NEEDLE ROLLERS

NADELLA

Technical features

Needle rollers

In certain applications, the limited amount of space available for bearings and the loads to be supported require the use of a full complement of needles independent of any system of retention. The dimensions of the needle, diameter and length, are determined in relation to the load capacity required.
The needles are placed directly between shaft and housing without the use of inner or outer rings. Thus a shaft of maximum diameter is permissible to increase rigidity and load capacity.
In rotating applications where the load capacity requires the use of needles that are long in relation to the shaft diameter, it is preferable to employ two rows of needles of equal length separated by a spacer ring. In such cases, the needles must be selected with diameters in the same tolerance class. This arrangement is particularly recommended for mounting parts such as long idler wheels, especially where they are subjected to rotational torque.

RACEWAYS
Maximum load capacity is obtained with hardened inner and outer raceways of surface hardness 58-64 HRC. Parts used for the lateral retention of needles at their ends should be of equivalent hardness.
The inner and outer raceways should both be aligned on installation and before operation under load. In the case of parts fitted with a single row of needles, the inner raceway may be ground convex to allow misalignment. A convexity permitting misalignment of 1 in 1000 (or up to 2 in 1000 in cases of instantaneous overloading) does not reduce the calculated load capacity. This convexity, which also depends on the length of the needles, may be produced on a separate inner ring or directly on the shaft journal using a grinding wheel with concave profile obtained by inclining the diamond impregnated cutting wheel. Further technical information is available, consult Nadella Technical Department.

TYPES AND DIMENSIONS
The standard needle type **BR**, of increased use, has rounded ends. On request, can also be supplied needles with flat ends, type **BP**.
The standard dimensions of the BR type needles are given in the table following (pages 198, 199 and 200). Needles of special dimensions may be manufactured on request.

CHARACTERISTICS
Nadella standard needles are made in through-hardened bearing steel of hardness 58-65 HRC.
Needles in heat treated corrosion resistant steel (hardness 57-62 HRC) may be produced on request, the preferred diameters being 1.5, 2, 2.5, 3 and 4 mm.
The surface finish is 0.2 micron according to Ra system.
The profile of a needle is not cylindrical along its whole length as there is a very slight tape towards the ends. Therefore, precise measurement of the diameter can only be carried out in the central area of the needle. Needles having a greater taper at the ends may be supplied on request (suffix ... **DTN**).

MANUFACTURING TOLERANCES
In general, the diameter of standard needles with rounded ends type **BR** and with flat ends type **BP** is produced to a tolerance up to 10 micron less from the nominal dimension.
However, the maximum variation on any one production lot is 5 µm according to one of the classes of grade G5 in the table below. On request, a variation of 3 µm may be obtained according to the classes of grade G3, and a variation of 2 µm according to the classes of grade G2.
Unless specified otherwise, quantities supplied are divided by Nadella into different classes of each grade G2, G3 or G5. However the current supply are generally available in grade G2 according to the classes printed in bold type.
The colour codes shown for class G2 are only used by agreement.
The length of needles type BR and BP is kept within tolerance h13.

TOLERANCES ON NEEDLE DIAMETER

Grade G	Variation in diameter µm	Standard classes	Deviation from true circularity µm
2	2	**0-2 -1-3 -2-4 -3-5 -4-6** 5-7 -6-8 -7-9 -8-10	1
3	3	0-3 -15-4,5 -3-6 -4,5-7,5 -6-9 -7-10	1,5
5	5	0-5 -3-8 -5-10	2,5

Example of designation: ∅ 2,5 x 15,8 BR/G2-2-4

COLOUR CODES FOR THE CLASSES OF GRADE G2

0-2 red	1-3 pink	2-4 blue	3-5 sky blue	4-6 white	5-7 grey	6-8 green	7-9 orange	8-10 yellow

Technical features

Needle rollers

SHAFT AND HOUSING TOLERANCES

Operating conditions	Shaft Fw	Housing	
		Quota D	Quota B (1)
Rotation on a convex inner raceway	j 5	F 6	H12
Rotation on a cylindrical inner raceway	h 5	F 6	
Oscillatory motion	h 5	G 6	

(1) Nominal dimension B = length of needle Lw +0,2 mm
The cylindrical tolerance, defined as the difference in radii of two coaxial cylinders (ISO Standard 1101), should normally be less than a quarter of the manufacturing tolerance. However, far high precision or high speed applications, it is recommended to restrict this tolerance to one-eighth of the manufacturing tolerance.

