

701-3164 / 3176

1. Classification and Characteristics of Rolling Bearings

1.1 Rolling bearing construction

Most rolling bearings consist of rings with raceway (an inner ring and an outer ring), rolling elements (either balls or rollers) and a rolling element retainer. The retainer separates the rolling elements at regular intervals holds them in place within the inner and outer raceways, and allows them to rotate freely. See diagrams 1.1 - 1.8.

Rolling elements come in two general shapes: ball or rollers. Rollers come in four basic styles: cylindrical, needle, tapered, and spherical.

Balls geometrically contact the raceway surfaces of the inner and outer rings at "points", while the contact surface of rollers is a "line" contact.

Theoretically, rolling bearings are so constructed as to allow the rolling elements to rotate orbitally while also rotating on their own axes at the same time.

While the rolling elements and the bearing rings take any load applied to the bearings (at the contact point between the rolling elements and raceway surfaces), the retainer takes no direct load. It only serves to hold the rolling units at equal distances from each other and prevent them from falling out.

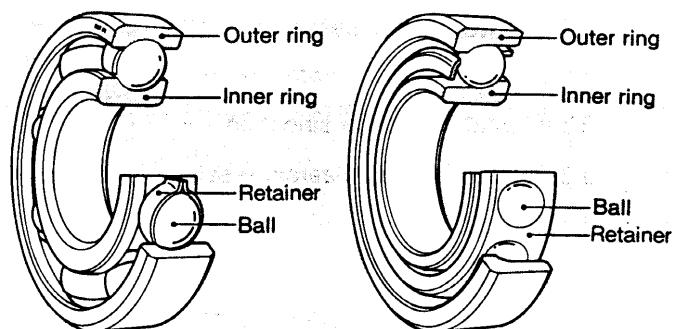
1.2 Classification of rolling bearings

Rolling bearings fall into two main classifications: ball bearings and roller bearings. Ball bearings are classified according to their bearing ring configurations: deep groove, angular contact and thrust types. Roller bearings on the other hand are classified according to the shape of the rollers: cylindrical, needle, taper and spherical.

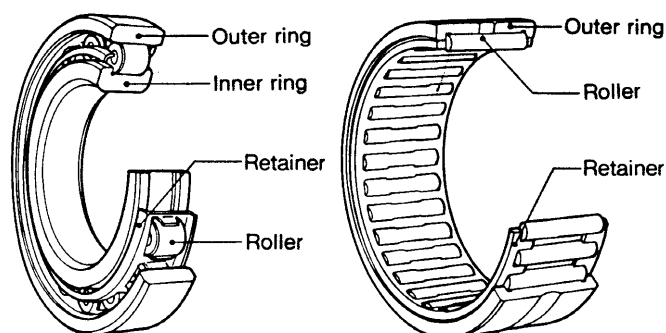
Rolling bearings can be further classified according to the direction in which the load is applied; radial bearings carry radial loads and thrust bearings carry axial loads.

Other classification methods include: 1) number of rolling rows (single, multiple, or 4-row), 2) separable and non-separable, in which either the inner ring or the outer ring can be detached, 3) thrust bearings which can carry axial loads in only one direction, and double direction thrust bearings which can carry loads in both directions.

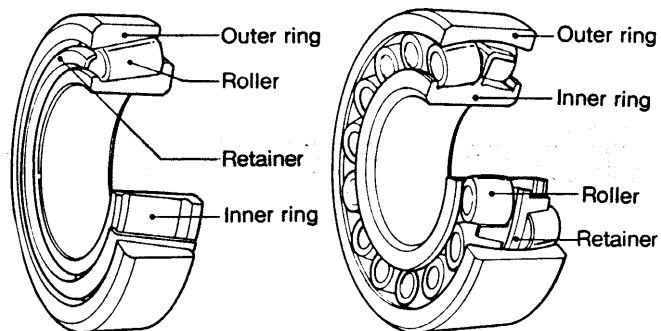
There are also bearings designed for special applications, such as: railway car journal roller bearings (RCT bearings), ball screw support bearings, turntable bearings, as well as rectilinear motion bearings (linear ball bearings, linear roller bearings and linear flat roller bearings).



