

MACHINERY & TESTING FACILITIES

Smith Bearing® has a fully-integrated manufacturing facility capable of producing high-precision needle roller bearings for both the Aerospace and Industrial market. Our computerized (CNC) grinding and precision machining centers, considered to be the most advanced in the industry are capable of manufacturing a wide range of products to exacting tolerances in order to meet the needs of our customers. Our advanced metallurgical department routinely verifies and tests all raw materials, plating and heat-treating processes used in the manufacturing of our products. This careful analysis and scrutiny in each phase of our procedure assures proper conformance to all Aerospace requirements and guarantees that only materials meeting our rigid standards are used in **Smith Bearing®** products.

ENGINEERING

Extensive experience in our engineering department allows **Smith Bearing®** to work closely with end-users and OEMs (original equipment manufactures) in order to offer the best solution for their bearing requirements. **Smith Bearing®** engineers have extensive knowledge of available metallurgies so that they may offer customers their experience to determine the best suitable material for a special design and application. Smith manufactures bearings in a wide range of materials including high-carbon alloy steels, stainless steels, tool steels, and other exotic alloys.

CUSTOM ASSEMBLIES

Smith Bearing® has the ability to manufacture a variety of custom bearing assemblies. Typically this entails the precision machining of a bearing housing and the assembly of needle or ball bearings into the housing. By controlling the entire design and manufacturing process of a custom order, Smith Bearing® guarantees the quality, performance, and delivery of an assembly. Smith Bearing® performs all aspects of such projects from design to finish including the machining process, applications of special coatings and plating, assembling and testing of the final product.

QUALITY & DEPENDABILITY

Smith Bearing® has received both **ISO 9001** and **AS 9100** quality registrations in recognition of our continued commitment to world-class quality control systems. Our quality system is recognized by General Electric, Lockheed, Boeing Aircraft Corporation, British Aerospace, as well as many other military and aerospace companies. Our Military bearings meet the requirements of **Mil-B-3990 (SAE AS 39901)**. This level of quality certifications and approvals assures our customers unequaled dependability of our products.



Cam Followers – Stud & Yoke Type

SMITH Cam Followers are anti-friction needle roller bearings developed for use in cam or track roller applications. They were specifically designed and built to handle intermittent shock and heavy loads. Full compliment (non-caged) needle bearings maximize the radial load carrying capability while the soft inner core of the stud gives these cam followers the ability to absorb extreme shock loads without fracturing.

In addition to standard models, special bearings are manufactured to customer specification for unique applications. It is often found that the use of special bearings reduces machine costs and improves performance. We have the ability to economically manufacture custom bearings in small or large volumes. Please call us to discuss your special applications.

Material Selection

The common material selection for needle roller bearings are high-strength bearing steel (SAE 52100) or carburized low-carbon alloy steels. These materials give us an excellent combination of strength and economy and are more than sufficient for the majority of industrial applications.

High-Temperature & Corrosive Applications:

In extreme applications where bearings are being subjected to high-temperature or corrosive environments, alternative materials or special platings must be considered.

Smith Bearing® manufactures needle roller bearings in a wide variety of high-temperature and corrosive resistant exotic alloys including **440-C stainless steel** and **M-50, M-2, M-10 tool steels**.

Corrosion resistant plating is effective when using bearings in corrosive environments. Non-bearing surfaces such as inner races and end washers are cadmium plated to resist corrosion. The outer races of the bearings are typically hard-chrome plated to resist wear as well as corrosion.

Construction of Standard Needle Rollers

Cam Follower materials and finishes are selected to provide a minimum of friction and to assure dependable performance for the required service life.

OUTER RACE High-carbon chrome bearing steel (SAE 52100), hardened and ground.

INNER RACES are manufactured from low-carbon alloy steel, carburized, and case hardened on the raceway area. This gives the inner race two very key characteristics. **1):** Tremendous strength and forgiveness when subject to tensile, shear, and other bending stresses and **2):** extreme hardness on the wear area for long bearing life. The studs are metallurgically designed not to fracture or fail when subject to intermittent shock and heavy loads found in cam follower applications.

NEEDLE ROLLERS are made from high-carbon chrome bearing steel. They are through-hardened, ground and lapped for ultimate life and performance.

