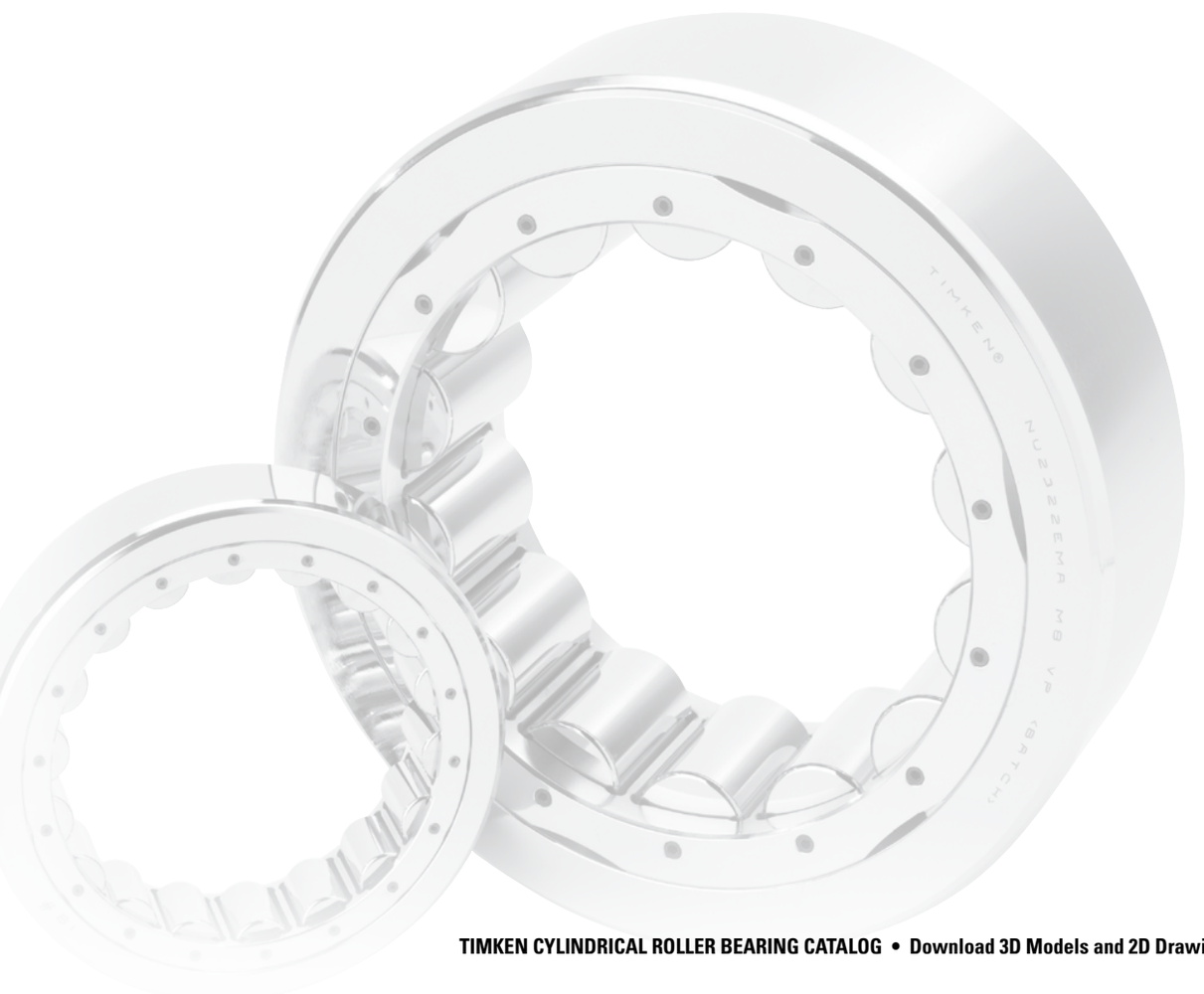
ENGINEERING

The following topics are covered within this engineering section:

- Cylindrical roller bearing design types.
- Cage design types.
- Fitting practice and mounting recommendations.
- Lubrication recommendations.

This engineering section is not intended to be comprehensive, but does serve as a useful guide in cylindrical roller bearing selection.

To view the complete engineering catalog, please visit www.timken.com. To order the catalog, please contact your Timken engineer and request a copy of the Timken Engineering Manual, order number 10424.



RADIAL CYLINDRICAL ROLLER BEARING TYPES AND CAGES

Radial cylindrical roller bearings can offer higher radial load capacity than other bearing designs. The Timken Company offers a wide range of full complement, one -, two -, and four-row designs to meet various application requirements.

RADIAL CYLINDRICAL ROLLER BEARINGS

STANDARD STYLES

Timken® cylindrical roller bearings consist of an inner and outer ring, a roller-retaining cage, and a complement of controlled-contour cylindrical rollers. Depending on the type of bearing, either the inner or the outer ring has two roller-guiding ribs. The other ring is separable from the assembly and has one rib or none. The ring with two ribs axially locates the position of the roller assembly. The ground diameters of these ribs may be used to support the roller cage. One of the ribs may be used to carry light thrust loads when an opposing rib is provided.

The decision as to which ring should be double ribbed is normally determined by considering assembly and mounting procedures in the application.

Type NU has double-ribbed outer and straight inner rings. Type N has double-ribbed inner and straight outer rings. The use of either type at one position on a shaft is ideal for accommodating shaft expansion or contraction. The relative axial displacement of one ring to the other occurs with minimum friction while the bearing is rotating. These bearings may be used in two positions for shaft support if other means of axial location are provided.

Type NJ has double-ribbed outer and single-ribbed inner rings. Type NF has double-ribbed inner and single-ribbed outer rings. Both types can support heavy radial loads, as well as light unidirectional thrust loads. The thrust load is transmitted between the diagonally opposed rib faces in a sliding action. When limiting thrust conditions are approached, lubrication can become critical. Your Timken engineer should be consulted for assistance in such applications. When thrust loads are very light, these bearings may be used in an opposed mounting to locate the shaft. In such cases, shaft endplay should be adjusted at time of assembly.

Type NUP has double-ribbed outer and single-ribbed inner ring with a loose rib that allows the bearing to provide axial location in both directions. Type NP has a double-ribbed inner ring and a single-ribbed outer ring with a loose rib. Both types can carry heavy radial loads and light thrust loads in both directions. Factors governing the thrust capacity are the same as for types NJ and NF bearings.

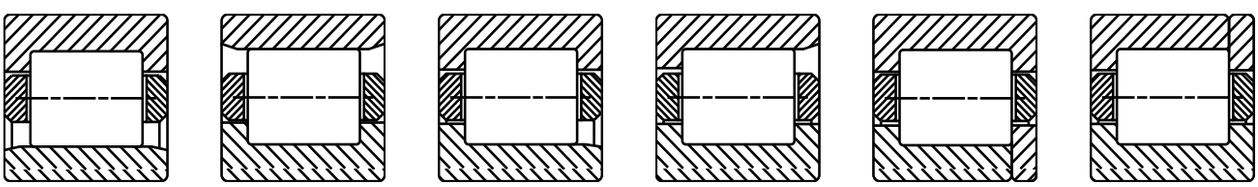
A type NUP or NP bearing may be used in conjunction with type N or NU bearings for applications where axial shaft expansion is anticipated. In such cases, the N or NU bearing accommodates the shaft expansion. The NUP or NP bearing is considered the fixed bearing because the ribs restrict the axial movement of the rolling element. The fixed bearing is usually placed nearest the drive end of the shaft to minimize alignment variations in the drive. Shaft endplay, or float, is determined by the axial clearance in the fixed bearing.

Types NU, N, NJ, NF, NUP and NP conform to ISO and DIN standards for loose rib rings (thrust collars) and typical industry diameters over or under roller.

The cylindrical roller bearing part numbers are in accordance with ISO 15. They are composed of four digits, the first two digits identify the dimensional series and the last two digits of the part number are the bore size divided by 5. In the dimensional series, the first digit is the width series and the second is the diameter (outer) series. The width series increase width in the sequence 8 0 1 2 3 4 5 6 7. The diameter series increase radial section in the sequence 7 8 9 0 1 2 3 4.

Types having an R prefix are similar in construction to their N counterparts. However, they were designed to conform to ABMA standards.

Inch-size bearings are identified by the letter I in the part number. RIU, for example, indicates an inch bearing while RU indicates the equivalent style in metric dimensions.



NU, RIU, RU | N, RIN, RN | NJ, RIJ, RJ | NF, RIF, RF | NUP, RIT, RT | NP, RIP, RP

Fig. 1. Radial cylindrical roller bearings.

EMA SERIES

The Timken® single-row EMA series cylindrical roller bearings incorporate a unique cage design, proprietary internal geometry and special surface textures. These features help to improve bearing performance and can help to improve uptime and reduce maintenance costs.

The cage is a one-piece brass design with full-milled pockets. It is a land-riding cage which, unlike traditional roller-riding cages, minimizes drag on the roller elements. This reduces heat generation and improves bearing life. The high cage rigidity allows for more rollers than possible with other brass cage configurations.

Proprietary profiles on the rings and/or rollers increase the ability to handle heavier loads than competing designs.

Engineered processes for rings and rollers provide enhanced surface textures, resulting in lower friction, lower operating temperatures and longer bearing life.

EMA series bearings are available in types N, NU, NJ and NUP.

FULL-COMPLEMENT (NCF)

The full-complement (NCF) single-row bearings include integral flanges on the inner and outer rings. These bearings also can manage axial loads in one direction and permit small axial displacements.

5200 METRIC SERIES

This series features enhanced radial load ratings due to its internal design proportions. In this series, the outer ring is double-ribbed and the inner ring is full-width with a cylindrical O.D. The bearing also can be furnished without an inner ring for applications where radial space is limited. When so used, the shaft journal must be hardened to HRC 58 minimum, and the surface finished to 15 RMS maximum. The W designation in the suffix indicates the outer ring is provided. The inner ring also can be furnished separately. The A prefix indicates that the inner ring is furnished either separately or as part of the assembly.

The bearing is usually provided with a rugged stamped-steel cage (S designation) and is land-riding on the outer ring ribs. The cage features depressed bars, which not only space rollers evenly, but retain them as a complete assembly with the outer ring. Cages of machined brass (M designation) are available for applications where reversing loads or high speeds might indicate their need. Outer rings are made from bearing quality alloy steel. The inner rings are deep-case hardened to accommodate the hoop stresses resulting from heavy press fits.

The standard bearing is produced with radial internal clearances designated as R6. Other internal clearances can be supplied upon request. Proper roller guidance is assured by integral ribs and roller end clearance control.

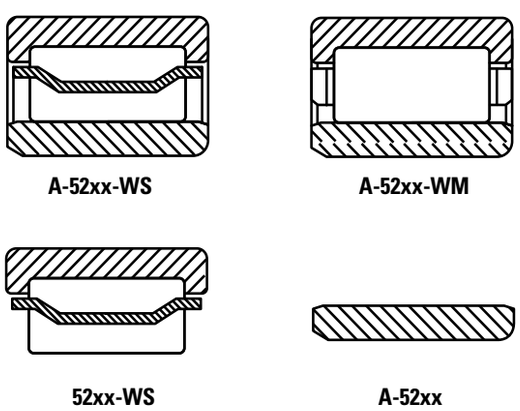


Fig. 2. 5200 metric series bearings.

TWO-ROW BEARINGS

Two-row, or double-row, cylindrical bearings offer added radial capacity over tradition one-row types. These bearing types are interchangeable so the dimensions and diameter under the rollers (NNU style) and diameter over the rollers (NN style) are held to an ISO/DIN standard. The standard cage design is a drilled pocket, finger-style retainer.

FOUR-ROW BEARINGS

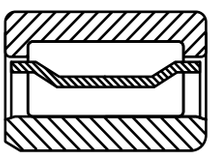
Four-row cylindrical bearings have an extremely high radial load capacity, but no thrust capacity. This bearing type is mostly used in roll neck and work roll applications in the metal rolling industry. Straight and tapered bore designs are available.

CYLINDRICAL ROLLER BEARING CAGES

STAMPED-STEEL CAGES

Stamped-steel cages for cylindrical roller bearings consist of low-carbon steel and are manufactured using a series of cutting, forming, and punching operations. These cages are made in a variety of different designs and are suitable for most general purpose cylindrical roller bearing applications. One specific type is the S-type design for the 5200 series cylindrical roller bearing, which is a land-riding cage piloted on the outer ring ribs. This design has depressed cage bridges which evenly space the rolling elements and retain them on the outer ring. Stamped-steel cages are easily mass produced and can be used in high-temperature and harsh-lubricant environments.

Fig. 3. S-type cage.



MACHINED CAGES

Machined cages are an option for smaller cylindrical bearing sizes, and are typically made from brass. Machined cage designs for cylindrical roller bearings offer increased strength for more demanding applications.

Designs can be one-piece or two-piece cages. One-piece designs can be either a finger-type as shown in fig. 4 or a standard cage configuration having fully milled pockets. The one-piece finger-type and the two-piece design with cage ring (fig. 5) are more common in standard cylindrical roller bearings. They also are roller-guided designs.

The one-piece version with fully milled roller pockets (fig. 6) is our premium cage. This cage is used with our EMA series bearings. Unlike traditional roller-riding cages, it is a land-riding cage which minimizes drag on the roller elements. This reduces heat generation, resulting in improved bearing life. Compared to a two-piece design, this one-piece cage also reduces heat and wear by enhancing lubrication flow.

PIN-TYPE CAGES

Pin-type cages for cylindrical roller bearings consist of two rings and a series of pins running through the center of the rolling elements. These cages are used for large diameter cylindrical roller bearings where machined brass cages are not available. With this design, additional rollers can typically be added, resulting in increased load capacity.

Fig. 7. Pin-type cage.

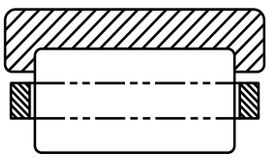


Fig. 4. One-piece finger-type cage.

Fig. 5. Two-piece brass cage.

Fig. 6. One-piece premium cage.

METRIC SYSTEM TOLERANCES
CYLINDRICAL ROLLER BEARINGS

Cylindrical roller bearings are manufactured to a number of specifications with each having classes that define tolerances on dimensions such as bore, O.D., width and runout. Metric bearings have been manufactured to corresponding standard negative tolerances.

Boundary dimension tolerances for cylindrical roller bearing usage are listed in the following tables. These tolerances are provided for use in selecting bearings for general applications in conjunction with the bearing mounting and fitting practices offered in later sections.

The following table summarizes the different specifications and classes for cylindrical roller bearings.

TABLE 2. BEARING SPECIFICATIONS AND CLASSES

System	Specification	Bearing Type	Standard Bearing Class		Precision Bearing Class			
Metric	Timken	Tapered Roller Bearings	K	N	C	B	A	AA
	ISO/DIN	All Bearing Types	P0	P6	P5	P4	P2	-
	ABMA	Cylindrical, Spherical	RBEC 1	RBEC 3	RBEC 5	RBEC 7	RBEC 9	-
		Ball Bearings	ABEC 1	ABEC 3	ABEC 5	ABEC 7	ABEC 9	-
		Tapered Roller Bearings	K	N	C	B	A	-
Inch	Timken	Tapered Roller Bearings	4	2	3	0	00	000
	ABMA	Tapered Roller Bearings	4	2	3	0	00	-

Standard Timken radial cylindrical roller bearings maintain normal tolerances according to ISO 492. Tables 3 and 4 list the critical tolerances for these radial cylindrical roller bearings. For applications where running tolerance is critical, P6 or P5 tolerances are recommended.

The term deviation is defined as the difference between a single ring dimension and the nominal dimension. For metric tolerances, the nominal dimension is at a +0 mm (0 in.) tolerance. The deviation is the tolerance range for the listed parameter. Variation is defined as the difference between the largest and smallest measurements of a given parameter for an individual ring.

TABLE 3. CYLINDRICAL ROLLER BEARING TOLERANCES – INNER RING (Metric)[1]

Bearing Bore		Bore Deviation[2] Δ_{dmp}			Width Variation V_{BS}			Radial Runout K_{ia}			Face Runout with Bore S_d	Axial Runout S_{ia}	Width Deviation Inner and Outer Rings[2] Δ_{Bs} and Δ_{Cs}	
Over	Incl.	P0	P6	P5	P0	P6	P5	P0	P6	P5	P5	P5	P0, P6	P5
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
2.5000 0.0984	**10.000** 0.3937	**-0.008** -0.0003	**-0.007** -0.0003	**-0.005** -0.0002	**0.015** 0.0006	**0.015** 0.0006	**0.005** 0.0002	**0.010** 0.0004	**0.006** 0.0002	**0.004** 0.0002	**0.007** 0.0003	**0.007** 0.0003	**-0.120** -0.0047	**-0.040** -0.0157
10.000 0.3937	**18.000** 0.7087	**-0.008** -0.0003	**-0.007** -0.0003	**-0.005** -0.0002	**0.020** 0.0008	**0.020** 0.0008	**0.005** 0.0002	**0.010** 0.0004	**0.007** 0.0003	**0.004** 0.0002	**0.007** 0.0003	**0.007** 0.0003	**-0.120** -0.0047	**-0.080** -0.0031
18.000 0.7087	**30.000** 1.1811	**-0.010** -0.0004	**-0.008** -0.0003	**-0.006** -0.0002	**0.020** 0.0008	**0.020** 0.0008	**0.005** 0.0002	**0.013** 0.0005	**0.008** 0.0003	**0.004** 0.0002	**0.008** 0.0003	**0.008** 0.0003	**-0.120** -0.0047	**-0.120** -0.0047
30.000 1.1811	**50.000** 1.9685	**-0.012** -0.0005	**-0.010** -0.0004	**-0.008** -0.0003	**0.020** 0.0008	**0.020** 0.0008	**0.005** 0.0002	**0.015** 0.0006	**0.010** 0.0004	**0.005** 0.0002	**0.008** 0.0003	**0.008** 0.0003	**-0.120** -0.0047	**-0.120** -0.0047
50.000 1.9685	**80.000** 3.1496	**-0.015** -0.0006	**-0.012** -0.0005	**-0.009** -0.0004	**0.025** 0.0010	**0.025** 0.0010	**0.006** 0.0002	**0.020** 0.0008	**0.010** 0.0004	**0.005** 0.0002	**0.008** 0.0003	**0.008** 0.0003	**-0.150** -0.0059	**-0.150** -0.0059
80.000 3.1496	**120.000** 4.7244	**-0.020** -0.0008	**-0.015** -0.0006	**-0.010** -0.0004	**0.025** 0.0010	**0.025** 0.0010	**0.007** 0.0003	**0.025** 0.0010	**0.013** 0.0005	**0.006** 0.0002	**0.009** 0.0004	**0.009** 0.0004	**-0.200** -0.0079	**-0.200** -0.0079
120.000 4.7244	**150.000** 5.9055	**-0.025** -0.0010	**-0.018** -0.0007	**-0.013** -0.0005	**0.030** 0.0012	**0.030** 0.0012	**0.008** 0.0003	**0.030** 0.0012	**0.018** 0.0007	**0.008** 0.0003	**0.010** 0.0004	**0.010** 0.0004	**-0.250** -0.0098	**-0.250** -0.0098
150.000 5.9055	**180.000** 7.0866	**-0.025** -0.0010	**-0.018** -0.0007	**-0.013** -0.0005	**0.030** 0.0012	**0.030** 0.0012	**0.008** 0.0003	**0.030** 0.0012	**0.018** 0.0007	**0.008** 0.0003	**0.010** 0.0004	**0.010** 0.0004	**-0.250** -0.0098	**-0.250** -0.0098
180.000 7.0866	**250.000** 9.8425	**-0.030** -0.0012	**-0.022** -0.0009	**-0.015** -0.0006	**0.030** 0.0012	**0.030** 0.0012	**0.010** 0.0004	**0.040** 0.0016	**0.020** 0.0008	**0.010** 0.0004	**0.011** 0.0004	**0.013** 0.0005	**-0.300** -0.0018	**-0.300** -0.0018
250.000 9.8425	**315.000** 12.4016	**-0.035** -0.0014	**-0.025** -0.0010	**-0.018** -0.0007	**0.035** 0.0014	**0.035** 0.0014	**0.013** 0.0005	**0.050** 0.0020	**0.025** 0.0010	**0.013** 0.0005	**0.013** 0.0005	**0.015** 0.0006	**-0.350** -0.0138	**-0.350** -0.0138
315.000 12.4016	**400.000** 15.7480	**-0.040** -0.0016	**-0.030** -0.0012	**-0.023** -0.0009	**0.040** 0.0016	**0.040** 0.0016	**0.015** 0.0006	**0.060** 0.0024	**0.030** 0.0012	**0.015** 0.0006	**0.015** 0.0006	**0.020** 0.0008	**-0.400** -0.0157	**-0.400** -0.0157
400.000 15.7480	**500.000** 19.6850	**-0.045** -0.0018	**-0.035** -0.0014	– –	**0.050** 0.0020	**0.045** 0.0018	– –	**0.065** 0.0026	**0.035** 0.0014	– –	– –	– –	**-0.450** -0.0177	– –
500.000 19.6850	**630.000** 24.8031	**-0.050** -0.0020	**-0.040** -0.0016	– –	**0.060** 0.0024	**0.050** 0.0020	– –	**0.070** 0.0028	**0.040** 0.0016	– –	– –	– –	**-0.500** -0.0197	– –
630.000 24.8031	**800.000** 31.4961	**-0.075** -0.0030	– –	– –	**0.070** 0.0028	– –	– –	**0.080** 0.0031	– –	– –	– –	– –	**-0.750** -0.0295	– –

[1]Symbol definitions are found on pages 32-33 of the Timken Engineering Manual (order no. 10424).
[2]Tolerance range is from +0 to value listed.