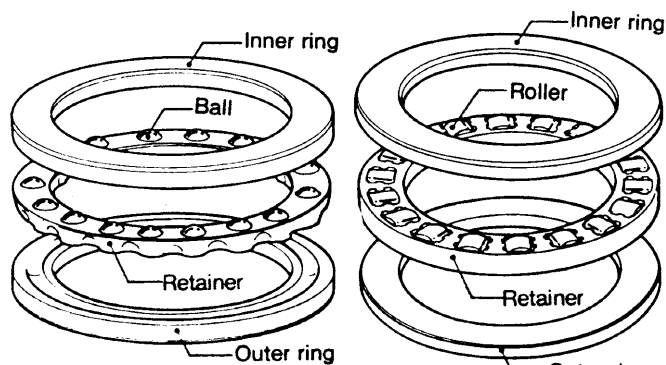
Deep groove ball bearing Fig. 1.1 Angular contact ball bearing Fig. 1.2



Cylindrical roller bearing Fig. 1.3 Needle roller bearing Fig. 1.4



Tapered roller bearing Fig. 1.5 Spherical roller bearing Fig. 1.6



Thrust ball bearing Fig. 1.7 Thrust roller bearing Fig. 1.8

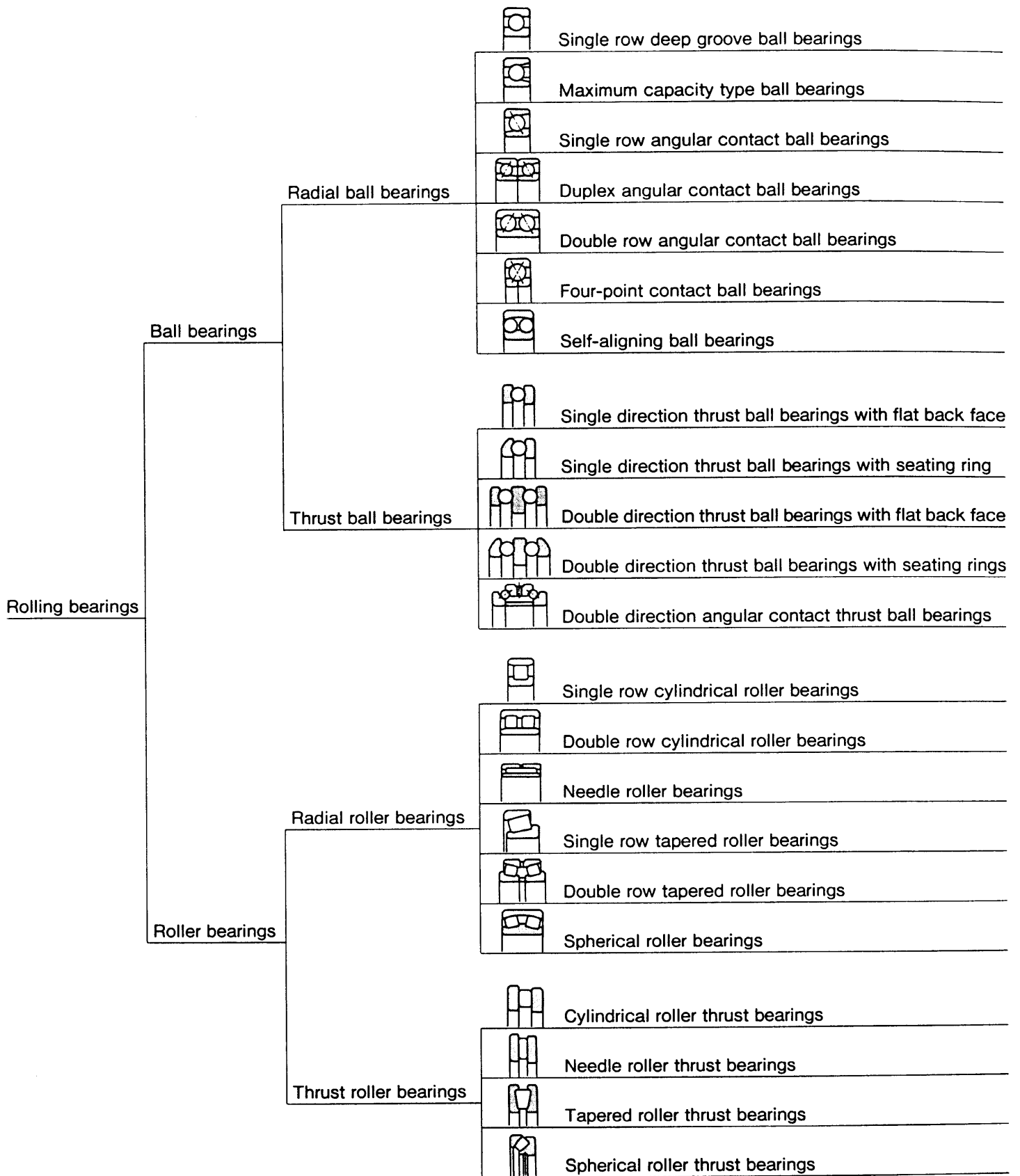


Fig. 1.9 Classification of rolling bearings

1.3 Characteristics of rolling bearings

1.3.1 Characteristics of rolling bearings

Rolling bearings come in many shapes and varieties, each with its own distinctive features.

However, when compared with sliding bearings, rolling bearings all have the following advantages:

- (1) The starting friction coefficient is lower and only a little difference between this and the dynamic friction coefficient is produced.
- (2) They are internationally standardized, interchangeable and readily obtainable.
- (3) Ease of lubrication and low lubricant consumption.
- (4) As a general rule, one bearing can carry both radial and axial loads at the same time.
- (5) May be used in either high or low temperature applications.
- (6) Bearing rigidity can be improved by preloading.

Construction, classes, and special features of rolling bearings are fully described in the boundary dimensions and bearing numbering system section.

1.3.2. Ball bearings and roller bearings

Generally speaking, when comparing ball and roller bearings of the same dimensions, ball bearings exhibit a lower frictional resistance and lower face run-out in rotation than roller bearings.

This makes them more suitable for use in applications which require high speed, high precision, low torque and low vibration. Conversely, roller bearings have a larger load carrying capacity which makes them more suitable for applications requiring long life and endurance for heavy loads and shock loads.

