TECHNICAL CHARACTERISTICS

LOAD CAPACITY OF CYLINDRICAL ROLLER BEARINGS

The rating of cylindrical roller bearings is based on their load capacity and lifetime. In the case of rotating bearings, the dynamic load coefficient must be taken into consideration; for roller bearings that have an occasional rotation, the static load coefficient must be considered. The load coefficients and the calculation procedures refer to DIN ISO 281/1 and ISO 76 regulations. Load capacities for cylindrical roller bearings are adequate to their practical use and performance.

DYNAMIC LOAD CAPACITY OF CYLINDRICAL ROLLER BEARINGS

Dynamic coefficient "C" is necessary for the calculation of rotating bearings, that is to say bearings subject to dynamic strain. It indicates the maximum possible load that a bearing can bear (in Kg/N): in theory the lifetime is 1 million rotations.

STATIC LOAD CAPACITY OF CYLINDRICAL ROLLER BEARINGS

Static coefficient C_o is used for the calculation of non-revolving bearings (that is to say fixed or subject to slow oscillations) or rotating at very low speed. The static load coefficient C_o is defined as the static load which causes a permanent deformation of the revolving bodies and of the raceways equal to 1/10,000 of the diameter of the revolving bodies, on the most stressed contact point.

AXIAL LOAD CAPACITY OF RADIAL CYLINDRICAL ROLLER BEARINGS

C.R. and Tecom cylindrical roller bearings can bear high axial thrusts and very high radial loads. The axial capacity of radial bearings depends on the dimensions of the edges, in relation to the front surfaces of the rolling bodies. The load capacity of the contact surfaces depends on the shearing speed and on the lubrication. With specific formulas it is possible to obtain axial load values that C.R. and Tecom bearings can bear: continuous, temporary and alternate loads.

LUBRICATION

Regular lubrication (except for "Lube-for-Life" bearings) and maintenance are essential for a long lifetime of revolving bearings. The lubricant has the following functions:

- It provides a film, which is enough to separate the surfaces of contact.
- It allows the removal of heat (oil lubrication)
- It prevents the entry of liquid or solid agents inside the bearing (grease lubrication).
- It decreases the noise of the bearing
- It protects against corrosion.

Revolving bearings can be lubricated – according to a technical choice – with grease or oil, depending on:

- Form of construction and dimension of the bearing.
- Type of execution of the housings and of the parts in contact with the bearing.
- Working condition.

GREASE LUBRICATION

The choice of the lubricant grease must be executed according to the specific instruction of lubricant suppliers. Revolving bearings are usually provided with lubricant greases that do not have high density at low temperature. Bearings working at high speed are provided with greases with low dynamic viscosity. In case the bearing is subject to high strain, C.R. and Tecom recommend the use of EP greases and high viscosity of the oil.

Normally, the bearing should not reach higher temperature than 90° C. In this way, the characteristics of the grease will not be altered. The lifetime of the lubricant is influenced by environmental conditions. According to C.R. and Tecom experience, the lifetime of the lubricant is guaranteed for three years, provided that the following conditions are fulfilled:

- Closed environment (warehouse)
- Temperature range 0°-40°C
- Air humidity below 70%
- Non-contamination by chemical agents.

After 3-year store time, the grease can lose some of its lubricant power. When re-lubrication is not possible, the lifetime of the grease becomes a main point. For security reason, it is necessary to take into consideration that generally the grease does not have a lifetime of more than three years.

In case the bearing is still functional, it must be cleaned and lubricated with the same quantity of grease which was used at the beginning. When possible, re-lubrication must be done at working temperature and while the bearing is rotating.

The necessary quantity of grease can vary from 20% to 80% compared to the original one.

It is necessary to verify that the old grease can go out without any problem. Lubrication range can be exactly calculated only with verifications made during real working conditions. It is possible to establish an indicative value of lubrication range following specific formulas.

OIL LUBRICATION

Oil lubrication guarantees a good distribution of the lubricant and of the bearing surfaces. Oil lubrication is used when the mechanical elements adjacent to the bearing are already lubricated with oil, or in case it is necessary to remove heat from the support. Oils with mineral base or synthesis oils are suitable for oil lubrication. Mineral oils with additive can be used for continuous working temperatures up to 120° C; synthesis oils up to 210° C.