TABLE 4. CYLINDRICAL ROLLER BEARING TOLERANCES – OUTER RING (Metric)[1]

Bearing O.D.		Outside Deviation[2] Δ_{Dmp}			Width Variation V_{cs}		Radial Runout K_{ea}			Axial Runout S_{ea}	Outside Diameter Runout With Face S_D
Over	Incl.	P0	P6	P5	P0	P6	P0	P6	P5	P5	P5
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
0.000 0.0000	**18.000** 0.7087	**-0.008** -0.0003	**-0.007** -0.0003	**-0.005** -0.0002	**0.015** 0.0006	**0.005** 0.0002	**0.015** 0.0006	**0.008** 0.0003	**0.005** 0.0002	**0.008** 0.0003	**0.008** 0.0003
18.000 0.7087	**30.000** 1.1811	**-0.009** -0.0004	**-0.008** -0.0003	**-0.006** -0.00024	**0.020** 0.0008	**0.005** 0.0002	**0.015** 0.0006	**0.009** 0.0004	**0.006** 0.00024	**0.008** 0.0003	**0.008** 0.0003
30.000 1.1811	**50.000** 1.9685	**-0.011** -0.0004	**-0.009** -0.0004	**-0.007** -0.0003	**0.020** 0.0008	**0.005** 0.0002	**0.020** 0.0008	**0.010** 0.0004	**0.007** 0.0003	**0.008** 0.0003	**0.008** 0.0003
50.000 1.9685	**80.000** 3.1496	**-0.013** -0.0005	**-0.011** -0.0004	**-0.009** -0.0004	**0.025** 0.0010	**0.006** 0.00024	**0.025** 0.0010	**0.013** 0.0005	**0.008** 0.0003	**0.010** 0.0004	**0.008** 0.0003
80.000 3.1496	**120.000** 4.7244	**-0.015** -0.0006	**-0.013** -0.0005	**-0.010** -0.0004	**0.025** 0.0010	**0.008** 0.0003	**0.035** 0.0014	**0.018** 0.0007	**0.010** 0.0004	**0.011** 0.0004	**0.009** 0.0004
120.000 4.7244	**150.000** 5.9055	**-0.018** -0.0007	**-0.015** -0.0006	**-0.011** -0.0004	**0.030** 0.0012	**0.008** 0.0003	**0.040** 0.0016	**0.020** 0.0008	**0.011** 0.0004	**0.013** 0.0005	**0.010** 0.0004
150.000 5.9055	**180.000** 7.0866	**-0.025** -0.0010	**-0.018** -0.0007	**-0.013** -0.0005	**0.030** 0.0012	**0.008** 0.0003	**0.045** 0.0018	**0.023** 0.0009	**0.013** 0.0005	**0.014** 0.0006	**0.010** 0.0004
180.000 7.0866	**250.000** 9.8425	**-0.030** -0.0012	**-0.020** -0.0008	**-0.015** -0.0006	**0.030** 0.0012	**0.010** 0.0004	**0.050** 0.0020	**0.025** 0.0010	**0.015** 0.0006	**0.015** 0.0006	**0.011** 0.0004
250.000 9.8425	**315.000** 12.4016	**-0.035** -0.0014	**-0.025** -0.0010	**-0.018** -0.0007	**0.035** 0.0014	**0.011** 0.0004	**0.060** 0.0024	**0.030** 0.0012	**0.018** 0.0007	**0.018** 0.0007	**0.013** 0.0005
315.000 12.4016	**400.000** 15.7480	**-0.040** -0.0016	**-0.028** -0.0011	**-0.020** -0.0008	**0.040** 0.0016	**0.013** 0.0005	**0.070** 0.0028	**0.035** 0.0014	**0.020** 0.0008	**0.020** 0.0008	**0.013** 0.0005
400.000 15.7480	**500.000** 19.6850	**-0.045** -0.0018	**-0.033** -0.0013	**-0.023** -0.0009	**0.045** 0.0018	**0.015** 0.0006	**0.080** 0.0031	**0.040** 0.0016	**0.023** 0.0009	**0.023** 0.0009	**0.015** 0.0006
500.000 19.6850	**630.000** 24.8031	**-0.050** -0.0020	**-0.038** -0.0015	**-0.028** -0.0011	**0.050** 0.0020	**0.018** 0.0007	**0.100** 0.0039	**0.050** 0.0020	**0.025** 0.0010	**0.025** 0.0010	**0.018** 0.0007
630.000 24.8031	**800.000** 31.4961	**-0.075** -0.0030	**-0.045** -0.0018	**-0.035** -0.0014	– –	**0.020** 0.0008	**0.120** 0.0047	**0.060** 0.0024	**0.030** 0.0012	**0.030** 0.0012	**0.020** 0.0008
800.000 31.4961	**1000.000** 39.3701	**-0.100** -0.0040	**-0.060** -0.0024	– –	– –	– –	**0.140** 0.0055	**0.075** 0.0030	– –	– –	– –
1000.000 39.3701	**1250.000** 49.2126	**-0.125** -0.0050	– –	– –	– –	– –	**0.160** 0.0063	– –	– –	– –	– –

[1]Symbol definitions are found on pages 32-33 of the Timken Engineering Manual (order no. 10424).
[2]Tolerance range is from +0 to value listed.

CYLINDRICAL ROLLER BEARING MOUNTING, FITTING, SETTING AND INSTALLATION

MOUNTING

Cylindrical roller bearings can be mounted individually, but most often are mounted in combination with another cylindrical roller, a spherical roller or a tapered roller bearing.

Fig. 8 shows a pulverizer wheel assembly where a two-row spherical roller bearing is mounted in combination with a cylindrical roller bearing. In this application, the cylindrical roller bearing allows the shaft to float relative to the housing.

Fig. 9 shows a single-reduction gear reducer with herringbone gears. A tapered roller bearing is mounted in combination with a cylindrical roller bearing on the upper shaft, and two cylindrical bearings are mounted on the lower shaft.

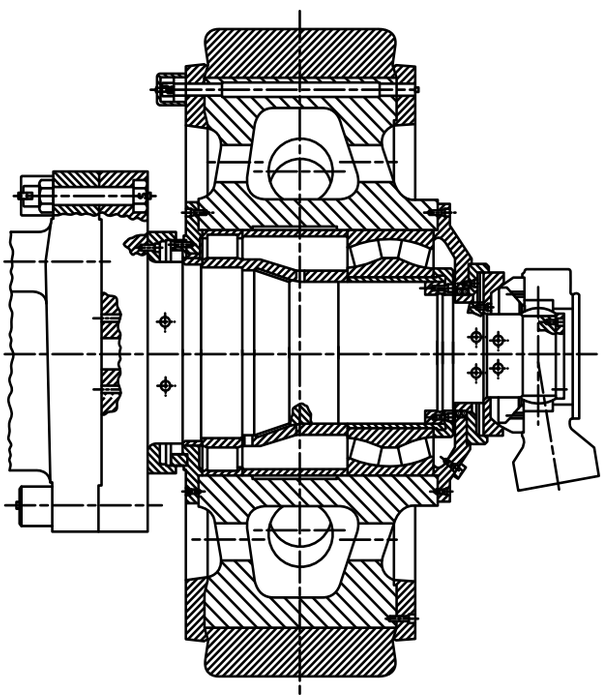


Fig. 8. Pulverizer wheel assembly.

FITTING PRACTICE

Tables 6-18 on pages 22-39 list the recommended fitting practice for cylindrical roller bearings. The tables assume:

- The bearing is of normal precision.
- The housing is thick and made from steel or cast iron.
- The shaft is solid and made from steel.
- The bearing seats are ground or accurately turned to less than approximately 1.6 µm Ra finish.

The suggested fit symbols are in accordance with ISO 286. For help with recommended fitting practices, contact your Timken representative.

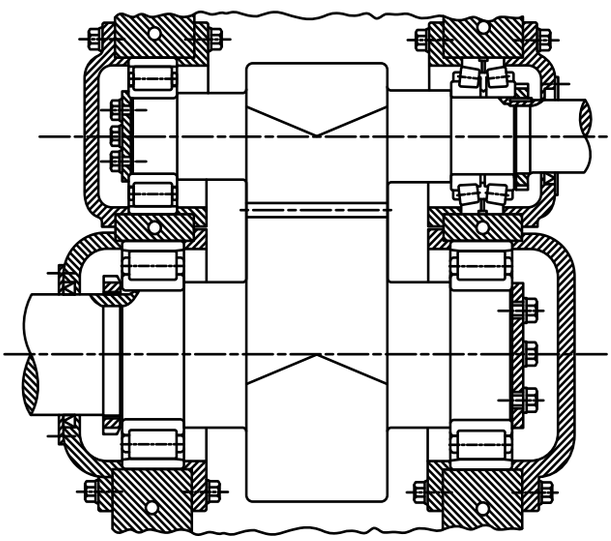


Fig. 9. Single-reduction gear reducer.

⚠ WARNING
Failure to observe the following warnings could create a risk of death or serious injury.

Proper maintenance and handling practices are critical. Always follow installation instructions and maintain proper lubrication.

Never spin a bearing with compressed air. The rollers may be forcefully expelled.

As a general guideline, rotating inner rings should be applied with an interference fit. Loose fits may permit the inner rings to creep or turn and wear the shaft and the backing shoulder. This wear may result in excessive bearing looseness and possible bearing and shaft damage. Additionally, abrasive metal particles resulting from creep or turning may enter into the bearing and cause damage and vibration.

Stationary inner-ring fitting practice depends on the loading of the application. The load conditions and bearing envelope dimensions should be used to select the suggested shaft fit from the tables.

Similarly, rotating outer-ring applications should use an interference fit between the outer ring and housing.

Stationary outer rings are generally mounted with loose fits to permit assembly and disassembly.

Thin-walled housings, light-alloy housings or hollow shafts must use press fits tighter than required for thick-walled housings, steel or cast iron housings or solid shafts. Tighter fits also are required when mounting the bearing on relatively rough, or unground surfaces.

SETTING

To achieve appropriate operation clearance, attention must be paid to the effects fitting practice and thermal gradients have within the bearing.

FITTING PRACTICE

- An interference fit between the inner ring and a solid steel shaft will reduce the radial clearance within the bearing by approximately 85 percent of the fit.
- Interference fits between the outer ring and steel or cast iron housing will reduce radial clearance by approximately 60 percent.

THERMAL GRADIENTS

- Thermal gradients within the bearing are primarily a function of the bearing rotational speed. As speed increases, thermal gradients increase, thermal growth occurs and the radial clearance is reduced.
- As a rule of thumb, radial clearance should be increased for speeds in excess of 70 percent of the speed rating.

For help selecting the correct radial internal clearance for your application, consult with your Timken representative.

Radial internal clearance tolerances are listed in table 5.

Cylindrical roller bearings are ordered with a specified standard or non-standard radial internal clearance value. The standard radial internal clearances are designated as C2, C0 (normal), C3, C4 or C5 and are in accordance with ISO 5753. C2 represents the minimum clearance and C5 represents the maximum clearance. Non-standardized values also are available by special request.

The clearance required for a given application depends on the desired operating precision, the rotational speed of the bearing, and the fitting practice used. Most applications use a normal or C3 clearance. Typically, larger clearance reduces the operating load zone of the bearing, increases the maximum roller load and reduces the bearing's expected life. However, a cylindrical roller bearing that has been put into a preload condition can experience premature bearing damage caused by excessive heat generation and/or material fatigue. As a general guideline, cylindrical roller bearings should not operate in a preloaded condition.

ENGINEERING

MOUNTING, FITTING, SETTING AND INSTALLATION

TABLE 5. RADIAL INTERNAL CLEARANCE LIMITS – CYLINDRICAL ROLLER BEARINGS – CYLINDRICAL BORE

Bore – RIC											
Bore (Nominal)		C2		C0		C3		C4		C5	
Over	Incl.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
– –	**10** 0.3937	**0.000** 0.0000	**0.025** 0.0010	**0.020** 0.0008	**0.0045** 0.0018	**0.035** 0.0014	**0.060** 0.0024	**0.050** 0.0020	**0.075** 0.0030	– –	– –
10 0.3937	**24** 0.9449	**0.000** 0.0000	**0.025** 0.0010	**0.020** 0.0008	**0.0045** 0.0018	**0.035** 0.0014	**0.060** 0.0024	**0.050** 0.0020	**0.075** 0.0030	**0.065** 0.0026	**0.090** 0.0035
24 0.9449	**30** 1.1811	**0.000** 0.0000	**0.025** 0.0010	**0.020** 0.0008	**0.0045** 0.0018	**0.035** 0.0014	**0.060** 0.0024	**0.050** 0.0020	**0.075** 0.0030	**0.070** 0.0028	**0.095** 0.0037
30 1.1811	**40** 1.5748	**0.005** 0.0002	**0.030** 0.0012	**0.025** 0.0010	**0.050** 0.0020	**0.0045** 0.0018	**0.070** 0.0028	**0.060** 0.0024	**0.085** 0.0033	**0.080** 0.0031	**0.105** 0.0041
40 1.5748	**50** 1.9685	**0.005** 0.0002	**0.035** 0.0014	**0.030** 0.0012	**0.060** 0.0024	**0.050** 0.0020	**0.080** 0.0031	**0.070** 0.0028	**0.100** 0.0039	**0.095** 0.0037	**0.125** 0.0049
50 1.9685	**65** 2.5591	**0.010** 0.0004	**0.040** 0.0016	**0.040** 0.0016	**0.070** 0.0028	**0.060** 0.0024	**0.090** 0.0035	**0.080** 0.0031	**0.110** 0.0043	**0.110** 0.0043	**0.140** 0.0055
65 2.5591	**80** 3.1496	**0.010** 0.0004	**0.0045** 0.0018	**0.040** 0.0016	**0.075** 0.0030	**0.065** 0.0026	**0.100** 0.0039	**0.090** 0.0035	**0.125** 0.0049	**0.130** 0.0051	**0.165** 0.0065
80 3.1496	**100** 3.9370	**0.015** 0.0006	**0.050** 0.0020	**0.050** 0.0020	**0.085** 0.0033	**0.075** 0.0030	**0.110** 0.0043	**0.105** 0.0041	**0.140** 0.0055	**0.155** 0.0061	**0.190** 0.0075
100 3.9370	**120** 4.7244	**0.015** 0.0006	**0.055** 0.0022	**0.050** 0.0020	**0.090** 0.0035	**0.085** 0.0033	**0.125** 0.0049	**0.125** 0.0049	**0.165** 0.0065	**0.180** 0.0071	**0.220** 0.0087
120 4.7244	**140** 5.5118	**0.015** 0.0006	**0.060** 0.0024	**0.060** 0.0024	**0.105** 0.0041	**0.100** 0.0039	**0.145** 0.0057	**0.145** 0.0057	**0.190** 0.0075	**0.200** 0.0079	**0.245** 0.0096
140 5.5118	**160** 6.2992	**0.020** 0.0008	**0.070** 0.0028	**0.070** 0.0028	**0.120** 0.0047	**0.115** 0.0045	**0.165** 0.0065	**0.165** 0.0065	**0.215** 0.0085	**0.225** 0.0089	**0.275** 0.0108
160 6.2992	**180** 7.0866	**0.025** 0.0010	**0.075** 0.0030	**0.075** 0.0030	**0.125** 0.0049	**0.120** 0.0047	**0.170** 0.0067	**0.170** 0.0067	**0.220** 0.0087	**0.250** 0.0098	**0.300** 0.0118
180 7.0866	**200** 7.8740	**0.035** 0.0014	**0.090** 0.0035	**0.090** 0.0035	**0.145** 0.0057	**0.140** 0.0055	**0.195** 0.0077	**0.195** 0.0077	**0.250** 0.0098	**0.275** 0.0108	**0.330** 0.0130
200 7.8740	**225** 8.8583	**0.045** 0.0018	**0.105** 0.0041	**0.105** 0.0041	**0.165** 0.0065	**0.160** 0.0063	**0.220** 0.0087	**0.220** 0.0087	**0.280** 0.0110	**0.305** 0.0120	**0.365** 0.0144
225 8.8583	**250** 9.8425	**0.045** 0.0018	**0.110** 0.0043	**0.110** 0.0043	**0.175** 0.0069	**0.170** 0.0067	**0.235** 0.0093	**0.235** 0.0093	**0.300** 0.0118	**0.330** 0.0130	**0.395** 0.0156
250 9.8425	**280** 11.0236	**0.055** 0.0022	**0.125** 0.0049	**0.125** 0.0049	**0.195** 0.0077	**0.190** 0.0075	**0.260** 0.0102	**0.260** 0.0102	**0.330** 0.0130	**0.370** 0.0146	**0.440** 0.0173
280 11.0236	**315** 12.4016	**0.055** 0.0022	**0.130** 0.0051	**0.130** 0.0051	**0.205** 0.0081	**0.200** 0.0079	**0.275** 0.0108	**0.275** 0.0108	**0.350** 0.0138	**0.410** 0.0161	**0.485** 0.0191
315 12.4016	**355** 13.9764	**0.065** 0.0026	**0.145** 0.0057	**0.145** 0.0057	**0.225** 0.0089	**0.225** 0.0089	**0.305** 0.0120	**0.305** 0.0120	**0.385** 0.0152	**0.455** 0.0179	**0.535** 0.0211
355 13.9764	**400** 15.7480	**0.100** 0.0039	**0.190** 0.0075	**0.190** 0.0075	**0.280** 0.0110	**0.280** 0.0110	**0.370** 0.0146	**0.370** 0.0146	**0.460** 0.0181	**0.510** 0.0201	**0.600** 0.0236
400 15.7480	**450** 17.7165	**0.110** 0.0043	**0.210** 0.0083	**0.210** 0.0083	**0.310** 0.0122	**0.310** 0.0122	**0.410** 0.0161	**0.410** 0.0161	**0.510** 0.0201	**0.565** 0.0222	**0.665** 0.0262
450 17.7165	**500** 19.6850	**0.110** 0.0043	**0.220** 0.0087	**0.220** 0.0087	**0.330** 0.0130	**0.330** 0.0130	**0.440** 0.0173	**0.440** 0.0173	**0.550** 0.0217	**0.625** 0.0246	**0.735** 0.0289
500 19.6850	**560** 22.0472	**0.120** 0.0047	**0.240** 0.0095	**0.240** 0.0095	**0.360** 0.0142	**0.360** 0.0142	**0.480** 0.0189	**0.480** 0.0189	**0.600** 0.0236	**0.690** 0.0272	**0.810** 0.0319
560 22.0472	**630** 24.8031	**0.140** 0.0055	**0.260** 0.0102	**0.260** 0.0102	**0.380** 0.0150	**0.380** 0.0150	**0.500** 0.0197	**0.500** 0.0197	**0.620** 0.0244	**0.780** 0.0307	**0.900** 0.0354
630 24.8031	**710** 27.9528	**0.145** 0.0057	**0.285** 0.0112	**0.285** 0.0112	**0.425** 0.0167	**0.425** 0.0167	**0.565** 0.0222	**0.565** 0.0222	**0.705** 0.0278	**0.865** 0.0341	**1.005** 0.0396
710 27.9528	**800** 31.4961	**0.150** 0.0059	**0.310** 0.0122	**0.310** 0.0122	**0.470** 0.0185	**0.470** 0.0185	**0.630** 0.0248	**0.630** 0.0248	**0.790** 0.0311	**0.975** 0.0384	**1.135** 0.0447
800 31.4961	**900** 35.4331	**0.180** 0.0071	**0.350** 0.0138	**0.350** 0.0138	**0.520** 0.0205	**0.520** 0.0205	**0.690** 0.0272	**0.690** 0.0272	**0.860** 0.0339	**1.095** 0.0431	**1.265** 0.0498
900 35.4331	**1000** 39.3701	**0.200** 0.0079	**0.390** 0.0154	**0.390** 0.0154	**0.580** 0.0228	**0.580** 0.0228	**0.770** 0.0303	**0.770** 0.0303	**0.960** 0.0378	**1.215** 0.0478	**1.405** 0.0553

Shaft fit RIC reductions and clearance:

For a 150 mm nominal bore at C3, the RIC will be 0.115 to 0.165 mm (0.0045 to 0.0065 in.). Recalculating shaft fit RIC reduction and clearance:

max. clearance = max. RIC - min. fit reduction
= 0.165 - 0.034 = 0.131 mm (0.0052 in.)

min. clearance = min. RIC - max. fit reduction
= 0.115 - 0.074 = 0.041 mm (0.0016 in.)

Since the minimum mounted clearance is less than the minimum suggested RIC of 0.056 mm (0.0022 in.), the C3 RIC clearance limit needs to be reevaluated.

INSTALLATION

When using a tight-fit inner ring, the method of assembly will depend on whether the bearing has a cylindrical or tapered bore.

Mounting cylindrical bore bearings

Heat expansion method

- Most applications require a tight interference fit on the shaft.
- Mounting is simplified by heating the bearing to expand it sufficiently to slide easily onto the shaft.
- Two methods of heating are commonly used:
  - Tank of heated oil.
  - Induction heating.
- The first is accomplished by heating the bearing in a tank of oil that has a high flash point.
- The oil temperature should not be allowed to exceed 121° C (250° F). A temperature of 93° C (200° F) is sufficient for most applications.
- The bearing should be heated for 20 or 30 minutes, or until it is expanded sufficiently to slide onto the shaft easily.
- The induction heating process can be used for mounting bearings.
- Induction heating is rapid. Care must be taken to prevent bearing temperature from exceeding 93° C (200° F).
- Trial runs with the unit and bearing are usually necessary to obtain proper timing.
- Thermal crayons melted at predetermined temperatures can be used to check the bearing temperature.
- While the bearing is hot, it should be positioned squarely against the shoulder.

