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Application Consideration	Mounted Bearing Recommendation	Reference	Starting Page
Vibration	Where vibration is a concern typified by fan and blower applications BOA Concentric Ball Bearings can be used. The concentric lock keeps the shaft centered in the bearing, maintains ball path roundness, and reduces bearing induced vibration. Rubber Mounted inserts and pillow blocks are available for shock absorption.	Mounted Ball Information BOA Concentric Information Rubber Mount Information Vibration Analysis	 50 85, 91 289
Reversing	Eccentric Locking should be avoided on reversing applications. This lock may be loosened where frequent and quick reversing takes place. Set screw, BOA Concentric, tapered adapter or press fit locking is recommended.	Mounted Ball Information Set Screw Lock BOA Concentric Spherical Roller Information 1000/1100 22200/22500 Tapered Roller Information E920 970	 4 50 122 136 98 112
Thin Mounting Surface	When applying mounted ball bearings to thin framework solid base housings avoid frame bending. Controlled loose fit between insert and housing in the "AH" ball bearing provides misalignment without causing frame flexing. Identify stock Air Handling units by noting the (AH) symbol next to the housing size on dimension pages. Other sizes may be available depending on quantities and lead time requirements.	Ball Bearing Information Set Screw Lock BOA Concentric "AH" Ball Bearing Information	 4 50 48
Tight Space Constraint	Tapped Base pillow block housings provide reduced dimensions with mounting through the base where space is at a premium. Two bolt flanges are convenient for side mounting in space restricted areas.	Tapped Base Information Set Screw Lock (200) BOA Concentric (200) Eccentric Lock (100) Two Bolt Flange Information Set Screw Lock (200) Set Screw Lock (300) Set Screw Lock (100) BOA Concentric (200) BOA Concentric (300) Eccentric Lock (200) Eccentric Lock (100)	 11 56 80 8 19 28 54 61 70 78
Specialty Shafting	When expensive shafting such as hardened or stainless steel is used Tapered Adapter and BOA Concentric bearings will provide more reliable locking and eliminate shaft marring caused by Set Screw and Eccentric lock bearings.	BOA Concentric Information Tapered Adapter Information	50 136
Frequent Bearing Removal	Eccentric Lock and BOA Concentric bearings provide easy removal from the shaft on applications that require frequent bearing adjustment or relocation on the shaft.	BOA Concentric Information Eccentric Lock Ball Bearings Eccentric Lock Tapered 900 950	50 66 108 112

Application Consideration	Mounted Bearing Recommendation	Reference	Starting Page
High Speed	Consider Ball Bearings. Point contact between balls and bearing race has low friction. Maximum speed capacity varies by bore size. Concentric locking as available with BOA Concentric is best for very high speeds.	Mounted Ball Information Load / Speed Ratings BOA Concentric Information	 266 50
High Load	Roller Bearings have higher load capacity than ball bearings. Spherical Rollers handle higher speeds than Tapered Rollers where combinations of higher speed and higher load exist.	Load / Speed Ratings Spherical Roller Information 1000/1100 22200/22500 Tapered Roller Information 900/950 920/970	268 270 271 268 269
Thrust Load	Tapered Roller Bearing can handle high thrust and combination loads. Spherical Bearings and Ball Bearings can handle limited thrust. An engineering review is recommended where thrust and high speed exist.	Load / Speed Ratings Tapered Roller Information 900/950 920/970	268 268 269
Shock Load	Ductile and Cast Steel Housings can be used in heavy shock environments. These materials have a higher modulus of elasticity and therefore absorb impacts better.	Ductile Tapered Roller Bearings Ductile Shperical Roller Bearings Cast Steel Spherical Roller Bearings	112 123 140, 142
Static Misalignment	950 and 970 Tapered Roller Bearings and all Housed Mounted Ball Bearings are externally self aligning (the bearing insert can misalign with respect to the housing.) These bearings are well suited for applications with static misalignment. Misalignment limits should be considered for each specific bearing type relative to application needs.	Ball Bearing Information Set Screw Lock BOA Concentric Eccentric Lock Tapered Roller Information 950/970	 4 50 66 112
Dynamic Misalignment	All Spherical Roller Bearings are internally self aligning (the rollers can misalign with respect to the bearing races.) This design permits dynamic misalignment. Misalignment limits should be considered for each specific bearing type relative to application needs.	Spherical Bearing Information 1000/1100 22200/22500	 122 136
Vertical Shaft	Set Screw locking is generally recommended on vertical shaft applications. Considerations should be made to account for thrust loads typical on vertical shafts. Other locking types can be used if proper support is provided. Four Bolt Flanges and Flange Cartridges provide good bearing support for vertical shafts.	Mounted Ball Information Set Screw Lock Spherical Roller Information 1000/1100 Tapered Roller Information 920 970	 4 122 100 112
Noise	Where bearing noise is an issue, Ball bearings with an "AH" suffix can be used. The "AH" suffix specifies bearings with a special housing fit and 100% noise testing. Identify stock Air Handling units by noting the (AH) symbol next to the housing size on dimension pages. Other sizes may be available depending on quantities and lead time requirements.	AH Ball Bearing Information	48

Application Consideration	Mounted Bearing Recommendation	Reference	Starting Page
Adjustable Shaft Centers	Applications requiring adjustment of shaft centers necessary for belt tensioning may require take up bearings and frames. The housings are slotted and can travel along the frame to change the location of the belt pulleys or sheaves.	Ball Bearing Take-up Information	
		Set Screw Lock (200)	6
		Set Screw Lock (300)	18
		Set Screw Lock (100)	26
		Eccentric Lock (200)	68
		Eccentric Lock (100)	76
		Tapered Roller Take-up Information	
		900	98
		E920	98
		Spherical Roller Take-up Information	
		1000	122
		Take Up Frames for Pillow Blocks	
		Ball Bearing	13
		Spherical Roller	149
Eccentric Loads	Equipment with eccentric loading may require a housing that prevents movement between the housing and the mounting surface. Piloted Flange Cartridges have a machined flange that mates with a machined opening in the equipment to maintain bearing location. For eccentric loads a technical review is recommended.	Ball Bearing Piloted Flanges	
		Set Screw Lock (200)	10
		Set Screw Lock (300)	21
		BOA Concentric (200)	57
		BOA Concentric (300)	63
		Roller Bearing Piloted Flanges	
		900	102
		1000	130
		1100	134
Rollers and Idlers	VER bearings are designed to be pressed into a conveyor pulley or idler roll. The cylindrical outside diameter presses into the mating part and location is controlled by a snap ring.	VER Ball Bearing Information	14
		Machining requirements	15
Bearing Life	Bearing life can be estimated using available formulas. Keep in mind that life varies by application and the formulas estimate metal fatigue under ideal conditions.	Life Formulas	262
		Sample Calculations	274
Shaft Expansion	Where shaft expansion or axial movement is caused by temperature changes or frame flexing on long shafts, a bearing with expansion capabilites should be used. Use only one fixed bearing on the drive end of the shaft.	Expansion Spherical Bearings	
		1000/1100	122
		22200/22500	136
		Expansion Tapered Bearings	
		950/970	112
		Technical Information	272
Bearing Installation	Bearing performance can be greatly impacted by proper installation practices. Refer to installation information included with the product or to the catalog installation instructions.	Set Screw Lock	276
		BOA Concentric	277
		Eccentric Lock	278
Bearing Lubrication	Bearing Performance relies on proper relubrication. This includes lubricant type, relubrication frequency, and good practices.	Ball Bearing Lubrication	284
		Spherical Bearing Lubrication	286
		Tapered Bearing Lubrication	285

Application Consideration	Mounted Bearing Recommendation	Reference	Starting Page
Cartridge Replacement	All Housed Mounted Ball Bearings come with a replaceable insert. While this can save money, complete units should be purchased to avoid possible housing fit and misalignment issues. 950 and 970 series tapered roller bearings with easy to replace cartridges are also available. These provide cost effective replacements and allow bearing housings to stay mounted and in alignment with equipment.	Ball Bearing Insert Replacement Tapered RollerBearings 950/970	282 283
Corrosion	Electroless nickel plating is available as a standard option on many ball bearing sizes. Identify stock nickel plated units by noting the (NK) symbol next to the housing size on dimension pages. Other sizes may be available depending on quantities and lead time requirements.		

BEARING SYMBOLS FOR LIFE CALCULATION

C	-	Basic Dynamic Rating (lbs) 1,000,000 Revolutions	C_0	-	Static Rating (lbs)
P	-	Equivalent Radial Load (lbs)	n	-	Speed (RPM)
L10	-	Rated Life (Hours)	K	-	Geometry Factor
L_{na}	-	Adjusted Rated Life	X	-	Radial Factor
F_a	-	Applied Thrust Load (lbs)	Y	-	Thrust Factor
F_r	-	Applied Radial Load (lbs)	e	-	Geometry Ratio

Ball Bearing Life Calculation

The following formula provided by the Anti Friction Bearing Manufacturers Association (ABMA) provides a method for calculating estimated fatigue life of Ball Bearings.

$$L10 = (C/P)^3 \times \frac{16667}{n}$$

Where:

L10 = The number of hours that 90% of a group of identical bearings under ideal conditions will operate at a specific speed and load condition before fatigue failure is expected to occur.

Additionally, the ABMA provides application factors for Ball Bearings which need to be considered to determine an adjusted Rated Life (L_{na}).

$$L_{na} = a_1 \times a_2 \times a_3 \times L_{10}$$

Where:

$\mathbf{L_{na}}$ = Adjusted Rated Life.

$\mathbf{a_1}$ = Reliability Factor.

Adjustment factor applied where estimated fatigue life is based on reliability other than 90% (See Table No 1).

Table 1 Life Adjustment Factor for Reliability

RELIABILITY %	L_{na}	a_1
90	L10	1
95	L5	0.62
96	L4	0.53
97	L3	0.44
98	L2	0.33
99	L1	0.21
50	L50	5

$\mathbf{a_2}$ = Material Factor

Life adjustment for Bearing race material. All Browning Ball bearing races are manufactured from 52100 Vacuum Degassed Bearing steel. Therefore the a_2 factor is 1.0 for all Browning Ball Bearings. It is important to check with all manufacturers to ensure that proper adjustments are made when other bearing steels are used.

$\mathbf{a_3}$ = Life Adjustment Factor for Operating Conditions

This factor should take into account the adequacy of lubricant, presence of foreign matter, conditions causing changes in material properties, and unusual loading or mounting conditions. Assuming a properly selected bearing having adequate seals and lubricant operating below 200°F and tight fitted to the shaft, the a_3 factor should be 1.0.

Mounted ball bearings are typically "slip fitted' to the shaft and rely on design features such as the inner race length and locking device for support. ABMA recommends an a_3 factor of .456 for "slip fit" ball bearings.*

Shock and Vibration—Vibration and shock loading can act as an additional loading to the steady expected applied load. When shock or vibration is present, the following a_3, Life Adjustment Factors are recommended. The shock factor is used in combination with the "slip fit" factor.

Table 2 Shock/Vibration Factor

Steady Loading	1.0
Light Shock/Vibration	.5
Moderate Shock/Vibration	.3

The a_3 factor takes into account a wide range of application and mounting conditions as well as bearing features and design. Accurate determiniation of this factor is normally achieved through testing and in-field experience. Consult EPT Mounted Bearing Tech Support for more information.

*See sample calculations on page 294.

Selection

Select an initial bearing size and calculate the expected L_{na} life. If the life is not acceptable, select another bearing size as appropriate and recalculate the L_{na} life. Continue this iterative process until an appropriate L_{na} life is obtained.

Combined Load Calculation

For applications where combined radial and thrust loads are present the equivalent radial load (P) must be calculated before applying L10 life formula.

- For applications with only a radial load present $P = F_r$
  Where F_r = Applied radial load in pounds.