For working security, C.R. and Tecom recommend lubricant oils with EP additive. They must be used in the following cases:

• Radial cylindrical roller bearings subject to very high loads and axial thrusts.
• Axial cylindrical roller bearings: before using lubricant oils, it is necessary to verify their compatibility with plastic materials, non-ferrous metals or light alloys.
These are the most popular lubrication systems:
• Drop oil lubrication: it is used for high speed radial bearings provided with a lubrication hole on the outer ring.
• Oil bath lubrication, immersion lubrication or oil sump lubrication: it is used for radial bearings.
• Oil mist lubrication, and oil-air lubrication: they are particularly suitable for radial bearings working at very high speed with low load.
• Oil recirculation lubrication: it is possible to filter the lubricant and cool it continuously. It is particularly suitable to remove heat from bearings working at high temperature.

During the run-in of the device, a high contamination of the lubricant can be noticed: in this case, the oil must be changed when the test is over.
According to C.R. and Tecom experience, it is enough to change the oil once a year, if the bearing temperature is kept below 60° C with a minimum amount of impurities.
In case of unfavourable working condition, C.R. and Tecom recommend to control the lubricant on regular basis, according to the manufacturer's instructions.

ASSEMBLING, DISASSEMBLING AND WASHING

C.R. and Tecom cylindrical roller bearings are precision products. This is why they need to be treated with very high care, before and during the assembling. Correct functioning mainly depends on good maintenance.

ASSEMBLING

The environment where the bearings are assembled must be clean and without dust. Before the assembling, it is useful to have a suitable equipment and a press. If a press is not available, the assembling can be done by strokes on the bushing's edges.

Warning: During the assembling, no thrusts nor strokes must be transferred on the revolving bodies! Deforming actions on the bearing rings must be avoided.
The assembling of the outer and inner rings can be facilitated by grooves or radii manufactured for this reason, and by a light lubricating treatment of the different surfaces.

The assembling of the inner rings on the shaft, with interference, is made through their heating with a suitable induction device. If this device is not available, the heating of the rings can be done in an oil bath or in an oven at a temperature of about 110° C.
C.R. and Tecom recommend the cooling of the housing, before assembling the bearing in it. It is necessary to make a working test of the bearing, once the assembling is finished.

DISASSEMBLING

During design phase, bordering holes or suitable cavities for the extractor should be foreseen in order to allow the bearing to be disassembled. If the bearing is re-used, be careful and avoid strokes and thrusts. After disassembling, the bearing must be cleaned in all its parts.

WASHING

The following cleansers can be used to degrease and wash the bearings:

- Water-based cleansers
- Organic cleansers

Water-based cleansers can be neutral, acid or alkaline.
Organic cleansers are: petroleum, provided that it is without water or acids, - and gasoline (not the one used for vehicles). After the procedure of washing, the bearings must be immediately dried and treated with a suitable lubricant.

LIFETIME CALCULATION

The lifetime of the bearing depends on the applied load and number of rotations, and it is calculated in the following way:

$$L = (C/P)^p \qquad L_h = (16666/n) \cdot (C/P)^p$$

$L = 10^6$ The lifetime of the bearings depends on the load. Rated duration in million of rotations, which is achieved or overcome by 90% of a representative number of equal bearings, before the material shows signs of wear.

$L_h = h$ Rated duration in hours of working corresponding to L.

$C = N$ Dynamic load coefficient. With reference to radial bearings, C corresponds to a load with constant entity and direction. The test on a representative number of bearings proved that the rated duration is one million rotations. With reference to axial bearings, C corresponds to the axial load which operates in central position.

$P = N$ Equivalent load on the bearings for radial or axial bearings.

p Lifetime exponent
p=10/3 for needle roller and cylindrical roller bearings

$n = min^{-1}$ Number of rotations

BASIC LUBRICATION RANGE

Basic lubrication range "t_f" depends on the GKW speed coefficient and is shown in diagram 02 according to the following formula, considering K_L bearing type, the number of rotation n and the medium diameter d_M of the bearing.