NOTE

Never use steam or hot water when cleaning the bearings because these methods can create rust or corrosion.

NOTE

Never expose any surface of a bearing to the flame of a torch.

NOTE

Do not heat bearing beyond 149° C (300° F).

- Lockwashers and locknuts or clamping plates are then installed to hold the bearing against the shoulder of the shaft.
- As the bearing cools, the locknut or clamping plate should be tightened.
- In cases of outer ring rotation, where the outer ring is a tight fit in the housing, the housing member can be expanded by heating.
- The oil bath is shown in fig. 10. The bearing should not be in direct contact with the heat source.
- The usual arrangement is to have a screen several inches from the bottom of the tank. Small support blocks separate the bearing from the screen.
- It is important to keep the bearing away from any localized high-heat source that may raise its temperature excessively, resulting in ring hardness reduction.

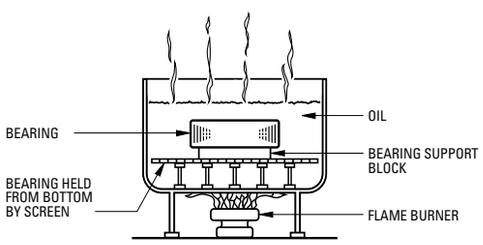


Fig. 10. Heat expansion method.

- Flame-type burners are commonly used. An automatic device for temperature control is desirable.
- If safety regulations prevent the use of an open heated oil bath, a mixture of 15 percent soluble-oil water may be used. This mixture may be heated to a maximum of 93° C (200° F) without being flammable.

⚠ CAUTION

Failure to observe the following warnings could create a risk of death or serious injury.

Remove oil or rust inhibitor from parts before heating, to avoid fire and fumes.

Arbor press method

- An alternate method of mounting, generally used only on smaller size bearings, is to press the bearing onto the shaft or into the housing. This can be done by using an arbor press and a mounting tube as shown in fig. 11.
- The tube should be made from soft steel with an inside diameter slightly larger than the shaft.
- The O.D. of the tube should not exceed the shaft backing diameter given in the Timken® Spherical Roller Bearing Catalog (order no. 10446), found on timken.com/catalogs.

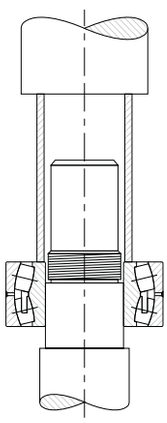


Fig. 11. Arbor press method.

- The tube should be faced square at both ends. It should be thoroughly clean inside and out, and long enough to clear the end of the shaft after the bearing is mounted.
- If the outer ring is being pressed into the housing, the O.D. of the mounting tube should be slightly smaller than the housing bore. The I.D. should not be less than the suggested housing backing diameter in the table of dimensions available in the Timken Spherical Roller Bearing Catalog (order no. 10446), found on timken.com/catalogs.
- Coat the shaft with a light machine oil to reduce the force needed for a press fit.
- Carefully place the bearing on the shaft, making sure it is square with the shaft axis.
- Apply steady pressure from the arbor ram to drive the bearing firmly against the shoulder.

NOTE

Never attempt a press fit on a shaft by applying pressure to the outer ring or a press fit in a housing by applying pressure to the inner ring.

SHAFT AND HOUSING FITS
CYLINDRICAL ROLLER BEARINGS

TABLE 6. CYLINDRICAL ROLLER BEARINGS SHAFT FITS (EXCEPT 5200 SERIES AND FOUR-ROW CYLINDRICALS)

Load Limit		Shaft Diameter		Shaft Tolerance
Lower	Upper	**mm** in.	**mm** in.	Symbol[1]
INNER RING STATIONARY				
0	C[2]	All	All	g6
0	C	All	All	h6
INNER RING ROTATION OR INDETERMINATE				
		Over	Incl.	
0	0.08C	**0** 0	**40** 1.57	k6[3]
		40 1.57	**140** 5.51	m6[4]
		140 5.51	**320** 12.60	n6
		320 12.60	**500** 19.68	p6
		500 19.68	– –	–
0.08C	0.18C	**0** 0	**40** 1.57	k5
		40 1.57	**100** 3.94	m5
		100 3.94	**140** 5.51	m6
		140 5.51	**320** 12.60	n6
		320 12.60	**500** 19.68	p6
		500 19.68	– –	r6
0.18C	C	**0** 0	**40** 1.57	m5[5]
		40 1.57	**65** 2.56	m6[5]
		65 2.56	**140** 5.51	n6[5]
		140 5.51	**320** 12.60	p6[5]
		320 12.60	**500** 19.68	r6[5]
		500 19.68	– –	r7[5]
THRUST LOADS				
Not suggested, consult your Timken engineer.				

[1]For solid shaft. See pages 24-29 for tolerance values.
[2]C = dynamic load rating.
[3]Use k5 for high-precision applications.
[4]Use m5 for high-precision applications.
[5]Bearings with greater than nominal clearance must be used.

TABLE 7. FOUR-ROW CYLINDRICAL ROLLER BEARING SHAFTS

Load Limit		Shaft Diameter		Shaft Tolerance
Lower	Upper	**mm** in.	**mm** in.	Symbol[1]
All		**100** 3.93	**120** 4.72	n6
		120 4.72	**225** 8.85	p6
		225 8.85	**400** 15.75	r6
		400 15.75		s6

[1]For solid shaft. See pages 24-29 for tolerance values.

TABLE 8. CYLINDRICAL ROLLER BEARING HOUSING FITS

	Operating Conditions		Examples	Housing Tolerance Symbol[1]	Outer Ring Displaceable Axially
	OUTER RING ROTATING				
	Heavy loads with thin-walled housing		Crane support wheels Wheel hubs (roller bearings) Crank bearings	P6	No
	Normal to heavy loads		Wheel hubs (ball bearings) Crank bearings	N6	No
	Light loads		Conveyor rollers Rope sheaves Tension pulleys	M6	No
	INDETERMINATE LOAD DIRECTION				
	Heavy shock loads		Electric traction motors	M7	No
	Normal to heavy loads, axial displacement of outer ring not required.		Electric motors Pumps Crankshaft main bearings	K6	No, normally
Below this line, housing can either be one piece or split. Above this line, a split housing is not suggested.	Light to normal loads, axial displacement of outer ring desired.		Electric motors Pumps Crankshaft main bearings	J6	Yes, normally
	OUTER RING STATIONARY				
	Shock loads, temporary complete unloading		Heavy rail vehicles	J6	Yes, normally
	All	One-piece housing	General applications Heavy rail vehicles	H6	Easily
		Radially split housing	Transmission drives	H7	Easily
	Heat supplied through shaft		Dryer cylinders	G7	Easily

[1]Cast iron steel housing. See pages 30-37 for numerical values. Where wider tolerances are permissible, P7, N7, M7, K7, J7 and H7 values may be used in place of P6, N6, M6, K6, J6 and H6 values, respectively.

ENGINEERING

SHAFT AND HOUSING FITS

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

RADIAL BALL, SPHERICAL ROLLER AND CYLINDRICAL ROLLER BEARINGS

SHAFT TOLERANCES

TABLE 9. RADIAL BALL, SPHERICAL AND CYLINDRICAL ROLLER BEARING SHAFT TOLERANCES

Bearing Bore			g6			h6			h5			j5		
Nominal (Max.)		Tolerance[1]	Shaft Diameter		Fit	Shaft Diameter		Fit	Shaft Diameter		Fit	Shaft Diameter		Fit
Over	Incl.		Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.	
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
3.000 0.1181	**6.000** 0.2362	**-0.008** -0.003	**-0.004** -0.0002	**-0.012** -0.0005	**0.012L 0.004T** 0.0005L 0.0001T	**0.000** 0.0000	**-0.008** -0.003	**0.008L 0.008T** 0.0003L 0.0003T	**0.000** 0.0000	**-0.005** -0.0002	**0.005L 0.008T** 0.0002L 0.0003T	**+0.003** +0.0001	**-0.002** -0.0001	**0.002L 0.011T** 0.0001L 0.0004T
6.000 0.2362	**10.000** 0.3937	**-0.008** -0.003	**-0.005** -0.0002	**-0.014** -0.0006	**0.014L 0.003T** 0.0006L 0.0001T	**0.000** 0.0000	**-0.009** -0.0004	**0.009L 0.008T** 0.0004L 0.0003T	**0.000** 0.0000	**-0.006** -0.0002	**0.006L 0.008T** 0.0002L 0.0003T	**+0.004** +0.0002	**-0.002** -0.0001	**0.002L 0.012T** 0.0001L -0.0005T
10.000 0.3937	**18.000** 0.7087	**-0.008** -0.003	**-0.006** -0.0002	**-0.017** -0.0007	**0.017L 0.002T** 0.0007L -0.0001T	**0.000** 0.0000	**-0.011** -0.0004	**0.011L 0.008T** 0.0004L 0.0003T	**0.000** 0.0000	**-0.008** -0.0003	**0.008L 0.008T** 0.0003L 0.0003T	**+0.005** +0.0002	**-0.003** -0.0001	**0.003L 0.013T** 0.0001L 0.0005T
18.000 0.7087	**30.000** 1.1811	**-0.010** -0.0004	**-0.007** -0.0003	**-0.020** -0.0008	**0.020L 0.003T** 0.0008L 0.0001T	**0.000** 0.0000	**-0.013** -0.0005	**0.013L 0.010T** 0.0005L 0.0004T	–	–	–	**+0.005** +0.0002	**-0.004** -0.0002	**0.004L 0.015T** 0.0002L 0.0006T
30.000 1.1811	**50.000** 1.9685	**-0.014** -0.0006	**-0.009** -0.0004	**-0.025** -0.0010	**0.025L 0.003T** 0.0010L 0.0001T	**0.000** 0.0000	**-0.016** -0.0006	**0.016L 0.012T** 0.0006L 0.0005T	–	–	–	**+0.006** +0.0002	**-0.005** -0.0002	**0.005L 0.018T** 0.0002L 0.0007T
50.000 1.9685	**80.000** 3.1496	**-0.015** -0.0006	**-0.010** -0.0004	**-0.029** -0.0011	**0.029L 0.005T** 0.0011L 0.0002T	**0.000** 0.0000	**-0.019** -0.0007	**0.019L 0.015T** 0.0007L 0.0006T	–	–	–	**+0.006** +0.0002	**-0.007** -0.0003	**0.007L 0.021T** 0.0003L 0.0008T
80.000 3.1496	**120.000** 4.7244	**-0.020** -0.0008	**-0.012** -0.0005	**-0.034** -0.0013	**0.034L 0.008T** 0.0013L 0.0003T	**0.000** 0.0000	**-0.022** -0.0009	**0.022L 0.020T** 0.0009L 0.0008T	–	–	–	**+0.006** +0.0002	**-0.009** -0.0004	**0.009L 0.026T** 0.0004L 0.0010T
120.000 4.7244	**180.000** 7.0866	**-0.025** -0.0010	**-0.014** -0.0006	**-0.039** -0.0015	**0.039L 0.011T** 0.0015L 0.0004T	**0.000** 0.0000	**-0.025** -0.0010	**0.025L 0.025T** 0.0010L 0.0010T	–	–	–	**+0.007** +0.0003	**-0.011** -0.0004	**0.011L 0.032T** 0.0004L 0.0013T
180.000 7.0866	**200.000** 7.8740	**-0.030** -0.0012	**-0.015** -0.0006	**-0.044** -0.0017	**0.044T 0.015T** 0.0017L 0.0006T	**0.000** 0.0000	**-0.029** -0.0011	**0.029L 0.030T** 0.0011L 0.0012T	–	–	–	**+0.007** +0.0003	**-0.013** -0.0005	**0.013L 0.037T** 0.0005L 0.0015T
200.000 7.8740	**225.000** 8.8583	**-0.030** -0.0012	**-0.015** -0.0006	**-0.044** -0.0017	**0.044T 0.015T** 0.0017L 0.0006T	**0.000** 0.0000	**-0.029** -0.0011	**0.029L 0.030T** 0.0011L 0.0012T	–	–	–	**+0.007** +0.0003	**-0.013** -0.0005	**0.013L 0.037T** 0.0005L 0.0015T
225.000 8.8583	**250.000** 9.8425	**-0.030** -0.0012	**-0.015** -0.0006	**-0.044** -0.0017	**0.044T 0.015T** 0.0017L 0.0006T	**0.000** 0.0000	**-0.029** -0.0011	**0.029L 0.030T** 0.0011L 0.0012T	–	–	–	**+0.007** +0.0003	**-0.013** -0.0005	**0.013L 0.037T** 0.0005L 0.0015T
250.000 9.8425	**280.000** 11.0236	**-0.035** -0.0014	**-0.017** -0.0007	**-0.049** -0.0019	**0.049L 0.018T** 0.0019L 0.0007T	**0.000** 0.0000	**-0.032** -0.0013	**0.032L 0.035T** 0.0013L 0.0014T	–	–	–	**+0.007** +0.0003	**-0.016** -0.0006	**0.016L 0.042T** 0.0006L 0.0017T
280.000 11.0236	**315.000** 12.4016	**-0.035** -0.0014	**-0.017** -0.0007	**-0.049** -0.0019	**0.049L 0.018T** 0.0019L 0.0007T	**0.000** 0.0000	**-0.032** -0.0013	**0.032L 0.035T** 0.0013L 0.0014T	–	–	–	**+0.007** +0.0003	**-0.016** -0.0006	**0.016L 0.042T** 0.0006L 0.0017T

NOTE: Tolerance and shaft diameters are shown in the table as variances from nominal bearing bore.
[1]Tolerance range is from +0 to value listed.

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

j6			k5			k6			m5		
Shaft Diameter		Fit	Shaft Diameter		Fit	Shaft Diameter		Fit	Shaft Diameter		Fit
Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.	
mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.
+0.006 +0.0002	**-0.002** -0.0001	**0.002L** **0.014T** 0.0001L 0.0005T	**+0.006** +0.0002	**+0.001** +0.0000	**0.001T** **0.014T** 0.0000T 0.0005T	–	–	–	**+0.009** +0.0004	**+0.004** +0.0002	**0.004T** **0.017T** 0.0002T 0.0007T
+0.007 +0.0003	**-0.002** -0.0001	**0.002L** **0.015T** 0.0001L 0.0006T	**+0.007** +0.0003	**+0.001** +0.0000	**0.001T** **0.015T** 0.0000T 0.0006T	–	–	–	**+0.012** +0.0005	**+0.006** +0.0002	**0.006T** **0.020T** 0.0002T 0.0008T
+0.008 +0.0003	**-0.003** -0.0001	**0.003L** **0.016T** 0.0001L 0.0006T	**+0.009** +0.0004	**+0.001** +0.0000	**0.001T** **0.017T** 0.0000T 0.0007T	–	–	–	**+0.015** +0.0006	**+0.007** +0.0003	**0.007T** **0.023T** 0.0003T 0.0009T
+0.009 +0.0004	**-0.004** -0.0002	**0.004L** **0.019T** 0.0002L 0.0008T	**+0.011** +0.0004	**+0.002** +0.0001	**0.002T** **0.021T** 0.0001T 0.0008T	–	–	–	**+0.017** +0.0007	**+0.008** +0.0003	**0.008T** **0.027T** 0.0003T 0.0011T
+0.011 +0.0004	**-0.005** -0.0002	**0.005L** **0.023T** 0.0002L 0.00085T	**+0.013** +0.0005	**+0.002** +0.0001	**0.002T** **0.025T** 0.0001T 0.0010T	**+0.018** +0.0007	**+0.002** +0.0001	**0.002T** **0.030T** 0.0001T 0.0012T	**+0.020** +0.0008	**+0.009** +0.0004	**0.009T** **0.032T** 0.0004T 0.00125T
+0.012 +0.0005	**-0.007** -0.0003	**0.007L** **0.027T** 0.0003L 0.0011T	**+0.015** +0.0006	**+0.002** +0.0001	**0.002T** **0.030T** 0.0001T 0.0012T	**+0.021** +0.0008	**+0.002** +0.0001	**0.002T** **0.036T** 0.0001T 0.0014T	**+0.024** +0.0009	**+0.011** +0.0004	**0.011T** **0.039T** 0.0004T 0.0015T
+0.013 +0.0005	**-0.009** -0.0004	**0.009L** **0.033T** 0.0004L 0.0013T	**+0.018** +0.0007	**+0.003** +0.0001	**0.003T** **0.038T** 0.0001T 0.0015T	**+0.025** +0.0010	**+0.003** +0.0001	**0.003T** **0.045T** 0.0001T 0.0018T	**+0.028** +0.0011	**+0.013** +0.0005	**0.013T** **0.048T** 0.0005T 0.0019T
+0.014 +0.0006	**-0.011** -0.0004	**0.011L** **0.039T** 0.0004L 0.0016T	**+0.021** +0.0008	**+0.003** +0.0001	**0.003T** **0.046T** 0.0001T 0.0018T	**+0.028** +0.0011	**+0.003** +0.0001	**0.003T** **0.053T** 0.0001T 0.0021T	**+0.033** +0.0013	**+0.015** +0.0006	**0.015T** **0.058T** 0.0006T 0.0023T
+0.016 +0.0006	**-0.013** -0.0005	**0.013L** **0.046T** 0.0005L 0.0018T	**+0.024** +0.0009	**+0.004** +0.0002	**0.004T** **0.054T** 0.0002T 0.0021T	–	–	–	**+0.037** +0.0015	**+0.017** +0.0007	**0.017T** **0.067T** 0.0007T 0.0027T
+0.016 +0.0006	**-0.013** -0.0005	**0.013L** **0.046T** 0.0005L 0.0018T	**+0.024** +0.0009	**+0.004** +0.0002	**0.004T** **0.054T** 0.0002T 0.0021T	–	–	–	**+0.037** +0.0015	**+0.017** +0.0007	**0.017T** **0.067T** 0.0007T 0.0027T
+0.016 +0.0006	**-0.013** -0.0005	**0.013L** **0.046T** 0.0005L 0.0018T	**+0.024** +0.0009	**+0.004** +0.0002	**0.004T** **0.054T** 0.0002T 0.0021T	–	–	–	**+0.037** +0.0015	**+0.017** +0.0007	**0.017T** **0.067T** 0.0007T 0.0027T
+0.016 +0.0006	**-0.016** -0.0006	**0.016L** **0.051T** 0.0006L 0.0020T	**+0.027** +0.0011	**+0.004** +0.0002	**0.004T** **0.062T** 0.0002T 0.0025T	–	–	–	**+0.043** +0.0017	**+0.020** +0.0008	**0.020T** **0.078T** 0.0008T 0.0031T
+0.016 +0.0006	**-0.016** -0.0006	**0.016L** **0.051T** 0.0006L 0.0020T	**+0.027** +0.0011	**+0.004** +0.0002	**0.004T** **0.062T** 0.0002T 0.0025T	–	–	–	**+0.043** +0.0017	**+0.020** +0.0008	**0.020T** **0.078T** 0.0008T 0.0031T

Continued on next page.

ENGINEERING

SHAFT AND HOUSING FITS

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

Table 9 continued.

