ESC REPORT

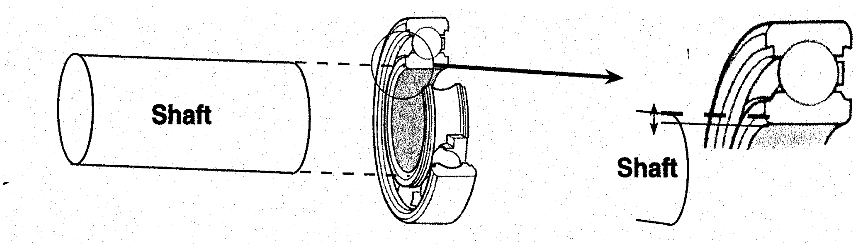
Bearing Installation — Fitting Practice

May 2000

One of the objectives of proper bearing installation is to achieve radial retention of the bearing rings on their respective seats.

Neither ring should be allowed to rotate on its seating surface (shaft for the inner, housing bore for the outer). such movement will allow the ring(s) to wear away the seating surface, making subsequent installations more susceptible to this abrasion. For this reason, it is very important to prevent loss of radial retention by proper selection of shaft and housing bore dimensions and tolerances.

The recommended method for achieving radial retention is to create an interference, or press fit, between the bearing ring and its seat.By manufacturing the shaft diameter slightly larger than the bearing bore, the inner ring is expanded during installation and thus "grips" the shaft. Likewise, when the housing bore is machined slightly smaller than the outside diameter of the outer ring, a press fit is also accomplished. The pressed ring grips the seat with enough force to overcome rotational torque during bearing operation.



Bearing bore slightly smaller than the shaft diameter

General rule

To Facilitate ease of installation and ensure adequate residual radial internal clearance, it is desirable to press fit only the ring most susceptible to rotation in its seat. Bearing load direction and magnitude determine which ring to be press fitted and how much interference is necessary to achieve retention. The chart in the Appendix shows that the general rule is to press fit the ring that rotates in relation to the load direction. Also

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in the Appendix, the degree of interference is shown based on the type of application, and the ratio of the bearing load to the bearing dynamic capacity. Heavier loads require a greater interference since the rotational torque inside the bearing tends to break the ring free to rotate.

Note that the chart in the Appendix recommends a "loose fit" for rings, which must move axially on their seats to allow thermal expansion of the seat without inducing a thrust load on the learing. These rings are allowed to "float" on their seats and hence must not be installed with a press fit.

ISO Coding System

The International Standards Organization (ISO), has established standards for both machining quality (tolerances), and degree of interference/clearance between ring and seat. This allows manufacturers worldwide to communicate fitting practice without confusion.

The ISO code consists of a letter (degree of interference/clearance), followed by a number defining the machining quality (amount of tolerance). To prevent confusion, the lower case letters are used to define an outside diameter (shaft OD) and conversely the upper case letters define an inside diameter (housing bore) dimension. The degree of interference furthermore increases as the letters get further down the alphabet (i.e.,"m" is a greater press fit than "j").The number that follows the letter is a code that defines the quality of machining, or the acceptable spread of diameter tolerances. The smaller the number, the smaller the tolerance. A common fitting practice in use for many bearing applications is j6/H7.

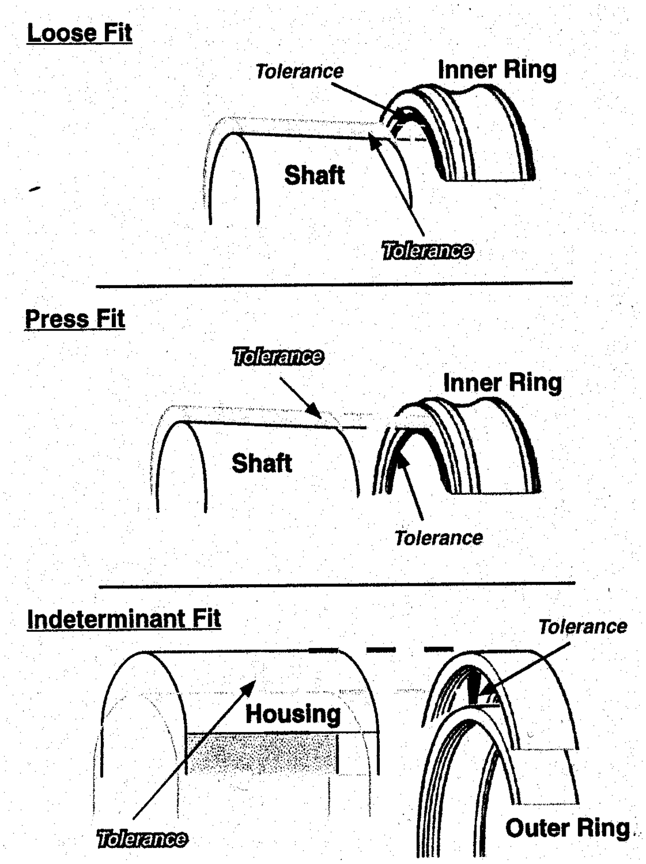
For example

T**hree different conditions** can be achieved by comparing the tolerances of the bearing ring with that of the respective seat.