1.3.3. Radial and thrust bearings

Almost all types of rolling bearings can carry both radial and axial loads at the same time.

Generally, bearings with a contact angle of less than 45° have a much greater radial load capacity and are classed as radial bearings; whereas bearings which have a contact angle over 45° have a greater axial load capacity and are classed as thrust bearings. There are also bearings classed as complex bearings which combine the loading characteristics of both radial and thrust bearings.

1.3.4 Standard bearings and special bearings

Bearings which are internationally standardized as to shape and size are much more economical to use, as they are interchangeable and available on a worldwide basis.

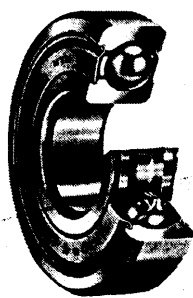
However, depending on the type of machine they are to be used in, and the expected application and function, a non-standard or specially designed bearing may be best to use. Bearings that are adapted to specific applications, and "unit bearings" which are integrated (built-in) into a machine's components, and other specially designed bearings are also available.

Deep Groove Ball Bearings

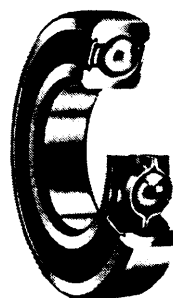
Deep Groove Ball Bearings



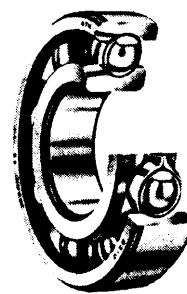
Open type



Shielded type



Sealed type (Non-contact)



Maximum capacity type

Deep groove ball bearings

Deep groove ball bearings are very widely used. A deep groove is formed on each inner and outer ring of a deep groove ball bearing. Radial load and axial loads in either direction and the resultant forces of these loads can be sustained. These bearings are suitable for high speed operation.