- For applications with only a thrust load present
  EPT Mounted Bearing Tech Support.

Calculate (P) equivalent radial Load.

1. Use Table 3 to identify the relative axial load factor (ND2).
2. Determine the relative axial load (RAL):

$$RAL = \frac{F_a}{ND_2}$$

-applied thrust load

-relative axial load factor

3. Match the nearest relative axial load value in Table #3 to the corresponding "e" value. for precise calculation, linearly interpolate the values for "e" for your exact relative axial load value.
4. Calculate F_a/F_r and compare value to the "e" value found in step #3 above.
5. Choose values for "X" and "Y" based on step #3 & 4 and from Table No. 3. Linear interpolation is recommended for exact calculations.
6. Calculate equivalent radial load using the following equation: $P=XF_r+YF_a$
7. Calculate the adjusted life (L_{na}) using the life calculation formula above.

Refer to Page 296 for Relevant Disclaimer.

For Inserts not shown in table 4:

Insert: VE-200, VB-200, VER-200, SLS-100, SLE-100, LR-100, LRS-100, VS-100, VE-100, LS-100, LE-100, RUBRE-100, RUBRS-100

Ratings: Use standard duty, 200 Series, ratings and factors for respective bore size.

Select 200 Series for highest reliability.

Insert: VS-300
VB-300

Ratings: Use medium duty, 300 Series, ratings and factors for respective bore size.

Contact EPT Mounted Bearing Tech Support at 630-898-9620 for additional Details.

Table 3 Equivalent Load Calculation Data Ball Bearings

Relative Axial Load	e	Fa/Fr <= e		Fa/Fr > e	
		X	Y	X	Y
24.92	0.19	1	0	0.56	2.30
50.03	0.22	1	0	0.56	1.99
99.91	0.26	1	0	0.56	1.71
149.35	0.28	1	0	0.56	1.55
200.10	0.30	1	0	0.56	1.45
300.15	0.34	1	0	0.56	1.31
500.25	0.38	1	0	0.56	1.15
749.65	0.42	1	0	0.56	1.04
999.05	0.44	1	0	0.56	1.00

New Applicatioins:

Using variations of the life formulas and application information, it is possible to select bearings based on desired life, load applied, and shaft speed. ***This method can be applied where axial load is less than or equal to 1/2 the radial load.***

1. Determine required application hours (L_{na}).
2. Calculate L_{10} using adjustment factors:

$$L_{10} = \frac{L_{na}}{a1 \times a2 \times a3}$$

3. Calculate Basic Dynamic Radial Rating (C_{req}).

$$C_{req} = \left(\frac{L_{10}\,(N)}{16667}\right)^{1/3} P$$

4. Use Table 4, find a basic Dynamic Radial Rating Value greater than or equal to Creq calculated in step #3.
5. Select any bearing from the row in step #4 or larger. If C_{req} is greater than the largest Basic Dynamic Radial Rating Value of Table 4, go to a tapered or spherical Roller Bearing Selection on page 264, 265.

Table 4 Load Ratings - Ball Bearings

STANDARD DUTY		MEDIUM DUTY		BASIC DYNAMIC RADIAL RATING	STATIC RADIAL RATING	Relative Axial Load Factor ND^2	THRUST RATING
SHAFT SIZE	INSERT #	SHAFT SIZE	INSERT #				
1/2	VS-208			2108	1117	0.5625	320
5/8	VS-210						
1/2	VS-208			2611	1444	0.7056	740
5/8	VS-209						
3/4	VS-212						
13/16	VS-213			2801	1651	0.7840	490
7/8	VS-214						
1/16	VS-215						
1	VS-216						
1-1/16	VS-217			4381	2567	1.2996	1170
1-1/8	VS-218	1	VS-316				
1-3/16	VS-219						
1-1/4	VS-220S						
1-1/4	VS-220			5782	3493	1.7424	1700
1-5/16	VS-221	1-3/16	VS-319				
1-3/8	VS-222						
1-7/16	VS-223						
1-1/2	VS-224			7340	4467	2.2500	2250
1-9/16	VS-225	1-7/16	VS-323				
1-5/8	VS-226	1-1/2	VS-324	7901	5139	2.5000	2350
1-11/16	VS-227						
1-3/4	VS-228						
1-13/16	VS-229	1-11/16	VS-327	7889	5216	2.5000	2350
1-7/8	VS-230	1-3/4	VS-328				
1-15/16	VS-231						
2	VS-232S	1-15/16	VS-331				
2	VS-232			9752	6601	3.3160	2880
2-1/8	VS-234						
2-3/16	VS-235						
2-1/4	VS-236			11789	8150	3.9690	4100
		2-3/16	VS-335				
2-7/16	VS-239						
2-1/2	VS-240	2-7/16	VS-339	13971	10063	4.7610	4500
2-11/16	VS-243	2-1/2	VS-340				
		2-11/16	VS-343	14839	11224	5.2371	5200
2-15/16	VS-247						
		2-15/16	VS-347	17412	13174	6.1875	6030
		3	VS-348				
3-1/2	VS-256	3-7/16	VS-355	21566	16301	7.7440	7830
		3-15/16	VS-363	29905	23553	11.2360	11090

1. See page 266-267 for load and speed capabilities.
2. See General Engineering page 272.

Tapered Roller Bearings

This section outlines the formula used to select bearing size or calculate expected bearing life for Browning Tapered Roller Bearings.

Tapered Roller Bearings are excellent for applications where radial and/or thrust load ratings exceed the capabilities of a ball bearing. *Note: Maximum speeds are lower for Tapered Roller Bearings than Ball Bearings and Spherical Roller Bearings.*

Bearing Symbols for Tapered Life Calculations

C = Basic Dynamic Rating (lbs.) 90,000,000 revolutions
P = Equivalant Radial Load (lbs.)
L10 = Rated Life (hrs.)
Fa = Applied Thrust Load
Fr = Applied Radial Load
K = Geometry Factory
n = Speed RPM
FIR = Bearing Internal Thrust

Tapered Roller Bearing Life Calculation

Use Step 1-4 at right and follow formula.

$$L10 = (C/P)^{10/3} \times \frac{3000 \text{ hours} \times 500 \text{ RPM}}{n}$$

Select an initial bearing size, and calculate the expected L10 life. If the life is not acceptable, select another bearing size as appropriate and recalculate the L10. Continue this iterative process until an appropriate L10 life is obtained.

Table 5 Shock/Vibration Factor

Steady Loading	1.0
Light Shock/Vibration	.5
Moderate Shock/Vibration	.3

Multiply the theoretical life by the above factors to determine derated theoretical life.

Combined Load Calculation

For applications where combined radial and thrust loads are present the equivalent radial load (P) must be calculated before applying the L10 life formula,

For applications with only a radial load present $P=F_r$
Where F_r = Applied radial load in pounds

For applications with only a thrust load present, Consult EPT Mounted Bearing Tech Support

Calculate (P) equivalent radial load.

1. Calculate the bearing internal thrust reaction (FIR):

$$FIR = \frac{0.6 \times F_r}{K}$$

- applied radial load
- factor K for 900/950 Series page 268
  920/970 Series page 269

2. If the thrust load (F_a) is less than or equal to FIR, then calculate the equivalent radial load as follows:

$$P = (0.5 \times F_r) + (0.83 \times K \times F_a)$$

3. If the thrust load (Fa) is greater than FIR then calculate the equivalent radial load as follows:

$$P = (0.4 \times F_r) + (K \times F_a)$$

4. Calculate the expected L10 life using the single row basic dynamic load rating. For 900/950 Series page 268.
For 920/970 Series page 269.

$$L10 = \left(\frac{\text{single row load rating}}{P}\right)^{10/3} \times \frac{3000 \times 500}{n}$$

1. See page 268, 269 for load and speed capabilities.
2. See General Engineering page 272.

Spherical Roller Bearings Life Calculations

This section outlines the formula used to select bearing size or calculate expected bearing life for Browning spherical roller bearings.

Spherical Roller Bearings

Spherical roller bearings are excellent for applications where radial loads exceed the capabilities of a ball bearing or the speed limits of a tapered roller bearing.

Bearing Symbols for Spherical Life Calculations

C = Basic Dynamic Rating (lbs) 1,000,000 revolutions
P = Equivalent Radial Load (lbs)
L10 = Rated Life (hrs)
Fa = Applied Thrust Load
Fr = Applied Radial Load
n = Speed RPM
X = Radial Factor
Y = Thrust Factor
e = Geometry Ratio

Spherical Roller Bearing Life Calculations

$$L10 = \left(\frac{C}{P}\right)^{10/3} x \ \frac{16667}{n}$$

Table 6 **Shock/Vibration Factor**

Steady Loading	1.0
Light Shock/Vibration	.5
Moderate Shock/Vibration	.3

Multiply the theoretical life by the above factors to determine derated theoretical life.

Combined Load Calculation

1. Select an initial spherical roller type and bore size.
2. Calculate Fa/Fr and compare the value to the “e” value found in the tables 7, 8 and 9.
3. Choose values for “X” and “Y” based on Step 1 above from the appropriate table 7, 8 and 9 based on the spherical bearing type selected.
4. Calculate equivalent load using the following equation:

$$P = XFr + YFa$$

5. Calculate the expected L10 life using the life equation above.
6. Determine if the calculated L10 meets application requirements.
7. If L10 is not acceptable, select another bearing size as appropriate and recalculate the L10 life. Continue this iterative process until an acceptable L10 is obtained.

NOTE: Always use (1) fixed and (1) floating spherical roller bearing.

Table 7

1000/1100 SERIES						
x+y Values for Combined Loading Equation						
Shaft Size	C Basic Load	e	Fa/Fr <= e		Fa/Fr > e	
			X1	Y1	X2	Y2
1 1/8-1 1/2	16,600	0.28	1.0	2.4	0.67	3.6
1 11/16-1 3/4	17,300	0.26	1.0	2.6	0.67	3.9
1 15/16-2	18,000	0.24	1.0	2.8	0.67	4.2
2 3/16	22,400	0.24	1.0	2.8	0.67	4.2
2 7/16-2 1/2	32,400	0.24	1.0	2.8	0.67	4.2
2 11/16-3	34,600	0.22	1.0	3.0	0.67	4.6
3 3/16-3 1/2	54,900	0.23	1.0	2.9	0.67	4.4
3 11/16-4	70,000	0.24	1.0	2.8	0.67	4.2
4 7/16-4 1/2	91,800	0.25	1.0	2.7	0.67	4.0
4 15/16	124,000	0.26	1.0	2.6	0.67	3.9

Table 8

22200 & 22500 SERIES - ADAPTER MOUNT							
X & Y Values for Combined Loading Equation							
Shaft Size		C Basic Load	e	Fa/Fr<=e		Fa/Fr>e	
Popular	Other			x	y	x	y
2 7/16	2 1/2	34,600	0.22	1.0	3.0	0.67	4.6
2 11/16	2 3/4	39,600	0.22	1.0	3.0	0.67	4.6
2 15/16	3	45,400	0.22	1.0	3.0	0.67	4.6
3 3/16	-	54,900	0.23	1.0	2.9	0.67	4.4
3 7/16 -	3 1/2 3 11/16	70,000	0.24	1.0	2.8	0.67	4.2
3 15/16	4	91,800	0.25	1.0	2.7	0.67	4.0
4 3/16	-	105,000	0.25	1.0	2.7	0.67	4
4 7/16	4 1/2	124,000	0.26	1.0	2.6	0.67	3.9
4 15/16	5	140,000	0.26	1.0	2.6	0.67	3.9
5 3/16	-	166,000	0.26	1.0	2.6	0.67	3.9
5 7/16	5 1/2	194,000	0.26	1.0	2.6	0.67	3.9
5 15/16	6	220,000	0.27	1.0	2.7	0.67	3.7
6 7/16	6 1/2	227,000	0.26	1.0	2.6	0.67	3.9
6 15/16	7	250,000	0.26	1.0	2.6	0.67	3.9
7 3/16	7 1/2	286,000	0.26	1.0	2.6	0.67	3.9
7 15/16	8	342,000	0.27	1.0	2.7	0.67	3.7