LIMITING SPEED

With effective oil lubrication and good alignment between shaft and housing, limiting speed may reach:

$$n\ (min^{-1}) = \frac{380\ 000}{Fw}$$

(Fw: diameter of inner raceway in mm)

up to a maximum speed of 70 000 mm-1. For grease lubrication, use approximately half these values.

DYNAMIC AND STATIC CAPACITIES

The dynamic capacity C_R, in Newton (N), is given by the formula:

1) $C_R = K\ Lu$

K: variable factor relating to diameter of inner raceway Fw, according to tables on pages 201, 202 and 203.
Lu (mm): effective needle length, as shown in the table of dimensions.

The static capacity C_{OR} in Newton (N), is given by the formula:

2) $C_{OR} = 44\ \frac{(1 - \varnothing)}{Fw+\varnothing}\ \varnothing\ Lu\ Z$

∅ (mm): diameter of needles
Lu (mm): effective needle length, as shown in the table of dimensions.
Z: number of needles
Fw: diameter of inner raceway in mm.

NUMBER OF NEEDLES- CIRCUMFERENTIAL PLAY

The number of needles Z is given, as a function of the proposed shaft diameter Fw and the needle diameter ∅, by the formula:

$$3)\ Z = \frac{\pi\ (Fw + \varnothing)}{\varnothing}$$

adjusted to the nearest whole number.

To ensure the circumferential play jc, which should normally be between 0.3 and 1 mm, the shaft diameter Fw is corrected with the following formula:

$$4)\ Fw = \gamma\ \varnothing + \frac{jc}{\pi}$$

is a variable factor shown in the tables on pages 201, 202 and 203 in respect to the number of needles Z.

Example: needles of diameter d = 2. 5 mm on a shaft of diameter Fw = approx. 30 mm.

$$\text{Number of needle } Z = \frac{\pi\ (30 + 2{,}5)}{2{,}5}$$

To ensure circumferential play jc = 0,3 mm the shaft diameter Fw planned is corrected with the formula 4) with γ = 12.06 for 41 needles (tables on pages 201, 202 and 203), thus:

$$Fw = 12{,}06 \times 2{,}5 + \frac{0{,}3}{\pi} = 30{,}25\ \text{mm (adjusted up)}$$

The shaft diameter Fw can therefore be designed at the nominal dimension adjusted up to 30.3 mm to take 41 needles of diameter 2.5 mm, with a circumferential play of approx. 0.3 mm.

Note: Having established the number of needles Z, reference may then be made to the table on pages 201, 202 and 203, giving the corresponding Fw dimensions according to needle diameter and for a circumferential play between 0.3 and 0.6 mm. Thus, for 41 needles of diameter 2.5 mm, diameter Fw is 30.3 mm.

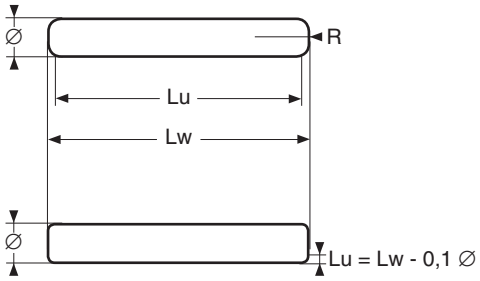
INSTALLATION OF LOOSE NEEDLE

Because of the large number of shaft diameters possible, depending on the number of needles chosen and their diameter, needles cannot be packed in rings ready for installation.
The needles, which are supplied loose, should therefore be arranged in a ring around the inner or outer raceway, which must be pregreased to ensure their retention during installation of the parts that will retain them.
In cases where the shaft has to be introduced blind into a ring of needles, it may be useful to retain the needles in their housing by means of a mounting shaft of the same length as the needles. This can then be withdrawn when the shaft is introduced.
Arrangement of the needles in a ring may be carried out by hand where the number of installations is small. The use of automatic machines with high-speed rotary loading should be considered only for production quantities large enough to ensure that the high cost of investment can be absorbed.