RETAINING WASHERS are made from low-carbon alloy steel, and case-hardened. This gives both a hardened and smooth internal surface that is desirable for proper cam follower performance. The soft core of the end washer resists fracture during use.

Various Needle Rollers - Stud & Yoke Type



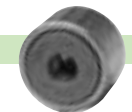
REGULAR STUD TYPE CR Series

are recommended where loads and shock are moderate. Bearing capacity on the CR Series is limited by their moderately sized stud. See capacity ratings.



HEAVY STUD TYPE HR Series

are recommended for applications with high-loads and/or heavy shock and where deflection should be held to a minimum. Rollers and outer races are identical to the standard CR Series.



YOKE TYPE YR Series

have similar internal construction to the stud type CR Series except the inner race is made for shaft or clevis mounting. Generally, heavier loads can be supported by the yoke mounting arrangement, since stud deflection is removed from consideration.



HEX-DRIVE SOCKET Add Suffix "B"

are favorable for most applications where the bearing is installed in a blind or threaded hole. The Hex-drive allows for more secure installation and easier removal of the cam follower.



SCREWDRIVER SLOT Standard

Screw-driver slot configuration is normally sufficient for most applications.

Cam Followers – Stud & Yoke Type



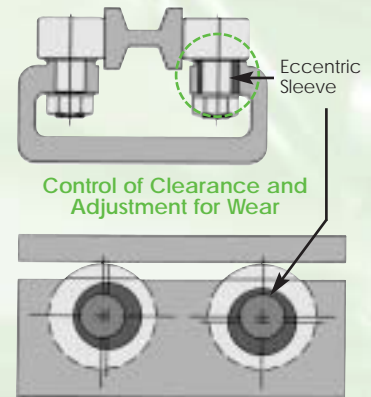
ECCENTRIC CAM FOLLOWERS

Add Suffix "E"

The eccentric sleeve allows for easy radial positioning for stud-type cam followers.

Eccentric Sleeves Allow for Radial Location Adjustment of Cam Followers

Cam Followers with a Press Fit **Eccentric Sleeve** provide correct alignment and adjustment without costly preparation of close tolerance mounting holes and members. They eliminate problems of clearances, preloading and wear compensation and assure load sharing in multiple cam follower applications. The hex-drive socket allows positive torque for locking and adjustment. A lock nut will normally provide adequate clamping to hold bearing and eccentric sleeve in their proper position. When permanent locking of eccentric sleeve is required, drill through the housing, eccentric sleeve, and bearing stud and secure with a dowel or set-screw.



Control of Clearance and Adjustment for Wear

In-line Adjustment Allows Greater Location Tolerance for Mounting Holes



CROWNED CAM FOLLOWERS

Add Suffix "C"

Crowned outer races are recommended when the track is not exactly aligned and square with the cam follower. Crowned outer races reduce undesirable thrust loads on the rollers when track-bearing misalignment happens to occur. This increases life and reliability of the bearing.

Available in stud type and yoke type cam followers.

Crowned Outer Races Reduce Edge Loading when Bearing/Track are Misaligned

Unwanted edge loading of needle bearings causes skewing and end thrusting of the needles which contribute to premature bearing failure. In situations where it is impractical or too costly to provide for perfect alignment, crowned bearing O.D.'s provide compensation for misalignment between the cam follower and the surface of a slanted track or cam. The radius also eliminates skidding of the outer race when bearing is on contact with a flat, circular cam.



SEALED CAM FOLLOWERS

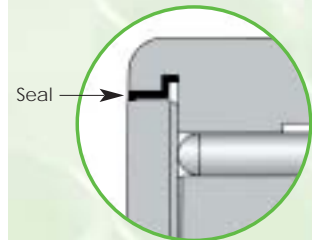
Add Suffix "X"

Seals provide an effective means of protection from outside contamination and ensure lubricant retention.

Available in stud type and yoke type cam followers.