Bearing Bore			g6			h6			h5			j5		
Nominal (Max.)		Tolerance[1]	Shaft Diameter		Fit	Shaft Diameter		Fit	Shaft Diameter		Fit	Shaft Diameter		Fit
Over	Incl.		Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.	
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
315.000 12.4016	**355.000** 13.9764	**-0.040** -0.0016	**-0.018** -0.0007	**-0.054** -0.0021	**0.054L** **0.022T** 0.0021L 0.0009T	**0.000** 0.0000	**-0.036** -0.0014	**0.036L** **0.040T** 0.0014L 0.0016T	–	–	–	**+0.007** +0.0003	**-0.018** -0.0007	**0.018L** **0.047T** 0.0007L 0.0019T
355.000 13.9764	**400.000** 15.7480	**-0.040** -0.0016	**-0.018** -0.0007	**-0.054** -0.0021	**0.054L** **0.022T** 0.0021L 0.0009T	**0.000** 0.0000	**-0.036** -0.0014	**0.036L** **0.040T** 0.0014L 0.0016T	–	–	–	**+0.007** +0.0003	**-0.018** -0.0007	**0.018L** **0.047T** 0.0007L 0.0019T
400.000 15.7480	**450.000** 17.7165	**-0.045** -0.0018	**-0.020** -0.0008	**-0.060** -0.0024	**0.060L** **0.025T** 0.0024L 0.0010T	**0.000** 0.0000	**-0.040** -0.0016	**0.040L** **0.045T** 0.0016L 0.0018T	–	–	–	**+0.007** +0.0003	**-0.020** -0.0008	**0.020L** **0.052T** 0.0008L 0.0021T
450.000 17.7165	**500.000** 19.6850	**-0.045** -0.0018	**-0.020** -0.0008	**-0.060** -0.0024	**0.060L** **0.025T** 0.0024L 0.0010T	**0.000** 0.0000	**-0.040** -0.0016	**0.040L** **0.045T** 0.0016L 0.0018T	–	–	–	**+0.007** +0.0003	**-0.020** -0.0008	**0.020L** **0.052T** 0.0008L 0.0020T
500.000 19.6850	**560.000** 22.0472	**-0.050** -0.0020	**-0.022** -0.0009	**-0.066** -0.0026	**0.066L** **0.028T** 0.0026L 0.0011T	**0.000** 0.0000	**-0.044** -0.0017	**0.044L** **0.050T** 0.0017L 0.0020T	–	–	–	**+0.008** 0.0003	**-0.022** -0.0009	**0.022L** **0.058T** 0.0009L 0.0023T
560.000 22.0472	**630.000** 24.8032	**-0.050** -0.0020	**-0.022** -0.0009	**-0.066** -0.0026	**0.066L** **0.028T** 0.0026L 0.0011T	**0.000** 0.0000	**-0.044** -0.0017	**0.044L** **0.050T** 0.0017L 0.0020T	–	–	–	**+0.008** +0.0003	**-0.022** -0.0009	**0.022L** **0.058T** 0.0009L 0.0023T
630.000 24.8032	**710.000** 27.9528	**-0.075** -0.0030	**-0.024** -0.0009	**-0.074** -0.0029	**0.074L** **0.051T** 0.0029L 0.0021T	**0.000** 0.0000	**-0.050** -0.0020	**0.050L** **0.075T** 0.0020L 0.0030T	–	–	–	**+0.010** +0.0004	**-0.025** -0.0010	**0.025L** **0.085T** 0.0010L 0.0035T
710.000 27.9528	**800.000** 31.4961	**-0.075** -0.0030	**-0.024** -0.0009	**-0.074** -0.0029	**0.074L** **0.051T** 0.0029L 0.0021T	**0.000** 0.0000	**-0.050** -0.0020	**0.050L** **0.075T** 0.0020L 0.0030T	–	–	–	**+0.010** +0.0004	**-0.025** -0.0010	**0.025L** **0.085T** 0.0010L 0.0035T
800.000 31.4961	**900.000** 35.4331	**-0.100** -0.0039	**-0.026** -0.0010	**-0.082** 0.0032	**0.082L** **0.074T** 0.0032L 0.0029T	**0.000** 0.0000	**-0.056** -0.0022	**0.056L** **0.100T** 0.0022L 0.0039T	–	–	–	**+0.012** +0.0005	**-0.028** -0.0011	**0.028L** **0.112T** 0.0011L 0.0044T
900.000 35.4331	**1000.000** 39.3701	**-0.100** -0.0039	**-0.026** -0.0010	**-0.082** 0.0032	**0.082L** **0.074T** 0.0032L 0.0029T	**0.000** 0.0000	**-0.056** -0.0022	**0.056L** **0.100T** 0.0022L 0.0039T	–	–	–	**+0.012** +0.0005	**-0.028** -0.0011	**0.028L** **0.112T** 0.0011L 0.0044T
1000.000 39.3701	**1120.000** 44.0945	**-0.125** -0.0049	**-0.028** -0.0011	**-0.094** -0.0037	**0.094L** **0.097T** 0.0037L 0.0038T	**0.000** 0.0000	**-0.066** -0.0026	**0.066L** **0.125T** 0.0022L 0.0039T	–	–	–	**+0.013** +0.0005	**-0.033** -0.0013	**0.033L** **0.138T** 0.0013L 0.0054T
1120.000 44.0945	**1250.000** 49.2126	**-0.125** -0.0049	**-0.028** -0.0011	**-0.094** -0.0037	**0.094L** **0.097T** 0.0037L 0.0038T	**0.000** 0.0000	**-0.066** -0.0026	**0.066L** **0.125T** 0.0022L 0.0039T	–	–	–	**+0.013** +0.0005	**-0.033** -0.0013	**0.033L** **0.138T** 0.0013L 0.0054T

NOTE: Tolerance and shaft diameters are shown in the table as variances from nominal bearing bore.
[1]Tolerance range is from +0 to value listed.

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

j6			k5			k6			m5		
Shaft Diameter		Fit	Shaft Diameter		Fit	Shaft Diameter		Fit	Shaft Diameter		Fit
Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.	
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
+0.018 +0.0007	**-0.018** -0.0007	**0.018L** **0.058T** 0.0007L 0.0023T	**+0.029** +0.0011	**+0.046** +0.0002	**0.004T** **0.069T** 0.0002T 0.0027T	–	–	–	**+0.046** +0.0018	**+0.021** +0.0008	**0.021T** **0.086T** 0.0008T 0.0034T
+0.018 +0.0007	**-0.018** -0.0007	**0.018L** **0.058T** 0.0007L 0.0023T	**+0.029** +0.0011	**+0.004** +0.0002	**0.004T** **0.069T** 0.0002T 0.0027T	–	–	–	**+0.046** +0.0018	**+0.021** +0.0008	**0.021T** **0.086T** 0.0008T 0.0034T
+0.020 +0.0008	**-0.020** -0.0008	**0.020L** **0.065T** 0.0008L 0.0026T	**+0.032** +0.0013	**+0.005** +0.0002	**0.005T** **0.077T** 0.0002T 0.0031T	–	–	–	**+0.050** +0.0020	**+0.023** +0.0009	**0.023T** **0.095T** 0.0009T 0.0037T
+0.020 +0.0008	**-0.020** -0.0008	**0.020L** **0.065T** 0.0008L 0.0026T	**+0.032** +0.0013	**+0.005** +0.0002	**0.005T** **0.077T** 0.0002T 0.0031T	–	–	–	**+0.050** +0.0020	**+0.023** +0.0009	**0.023T** **0.095T** 0.0009T 0.0037T
+0.022 +0.0009	**-0.022** -0.0009	**0.022L** **0.072T** 0.0009L 0.0029T	**+0.030** +0.0012	**0.000** 0.0000	**0.00T** **0.080T** 0.0000T 0.0032T	–	–	–	**+0.056** +0.0022	**+0.026** +0.0010	**0.026T** **0.106T** 0.0010T 0.0042T
+0.022 +0.0009	**-0.022** -0.0009	**0.022L** **0.072T** 0.0009L 0.0029T	**+0.030** +0.0012	**0.000** 0.0000	**0.00T** **0.080T** 0.0000T 0.0032T	–	–	–	**+0.056** +0.0022	**+0.026** +0.0010	**0.026T** **0.106T** 0.0010T 0.0042T
+0.025 +0.0010	**-0.025** -0.0010	**0.025L** **0.100T** 0.0010L 0.0040T	**+0.035** +0.0014	**0.000** 0.0000	**0.000T** **0.110T** 0.0000T 0.0044T	–	–	–	**+0.065** +0.0026	**+0.030** +0.0012	**0.030T** **0.140T** 0.0012T 0.0056T
+0.025 +0.0010	**-0.025** -0.0010	**0.025L** **0.100T** 0.0010L 0.0040T	**+0.035** +0.0014	**0.000** 0.0000	**0.000T** **0.110T** 0.0000T 0.0044T	–	–	–	**+0.065** +0.0026	**+0.030** +0.0012	**0.030T** **0.140T** 0.0012T 0.0056T
+0.025 +0.0010	**-0.025** -0.0010	**0.028L** **0.128T** 0.0011L 0.0050L	**+0.040** +0.0016	**0.000** 0.0000	**0.000T** **0.140T** 0.0000T 0.0055T	–	–	–	**+0.074** +0.0029	**+0.0030** +0.0012	**0.034T** **0.174T** 0.0012T 0.0056T
+0.028 +0.0011	**-0.028** -0.0011	**0.028L** **0.128T** 0.0011L 0.0050T	**+0.040** +0.0016	**0.000** 0.0000	**0.000T** **0.140T** 0.0000T 0.0055T	–	–	–	**+0.074** +0.0029	**+0.034** +0.0013	**0.034T** **0.174T** 0.0013T 0.0068T
+0.028 +0.0011	**-0.028** -0.0011	**0.033L** **0.158T** 0.0013L 0.0062T	**+0.046** +0.0018	**0.000** 0.0000	**0.000T** **0.171T** 0.0000T 0.0067T	–	–	–	**+0.086** +0.0034	**+0.040** +0.0016	**0.040T** **0.211T** 0.0016T 0.0083T
+0.033 +0.0013	**-0.033** -0.0013	**0.033L** **0.158T** 0.0013L 0.0062T	**+0.046** +0.0018	**0.000** 0.0000	**0.000T** **0.171T** 0.0000T 0.0067T	–	–	–	**+0.086** +0.0034	**+0.040** +0.0016	**0.040T** **0.211T** 0.0016T 0.0083T

ENGINEERING

SHAFT AND HOUSING FITS

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

TABLE 10. RADIAL BALL, SPHERICAL ROLLER AND CYLINDRICAL ROLLER BEARING SHAFT TOLERANCES

Bearing Bore			m6			n6			p6			r6			r7		
Nominal (Max.)		Tolerance[1]	Shaft Diameter		Fit	Shaft Diameter		Fit	Shaft Diameter		Fit	Shaft Diameter		Fit	Shaft Diameter		Fit
Over	Incl.		Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.	
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
3.000 0.1181	**6.000** 0.2362	**-0.008** -0.0003	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6.000 0.2362	**10.000** 0.3937	**-0.008** -0.0003	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10.000 0.3937	**18.000** 0.7087	**-0.008** -0.0003	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
18.000 0.7087	**30.000** 1.1811	**-0.010** -0.0004	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
30.000 1.1811	**50.000** 1.9685	**-0.012** -0.0005	**+0.025** +0.0010	**+0.009** +0.0004	**0.009T** 0.037T 0.0004T 0.0145T	–	–	–	–	–	–	–	–	–	–	–	–
50.000 1.9685	**80.000** 3.1496	**-0.015** -0.0006	**+0.030** +0.0012	**+0.011** +0.0004	**0.011T** 0.045T 0.0004T 0.0018T	**+0.039** +0.0015	**+0.020** +0.0008	**0.020T** 0.054T 0.0008T 0.0021T	–	–	–	–	–	–	–	–	–
80.000 3.1496	**120.000** 4.7244	**-0.020** -0.0008	**+0.035** +0.0014	**+0.013** +0.0005	**0.013T** 0.055T 0.0005T 0.0022T	**+0.045** +0.0018	**+0.023** +0.0009	**0.023T** 0.065T 0.0009T 0.0026T	**+0.059** +0.0023	**+0.037** +0.0015	**0.037T** 0.079T 0.0015T 0.0031T	–	–	–	–	–	–
120.000 4.7244	**180.000** 7.0866	**-0.025** -0.0010	**+0.040** +0.0016	**+0.015** +0.0006	**0.015T** 0.065T 0.0006T 0.0026T	**+0.052** +0.0020	**+0.027** +0.0011	**0.027T** 0.077T 0.0011T 0.0030T	**+0.068** +0.0027	**+0.043** +0.0017	**0.043T** 0.093T 0.0017T 0.0037T	**+0.090** +0.0035	**+0.065** +0.0026	**0.065T** 0.115T 0.0026T 0.0045T	–	–	–
180.000 7.0866	**200.000** 7.8740	**-0.030** -0.0012	**+0.046** +0.0018	**+0.017** +0.0007	**0.017T** 0.076T 0.0007T 0.0030T	**+0.060** +0.0024	**+0.031** +0.0012	**0.031L** 0.090T 0.0012L 0.0036T	**+0.079** +0.0031	**+0.050** +0.0020	**0.050T** 0.109T 0.0020T 0.0043T	**+0.106** +0.0042	**+0.077** +0.0030	**0.077T** 0.136T 0.0030T 0.0054T	–	–	–
200.000 7.8740	**225.000** 8.8583	**-0.030** -0.0012	**+0.046** +0.0018	**+0.017** +0.0007	**0.017T** 0.076T 0.0007T 0.0030T	**+0.060** +0.0024	**+0.031** +0.0012	**0.031L** 0.090T 0.0012L 0.0036T	**+0.079** +0.0031	**+0.050** +0.0020	**0.050T** 0.109T 0.0020T 0.0043T	**+0.109** +0.0043	**+0.080** +0.0031	**0.080T** 0.139T 0.0031T 0.0055T	**+0.126** +0.0050	**+0.080** +0.0031	**0.080T** 0.156T 0.0031T 0.0062T
225.000 8.8583	**250.000** 9.8425	**-0.030** -0.0012	**+0.046** +0.0018	**+0.017** +0.0007	**0.017T** 0.076T 0.0007T 0.0030T	**+0.060** +0.0024	**+0.031** +0.0012	**0.031L** 0.090T 0.0012L 0.0036T	**+0.079** +0.0031	**+0.050** +0.0020	**0.050T** 0.109T 0.0020T 0.0043T	**+0.113** +0.0044	**+0.084** +0.0033	**0.084T** 0.143T 0.0033T 0.0056T	**+0.130** +0.0051	**+0.084** +0.0033	**0.084T** 0.160T 0.0033T 0.0063T
250.000 9.8425	**280.000** 11.0236	**-0.035** -0.0014	**+0.052** +0.0020	**+0.020** +0.0008	**0.020T** 0.087T 0.0008T 0.0034T	**+0.066** +0.0026	**+0.034** +0.0013	**0.034T** 0.101T 0.0013T 0.0040T	**+0.088** +0.0035	**+0.056** +0.0022	**0.056T** 0.123T 0.0022T 0.0049T	**+0.126** +0.0050	**+0.094** +0.0037	**0.094T** 0.161T 0.0037T 0.0064T	**+0.146** +0.0057	**+0.094** +0.0037	**0.094T** 0.181T 0.0037T 0.0071T
280.000 11.0236	**315.000** 12.4016	**-0.035** -0.0014	**+0.052** +0.0020	**+0.020** +0.0008	**0.020T** 0.087T 0.0008T 0.0034T	**+0.066** +0.0026	**+0.034** +0.0013	**0.034T** 0.101T 0.0013T 0.0040T	**+0.088** +0.0035	**+0.056** +0.0022	**0.056T** 0.123T 0.0022T 0.0049T	**+0.130** +0.0051	**+0.098** +0.0039	**0.098T** 0.165T 0.0039T 0.0065T	**+0.150** +0.0059	**+0.098** +0.0039	**0.098T** 0.185T 0.0039T 0.0073T

NOTE: Tolerance and shaft diameters are shown in the table as variances from nominal bearing bore.
[1]Tolerance range is from +0 to value listed.

Continued on next page.

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

Table 10 continued.

Bearing Bore			m6			n6			p6			r6			r7		
Nominal (Max.)		Tolerance[1]	Shaft Diameter		Fit	Shaft Diameter		Fit	Shaft Diameter		Fit	Shaft Diameter		Fit	Shaft Diameter		Fit
Over	Incl.		Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.	
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
315.000 12.4016	**355.000** 13.9764	**-0.040** -0.0016	**+0.057** +0.0022	**+0.021** +0.0008	**0.021T** **0.097T** 0.0008T 0.0038T	**+0.073** +0.0029	**+0.037** +0.0015	**0.037T** **0.113T** 0.0015T 0.0045T	**+0.098** +0.0039	**+0.062** +0.0024	**0.062T** **0.138T** 0.0024T 0.0055T	**+0.144** +0.0057	**+0.108** +0.0043	**0.108T** **0.184T** 0.0043T 0.0073T	**+0.165** +0.0065	**+0.108** +0.0043	**0.108T** **0.205T** 0.0043T 0.0081T
355.000 13.9764	**400.000** 15.7480	**-0.040** -0.0016	–	–	–	**+0.073** +0.0029	**+0.037** +0.0015	**0.037T** **0.113T** 0.0015T 0.0045T	**+0.098** +0.0039	**+0.062** +0.0024	**0.062T** **0.138T** 0.0024T 0.0055T	**+0.150** +0.0059	**+0.114** +0.0045	**0.114T** **0.190T** 0.0045T 0.0075T	**+0.171** +0.0067	**+0.114** +0.0045	**0.114T** **0.211T** 0.0045T 0.0083T
400.000 15.7480	**450.000** 17.7165	**-0.045** -0.0018	–	–	–	**+0.080** +0.0031	**+0.040** +0.0016	**0.040T** **0.125T** 0.0016T 0.0049T	**+0.108** +0.0043	**+0.068** +0.0027	**0.068T** **0.153T** 0.0027T 0.0061T	**+0.166** +0.0065	**+0.126** +0.0050	**0.126T** **0.211T** 0.0050T 0.0083T	**+0.189** +0.0074	**+0.126** +0.0050	**0.126T** **0.234T** 0.0050T 0.0092T
450.000 17.7165	**500.000** 19.6850	**-0.045** -0.0018	–	–	–	**+0.080** +0.0031	**+0.040** +0.0016	**0.040T** **0.125T** 0.0016T 0.0049T	**+0.108** +0.0043	**+0.068** +0.0027	**0.068T** **0.153T** 0.0027T 0.0061T	**+0.172** +0.0068	**+0.132** +0.0052	**0.132T** **0.217T** 0.0052T 0.0086T	**+0.195** +0.0077	**+0.132** +0.0052	**0.132T** **0.240T** 0.0052T 0.0095T
500.000 19.6850	**560.000** 22.0472	**-0.050** -0.0020	–	–	–	–	–	–	**+0.122** +0.0048	**+0.078** +0.0031	**0.078T** **0.172T** 0.0031T 0.0068T	**+0.194** +0.0076	**+0.150** +0.0059	**0.150T** **0.244T** 0.0059T 0.0096T	**+0.220** +0.0087	**+0.150** +0.0059	**0.150T** **0.270T** 0.0059T 0.0107T
560.000 22.0472	**630.000** 24.8032	**-0.050** -0.0020	–	–	–	–	–	–	**+0.122** +0.0048	**+0.078** +0.0031	**0.078T** **0.172T** 0.0031T 0.0068T	**+0.199** +0.0078	**+0.155** +0.0061	**0.155T** **0.249T** 0.0061T 0.0098T	**+0.225** +0.0089	**+0.155** +0.0061	**0.155T** **0.275T** 0.0061T 0.0109T
630.000 24.8032	**710.000** 27.9528	**-0.075** -0.0030	–	–	–	–	–	–	**+0.138** +0.0054	**+0.088** +0.0035	**0.088T** **0.213T** 0.0035T 0.0084T	**+0.225** +0.0089	**+0.175** +0.0069	**0.175T** **0.300T** 0.0069T 0.0119T	**+0.255** +0.0100	**+0.175** +0.0069	**0.175T** **0.330T** 0.0069T 0.0130T
710.000 27.9528	**800.000** 31.4961	**-0.075** -0.0030	–	–	–	–	–	–	**+0.138** +0.0054	**+0.088** +0.0035	**0.088T** **0.213T** 0.0035T 0.0084T	**+0.235** +0.0093	**+0.185** +0.0073	**0.185T** **0.310T** 0.0073T 0.0123T	**+0.265** +0.0104	**+0.185** +0.0073	**0.185T** **0.340T** 0.0073T 0.0134T
800.000 31.4961	**900.000** 35.4331	**-0.100** -0.0039	–	–	–	–	–	–	**+0.156** +0.0061	**+0.100** +0.0039	**0.100T** **0.256T** 0.0039T 0.0100T	**+0.266** +0.0105	**+0.210** +0.0083	**0.210T** **0.366T** 0.0083T 0.0144T	**+0.300** +0.0118	**+0.210** +0.0083	**0.210T** **0.400T** 0.0083T 0.0157T
900.000 35.4331	**1000.000** 39.3701	**-0.100** -0.0039	–	–	–	–	–	–	**+0.156** +0.0061	**+0.100** +0.0039	**0.100T** **0.256T** 0.0039T 0.0100T	**+0.276** +0.0109	**+0.220** +0.0087	**0.220T** **0.366T** 0.0087T 0.0148T	**+0.0310** +0.0122	**+0.220** +0.0087	**0.220T** **0.410T** 0.0087T 0.0161T
1000.000 39.3701	**1120.000** 44.0945	**-0.125** -0.0049	–	–	–	–	–	–	**+0.186** +0.0073	**+0.120** +0.0047	**0.120T** **0.311T** 0.0047T 0.0122T	**+0.316** +0.0124	**+0.250** +0.0098	**0.250T** **0.441T** 0.0098T 0.0173T	**+0.355** +0.0140	**+0.250** +0.0098	**0.250T** **0.480T** 0.0098T 0.0189T
1120.000 44.0945	**1250.000** 49.2126	**-0.125** -0.0049	–	–	–	–	–	–	**+0.186** +0.0073	**+0.120** +0.0047	**0.120T** **0.311T** 0.0047T 0.0122T	**+0.326** +0.0128	**+0.260** +0.0102	**0.260T** **0.451T** 0.0102T 0.0177T	**+0.365** +0.0144	**+0.260** +0.0102	**0.260T** **0.490T** 0.0102T 0.0193T

