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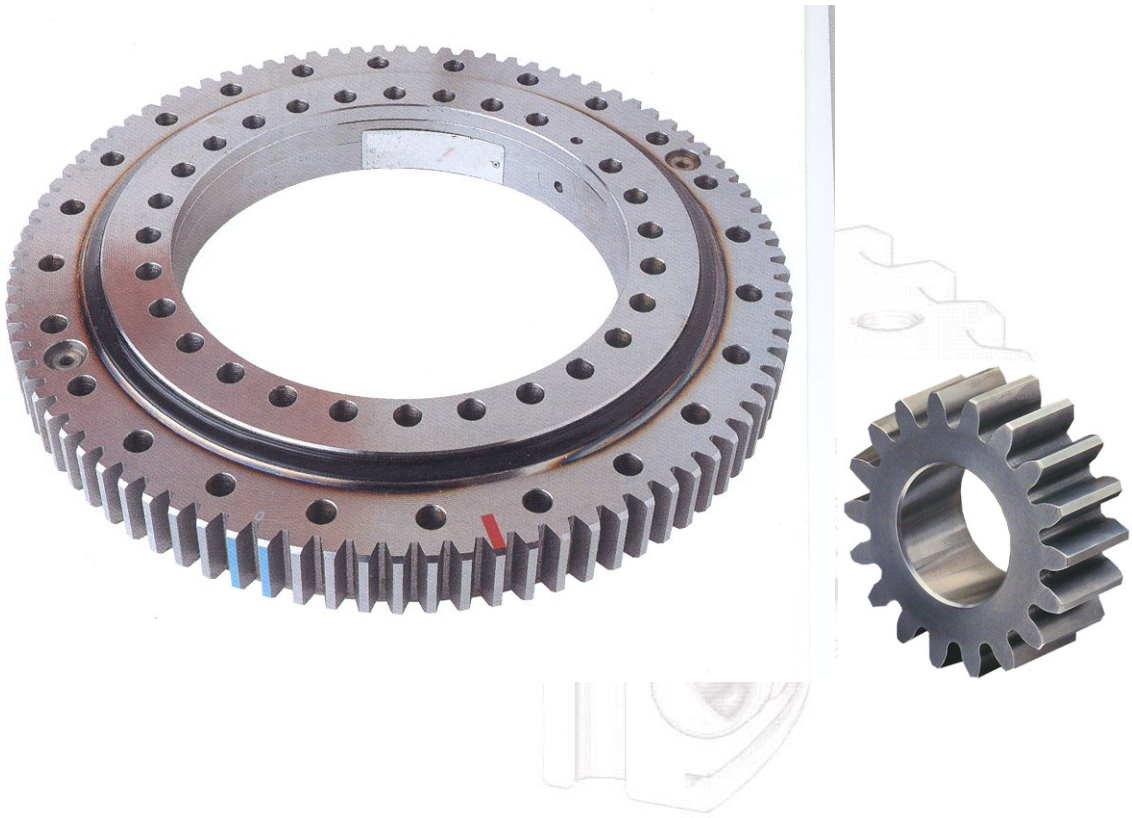


INSTALLATION AND MAINTENANCE OF SLEWING RING BEARINGS

Transport, handling and storage

Slewing rings must be handled, transported and stored in a horizontal position or on specially built incline cradles that support the ring structure appropriately. Any ovality so developed must be removed during installation.

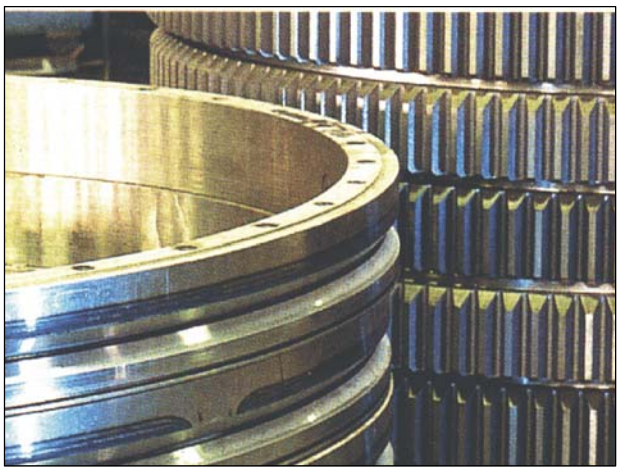
Large slewing rings usually have lifting holes for eye-bolts to assist lifting in the inner and outer rings. Please check the weight of the ring to ensure slings and/or chains are of sufficient capacity!