Seals Provide Protection Against Contamination & Loss of Lubricant

Sealed cam followers are furnished with molded-acetyl full-contact seals contained within the outer race undercuts at both ends of the bearing. This is a low-friction material which keeps drag to a minimum yet is stable and unaffected by corrosive agents or lubricants. A small vent hole in the seals allows for purging during relubrication without causing seal displacement. The outer race on sealed cam followers is provided with a machined groove in the bore, which acts as a grease reservoir to extend time periods between relubrication. All sealed bearings are dimensionally interchangeable with the unsealed configuration of the same series.



Typical Seal Configuration

Cam Followers – Stud & Yoke Type

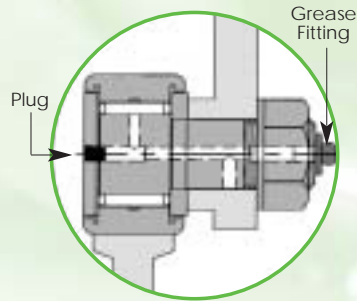


Fig. 1 Lubrication Through Thread-End

Fig. 1 shows the re-lubrication path through the threaded-end of the stud (white area). The head-end is properly closed off using one of the two the plugs provided with each cam follower. Due to diameter constraints of the stud, smaller cam followers cannot be re-lubricated through the threaded-end.

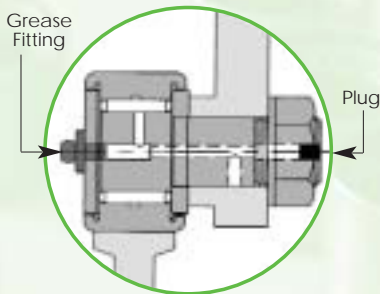


Fig. 2 Lubrication Through Head-End

Fig. 2 shows the re-lubrication path through the head-end of the stud (white area). The threaded-end is properly closed off using one of the two the plugs provided with each cam follower.

Note: Smaller cam followers with hex-drive socket can only be re-lubricated through threaded-end. See dimensional charts.

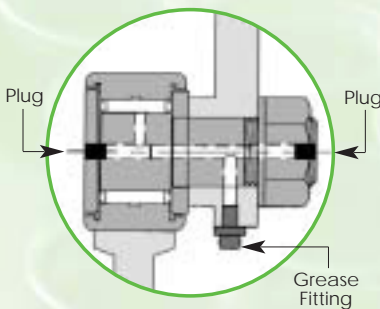


Fig. 3 Lubrication Through Center-Hole

Fig. 3 shows the re-lubrication path through the cross-drilled hole in the stud of the cam follower (white area). A lubrication grease fitting must be installed in the housing of the equipment. In this case, the threaded-end and head-end are properly closed off using both of the plugs provided with each cam follower.

Lubrication

Cam Followers and Cam Yoke Rollers are packed at the factory with a petroleum-base, lithium grease with extreme pressure and corrosive resistant additives. This lubricant is suitable for most bearing applications within a temperature range of -30 °F to 250 °F. Re-lubrication in service can be accomplished with any non-soap based roller bearing grease or oil. Special greases or oils can be specified if required.

Frequency of lubrication will depend upon the speed of bearing rotation, contaminants present in the application and the type of lubricant used. In continuously rotating applications, constant oil lubrication or frequent grease lubrication may be necessary.

Stud-Type Cam Followers can be re-lubricated in three areas: through either end of the stud (head-end or threaded-end) or through the cross-drilled hole in the stud. The four smallest size cam followers (CR-1/2, CR-9/16, CR-5/8, CR-11/16) can be re-lubricated through the head-end only due to the diameter constraints of the stud. The axial lubrication hole in the stud is linked to a radial hole in the raceway of the bearing allowing the lubricant to reach the needles. The ends of the stud are counter-bored and precision-reamed to accept a drive-type lubrication grease fitting (not furnished). Two precision-machined plugs are supplied with each cam follower and should be pressed into the unused re-lubrication holes in the end of the studs. The housing that the cam follower is mounted into serves to block the cross-drilled re-lubrication hole in the stud when the re-lubrication hole is not being used. (See Fig 1 & 2).

Yoke Rollers can be re-lubricated through the oil holes that are drilled in the inner race of the bearing. The mounting pin that supports the bearing must be drilled so that lubrication hole lines up with the oil hole in the bearing.

