THIN SECTION BALL BEARING ENGINEERING DATA

The methods, equations, and technical data presented in this section allow the user to select the correct bearings and estimate their performance for a wide range of applications. For applications with severe or unusual operating conditions, RBC is prepared to provide an in-depth analysis and recommend the most suitable bearing arrangement.

Where standard bearings cannot be used, RBC can meet the application requirements with a special bearing design specifically tailored for optimum performance. Contact your RBC Sales Engineer for special sizes, materials, application requirements, dimensions and tolerances.

Capacity and Fatigue Life of Ball Bearings

The BASIC DYNAMIC RADIAL LOAD RATING, C, or "dynamic capacity", for a ball bearing is the calculated, constant radial load at which 90% of a group of apparently identical bearings with stationary outer rings can statistically endure 10^6 revolution of the inner ring. ANSI/ABMA Standard 9 with correction factors for race curvatures was used to calculate the catalog ratings.

The DYNAMIC THRUST and DYNAMIC MOMENT LOAD RATINGS are also shown in the product tables. The ratings shown are a guide for the maximum loads under which these bearings should be operated with either pure thrust or pure moment loading. Thrust ratings are 2.5 to 3.0 times the radial ratings depending on the bearing type and cross section. These load ratings are not additive. For combined radial and thrust loads, an equivalent radial load is to be calculated.

The BASIC STATIC LOAD RATING, C_o, or "static capacity", is that uniformly distributed load, which produces a maximum theoretical contact stress of 609,000 psi. At this contact stress permanent deformation of ball and raceway occurs. This deformation is approximately .0001% of the ball diameter.

The RATING LIFE, L_{10}, is a statistical measure of the life which 90% of a large group of apparently identical ball bearings will achieve or exceed. For a single bearing, L_{10} also refers to the life associated with 90% reliability. Median Life, L_{50}, is the life which 50% of the group of ball bearings will achieve or exceed. Median life is approximately five times the rating life.
The relationship between rating life, load rating, and load is:

$L_{10} = (C/P)^3$ with L_{10} = rating life (10^6 rev)
C = basic dynamic radial load rating (lbf)
P = equivalent radial load (lbf)

To obtain the rating life in hours, use:
$L_{10\ hrs} = 16667/N * (C/P)^3$ with N = speed (rpm)

The Equivalent Radial Load is defined as:
$P = XF_r + YF_a$ with F_r = radial load (lbf)
F_a = axial load (lbf)
X - see below
Y - see below

Radial Contact Bearing Calculations

For radial contact bearings calculate P with X = 1 and Y = 0. Then recalculate P with X = 0.56 and Y = (see chart below). Use the larger value of P to determine L_{10} life.

$\frac{F_a}{nd^2}$	Y
25	2.30
50	1.99
100	1.71
150	1.55
200	1.45
300	1.31
500	1.15
750	1.04
1000	1.00

n = number of balls
d = diameter of balls (in.)

Angular or 4-Point Contact Bearing Calculations

For angular contact and 4-point contact bearings calculate P with X = 1.0 and Y = 0. Then recalculate P with X = 0.39 and Y = 0.76. Use the larger value of P to determine L_{10} life.

The equations are valid in the range of approximately 100 hrs to 100,000 hrs of life. Extreme loads or speeds may result in a shorter life; while in less demanding applications, metal fatigue may never affect bearing service life.

Capacity and fatigue life information is based on ANSI/ABMA Standard 9-1990 published by: The American Bearing Manufacturers Association, Inc., 1200 19th Street, NW, Suite 300, Washington, DC 20036-2401

Adjustment Factors for Rating Life

If a bearing design and operation deviates significantly from normal, it may be necessary to use additional factors to estimate the fatigue life L_n.

$L_n = a_1 * a_2 * a_3 * L_{10\ hrs}$

with a_1 = reliability factor
a_2 = material & processing factor
a_3 = application factor

Reliability Factor a_1

Reliability is the percentage of a group of apparently identical ball bearings that is expected to attain or exceed a specified life. For an individual bearing it is the probability that the bearing will attain or exceed a specified life. Typical bearing fatigue life is calculated for 90% reliability. The life adjustment factors for other reliability numbers are shown below.

Reliability %	L_n	Reliability Factor a_1
90	L_{10}	1.00
95	L_5	.62
96	L_4	.53
97	L_3	.44
98	L_2	.33
99	L_1	.21

Material Factor a_2

For standard bearings the material factor a_2 is equal to 1.00. Factor a_2 is determined by material processing, forming methods, heat treatment, and other manufacturing methods. Some commonly used material factors are listed below:

Material, Condition	a_2 max
52100, Air melt	1.00
52100, Vacuum degassed	1.50
52100, Air melt & TDC Plate	2.00
52100, Vacuum melt, (CEVM)	3.00
440C, Air melt	1.00
440C, Vacuum melt (CEVM)	3.00
M50, Vacuum melt (CEVM)	5.00
M50, Vacuum re-melt (VIM-VAR)	8.00

Application Factor a_3

The application factor a_3 is equal to 1.0 for most applications. Unusual or extreme conditions in certain applications such as low speed, shock loading, vibration, and extreme temperature may lower the application factor to 0.50. Contact your RBC Sales Engineer for help in determining this factor for your special applications.

Load and Speed Limitations

The load ratings shown in the product tables are not additive. For combined simultaneous loading, an equivalent radial or thrust load must be considered. In general, C-Type bearings are designed for radial loading applications; moderate thrust and/or moment loading may be applied in combination with radial loading. For thrust loading applications use the A-Type bearing; any radial loading should only be applied in combination with thrust loading. X-Type bearings are primarily for reversing thrust and moment loading, pure radial loading should not be applied.

The limiting speeds shown in the product tables are based on standard lubrication. The unsealed bearing speeds are calculated assuming the bearings are lubricated with MIL-PRF-6085. Limiting speeds for sealed bearings are calculated assuming the bearings are lubricated with MIL-PRF-23827 grease. If bearings are lubricated with alternate oils or greases, new limiting speeds must be calculated, see page 113.