ENGINEERING

SHAFT AND HOUSING FITS

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

HOUSING TOLERANCES

TABLE 11. RADIAL BALL, SPHERICAL ROLLER AND CYLINDRICAL ROLLER BEARING HOUSING TOLERANCES

Bearing O.D.			F7			G7			H6			H7		
Nominal (Max.)		Tolerance[1]	Housing Bore		Fit	Housing Bore		Fit	Housing Bore		Fit	Housing Bore		Fit
Over	Incl.		Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.	
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
10.000 0.3937	**18.000** 0.7087	**-0.008** -0.0003	**+0.034** +0.0013	**+0.016** +0.0006	**0.016L** 0.042L 0.0006L 0.0016L	**+0.024** +0.0009	**+0.002** +0.0002	**0.006L** 0.032L 0.0002L 0.0012L	**+0.011** +0.0004	**0.000** 0.0000	**0.000L** 0.019L 0.0000L 0.0007L	**+0.018** +0.0007	**0.000** 0.0000	**0.000L** 0.026L 0.0000L 0.0010L
18.000 0.7087	**30.000** 1.1811	**-0.009** -0.0035	**+0.041** +0.0016	**+0.020** +0.0008	**0.020L** 0.050L 0.0008L 0.00195L	**+0.028** +0.0011	**+0.007** +0.0003	**0.007L** 0.037L 0.0003L 0.00145L	**+0.013** +0.0005	**0.000** 0.0000	**0.000L** 0.022L 0.0000L 0.00085L	**+0.021** +0.0008	**0.000** 0.0000	**0.000L** 0.030L 0.0000L 0.00125L
30.000 1.1811	**50.000** 1.9685	**-0.011** -0.00045	**+0.050** +0.0020	**+0.025** +0.0010	**0.025L** 0.061L 0.0010L 0.00245L	**+0.034** +0.0013	**+0.009** +0.0004	**0.009L** 0.045L 0.0004L 0.00175L	**+0.016** +0.0006	**0.000** 0.0000	**0.000L** 0.027L 0.0000L 0.00105L	**+0.025** +0.0010	**0.000** 0.0000	**0.000L** 0.036L 0.0000L 0.00145L
50.000 1.9685	**80.000** 3.1496	**-0.013** -0.0005	**+0.060** +0.0024	**+0.030** +0.0012	**0.030L** 0.073L 0.0012L 0.0029L	**+0.040** +0.0016	**+0.010** +0.0004	**0.010L** 0.053L 0.0004L 0.0021L	**+0.019** +0.0007	**0.000** 0.0000	**0.000L** 0.032L 0.0000L 0.0012L	**+0.030** +0.0012	**0.000** 0.0000	**0.000L** 0.059L 0.0000L 0.0017L
80.000 3.1496	**120.000** 4.7244	**-0.015** -0.0006	**+0.071** +0.0028	**+0.036** +0.0014	**0.036L** 0.086L 0.0014L 0.0034L	**+0.047** +0.0019	**+0.012** +0.0005	**0.012L** 0.062L 0.0005L 0.0025L	**+0.022** +0.0009	**0.000** 0.0000	**0.000L** 0.037L 0.0000L 0.0015L	**+0.035** +0.0014	**0.000** 0.0000	**0.000L** 0.050L 0.0000L 0.0020L
120.000 4.7244	**150.000** 5.9055	**-0.018** -0.0007	**+0.083** +0.0033	**+0.043** +0.0017	**0.043L** 0.101L 0.0017L 0.0040L	**+0.054** +0.0021	**+0.014** +0.0006	**0.014L** 0.072L 0.0006L 0.0028L	**+0.025** +0.0010	**0.000** 0.0000	**0.000L** 0.043L 0.0000L 0.0017L	**+0.040** +0.0016	**0.000** 0.0000	**0.000L** 0.058L 0.0000L 0.0023L
150.000 5.9055	**180.000** 7.0866	**-0.025** -0.0010	**+0.083** +0.0033	**+0.043** +0.0017	**0.043L** 0.108L 0.0017L 0.0043L	**+0.054** +0.0021	**+0.014** +0.0006	**0.014L** 0.079L 0.0006L 0.0031L	**+0.025** +0.0010	**0.000** 0.0000	**0.000L** 0.050L 0.0000L 0.0020L	**+0.040** +0.0016	**0.000** 0.0000	**0.000L** 0.065L 0.0000L 0.0026L
180.000 7.0866	**250.000** 9.8425	**-0.030** -0.0012	**+0.096** +0.0038	**+0.050** +0.0020	**0.050L** 0.126L 0.0020L 0.0050L	**+0.061** +0.0024	**+0.015** +0.0006	**0.015L** 0.091L 0.0006L 0.0036L	**+0.029** +0.0011	**0.000** 0.0000	**0.000L** 0.059L 0.0000L 0.0023L	**+0.046** +0.0018	**0.000** 0.0000	**0.000L** 0.076L 0.0000L 0.0030L
250.000 9.8425	**315.000** 12.4016	**-0.035** -0.0014	**+0.108** +0.0043	**+0.056** +0.0022	**0.056L** 0.143L 0.0022L 0.0057L	**+0.069** +0.0027	**+0.017** +0.0007	**0.017L** 0.104L 0.0007L 0.0041L	**+0.032** +0.0013	**0.000** 0.0000	**0.000L** 0.067L 0.0000L 0.0027L	**+0.052** +0.0020	**0.000** 0.0000	**0.000L** 0.087L 0.0000L 0.0034L
315.000 12.4016	**400.000** 15.7480	**-0.040** -0.0016	**+0.119** +0.0047	**+0.062** +0.0024	**0.063L** 0.159L 0.0024L 0.0063L	**+0.075** +0.0030	**+0.018** +0.0007	**0.018L** 0.115L 0.0007L 0.0046L	**+0.089** +0.0014	**0.000** 0.0000	**0.000L** 0.129L 0.0000L 0.0030L	**+0.057** +0.0022	**0.000** 0.0000	**0.000L** 0.097L 0.0000L 0.0038L
400.000 15.7480	**500.000** 19.6850	**-0.045** -0.0018	**+0.131** +0.0052	**+0.068** +0.0027	**0.068L** 0.176L 0.0027L 0.0070L	**+0.083** +0.0033	**+0.020** +0.0008	**0.020L** 0.128L 0.0008L 0.0051L	**+0.097** +0.0016	**0.000** 0.0000	**0.000L** 0.142L 0.0000L 0.0034L	**+0.063** +0.0025	**0.000** 0.0000	**0.000L** 0.108L 0.0000L 0.0043L
500.000 19.6850	**630.000** 24.8032	**-0.050** -0.0020	**+0.146** +0.0057	**+0.076** +0.0030	**0.076L** 0.196L 0.0030L 0.0077L	**+0.092** +0.0036	**+0.022** +0.0009	**0.022L** 0.142L 0.0009L 0.0056L	**+0.110** +0.0017	**0.000** 0.0000	**0.000L** 0.160L 0.0000L 0.0037L	**+0.070** +0.0028	**0.000** 0.0000	**0.000L** 0.120L 0.0000L 0.0048L

NOTE: Tolerance and shaft diameters are shown in the table as variances from nominal bearing O.D.
[1]Tolerance range is from +0 to value listed.

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

H8			J6			J7			K6			K7		
Housing Bore		Fit	Housing Bore		Fit	Housing Bore		Fit	Housing Bore		Fit	Housing Bore		Fit
Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.	
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
+0.027 +0.0011	**0.000** 0.0000	**0.000L** **0.035L** 0.0000L 0.0014L	**+0.006** +0.0002	**-0.005** -0.0002	**0.005T** **0.014L** 0.0002T 0.0005L	**+0.10** +0.004	**-0.008** -0.0003	**0.008T** **0.018L** 0.0003T 0.0007L	**+0.002** +0.0001	**-0.009** -0.0004	**0.009T** **0.010L** 0.0004T 0.0004L	**+0.006** +0.0002	**-0.012** -0.0005	**0.012T** **0.014L** 0.0005T 0.0005L
+0.033 +0.0013	**0.000** 0.0000	**0.000L** **0.030L** 0.0000L 0.00165L	**+0.008** +0.0003	**-0.005** -0.0002	**0.005T** **0.017L** 0.0002T 0.00065L	**+0.012** +0.0005	**-0.009** -0.0004	**0.009T** **0.021L** 0.0004T 0.00085L	**+0.002** +0.0001	**-0.011** -0.0004	**0.011T** **0.011L** 0.0004T 0.00045L	**+0.006** +0.0002	**-0.015** -0.0006	**0.015T** **0.015L** 0.0006T 0.00055L
+0.039 +0.0015	**0.000** 0.0000	**0.000L** **0.050L** 0.0000L 0.00195L	**+0.010** +0.0002	**-0.006** -0.0002	**0.006T** **0.021L** 0.0002T 0.00085L	**+0.014** +0.0006	**-0.011** -0.0004	**0.011T** **0.025L** 0.0004T 0.00105L	**+0.003** +0.0001	**-0.014** -0.0005	**0.013T** **0.014L** 0.0005T 0.00055L	**+0.007** +0.0003	**-0.018** -0.0007	**0.018T** **0.018L** 0.0007T 0.00065L
+0.046 +0.0018	**0.000** 0.0000	**0.000L** **0.059L** 0.0000L 0.0023L	**+0.013** +0.0005	**-0.006** -0.0002	**0.006T** **0.026L** 0.0002T 0.0010L	**+0.018** +0.0007	**-0.012** -0.0005	**0.012T** **0.031L** 0.0005T 0.0012L	**+0.004** +0.0002	**-0.015** -0.0006	**0.015T** **0.017L** 0.0006T 0.0007L	**+0.009** +0.0004	**-0.021** -0.0008	**0.021T** **0.022L** 0.0008T 0.0009L
+0.054 **+0.054** +0.0021	**0.000** **0.000** 0.0000	**0.000L** **0.069L** 0.0000L 0.0027L	**+0.016** +0.0006	**-0.006** -0.0002	**0.006T** **0.031L** 0.0002T 0.0012L	**+0.022** +0.0009	**-0.013** -0.0005	**0.013T** **0.037L** 0.0005T 0.0015L	**+0.004** +0.0002	**-0.018** -0.0007	**0.018T** **0.019L** 0.0007T 0.0008L	**+0.010** +0.0004	**-0.025** -0.0010	**0.025T** **0.025L** 0.0010T 0.0010L
+0.063 +0.0025	**0.000** 0.0000	**0.000L** **0.081L** 0.0000L 0.0032L	**+0.018** +0.0007	**-0.007** -0.0003	**0.007T** **0.036L** 0.0003T 0.0014L	**+0.026** +0.0010	**-0.014** -0.0006	**0.014T** **0.044L** 0.0006T 0.0017L	**+0.004** +0.0002	**-0.021** -0.0008	**0.021T** **0.022L** 0.0008T 0.0009L	**+0.012** +0.0005	**-0.028** -0.0011	**0.028T** **0.030L** 0.0011T 0.0012L
+0.063 +0.0025	**0.000** 0.0000	**0.000L** **0.088L** 0.0000L 0.0035L	**+0.018** +0.0007	**-0.007** -0.0003	**0.007T** **0.043L** 0.0003T 0.0017L	**+0.026** +0.0010	**-0.014** -0.0006	**0.014T** **0.051L** 0.0006T 0.0020L	**+0.004** +0.0002	**-0.021** -0.0008	**0.021T** **0.029L** 0.008T 0.0012L	**+0.012** +0.0005	**-0.033** -0.028	**0.028T** **0.037L** 0.0011T 0.0015L
+0.072 +0.0028	**0.000** 0.0000	**0.000L** **0.102L** 0.0000L 0.0040L	**+0.022** +0.0007	**-0.007** -0.0003	**0.007T** **0.052L** 0.0003T 0.0021L	**+0.030** +0.0012	**-0.016** -0.0006	**0.016T** **0.060L** 0.0006T 0.0024L	**+0.005** +0.0002	**-0.024** -0.0009	**0.024T** **0.035L** 0.0009T 0.0014L	**+0.013** +0.0005	**-0.0011** -0.0013	**0.033T** **0.043L** 0.0013T 0.0017L
+0.081 +0.0032	**0.000** 0.0000	**0.000L** **0.116L** 0.0000L 0.0046L	**+0.025** +0.0010	**-0.007** -0.0003	**0.007T** **0.060L** 0.0003T 0.0024L	**+0.036** +0.0014	**-0.016** -0.0006	**0.016T** **0.071L** 0.0006T 0.0028L	**+0.005** +0.0002	**-0.027** -0.0011	**0.027T** **0.040L** 0.0011T 0.0016L	**+0.016** +0.0006	**-0.036** -0.0014	**0.036T** **0.051L** 0.0014T 0.0020L
+0.036 +0.035	**0.000** 0.0000	**0.000L** **0.076L** 0.0000L 0.0051L	**+0.029** +0.0011	**-0.007** -0.0003	**0.007T** **0.069L** 0.0003T 0.0027L	**+0.039** +0.0015	**-0.018** -0.0007	**0.018T** **0.079L** 0.0007T 0.0031L	**+0.007** +0.0003	**-0.029** -0.0011	**0.029T** **0.047L** 0.0011T 0.0019L	**+0.017** +0.0007	**-0.040** -0.0016	**0.040T** **0.057L** 0.0016T 0.0023L
+0.040 +0.0038	**0.000** 0.0000	**0.000L** **0.085** 0.0000L 0.0056L	**+0.033** +0.0013	**-0.007** -0.0003	**0.007T** **0.078L** 0.0003T 0.0031L	**+0.043** +0.0017	**-0.020** -0.0008	**0.020T** **0.088L** 0.0008T 0.0035L	**+0.008** +0.0003	**-0.032** -0.0013	**0.032T** **0.053L** 0.0013T 0.0021L	**+0.018** +0.0007	**-0.045** -0.0018	**0.045T** **0.063L** 0.0018T 0.0025L
+0.044 +0.0043	**0.000** 0.0000	**0.000L** **0.094L** 0.0000L 0.0063L	**+0.037** +0.0015	**-0.007** -0.0003	**0.022T** **0.098L** 0.0003T 0.0035L	**+0.048** +0.0019	**-0.022** -0.0009	**0.022T** **0.098L** 0.0009T 0.0039L	**0.000** 0.0000	**-0.044** -0.0017	**0.044T** **0.050L** 0.0017T 0.0020L	**0.000** 0.0000	**-0.070** -0.0028	**0.070T** **0.050L** 0.0028T 0.0020L

Continued on next page.

ENGINEERING

SHAFT AND HOUSING FITS

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

Table 11 continued.

Bearing O.D.			F7			G7			H6			H7		
Nominal (Max.)		Tolerance[1]	Housing Bore		Fit	Housing Bore		Fit	Housing Bore		Fit	Housing Bore		Fit
Over	Incl.		Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.	
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
630.000 24.8032	**800.000** 31.4961	**-0.075** -0.0030	**+0.160** +0.0063	**+0.080** +0.0031	**0.080L** **0.235L** 0.0031L 0.0093L	**+0.104** +0.0041	**+0.024** +0.0009	**0.024L** **0.179L** 0.0009L 0.0071L	**+0.125** +0.0020	**0.000** 0.0000	**0.000L** **0.200L** 0.0000L 0.0030L	**+0.080** +0.0031	**0.000** 0.0000	**0.000L** **0.155L** 0.0000L 0.0061L
800.000 31.4961	**1000.000** 39.3701	**-0.100** -0.0039	**+0.179** +0.0063	**+0.086** +0.0034	**0.086L** **0.276L** 0.0034L 0.0108L	**+0.116** +0.0046	**+0.026** +0.0010	**0.026L** **0.216L** 0.0010L 0.0085L	**+0.140** +0.0022	**0.000** 0.0000	**0.000L** **0.240L** 0.0000L 0.0061L	**+0.090** +0.0035	**0.000** 0.0000	**0.000L** **0.190L** 0.0000L 0.0074L
1000.000 39.3701	**1250.000** 49.2126	**-0.125** -0.0049	**+0.203** +0.0080	**+0.098** +0.0039	**0.098L** **0.328L** 0.0039L 0.0129L	**+0.133** +0.0052	**+0.028** +0.0011	**0.028L** **0.258L** 0.0011L 0.0101L	**+0.165** +0.0026	**0.000** 0.0000	**0.000L** **0.290L** 0.0000L 0.0075L	**+0.105** +0.0041	**0.000** 0.0000	**0.000L** **0.230L** 0.0000L 0.0090L
1250.000 49.2126	**1600.000** 62.9921	**-0.160** -0.0063	**+0.155** +0.0093	**+0.030** +0.0043	**0.110L** **0.395L** 0.0043L 0.0156L	**+0.155** +0.0061	**+0.030** +0.0012	**0.030L** **0.315L** 0.0012L 0.0124L	**+0.195** +0.0031	**0.000** 0.0000	**0.000L** **0.355L** 0.0000L 0.0094L	**+0.125** +0.0049	**0.000** 0.0000	**0.000L** **0.355L** 0.0000L 0.0112L
1600.000 62.9921	**2000.000** 78.7402	**-0.200** -0.0079	**+0.270** +0.0106	**+0.120** +0.0047	**0.120L** **0.470L** 0.0047L 0.0185L	**+0.182** +0.0072	**+0.032** +0.0013	**0.032L** **0.382L** 0.0013L 0.0151L	**+0.230** +0.0036	**0.000** 0.0000	**0.000L** **0.430L** 0.0000L 0.0115L	**+0.150** +0.0059	**0.000** 0.0000	**0.000L** **0.350L** 0.0000L 0.0138L
2000.000 78.7402	**2500.000** 98.4252	**-0.250** -0.0098	**+0.305** 0.0120	**+0.0130** +0.0051	**0.130L** **0.555L** 0.0051L 0.0218L	**+0.209** +0.0082	**+0.034** +0.0013	**0.034L** **0.459L** 0.0013L 0.0180L	**+0.280** +0.043	**0.000** 0.0000	**0.000L** **0.530L** 0.0000L 0.0141L	**+0.175** +0.0069	**0.000** 0.0000	**0.000L** **0.425L** 0.0000L 0.0167L

NOTE: Tolerance and shaft diameters are shown in the table as variances from nominal bearing O.D.
[1]Tolerance range is from +0 to value listed.

ENGINEERING

SHAFT AND HOUSING FITS

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

H8			J6			J7			K6			K7		
Housing Bore		Fit	Housing Bore		Fit	Housing Bore		Fit	Housing Bore		Fit	Housing Bore		Fit
Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.	
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
+0.050 +0.0049	**0.000** 0.0000	**0.000L** **0.125L** 0.0000L 0.0079L	**+0.040** +0.0016	**-0.010** -0.0004	**0.010T** **0.115L** 0.0004T 0.0046L	**+0.056** +0.0022	**-0.024** -0.0009	**0.024T** **0.131L** 0.0009T 0.0052L	**0.000** 0.0000	**-0.050** -0.0020	**0.050T** **0.075L** 0.0020T 0.0030L	**0.000** 0.0000	**-0.080** -0.0031	**0.080T** **0.075L** 0.0031T 0.0030L
+0.056 +0.0055	**0.000** 0.0000	**0.000L** **0.156L** 0.0000L 0.0094L	**+0.046** +0.0018	**-0.010** -0.0004	**0.010T** **0.146L** 0.0004T 0.0057L	**+0.064** +0.0025	**-0.026** -0.0010	**0.026T** **0.164L** 0.0010T 0.0064L	**0.000** 0.0000	**-0.056** -0.0022	**0.056T** **0.100L** 0.0022T 0.0039L	**0.000** 0.0000	**-0.090** -0.0035	**0.090T** **0.100L** 0.0035T 0.0039L
+0.066 +0.0065	**0.000** 0.0000	**0.000L** **0.191L** 0.0000L 0.0114L	**+0.056** +0.0022	**-0.010** -0.0004	**0.010T** **0.181L** 0.0004T 0.0071L	**+0.077** +0.0030	**-0.028** -0.0011	**0.028T** **0.202L** 0.0011T 0.0079L	**0.000** 0.0000	**-0.066** -0.0026	**0.066T** **0.125L** 0.0026T 0.0049L	**0.000** 0.0000	**-0.105** -0.0041	**0.105T** **0.125L** 0.0041T 0.0049L
+0.078 +0.0077	**0.000** 0.0000	**0.000L** **0.238L** 0.0000L 0.0104L	**+0.068** +0.0027	**-0.010** -0.0004	**0.010T** **0.228L** 0.0004T 0.0090L	**+0.095** +0.0037	**-0.030** -0.0012	**0.030T** **0.255L** 0.0012T 0.0100L	**0.000** 0.0000	**-0.078** -0.0031	**0.078T** **0.160L** 0.0031T 0.0063L	**0.000** 0.0000	**-0.125** -0.0049	**0.125T** **0.160L** 0.0049T 0.0063L
+0.092 +0.0091	**0.000** 0.0000	**0.000L** **0.292L** 0.0000L 0.0170L	**+0.082** +0.0032	**-0.010** -0.0004	**0.110T** **0.282L** 0.0004T 0.0111L	**+0.118** +0.0046	**-0.032** -0.0013	**0.032T** **0.318L** 0.0013T 0.0125L	**0.000** 0.0000	**-0.092** -0.0036	**0.092T** **0.200L** 0.0036T 0.0079L	**0.000** 0.0000	**-0.150** -0.0059	**0.150T** **0.200L** 0.0059T 0.0079L
+0.110 +0.0110	**0.000** 0.0000	**0.000L** **0.360L** 0.0000L 0.0208L	**+0.100** +0.0039	**-0.010** -0.0004	**0.010T** **0.350L** 0.0004T 0.0137L	**+0.141** +0.0056	**-0.034** -0.0013	**0.034T** **0.391L** 0.0013T 0.0154L	**0.000** 0.0000	**-0.110** -0.0043	**0.110T** **0.250L** 0.0043T 0.0098L	**0.000** 0.0000	**-0.175** -0.0069	**0.175T** **0.250L** 0.0069T 0.0098L

