

## 2. Design Features and Advantages

### 2.1 Maintenance free type

The **NSK** Maintenance free bearing unit contains a high-grade lithium-based grease, good for use over a long period, which is ideally suited to sealed-type bearings. Also provided is an excellent sealing device, which prevents any leakage of grease or penetration of dust and water from outside.

It is designed so that the rotation of the shaft causes the sealed-in grease to circulate through the inside space, effectively providing maximum lubrication. The lubrication effect is maintained over a long period with no need for replenishment of grease.

To summarize the advantages of the **NSK** maintenance free bearing unit:

- (1) As an adequate amount of good quality grease is sealed in at the time of manufacture, there is no need for replenishment. This means savings in terms of time and maintenance costs.
- (2) Since there is no need for any regreasing facilities, such as piping, a more compact design is possible.
- (3) The sealed-in design eliminates the possibility of grease leakage, which could lead to stained products.

### 2.2 Relubricatable type

The **NSK** relubricatable type bearing unit has an advantage over other similar units being so designed as to permit regreasing even in the case of misalignment of 2° to the right or left. The hole through which the grease fitting is mounted usually causes structural weakening of the housing.

However, as a result of extensive testing, in the **NSK** bearing unit the hole is positioned so as to minimize this adverse effect. In addition, the regreasing groove has been designed to minimize weakening of the housing.

While the **NSK** maintenance free type bearing unit is satisfactory for use under normal operating conditions in-doors, in the following circumstances it is necessary to use the relubricatable type bearing unit:

- (1) Cases where the temperature of the bearing rises above 100°C, 212°F:  
\* -Normal temperature of up to 130°C, 266°F heat-resistant bearing units.
- (2) Cases where there is excessive dust, but space does not permit using a bearing unit with a cover.
- (3) Cases where the bearing unit is constantly exposed to splashes of water or any other liquid, but space does not permit using a bearing unit with a cover.
- (4) Cases in which the humidity is very high, and the machine in which the bearing unit is used is run

only intermittently.

- (5) Cases involving a heavy load of which the  $C/P_r$  value is about 10 or below, and the speed is 10 min<sup>-1</sup> or below, or the movement is oscillatory.
- (6) Cases where the number of revolutions is relatively high and the noise problem has to be considered; for example, when the bearing is used with the fan of an air conditioner.

### 2.3 Special sealing feature

#### 2.3.1 Standard bearing units

The sealing device of the ball bearing for the **NSK** bearing unit is a combination of a heat-resistant and oil-proof synthetic rubber seal and a slinger of an exclusive design.

The seal, which is fixed in the outer ring, is steel-reinforced, and its lip, in contact with the inner ring, is designed to minimize frictional torque.

The slinger is fixed to the inner ring of the bearing with which it rotates. There is a small clearance between its periphery and the outer ring.

These two types of seals on both sides of the bearing prevent grease leakage, and foreign matter is prevented from entering the bearing from outside.

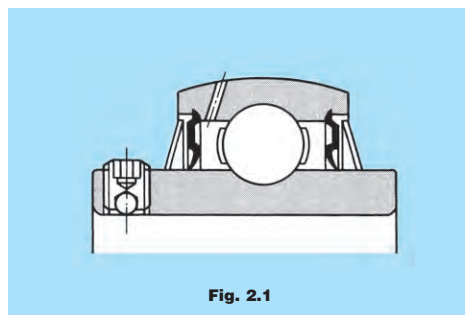


Fig. 2.1

#### 2.3.2 Bearing units with covers

The **NSK** bearing unit with a cover consists of a standard bearing unit and an outside covering for extra protection against dust. Special consideration has been given to its design with respect to dust-proofing.

Sealing devices are provided in both the bearing and the housing, so that units of this type operate satisfactorily even in such adverse environments as flour mills, steel mills, foundries, galvanizing plants and chemical plants, where excessive dust is produced and/or liquids are used. They are also eminently suitable for outdoor environments where dust and rain are inevitable, and in heavy industrial machinery such as construction and transportation equipment.

The rubber seal of the cover contacts with the shaft by its two lips, as shown in Fig. 2.2 and 2.3. By filling the groove between the two lips with grease, an excellent sealing effect is obtained and, at the same time, the contacting portions of the lips are lubricated. Furthermore, the groove is so designed that when the shaft is inclined the rubber seal can move in the radial direction.

When bearing units are exposed to splashes of water rather than to dust, a drain hole (5 to 8 mm, 0.2 to 0.3 inches in diameter) is provided at the bottom of the cover, and grease should be applied to the side of the bearing itself instead of into the cover.