Standard needles with rounded ends type BR and BP

Example of designation:
∅ **3 x 23,8 BR**

BR



Example of designation:
∅ **3 x 23,8 BP**

BP

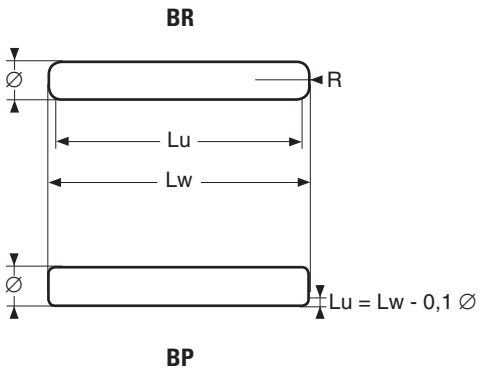
∅		in mm	
>	≤	r min.	r max.
-	1	0,1	0,3
1	3	0,1	0,4
3	5	0,1	0,6

∅ mm	BP Lw mm	BR		Weight ‰ g
		Lw mm	Lu mm	
1		5.8	5	34
		7.8	7	46
1.5	5.8	5.8	4.9	76
	6.8	6.8	5.9	90
		7.8	6.9	103
	9.8	9.8	8.9	130
		11.8	10.9	157
		13.8	12.9	185
		15.8	14.9	210
2		3.8	2.8	87
		5.8	4.8	135
	7.8	7.8	6.8	182
	8.8			
	9.8	9.8	8.8	230
		11.8	10.8	280
	12.8			
	13.8	13.8	12.8	325
	15.8	15.8	14.8	375
		17.8	16.8	420
	19.8	19.8	18.8	470
2.5	7.8	7.8	6.7	285
		9.8	8.7	360
		11.8	10.7	430
		13.8	12.7	510
	14			
	15.8	15.8	14.7	580
		17.8	16.7	660
		19.8	18.7	730
		21.8	20.7	800
	27.8	23.8	22.7	880

Standard needles with rounded ends type BR and BP

Example of designation:
∅ **3 x 23,8 BR**

Example of designation:
∅ **3 x 23,8 BP**



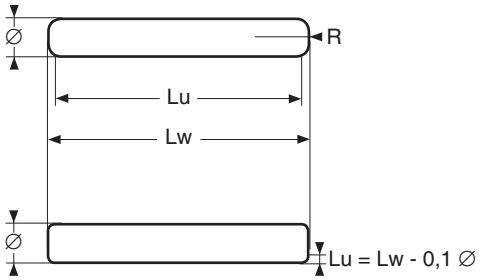
∅		in mm	
>	≤	r min.	r max.
-	1	0,1	0,3
1	3	0,1	0,4
3	5	0,1	0,6

∅ mm	BP Lw mm	BR Lw mm	BR Lu mm	Weight ‰ g
3	9.8	9.8	8.5	510
	11.8	11.8	10.5	620
	12.8			
	13.8	13.8	12.5	730
	15.8	15.8	14.5	840
	17.8	17.8	16.5	940
	19.8	19.8	18.5	1 050
	21.8	21.8	20.5	1 150
	23.8	23.8	22.5	1 260
	25.4			
	25.8	25.8	24.5	1 370
	26.8			
	27.8	27.8	26.5	1 480
	29.8	29.8	28.5	1 600
3.5	8.8			
		11.8	10.3	840
		13.8	12.3	990
		15.8	14.3	1 130
		17.8	16.3	1 280
		19.8	18.3	1 430
		21.8	20.3	1 510
		23.8	22.3	1 720
		25.8	24.3	1 850
		27.8	26.3	2 000
		29.8	28.3	2 150
		34.8	33.3	2 500

Standard needles with rounded ends type BR and BP

Example of designation:
∅ **3 x 23,8 BR**

BR



Example of designation:
∅ **3 x 23,8 BP**

BP

∅		in mm	
>	≤	r min.	r max.
-	1	0,1	0,3
1	3	0,1	0,4
3	5	0,1	0,6

∅ mm	BP Lw mm	BR		Weight ‰ g
		Lw mm	Lu mm	
4	8.8	13.8	12.1	1 280
		15.8	14.1	1 480
		17.8	16.1	1 650
		19.8	18.1	1 850
		21.8	20.1	2 050
		23.8	22.1	2 250
		25.8	24.1	2 450
		27.8	26.1	2 600
		29.8	28.1	2 800
		34.8	33.1	3 300
		39.8	38.1	3 800
		44.8	43.1	4 200
5	8.8			
		19.8	17.5	2 900
		21.8	19.5	3 200
		23.8	21.5	3 500
		25.8	23.5	3 800
		27.8	25.5	4 100
		29.8	27.5	4 400
		34.8	32.5	5 100
		39.8	37.5	5 900
		49.8	47.5	7 400
				Unit weight g
6		29.8	27.6	6.3
		39.8	37.6	8.4
		59.8	57.2	12.7
7		69.8	66.9	20.2
8		79.8	76.7	30