Table 9

22200 SERIES - CYLINDRICAL BORE							
x+y Values for Combined Loading							
Shaft Size		C Basic Load	e	Fa/Fr <= e		Fa/Fr > e	
S2	S3			X1	Y1	X1	Y1
3 5/8	3	39,600	0.22	1.0	3.0	0.67	4.6
3 15/16	3 3/19	45,400	0.22	1.0	3.0	0.67	4.6
4 1/8	3 3/8	54,900	0.23	1.0	2.9	0.67	4.4
4 1/2	3 13/16	70,000	0.24	1.0	2.8	0.67	4.2
4 7/8	4 3/16	91,800	0.25	1.0	2.7	0.67	4
5 5/16	4 9/16	105,000	0.25	1.0	2.7	0.67	4
5 7/8	4 15/16	124,000	0.26	1.0	2.6	0.67	3.9
6 1/4	5 5/16	140,000	0.26	1.0	2.6	0.67	3.9
6 5/8	5 3/4	166,000	0.26	1.0	2.6	0.67	3.9
7	6 1/16	194,000	0.26	1.0	2.6	0.67	3.9
7 7/16	6 7/16	220,000	0.27	1.0	2.5	0.67	3.7
7 13/16	6 7/8	227,000	0.26	1.0	2.6	0.67	3.9
8 3/8	7 1/4	250,000	0.26	1.0	2.6	0.67	3.9
8 3/4	7 5/8	286,000	0.26	1.0	2.6	0.67	3.9
9 9/16	8 5/16	342,000	0.27	1.0	2.5	0.67	3.7

1. See page 265 for load and speed capabilities.
2. See General Engineering page 272.

BALL BEARING 100 SERIES RATINGS

This chart displays 100 series ball bearing load capacity for a given L10 life, speed, and shaft size. Values in the table represent loads at ideal conditions with press fit mounting to the shaft. ABMA recommends de-rating of slip fit mounted bearings. To obtain de-rated load, divide load in table by 1.3. Values in the table represent equivalent radial loads only. For combined load determination, see **THE BEARING SELECTION SECTION,** page 262. Areas designated by "-" exceed maximum speed value.

Table 10 Match Bore Size

100 Shaft Size	L10 HOURS	REVOLUTIONS PER MINUTE															
		50	150	250	500	750	1000	1500	1750	2000	2500	3000	3500	4000	45000	5000	5500
1/2	5000	315	315	315	315	315	315	275	261	250	232	218	207	198	191	184	
5/8	10000	315	315	315	315	275	250	218	207	198	184	173	165	157	151	146	
275	250	315	315	275	218	191	173	151	144	138	128	120	114	109	105	101	
	50000	315	275	232	184	161	146	128	121	116	108	101	96	92	89	85	
	100000	315	218	184	146	128	116	101	96	92	85	80	76	73	70	68	
3/4	5000	390	390	390	390	390	390	341	324	310	287	270	257	246			
	10000	390	390	390	390	341	310	270	257	246	228	215	204	195			
	30000	390	390	341	270	236	215	188	178	170	158	149	141	135			
	50000	390	341	287	228	199	181	158	150	144	133	126	119	114			
	100000	390	270	228	181	158	144	126	119	114	106	100	95	91			
7/8	5000	418	418	418	418	418	418	366	347	332	308	290	276				
15/16	10000	418	418	418	418	366	332	290	279	264	245	230	219				
1	30000	418	418	366	290	253	230	201	191	183	170	160	152				
	50000	418	366	308	245	214	194	170	161	154	143	135	128				
	100000	418	290	245	194	170	154	135	128	122	114	107	102				
1 1/8	5000	654	654	654	654	654	654	572	543	519	482	454					
1 3/16	10000	654	654	654	654	572	519	454	431	412	383	360					
1 1/4	30000	654	654	572	454	396	360	315	299	286	265	250					
	50000	654	572	482	383	334	304	265	252	241	224	211					
	100000	654	454	383	304	255	241	211	200	191	178	167					
1 1/4	5000	864	864	864	864	864	864	755	717	686	636						
1 3/8	10000	864	864	864	864	755	686	599	569	544	505						
1 7/16	30000	864	864	755	599	523	475	415	394	377	350						
	50000	864	755	636	505	441	401	350	333	318	295						
	100000	864	599	505	401	350	318	278	264	253	234						
1 1/2	5000	1096	1096	1096	1096	1096	1096	958	910	870	808						
	10000	1096	1096	1096	1096	958	870	760	722	691	641						
	30000	1096	1096	958	760	664	603	527	501	479	445						
	50000	1096	958	808	641	560	509	445	422	404	375						
	100000	1096	760	641	509	445	404	353	335	321	298						
1 11/16	5000	1180	1180	1180	1180	1180	1180	1031	979	937							
1 3/4	10000	1180	1180	1180	1180	1031	937	818	777	744							
	30000	1180	1180	1031	818	715	650	567	539	516							
	50000	1180	1031	870	690	603	548	479	455	435							
	100000	1180	818	690	548	479	435	380	361	345							
1 15/16	5000	1178	1178	1178	1178	1178	1178	1029	978	935							
2	10000	1178	1178	1178	1178	1029	935	817	776	742							
	30000	1178	1178	1029	817	714	649	567	538	515							
	50000	1178	1029	868	689	602	547	478	454	434							
	100000	1178	817	689	547	478	434	379	360	345							
2	5000	1457	1457	1457	1457	1457	1457	1273	1209								
2 3/16	10000	1457	1457	1457	1457	1273	1156	1010	959								
	30000	1457	1457	1273	1010	882	802	700	665								
	50000	1457	1273	1073	852	744	676	591	561								
	100000	1457	1010	852	676	591	537	469	445								

See General Engineering page 272.

BALL BEARING 200 AND 300 SERIES RATINGS

This chart displays 200 and 300 series ball bearing load capacity for a given L10 life, speed, and shaft size. Values in the table represent loads at ideal conditions with press fit mounting to the shaft. ABMA recommends de-rating of slip fit mounted bearings. To obtain de-rated load, divide load in table by 1.3. Values in the table represent equivalent radial loads only. For combined load determination, see **THE BEARING SELECTION SECTION,** page 262. Areas designated by "-" exceed maximum speed value.

Table 11 Match Bore Size

SHAFT SIZES		L10	REVOLUTIONS PER MINUTE																	
200 Dia. Inches	300 Dia. Inches	HOURS	50	150	250	500	750	1000	1500	1750	2000	2500	3000	3500	4000	4500	5000	5500	6500	7500
1/2		5000	500	500	500	397	347	315	275	261	250	232	218	207	198	191	184	178	169	161
5/8		10000	500	470	397	315	275	250	218	207	198	184	173	165	157	151	146	142	134	128
		30000	470	326	275	218	191	173	151	144	138	128	120	114	109	105	101	98	93	89
		50000	397	275	232	184	161	146	128	121	116	108	101	96	92	89	85	83	78	75
		100000	315	218	184	146	128	116	101	96	92	85	80	76	73	70	68	66	62	59
3/4		5000	619	619	619	491	429	390	341	324	310	287	270	257	246	236	228	221	209	
		10000	583	583	491	390	341	310	270	257	246	228	215	204	195	188	181	175	166	
		30000	583	404	341	270	236	215	188	178	170	158	149	141	135	130	126	122	115	
		50000	491	341	287	228	199	181	158	150	144	133	126	119	114	110	106	103	97	
		100000	390	270	228	181	158	144	126	119	114	106	100	95	91	87	84	81	77	
7/8		5000	664	664	664	527	461	418	366	347	332	308	290	276	264	253	245	237		
15/16		10000	625	625	527	418	366	332	290	276	264	245	230	219	209	201	194	188		
1		30000	625	433	366	290	253	230	201	191	183	170	160	152	145	139	135	130		
		50000	527	366	308	245	214	194	170	161	154	143	135	128	122	118	114	110		
		100000	418	290	245	194	170	154	135	128	122	114	107	102	97	93	90	87		
1 1/8	1	5000	1039	1039	1039	825	720	654	572	543	519	482	454	431	412	396				
1 3/16		10000	978	978	825	654	572	519	454	431	412	383	360	342	327	315				
1 1/4		30000	978	678	572	454	396	390	315	299	286	265	250	237	227	218				
		50000	825	572	482	383	334	304	265	252	241	224	211	200	191	184				
		100000	654	454	383	304	265	241	211	200	191	178	167	159	152	146				
1 1/4	1 3/16	5000	1290	1290	1290	1088	951	864	755	717	686	636	599	569	544					
1 3/8	1 1/4	10000	1290	1290	1088	864	755	686	599	569	544	505	475	452	432					
1 7/16		30000	1290	895	755	599	523	475	415	394	377	350	330	313	299					
		50000	1088	755	636	505	441	401	350	333	318	295	278	264	253					
		100000	864	599	505	401	350	318	278	264	253	234	221	210	200					
1 1/2	1 7/16	5000	1638	1638	1638	1381	1207	1096	958	910	870	808	760	722						
		10000	1638	1638	1381	1096	958	870	760	722	691	641	603	573						
		30000	1638	1136	958	760	664	603	527	501	479	445	418	397						
		50000	1381	958	808	641	560	509	445	422	404	375	353	335						
		100000	1096	760	641	509	445	404	353	335	321	298	280	266						
1 5/8	1 1/2	5000	1763	1763	1763	1487	1299	1180	1031	979	937	870	818							
1 11/16		10000	1763	1763	1487	1180	1031	937	818	777	744	690	650							
1 3/4		30000	1763	1222	1031	818	715	650	567	539	516	479	450							
		50000	1487	1031	870	690	603	548	479	455	435	404	380							
		100000	1180	818	690	548	479	435	380	361	345	320	301							
1 15/16	1 11/16	5000	1760	1760	1760	1485	1297	1178	1029	978	935	868	817							
2	1 3/4	10000	1760	1760	1485	1178	1029	935	817	7769	742	689	649							
		30000	1760	1221	1029	817	714	649	567	538	515	478	450							
		50000	1485	1029	868	689	602	547	478	454	434	403	379							
		100000	1178	817	689	547	478	434	379	360	345	320	301							
2	1 15/16	5000	2176	2176	2176	1835	1603	1457	1273	1209	1156	1073								
2 3/16	2	10000	2176	2176	1835	1457	1273	1156	1010	959	918	852								
		30000	2176	1509	1273	1010	882	802	700	665	636	591								
		50000	1835	1273	1073	852	744	676	591	561	537	498								
		100000	1457	1010	852	676	591	537	469	445	426	395								
2 1/4	2 3/16	5000	2631	2631	2631	2219	1938	1761	1538	1461	1398	1298								
2 7/16	2 1/4	10000	2631	2631	2219	1761	1538	1398	1221	1160	1109	1030								
		30000	2631	1824	1538	1221	1067	969	847	804	769	714								
		50000	2219	1538	1298	1030	900	817	714	678	649	602								
		100000	1761	1221	1030	817	714	649	567	538	515	478								
2 11/16	2 7/16	5000	3118	3118	3118	2629	2297	2087	1823	1732	1656									
	2 1/2	10000	3118	3118	2629	2087	1823	1656	1447	1375	1315									
		30000	3118	2162	1823	1447	1264	1149	1003	953	912									
		50000	2629	1823	1538	1220	1066	969	846	804	769									
		100000	2087	1447	1220	969	846	769	672	638	610									
2 15/16	2 11/16	5000	3311	3311	3311	2793	2440	2217	1936	1839	1759									
		10000	3311	3311	2793	2217	1936	1759	1537	1460	1396									
		30000	3311	2296	1936	1537	1343	1220	1066	1012	968									
		50000	2793	1936	1633	1296	1332	1029	899	854	817									
		100000	2217	1537	1296	1029	899	817	713	678	648									
	2 15/16	5000	3885	3885	3885	3277	2863	2601	2272	2158	2064									
	3	10000	3885	3885	3277	2601	2272	2064	1803	1713	1639									
		30000	3885	2694	2272	1803	1575	1431	1250	1188	1136									
		50000	3277	2272	1916	1521	1329	1207	1055	1002	958									
		100000	2601	1803	1521	1207	1055	958	837	795	761									
	3 7/16	5000	4812	4812	4812	4059	3546	3222	2814	2673										
	3 1/2	10000	4812	4812	4059	3222	2814	2557	2234	2122										
		30000	4812	3337	2814	2234	1951	1773	1549	1471										
		50000	4059	2814	2374	1884	1646	1495	1306	1241										
		100000	3222	2234	1884	1495	1306	1187	1037	985										
	3 15/16	5000	6673	6673	6673	5628	4917	4467	3902											
		10000	6673	6673	5628	4467	3902	3546	3097											
		30000	6673	4627	3902	3097	2706	2458	2148											
		50000	5628	3902	3291	2612	2282	2074	1811											
		100000	4467	3097	2612	2074	1811	1646	1438											

See General Engineering page 272.