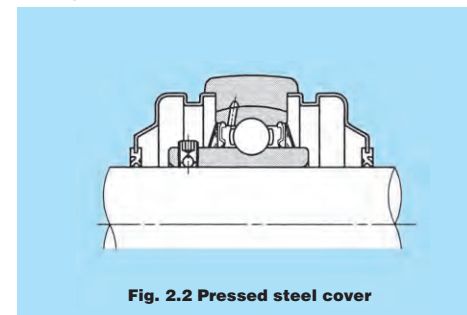


Fig. 2.2 Pressed steel cover

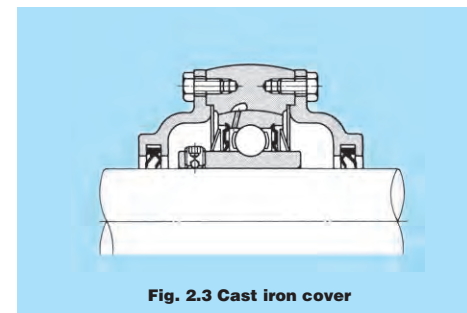


Fig. 2.3 Cast iron cover

### 2.4 Secure fitting

Fastening the bearing to the shaft is effected by tightening the ball-end set screw, situated on the inner ring. This is a unique feature which prevents loosening, even if the bearing is subjected to intense vibrations and shocks.

### 2.5 Self-aligning

With the **NSK** bearing unit, the outer surface of the ball bearing and the inner surface of the housing are spherical, thus this bearing unit has self-aligning characteristic. Any misalignment of axis that may arise from poor workmanship on the shaft or errors in fitting will be properly adjusted.

### 2.6 Higher rated load capacity

The bearing used in the unit is of the same internal construction as those in bearing series 62 and 63, and is capable of accommodating axial load as well as radial load, or composite load. The rated load capacity of this bearing is considerably higher than that of the corresponding self-aligning ball bearings used for standard plummer blocks.

### 2.7 Light weight yet strong housing

Housings for **NSK** bearing units come in various shapes. They consist of either high-grade cast iron, one-piece casting, or of precision finished pressed steel, the latter being lighter in weight. In either case, they are practically designed to combine lightness with maximum strength.

### 2.8 Easy mounting

The **NSK** bearing unit is an integrated unit consisting of a bearing and a housing.

As the bearing is prelubricated at manufacture with the correct amount of high-grade lithium base, it can be mounted on the shaft just as it is. It is sufficient to carry out a short test run after mounting.

### 2.9 Accurate fitting of the housing

In order to simplify the fitting of the pillow block and flange type bearing units, the housings are provided with a seat for a dowel pin, which may be utilized as needed.

### 2.10 Bearing replaceability

The bearing used in the **NSK** bearing unit is replaceable. In the event of bearing failure, a new bearing can be fitted to the existing housing.

$$L = \frac{1}{\left(\frac{1}{L_1^{1.1}} + \frac{1}{L_2^{1.1}} + \dots + \frac{1}{L_n^{1.1}}\right)^{1/1.1}} \dots\dots\dots(4.6)$$

where,  
L :Total life of the whole bearing assembly,h  
L1, L2, ... Ln: Rated life of bearings 1, 2,... n, h

In the case where load and the number of revolutions change at regulated intervals, after finding the rated life L1, L2, ..., Ln under conditions of n1, P1; n2, P2; ... nn, Pn: the built-in life Lm can be given by the formula (4.7).

$$L_1 = \frac{10^6}{60n_1} \left(\frac{C_r}{P_1}\right)^3$$
$$L_2 = \frac{10^6}{60n_2} \left(\frac{C_r}{P_1}\right)^3$$
$$\vdots$$
$$L_n = \frac{10^6}{60n_n} \left(\frac{C_r}{P_n}\right)^3$$
$$L_m = \left(\frac{\phi_1}{L_1} + \frac{\phi_2}{L_2} + \dots + \frac{\phi_n}{L_n}\right)^{-1} \dots\dots\dots(4.7)$$

where,  
L1, L2, ... Ln: Rated life under condition 1, 2,... n, h  
n1, n2, ... nn: Number of revolutions under condition 1, 2, ... n, min<sup>-1</sup>  
P1, P2, ... Pn: Equivalent load under condition 1, 2, ... n, N, lbf  
φ1, φ2, ... φn: Ratio of condition 1, 2, ... n accounting for the total operating time  
Lm: Built-in life, h