Standard needles

Shaft diameter Fw for Z needles of diameter ∅ and a circumferential clearance jc between 0.3 and 0.6 mm

Coefficient γ : formula 4)
Coefficient K: formula 1)

∅ → mm		1		1.5		2		2.5		3		3.5		4		5	
Z	γ	Fw mm	K	Fw mm	K	Fw mm	K	Fw mm	K	Fw mm	K	Fw mm	K	Fw mm	K	Fw mm	K
10	2.24	2.3	531	3.5	823	4.6	1 119	5.7	1 420	6.9	1 730	8.0	2 040	9.1	2 351	11.3	2 985
11	2.55	2.7	586	4	905	5.2	1 228	6.5	1 561	7.8	1 898	9.1	2 241	10.3	2 583	12.9	3 283
12	2.86	3	635	4.4	978	5.9	1 334	7.3	1 693	8.7	2 058	10.2	2 429	11.6	2 803	14.5	3 562
13	3.18	3.3	680	4.9	1 050	6.5	1 430	8.1	1 817	9.7	2 210	11.3	2 608	12.9	3 010	16	3 822
14	3.49	3.6	723	5.4	1 118	7.1	1 522	8.9	1 935	10.6	2 352	12.4	2 776	14.1	3 203	17.6	4 070
15	3.81	3.9	765	5.9	1 182	7.8	1 609	9.7	2 045	11.6	2 488	13.5	2 936	15.4	3 388	19.2	4 306
16	4.13	4.2	804	6.3	1 242	8.4	1 693	10.5	2 151	12.5	2 617	14.6	3 088	16.6	3 564	20.8	4 530
17	4.44	4.5	841	6.8	1 301	9	1 772	11.2	2 253	13.5	2 740	15.7	3 233	17.9	3 732	22.3	4 743
18	4.76	4.9	878	7.3	1 356	9.7	1 849	12.0	2 349	14.4	2 858	16.8	3 372	19.2	3 893	23.9	4 948
19	5.08	5.2	913	7.8	1 411	10.3	1 921	12.8	2 443	15.4	2 971	17.9	3 507	20.4	4 048	25.5	5 144
20	5.39	5.5	945	8.2	1 463	10.9	1 992	13.6	2 532	16.3	3 080	19	3 635	21.7	4 196	27.1	5 333
21	5.71	5.8	978	8.7	1 512	11.6	2 059	14.4	2 618	17.3	3 185	20.1	3 758	23	43 39	28.7	5 515
22	6.03	6.1	1 010	9.2	1 560	12.2	2 125	15.2	2 701	18.2	3 286	21.2	3 879	24.3	4 477	30.3	5 690
23	6.34	6.4	1 039	9.6	1 607	12.8	2 189	16	2 783	19.2	3 385	22.3	3 996	25.5	4 611	31.8	5 861
24	6.66	6.8	1 067	10.1	1 652	13.5	2 250	16.8	2 861	20.1	3 481	23.4	4 107	26.8	4 741	33.4	6 026
25	6.98	7.1	1 097	106	1 695	14.1	2 311	17.6	2 936	21.1	3 572	24.6	4 216	28.1	4 866	35	6 187
26	7.30	7.4	1 124	11.1	1 738	14.7	2 369	18.4	3 011	22	3 664	25.7	4 322	29.3	4 991	36.6	6 342
27	7.61	7.7	1 151	11.6	1 779	15.4	2 425	19.2	3 082	23	3 751	26.8	4 426	30.6	5 109	38.2	6 494
28	7.93	8	1 178	12	1 822	16	2 481	20	3 153	23.9	3 836	27.9	4 528	31.9	5 225	39.8	6 642
29	8.25	8.4	1 202	12.5	1 860	16.6	2 535	20.8	3 221	24.9	3 919	29	4 626	33.1	5 341	41.4	6 786
30	8.57	8.7	1 228	13	1 898	17.3	2 587	21.6	3 289	25.8	4 002	30.1	4 723	34.4	5 451	43	6 927
31	8.88	9	1 252	13.5	1 936	17.9	2 639	22.3	3 356	26.8	4 081	31.2	4 818	35.7	5 560	44.5	7 069
32	9.20	9.3	1 277	13.9	1 975	18.5	2 691	23.1	3 420	27.7	4 161	32.3	4 910	36.9	5 668	46.1	7 204
33	9.52	9.6	1 301	14.4	2 011	19.2	2 739	23.9	3 483	28.7	4 236	33.5	4 998	38.2	5 772	47.7	7 336
34	9.84	9.9	1 325	14.9	2 046	19.8	2 788	24.7	3 545	29.7	4 311	34.6	5 088	39.5	5 874	49.3	7 466
35	10.16	10.3	1 345	15.4	2 081	20.5	2 835	25.5	3 606	30.6	4 386	35.7	5 176	40.8	5 974	50.9	7 595
36	10.47	10.6	1 368	15.8	2 118	21.1	2 883	26.3	3 666	31.5	4 460	36.8	5 262	42	6 075	52.5	7 720
37	10.79	10.9	1 390	16.3	2 150	21.7	2 930	27.1	3 725	32.5	4 530	37.9	5 346	43.3	6 172	54.1	7 843
38	11.11	11.2	1 413	16.8	2 183	22.4	2 974	27.9	3 782	33.5	4 600	39	5 430	44.6	6 267	55.7	7 965
39	11.43	11.5	1 434	17.3	2 216	23	3 020	28.7	3 839	34.4	4 670	40.1	5 512	45.9	6 360	57.3	8 085
40	11.75	21.9	1 453	17.8	2 247	23.6	3 065	29.5	3 895	35.4	4 738	41.3	5 590	47.1	6 455	58.9	8 202