TAPERED ROLLER BEARINGS 900 AND 950 SERIES

This chart displays the Browning 900 and 950 Series Tapered Roller Bearing's load capacity for a given L10 life, speed and shaft size. Values in the table represent loads at ideal conditions. The shaded areas indicate the maximum speed for the 950 series only. Select 950 Series where aligning capability is required. For combined load determination, see **THE BEARING SELECTION SECTION,** page 264. Areas designated by "-" exceed maximum speed value.

Table 12 Match Bore Size

SIZE	"K" FACTOR	"C" 2 ROW RATING	1 ROW RATING	THRUST RATING*	L10 HOURS	REVOLUTIONS PER MINUTE 50	100	150	250	500	750	1000	1500	1750	2000	2500	3000	3500
1	1.42	3700	2130	1500	5000	4179	4179	4179	3908	3174	2811	2578	2283	2180	2094	1959	1854	1771
					10000	4179	4179	3700	3174	2578	2283	2094	1854	1771	1701	1591	1506	1438
					30000	3700	3005	2611	2283	1854	1642	1506	1334	1273	1223	1144	1083	1034
					50000	3174	2578	2283	1959	1591	1409	1292	1144	1093	1050	982	929	887
					100000	2578	2094	1854	1591	1292	1144	1050	929	887	853	797	755	721
1 3/16	1.53	5130	2950	1930	5000	5794	5794	5794	5418	4401	3897	3575	3165	3022	2904	2716	2571	2455
1 1/4					10000	5794	5794	5130	4401	3575	3165	2904	2571	2455	2358	2206	2088	1944
1 3/8					30000	5130	4167	3690	3165	2571	2277	2088	1849	1766	1696	1586	1502	1434
					50000	4401	3575	3165	2716	2206	1953	1792	1586	1515	1455	1361	1289	1230
					100000	3575	2904	2571	2206	1792	1586	1455	1289	1230	1182	1106	1047	999
1 7/16	1.46	5930	3410	2330	5000	6697	6697	6697	6263	5087	4505	4132	3659	3494	3356	3139	2972	
1 1/2					10000	6697	6697	5930	5087	4132	3659	3356	2972	2838	2726	2550	2414	
					30000	5930	4817	4265	3659	2972	2632	2414	2138	2041	1961	1834	1736	
					50000	5087	4132	3659	3139	2550	2258	2071	1834	1751	1682	1573	1490	
					100000	4132	3356	2972	2550	2071	1834	1682	1490	1422	1366	1278	1210	
1 5/8	1.37	6050	3470	2540	5000	6833	6833	6833	6390	5190	4596	4216	3733	3564	3424	3203		
1 11/16					10000	6833	6833	6050	5190	4216	3733	3424	3032	2895	2781	2601		
1 3/4					30000	6050	4914	4351	3733	3032	2685	2463	2181	2082	2000	1871		
					50000	5190	4216	3733	3203	2601	2303	2113	1871	1786	1716	1605		
					100000	4216	3424	3032	2601	2113	1871	1716	1520	1451	1394	1304		
1 7/8	1.65	8550	4910	2980	5000	9656	9656	8656	9031	7335	6495	5958	5276	5037	4839			
1 15/16					10000	9656	9656	8550	7335	5958	5276	4839	4285	4091	3931			
2					30000	8550	6945	6149	5276	4285	3794	3481	3082	2943	2827			
2 1/8					50000	7335	5958	5276	4526	3676	3255	2986	2644	2525	2425			
					100000	5958	4839	4285	3676	2986	2644	2425	2148	2051	1970			
2 3/16	1.51	9090	5220	3470	5000	10266	10266	10266	9601	7798	6905	6334	5609	5355	5145			
					10000	10266	10266	9090	7798	6334	5609	5145	4556	4350	4179			
					30000	9090	7383	6538	5609	4556	4034	3700	3277	3129	3006			
					50000	7798	6334	5609	4812	3908	3461	3175	2811	2684	2579			
					100000	6334	5145	4556	3908	3175	2811	2579	2283	2180	2095			
2 1/4	1.45	9290	5340	3670	5000	10492	10492	10492	9812	7970	7057	6474	5732	5473				
2 7/16					10000	10492	10492	9290	7970	6474	5732	5258	4656	4446				
2 1/2					30000	9290	7546	6682	5732	4656	4123	3782	3349	3197				
					50000	7970	6474	5732	4918	3994	3537	3245	2873	2743				
					100000	6474	5258	4656	3994	3245	2873	2635	2334	2228				
2 11/16	1.30	9600	5510	4260	5000	10842	10842	10842	10140	8236	7293	6690	5924					
2 3/4					10000	10842	10842	9600	8236	6690	5924	5434	4811					
2 15/16					30000	9600	7798	6905	5924	4811	4260	3908	3460					
					50000	8236	6690	5924	5082	4128	3655	3353	2969					
					100000	6690	5434	4811	4128	3353	2969	2723	2411					
3	1.31	14500	8330	6340	5000	16376	16376	16376	15315	12440	11015	10104						
3 3/16					10000	16376	16378	14500	12440	10104	8947	8207						
					30000	14500	11778	10429	8947	7267	6435	5903						
					50000	12440	10104	8947	7676	6235	5521	5064						
					100000	10104	8207	7267	6235	5064	4484	4113						
3 7/16	1.19	15300	8790	7410	5000	17279	17279	17279	16160	13126	11623	10662						
3 1/2					10000	17279	17279	15300	13126	10662	9441	8660						
					30000	15300	12427	11004	9441	7668	6790	6228						
					50000	13126	10104	9441	8099	6579	5825	5344						
					100000	10662	8207	7668	6579	5344	4732	4340						
3 15/16	1.45	18400	10600	7270	5000	20780	20780	20780	19434	15786	13978	12822						
4					10000	20780	20780	18400	15786	12822	11353	10415						
					30000	18400	14945	13234	11353	9222	8166	7490						
					50000	15786	12822	11353	9740	7912	7005	6426						
					100000	12822	10415	9222	7912	6426	5690	5220						
4 7/16	1.91	25200	14500	7550	5000	28460	28460	28460	26617	21620	19143	17561						
4 1/2					10000	28460	28460	25200	21620	17561	15549	14264						
					30000	25200	20469	18124	15549	12630	11183	10259						
					50000	21620	17561	15549	13340	10835	9594	8801						
					100000	17561	14264	12630	10835	8801	7793	7149						
4 15/16	1.82	26600	15300	8390	5000	30041	30041	30041	28095	22821	20207							
5					10000	30041	30041	26600	22821	18536	16413							
					30000	26600	21606	19131	16413	13332	11805							
					50000	22821	18536	16413	14081	11437	10127							
					100000	18536	15056	13332	11437	9290	8226							

See General Engineering page 272.

TAPERED ROLLER BEARINGS 920 AND 970 SERIES

This chart displays the Browning 920 and 970 Series Tapered Roller Bearing's load capacity for a given L10 life, speed and shaft size. Values in the table represent loads at ideal conditions. The shaded areas indicate the maximum speed for the 970 series only. For combined load determination, see **THE BEARING SELECTION SECTION**, page 264. Areas designated by "-" exceed maximum speed value.

Table 13 Match Bore Size

SIZE	"K" FACTOR	"C" 2 ROW RATING	1 ROW RATING	THRUST RATING*	HOURS	REVOLUTIONS PER MINUTE 50	100	150	250	500	750	1000	1500	1750	2000	2500	3000	3500	4000
1 3/16	1.23	2975	1710	1390	5000	3360	3360	3360	3142	2552	2260	2073	1836	1753	1684	1575	1491	1424	1368
1 1/4					10000	3360	3360	2975	2552	2073	1836	1684	1491	1424	1368	1279	1211	1156	1111
					30000	2975	2416	2140	1836	1491	1320	1211	1072	1024	984	920	871	832	799
					50000	2552	2073	1836	1575	1279	1133	1039	920	878	844	789	747	714	685
					100000	2073	1684	1491	1279	1039	920	844	747	714	685	641	607	580	556
1 3/8	1.31	4760	2740	2080	5000	5376	5376	5376	5028	4084	3616	3317	2937	2804	2694	2520	2386	2278	
1 7/16					10000	5376	5376	4760	4084	3317	2937	2694	2386	2278	2188	2047	1938	1850	
					30000	4760	3866	3424	2937	2386	2112	1938	1716	1638	1574	1472	1394	1331	
					50000	4084	3317	2937	2520	2047	1812	1662	1472	1406	1350	1263	1196	1142	
					100000	3317	26741	2386	2047	1662	1472	1350	1196	1142	1097	1026	971	927	
1 1/2	1.36	6140	3530	2600	5000	6934	6934	6934	6485	5268	4664	4279	3789	3617	3475	3250	3077		
1 11/16					10000	6934	6934	6140	5268	4279	3789	3475	3077	2938	2823	2640	2500		
					30000	6140	4987	4416	3789	3077	2725	2500	2213	2113	2030	1899	1798		
					50000	5268	4279	3789	3250	2640	2338	2144	1899	1813	1742	1629	1542		
					100000	4279	3475	3077	2640	2144	1899	1742	1542	1473	1415	1323	1253		
1 3/4	1.83	8070	4640	2540	5000	9114	9114	9114	8524	6923	6130	5624	4979	4754	4568	4272			
1 15/16					10000	9114	9114	8070	6923	5624	4979	4568	4045	3862	3710	3470			
2					30000	8070	6555	5804	4979	4045	3581	3285	2909	2777	2668	2496			
					50000	6923	5624	4979	4272	3470	3072	2818	2496	2383	2289	2141			
					100000	5624	4568	4045	3470	2818	2496	2289	2027	1935	1859	1739			
2 3/16	1.65	8570	4910	2980	5000	9679	9679	9679	9052	7352	6510	5972	5288	5049	4851	4537			
					10000	9679	9679	8570	7352	5972	5288	4851	4295	4101	3940	3685			
					30000	8570	6961	6164	5288	4295	3803	3489	3089	2950	2834	2650			
					50000	7352	5972	5288	4537	3685	3263	2993	2650	2530	2431	2274			
					100000	5972	4851	4295	3685	2993	2650	2431	2153	2055	1975	1847			
2 1/4	1.51	9030	5220	3470	5000	10198	10198	10198	9538	7747	6860	6293	5572	5320	5111				
2 7/16					10000	10198	10198	9030	7747	6293	5572	5111	4526	4321	4152				
2 1/2					30000	9030	7335	6495	5572	4526	4007	3676	3255	3108	2986				
					50000	7747	6293	5572	4780	3883	3438	3154	2793	2666	2562				
					100000	6293	5111	4526	3883	3154	2793	2562	2268	2166	2081				
2 11/16	1.30	9630	5510	4260	5000	10876	10876	10876	10171	8262	7316	6711	5942	5674					
2 15/16					10000	10876	10876	9630	8262	6711	5942	5451	4826	4608					
3					30000	9630	7822	6926	5942	4826	4274	3920	3471	3314					
					50000	8262	6711	5942	5098	4141	3666	3363	2978	2843					
					100000	6711	5451	4826	4141	3363	2978	2732	2419	2310					
3 3/16	1.19	15320	8790	7410	5000	17302	17302	17302	16181	13143	11638	10676	9453						
3 7/16					10000	17302	17302	15320	13143	10676	9453	8671	7678						
3 1/2					30000	15320	12444	11018	9453	7678	6799	6273	5522						
					50000	13143	10676	9453	8110	6587	5833	5351	4738						
					100000	10676	8671	7678	6587	5351	4738	4346	3848						
3 15/16	1.23	20980	12100	9800	5000	23694	23694	23694	22159	17999	15938	14620	12945						
4					10000	23694	23694	20980	17999	14620	12945	11875	10515						
					30000	20980	17041	15089	12945	10515	9311	5841	7563						
					50000	17999	14620	12945	11106	9021	7988	7327	6488						
					100000	14620	11875	10515	9021	7327	6488	5952	5270						
4 7/16	1.13	25750	14800	13100	5000	29081	29081	29081	27198	22091	19561	17944							
4 1/2					10000	29081	29081	25750	22091	17944	15889	14575							
					30000	25750	20915	18520	15889	12906	11427	10483							
					50000	22091	17944	15889	13631	11072	9804	8993							
					100000	17944	14575	12906	11072	8993	7963	7305							
4 15/16	1.27	35520	20400	16000	5000	40114	40114	40114	37517	30473	26983	24752							
5					10000	40114	40114	35520	30473	24752	21917	20105							
					30000	35520	28851	25547	21917	17802	15763	14460							
					50000	30473	24752	21917	18803	15273	13524	12405							
					100000	24752	20105	17802	15273	12405	10985	10076							