ENGINEERING

SHAFT AND HOUSING FITS

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

TABLE 12. RADIAL BALL, SPHERICAL ROLLER AND CYLINDRICAL ROLLER BEARING HOUSING TOLERANCES

Bearing O.D.			M6			M7			N6			N7		
Nominal (Max.)		Tolerance[1]	Housing Bore		Fit	Housing Bore		Fit	Housing Bore		Fit	Housing Bore		Fit
Over	Incl.		Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.	
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
10.000 0.3937	**18.000** 0.7087	**-0.008** -0.0003	**-0.004** -0.0002	**-0.015** -0.0006	**0.015T 0.004L** 0.0006T 0.0001L	**0.000** 0.0000	**-0.018** -0.0007	**0.018T 0.008L** 0.0007T 0.0003L	**-0.009** -0.0004	**-0.020** -0.0008	**0.020T 0.001T** 0.0008T 0.0001T	**-0.005** -0.0002	**-0.023** -0.0009	**0.023T 0.003L** 0.0009T 0.0001L
18.000 0.7087	**30.000** 1.1811	**-0.009** -0.0035	**-0.004** -0.0002	**-0.017** -0.0007	**0.017T 0.005L** 0.0007T 0.00015L	**0.000** 0.0000	**-0.021** -0.0008	**0.021T 0.009L** 0.0008T 0.0035L	**-0.007** -0.0004	**-0.028** -0.0009	**0.024T 0.002T** 0.0009T 0.00005T	**-0.007** -0.0003	**-0.028** -0.0011	**0.028T 0.002L** 0.0011T 0.00005L
30.000 1.1811	**50.000** 1.9685	**-0.011** -0.0045	**-0.004** -0.0002	**-0.020** -0.0008	**0.020T 0.007L** 0.0008T 0.00025L	**0.000** 0.0000	**-0.025** -0.0010	**0.025T 0.011L** 0.0010T 0.00045L	**-0.012** -0.0005	**-0.028** -0.0011	**0.028T 0.001T** 0.0011T 0.00005T	**-0.008** -0.0003	**-0.033** -0.0013	**0.033T 0.003L** 0.0013T 0.00015L
50.000 1.9685	**80.000** 3.1496	**-0.013** -0.0005	**-0.005** -0.0002	**-0.024** -0.0009	**0.024T 0.008L** 0.0009T 0.0003L	**0.000** 0.0000	**-0.030** -0.0012	**0.030T 0.013L** 0.0012T 0.0005L	**-0.014** -0.0006	**-0.033** -0.0013	**0.033T 0.001T** 0.0013T 0.0001T	**-0.009** -0.0004	**-0.039** -0.0015	**0.039T 0.004L** 0.0015T 0.0001L
80.000 3.1496	**120.000** 4.7244	**-0.015** -0.0006	**-0.006** -0.0002	**-0.028** -0.0011	**0.028T 0.009L** 0.0011T 0.0004L	**0.000** 0.0000	**-0.035** -0.0014	**0.035T 0.015L** 0.0014T 0.0006L	**-0.016** -0.0006	**-0.038** -0.0015	**0.038T 0.001T** 0.0015T 0.0000T	**-0.010** -0.0004	**-0.045** -0.0018	**0.045T 0.005L** 0.0018T 0.0002L
120.000 4.7244	**150.000** 5.9055	**-0.018** -0.0007	**-0.008** -0.0003	**-0.033** -0.0013	**0.033T 0.010L** 0.0013T 0.0004L	**0.000** 0.0000	**-0.040** -0.0016	**0.040T 0.018L** 0.0016T 0.0007L	**-0.020** -0.0008	**-0.045** -0.0018	**0.045T 0.002T** 0.0018T 0.0001T	**-0.012** -0.0005	**-0.052** -0.0020	**0.061T 0.018L** 0.0020T 0.0002L
150.000 5.9055	**180.000** 7.0866	**-0.025** -0.0010	**-0.008** -0.0003	**-0.033** -0.0013	**0.033T 0.017L** 0.0013T 0.0007L	**0.000** 0.0000	**-0.040** -0.0016	**0.040T 0.025L** 0.0016T 0.0010L	**-0.020** -0.0008	**-0.045** -0.0018	**0.045T 0.005T** 0.0018T 0.0002T	**-0.012** -0.0005	**-0.052** -0.0020	**0.052T 0.013L** 0.0020T 0.0005L
180.000 7.0866	**250.000** 9.8425	**-0.030** -0.0012	**-0.008** -0.0003	**-0.037** -0.0015	**0.037T 0.022L** 0.0015T 0.0009L	**0.000** 0.0000	**-0.046** -0.0018	**0.046T 0.030L** 0.0018T 0.0012L	**-0.022** -0.0009	**-0.051** -0.0020	**0.051T 0.008T** 0.0020T 0.0003T	**-0.014** -0.0006	**-0.060** -0.0024	**0.060T 0.016L** 0.0024T 0.0006L
250.000 9.8425	**315.000** 12.4016	**-0.035** -0.0014	**-0.009** -0.0004	**-0.041** -0.0016	**0.041T 0.026L** 0.0016T 0.0010L	**0.000** 0.0000	**-0.052** -0.0020	**0.052T 0.035L** 0.0020T 030014L	**-0.025** -0.0010	**-0.057** -0.0022	**0.057T 0.010T** 0.0022T 0.0004T	**-0.014** -0.0006	**-0.066** -0.0026	**0.066T 0.021L** 0.0025T 0.0008L
315.000 12.4016	**400.000** 15.7480	**-0.040** -0.0016	**-0.010** -0.0004	**-0.046** -0.0018	**0.046T 0.030L** 0.0018T 0.0012L	**0.000** 0.0000	**-0.057** -0.0022	**0.057T 0.040L** 0.0022T 0.0016L	**-0.026** -0.0006	**-0.062** -0.0029	**0.062T 0.014T** 0.0024T 0.0006T	**-0.016** -0.0006	**-0.073** -0.0029	**0.073T 0.024L** 0.0029T 0.0010L
400.000 15.7480	**500.000** 19.6850	**-0.045** -0.0018	**-0.010** -0.0004	**-0.050** -0.0020	**0.050T 0.035L** 0.0020T 0.0014L	**0.000** 0.0000	**-0.063** -0.0025	**0.063T 0.045L** 0.0025T 0.0018L	**-0.027** -0.0011	**-0.067** -0.0026	**0.067T 0.018T** 0.0026T 0.0007T	**-0.017** -0.0007	**-0.080** -0.0031	**0.080T 0.028L** 0.0031T 0.0011L
500.000 19.6850	**630.000** 24.8032	**-0.050** -0.0020	**-0.026** -0.0010	**-0.070** -0.0028	**0.070T 0.024L** 0.0028T 0.0010L	**-0.026** -0.0010	**-0.096** -0.0038	**0.096T 0.024L** 0.0038T 0.0010L	**-0.044** -0.0017	**-0.088** -0.0035	**0.088T 0.006T** 0.0035T 0.0003T	**-0.044** -0.0017	**-0.114** -0.0045	**0.114T 0.006L** 0.0045T 0.0003L

NOTE: Tolerance and shaft diameters are shown in the table as variances from nominal bearing O.D.
[1]Tolerance range is from +0 to value listed.

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

P6			P7		
Housing Bore		Fit	Housing Bore		Fit
Max.	Min.		Max.	Min.	
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
-0.015 -0.0006	**-0.026** -0.0010	**0.026T** **0.007T** 0.0010T 0.0003T	**-0.011** -0.0004	**-0.029** -0.0011	**0.029T** **0.003T** 0.0011T 0.0001T
-0.018 -0.0007	**-0.031** -0.0012	**0.031T** **0.009T** 0.0012T 0.00035T	**-0.014** -0.0006	**-0.035** -0.0014	**0.035T** **0.005T** 0.0014T 0.0025T
-0.021 -0.0008	**-0.037** -0.0015	**0.037T** **0.010T** 0.0015T 0.00035T	**-0.017** -0.0007	**-0.042** -0.0017	**0.042T** **0.006T** 0.0017T 0.0025T
-0.026 -0.0010	**-0.045** -0.0018	**0.045T** **0.013T** 0.0018T 0.0005T	**-0.021** -0.0008	**-0.051** -0.0020	**0.051T** **0.008T** 0.0020T 0.0003T
-0.030 -0.0012	**-0.052** -0.0020	**0.052T** **0.015T** 0.0020T 0.0006T	**-0.024** -0.0009	**-0.059** -0.0023	**0.059T** **0.009T** 0.0023T 0.0003T
-0.036 -0.0014	**-0.061** -0.0024	**0.061T** **0.018T** 0.0024T 0.0007T	**-0.028** -0.0011	**-0.068** -0.0027	**0.068T** **0.010T** 0.0027T 0.0004T
-0.036 -0.0014	**-0.061** -0.0024	**0.061T** **0.011T** 0.0024T 0.0004T	**-0.028** -0.0011	**-0.068** -0.0027	**0.068T** **0.003T** 0.0027T 0.0001T
-0.041 -0.0016	**-0.070** -0.0028	**0.070T** **0.011T** 0.0028T 0.0004T	**-0.033** -0.0013	**-0.079** -0.0031	**0.079T** **0.003T** 0.0031T 0.0001T
-0.047 -0.0019	**-0.079** -0.0031	**0.079T** **0.012T** 0.0031T 0.0005T	**-0.036** -0.0014	**-0.088** -0.0035	**0.088T** **0.001T** 0.0035T 0.0000T
-0.051 -0.0020	**-0.087** -0.0034	**0.087T** **0.011T** 0.0034T 0.0004T	**-0.041** -0.0016	**-0.098** -0.0039	**0.098T** **0.001T** 0.0039T 0.0000T
-0.055 -0.0022	**-0.095** -0.0037	**0.095T** **0.010T** 0.0037T 0.0004T	**-0.045** -0.0018	**-0.108** -0.0043	**0.108T** **0.000T** 0.0043T 0.0000T
-0.078 -0.0031	**-0.122** -0.0048	**0.122T** **0.028T** 0.0048T 0.0011T	**-0.078** -0.0031	**-0.148** -0.0058	**0.148T** **0.028T** 0.0058T 0.0011T

Continued on next page.

ENGINEERING

SHAFT AND HOUSING FITS

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

Table 12 continued.

Bearing O.D.			M6			M7			N6			N7		
Nominal (Max.)		Tolerance[1]	Housing Bore		Fit	Housing Bore		Fit	Housing Bore		Fit	Housing Bore		Fit
Over	Incl.		Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.	
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
630.000 24.8032	**800.000** 31.4961	**-0.075** -0.0030	**-0.030** -0.0012	**-0.080** -0.0031	**0.080T 0.045L** 0.0031T 0.0018L	**-0.030** -0.0012	**-0.110** -0.0043	**0.110T 0.045L** 0.0043T 0.0018L	**-0.050** -0.0020	**-0.100** -0.0039	**0.100T 0.025T** 0.0039T 0.0010T	**-0.050** -0.0020	**-0.130** -0.0051	**0.130T 0.025L** 00051T 0.0010L
800.000 31.4961	**1000.000** 39.3701	**-0.100** -0.0039	**-0.034** -0.0013	**-0.090** -0.0035	**0.090T 0.066L** 0.0035T 0.0026L	**-0.034** -0.0013	**-0.124** -0.0049	**0.124T 0.066L** 0.0049T 0.0026L	**-0.056** -0.0022	**-0.112** -0.0044	**0.112T 0.044T** 0.0044T 0.0017T	**-0.056** -0.0022	**-0.146** -0.0057	**0.146T 0.044L** 0.0057T 0.0017L
1000.000 39.3701	**1250.000** 49.2126	**-0.125** -0.0049	**-0.040** -0.0016	**-0.106** -0.0042	**0.106T 0.085L** 0.0042T 0.0033L	**-0.040** -0.0016	**-0.145** -0.0057	**0.145T 0.085L** 0.0057T 0.0033L	**-0.066** -0.0026	**-0.132** -0.0052	**0.132T 0.059T** 0.0052T 0.0023T	**-0.066** -0.0026	**-0.171** -0.0067	**0.171T 0.059L** 0.0067T 0.0023L
1250.000 49.2126	**1600.000** 62.9921	**-0.160** -0.0063	**-0.048** -0.0019	**-0.126** -0.0050	**0.126T 0.112L** 0.0050T 0.0044L	**-0.048** -0.0019	**-0.173** -0.0068	**0.173T 0.112L** 0.0068T 0.0044L	**-0.078** -0.0031	**-0.156** -0.0061	**0.156T 0.082T** 0.0061T 0.0032T	**-0.078** -0.0031	**-0.203** -0.0080	**0.203T 0.082L** 0.0080T 0.0023L
1600.000 62.9921	**2000.000** 78.7402	**-0.200** -0.0079	**-0.058** -0.0023	**-0.150** -0.0059	**0.150T 0.142L** 0.0059T 0.0056L	**-0.058** -0.0023	**-0.208** -0.0082	**0.208T 0.142L** 0.0082T 0.0056L	**-0.092** -0.0036	**-0.184** -0.0072	**0.184T 0.108T** 0.0072T 0.0043T	**-0.092** -0.0036	**-0.242** -0.0095	**0.242T 0.108L** 0.0095T 0.0043L
2000.000 78.7402	**2500.000** 98.4252	**-0.250** -0.0098	**-0.068** -0.0027	**-0.178** -0.0070	**0.178T 0.182L** 0.0070T 0.0071L	**-0.068** -0.0027	**-0.243** -0.0096	**0.243 0.182L** 0.0096T 0.0071L	**-0.110** -0.0043	**-0.220** -0.0087	**0.285T 0.140T** 0.112T 0.055T	**-0.110** -0.0043	**-0.285** -0.0112	**0.285T 0.140L** 0.0112T 0.0055L

NOTE: Tolerance and shaft diameters are shown in the table as variances from nominal bearing O.D.
[1]Tolerance range is from +0 to value listed.

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

P6			P7		
Housing Bore		Fit	Housing Bore		Fit
Max.	Min.		Max.	Min.	
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
-0.088 -0.0035	**-0.138** -0.0054	**0.138T** **0.013T** 0.0054T 0.0005T	**-0.088** -0.0035	**-0.168** -0.0066	**0.168T** **0.013T** 0.0066T 0.0005T
-0.100 -0.0039	**-0.156** -0.0061	**0.156T** **0.000T** 0.0061T 0.0000T	**-0.100** -0.0039	**-0.190** -0.0075	**0.190T** **0.000T** 0.0075T 0.0000T
-0.120 -0.0047	**-0.186** -0.0073	**0.186T** **0.005L** 0.0073T 0.0002L	**-0.120** -0.0047	**-0.225** -0.0089	**0.225T** **0.005T** 0.0089T 0.0002T
-0.140 -0.0055	**-0.218** -0.0086	**0.218T** **0.020L** 0.0086T 0.0008L	**-0.140** -0.0055	**-0.265** -0.0104	**0.265T** **0.020L** 0.0104T 0.0008L
-0.170 -0.0067	**-0.262** -0.0103	**0.262T** **0.030L** 0.0103T 0.0012L	**-0.170** -0.0067	**-0.320** -0.0126	**0.320T** **0.030L** 0.0126T 0.0012L
-0.195 -0.0077	**-0.305** -0.0120	**0.305T** **0.055L** 0.0120T 0.0021L	**-0.195** -0.0077	**-0.370** -0.0146	**0.370T** **0.055L** 0.0146T 0.0021L

5200, A5200 METRIC SERIES SHAFT AND HOUSING FITS AND TOLERANCES

TABLE 13. SHAFT FITS[1]

Bearing Bore		Bore Tolerance[2]	Press Fit Rotating Inner Ring				Slip Fit Stationary Inner Ring			
			Shaft Diameter		Fit		Shaft Diameter		Fit	
Over	Incl.		Max.	Min.			Max.	Min.		
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
80 3.1496	**120** 4.7236	**-0.020** -0.0008	**+0.048** +0.0019	**+0.025** +0.0010	**0.025T** 0.0010T	**0.069T** 0.0027T	**0.000** 0.0000	**-0.023** -0.0009	**0.023L** 0.0009L	**0.020T** 0.0008T
120 4.7236	**140** 5.5108	**-0.025** -0.0010	**+0.056** +0.0022	**+0.030** +0.0012	**0.030T** 0.0012T	**0.081T** 0.0032T	**0.000** 0.0000	**-0.025** -0.0010	**0.025L** 0.0010L	**0.025T** 0.0010T
140 5.5108	**180** 7.0856	**-0.025** -0.0010	**+0.071** +0.0028	**+0.046** +0.0018	**0.046T** 0.0018T	**0.097T** 0.0038T	**0.000** 0.0000	**-0.025** -0.0010	**0.025L** 0.0010L	**0.025T** 0.0010T
180 7.0856	**240** 9.4476	**-0.030** -0.0012	**+0.081** +0.0032	**+0.051** +0.0020	**0.051T** 0.0020T	**0.112T** 0.0044T	**0.000** 0.0000	**-0.030** -0.0012	**0.030L** 0.0012L	**0.030T** 0.0012T

[1] When shaft is used as ring surface, hardness to be Rc58 minimum and surface finish to be 15 RMS.
[2] Tolerance range is from +0 to value listed.

TABLE 14. HOUSING FITS

Bearing O.D.		O.D. Tolerance[1]	Slip Fit Stationary Outer Ring				Press Fit Rotating Outer Ring			
			Housing Diameter		Fit		Housing Diameter		Fit	
Over	Incl.		Max.	Min.			Max.	Min.		
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
– –	**180** 7.0866	**-0.025** -0.0010	**+0.022** +0.0008	**-0.015** -0.0006	**0.015T** 0.0006T	**0.046L** 0.0018L	**-0.025** -0.0010	**-0.056** -0.0022	**0.056T** 0.0022T	**0.000L** 0.0000L
180 7.0866	**200** 7.8740	**-0.030** -0.0012	**+0.018** +0.0007	**-0.018** -0.0007	**0.018T** 0.0007T	**0.048L** 0.0019L	**-0.030** -0.0012	**-0.066** -0.0026	**0.066T** 0.0026T	**0.000L** 0.0000L
200 7.874	**230** 9.0551	**-0.030** -0.0012	**+0.023** +0.0009	**-0.018** -0.0007	**0.018T** 0.0007T	**0.053L** 0.0021L	**-0.030** -0.0012	**-0.066** -0.0026	**0.066T** 0.0026T	**0.000L** 0.0000L
230 9.0551	**250** 9.8425	**-0.030** -0.0012	**+0.028** +0.0011	**-0.018** -0.0007	**0.018T** 0.0007T	**0.058L** 0.0023L	**-0.030** -0.0012	**-0.066** -0.0026	**0.066T** 0.0026T	**0.000L** 0.0000L
250 9.8425	**270** 10.6299	**-0.036** -0.0014	**+0.028** +0.0011	**-0.018** -0.0007	**0.018T** 0.0007T	**0.064L** 0.0025L	**-0.030** -0.0012	**-0.071** -0.0028	**0.071T** 0.0028T	**0.005L** 0.0002L
270 10.6299	**310** 12.2047	**-0.036** -0.0014	**+0.033** +0.0013	**-0.018** -0.0007	**0.018T** 0.0007T	**0.069L** 0.0027L	**-0.036** -0.0014	**-0.071** -0.0028	**0.071T** 0.0028T	**0.005L** 0.0002L
310 12.2047	**400** 15.7480	**-0.041** -0.0016	**+0.038** +0.0015	**-0.018** -0.0007	**0.018T** 0.0007T	**0.079L** 0.0031L	**-0.036** -0.0014	**-0.076** -0.0030	**0.079T** 0.0030T	**0.005L** 0.0002L
400 15.748	**440** 17.3228	**-0.046** -0.0018	**+0.041** +0.0016	**-0.023** -0.0009	**0.023T** 0.0009T	**0.086L** 0.0034L	**-0.036** -0.0014	**-0.086** -0.0034	**0.086T** 0.0034T	**0.010L** 0.0004L

[1] Tolerance range is from +0 to value listed.

TABLE 15. 5200 METRIC SERIES RADIAL INTERNAL CLEARANCE (R6)

Bearing Bore		Radial Internal Clearance	
Over	Incl.	Max.	Min.
mm in.	**mm** in.	**mm** in.	**mm** in.
– –	**100** 3.937	**0.183** 0.0072	**0.127** 0.005
100 3.937	**120** 4.7244	**0.188** 0.0074	**0.127** 0.005
120 4.7244	**140** 5.5118	**0.208** 0.0082	**0.142** 0.0056
140 5.5118	**170** 6.6929	**0.224** 0.0088	**0.152** 0.006
170 6.6929	**180** 7.0866	**0.229** 0.009	**0.152** 0.006
180 7.0866	**220** 8.6614	**0.254** 0.01	**0.173** 0.0068
220 8.6614	**240** 9.4488	**0.269** 0.0106	**0.183** 0.0072

TABLE 16. 5200 METRIC SERIES INNER RING TOLERANCES

Bearing Bore		Bore & Inner O.D.[1]	Width +0
Over	Incl.		
mm in.	**mm** in.	**mm** in.	**mm** in.
80 3.1496	**120** 4.7244	**-0.020** -0.0008	**-0.203** -0.0080
120 4.7244	**80** 7.0866	**-0.025** -0.0010	**-0.254** -0.0100
180 7.0866	**250** 9.8425	**-0.030** -0.0012	**-0.305** -0.0120

[1]Tolerance range is from +0 to value listed.

TABLE 17. 5200 METRIC SERIES OUTER RING TOLERANCES

Bearing Bore		O.D.[1]	Width +0
Over	Incl.		
mm in.	**mm** in.	**mm** in.	**mm** in.
150 5.9055	**180** 7.0866	**-0.025** -0.0010	**+0.036** +0.0014
180 7.0866	**250** 9.8425	**-0.030** -0.0012	**+0.041** +0.0016
250 9.8425	**315** 12.4016	**-0.036** -0.0014	**+0.046** +0.0018
315 12.4016	**400** 15.748	**-0.041** -0.0016	**+0.051** +0.0020
400 15.748	**500** 19.685	**-0.046** -0.0018	**+0.056** +0.0022

[1]Tolerance range is from +0 to value listed.