Shock loads, especially in the radial direction, must be avoided as this may damage the raceways. If stacked on a pallet then care must be taken not to dislodge seal strips or grease fittings during movement. Wooden or rubber spacers would be of benefit between each bearing. External gear teeth (especially) should be protected from any impact damage.

As supplied slewing rings are generally packed for storage in a covered store and for a period not exceeding 6 months. Light surface corrosion can usually be removed from exterior surfaces – and it is more important that the raceways are well greased and rust free. Standard commercial solvents can be used to degrease the slewing ring if necessary.

In extreme cases after long term storage bearings may need professionally reconditioning before installation.

When unwrapping, care must be taken not to cut and damage the integral seals.



Supporting surfaces

The supporting surfaces must have a flat machined surface and be rigid enough to eliminate torsional buckling under load that would affect the smooth operation of the slewing ring.

The thickness of the supporting plates should be no less than that indicated below – which is offered as a rough approximation only!

Definitive results are best achieved with *Finite Element Analysis*.

Raceway dia (mm)	500	750	1000	1250	1500	2000	2500	3000
Min. Support Thickness (mm)	25	30	35	40	50	60	70	80

The width of the supporting surface must at least be equal to the width of the ring it supports.

The flatness defects under load must not exceed the values indicated below to avoid tight spots or seizure; both of which will reduce slewing ring bearing service life.

Raceway dia (mm)	500	750	1000	1250	1500	2000	2500	3000
Max. allowable flatness defect (mm) Single row ball bearings	0.12	0.18	0.21	0.25	0.28	0.33	0.38	0.42
Max. allowable flatness defect (mm) X-Roller or double row ball bearings	0.10	0.12	0.15	0.18	0.20	0.25	0.29	0.32

If the above tolerances cannot be met, epoxy resins such as **CHOCKFAST Orange** can be used.

Call NBC Technical for further details.

Circularity of the slewing ring

In the event of high radial loads, then the circularity of the slewing ring may be affected. If circularity cannot be maintained by use of the machined step on at least one of the machined diameters of the bearing, then a number of dowel pins through the rings might be considered.

Please consult with NBC Technical for approval of this before drilling – or you will negate the manufacturer's warranty.

The general tolerance for pilot and spigot diameters according to ISO 286-2 are:-

Diameter (mm)	180-250	251-315	316-400	401-500	501-630	631-800	801-1000	1001-1250	1251-1600	1601-2000	2001-2500	2501-3150
Pilot H9 (micron)	+115	+130	+140	+155	+175	+200	+230	+260	+310	+370	3440	+540
Spigot f9 (micron)	-50 -165	-56 -185	-62 -202	-68 -223	-76 -251	-80 -280	-86 -316	-98 -358	-110 -420	-120 -490	-130 -570	-145 -685

Orientation of the slewing ring

Most slewing rings have a "filling plug" either on the inner diameter or outer diameter face. Double row bearings have 2 filling plugs, usually at 180 degrees. The filling plug is normally machined in the same place as the start/finish of the hardening path (these should never overlap) as this is a zone of softness.

The filler plug should always be placed at the point of minimum strain (for example at right angles to the main load axis). In some cases the bolt pattern will be asymmetric to force this orientation.

Gear eccentricity

The point of maximum eccentricity of a geared slewing ring will be marked by the manufacturer, usually with green or red paint covering 2 or 3 teeth. This is the point at which the backlash must be set.

Remember to use this point of maximum eccentricity to set all pinions in the case of multiple drive systems.

The matching pinion should have a minimum clearance of 0.03 - 0.05mm x gear module.

The system should be rotated a few times to check gear mesh (across the whole tooth face) before lubrication.

Module	Normal backlash	Module	Normal backlash	Module	Normal backlash
4	0.12 - 0.16 mm	10	0.30 - 0.40 mm	18	0.54 - 0.72 mm
5	0.15 - 0.20 mm	12	0.36 - 0.48 mm	20	0.60 - 0.80 mm
6	0.18 - 0.24 mm	14	0.42 - 0.56 mm	22	0.66 - 0.88 mm
8	0.24 - 0.32 mm	16	0.48 - 0.64 mm	24	0.72 - 0.96 mm

Seal Strip

Seal strip is usually specific to each manufacturer and the profiles and groove dimensions vary.

Seals must be inspected at least annually and replaced as required. Standard nitrile seals will perish in approximately 5 years, VITON seals (usually reserved for high temperature applications) should last slightly longer.

A competent supplier should be able to offer replacement seal strip from stock as required.