See General Engineering page 272.

SPHERICAL ROLLER BEARINGS 1000 AND 1100 SERIES

This chart displays the Browning 1000 and 1100 Series Spherical Roller Bearing's load capacity for a given L10 life, speed and shaft size. Values in the table represent loads at ideal conditions. The shaded areas indicate the maximum speed for the MULTI-TRAP Seal. The maximum speed for the Contact Seal is indicated in the non-shaded areas. For combined load determination, see **THE BEARING SELECTION SECTION**, page 265. Areas designated by "-" exceed maximum speed value.

Table 14 Match Bore Size

		L10	REVOLUTIONS PER MINUTE												
Size	Rating	Hours	50	100	150	250	500	750	1000	1500	1750	2000	2500	3000	3500
1 1/8	16600	5000	4880	4880	4880	4546	3692	3269	2999	2656	2535	2436	2278	2157	2059
1 3/16		10000	4880	4860	4304	3692	2999	2656	2436	2157	2059	1979	1850	1752	1673
1 1/4		30000	4304	3496	3095	2656	2157	1910	1752	1551	1481	1423	1331	1260	1203
1 7/16		50000	3692	2999	2656	2278	1850	1639	1503	1331	1271	1221	1142	1081	1032
1 1/2		100000	3999	2436	2157	1850	1503	1331	1221	1081	1032	992	927	878	838
1 11/16	17300	5000	5090	5090	5090	4737	3848	3407	3125	2767	2642	2539	2374	2248	2146
1 3/4		10000	5090	5065	4485	3848	3125	2767	2539	2248	2146	2062	1929	1826	1743
		30000	4485	3643	3226	2767	2248	1990	1826	1617	1544	1483	1387	1313	1254
		50000	3848	3125	2767	2374	1929	1708	1566	1387	1324	1272	1190	1127	1076
		100000	3125	2539	2248	1929	1566	1387	1272	1127	1076	1033	967	915	874
1 15/16	18000	5000	5290	5290	5290	4929	4004	3545	3252	2879	2749	2641	2470	2339	2233
2		10000	5290	5270	4667	4004	3252	2879	2641	2339	2233	2145	2007	1900	1814
		30000	4667	3790	3356	2879	2339	2071	1900	1682	1606	1543	1443	1366	1305
		50000	4004	3252	2879	2470	2007	1777	1630	1443	1378	1324	1238	1172	1119
		100000	3252	2641	2339	2007	1630	1443	1324	1172	1119	1075	1006	952	909
2 3/16	22400	5000	6590	6590	6590	6134	4982	4412	4047	3583	3421	3287	3074	2911	2779
		10000	6590	6559	5807	4982	4047	3583	3287	2911	2779	2670	2497	2364	2257
		30000	5807	4717	4177	3583	2911	2577	2364	2093	1999	1920	1796	1700	1623
		50000	4982	4047	3583	3074	2497	2211	2028	1796	1715	1647	1541	1459	1393
		100000	4047	3287	2911	2497	2028	1796	1647	1459	1393	1338	1251	1185	1131
2 7/16	32400	5000	9530	9530	9530	8872	7206	6381	5853	5183	4949	4754	4447	4210	
2 1/2		10000	9530	9486	8400	7206	5853	5183	4754	4210	4020	3682	3612	3420	
		30000	8400	6823	6041	5183	4210	3728	3420	3028	2891	2778	2598	2459	
		50000	7206	5853	5183	4447	3612	3198	2934	2598	2480	2383	2229	2110	
		100000	5853	4754	4210	3612	2934	2598	2383	2110	2015	1936	1810	1714	
2 11/16	34600	5000	10175	10175	10175	9475	7696	68144	6251	5535	5285	5077	4749	4496	
2 3/4		10000	10175	10131	8970	7696	6251	5535	5077	4496	4293	4124	3857	3652	
2 15/16		30000	8970	7286	6452	5535	4496	3981	3652	3233	3087	2966	2774	2626	
3		50000	7696	6251	5535	4749	3857	3415	3133	2774	2649	2545	2380	2253	
		100000	6251	5077	4496	3857	3133	2774	2545	2253	2151	2067	1933	1830	
3 3/16	54900	5000	16150	16150	16150	15033	12211	10812	9918	8782	8385	8056			
3 7/16		10000	16150	16074	14233	12211	9918	8782	8056	7133	6811	6544			
3 1/2		30000	14233	11561	10237	8782	7133	6316	5794	5131	4899	4706			
		50000	12211	9918	8782	7535	6120	5419	4971	4402	4203	4038			
		100000	9918	8056	7133	6120	4971	4402	4038	3575	3414	3280			
3 11/16	70000	5000	20590	20590	20590	19168	15569	13786	12646	1198	10692	10272			
3 15/16		10000	20590	20495	18148	15569	12646	11198	10272	9096	8684	8343			
4		30000	18148	14741	13052	11198	9096	8054	7388	6542	6246	6001			
		50000	15569	12646	11198	9607	7803	6909	6338	5612	5359	5148			
		100000	12646	10272	9096	7803	6338	5612	5148	4559	4353	4182			
4 7/16	91800	5000	27000	27000	27000	25138	20418	18080	16585						
4 1/2		10000	27000	26878	23800	20148	16585	14685	13471						
		30000	23800	19331	17117	14685	11928	10562	9689						
		50000	20418	16585	14685	12599	10233	9061	8312						
		100000	16585	13471	11928	10233	8312	7360	6751						
4 15/16	124,000	5000	36470	36470	36470	33955	27580	24421							
		10000	36470	36306	32148	27580	22402	19836							
		30000	32148	26112	23121	19836	16112	14267							
		50000	27580	22402	19836	17018	13823	12240							
		100000	22402	18196	16112	13823	11228	9942							

See General Engineering page 272.

SPHERICAL ROLLER BEARINGS 22200 AND 22500 SERIES

This chart displays the Browning 22200 and 22500 Series Spherical Roller Bearing's load capacity for a given L10 life, speed and shaft size. Values in the table represent loads at ideal conditions. For combined load determination, see **THE BEARING SELECTION SECTION**, page 265. Areas designated by "-" exceed maximum speed value.

