Radial Clearance

Virtually all rolling element bearings are designed with a specific internal clearance. The internal clearance is defined as the total clearance between the rings and the rolling elements. This clearance provides:

- Free rotation of rolling element
- Compensation for thermal expansion
- Optimum load distribution

Selecting the correct internal clearance is important because bearings hold the rotating parts of a mechanism in proper position across the entire performance envelope of the application. The amount of internal clearance can influence:

- Noise
- Vibration
- Heat build-up
- Fatigue life

Vibration, interface fits and temperature will also have some effect on internal clearance. To obtain the optimal internal clearance for a specific application, these parameters must be taken into consideration. In certain applications, the correct choice of clearance for the bearings is critical. Internal clearance can be separated into two categories:

- Radial
- Axial

The total internal clearance is the amount that one ring can be displaced relative to the other ring, either radially or axially. The radial clearance is the total clearance between the raceway and the rolling elements - measured normal to the bearing axis.

The clearance changes with the expansion or contraction of the bearing rings. The axial clearance is the total amount that one ring can be displaced relative to the other in an axial direction.

In ball bearings, as the radial clearance increases, the axial clearance increases as well. The more room between the balls and the rings (radial clearance), the more the elements can shift in relation to each other. Generally, internal clearances are designated from C1 (the tightest) through to C5 (the loosest or largest). The 'normal' clearance is CN, a range sitting between C2 and C3. It is worth noting that if the bearing clearance is not stated in the bearing reference it can be assumed to be normal clearance. With a higher clearance there is more tolerance of thermal expansion effects on the rings and rolling elements. When noise and vibration must be restricted, lower clearances are necessary. Ultimately the specific application and operating conditions determine the appropriate internal clearance. For example, paper-drying machines that operate under hot conditions usually need C3 and C4 clearances. The severe vibration in vibrating screens normally means that C3 and C4 clearances are required. Selection of the correct radial internal clearance group is by calculation and you should refer to your bearing manufacturers' handbook. Factors to be assessed include:

- Expansion of the inner ring due to interference fit on shaft.
- Contraction of the outer ring due to interference fit in the housing.
- Differential temperature between the inner and outer rings
- Differential expansions due to non-ferrous mountings

In addition to the ISO clearances, manufacturers such as NSK also offer specific clearances for electric motors known as CM clearance. This class includes a tighter noise specification. The CM clearance falls within the range of the CN clearance. Some motor manufacturers specify CM clearance where closer radial internal clearance helps reduce noise. C3 clearance, which is frequently used in the aftermarket, is greater than the CN and CM clearances.