First there is the "press/interference" fit where regardless of where the seat dimension falls in its tolerance range, an interference fit will always result. Referring to the attached charts:

Bearing bore = 50 mm (+O/-l2 microns)

k6 tolerance for a shaft 50 mm (+2/+18 microns) Therefore the largest bearing bore (50.000 mm) when matched with the smallest



shaft (50.002 mm) will still yield an interference of 2 microns.

Secondly, a fitting practice may be selected to ensure a loose fit occurs, possibly to allow a ring to float axially.

Bearing outside diameter = 100 mm (+O/-l5 microns),

G7 tolerance for housing bore is (+l2/+47 microns).

So the largest bearing outside diameter is 100 mm and the smallest housing bore is 100.012 mm, thus a loose fit is ensured.

Finally, an "indeterminant" fit can be achieved.

Bearing bore = 80 mm (+O/-l5 microns),

j6 tolerance for a shaft 80mm is (-7/+12 microns).

Largest bearing bore = 80.000 mm, smallest shaft diameter is 79.993 mm (loose fit of 7 microns). Smallest bearing bore = 79.985 mm, largest shaft diameter is 80.012 mm (interference of 27 microns). It can be seen that the resultant fit will likely be a slight interference (average press = 1 0 microns).

Conclusion:

By carefully selecting and maintaining the correct fitting practice associated with the application, the bearing will be retained in the radial direction to prevent shaft, housing, and/or bearing damage.

One of the objectives of proper bearing installation is to achieve radial retention of the bearing rings on their respective seats.

Neither ring should be allowed to rotate on its seating surface (shaft for the inner, housing bore for the outer). Such movement will allow the ring(s) to wear away the seating surface, making subsequent installations more susceptible to this abrasion. For this reason, it is very important to prevent loss of radial retention by proper selection of shaft and housing bore dimensions and tolerances.

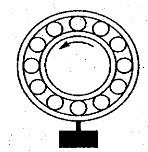
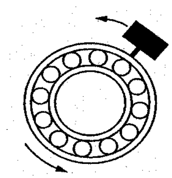
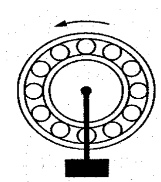
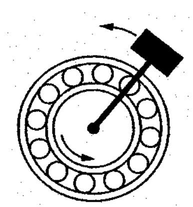
The recommended method for achieving radial retention is to create an interference, or press fit, between the bearing ring and its seat. By manufacturing the shaft diameter slightly larger than the bearing bore, the inner ring is expanded during installation and thus "grips" the shaft. Likewise, when the housing bore is machined slightly smaller than the outside diameter of the outer ring, a press fit is also accomplished. The pressed ring grips the seat with enough force to overcome rotational torque during bearing operation.

To facilitate ease of installation and ensure adequate residual radial internal clearance, it is desirable to press fit only the ring most susceptible to rotation on its seat. Bearing load direction and magnitude determine which ring to be press fitted and how much interference is necessary to achieve retention. The chart in the Appendix shows that the general rule is to press fit the ring that rotates in relation to the load direction. Also in the Appendix, the degree of interference is shown based on the type of application and the ratio of the bearing load to the bearing dynamic capacity. Heavier loads require a greater interference since the rotational torque inside the bearing tends to break the ring free to rotate.

Note that the chart in the Appendix recommends a "loose fit" for rings, which must move axially on their seats to allow thermal expansion of the seat without inducing a thrust load on the bearing. These rings are allowed to "float" on their seats and hence must not be installed with a press fit.

The Educational Services Committee acknowledges with appreciation the contribution of Peter Torras, SNR Bearings, for providing valuable information for this report.

Appendix: Radial retention rules and fit requirements

Bearing retention rules		Recommended fits	
Type of rotation	*Type of retention*	*Shafts*	*Housings*
Direction of the load fixed in relation to outer ring.			
Stationary housing and load	 Inner ring press fitted on the shaft	Normal loads C/P >5 j6/k6 Electric motors Machine tool spindel Pumps Fans Speed Reducers	General case H7/J7 Medium electric motors Pulleys Machine-tool spindles Power transmission systems
Rotating housing and load Stationary shaft		Heavy loads C/P <5 m6/p6 Traction motors Large gear reducers Large compressors	Ring loose fitted in its seat G7/H7 Axial displacement required (expansion or adjustment) Cylindrical and tapered bearings M7 to P7
Direction of the load fixed in relation to inner ring.			
Stationary shaft and load		General case g6/h6 Idler pulleys Tensioners Wheels	Normal loads C/P >5 M7/N7 Idler pullers, Tensioners Wheels
Rotating housing Rotating shaft & load Stationary housing	Outer ring press fitted in the housing. 	Ring loose fitted on its seatf f6/g6 Axial displacement required (expansion adjustment)	Very heavy loads Heavy loads with impact C/P<5 N7/P7 Railway equipment Large roller bearings
Other cases		Axial loads only h6/j6 Thrust bearings Adapter sleeves h9 Power transmission for agricultural equipment	Axial loads only G7/H7 Thrust bearings