Table 15 Match Bore Size

Size	Rating	L10 Hours	REVOLUTIONS PER MINUTE 50	100	150	250	500	750	1000	1500	1750	2000	2500	3000	3500
22515	34600	5000	10131	10131	10131	9475	7696	6814	6251	5535	5285	5077	4749	4496	
		10000	10131	1013	8970	7696	6251	5535	5077	4496	4293	4124	3857	3652	
		30000	8970	7286	6452	5535	4496	3981	3652	3233	3087	2966	2774	2626	
		50000	7696	6251	5535	4749	3857	3415	3133	2774	2649	2545	2380	2253	
		100000	6251	5077	4496	3857	3133	2774	2545	2253	2151	2067	1933	1830	
22516	39600	5000	11595	11595	11595	10844	8808	7799	7154	6335	6049	5811	5435	5145	
		10000	11595	11595	10267	8808	7154	6335	5811	5145	4913	4720	4414	4179	
		30000	10267	8339	7384	6335	5145	4556	4179	3701	3533	3395	3175	3006	
		50000	8808	7154	6335	5435	4414	3909	3586	3175	3031	2912	2724	2579	
		100000	7154	5811	5145	4414	3586	3175	2912	2579	2462	2366	2212	2095	
22517	45400	5000	13293	13293	13293	12432	10098	8941	8202	7263	6934	6662	6231	5899	
		10000	13293	13293	11770	10098	8202	7263	6662	5899	5633	5411	5061	4792	
		30000	11770	9560	8465	7263	5899	5229	4792	4243	4051	3892	3640	3446	
		50000	10098	8202	7263	6231	5061	4481	4111	3640	3475	3339	3123	2957	
		100000	8202	6662	5899	5061	4111	3640	3339	2957	2823	2712	2536	2401	
22518	54900	5000	16074	16074	16074	15033	12211	10812	9918	8782	8385	8056	7535		
		10000	16074	16074	14233	12211	9918	8782	8056	7133	6811	6544	6120		
		30000	14233	11561	10237	8782	7133	6316	5794	5131	4899	4706	4402		
		50000	12211	9918	8782	7535	6120	5419	4971	4402	4203	4038	3776		
		100000	9918	8056	7133	6120	4971	4402	4038	3575	3414	3280	3067		
22520	70000	5000	20495	20495	20495	19168	15569	13786	12646	11198	10692	10272			
		10000	20495	20495	18148	15569	12646	11198	10272	9096	8684	8343			
		30000	18148	14741	13052	11198	9096	8054	7388	6542	6246	6001			
		50000	15569	12646	11198	9607	7803	6909	6338	5612	5359	5148			
		100000	12646	10272	9096	7803	6338	5612	5148	4559	4353	4182			
22522	91800	5000	26878	26878	26878	25138	204018	18080	16585	14685	14022	13471			
		10000	26878	26878	23800	20418	16585	14685	13471	11928	11389	10942			
		30000	23800	19331	17117	14685	11928	10562	9689	8579	8191	7870			
		50000	20418	16585	14685	12599	10233	9061	8312	7360	7027	6751			
		100000	16585	13471	11928	10233	8312	7360	6751	5978	5708	5484			
22524	105000	5000	30743	30743	30743	28752	23354	20679	18969	16797	16038				
		10000	30743	30743	27222	23354	18969	16797	15408	13643	13027				
		30000	27222	22111	19579	16797	13643	12081	11082	9813	9639				
		50000	23354	18969	16797	14410	11705	10364	9507	8418	8038				
		100000	18969	15408	13643	11705	9507	8418	7722	6838	6529				
22526	124000	5000	36306	36306	36306	33955	27580	24421	22402	19836	18940				
		10000	36306	36306	32148	27580	22402	19836	18196	16112	15384				
		30000	32148	26112	23121	19836	16112	14267	13087	11588	11064				
		50000	27580	22402	19836	17018	13823	12240	11228	9942	9492				
		100000	22402	18196	16112	13823	11228	9942	9120	8075	7710				
22528	140000	5000	40991	40991	40991	38336	31139	27572	25293	22396					
		10000	40991	40991	36296	31139	25293	22396	20544	18191					
		30000	36296	29481	26105	22396	18191	16108	14776	13083					
		50000	31139	25293	22396	19214	15606	13819	12676	11244					
		100000	25293	20544	18191	15606	12676	1124	10296	9117					
22530	166000	5000	48603	48603	48603	45456	36922	3293	29990	26555					
		10000	48603	48603	43037	36922	29990	26555	24359	21569					
		30000	43037	34957	30953	26555	21569	19099	17520	15513					
		50000	36922	29990	26555	22782	18505	16385	15031	13309					
		100000	29990	24359	21569	18505	15031	13309	12209	10810					
22532	194000	5000	56801	56801	56801	53123	43150	38208	35048	31034					
		10000	56801	56801	50296	43150	35048	31034	28468	25208					
		30000	50296	40853	36174	31034	25208	22321	20475	18130					
		50000	43150	35048	31034	26625	21626	19149	17566	15554					
		100000	35048	28468	25208	21626	17566	15554	14268	12634					
22534	220000	5000	64414	64414	64414	60243	48933	43328	39746						
		10000	64414	64414	57036	48933	39746	35193	32283						
		30000	57036	46328	41022	35193	28586	25312	23219						
		50000	48933	39746	35193	30193	24524	21716	19920						
		100000	39746	32283	28586	24524	19920	17638	16180						
22536	227000	5000	66463	66463	66463	62160	50489	44707	41010						
		10000	66463	66463	58851	50489	41010	36313	33311						
		30000	58851	47802	42327	36313	29495	26117	23958						
		50000	50489	41010	36313	31154	25305	22406	20554						
		100000	41010	33311	29495	25305	20554	18200	16695						
22538	250000	5000	73198	73198	73198	68458	55605	49237	45165						
		10000	73198	73198	64814	55605	45165	39993	36686						
		30000	64814	52645	46616	39993	32484	28764	26385						
		50000	55605	45165	39993	34310	27869	24677	22636						
		100000	45165	36686	32484	27869	22636	20044	18386						
22540	286000	5000	83738	83738	83738	78316	63612	56327	51669						
		10000	83738	83738	74147	63612	51669	45751	41968						
		30000	74147	60226	53329	45751	37162	32905	30185						
		50000	63612	51669	45751	39251	31882	28230	25896						
		100000	516694	41968	37162	31882	25896	22930	21034						
22544	342000	5000	100134	100134	100134	93651	76068	67356							
		10000	100134	100134	88666	76068	61786	54710							
		30000	88666	72019	63770	54710	44438	39349							
		50000	76068	61786	54710	46936	38124	33758							
		100000	61786	50186	44438	38124	30967	27420							

See General Engineering page 272.

BEARING SELECTION:

Consult EPT Mounted Bearing Technical Support for

1. Moderate to High Thrust Load Applications
2. Housing Strength and Capabilities
3. High Load/High Speed Applications
4. See Bearing Dimension/Data Tables for General Bearing Capabilities

LINEAL SHAFT EXPANSION

Lineal shaft expansion is the change in length of a shaft due to a relative change in its temperature.For steel shafts, lineal expansion can be calculated using the following formula:

Expansion (Growth) = .0000063 x Length (inches) x Temperature Change °F

The following Roller Bearings can accommodate shaft lineal expansion as listed in the table below.

Table 16

Series	Lineal Expansion Capability
950, 970	.310 inched
1000, 1100, thru 1-3/4"	.050 inches
1000/1100 1-15/16 up	.080 inches
22200/22500	.080 inches

Consult EPT Mounted Bearing Tech Support for applications where lineal expansion is a factor on other types of Browning Bearing Products or the lineal expansion exceeds the capability of the Roller Bearings listed above.

BEARING ALIGNMENT CAPABILITY (IN)
ALLOWABLE ALIGNMENT ERROR (IN)

Table 17

	DISTANCE BETWEEN BEARINGS (feet)									
	1 Ft.	2 Ft.	3 Ft.	4 Ft.	5 Ft.	6 Ft.	7 Ft.	8 Ft.	9 Ft.	10 Ft.
Labyrinth (Multi-trap) 1000/1100 950/970/Ball *	.3	0.6	.9	1.3	1.6	1.9	2.2	2.5	2.8	3.63
Contact (Double Lip) 1000/1100	.25	.5	.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6
22500 (LER) 22200 (LER)	.05	.1	.2	.2	.3	.3	.4	.4	.5	.5

* Ball except cylindrical O. D. inserts

SEALS

- 900/950 series bearings are designed with metal labyrinth seals. Labyrinth seals rely on frequent lubrication for full effectiveness. 920 and 970 series bearings with contact seals should be selected in moist, wet or highly contaminated environments.
- 1000/1100 series are standard with metal labyrinth seals. Labyrinth seals rely on frequent lubrication for full effectiveness. Contact seals should be specified in moist, wet or highly contaminated environments.

Browning® Engineering

Application Worksheet

EMERSON POWER TRANSMISSION

EPT MOUNTED BEARING DIVISION

Mail To: EPT Bearing Operations - Application Engineering
1901 Bilter Rd.
Aurora IL 60507

Fax to: Application Engineering 630-898-6064

Distributor Information	Customer Information
Distributor Name Contact Name	Company Name Contact Name
Street Address City/State/Zip	Street Address City/State/Zip
Phone Fax E-Mail	Phone Fax E-Mail
Is the Customer an: OEM or End User	Industry

Application Information

Is this a new application Yes or No	Complete Climate Description
Speed: (rpm)	EXPLAIN: Climate Conditions: Wet ❑ Washdown ❑ Dry ❑ Clean ❑ Dirty ❑ Chemicals ❑
Service Life Required: (hours):	
Shaft Diameter:	
Load Information (lbs.): Load Conditions: Steady ❑ Radial (lbs.): Shock ❑ Axial / Thrust (lbs.): Thrust ❑ Oscillation ❑ If loads unknown attach detailed sketch*** Other ❑	Operating Temperature (°F): Is the bearing in the elevated temp? Yes / No Is the heat coming through the shaft? Yes / No Can the bearings be re-lubricated? Yes ❑ No ❑
Complete Application Description: Horsepower (bhp):	Motor Driven Pulley Diameter (in.): Distance Between Bearings:

***PLEASE ATTACH DETAILED SKETCH OF APPLICATION.

INCLUDE ALL DIMENSIONS AND SYSTEM LOAD LOCATIONS

See page 152 for trademark acknowledgments.

APPLICATION EXAMPLES:

EXAMPLE # 1
Pure Radial Load

Question # 1:

What is the adjusted bearing life (L_{na} hours) for an VPS-239 Browning Ball Bearing with no shock conditions and the following application criteria?

Design Load (P)	=	1300 lbs.
Speed (n)	=	1000 RPM
Shaft Size	=	$2^7/_{16}$ Inches
Operating Temperature	=	125°F

Solution:

1. Begin with the L_{10} life formula: $L_{10} = (C/P)^3 \times \frac{16667}{n}$

   Look up the insert of an VPS-239 on page 6. From Table 4 on page 265, the Basic Dynamic Radial Rating is 11,789 lbs.

$$L_{10} = \left(\frac{11789}{1300}\right)^3 \times \frac{16667}{1000} = 12{,}430 \text{ hours}$$

2. Apply the life adjustment factors:
   L_{na} hours = $L_{10} \times a_1 \times a_2 \times a_3$
   L_{na} hours = 12,430 x 1 x 1 x 0.456
   L_{na} hours = 5,700 hours *

Question # 2:

What is the adjusted bearing life (L_{10} hours) for an VPS-39 Browning Ball Bearing with moderate shock conditions and the same application criteria from above?

Solution:

1. From Table 2 on page 262: a_3 = 0.5 x 0.456.
2. Re-Apply the life adjustment factors to the previously calculated L10 life:
   L_{na} hours = $L_{10} \times a_1 \times a_2 \times a_3$
   L_{na} hours = 12,430 x 1 x 1 x (0.5 x 0.456)
   L_{na} hours = 2,830 hours*

Question # 3:

What is the bearing life (L_{10} hours) for an PB-970NEx 2 7/16 Tapered Roller Bearing with no shock conditions and the same application criteria from above?

Solution:

1. Begin with the L_{10} life formula: $L_{10} = (C/P)^{10/3} \times \frac{500 \times 3{,}000}{n}$
2. PB-970NEx 2 7/16 has 2 7/16" shaft size. From Table 13 x on page 269, the Radial Rating is 9,030 lbs.

$$L_{10} = \left(\frac{9030}{1300}\right)^{10/3} \times \frac{500 \times 3{,}000}{1000} = 959{,}000 \text{ hrs.}$$

For moderate shock (from table 5) L_{10} = .5* 959,000 = 480,000 hrs*

Question # 4:

What is the bearing life (L_{10} hours) for an SPB-1000NEx 2 7/16 Spherical Roller Bearing with moderate shock conditions and the same application criteria from above?

Solution:

1. From Table No. 14 on page 270:

$$L_{10} = ? \times \left(\frac{32{,}400}{1300}\right)^{10/3} \times \frac{16{,}667}{1000} = 754{,}000^* \text{ hrs.}$$

For moderate shock (from Table 6 page 265)
L10 = .5 x 754,000 = 37,000 hrs*

* Excessively high or low hours are not realistic in applications.

EXAMPLE # 2 Combined Radial and Thrust Load

Question # 1:

What is the adjusted bearing life (L_{na} hours) for an VPS-239 Browning Ball Bearing with no shock conditions and the following application criteria?

Design Radial Load (F_r)	=	500 lbs.
Design Thrust Load (F_a)	=	1000 lbs.
Speed (n)	=	1000 RPM
Shaft Size	=	$2^7/_{16}$ Inches
Operating Temperature	=	125°F

Solution:

1. Calculate F_a/F_r = 1000/500 = 2
2. Begin by calculating the Relative Axial Load (RAL): (From Table 3, page 263)

$$RAL = \frac{F_a}{ND^2} = \frac{1000}{3.9690} = 251 \text{ lbs.}$$

3. From Table 3 on page 263, interpolate RAL between 200.10 and 300.15 and "e" between 0.30 and 0.34 to obtain an "e" value:

$$\frac{251 - 200.10}{300.15 - 200.10} = \frac{e - 0.30}{0.34 - 0.30} \qquad \text{Therefore } e=.32$$

4. From Table 3 on page 263, determine the value of "X" and "Y" through interpolation. Interpolate "e" between 0.30 and 0.34 and "Y" between 1.45 and 1.31 because $F_a/F_r > e$;

$$\frac{0.32 - 0.30}{0.34 - 0.30} = \frac{Y - 1.45}{1.31 - 1.45}$$

Therefore Y = 1.38

X = .56

5. Determine the equivalent radial load (P):
   $P = (X\ F_r) + (Y\ F_a)$
   = (0.56 x 500) + (1.38 x 1000) = 1660 lbs.

   $L_{10} = (C/P)^3 \times \frac{16667}{n}$

   Look up the insert of an VPS-239 on page 6. From Table 4 on page 263, the Basic Dynamic Radial Rating is 11,789 lbs.

$$L_{NA} = .456 \times \left(\frac{11789}{1660}\right)^3 \times \frac{16667}{1000} = 2720 \text{ hours}$$

Question # 2:

What is the bearing life (L_{10} hours) for an PB-970NEx 2 7/16 Tapered Roller Bearing with no shock conditions and the same application criteria from above?