For grease relubrication of the Cam Follower **CR** Series and **HR** Series, the following drive type fittings are suggested:

Cam Follower Size	Lubrication Fitting
CR-1/2 to CR-11/16 HR-1/2 to HR-5/8	1/8" Alemite Fitting #3019
CR-3/4 to CR-23/4 HR-3/4 to HR-23/4	3/16" Alemite Fitting #1728-B, #1633, #1645-B, #3005, #3006, #3009, #3012-BB
CR-3 to CR-4 HR-3 to HR-4	1/4" Alemite Fitting #1743 or #1743-B
CR-5 to CR-6	1/4" N.P.T. fitting

Cam Followers – Stud & Yoke Type

Mounting Stud-Type Cam Followers

Proper cam follower mounting requires a close precision fit between the stud and housing bore. We recommend using bore sizes provided in the dimensional tables. An arbor press is the preferred means of stud installation with pressure applied to the central area of the stud, not to the outer flange edges.

In positioning the cam follower, the end washer should be firmly supported by the shoulder of the machine member, which must be square with the centerline of the stud. The shoulder should be at least as large as the minimum boss diameter given in the dimensional tables as denoted by the "E" dimension (**Fig. 4**). It is also important that the alignment be maintained between the bearing axis and the cam or track surface to prevent edge loading of the bearing outer race. The dimensional tables list the recommended torque to be applied to the nut. Excessive torque, in particular with small sizes, may damage the internal elements. Torque value for lubricated threads should be reduced by half the value given in the dimensional tables.

Mounting Yoke-Type Cam Followers

The mounting of yoke rollers should provide for endwise clamping to prevent axial movement and displacement of the end washer. The end washer should be firmly supported by a flat housing shoulder, which must be square with the centerline of the bearing. The shoulder should be at least as large as the minimum clamping diameter shown in the dimensional tables as denoted by the "E" dimension (**Fig. 5**) to provide adequate washer support.

The recommended shaft diameters listed in the dimensional tables provide for either a slip or press fit. In applications with extreme loads, the stud should be heat-treated and press-fit into the bearing bore. With moderate loads, a hardened stud should be used but a slip-fit is sufficient. In lightly loaded applications, a slip-fit may be used with a non-hardened stud.

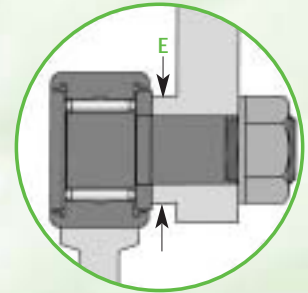


Fig. 4 Mounting of a Stud Type Cam Follower

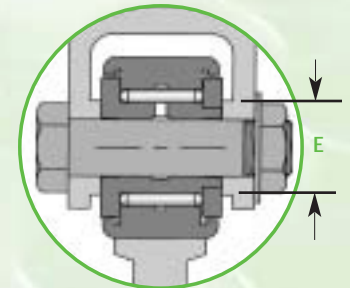


Fig. 5 Mounting of a Yoke Type Cam Follower

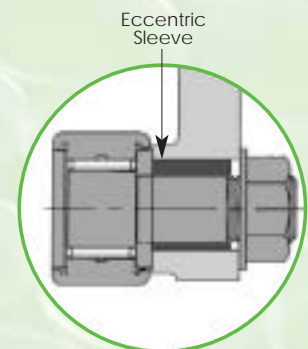


Fig. 6 Mounting of a Stud Type Cam Follower with Eccentric Sleeve

Bearing Life & Load Calculations

Bearing Life

Properly selected bearings that have been suitably mounted and lubricated will operate for extended periods of time with minimal wear until the fatigue life of the rolling elements is reached. Fatigue life of a bearing is reached when "spalling" or flaking of the contact surfaces (rolling element and raceway) occur from repeated stresses. Once the fatigue life of the rolling element or raceway is reached, wear and ultimate failure of the bearing will occur very rapidly. The purpose is to select the proper type and size of bearing for the intended application in order to optimize performance and operating life.