Table 4.1 Rating life for applications

Service classification	Machine application	Life time Lm
Machines used occasionally	Door mechanisms,Garage shutter	500
Equipment for short period or intermittent service-interruption permissible	Household appliances,Electric hand tools, Agricultural machines,Lifting tackles in shops	4 000 to 8 000
Intermittent service machines-high reliability	Power-Station auxiliary equipment,Elevators, Conveyors,Deck cranes	8 000 to 14 000
Machines used for 8 hours a day,but not always in full operation	Ore wagon axles,important gear units	14 000 to 20 000
Machines fully used for 8 hours	Blowers,General machinery in shops,Continuous operation cranes	20 000 to 30 000
Machines continuously used for 24 hours a day	Compressors,Pumps	50 000 to 60 000
Machines continuously used for 24 hours a day with maximum reliability	Power-station equipment,Water-supply equipment for urban areas,Mine ventilators	100 000 to 200 000

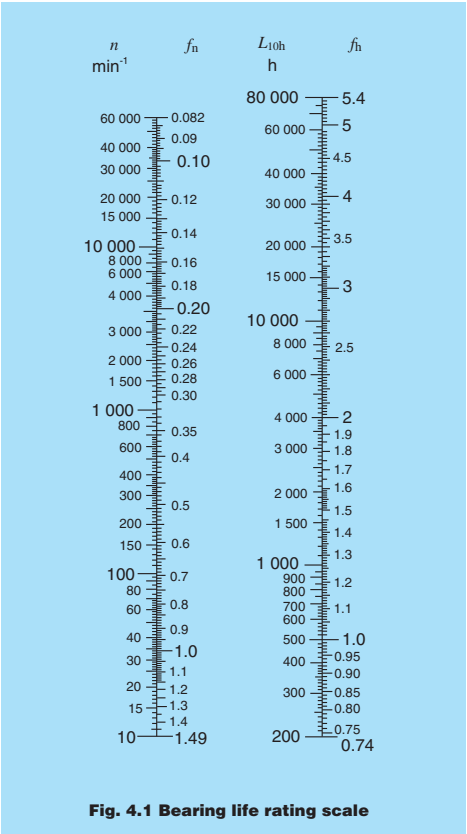


Fig. 4.1 Bearing life rating scale

4.3 Basic static load rating

When stationary rolling bearings are subjected to static loads, they suffer from partial permanent deformation of the contact surfaces at the contact point between the rolling elements and the raceway. The amount of deformity increases as the load increases, and if this increase in load exceeds certain limits, the subsequent smooth operation of the bearing is impaired.

It has been found through experience that a permanent deformity of 0.0001 times the diameter of the rolling element, occurring at the most heavily stressed contact point between the raceway and the rolling elements, can be tolerated without any impairment in running efficiency.

The basic rated static load refers to a fixed static load limit at which a specified amount of permanent deformation occurs. It applies to pure radial loads for radial bearings. The maximum applied load values for contact stress occurring at the rolling element and raceway contact points are given below.

For ball bearings (for bearing unit): 4 200 MPa.

4.4 Allowable static equivalent load

Generally the static equivalent load which can be permitted is limited by the basic static rated load as stated in Section 4.3. However, depending on requirements regarding friction and smooth operation, these limits may be greater or lesser than the basic static rated load.

In the following formula (4.8) and Table 4.2 the safety factor S0 can be determined considering the maximum static equivalent load.

$$S_0 = \frac{C_0}{P_{0 \max}} \dots\dots\dots(4.8)$$

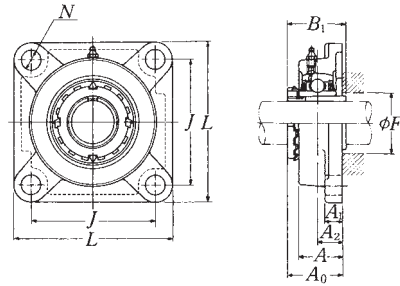
where,  
S0: Safety factor  
C0: Basic static rated load, N, lbf  
P0 max: Maximum static equivalent load, N, lbf

Table 4.2 Minlmm safety factor values S0

Operating conditions	Ball bearings
High rotational accuracy demand	2
Normal rotating accuracy demand (Universal application)	1
Slight rotational accuracy deterioration permitted (Lcw speed,heavy loading,etc.)	0.5

Remarks When vibration and/or shock loads are present, a load factor based on the shock load needs to be included in the P0 max value.