Various types of these bearings exist such as prelubricated bearings, bearings with both sides shielded or sealed and prelubricated, bearings with snap rings and open types bearings. By using these bearings, housings can be easily designed for mounting.

As shown in Table 1, pressed cages are generally used in deep groove ball bearings. However, machined cages are also applied in larger sized bearings used for high speed operation.

Table 1 Standard cages of deep groove ball bearings

Bearing series	Pressed cage	Machined cage
67	6700 ~ 6706	—
68	6800 ~ 6834	6836 ~ 68/600
69	6900 ~ 6934	6936 ~ 69/500
160	16001 ~ 16052	16056 ~ 16072
60	6000 ~ 6052	6056 ~ 6084
62	6200 ~ 6244	—
63	6300 ~ 6344	—
64	6403 ~ 6426	—

Shielded ball bearings

Shielded ball bearings are deep groove ball bearings having the same boundary dimensions as those of open type bearings. Protection against the penetration of foreign material and the prevention of grease leakage are provided by the steel shield plates of these bearings.

There are two types; one is Type ZZ fitted with shield plates on both sides and the other is Type Z fitted with a plate on one side. Since the shields are non-contact type, friction torque is very low.

Sealed ball bearings

Like shielded ball bearings, sealed ball bearings have the same boundary dimensions as those of the open type bearings. Sealed ball bearings also have the function of keeping foreign matter out and grease in with a seal.

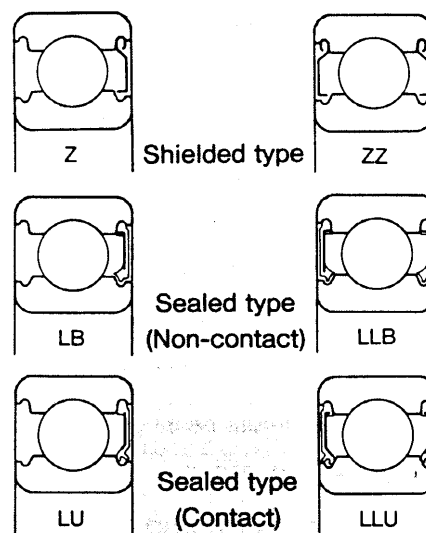


Fig. 1

Seals consisting of synthetic rubber molded to a steel plate are incorporated into the outer rings of these ball bearings. There are two types of sealed bearings. One uses contact seals where the inner ring is contacted by the seal and the other is the non-contact seal where the inner ring is not contacted by the seal. The LLU type is use two contact seals, one on each side of the bearings. Similarly the LLB type uses non-contact type seals, one on each side of the bearing. Also, there are the LU and LB types which seal only one side of bearing. Bearings with contact seals have excellent and effective dust proofing functions. Bearings with non-contact seals are suitable for applications requiring low torque operation.

Cartridge type single row deep groove ball bearings

Cartridge type bearings have the same standard bore and O.D. as deep groove ball bearings, but are as wide as double row ball bearings. They are supplied with two seals and contain a large grease capacity found useful in extremely dirty and dusty conditions.

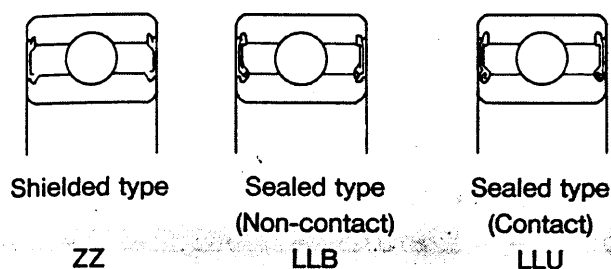


Fig. 2

Maximum capacity type ball bearings

The boundary dimensions of the maximum capacity type ball bearings are the same as those of series 62 and 63 of deep groove ball bearings. In order to assemble the steel balls, filling slots are provided on both inner and outer rings of the bearings. Accordingly, more steel balls are assembled in these bearings than those of series 62 or 63 of deep groove ball bearings or the standard type. Therefore, the dynamic load rating of these bearings becomes 20% to 35% larger than that of standard type.