$$GKW = \frac{K_L \cdot 270.000}{(n \cdot d_M)}$$

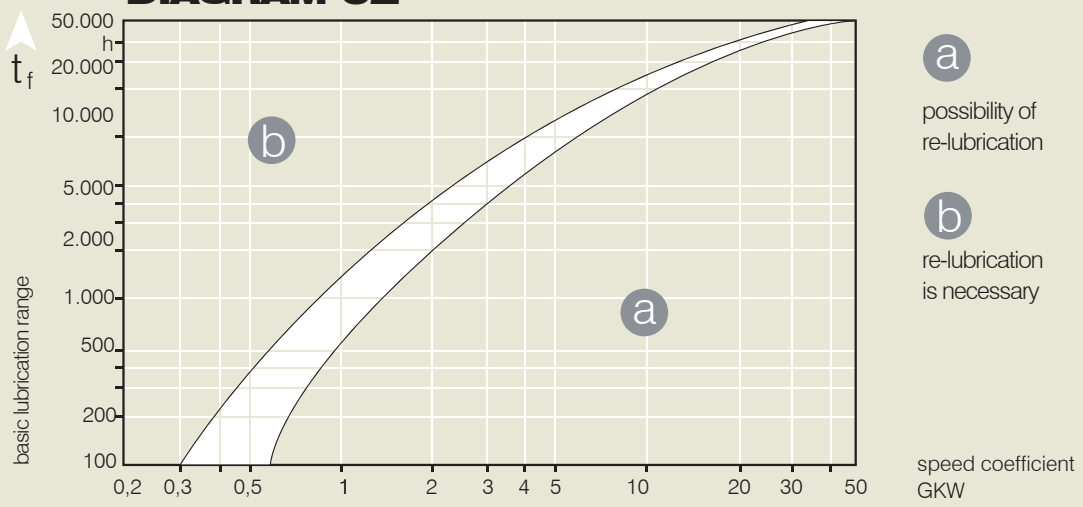
GKW = Speed coefficient
K_L = Tab 01
n = Number of rotation
d_M = Medium diameter

TAB 01 BEARING TYPE	K_L
Support rolls and cam followers, with full-complement cage	*0,3*
Support rolls and cam followers, with full-complement rollers	*0,15*
Cylindrical roller bearings	*0,8*
Axial cylindrical roller bearings	*0,08*

DETAILS FOR LUBRICATION RANGE

PREMISES	CONDITIONS
Bearing temperature	*Up to 70°c*
Load ratio	*Co/p=20*
Number of rotations and load	*steady*
Load in the main direction	*radial on radial bearing – axial on axial bearing*
Lubrication grease	*grease with lithium soap*
Rotation axis	*horizontal for radial bearings*
Inner ring	*revolving*
Influence of the external	*no influence*

DIAGRAM 02



STATIC SECURITY COEFFICIENT

Static security coefficient defines the security grade against bearing deformations and is calculated with the following formula:

$$S_0 = C_0 / F_0$$

S_0 = static security coefficient
C_0 = static load coefficient (N)
F_0 = maximum load of the bearing (N)

With a static security coefficient $S_0 < 8$, the bearings are very pressed and with coefficient $S_0 \geq 8$, the bearings are medium or lightly pressed.

APPROXIMATE VALUES OF STATIC SECURITY COEFFICIENT

APPLICATION CASE	S_0
Silent working with few vibrations and normal working with minimum need for quietness: bearing with minimum rotation.	*≥1*
Normal working with more need for quietness.	*≥2*
Working with high impact loads.	*≥3*
Supports with high demand for precision of rotation and quietness.	*≥4*

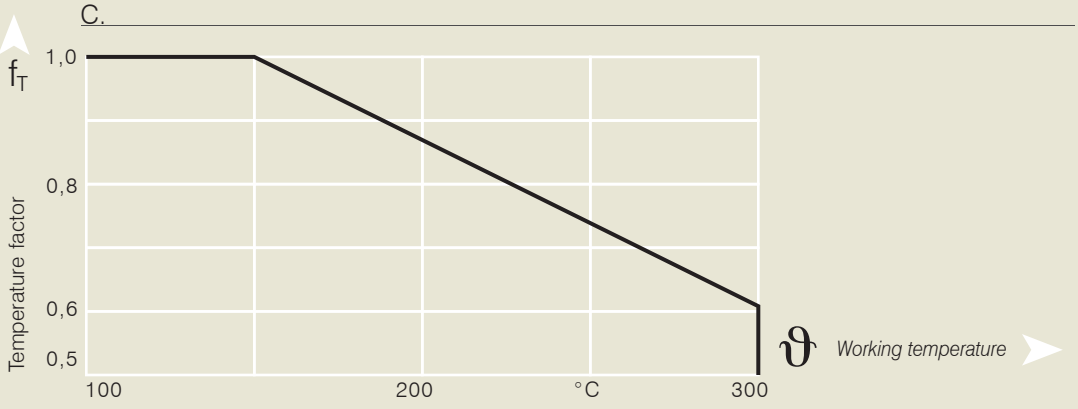
INFLUENCE OF TEMPERATURE ON THE BEARING

Temperature influences the bearing by decreasing the dynamic load capacity "C"; such output is calculated according to this correction formula:

$$C_T = f_T \cdot C$$

C_T = effective dynamic load coefficient for high temperatures
f_T = temperature factor according to graph 03
C = dynamic load coefficient

The reduction of hardness due to the increase of temperature does not affect the static load capacity "C_0", therefore it can be overlooked for temperatures up to +300° C.