# Square flanged unit, cast housing Adapter type



Shaft dia.  mm inch	Unit number <sup>(1)</sup> ( <sup>(2)</sup> )	Nominal dimensions									Bolt size  mm inch	Bearing number
		L	J	A <sub>2</sub>	A <sub>1</sub>	A mm inch	N	A <sub>0</sub>	B <sub>1</sub>	F min.		
20 3/4	UKF205D1;H2305X UKF205D1;HE2305	95 3 3/4	70 2 3/4	16 5/8	13 1/2	27 1 1/16	12 15/32	35.5 1 25/64	35 1.378	30 1 3/16	M10 3/8	UK205D1;H2305X UK205D1;HE2305
25 7/8	UKF206D1;H2306X UKF206D1;HS2306 UKF206D1;HE2306X	108 4 1/4	83 3 17/64	18 45/64	13 1/2	31 1 7/32	12 15/32	39 1 17/32	38 1.496	36 1 19/32	M10 3/8	UK206D1;H2306X UK206D1;HS2306 UK206D1;HE2306X
30 1 1/8	UKF207D1;H2307X UKF207D1;HS2307	117 4 19/32	92 3 5/8	19 3/4	15 19/32	34 1 11/32	14 35/64	42.5 1 43/64	43 1.693	40 1 1/16	M12 7/16	UK207D1;H2307X UK207D1;HS2307
35 1 1/4 1 3/8	UKF208D1;H2308X UKF208D1;HE2308X UKF208D1;HS2308X	130 5 1/8	102 4 1/64	21 53/64	15 19/32	36 1 13/32	16 5/8	46.5 1 53/64	46 1.811	46 1 13/16	M14 1/2	UK208D1;H2308X UK208D1;HE2308X UK208D1;HS2308X
40 1 7/16 1 1/2 1 5/8	UKF209D1;H2309X UKF209D1;HA2309 UKF209D1;HE2309X UKF209D1;HS2309X	137 5 13/32	105 4 9/64	22 55/64	16 5/8	38 1 1/2	16 5/8	48.5 1 29/32	50 1.969	52 2 1/16	M14 1/2	UK209D1;H2309X UK209D1;HA2309 UK209D1;HE2309X UK209D1;HS2309X
45 1 5/8 1 11/16 1 3/4	UKF210D1;H2310X UKF210D1;HS2310 UKF210D1;HA2310 UKF210D1;HE2310X	143 5 5/8	111 4 3/8	22 55/64	16 5/8	40 1 9/16	16 5/8	50 1 31/32	55 2.165	57 2 1/4	M14 1/2	UK210D1;H2310X UK210D1;HS2310 UK210D1;HA2310 UK210D1;HE2310X
50 1 7/8 1 15/16 2	UKF211D1;H2311X UKF211D1;HS2311 UKF211D1;HA2311 UKF211D1;HE2311XY	162 6 3/8	130 5 1/8	25 63/64	18 23/32	43 1 11/16	19 3/4	54.5 2 9/64	59 2.323	64 2 17/32	M16 5/8	UK211D1;H2311X UK211D1;HS2311 UK211D1;HA2311 UK211D1;HE2311XY
55 2 1/8	UKF212D1;H2312X UKF212D1;HS2312	175 6 7/8	143 5 5/8	29 1 9/64	18 23/32	48 1 7/8	19 3/4	61 2 13/32	62 2.441	69 2 23/32	M16 5/8	UK212D1;H2312X UK212D1;HS2312

Notes <sup>(1)</sup> These numbers indicate relubricatable type. If maintenance free type is needed, please order without suffix "D1".

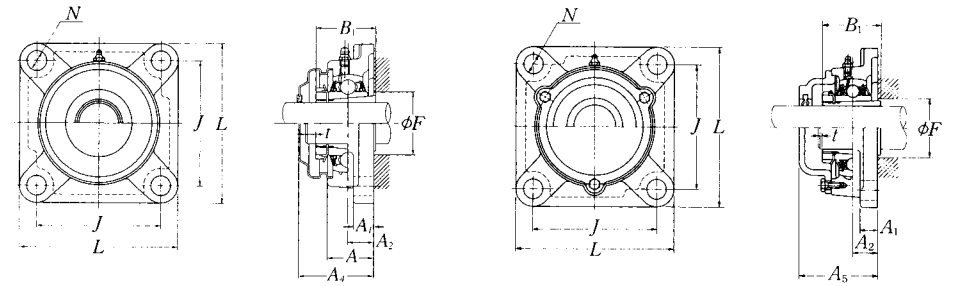
<sup>(2)</sup> Adapter number with suffix "X" means a narrow slot type adapter sleeve.  
In this case the lock washer with the straight inner prong should be used.