Fastening bolts

Slewing ring load curves assume that either Grade 8.8 or Grade 10.9 bolts will be used. Grade 12.9 bolts are used only in very rare circumstances. Check you have the right grade!

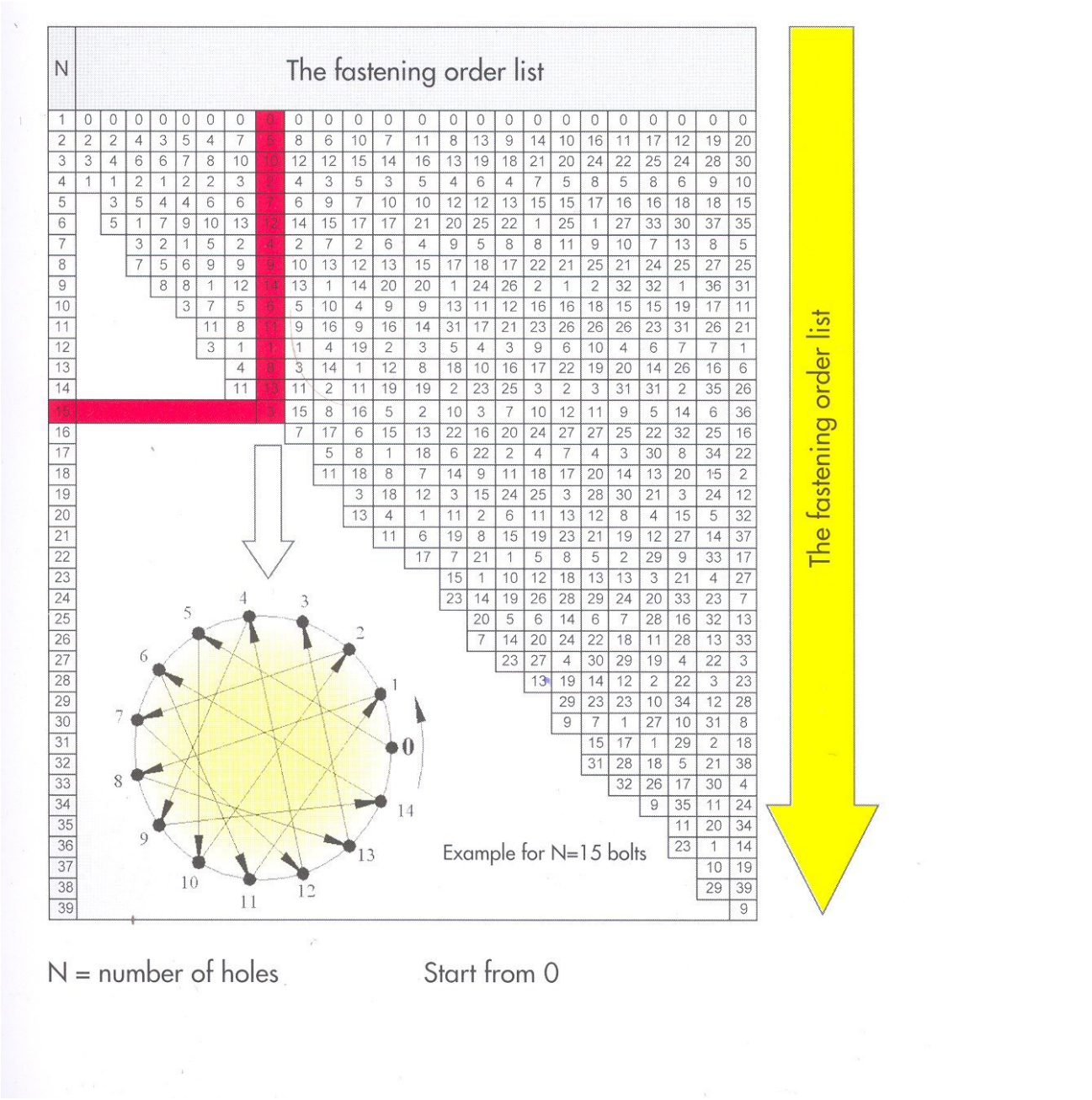
Bolts should be fitted to all bolt holes provided unless otherwise specified in the design report.

The recommended bolt tightening torque figures are tabulated below.