The life of a bearing can be defined in terms of hours of operation or number of revolutions the bearing will endure before failure. We need to keep in mind that some variations between individual bearings that look identical do exist. The most common definition of bearing life as defined by the ABMA (American Bearing Manufacturer's Association) is referred to as the **L₁₀ life**. The "**L₁₀ life**" of a bearing is the number of hours that 90% of a group of seemingly identical bearings will operate prior to fatigue failure occurring. The **L₁₀ life** can also be expressed in the number of revolutions when the speed is known. When selecting a bearing the machine designer should select an appropriate **L₁₀ life** for the particular application.

Note: Larger bearings will have a longer expected life than smaller bearings under identical conditions. Heavier loads will decrease the expected life of a bearing. Therefore, to maximize operating life, the largest bearing possible should be used. See equations to right.

Bearing Size and Selection

Once the type of bearing for a specific application has been selected, the designer must then choose the size of bearing required for the application. The larger the bearing the larger the load it is capable of handling. The **Basic Dynamic Rating (BDR)**, or its equivalent is an indication of how much dynamic load a given bearing size can handle. This rating is a reference value only and is based on an **L₁₀ life** of 500 hours at a rotation speed of 33^{1/3} RPM. In actual practice, the bearing should never be subjected to more than 50% of this value. The **Maximum Static Capacity** is the largest static load that can be applied to the bearing before the rolling elements become permanently deformed. For stud type cam followers, the maximum static capacity is the largest static load that can be applied before the stud will bend or deform.

The life expectancy (**L₁₀ life**) in hours of a bearing can be calculated by using the following formula:

$$L_{10} = \frac{16,666}{N} \left(\frac{BDR}{P} \right)^{10/3}$$

The **Basic Dynamic Rating (BDR)** required for a given application can be calculated by using following formula:

$$BDR = .054 \times P \times (L_{10} \times N)^{.3}$$

L₁₀ = Life of the bearing in hours of operation

BDR = Basic Dynamic Rating of the bearing

P = Radial Load (lbs)

N = Speed (RPM)

Bearing Life & Load Calculations

Example 1:

Determine the **L₁₀ life** of a **CR-7/8** cam follower operating at a speed of **500 RPM** under a load of **750 lbs**:

Find the **Basic Dynamic Rating (BDR)** in the specification page for the **CR-7/8** cam follower:

BDR (Basic Dynamic Rating) = 2140 lbs

From the given formula:

$$L_{10} = \frac{16,666}{N} \left(\frac{BDR}{P} \right)^{10/3}$$

$$L_{10} = \frac{16,666}{500} \left(\frac{2140}{750} \right)^{10/3}$$

$$L_{10} = 1098 \text{ hrs.}$$

Note: This shows the expected operating life for the **CR-7/8** under the above conditions is 1098 hours. If a longer life span is desired and room for installation permits, a larger bearing with a higher Basic Dynamic Rating (BDR) could be selected. For example: a **CR-1 1/4** cam follower with a BDR (Basic Dynamic Rating) of **4470 lbs** will operate for 12,794 hours in the identical application.

Example 2:

Determine the required **Basic Dynamic Rating (BDR)** for a bearing that will be operating at **1000 RPM** with an applied load of **400 lbs**. The machine designer has determined that the application requires an **L₁₀ life** of **15,000 hrs**.

From the given formula:

$$BDR = .054 \times P \times (L_{10} \times N)^{.3}$$

$$BDR = .054 \times 400 \times (15,000 \times 1,000)^{.3}$$

$$BDR = 3071 \text{ lbs}$$

Note: A **CR-1 1/4** cam follower with a Basic Dynamic Rating (BDR) of **4470 lbs**. would be chosen for this application. If A **CR-1** cam follower with a Basic Dynamic Rating (BDR) of **3030 lbs** were used, the operating life would be reduced to **14,226 hrs**. See Example 1.

Bearing Life Calculations using Speed Factor & Life Factor Charts

An alternative method for determining the **L₁₀ life** or the desired **Basic Dynamic Rating (BDR)** required for a particular application is by using the **SPEED Factor** and **LIFE Factor** charts. Use given formula below:

BDR = Applied Load x (SF) Speed Factor x (LF) Life Factor

Example 3:

Determine the **Basic Dynamic Rating (BDR)** for a bearing that will be operating at **250 RPM** with an applied load of **2000 lbs**. The required **L₁₀ life** for the application is **600 hrs**.