Solution:

1. Find the K factor value from Table 13 on page 269, K = 1.51.
2. Calculate the internal thrust reaction (FIR):

$$FIR = \frac{0.6 \times F_r}{K} \quad \begin{matrix}\text{-applied radial load} \\ \text{-factor K in Table 13}\end{matrix}$$

$$FIR = \frac{0.6 \times 500}{1.51} = 199 \text{ lbs.}$$

3. Since the thrust load is greater than the internal thrust reaction (FIR) use the following formula from page 264 to calculate the equivalent radial load.
   P = $(0.4 \times F_r) + (K \times F_a)$
   P = (0.4 X 500) + (1.51 X 1000) = 1710 lbs.
4. Caclulate the expected L_{10} life using the single row rating. Single row rating = 5,220 lbs. This is found in Table 13 on page 269.

$$L_{10} = \left(\frac{\text{single row load rating}}{P}\right)^{10/3} \times \frac{500 \times 3000}{n}$$

$$L_{10} = \left(\frac{5220}{1710}\right)^{10/3} \times \frac{3000 \times 500}{1000} = 61{,}900 \text{ hrs.}$$

COMPUTING BEARING LOADS:

In the computation of bearing loads in any application of a Browning unit, the principal factor determining the selection of the unit is the equivalent radial load to which the bearing will be subjected. These radial loads result from any one or any combination of the following sources:

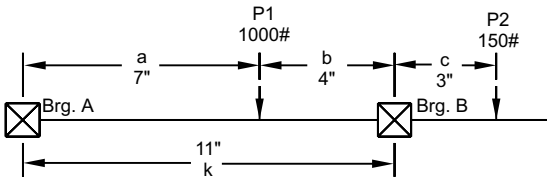
1. Weights of machine parts supported by bearings.
2. Tension due to belt or chain pull.
3. Centrifugal force from out of balance, eccentric or cam action.

The resulting load from any one, or any combination of the above sources is further determined by knowing:

1. The magnitude of the load.
2. Direction of the load.
3. The point of load application.
4. The distance between bearing centers.

Bearing loads are the result of force acting on the shaft. Direction, magnitude, and location with respect to the bearings must be considered when calculating bearing loads. The following cases are typical examples of loads encountered and methods of calculating bearing loads.

CASE # 1
Straddle Mount Fan, Cantilever Drive



$$\text{Load on Bearing A} = \frac{(P_1 \times b) - (P_2 \times c)}{k}$$

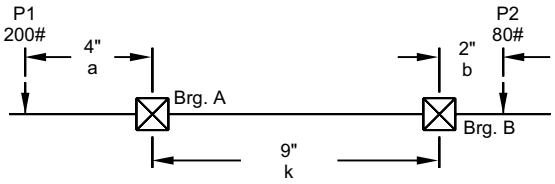
$$= \frac{(1{,}000 \times 4) - (150 \times 3)}{11} = 323 \text{ lbs.}$$

$$\text{Load on Bearing B} = \frac{(P_1 \times a) + (c + k) \times (P_2)}{k}$$

$$= \frac{(1{,}000 \times 7) + (3 + 11) \times (150)}{11}$$

$$= 827 \text{ lbs.}$$

CASE # 2
Cantilever Fan and Drive



$$\text{Load on Bearing A} = \frac{P_1 \times (a + k) - (P_2 \times b)}{k}$$

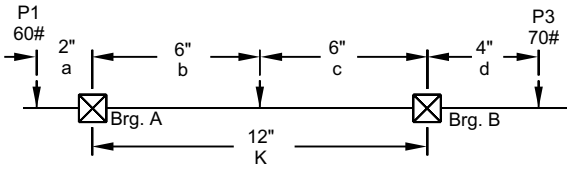
$$= \frac{200 \times (4 + 9) - (80 \times 2)}{9} = 271 \text{ lbs.}$$

$$\text{Load on Bearing B} = \frac{(P_2 \times (k + b) - (P_1 \times a)}{k}$$

$$= \frac{80 \times (9 + 2) - (200 \times 4)}{9}$$

$$= 9 \text{ lbs.}$$

CASE # 3
Straddle, Cantilever Fan, Cantilever Drive



$$\text{Load on Bearing A} = \frac{P_1 \times (k + a) + (P_2 \times c) - (P_3 \times d)}{k}$$

$$= \frac{60 \times (12 + 2) + (180 \times 6) - (70 \times 4)}{12}$$

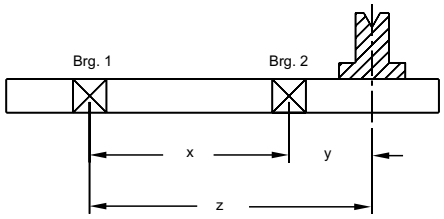
$$= 137 \text{ lbs.}$$

$$\text{Load on Bearing B} = \frac{-(P_1 \times a) + (P_2 \times b) + P_3 \times (k + d)}{k}$$

$$= \frac{-(60 \times 2) + (180 \times 6) + 70 \times (12 + 4)}{12}$$

$$= 173 \text{ lbs.}$$

CASE # 4
Drive Load Calculation



$$P = \frac{126{,}000 \times HP}{RPM \times d} \times K = \frac{126{,}000 \times 5}{2{,}400 \times 10} \times 1.5 = 39.4 \text{ lbs.}$$

HP = horsepower
RPM = revolutions per minute
d = pitch diameter of pulley in inches
K = constant for type of drive used
K = 1.5 for V-belts
K = 2 to 3 for flat transmission belts
K = 1.1 for chain drives

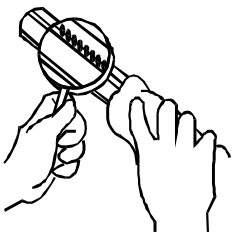
Apply P to Case 1, 2 or 3 if applicable

See page 152 for trademark acknowledgments.

SET SCREW LOCK

❶ INSPECT SHAFT

- Clean/remove burrs.
- Check diameter -Ref tables 25, 27, 35.
- Clean Mounting Surface.
- Mounting Surfaces Must be Flat.

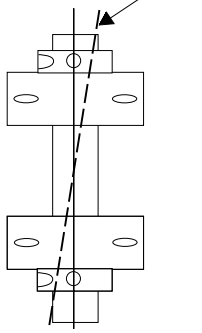


❷ PLACE BEARING ON SHAFT

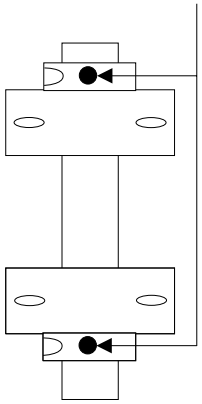
- Apply light film of oil on shaft.
- Slide, do not hammer, bearing onto shaft.

❸ BOLT HOUSING TO SUPPORT SURFACE

- Bearing and shaft must be in alignment.
  - Ball - 1 1/2 ° max
  - 1000/1100 - 1 1/2° max
  - 1000/1100 w/contact seals - 1 1/2° max
  - 920 - 1/20° max
  - 970 - 1 1/4° max
  - VER 1/20° max
- Rotate shaft to make sure it rotates.



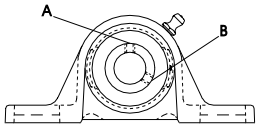
❹ ALIGN SETSCREWS ON BOTH BEARINGS IN LINE



❺ ALTERNATE TORQUING OF SETSCREWS

See Torque Specification Tables

- Step 1: Torque setscrew "A" to 1/2 recommended torque. In tables 18, 19, 20
- Step 2: Torque setscrew "B" to full recommended torque. In tables 18, 19, 20
- Step 3: Torque setscrew "A" to full recommended torque. In tables 18, 19, 20
- Double Lock: Repeat on opposite end.



Set Screw Tightening Torque

Table 18 Ball Bearings

Bearing Bore 100-200 Series (Inches)	Bore Size 300 series (Inches)	Set Screw Diameter	Hex Size Across Flats	Recommended Torque (Inch Lbs.)	Recommended Torque (Foot Lbs.)
1/2 - 5/8		10 - 32	3/32	28 - 36	
3/4 - 1 1/4	15/16 - 1	1/4 - 28	1/8	66 - 85	
1 1/4 - 1 3/4	1 3/16 - 1 1/2	5/16 - 24	5/32	126 - 164	11 - 14
1 15/16 - 2 7/16	1 11/16 - 2 3/16	3/8 - 24	3/16	228 - 296	19 - 25
2 1/2 - 3 15/16	2 7/16 - 3 15/16	7/16 - 20	7/32	348 - 452	29 - 38

Table 19 920/970 Tapered Roller

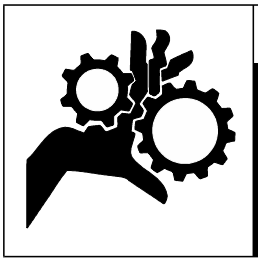
Bearing Bore (inches)	Set Screw Diameter (inches)	Recommended Torque (In-Lbs)	Recommended Torque (Ft-Lbs)
1 3/16 to 1 11/16	5/16 - 24	108 - 144	9 - 12
1 3/4 to 2 1/2	3/8 - 24	180 - 228	15 - 19
2 11/16 to 3 1/2	1/2 - 20	408 - 540	34 - 45
3 15/16 to 4	5/8 - 18	876 - 1140	73 - 95
4 7/16 to 5	3/4 - 16	1440 - 1800	120 - 150

Table 20 1000/1100 Spherical Roller

Bearing Bore (inches)	Set Screw Diameter (inches)	Recommended Torque (In-Lbs)	Recommended Torque (Ft-Lbs)
1 1/8 to 2 3/16	3/8 - 24	290 - 380	24 - 32
2 7/16 to 3 7/16	1/2 - 20	620 - 930	50 - 45
3 1/2 to 4 15/16	5/8 - 18	1300 - 1700	108 - 140

Monitor operating bearing during first 48 hours for unusual vibration or temperatures.

⚠WARNING
Failure to observe safety precautions could cause personal injury or equipment damage.



⚠WARNING
Do not operate without guards. Turn off power to install or service

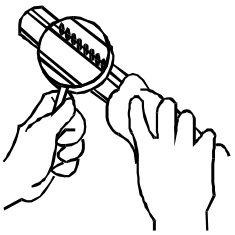
⚠CAUTION
High voltage and rotating parts may cause serious or fatal injury. Turn off power to install or service.

See page 152 for trademark acknowledgments.

BOA CONCENTRIC LOCKING

❶ INSPECT SHAFT

- Clean/remove burrs.
- Check diameter. Reference Table 25.
- Clean Mounting Surface.
- Mounting Surface Must be Flat.

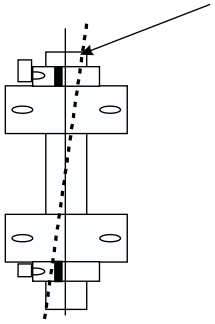


❷ PLACE BEARING ON SHAFT

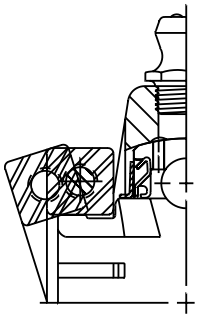
- Slide, do not hammer, bearing onto shaft.

❸ BOLT HOUSING TO SUPPORT SURFACE

- Bearing and shaft must be in alignment max 1 1/2°.
- Rotate shaft to make sure it rotates.



