	–	–	28	22	–	–	36,5	50	1,5	110	55
60	3,5	150	35	60	3,5	130	22	3,5	2	31	46	54	2	3,5	1,5	1,5	–	–	2,5	1,5	2	–	–	–	31	23	–	–	38,1	56	1,5	120	60
64	3,5	160	37	64	3,5	140	24	3,5	2	33	48	58,7	2	3,5	1,5	1,5	–	–	2,5	1,5	2	–	–	–	31	23	–	–	39,7	56	1,5	125	65
70	3,5	180	42	74	4	150	25	3,5	2,5	35	51	63,5	2,5	3,5	1,5	1,5	–	–	2,5	1,5	2	–	–	–	31	24	–	–	39,7	56	1,5	130	70
77	4	190	45	77	4	160	27	3,5	2,5	37	55	68,3	2,5	3,5	2	2	–	–	3	2	2,5	–	–	–	33	25	–	–	41,3	56	1,5	130	75
80	4	200	48	80	4	170	28	3,5	2,5	39	58	68,3	2,5	3,5	2	2	–	–	3	2	2,5	–	–	–	33	26	–	–	44,4	60	1,5	140	80
85	4	210	52	86	5	180	30	4	3	41	60	73	3	4	2	2	–	–	3	2	2,5	–	–	–	36	28	–	–	49,2	65	2	150	85
90	5	225	54	90	5	190	30	4	3	43	64	73	3	4	2	2	–	–	3	2	2,5	–	–	–	40	30	–	–	52,4	69	2	160	90
95	5	240	55	95	5	200	33	4	3	45	67	77,8	3	4	2,5	2,5	–	–	3,5	2	3	–	–	–	43	32	–	–	55,6	75	2	170	95
98	5	250	58	98	5	215	36	4	3,5	47	73	82,6	3,5	4	2,5	2,5	51	37	3,5	2,5	3	–	–	46	34	–	–	60,3	80	2,5	180	100
100	5	260	60	100	5	225	37	4	3,5	49	77	87,3	3,5	4	2,5	2,5	53	39	3,5	2,5	3	–	–	50	36	–	–	65,1	85	2,5	190	105
108	5	280	65	108	5	240	42	4	3,5	50	80	92,1	4	4	3	3	57	42	3,5	2,5	3	–	–	53	38	–	–	69,8	90	2,5	200	110
112	5	310	72	118	6	260	44	5	4	55	86	106	4	4	3	3	62	44	3,5	3	4	–	–	58	40	42	46	76	95	–	215	120
118	6	340	78	128	6	280	48	5	4	58	93	112	4	5	3	4	66	48	4	4	4	–	–	64	46	40	46	80	100	–	230	130
122	6	360	82	132	6	300	50	5	5	62	102	118	5	5	4	4	70	50	4	4	4	–	–	68	50	42	50	88	109	–	250	140
128	6	380	85	138	6	320	–	5	5	65	108	128	–	5	4	4	75	54	4	4	4	–	–	72	54	45	54	96	118	–	270	150
132	6	400	88	142	6	340	–	5	5	68	114	136	–	5	4	4	79	58	4	4	4	–	–	76	58	48	58	104	128	–	280	160
138	6	420	92	145	6	360	–	5	5	72	120	140	–	5	4	4	84	62	4	4	4	–	–	80	62	52	62	110	140	–	310	170
150	8	440	95	150	8	380	–	5	5	75	126	150	–	5	4	4	88	62	4	4	4	–	–	80	62	52	62	112	140	–	320	180
155	8	460	98	155	8	400	–	6	5	78	132	155	–	6	5	5	92	65	5	5	5	–	–	85	65	55	65	120	150	–	340	190
160	8	480	102	160	8	420	–	6	5	80	138	165	–	6	5	5	97	70	5	5	5	–	–	90	70	58	70	128	160	–	360	200
165	8	540	115	180	8	460	–	6	5	88	145	180	–	6	5	5	106	78	5	5	5	–	–	98	78	65	78	144	180	–	400	220
170	8	580	122	190	8	500	–	6	5	95	155	195	–	6	5	5	114	85	5	5	5	–	–	108	85	72	85	160	200	–	440	240
175	8	620	132	206	10	540	–	8	6	102	165	206	–	8	6	6	123	90	6	6	6	–	–	130	90	80	90	174	218	–	480	260
180	10	670	140	224	10	580	–	8	6	108	175	224	–	8	6	6	132	98	6	6	6	–	–	140	98	85	98	192	243	–	500	300
190	10	710	150	236	10	620	–	10	6	109	185	236	–	10	6	6	140	105	6	6	6	–	–	150	105	92	105	208	258	–	520	320