From the given formula above and using Speed and Life Charts below:

BDR = Applied Load x (SF) Speed Factor x (LF) Life Factor

BDR = 2000 x 1.83 x 1.064

BDR = 3895 lbs

Speed Factors Chart

RPM	SF	RPM	SF
33 1/3	1.000	1200	2.940
40	1.056	1300	3.000
50	1.120	1400	3.070
60	1.193	1500	3.125
70	1.249	1600	3.200
80	1.300	1700	3.250
90	1.347	1800	3.310
100	1.390	1900	3.365
125	1.499	2000	3.420
150	1.570	2100	3.460
175	1.644	2200	3.520
200	1.712	2400	3.610
250	1.830	2600	3.700
300	1.935	2800	3.780
350	2.025	3000	3.860
400	2.105	3200	3.930
450	2.185	3400	4.010
500	2.250	3600	4.070
600	2.380	3800	4.150
700	2.490	4000	4.210
800	2.590	4200	4.270
900	2.690	4400	4.330
1000	2.780	4600	4.380
1100	2.850	4800	4.440

Life Factors Chart

L ₁₀ Life (hrs)	LF	L ₁₀ Life (hrs)	LF
500	1.000	16,000	2.83
600	1.064	18,000	2.93
700	1.102	20,000	3.03
800	1.151	25,000	3.24
900	1.193	30,000	3.42
1000	1.231	35,000	3.57
1200	1.300	40,000	3.73
1400	1.362	45,000	3.86
1600	1.417	50,000	3.98
1800	1.468	60,000	4.21
2000	1.515	70,000	4.41
2500	1.620	80,000	4.59
3000	1.712	90,000	4.75
3500	1.793	100,000	4.90
4000	1.866	120,000	5.18
4500	1.933	140,000	5.43
5000	1.995	160,000	5.65
6000	2.110	180,000	5.85
7000	2.210	200,000	6.04
8000	2.300	220,000	6.20
9000	2.380	240,000	6.38
10000	2.460	260,000	6.54
12000	2.600	280,000	6.68
14000	2.720	300,000	6.81

Shock Load

The load ratings for bearings are based on smooth and uniformly applied loads. When the load on the bearing is such that shock or vibration is present the bearing capacity must be increased. Use the load classification chart to adjust the actual load to the effective load that is seen by the bearing. The actual bearing load should be multiplied by the relevant factor when calculating bearing life or when determining the required BDR (Basic Dynamic Rating) for the application.

Load Classification Chart

Load Classification	Factor
Uniform and Smooth	1.0
Light Shock	1.5
Moderate Shock	2.0
Heavy Shock	3.0

Example:

If a bearing is subjected to a 600 lb load under "moderate shock" conditions, a 1200 lb load should be assumed for bearing selection purposes.

Track Capacity

In normal applications cam followers and yoke rollers operate against a track, cam or rail on a piece of machinery or equipment. The **Track Capacity** is the maximum load that a steel track of a given tensile strength will withstand without plastic deformation or brinelling of the track surface when operating with a particular size bearing. Track capacities increase with larger bearings due to the increase in contact surface. The following tables allow you to determine the track capacities for steel tracks of various hardness and tensile strengths when used with different size cam followers and yoke rollers. When using crowned bearings assume 80% of the value for track capacities due to a decrease in contact area between the track and bearing outer race.

To determine the **Track Capacity** for a particular track of given hardness or tensile strength and bearing size, multiply the **Capacity Factor** in Table 2 by the **Track Capacity** in Table 1.

Example:

Track Hardness = 32 Rockwell "C"

Bearing Size = 1 1/2

To determine the **Track Capacity** multiply the **Capacity Factor** in Table 2 by the **Track Capacity** in Table 1.