TABLE 18. 5200 BEARINGS WITHOUT INNER RING SHAFT DIMENSIONS

Bearing Number	Slip Fit Housing[1]		Press Fit Housing[1]	
	Max.	Min.	Max.	Min.
	mm in.	**mm** in.	**mm** in.	**mm** in.
5220 WS	**121.064** 4.7663	**121.044** 4.7655	**121.036** 4.7652	**121.016** 4.7644
5222 WS	**133.007** 5.2365	**132.987** 5.2357	**132.969** 5.235	**132.949** 5.2343
5224 WS	**145.194** 5.7163	**145.174** 5.7155	**145.156** 5.7148	**145.136** 5.714
5226 WS	**155.042** 6.104	**155.016** 6.103	**155.004** 6.1025	**154.978** 6.1015
5228 WS	**168.529** 6.635	**168.504** 6.634	**168.491** 6.6335	**168.466** 6.6325
5230 WS	**181.623** 7.1505	**181.597** 7.1495	**181.587** 7.149	**181.559** 7.148
5232 WS	**193.713** 7.6265	**193.688** 7.6255	**193.675** 7.625	**193.65** 7.624
5234 WS	**205.562** 8.093	**205.537** 8.092	**205.524** 8.0915	**205.499** 8.0905
5236 WS	**216.37** 8.5185	**216.344** 8.5175	**216.319** 8.5165	**216.294** 8.5155
5238 WS	**229.032** 9.017	**229.001** 9.0158	**228.994** 9.0155	**228.963** 9.0143
5240 WS	**242.296** 9.5392	**242.265** 9.538	**242.245** 9.5372	**242.214** 9.536
5244 WM	**266.02** 10.4725	**265.971** 10.4713	**265.951** 10.4705	**265.92** 10.4693
5248WM	**291.292** 11.4682	**291.262** 11.467	**291.241** 11.4662	**291.211** 11.465

[1]All shaft diameters are based on a housing bore to housing O.D. ratio of 0.7.

OPERATING TEMPERATURES

Bearings operate in a wide range of applications and environments. In most cases, bearing operating temperature is not an issue. Some applications, however, operate at extreme speeds or in extreme temperature environments. In these cases, care must be taken not to exceed the temperature limits of the bearing. Minimum temperature limits are primarily based on lubricant capability. Maximum temperature limits are most often based on material and/or lubricant constraints, but also may be based on accuracy requirements of the equipment that the bearings are built into. These constraints/limitations are discussed below.

BEARING MATERIAL LIMITATIONS

Standard bearing steels with a standard heat treatment cannot maintain a minimum hardness of 58 HRC much above 120° C (250° F).

Dimensional stability of Timken bearings is managed through the proper selection of an appropriate heat-treat process. Standard Timken tapered roller and ball bearings are dimensionally stabilized from -54° C (-65° F) up to 120° C (250° F), while standard spherical roller bearings are dimensionally stabilized up to 200° C (392° F) and standard cylindrical roller bearings are stabilized up to 150° C (302° F). Upon request, these bearings can be ordered to higher levels of stability as listed below. These designations are in agreement with DIN Standard 623.

TABLE 19.

Stability Designation	Maximum Operating Temperature	
	°C	°F
S0	**150**	302
S1	**200**	392
S2	**250**	482
S3	**300**	572
S4	**350**	662

With dimensionally stabilized product, there still may be some changes in dimensions during service as a result of microstructural transformations. These transformations include the continued tempering of martensite and decomposition of retained austenite. The magnitude of change depends on the operating temperature, the time at temperature and the composition and heat-treatment of the steel.

Temperatures exceeding the limits shown in table 19 require special high-temperature steel. Consult your Timken engineer for availability of specific part numbers for non-standard heat stability or high-temperature steel grades.

Suggested materials for use in balls, rings and rollers at various operating temperatures are listed in table 20. Also listed are chemical composition recommendations, hardness recommendations and dimensional stability information.

Operating temperature affects lubricant film thickness and setting, both of which directly influence bearing life. Extremely high temperatures can result in a reduced film thickness that can lead to asperity contact between contacting surfaces.

Operating temperature also can affect performance of cages, seals and shields, which in turn can affect bearing performance. Materials for these components and their operating temperature ranges are shown in table 21.

LUBRICATION LIMITATIONS

Starting torque in grease-lubricated applications typically increases significantly at cold temperatures. Starting torque is not primarily a function of the consistency or channel properties of the grease. Most often, it is a function of the rheological properties of the grease.

The high-temperature limit for greases is generally a function of the thermal and oxidation stability of the base oil in the grease and the effectiveness of the oxidation inhibitors.

See the LUBRICATION AND SEALS section on page 45 for more information on lubrication limitations.

EQUIPMENT REQUIREMENTS

The equipment designer must evaluate the effects of temperature on the performance of the equipment being designed. Precision machine tool spindles, for example, can be very sensitive to thermal expansions. For some spindles, it is important that the temperature rise over ambient be held to 20° C to 35° C (36° F to 45° F).

Most industrial equipment can operate at considerably higher temperatures. Thermal ratings on gear drives, for example, are based on 93° C (200° F). Equipment such as gas turbines operates continuously at temperatures above 100° C (212° F). Running at high temperatures for extended periods of time, however, may affect shaft and housing fits, if the shaft and housing are not machined and heat-treated properly .

Although bearings can operate satisfactorily up to 120° C (250° F), an upper temperature limit of 80° C to 95° C (176° F to 203° F) is more practical. Higher operating temperatures increase the risk of damage from transient temperature spikes. Prototype testing of the application can help define the operating temperature range and should be conducted if possible. It is the responsibility of the equipment designer to weigh all relevant factors and make the final determination of satisfactory operating temperature.

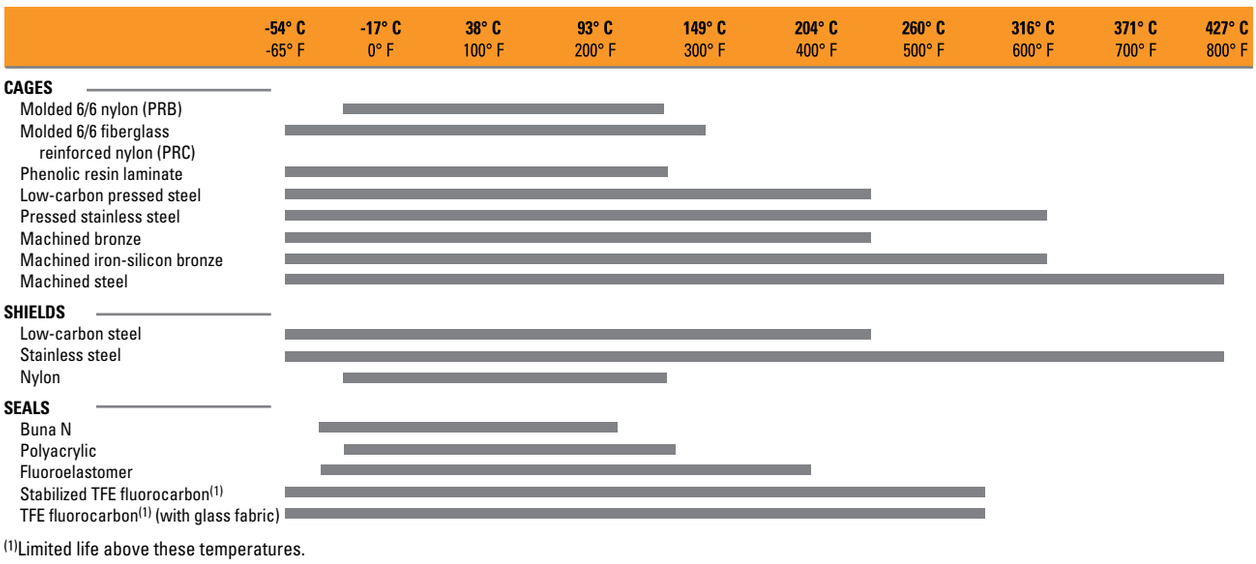
Tables 20 and 21 provide standard operating temperatures for common bearing component materials. They should be used for reference purposes only. Other bearing component materials are available on request. Contact your Timken engineer for more information.

TABLE 20. OPERATING TEMPERATURES FOR BEARING COMPONENT MATERIALS

Material	Approximate Chemical Analysis %	Temp. °F	Hardness HRC	-73° C -100° F	-54° C -65° F	-17° C 0° F	38° C 100° F	93° C 200° F	121° C 250° F	149° C 300° F	204° C 400° F	260° C 500° F	316° C 600° F	371° C 700° F	427° C 800° F
Low-alloy carbon-chromium bearing steels. 52100 and others per ASTM A295	1C 0.5–1.5Cr 0.35Mn	70	60	STANDARD DIMENSIONAL STABILIZATION <0.0001 in./in dimensional change in 2500 hours at 100° C (212° F). Good oxidation resistance.											
Low-alloy carbon-chromium bearing steels. 52100 and others per ASTM A295	1C 0.5–1.5Cr 0.35Mn	70 350 450	58 56 54	Heat stabilized per FS136, <0.0001in./in dimensional change in 2500 hours at 149° C (300° F). When given a stabilizing heat treatment, A295 steel is suitable for many applications in the 177°-232° C (350-450° F) range; however, it is not as dimensionally stable as it is at temperatures below 177° C (350° F). If utmost stability is required, use materials in the 316° C (600° F) group below.										
Deep-hardening steels for heavy sections per ASTM A485	1C 1–1.8Cr 1–1.5Mn .06Si	70 450 600	58 55 52	As heat-treated and tempered, it is stabilized, <0.0001 in./in dimensional change in 2500 hours at 149° C (300° F).											
Carburizing steels per ASTM A534 a) low alloy 4118, 8X19, 5019, 8620 (Ni-Moly grades) b) high nickel 3310	Ni-Moly: 0.2C, 0.4-2.0Mn, 0.3-0.8Cr, 0-2.0Ni, 0-0.3Mo .0.1C, 1.5Cr, 0.4Mn, 3.5Ni	70	58	Nickel-Moly grades of steel frequently used to achieve extra ductility in inner rings for locking device bearings. 3311 and others used for extra-thick-section rings.											
Corrosion-resistant 440C stainless steel per ASTM A756	1C 18Cr	70	58	Excellent corrosion resistance.											
Corrosion-resistant 440C stainless steel per ASTM A756	1C 18Cr	70 450 600	58 55 52	As heat stabilized for maximum hardness at high temperatures (FS238). Good oxidation resistance at higher temperatures. Note load capacity drops off more rapidly at higher temperatures than M50 shown below, which should be considered if loads are high, <0.0001 in./in dimensional change in 1200 hours.											
M-50 medium high speed	4Cr 4Mo 1V 0.8C	70 450 600	60 59 57	Suggested where stable high hardness at elevated temperature is required, <0.0001 in./in dimensional change in 1200 hours at 316° C (600° F).											

Note: Dimensional stability data shown above is the permanent metallurgical growth and/or shrinkage only. Thermal expansion effects are not included. For operating temperatures above 427° C (800° F), consult your Timken engineer.

TABLE 21. OPERATING TEMPERATURES FOR BEARING COMPONENT MATERIALS



(1)Limited life above these temperatures.

HEAT GENERATION AND DISSIPATION

Bearing operating temperature is dependent upon a number of factors, including heat generation of all contributing heat sources, heat flow rate between sources and the ability of the system to dissipate the heat. Heat sources include such things as bearings, seals, gears, clutches and oil supply. Heat dissipation is affected by many factors, including shaft and housing materials and designs, lubricant circulation and external environmental conditions. These and other factors are discussed in the following sections.

HEAT GENERATION

Under normal operating conditions, most of the torque and heat generated by the bearing is caused by the elastohydrodynamic losses at the roller/ring contacts.

Heat generation is the product of bearing torque and speed. The following equation is used to calculate the heat generated.

$$Q_{gen} = k_4 n M$$

If the bearing is a cylindrical roller bearing, the torque calculations are given in the subsequent sections.

HEAT DISSIPATION

The problem of determining the heat flow from a bearing in a specific application is rather complex. In general, it can be said that factors affecting the rate of heat dissipation include the following:

1. Temperature gradient from the bearing to the housing. This is affected by size configuration of the house and any external cooling such as fans, water cooling or fan action of the rotating components.
2. Temperature gradient from the bearing to the shaft. Any other heat sources, such as gears and additional bearings and their proximity to the bearing considered, will influence the temperature of the shaft.
3. The heat carried away by a circulating oil system.

To what extent nos. 1 and 2 can be controlled will depend on the application. The heat-dissipation modes include conduction through the system, convection along the inside and outside surfaces of the system, as well as radiation exchange to and from neighboring structures. In many applications, overall heat dissipation can be divided into two categories – heat removed by circulating oil and heat removed through the structure.

Heat dissipation by circulating oil

The amount of heat removed by the lubricant can be controlled more easily. In a splash lubrication system, cooling coils may be used to control the bulk oil temperature.

The amount of heat carried away in a circulating oil system by the lubricant can be approximated from the following equations.

$$Q_{oil} = k_6 C_p \rho f (\theta_o - \theta_i)$$

Where:

k_6 = 1.67×10^{-5} for Q_{oil} in W
= 1.67×10^{-2} for Q_{oil} in Btu/min

If the circulating lubricant is petroleum oil, the heat removed is further approximated by the following:

$$Q_{oil} = k_5 f (\theta_o - \theta_i)$$

The following factors apply to the heat generation and dissipation equations listed on this page.

Where:

k_5 = 28 for Q_{oil} in W when f in L/min and θ in °C
= 0.42 for Q_{oil} in Btu/min when f in U.S. pt/min and θ in °F

TORQUE

RUNNING TORQUE-M

The rotational resistance of a rolling bearing is dependent on load, speed, lubrication conditions and bearing internal characteristics.

The following formulas yield approximations to values of bearing running torque. The formulas apply to bearings lubricated by oil. For bearings lubricated by grease or oil mist, torque is usually lower, although for grease lubrication this depends on amount and consistency of the grease. The formulas also assume the bearing running torque has stabilized after an initial period referred to as running-in.

CYLINDRICAL ROLLER BEARINGS

The torque equations for cylindrical roller bearings are given as follows, where the coefficients are based on series and found in the following table:

$$M = \begin{cases} f_1 F_\beta dm + 10^{-7} f_0 (v \times n)^{2/3} dm^3 & \text{if } (v \times n) \geq 2000 \\ f_1 F_\beta dm + 160 \times 10^{-7} f_0 dm^3 & \text{if } (v \times n) < 2000 \end{cases}$$

Note that the viscosity is in units of centistokes. The load term (F_β) depends on the bearing type as follows:

Radial cylindrical roller: $F_\beta = \max \begin{pmatrix} 0.8F_a \cot \alpha \\ \text{or} \\ F_r \end{pmatrix}$

TABLE 22. COEFFICIENTS FOR THE TORQUE EQUATION

Bearing Type	Dimension Series	f_0	f_1
Single-row cylindrical roller bearings with cage	10	2	0.00020
	02	2	0.00030
	22	3	0.00040
	03	2	0.00035
	23	4	0.00040
	04	2	0.00040
Single-row cylindrical roller bearings full-complement	18	5	0.00055
	29	6	0.00055
	30	7	0.00055
	22	8	0.00055
	23	12	0.00055
Double-row cylindrical roller bearings full-complement	48	9	0.00055
	49	11	0.00055
	50	13	0.00055

LUBRICATION

To help maintain a bearing's antifriction characteristics, lubrication is needed to:

- Minimize rolling resistance due to deformation of the rolling elements and raceway under load by separating the mating surfaces.
- Minimize sliding friction occurring between rolling elements, raceways and cage.
- Transfer heat (with oil lubrication).
- Protect from corrosion and, with grease lubrication, from contaminant ingress.

LUBRICATION

The wide range of bearing types and operating conditions precludes any simple, all-inclusive statement or guideline allowing the selection of the proper lubricant. At the design level, the first consideration is whether oil or grease is best for the particular operation. The advantages of oil and grease are outlined in the table below. When heat must be carried away from the bearing, oil must be used. It is almost always preferred for very high-speed applications.

TABLE 23. ADVANTAGES OF OIL AND GREASE

Oil	Grease
Carries heat away from the bearings	Simplifies seal design and acts as a sealant
Carries away moisture and particulate matter	Permits prelubrication of sealed or shielded bearings
Easily controlled lubrication	Generally requires less frequent lubrication

European REACH compliance

Timken-branded lubricants, greases and similar products sold in stand-alone containers or delivery systems are subject to the European REACH (**R**egistration, **E**valuation, **A**uthorization and Restriction of **CH**emicals) directive. For import into the European Union, Timken can sell and provide only those lubricants and greases that are registered with ECHA (European CHemical Agency). For further information, please contact your Timken engineer.

OIL LUBRICATION

Oils used for bearing lubrication should be high-quality mineral oils or synthetic oils with similar properties. Selection of the proper type of oils depends on bearing speed, load, operating temperature and lubrication method. Some features and advantages of oil lubrication, in addition to the above are:

- Oil is a better lubricant for high speeds or high temperatures. It can be cooled to help reduce bearing temperature.
- It is easier to handle and control the amount of lubricant reaching the bearing. It is harder to retain in the bearing. Lubricant losses may be higher than with grease.
- Oil can be introduced to the bearing in many ways, such as drip-feed, wick-feed, pressurized circulating systems, oil bath or air-oil mist. Each is suited for certain types of applications.
- Oil is easier to keep clean for recirculating systems.

Oil may be introduced to the bearing housing in many ways. The most common systems are:

- **Oil bath.** The housing is designed to provide a sump through which the rolling elements of the bearing will pass. Generally, the oil level should be no higher than the center point of the lowest rolling element. If speed is high, lower oil levels should be used to reduce churning. Gages or controlled elevation drains are used to achieve and maintain the proper oil level.
- **Circulating system.** This system has the advantages of:
  - An adequate supply of oil for both cooling and lubrication.
  - Metered control of the quantity of oil delivered to each bearing.
  - Removal of contaminants and moisture from the bearing by flushing action.
  - Suitability for multiple bearing installations.
  - Large reservoir, which reduces deterioration. Increased lubricant life provides economical efficiency.
  - Incorporation of oil-filtering devices.
  - Positive control to deliver the lubricant where needed.
  - A typical circulating oil system consists of an oil reservoir, pump, piping and filter. A heat exchange may be required.
- **Oil-mist lubrication**. Oil-mist lubrication systems are used in high-speed, continuous-operation applications. This system permits close control of the amount of lubricant reaching the bearings. The oil may be metered, atomized by compressed air and mixed with air, or it may be picked up from a reservoir using a venturi effect. In either case, the air is filtered and supplied under sufficient pressure to assure adequate lubrication of the bearings. Control of this type of lubrication system is accomplished by monitoring the operating temperatures of the bearings being lubricated. The continuous passage of the pressurized air and oil through the labyrinth seals used in the system prevents the entrance of contaminants from the atmosphere to the system.

  The successful operation of this type of system is based upon the following factors:
  - Proper location of the lubricant entry ports in relation to the bearings being lubricated.
  - Avoidance of excessive pressure drops across void spaces within the system.
  - Proper air pressure and oil quantity ratio to suit the particular application.
  - Adequate exhaust of the air-oil mist after lubrication has been accomplished.

  To ensure “wetting” of the bearings, and to prevent possible damage to the rolling elements and rings, it is

imperative that the oil-mist system be turned on for several minutes before the equipment is started. The importance of "wetting" the bearing before starting cannot be overstated, and it also has particular significance for equipment that has been idled for extended periods of time.

Lubricating oils are commercially available in many forms for automotive, industrial, aircraft and other uses. Oils are classified as either petroleum types (refined from crude oil) or synthetic types (produced by chemical synthesis).

PETROLEUM OILS

Petroleum oils are made from a petroleum hydrocarbon derived from crude oil, with additives to improve certain properties. Petroleum oils are used for nearly all oil-lubricated applications of bearings.

SYNTHETIC OILS

Synthetic oils cover a broad range of categories and include polyalphaolefins, silicones, polyglycols and various esters. In general, synthetic oils are less prone to oxidation and can operate at extreme hot or cold temperatures. Physical properties, such as pressure-viscosity coefficients, tend to vary between oil types; use caution when making oil selections.

The polyalphaolefins (PAO) have a hydrocarbon chemistry that parallels petroleum oil both in chemical structures and pressure-viscosity coefficients. Therefore, PAO oil is mostly used in the oil-lubricated applications of bearings when severe temperature environments (hot and cold) are encountered or when extended lubricant life is required.

The silicone, ester and polyglycol oils have an oxygen-based chemistry that is structurally quite different from petroleum oils and PAO oils. This difference has a profound effect on its physical properties where pressure-viscosity coefficients can be lower compared to mineral and PAO oils. This means that these types of synthetic oils may actually generate a smaller elastohydrodynamic (EHD) film thickness than a mineral or PAO oil of equal viscosity at operating temperature. Reductions in bearing fatigue life and increases in bearing wear could result from this reduction of lubricant film thickness.

VISCOSITY

The selection of oil viscosity for any bearing application requires consideration of several factors: load, speed, bearing setting, type of oil and environmental factors. Since oil viscosity varies inversely with temperature, a viscosity value must always be stated with the temperature at which it was determined. High-viscosity oil is used for low-speed or high-ambient-temperature applications. Low-viscosity oil is used for high-speed or low-ambient-temperature applications.

There are several classifications of oils based on viscosity grades. The most familiar are the Society of Automotive Engineers (SAE) classifications for automotive engine and gear oils. The American Society for Testing and Materials (ASTM) and the International Organization for Standardization (ISO) have adopted standard viscosity grades for industrial fluids. Fig. 12 shows the viscosity comparisons of ISO/ASTM with SAE classification systems at 40° C (104° F).