Strength class to DIN/ISO 898			**Grade 8.8**		**Grade 10.9**		**Grade 12.9**	
Yield point $Rp_{0,2}$ (Nmm^{-2})			640 for <= M16 660 for > M16		940		1100	
ISO thread DIN 13	Stress x-section area A_s (mm^2)	Core x-section area A_3 (mm^2)	Tension force (kN)	Tightening torque (Nm)	Tension force (kN)	Tightening torque (Nm)	Tension force (kN)	Tightening torque (Nm)
M12	84.3	76.2	38.5	78	56	117	66	135
M14	115	105	53	126	77	184	90	216
M16	157	144	72	193	106	279	124	333
M18	193	175	92	270	129	387	151	459
M20	245	225	117	387	166	558	194	648
M22	303	282	146	522	208	747	243	873
M24	353	324	168	666	239	954	280	1116
M27	459	427	221	990	315	1395	370	1665
M30	561	519	270	1350	385	1890	450	2250
M33	694	547	335	To be determined by bolt elongation measurement	480	To be determined by bolt elongation measurement	560	To be determined by bolt elongation measurement
M36	817	759	395		560		660	
M39	976	913	475		670		790	
M42	1120	1045	542		772		904	
M45	1300	1224	635		905		1059	
M48	1470	1377	714		1018		1191	
M52	1760	1652	857		1221		1429	
M56	2030	1905	989		1408		1648	
M60	2360	2227	1156		1647		1927	

UNC and UNF figures Grade 5 and Grade 8 are available from NBC Technical

Untreated bolts should be lightly oiled and tightened progressively using a calibrated torque wrench or a hydraulic system (large sizes), moving around the slewing ring periphery in 120° steps or according to the chart below.



Only flat, hardened washers may be used under the bolt heads. Never use flexible or serrated washers as this will void any manufacturer's warranty.

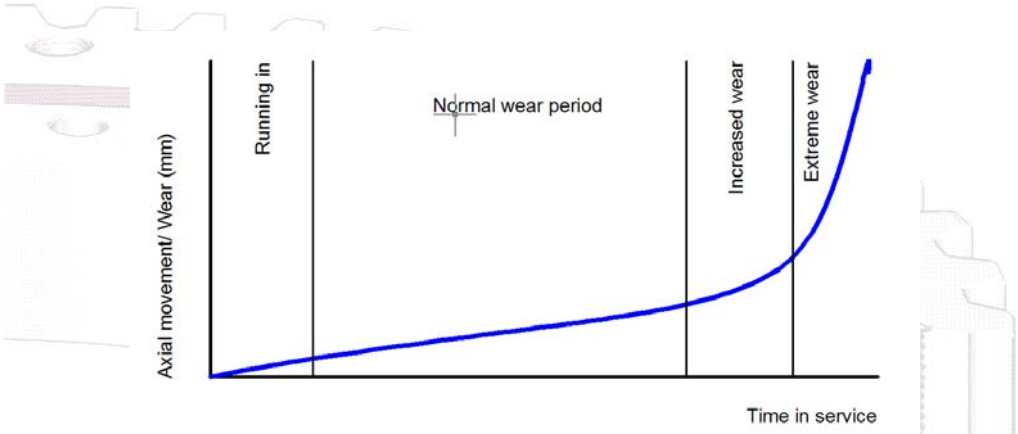
The slewing ring should be rotated during the tightening process as this will indicate the development of any tight spots, the cause of which must be investigated.

The bolt torque should be checked before the machine is finally operated to check for any loss of pre-load due to the structure settling, then after every 100 hours of operation or annually thereafter.

Slewing rings should never be fixed by welding, nor should welding processes be carried out nearby. Care must be taken not to earth through the slewing ring as this may damage the raceways permanently.

Operational or Machine clearance

Once assembled, most slewing rings will exhibit a wear curve similar to that shown below. After an initial period of "settling in", the normal wear period (which can last for some time) will be followed by a period of increased wear which will accelerate as the bearing deteriorates.



After assembly the clearance or total deflection in the bearing under a known load must be measured as this will serve as a reference point for later clearance checks that will be made at least annually to determine the amount of wear in the bearing.

Measurements must be taken as close to the raceway as possible to minimize elastic deflections in the structure and entered into the machine's maintenance logs. Measurements must be taken in a number of places as the boom is rotated.