Standard needles

Shaft diameter Fw for Z needles of diameter ∅ and a circumferential clearance jc between 0.3 and 0.6 mm

Coefficient γ : formula 4)
Coefficient K: formula 1)

∅ → mm		1		1.5		2		2.5		3		3.5		4		5	
Z	γ	Fw mm	K	Fw mm	K	Fw mm	K	Fw mm	K	Fw mm	K	Fw mm	K	Fw mm	K	Fw mm	K
41	12.06					24.3	3 107	30.3	3 949	36.3	4 805	42.3	5 673	48.4	6 546	60.4	8 321
42	12.38					24.9	3 150	31.1	4 005	37.3	4 871	43.5	5 748	49.7	6 635	62	8 435
43	12.70					25.5	3 194	31.9	4 058	38.2	4 938	44.6	5 826	50.9	6 726	63.6	8 548
44	13.02					26.2	3 233	32.7	4 111	39.2	5 001	45.7	5 902	52.2	6 813	65.2	8 660
45	13.34					26.8	3 275	33.5	4 163	40.2	5 064	46.8	5 978	53.5	6 899	66.8	8 769
46	13.65					27.4	3 317	34.3	4 215	41.1	5 127	47.9	6 052	54.7	6 986	68.4	8 879
47	13.97					28.1	3 356	35.1	4 266	42	5 190	49	6 126	56	7 071	70	8 986
48	14.29					28.7	3 396	35.9	4 316	43	5 251	50.2	6 197	57.3	7 153	71.6	9 091
49	14.61					29.4	3 434	36.7	4 366	44	5 311	51.3	6 286	58.6	7 236	73.2	9 196
50	14.93					30	3 474	37.5	4 415	44.9	5 372	52.4	6 339	59.9	7 317	74.8	9 300
51	15.24					30.6	3 513	38.2	4 465	45.9	5 430	53.5	6 409	61.1	7 399	76.3	9 405
52	15.56					31.3	3 550	39	4 514	46.8	5 490	54.6	6 479	62.4	7 479	77.9	9 506
53	15.88					31.9	3 588	39.8	4 561	47.8	5 547	55.7	6 548	63.7	7 556	79.5	9 606
54	16.20					32.5	3 626	40.6	4 609	48.7	5 606	56.8	6 616	64.9	7 637	81.1	9 706
55	16.52					33.2	3 661	41.4	4 655	49.7	5 661	58	6 681	66.2	7 713	82.7	9 804
56	16.83					33.8	3 699	42.2	4 701	50.6	5 719	59	6 750	67.5	7 789	84.3	9 901
57	17.15					34.4	3 736	43	4 747	51.6	5 774	60.2	6 814	68.7	7 867	85.9	9 997
58	17.47					35.1	3 770	43.8	4 793	52.5	5 831	61.3	6 880	70	7 942	87.5	10 093
59	17.79					35.7	3 806	44.6	4 837	53.5	5 884	62.4	6 944	71.3	8 016	89.1	10 188
60	18.11					36.4	3 840	45.4	4 882	54.5	5 938	63.5	7 009	72.6	8 090	90.7	10 282
61	18.43							46.2	4 926	55.4	5 992	64.6	7 073	73.9	8 162	92.3	10 374
62	18.74							47	4 970	56.4	6 045	65.7	7 136	75.1	8 236	93.8	10 468
63	19.06							47.8	5 013	57.3	6 100	66.8	7 198	76.4	8 307	95.4	10 559
64	19.38							48.6	5 056	58.3	6 150	68	7 258	77.7	8 379	97	10 651
65	19.70							49.4	5 099	59.2	6 204	69.1	7 320	78.9	8 451	98.6	10 740
66	20.02							50.2	5 141	60.2	6 254	70.2	7 381	80.2	8 521	100.2	10 829
67	20.33							51	5 184	61.1	6 306	71.3	7 442	81.5	8 590	101.8	10 917
68	20.65							51.8	5 225	62.1	6 357	72.4	7 502	82.7	8 660	103.4	11 005
69	20.97							52.6	5 266	63	6 408	73.5	7 562	84	8 729	105	11 092
70	21.29							53.4	5 308	64	6 458	74.7	7 620	85.3	8 796	106.6	11 179