Track Capacity= .61 x 3760 lbs. = 2282 lbs

Table 1

Basic Bearing Size	Track Capacity @ 180,000 P.S.I.
1/2	515
9/16	570
5/8	710
11/16	850
3/4	1050
7/8	1190
1	1560
1 1/8	1750
1 1/4	2425
1 3/8	2650
1 1/2	3475
1 5/8	3760
1 3/4	4640
1 7/8	4960
2	6725
2 1/4	7560
2 1/2	9640
2 3/4	12560
3	13750
3 1/4	14900
3 1/2	18800
4	20600
5	36400
6	52000

Table 2

Track Tensile	Rockwell "C" Hardness	Capacity Factor
120,000	26	.45
140,000	32	.61
160,000	36	.79
180,000	40	1.00
200,000	44	1.24
220,000	47	1.50
240,000	50	1.78

Bearing Weights (lbs)

Bearing Size	CR Series	HR Series	YR Series
1/2	.03	.03	-
9/16	.04	-	-
5/8	.05	.05	-
11/16	.06	-	-
3/4	.08	.08	.06
7/8	.10	.10	.08
1	.17	.20	.15
1 1/8	.20	.24	.17
1 1/4	.32	.38	.24
1 3/8	.38	.44	.30
1 1/2	.55	.69	.41
1 5/8	.61	.75	.50
1 3/4	.88	1.00	.64
1 7/8	.97	1.38	.80
2	1.41	1.56	1.05
2 1/4	1.69	1.88	1.32
2 1/2	2.50	2.75	1.80
2 3/4	3.00	3.19	2.25
3	4.00	4.56	3.10
3 1/4	4.50	5.19	3.62
3 1/2	6.42	7.01	4.95
4	9.46	10.83	7.05
5	19.60	-	14.34
6	32.75	-	20.25

Hexagonal Wrench Sizes

Bearing Size	Hex Wrench Size
1/2	1/8
9/16	1/8
5/8	1/8
11/16	1/8
3/4	3/16
7/8	3/16
1	1/4
1 1/8	1/4
1 1/4	1/4
1 3/8	1/4
1 1/2	5/16
1 5/8	5/16
1 3/4	5/16
1 7/8	5/16
2	7/16
2 1/4	7/16
2 1/2	1/2
2 3/4	1/2
3	5/8
3 1/4	5/8
3 1/2	5/8
4	3/4
5	1
6	1

High Temperature Applications:

When using bearings at elevated temperatures the subsequent load ratings will be reduced. Standard bearings manufactured from SAE-52100 Bearing Steel will lose 10% of their rating when operating at 400 °F. **Smith Bearing®** specializes in manufacturing bearings from exotic alloys designed for high-strength, corrosion-resistance or elevated temperatures. The temperature chart below demonstrates the different specialty alloys that are available and the effect that temperature has on the load rating.

Temperature Effect on % Load Rating (approx. percentages, ref. only)

MATERIALS	Temperature °F						
	200	300	400	500	600	700	800
M-50 Tool Steel	100	100	97	96	96	95	90
M-2 Tool Steel	100	100	100	100	100	100	98
M-10 Tool Steel	100	100	100	100	100	100	97
440-C	100	95	90	86	80	72	60
SAE 52-100	100	97	90	75	50	25	15

TOLERANCE CHART for Metric Bearings
MCR-Series, MYR-Series, NUKR-Series, MUTD-Series

Cylindrical Roller Diameter "D"

SIZE		TOLERANCE	
Over	Including	Maximum	Minimum
6 mm	18 mm	0	-0.008 mm
18 mm	30 mm	0	-0.009 mm
30 mm	50 mm	0	-0.010 mm
50 mm	80 mm	0	-0.013 mm
80 mm	120 mm	0	-0.015 mm

Crowned Roller Diameter "D"

SIZE		TOLERANCE	
Over	Including	Maximum	Minimum
6 mm	120 mm	0	-0.050 mm

Stud Diameter "d"

SIZE		TOLERANCE	
Over	Including	Maximum	Minimum
2 mm	6 mm	0	-0.012 mm
6 mm	10 mm	0	-0.015 mm
10 mm	18 mm	0	-0.018 mm
18 mm	30 mm	0	-0.021 mm

Bore Diameter "d" for Yoke Rollers

SIZE		TOLERANCE	
Over	Including	Maximum	Minimum
2 mm	17 mm	0	-0.008 mm
17 mm	30 mm	0	-0.010 mm
30 mm	50 mm	0	-0.012 mm
50 mm	80 mm	0	-0.015 mm
80 mm	120 mm	0	-0.200 mm