BEARING CLEARANCE AND WORKING CLEARANCE

The good functioning of revolving bearings depends on a correct working.
This depends on radial clearance and on the change of radial clearance as a consequence of the assembling interference and of working temperature.

WORKING CLEARANCE

The radial moving of the shaft with regard to the outer ring of the bearing determines the working clearance.
The working clearance depends on the reduction of the radial clearance, as a consequence of the assembling interference and the temperature.
The reduction of the radial clearance of the assembled bearing – due to the couplings – is the result of the inner ring expansion and the contraction of the outer ring.
The difference of temperature between inner ring and outer ring can cause a reduction or an increase of working clearance

RADIAL CLEARANCE OF THE BEARING

The radial clearance of the disassembled revolving bearing is expressed through the value of the radial shifting from edge to edge of the inner ring towards the outer ring.
The bearing radial clearance is divided into four groups (see table 04).
C.R. bearings manufactured with normal CN clearance guarantee a correct working clearance in normal working conditions, considering the suitable tolerances for shaft and housing. C3 and C4 radial clearances are taken into consideration for bearings having big dimensions, subject to high loads; in case of assembling interference and big difference of temperature between the inner ring and outer ring.
Bearings with C2 radial clearance are to be employed only in special cases (for example, in case of high combined alternate loads with swinging movements or a limited number of rotations).
In these particular cases it is highly recommended to check the bearings during the functioning, since they are subject to heating.
The values of C2, CN, C3 and C4 radial clearances are listed in table 05.
The customer must specify the bearing clearance, except for CN clearance.

TAB 04

FIELD	MEANING
C2	*Bearing radial clearance lower than CN*
CN	*Normal bearing radial clearance*
C3	*Bearing radial clearance higher than CN*
C4	*Bearing radial clearance higher than C3*

TAB 05	Rated Ø of the holes in mm. d		bearing radial clearance in μm. C2		CN		C3		C4	
	More than	up to	min.	max.	min.	max.	min.	max.	min.	max.
	-	24	0	25	20	45	35	60	50	75
	24	30	0	25	20	45	35	60	50	75
	30	40	5	30	25	50	45	70	60	85
	40	50	5	35	30	60	50	80	70	100
	50	65	10	40	40	70	60	90	80	110
	65	80	10	45	40	75	65	100	90	125
	80	100	15	50	50	85	75	110	105	140
	100	120	15	55	50	90	85	125	125	165
	120	140	15	60	60	105	100	145	145	190
	140	160	20	70	70	120	115	165	165	215
	160	180	25	75	75	125	120	170	170	220
	180	200	35	90	90	145	140	195	195	250
	200	225	45	105	105	165	160	220	220	280
	225	250	45	110	110	175	170	235	235	300
	250	280	55	125	125	195	190	260	260	330
	280	315	55	130	130	205	200	275	275	350
	315	355	65	145	145	225	225	305	305	385
	355	400	100	190	190	280	280	370	370	460
	400	450	110	210	210	310	310	410	410	510
	450	500	110	220	220	330	330	440	440	550

RADIAL BEARING TOLERANCES

The tolerances of cylindrical roller bearings are according to DIN 620 part 2 and 3. Generally C.R. bearings correspond to PN class; in case of need of higher precision bearings, the tolerances can be reduced to the values of classes P6 and P5.