Due to the filling slot, maximum capacity type bearings are not suitable for applications that employ heavy axial loads. Therefore, it is necessary to use these bearings in cases where there are compound radial and axial loads with radial loads predominate, loads are used or radial loads only.

Pressed cages are used in maximum capacity type ball bearings. These bearing type is available with shields-type (Types Z and ZZ). Note that the filling slot for double shielded (Type ZZ) maximum capacity type ball bearings use a special shield plate to cover the filling slot.

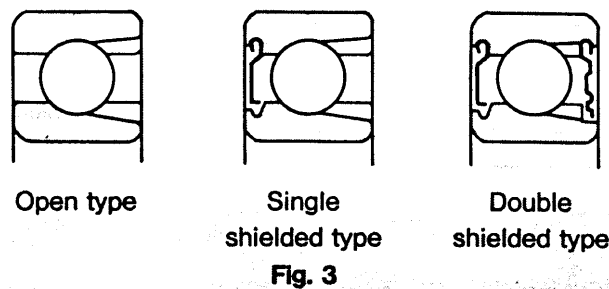
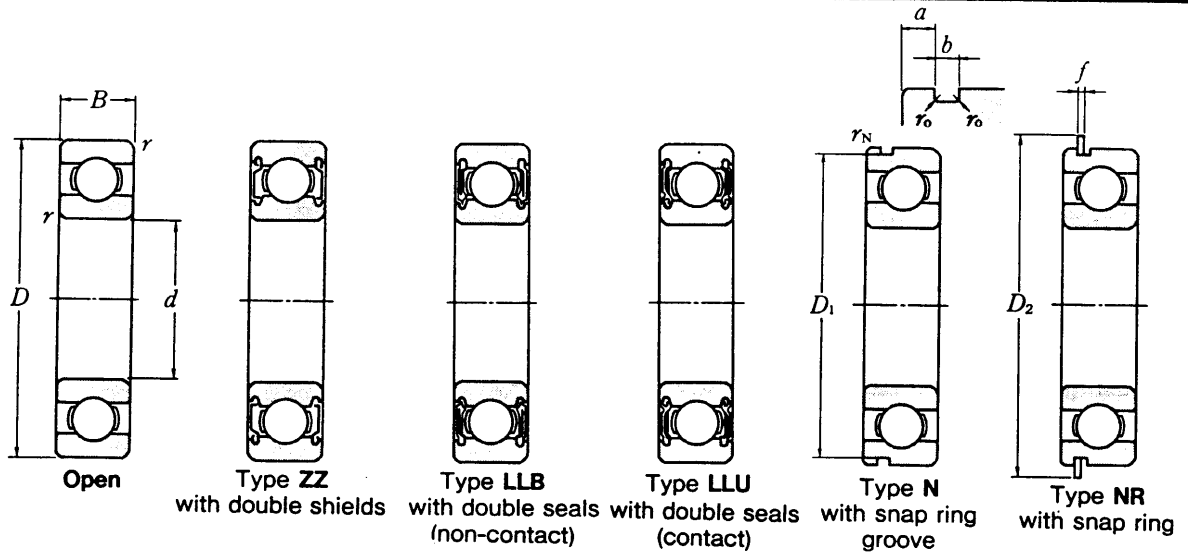