Standard needles

Shaft diameter Fw for Z needles of diameter ∅ and a circumferential clearance jc between 0.3 and 0.6 mm

Coefficient γ : formula 4)
Coefficient K: formula 1)

∅ → mm		1		1.5		2		2.5		3		3.5		4		5	
Z	γ	Fw mm	K	Fw mm	K	Fw mm	K	Fw mm	K	Fw mm	K	Fw mm	K	Fw mm	K	Fw mm	K
71	21.61							54.2	5 349	65	6 506	75.8	7 678	86.6	8 863	108.2	11 265
72	21.93							55	5 389	65.9	6 557	76.9	7 737	87.9	8 930	109.8	11 350
73	22.24							55.7	5 431	66.9	6 604	78	7 795	89.1	8 998	111.3	11 437
74	22.56							56.5	5 471	67.8	6 654	79.1	7 852	90.4	9 064	112.9	11 520
75	22.88							57.3	5 510	68.8	6 702	80.2	7 910	91.7	9 129	114.5	11 604
76	23.20							58.1	5 550	69.7	6 751	81.3	7 966	92.9	9 195	116.1	11 686
77	23.52							58.9	5 589	70.7	6 798	82.5	8 022	94.2	9 260	117.7	11 769
78	23.83							59.7	5 628	71.6	6 846	83.5	8 079	95.5	9 324	119.3	11 851
79	24.15							60.5	5 666	72.6	6 892	84.7	8 134	96.7	9 389	120.9	11 933
80	24.47							61.3	5 704	73.5	6 940	85.8	8 189	98	9 453	122.5	12 013
81	24.79									74.5	6 985	86.9	8 243	99.3	9 516	124.1	12 093
82	25.11									75.5	7 030	88	8 298	100.6	9 578	125.7	12 173
83	25.43									76.4	7 078	89.1	8 353	101.9	9 640	127.3	12 252
84	25.74									77.4	7 123	90.2	8 407	103.1	9 703	128.8	12 332
85	26.06									78.3	7 169	91.3	8 461	104.4	9 764	130.4	12 410
86	26.38									79.3	7 213	92.5	8 512	105.7	9 825	132	12 488
87	26.70									80.2	7 258	93.6	8 565	106.9	9 887	133.6	12 566
88	27.07									81.2	7 302	94.7	8 618	108.2	9 947	135.2	12 643
89	27.34									82.2	7 345	95.8	8 670	109.5	10 007	136.8	12 720
90	27.65									83.1	7 390	96.9	8 723	110.7	10 069	138.4	12 796
91	27.97									84	7 436	98	8 775	112	10 128	140	12 871
92	28.29									85	7 479	99.2	8 825	113.3	10 187	141.6	12 947
93	28.61									86	7 520	100.3	8 876	114.6	10 245	143.2	13 021
94	28.93									86.9	7 565	101.4	8 927	115.9	10 303	144.8	13 096
95	29.24									87.9	7 607	102.5	8 978	117.1	10 363	146.3	13 172
96	29.56									88.8	7 650	103.6	9 028	118.4	10 420	147.9	13 245
97	29.88									89.8	7 692	104.7	9 079	119.7	10 478	149.5	13 318
98	30.20									90.7	7 735	105.8	9 129	120.9	10 537	151.1	13 391
99	30.52									91.7	7 777	107	9 177	122.2	10 593	152.7	13 464
100	30.84									92.7	7 817	108.1	9 227	123.5	10 650	154.3	13 536