Dimensional and tolerance symbols

Symbol	d	C4
d	*rated hole diameter*	
D_{dmp}	*tolerance of the medium diameter of the hole in a plan*	
V_{dp}	*variation of hole diameter in a single radial plan*	◯ *circularity*
V_{dmp}	*variation of the medium diameter of the hole*	// *parallelism*
D	*rated outer diameter*	
D_{Dmp}	*tolerance of medium outer diameter in a single radial plan*	
V_{Dp}	*variation of medium outer diameter in a single radial plan*	◯ *circularity*
V_{Dmp}	*variation of medium outer diameter*	// *parallelism*
D_{Bs}	*tolerance of one single size of inner ring width*	
V_{Bs}	*variation of inner ring width*	// *parallelism*
D_{Cs}	*tolerance of one single width of outer ring*	
V_{Cs}	*variation of outer ring width*	// *parallelism*
K_{ia}	*radial defect of inner ring rotation, to be measured on the assembled bearing*	◎ *concentricity*
K_{ea}	*radial defect of outer ring rotation, to be measured on the assembled bearing*	◎ *concentricity*
S_d	*defect of quadrature of the surfaces with regard to the hole*	⏥ *flatness*
S_D	*variation of outer cylindrical surface inclination related to lateral surfaces*	⏥ *flatness*

CLASS OF TOLERANCE PN (normal tolerance)

TAB 06

Tolerance values in µm

INNER RINGS

d		Tolerance S_{dmp}		Range of diameters V_{dp}			V_{dmp}	K_{ia}	Tolerance S_{Bs}		V_{Bs}
mm.				8,9	0	2,3					
more than	up to	more than	up to	max			max	max	sup.	inf.	max
0,6 (1)	2,5	0	-8	10	8	6	6	10	0	-40	12
2,5	10	0	-8	10	8	6	6	10	0	-120	15
10	18	0	-8	10	8	6	6	10	0	-120	20
18	30	0	-10	13	10	8	8	13	0	-120	20
30	50	0	-12	15	12	9	9	15	0	-120	20
50	80	0	-15	19	19	11	11	20	0	-150	25
80	120	0	-20	25	25	15	15	25	0	-200	25
120	180	0	-25	31	31	19	19	30	0	-250	30
180	250	0	-30	38	38	23	23	40	0	-300	30
250	315	0	-35	44	44	26	26	50	0	-350	35
315	400	0	-40	50	50	30	30	60	0	-400	40
400	500	0	-45	56	56	34	34	65	0	-450	50
500	630	0	-50	63	63	38	38	70	0	-500	60
630	800	0	-75	-	-	-	-	80	0	-750	70
800	1000	0	-100	-	-	-	-	90	0	-1000	80
1000	1250	0	-125	-	-	-	-	100	0	-1250	100
1250	1600	0	-160	-	-	-	-	120	0	-1600	120
1600	2000	0	-200	-	-	-	-	140	0	-2000	140

(1) This diameter is included

TAB 06.1

Tolerance values in µm

OUTER RINGS

D		Tolerance S_{dmp}		Range of diameters V_{Dp} (2)			V_{Dmp}	K_{ea}	Tolerance S_{Cs}	V_{Cs}
mm.				8,9	0	2,3				
more than	up to	more than	up to	max			max	max		
2,5 (1)	6	0	-8	10	8	6	6	15	*Identical to S_{Bs} and V_{Bs} for inner ring of same bearing (see tab. 06)*	
6	18	0	-8	10	8	6	6	15		
18	30	0	-9	12	9	7	7	15		
30	50	0	-11	14	11	8	8	20		
50	80	0	-13	16	13	10	10	25		
80	120	0	-15	19	19	11	11	35		
120	150	0	-18	23	23	14	14	40		
150	180	0	-25	31	31	19	19	45		
180	250	0	-30	38	38	23	23	50		
250	315	0	-35	44	44	26	26	60		
315	400	0	-40	50	50	30	30	70		
400	500	0	-45	56	56	34	34	80		
500	630	0	-50	63	63	38	38	100		
630	800	0	-75	94	94	55	55	120		
800	1000	0	-100	125	125	75	75	140		
1000	1250	0	-125	-	-	-	-	160		
1250	1600	0	-160	-	-	-	-	190		
1600	2000	0	-200	-	-	-	-	220		
2000	2500	0	-250	-	-	-	-	250		

(1) This diameter is included

(2) Valid before the assembling of the bearing and/or after disassembling the outer and inner spring rings.