Fig. 3

Deep Groove Ball Bearings



d 10~20mm

Boundary dimensions mm				Basic load ratings N lbf		Limiting speeds r/min			Bearing numbers					
d	D	B	r _s min	dynamic C _r	static C _{0r}	grease ZZZ LB,LLB	oil open type Z,LB	LU,LLU	Type					
									open	ZZ	LLB	LLU	N	NR
10	15	3	0.1	1 010 227	555 124	36 000	42 000	-	6700	-	-	-	-	-
	19	5	0.3	1 830 410	925 208	32 000	38 000	24 000	6800	ZZ	LLB	LLU	-	-
	22	6	0.3	2 700 605	1 270 285	30 000	36 000	21 000	6900	ZZ	LLB	LLU	N	NR
	26	8	0.3	4 550 1 030	1 960 440	29 000	34 000	21 000	6000	ZZ	LLB	LLU	-	-
	30	9	0.6	5 100 1 150	2 390 540	25 000	30 000	18 000	6200	ZZ	LLB	LLU	N	NR
	35	11	0.6	8 200 1 840	3 500 785	23 000	27 000	16 000	6300	ZZ	LLB	LLU	N	NR
12	18	4	0.2	1 070 240	655 147	32 000	38 000	-	6701	-	-	-	-	-
	21	5	0.3	1 920 430	1 040 234	29 000	35 000	20 000	6801	ZZ	LLB	LLU	-	-
	24	6	0.3	2 890 650	1 460 330	27 000	32 000	19 000	6901	ZZ	LLB	LLU	N	NR
	28	7	0.3	5 100 1 150	2 390 540	26 000	30 000	-	16001	-	-	-	-	-
	28	8	0.3	5 100 1 150	2 390 540	26 000	30 000	18 000	6001	ZZ	LLB	LLU	-	-
	32	10	0.6	6 100 1 370	2 750 615	22 000	26 000	16 000	6201	ZZ	LLB	LLU	N	NR
37	12	1	9 700 2 180	4 200 940	20 000	24 000	15 000	6301	ZZ	LLB	LLU	N	NR	
15	21	4	0.2	1 150 259	790 178	29 000	34 000	-	6702	-	-	-	-	-
	24	5	0.3	2 080 465	1 260 283	26 000	31 000	17 000	6802	ZZ	LLB	LLU	-	-
	28	7	0.3	4 100 920	2 060 460	24 000	28 000	16 000	6902B	ZZ	LLB	LLU	N	NR
	32	8	0.3	5 600 1 260	2 840 635	22 000	26 000	-	16002	-	-	-	-	-
	32	9	0.3	5 600 1 260	2 840 635	22 000	26 000	15 000	6002	ZZ	LLB	LLU	N	NR
	35	11	0.6	7 750 1 740	3 600 805	19 000	23 000	15 000	6202	ZZ	LLB	LLU	N	NR
42	13	1	11 400 2 570	5 450 1 220	17 000	21 000	12 000	6302	ZZ	LLB	LLU	N	NR	
17	23	4	0.2	1 200 270	865 194	26 000	31 000	-	6703	-	-	-	-	-
	26	5	0.3	2 810 630	1 720 385	24 000	28 000	15 000	6803A	ZZ	LLB	LLU	-	-
	30	7	0.3	4 650 1 050	2 580 580	22 000	26 000	14 000	6903	ZZ	LLB	LLU	N	NR
	35	8	0.3	6 800 1 530	3 350 755	20 000	24 000	-	16003	-	-	-	-	-
	35	10	0.3	6 800 1 530	3 350 755	20 000	24 000	14 000	6003	ZZ	LLB	LLU	N	NR
	40	12	0.6	9 600 2 160	4 600 1 030	18 000	21 000	12 000	6203	ZZ	LLB	LLU	N	NR
47	14	1	13 500 3 050	6 550 1 470	16 000	19 000	11 000	6303	ZZ	LLB	LLU	N	NR	
62	17	1.1	22 700 5 100	10 800 2 420	14 000	16 000	9 500	6403	-	-	-	-	-	
20	27	4	0.2	1 790 405	1 320 296	23 000	28 000	-	6704	-	-	-	-	-
	32	7	0.3	4 000 900	2 470 555	21 000	25 000	13 000	6804	ZZ	LLB	LLU	N	NR
	37	9	0.3	6 400 1 430	3 700 825	19 000	23 000	12 000	6904	ZZ	LLB	LLU	N	NR
	42	8	0.3	7 900 1 780	4 500 1 010	18 000	21 000	-	16004	-	-	-	-	-
	42	12	0.6	9 400 2 110	5 050 1 140	18 000	21 000	11 000	6004	ZZ	LLB	LLU	N	NR
	47	14	1	12 800 2 890	6 650 1 500	16 000	18 000	10 000	6204	ZZ	LLB	LLU	N	NR
52	15	1.1	15 900 3 600	7 900 1 770	14 000	17 000	10 000	6304	ZZ	LLB	LLU	N	NR	