A quick and easily remembered 'rule of thumb' with regard to clearance states:

Initial measured clearance	$= J_0$
Clearance at time of survey	$= J_1$
Wear	$= J_1 - J_0$
When wear > J_0	Increase the frequency of the clearance surveys
When wear > 1.5 J_0	Replace the bearing

More specifically, and for larger bearings, Roth Erde list the following information

Table 1: Permissible increase in bearing clearance for single row ball bearings

Track dia (mm)	Ball diameter (mm)				
	20	25	30	35	40
< 1000	1.4	1.4	1.5	1.7	1.9
< 1250		1.5	1.6	1.7	2.0
< 1500		1.6	1.7	1.7	2.0
< 1750			1.7	1.8	2.1
< 2000			1.8	1.9	2.2

Table 2: Permissible increase in bearing clearance for double row ball bearings

Track dia (mm)	Ball diameter (mm)				
	20	25	30	35	40
< 1000	1.8	1.9	2.0	2.1	2.5
< 1250	1.9	2.0	2.1	2.2	2.6
< 1500	2.0	2.1	2.2	2.3	2.7
< 1750		2.2	2.3	2.4	2.8
< 2000		2.3	2.4	2.5	2.9

Table 3: Permissible increase in bearing clearance for single row roller bearings

Track dia (mm)	Ball diameter (mm)				
	20	25	32	40	45
< 500	0.22	0.24	0.28		
< 800	0.27	0.29	0.33	0.38	
< 1000	0.30	0.34	0.38	0.43	0.46
< 1500	0.50	0.54	0.58	0.63	0.66
< 2000	0.62	0.64	0.68	0.73	0.76

NOTE: Legal requirements pertaining to specific machines may override this data.

Raceway lubrication

During assembly of the machine ensure that the grease nipples are easily accessible or run supplementary greasing lines.

Although bearings will always be factory filled with grease, it is considered standard practice to lubricate a new bearing during fitting.

Any standard lithium or lithium calcium NLGI 2 grease with EP additives is usually suitable for most slewing ring applications. Lubricants typically recommended by manufacturers include:-

Brand	Bearing/Raceway grease	Operating temp range
ARAL	Aralub HLP2	-30 C to + 120 C
BECHEM	Rhus L474/2 or High-Lub L 2 EP	-20 C to + 120 C
BP	Energrease LS-EP 2	-20 C to + 120 C
ESSO	Beacon EP 2	-20 C to + 120 C
TOTAL FINA ELF	Multis EP2 or Lical EP2	-30 C to + 120 C
EXXONMOBIL	Mobilith SHC 460	-30 C to + 130 C
KLUBER	Centoplex 2 EP	-20 C to + 130 C
RHENUS	Norlith MZP 2	-30 C to + 130 C
SHELL	Retina EP2 or Alvania EP (LF) 2	-25 C to + 130 C

Two popular greases offered by NBC

Brand	Bearing/Raceway grease	Operating temp range
FUCHS	Stabyl LT 50	-50 C to + 130 C
TOTAL	Ceran HV	-25 C to + 180 C

NBC Technical can advise on specialist lubricants if required.

A simple formula helps determine the approximate amount of grease required

Ball bearings	Grease qty (grams) = 0.7 x Raceway dia x (ball dia) ^{2} / 1000
X - Roller bearings	Grease qty (grams) = 0.5 x Raceway dia x (roller dia) ^{2} / 1000

Bearings should be relubricated every 50-100 hours of operation but more frequently for operation in adverse environmental conditions.

Environmental conditions	Recommended relube interval
Dry & clean workshop	~ 300 operating hours or 6 months
Outside/ Exposed	~ 100-200 operating hours or 4 months
Aggressive environment	~ 50 hours or 2 months
Extreme conditions	~ continuous lubrication preferred

Before and after any long period of idleness the bearing should be relubricated.

Grease should be pumped in whole the bearing is turned. Excess grease will weep out from under the seals forming a film. Care must be taken not to overpressure the bearing which may 'pop' the seal. If this occurs, the seal must be re-seated before machine operation.

GREASEMAX constant lubrication systems

In cases where bearings are hard to access for relubrication, consideration should be given to using constant feed lubrication canisters such as the Greasemax system sold by NBC. Although not in the same league as a properly piped and monitored centralised lubrication system, there will at least be some fresh grease reaching the bearing throughout the life cycle of the grease dispenser.

Gear lubrication

The gear should be lubricated immediately after assembly. Suitable open gear grease should be brushed or sprayed on to cover the teeth completely. Relubrication is recommended every 3 – 6 months.

Gear lubricants typically recommended include:-

Brand	Gear grease	Operating temp range
ARAL	Aralub LFZ 1	-20 C to + 120 C
BECHEM	Berulit GA 400	-20 C to + 180 C
BP	Energol WRL	-20 C to + 120 C
TOTAL FINA ELF	Cardrexa DC1	-20 C to + 125 C
EXXONMOBIL	Mobiltac 81	-20 C to + 120 C
KLUBER	Grafloson CA 901	-20 C to + 180 C
RHENUS	Norplex AKG 0	-20 C to + 200 C
SHELL	Aeroshell Grease 14	-54 C to + 93 C