<sup>(3)</sup> For HE2311XY, screw thread pitch different from the standard is applied, because of the thin thread section of sleeve.  
To distinguish it, a suffix "Y" is added.

<sup>(4)</sup> If the inch series housing units with dust cover are ordered with a closed end, the suffixes E, S or A are not included.  
Example: ZM-UKF205D1;HE2305

Remarks Please refer to page A21 for size of grease fitting.

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## Pressed steel dust cover type

Open end Z-UKF...D1

Closed end ZM-UKF...D1

## Cast dust cover type

Open end C-UKF...D1

Closed end CM-UKF...D1

Housing number	Unit number <sup>(4)</sup> pressed steel dust cover type	Unit number <sup>(4)</sup> cast dust cover type	Nominal dimensions			Mass of unit		
			t max.	A <sub>4</sub> mm inch	A <sub>5</sub> mm inch	UKF	Z(ZM)	C(CM)
F205D1	Z(ZM)-UKF205D1;H2305X	C(CM)-UKF205D1;H2305X	2	40	51	0.8	0.8	1.0
F205D1	Z(ZM)-UKF205ED1;HE2305	C(CM)-UKF205ED1;HE2305	5/64	1 19/32	2	1.8	1.8	2.2
F206D1	Z(ZM)-UKF206D1;H2306X	C(CM)-UKF206D1;H2306X	2	45	56	1.1	1.1	1.3
F206D1	Z(ZM)-UKF206SD1;HS2306	C(CM)-UKF206SD1;HS2306	5/64	1 3/4	2 7/32	2.4	2.4	2.9
F206D1	Z(ZM)-UKF206ED1;HE2306X	C(CM)-UKF206ED1;HE2306X						
F207D1	Z(ZM)-UKF207D1;H2307X	C(CM)-UKF207D1;H2307X	3	49	59	1.6	1.6	1.9
F207D1	Z(ZM)-UKF207SD1;HS2307	C(CM)-UKF207SD1;HS2307	1/8	1 15/16	2 5/16	3.5	3.5	4.2
F208D1	Z(ZM)-UKF208D1;H2308X	C(CM)-UKF208D1;H2308X	3	56	66	1.8	1.9	2.4
F208D1	Z(ZM)-UKF208ED1;HE2308X	C(CM)-UKF208ED1;HE2308X	1/8	2 3/16	2 19/32	4.0	4.2	5.3
F208D1	Z(ZM)-UKF208SD1;HS2308X	C(CM)-UKF208SD1;HS2308X						
F209D1	Z(ZM)-UKF209D1;H2309X	C(CM)-UKF209D1;H2309X	3	57	70	2.3	2.3	2.8
F209D1	Z(ZM)-UKF209AD1;HA2309	C(CM)-UKF209AD1;HA2309						
F209D1	Z(ZM)-UKF209ED1;HE2309X	C(CM)-UKF209ED1;HE2309X	1/8	2 1/4	2 3/4	5.1	5.1	6.2
F209D1	Z(ZM)-UKF209SD1;HS2309X	C(CM)-UKF209SD1;HS2309X						
F210D1	Z(ZM)-UKF210D1;H2310X	C(CM)-UKF210D1;H2310X	3	60	72	2.6	2.7	3.2
F210D1	Z(ZM)-UKF210SD1;HS2310	C(CM)-UKF210SD1;HS2310						
F210D1	Z(ZM)-UKF210AD1;HA2310	C(CM)-UKF210AD1;HA2310	1/8	2 3/8	2 27/32	5.7	6.0	7.1
F210D1	Z(ZM)-UKF210ED1;HE2310X	C(CM)-UKF210ED1;HE2310X						
F211D1	Z(ZM)-UKF211D1;H2311X	C(CM)-UKF211D1;H2311X	4	64	75	3.5	3.6	4.3
F211D1	Z(ZM)-UKF211SD1;HS2311	C(CM)-UKF211SD1;HS2311						
F211D1	Z(ZM)-UKF211AD1;HA2311	C(CM)-UKF211AD1;HA2311	5/32	2 1/2	2 15/16	7.7	7.9	9.5
F211D1	Z(ZM)-UKF211ED1;HE2311XY	C(CM)-UKF211ED1;HE2311XY						
F212D1	Z(ZM)-UKF212D1;H2312X	C(CM)-UKF212D1;H2312X	4	74	86	4.0	4.2	5.0
F212D1	Z(ZM)-UKF212SD1;HS2312	C(CM)-UKF212SD1;HS2312	5/32	2 29/32	3 3/8	8.8	9.3	11

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