CLASS OF TOLERANCE P6

TAB 07

Tolerance values in µm

INNER RINGS

d		Tolerance S_{dmp}		Range of diameters V_{dp}			V_{dmp}	K_{ia}	Tolerance S_{Bs}		V_{Bs}
mm.				8,9	0	2,3					
more than	up to	more than	up to	max			max	max	sup.	inf.	max
0,6 (1)	2,5	0	-7	9	7	5	5	5	0	-40	12
2,5	10	0	-7	9	7	5	5	6	0	-120	15
10	18	0	-7	9	7	5	5	7	0	-120	20
18	30	0	-8	10	8	6	6	8	0	-120	20
30	50	0	-10	13	10	8	8	10	0	-120	20
50	80	0	-12	15	15	9	9	10	0	-150	25
80	120	0	-15	19	19	11	11	13	0	-200	25
120	180	0	-18	23	23	14	14	18	0	-250	30
180	250	0	-22	28	28	17	17	20	0	-300	30
250	315	0	-25	31	31	19	19	25	0	-350	35
315	400	0	-30	38	38	23	23	30	0	-400	40
400	500	0	-35	44	44	26	26	35	0	-450	45
500	630	0	-40	50	50	30	30	40	0	-500	50

(1) This diameter is included

TAB 07.1

Tolerance values in µm

OUTER RINGS

D		Tolerance S_{dmp}		Range of diameters V_{Dp} (2)			V_{Dmp}	K_{ea}	Tolerance S_{Cs}	V_{Cs}
mm.				8,9	0	2,3				
more than	up to	more than	up to	max			max	max		
2,5 (1)	6	0	-7	9	7	5	5	8	Identical to S_{Bs} and V_{Bs} for inner ring of same bearing (see tab. 07)	
6	18	0	-7	9	7	5	5	8		
18	30	0	-8	10	8	6	6	9		
30	50	0	-9	11	9	7	7	10		
50	80	0	-11	14	11	8	8	13		
80	120	0	-13	16	16	10	10	18		
120	150	0	-15	19	19	11	11	20		
150	180	0	-18	23	23	14	14	23		
180	250	0	-20	25	25	15	15	25		
250	315	0	-25	31	31	19	19	30		
315	400	0	-28	35	35	21	21	35		
400	500	0	-33	41	41	25	25	40		
500	630	0	-38	48	48	29	29	50		
630	800	0	-45	56	56	34	34	60		
800	1000	0	-60	75	75	45	45	75		

(1) This diameter is included

(2) Valid before the assembling of the bearing and/or after disassembling the outer and inner spring rings.

CLASS OF TOLERANCE P5

TAB 08

Tolerance values in µm

INNER RINGS

d		Tolerance S_{dmp}		Range of diameters V_{dp}		V_{dmp}	K_{ia}	Tolerance S_{Bs}		V_{Bs}
mm.				8,9	0,2,3					
more than	up to	more than	up to	max		max	max	sup.	inf.	max
0,6 (1)	2,5	0	-5	5	4	3	4	0	-40	5
2,5	10	0	-5	5	4	3	4	0	-40	5
10	18	0	-5	5	4	3	4	0	-80	5
18	30	0	-6	6	5	3	4	0	-120	5
30	50	0	-8	8	6	4	5	0	-120	5
50	80	0	-9	9	7	5	5	0	-150	6
80	120	0	-10	10	8	5	6	0	-200	7
120	180	0	-13	13	10	7	8	0	-250	8
180	250	0	-15	15	12	8	10	0	-300	10
250	315	0	-18	18	14	9	13	0	-350	13
315	400	0	-23	23	18	12	15	0	-400	15

(1) This diameter is included

TAB 08.1

Tolerance values in µm

OUTER RINGS

D		Tolerance S_{dmp}		Range of diameters V_{Dp} (2)		V_{Dmp}	K_{ea}	Tolerance S_{Cs}	V_{Cs}
mm.				8,9	0,2,3				
more than	up to	more than	up to	max		max	max	Identical to S_{Bs} and V_{Bs} for inner ring of same bearing (see tab. 08)	max
2,5 (1)	6	0	-5	5	4	3	5		5
6	18	0	-5	5	4	3	5		5
18	30	0	-6	6	5	3	6		5
30	50	0	-7	7	5	4	7		5
50	80	0	-9	9	7	5	8		6
80	120	0	-10	10	8	5	10		8
120	150	0	-11	11	8	6	11		8
150	180	0	-13	13	10	7	13		8
180	250	0	-15	15	11	8	15		10
250	315	0	-18	18	14	9	18		11
315	400	0	-20	20	15	10	20		13
400	500	0	-23	23	17	12	23		15
500	630	0	-28	28	21	14	25		18
630	800	0	-35	35	26	18	30		20

(1) This diameter is included

(2) Valid before the assembling of the bearing and/or after disassembling the outer and inner spring rings.