VISCOSITY CLASSIFICATION COMPARISON

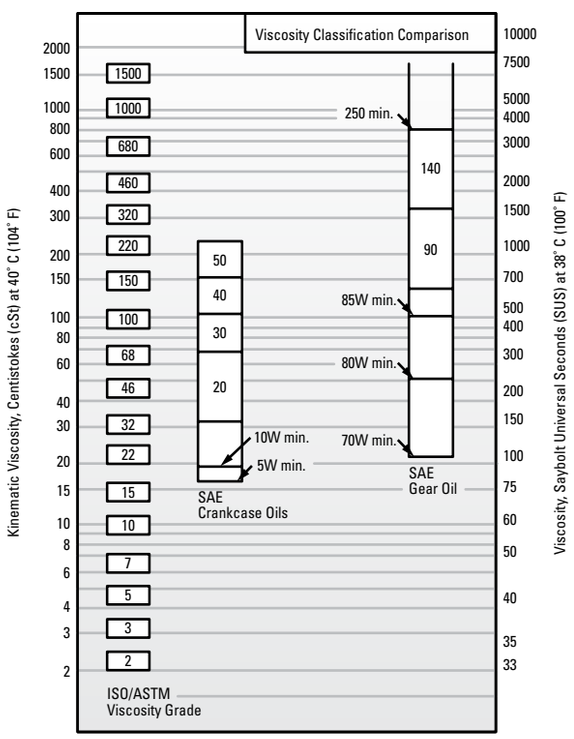


Fig. 12. Comparison between ISO/ASTM grades (ISO 3448/ASTM D2442) and SAE grades (SAE J 300-80 for crankcase oils, SAE J 306-81 for axle and manual transmission oils).

The ASTM/ISO viscosity grade system for industrial oils is depicted below.

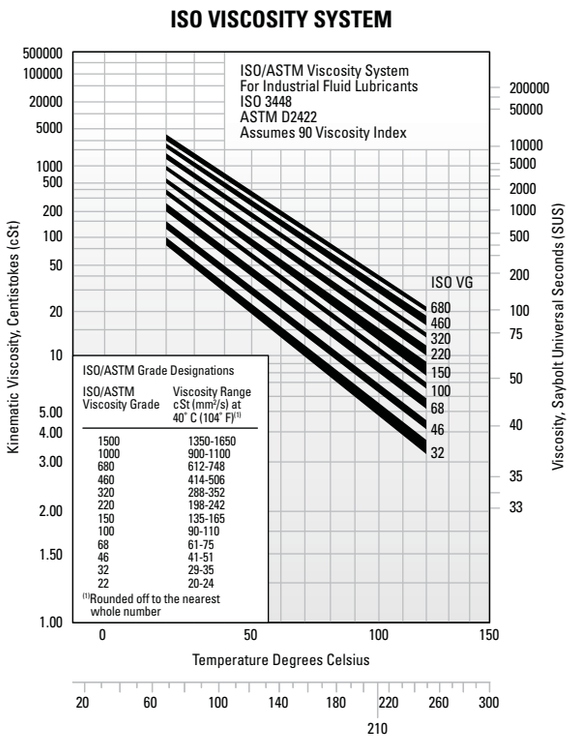


Fig. 13. Viscosity grade system for industrial oils.

TYPICAL BEARING LUBRICATION OILS

In this section, the properties and characteristics of lubricants for typical roller bearing applications are listed. These general characteristics are derived from successful performance in applications across all industries.

General-purpose rust and oxidation lubricating oil

General-purpose rust and oxidation (R&O) inhibited oils are the most common type of industrial lubricant. They are used to lubricate Timken® bearings in all types of industrial applications where conditions requiring special considerations do not exist.

TABLE 24. SUGGESTED GENERAL PURPOSE R&O LUBRICATING OIL PROPERTIES

	Properties
Base stock	Solvent-refined, high-viscosity-index petroleum oil
Additives	Corrosion and oxidation inhibitors
Viscosity index	80 min.
Pour point	-10° C max. (14° F)
Viscosity grades	ISO/ASTM 32 through 220

Some low-speed and/or high-ambient-temperature applications require the higher viscosity grades. High-speed and/or low-temperature applications require the lower viscosity grades.

Industrial extreme-pressure (EP) gear oil

Extreme-pressure gear oils are used to lubricate Timken bearings in most types of heavily loaded industrial equipment. They should be capable of withstanding abnormal shock loads that are common in heavy-duty equipment.

TABLE 25. SUGGESTED INDUSTRIAL EP GEAR OIL PROPERTIES

	Properties
Base stock	Solvent-refined, high-viscosity-index petroleum oil
Additives	Corrosion and oxidation inhibitors Extreme-pressure (EP) additive(1) - 15.8 kg (35 lb.) min.
Viscosity index	80 min.
Pour point	-10° C max. (14° F)
Viscosity grades	ISO/ASTM 100, 150, 220, 320, 460

(1) ASTM D 2782

Industrial EP gear oils should be composed of a highly refined petroleum oil-based stock plus appropriate inhibitors and additives. They should not contain materials that are corrosive or abrasive to bearings. The inhibitors should provide long-term protection from oxidation and protect the bearing from corrosion in the presence of moisture. The oils should resist foaming in service and have good water-separation properties. An EP additive protects against scoring under boundary-lubrication conditions. The viscosity grades suggested represent a wide range. High-temperature and/or slow-speed applications generally require the higher viscosity grades. Low temperatures and/or high speeds require the use of lower viscosity grades.

GREASE LUBRICATION

Grease lubrication is generally applicable to low-to-moderate speed applications that have operating temperatures within the limits of the grease. There is no universal antifriction bearing grease. Each grease has limiting properties and characteristics.

Greases consist of a base oil, a thickening agent and additives. Conventionally, bearing greases have consisted of petroleum base oils thickened to the desired consistency by some form of metallic soap. More recently synthetic base oils have been used with organic and inorganic thickeners. Table 26 summarizes the composition of typical lubricating greases.

TABLE 26. COMPOSITION OF GREASES

Base Oil	+	Thickening Agents	+	Additives	=	Lubricating Grease
Mineral oil Synthetic hydrocarbon Esters Perfluorinated oil Silicone		Soaps and complex soaps lithium, aluminum, barium, calcium Non-Soap (inorganic) microgel (clay), carbon black, silica-gel, PTFE Non-Soap (organic) Polyurea compounds		Rust inhibitors Dyes Tactifiers Metal deactivates Oxidation inhibitors Anti-wear EP		

Calcium- and aluminum-based greases have excellent water resistance and are used in industrial applications where water ingress is an issue. Lithium-based greases are multi-purpose and are used in industrial applications and wheel bearings.

Synthetic base oils such as esters, organic esters and silicones used with conventional thickeners and additives typically have higher maximum operating temperatures than petroleum-based greases. Synthetic greases can be designed to operate in temperatures from -73° C (-100° F) to 288° C (550° F).

Below are the general characteristics of common thickeners used with petroleum base oils.

TABLE 27. GENERAL CHARACTERISTICS OF THICKENERS USED WITH PETROLEUM BASE OILS

Thickener	Typical Dropping Point		Maximum Temperature		Typical Water Resistance
	°C	°F	°C	°F	
Lithium soap	**193**	380	**121**	250	Good
Lithium complex	**260+**	500+	**149**	300	Good
Aluminum complex	**249**	480	**149**	300	Excellent
Calcium sulfonate	**299**	570	**177**	350	Excellent
Polyurea	**260**	500	**149**	300	Good

Use of the thickeners in table 27 with synthetic hydrocarbon or ester base oils increases the maximum operating temperature by approximately 10° C (50° F).

Using polyurea as a thickener for lubricating fluids is one of the most significant lubrication developments in more than 30 years. Polyurea grease performance is outstanding in a wide range of bearing applications and, in a relatively short time, it has gained acceptance as a factory-packed lubricant for ball bearings.

LOW TEMPERATURES

Starting torque in a grease-lubricated bearing at low temperatures can be critical. Some greases may function adequately as long as the bearing is operating, but resistance to initial movement may be excessive. In certain smaller machines, starting may be impossible when very cold. Under such operating circumstances, greases containing low-temperature characteristic oils are generally required.

If the operating temperature range is wide, synthetic greases offer advantages. Synthetic greases are available to provide very low starting and running torque at temperatures as low as -73° C (-100° F). In certain instances, these greases perform better in this respect than oil.

An important point concerning lubricating greases is that the starting torque is not necessarily a function of the consistency or the channel properties of the grease. Starting torque is more a function of the individual rheological properties of a particular grease and is best evaluated by application experience.

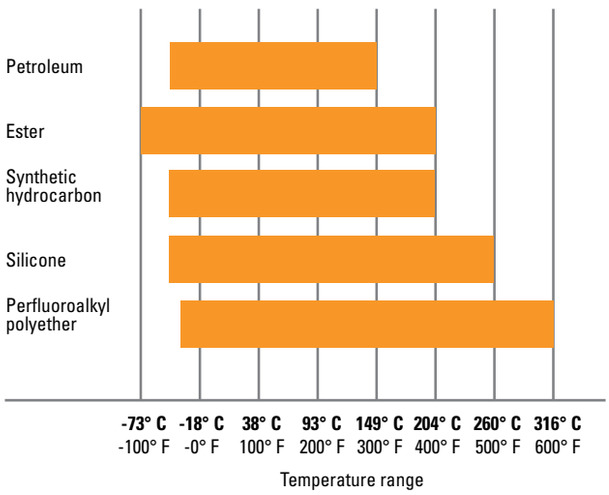
HIGH TEMPERATURES

The high temperature limit for lubricating greases is generally a function of the thermal and oxidation stability of the fluid and the effectiveness of the oxidation inhibitors. Grease temperature ranges are defined by both the dropping point of the grease thickener and composition of the base oil. Table 28 shows the temperature ranges of various base oils used in grease formulations.

A rule of thumb, developed from years of testing grease-lubricated bearings, indicates that grease life is halved for every 10° C (50° F) increase in temperature. For example, if a particular grease provides 2000 hours of life at 90° C (194° F), by raising the temperature to 100° C (212° F), reduction in life to approximately 1000 hours would result. On the other hand, 4000 hours could be expected by lowering the temperature to 80° C (176° F).

Thermal stability, oxidation resistance and temperature limitations must be considered when selecting greases for high-temperature applications. In non-relubricatable applications, highly refined mineral oils or chemically stable synthetic fluids are required as the oil component of greases for operation at temperatures above 121° C (250° F).

TABLE 28. TEMPERATURE RANGES FOR BASE OILS USED IN LUBRICATING GREASES



CONTAMINATION

Abrasive Particles

When roller bearings operate in a clean environment, the primary cause of damage is the eventual fatigue of the surfaces where rolling contact occurs. However, when particle contamination enters the bearing system, it is likely to cause damage such as bruising, which can shorten bearing life.

When dirt from the environment or metallic wear debris from some component in the application are allowed to contaminate the lubricant, wear can become the predominant cause of bearing damage. If bearing wear becomes significant, changes will occur to critical bearing dimensions that could adversely affect machine operation.

Bearings operating in a contaminated lubricant exhibit a higher initial rate of wear than those running in an uncontaminated lubricant. With no further contaminant ingress, this wear rate quickly diminishes. The contamination particles are reduced in size as they pass through the bearing contact area during normal operation.

Water

Water and moisture can be particularly conducive to bearing damage. Lubricating greases may provide a measure of protection from this contamination. Certain greases, such as calcium and aluminum-complex, are highly water-resistant.

Sodium-soap greases are water-soluble and should not be used in applications involving water.

Either dissolved or suspended water in lubricating oils can exert a detrimental influence on bearing fatigue life. Water can cause bearing etching that also can reduce bearing fatigue life. The exact mechanism by which water lowers fatigue life is not fully understood. It has been suggested that water enters micro-cracks in the bearing rings that are caused by repeated stress cycles. This leads to corrosion and hydrogen embrittlement in the micro-cracks, reducing the time required for these cracks to propagate to an unacceptable-sized spall.

Water-based fluids, such as water glycol and invert emulsions, also have shown a reduction in bearing fatigue life. Although water from these sources is not the same as contamination, the results support the previous discussion concerning water-contaminated lubricants.

GREASE SELECTION

The successful use of bearing grease depends on the physical and chemical properties of the lubricant as well as application and environmental conditions. Because the choice of grease for a particular bearing under certain service conditions is often difficult to make, you should consult with your lubricant supplier or equipment maker for specific questions about lubrication requirements for your application. You also can contact your Timken engineer for general lubrication guidelines for any application.

Grease must be carefully selected with regard to its consistency at operating temperature. It should not exhibit thickening, separation of oil, acid formation or hardening to any marked degree. It should be smooth, non-fibrous and entirely free from chemically active ingredients. Its dropping point should be considerably higher than the operating temperature.

Timken® application-specific lubricants were developed by leveraging our knowledge of tribology and antifriction bearings, and how these two elements affect overall system performance. Timken lubricants help bearings and related components operate effectively in demanding industrial operations. High-temperature, anti-wear and water-resistant additives offer superior protection in challenging environments. Table 29 provides an overview of the Timken greases available for general applications. Contact your Timken engineer for a more detailed publication on Timken lubrication solutions.

TABLE 29. GREASE LUBRICATION SELECTION GUIDE

ENVIRONMENT		APPLICATION
High Wear • Moderate Loads Moderate Speeds Moderate Temperatures	Timken Premium All-Purpose Industrial Grease	Agriculture • Bushings/Ball Joints Truck and Auto Wheel Bearings Heavy-Duty Industrial
Extreme Heat • Heavy Loads High Sliding Wear Dirty Environments Slow Speeds • Shock Loading	Timken Construction and Off-Highway Grease	Agriculture/Mining • Cement Plants Construction/Off Road • Rock Quarry Earth-Moving Equipment Fleet Equipment • Heavy Industry Pivot Pins/Splined Shafts
Wet and Corrosive Conditions Quiet Environments • Light Loads Moderate to High Speeds Moderate Temperatures Light Load Moderate Water	Timken Ball Bearing Pillow Block Grease	Lightly Loaded Pillow Blocks Idler Pulleys • Oven Conveyors Electric Motors • Fans • Pumps Alternators • Generators
Corrosive Media • Extreme Heat Heavy Loads • Wet Conditions Slow to Moderate Speeds	Timken Mill Grease	Aluminum Mills • Paper Mills Steel Mills • Offshore Rigs Power Generation
Incidental Food Contact Hot and Cold Temperatures Moderate to High Speeds Medium Loads	Timken Food Safe Grease	Food and Beverage Industries Pharmaceuticals
Extreme Low and High Temperatures Severe Loads Corrosive Media Slow to Moderate Speeds	Timken Synthetic Industrial Grease	Wind Energy Main Bearing Pulp and Paper Machines General Heavy Industry Marine Applications Centralized Grease Systems
Moderate Speeds Light to Moderate Loads Moderate Temperatures Moderate Water	Timken Multi-Use Lithium Grease	General Industrial Applications Pins and Bushings • Track Rollers Water Pumps Plain and Antifriction Bearings

This selection guide is not intended to replace the specifications by the equipment builder, who is responsible for its performance.

Many bearing applications require lubricants with special properties or lubricants formulated specifically for certain environments, such as:

- Friction oxidation (fretting corrosion).
- Chemical and solvent resistance.
- Food handling.
- Quiet running.
- Space and/or vacuum.
- Electrical conductivity.

For assistance with these or other areas requiring special lubricants, consult your Timken engineer.

GREASE USE GUIDELINES

It is important to use the proper amount of grease in the application. In typical industrial applications, the bearing cavity should be kept approximately one-third to one-half full. Less grease may result in the bearing being starved for lubrication. More grease may result in churning. Both conditions may result in excessive heat generation. As the grease temperature rises, viscosity decreases and the grease becomes thinner. This can reduce the lubricating effect and increase leakage of the grease from the bearing. It also may cause the grease components to separate, leading to a general breakdown of the lubricant properties. As the grease breaks down, bearing torque increases. In the case of excess grease resulting in churning, torque may also increase due to the resistance caused by the grease.

For best results, there should be ample space in the housing to allow room for excess grease to be thrown from the bearing. However, it is equally important that the grease be retained all around the bearing. If a large void exists between the bearings, grease closures should be used to prevent the grease from leaving the bearing area.

Only in low-speed applications may the housing be entirely filled with grease. This method of lubrication is a safeguard against the entry of foreign matter, where sealing provisions are inadequate for exclusion of contaminants or moisture.

During periods of non-operation, it is often wise to completely fill the housings with grease to protect the bearing surfaces. Prior to restarting operation, remove the excess grease and restore the proper level.

Applications utilizing grease lubrication should have a grease fitting and a vent at opposite ends of the housing near the top. A drain plug should be located near the bottom of the housing to allow the old grease to purge from the bearing.

Bearings should be relubricated at regular intervals to help prevent damage. Relubrication intervals are difficult to determine. If plant practice or experience with other applications is not available, consult your lubricant supplier.

Timken offers a range of lubricants to help bearings and related components operate effectively in demanding industrial operations. High-temperature, anti-wear and water-resistant additives offer greater protection in challenging environments. Timken also offers a line of single- and multi-point lubricators to simplify grease delivery.

Fig. 14. Grease can easily be packed by hand.

Fig. 15. Mechanical grease packer.

Grease application methods

Grease, in general, is easier to use than oil in industrial bearing lubrication applications. Most bearings that are initially packed with grease require periodic relubrication to operate efficiently.

Grease should be packed into the bearing so that it gets between the rolling elements – the rollers or balls. For tapered roller bearings, forcing grease through the bearing from the large end to the small end will ensure proper distribution.

Grease can be easily packed into small- and medium-size bearings by hand (fig. 14). In shops where bearings are frequently regreased, a mechanical grease packer that forces grease through the bearing under pressure may be appropriate (fig. 15). Regardless of the method, after packing the internal areas of the bearing, a small amount of grease also should be smeared on the outside of the rollers or balls.

The two primary considerations that determine the relubrication cycle are operating temperature and sealing efficiency. High-operating-temperature applications generally require more frequent regreasing. The less efficient the seals, the greater the grease loss and the more frequently grease must be added.

Grease should be added any time the amount in the bearing falls below the desired amount. The grease should be replaced when its lubrication properties have been reduced through contamination, high temperature, water, oxidation or any other factors. For additional information on appropriate regreasing cycles, consult with the equipment manufacturer or your Timken engineer.

CONSISTENCY

Greases may vary in consistency from semi-fluids that are hardly thicker than a viscous oil to solid grades almost as hard as a soft wood.

Consistency is measured by a penetrometer in which a standard weighted cone is dropped into the grease. The distance the cone penetrates (measured in tenths of a millimeter in a specific time) is the penetration number.

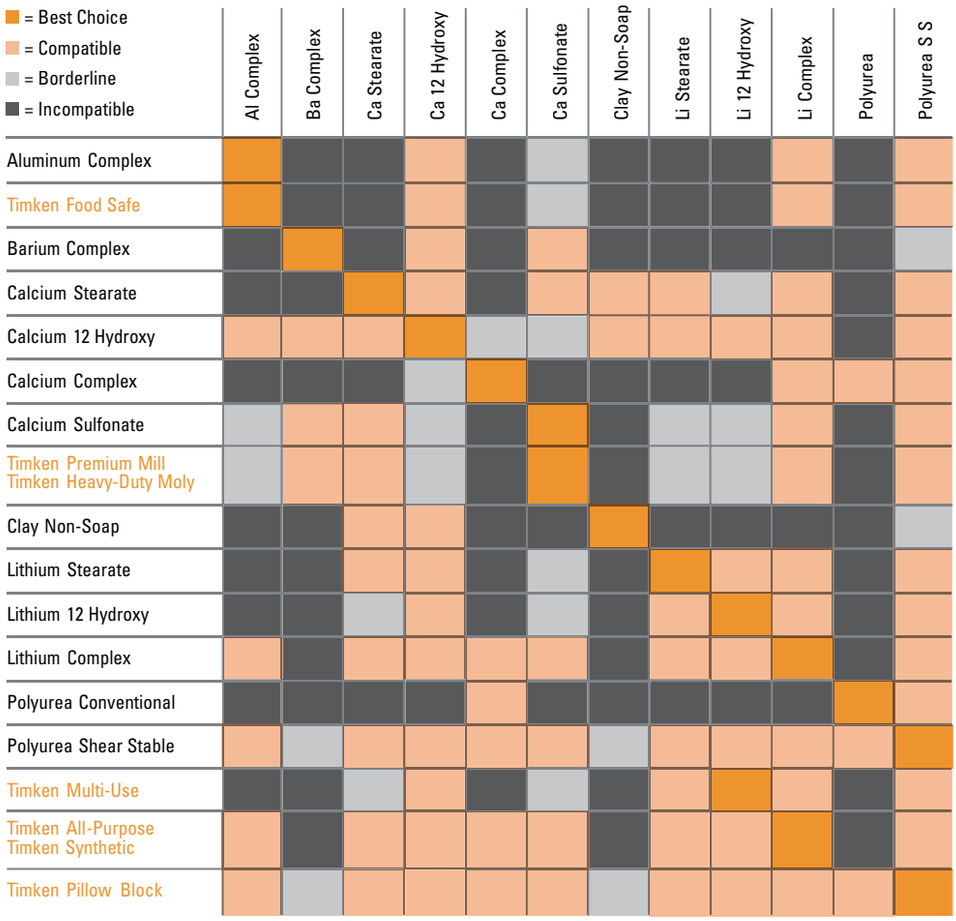
The National Lubricating Grease Institute (NLGI) classification of grease consistency is shown below:

TABLE 30. NLGI CLASSIFICATIONS

NLGI Grease Grades	Penetration Number
0	355-385
1	310-340
2	265-295
3	220-250
4	175-205
5	130-160
6	85-115

Grease consistency is not fixed; it normally becomes softer when sheared or “worked.” In the laboratory, this “working” is accomplished by forcing a perforated plate up and down through a closed container of grease. This “working” does not compare with the violent shearing action that takes place in a bearing and does not necessarily correlate with actual performance.

TABLE 31. GREASE COMPATIBILITY CHART



NOTE

Mixing greases can result in improper bearing lubrication.
Always follow the specific lubrication instructions of your equipment supplier.