200	12	750	155	250	12	670	–	10	6	112	200	258	–	10	6	6	155	118	6	6	6	–	–	165	118	92	118	224	280	–	540	340
212	15	800	165	265	12	710	–	10	8	118	212	272	–	10	8	8	165	125	8	8	8	–	–	170	122	95	122	232	290	–	560	360
218	15	850	180	280	12	750	–	10	8	125	224	290	–	10	8	8	170	132	8	8	8	–	–	175	132	95	132	240	300	–	580	380
230	15	900	190	300	12	780	–	10	8	128	230	300	–	10	8	8	175	136	8	8	8	–	–	185	140	103	140	256	315	–	600	400
238	15	950	200	315	15	820	–	10	8	136	243	308	–	10	8	8	185	145	8	8	8	–	–	195	150	109	150	272	335	–	630	420
240	15	980	206	325	15	850	–	12	8	136	250	315	–	12	8	8	190	155	8	8	8	–	–	200	155	112	155	280	345	–	650	440
250	15	1030	212	335	15	900	–	12	8	145	265	345	–	12	8	8	200	165	8	8	8	–	–	212	165	118	165	296	365	–	670	460
258	15	1060	218	345	15	950	–	12	8	155	280	365	–	12	8	8	212	170	8	8	8	–	–	224	170	125	170	310	388	–	710	480
272	18	1120	230	365	18	980	–	12	10	160	290	375	–	12	10	10	218	180	10	10	10	–	–	243	180	136	180	336	412	–	750	500
280	18	1150	236	375	18	1030	–	15	10	170	300	388	–	15	10	10	230	200	10	10	10	–	–	258	200	145	200	355	450	–	800	530
290	18	1220	250	400	18	1090	–	15	12	180	320	412	–	15	12	12	243	206	12	12	12	–	–	272	206	150	206	365	475	–	850	560
308	18	1280	258	412	18	1150	–	15	12	190	335	438	–	15	12	12	258	212	12	12	12	–	–	280	212	155	212	388	488	–	870	600
315	18	1360	272	438	18	1220	–	18	15	200	355	462	–	18	15	15	272	230	15	15	15	–	–	300	230	165	230	412	515	–	920	630
325	18	1420	280	450	18	1280	–	18	15	206	375	488	–	18	15	15	280	236	15	15	15	–	–	315	236	175	236	438	545	–	980	670
335	18	1500	290	475	18	1360	–	18	15	218	400	515	–	18	15	15	300	250	15	15	15	–	–	325	250	180	250	450	560	–	1030	710
–	–	–	–	–	–	1420	–	18	15	224	412	530	–	18	15	15	308	258	15	15	15	–	–	335	258	190	258	475	590	–	1090	750
–	–	–	–	–	–	1500	–	18	18	236	438	560	–	18	18	18	325	272	18	18	18	–	–	355	272	200	272	488	615	–	1150	800
–	–	–	–	–	–	1600	–	18	18	258	462	600	–	18	18	18	355	290	18	18	18	–	–	375	290	212	290	515	650	–	1220	850
–	–	–	–	–	–	1700	–	18	18	272	488	630	–	22	18	18	375	300	18	18	18	–	–	388	300	218	300	515	670	–	1280	900
–	–	–	–	–	–	1780	–	18	18	280	500	650	–	22	18	18	388	315	18	18	18	–	–	412	315	230	315	530	710	–	1360	950
–	–	–	–	–	–	1850	–	18	18	290	515	670	–	22	18	18	400	325	18	18	18	–	–	425	325	243	330	560	750	–	1420	1000
–	–	–	–	–	–	1950	–	18	18	300	545	710	–	22	18	18	412	335	18	18	18	–	–	438	335	250	345	580	775	–	1500	1060

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