❹ PUSH LOCKING COLLAR TIGHTLY AGAINST INNER RING SHOULDER



❺ TORQUE CAPSCREW TO RECOMMENDED VALUE

See Torque Specification Table 21

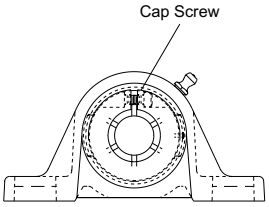
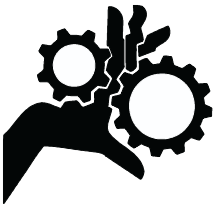


Table 21 BOA Concentric Cap Screw Tightening Torque

Bearing Bore Normal Duty (Inches)	Bearing Bore Medium Duty (inches)	Thread Size	Torx Size	Recommended Torque (Inch Lbs.)	Recommended Torque (Foot Lbs.)
3/4- 1 1/4R	15/16-1	8-32	T-25	63 -70	
1 1/4 - 1 3/4	1 3/16-1 1/2	10-24	T-27	81 - 90	
1 13/16 - 2 3/16	1 11/16-1 15/16	1/4-20	T-30	162 - 180	13-15
2 1/4 - 2 7/16	2 3/16	5/16-18	T-45	360 - 400	30 - 33

Monitor operating bearing during first 48 hours for unusual vibration or temperatures.

⚠WARNING
Failure to observe safety precautions could cause personal injury or equipment damage.



⚠WARNING
Do not operate without guards. Turn off power to install or service

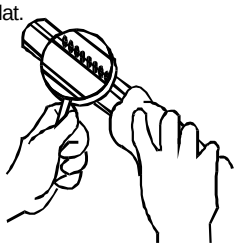
⚠CAUTION
High voltage and rotating parts may cause serious or fatal injury. Turn off power to install or service.

See page 152 for trademark acknowledgments.

ECCENTRIC LOCK

❶ INSPECT SHAFT (TABLE 1)

- Clean/remove burrs.
- Check diameter - Ref table 25, 31.
- Clean Mounting Surface.
- Mounting Surfaces Must be Flat.

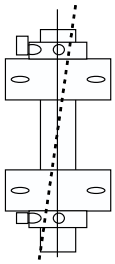


❷ PLACE BEARING ON SHAFT

- Do not hammer bearing onto shaft.
- Apply light film of oil on shaft.

❸ BOLT HOUSING TO SUPPORT SURFACE

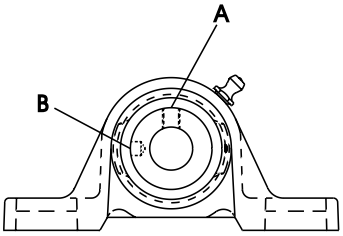
- Bearing and shaft must be in alignment
  - 900 - 1/20° max
  - 950 - 1 1/2° max
  - Ball - 1 1/2° max
- Rotate shaft to make sure it rotates.



❹ FASTEN UNIT TO SHAFT

See Torque Specification Tables

- Step 1:
  Place collar on inner race and rotate by hand i**n direction of shaft rotation** unitl eccentrics are engaged.
- Step 2:
  Insert drift pin into the hole in the collar O.D. and lock in direction of shaft rotation with the aid of small hammer.
- Step 3:
  Torque single setscrew to recommended torque - Ref table 22, 23.



Eccentric Lock Set Screw Tightening Torque

Table 22 Ball Bearings

Bearing Bore (Inches)	Set Screw Diameter	Hex Size Across Flats	Recommended Torque	
			Inch Lbs.	Foot Lbs.
1/2 - 1	...-28	1/8	66 - 85	
1 1/8 - 1 1/4	5/16-24	5/32	126 - 164	
1 1/4 - 1 15/16	3/8-24	3/16	228 - 296	19-25
2 - 2 7/16	7/16-20	7/32	348 - 452	29-38
2 11/16 - 2 15/16	‰-20	1/4	504 - 655	42-55

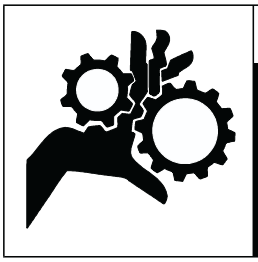
Table 23 900/950 Tapered Roller

Bearing Bore (Inches)	Set-Screw Diameter (Inches)	Recommended Torque	
		(In-Lbs)	(Ft-Lbs)
1 3/16 to 1 11/16	5/16 - 24	108-140	9-12
1 3/4 to 2 1/2	3/8 - 24	180-230	15-19
2 11/16 to 3 1/2	1/2 - 20	408-530	34-45
3 15/16 to 5	5/8 - 18	876-1000	73-95

- **Eccentric Lock not recommended for reversing shaft rotation applications.**
- **Monitor operating bearing during first 48 hours for unusual vibration or temperatures.**

⚠WARNING

Failure to observe safety precautions could cause personal injury or equipment damage.



⚠WARNING

Do not operate without guards. Turn off power to install or service

⚠CAUTION

High voltage and rotating parts may cause serious or fatal injury. Turn off power to install or service.

See page 152 for trademark acknowledgments.

Table 24 Ball Bearings

Bore Tolerances For Ball Bearings	
Shaft Size (Inches)	**Tolerances (Inches)**
1/2 to 1 15/16	+.0006/-.0000
2 to 3 3/16	+.0006/-.0000
3 1/4 to 5	+.0007/-.0000

Table 25

Recommended Shaft Tolerances	
Shaft Size (Inches)	**Tolerances (Inches)**
1/2 to 1 15/16	+.0000/-.0005
2 to 3 3/16	+.0000/-.0010
3 1/4 to 5	+.0000/-.0015

Table 26 920/970 Tapered Roller Bearings

Bore Tolearnces	
Shaft Size (Inches)	Bore Tolerance (Inches)
1 3/16 to 3	+.001 / -.000
3 3/16 to 5	+.002 / -.000

Table 27

RECOMMENDED SHAFT TOLERANCES	
Nominal Shaft Size (Inches)	Shaft Tolerances (Inches)
1 3/16 to 1 15/16	+.0000 / -.0005
2 to 3 15/16	+.0000 / -.0010
4 to 5	+.0000 / -.0015

Table 28

HOUSING CAP BOLT TORQUES 970 SERIES PILLOW BLOCKS		
SHAFT SIZE	HOUSING CAP BOLT TORQUES	
(Inches)	(Ft-Lbs)	(In-Lbs)
1 3/8, 1 7/16,	30-35	360-400
1 1/2, 1 11/16,	40-45	465-515
1 3/4, 1 15/16, 2	50-55	615-680
2 3/16	70-75	815-900
2 1/4, 2 7/16, 2 1/2	70-80	860-950
2 11/16, 2 15/16, 3	90-100	1100-1215
3 3/16, 3 7/16, 3 1/2	170-190	2040-2250
3 15/16, 4	265-295	3190-3525
4 7/16, 4 1/2	120-135	1470-1620
4 15/16, 5	195-220	2360-2610

Table 29

HOUSING CAP BOLT TORQUES 970 SERIES FLANGED HOUSINGS		
SHAFT SIZE	HOUSING CAP BOLT TORQUES	
(Inches)	(Ft-Lbs)	(In-Lbs)
1 3/8, 1 7/16,	30-35	365-405
1 1/2, 1 11/16,	40-45	465-515
1 3/4, 1 15/16, 2	50-55	615-680
2 3/16	65-75	810-895
2 1/4, 2 7/16, 2 1/2	70-80	855-945
2 11/16, 2 15/16, 3	90-100	1095-1210
3 3/16, 3 7/16, 3 1/2	170-190	2040-2255
3 15/16, 4	265-295	3190-3530
4 7/16, 4 1/2	325-360	3910-4320
4 15/16, 5	505-560	6065-6705

Table 30 900/950 Tapered Roller Bearings

Bore Tolearnces	
Shaft Size (Inches)	Bore Tolerance (Inches)
1 to 3 1/2	+.001 / -.000
3 15/16 to 5	+.002 / -.000

Table 31

RECOMMENDED SHAFT TOLERANCES	
Nominal Shaft Size (Inches)	Shaft Tolerances (Inches)
1 to 1 15/16	+.0000 / -.0005
2 to 3 15/16	+.0000 / -.0010
4 to 5	+.0000 / -.0015

Table 32

HOUSING CAP BOLT TORQUES 950 SERIES PILLOW BLOCKS		
SHAFT SIZE	HOUSING CAP BOLT TORQUES	
(Inches)	(Ft-Lbs)	(In-Lbs)
1 7/16, 1 1/2	30-35	360-400
1 5/8, 1 11/16, 1 3/4	40-45	465-515
1 7/8, 1 15/16, 2, 2 1/8	50-55	615-680
2 3/16	70-75	815-900
2 1/4, 2 7/16, 2 1/2	70-80	860-950
2 11/16, 2 3/4, 2 15/16	90-100	1100-1215
3,3 3/16	140-150	1680-1800
3 7/16, 3 1/2	170-190	2040-2250
3 15/16, 4	265-295	3190-3525
4 7/16, 4 1/2	120-135	1470-1620
4 15/16, 5	195-220	2360-2610

Table 33

HOUSING CAP BOLT TORQUES 950 SERIES FLANGED HOUSINGS		
SHAFT SIZE	HOUSING CAP BOLT TORQUES	
(Inches)	(Ft-Lbs)	(In-Lbs)
1 7/16, 1 1/2	30-35	365-405
1 5/8, 1 11/16, 1 3/4	40-45	465-515
1 7/8, 1 15/16, 2, 2 1/8	50-55	615-680
2 3/16	65-75	810-895
2 1/4, 2 7/16, 2 1/2	70-80	855-945
2 11/16, 2 3/4, 2 15/16	90-100	1095-1210
3,3 3/16	140-150	1655-1825
3 7/16, 3 1/2	170-190	2040-2255
3 15/16, 4	265-295	3190-3530
4 7/16, 4 1/2	325-360	3910-4320
4 15/16, 5	505-560	6065-6705

Table 34 1000/1100 Spherical Roller Bearings

Bore Tolerances	
Nominal Shaft Size	Shaft Tolerances
(Inches)	(Inches)
1 1/8	+.0005 / +0
1 3/16 to 1 15/16	+.0006 / +0
2 to 3	+.0007 / +0
3 3/16 to 4 15/16	+.0009 / +0

Table 35

Recommended Shaft Tolerances	
Nominal Shaft Size	Shaft Tolerances
(Inches)	(Inches)
1 1/8 to 1 15/16	+.0000 / -.0005
2 to 3 15/16	+.0000 / -.0010
4 - 4 15/16	+.0000 / -.0015

See page 152 for trademark acknowledgments.

Mounting the Bearing and Seal Assemblies in the Housing

- Remove the nuts and lockwashers from the housing cap bolts.
- Lift off the cap and remove the stabilizing ring. **⚠CAUTION** Do not mix housing caps and bases. They are machined as a matched set and mixing the cap and bases could result in premature failure.
- Install the outward seal rings on the shaft.
- Clean the housing using an OSHA approved solvent.
- Lift the shaft assembly and place the bearings in the housings, being sure that the seal rings mate with the grooves in the housing.
- Install a stabilizing ring in one bearing housing only, making it non-expansion. Leave out the stabilizing ring for the other bearing, and then center the other bearing in the other housing so that it is free to move in both directions.
- Check the rotation of the shaft. The shaft should rotate freely. Any roughness or binding would indicate an error in assembly and/or dirt in the bearings and should be corrected before operating the bearings.
- Secure the pillow block to the mounting surface by tightening the base bolts. Torque the base bolts to the values recommended by the base bolt supplier.
- Place the corresponding housing caps into position. Tighten the nuts on the cap bolts to the specified values, using the washers included.
- Rotate the shaft again. The shaft should rotate freely.

⚠WARNING **The load rating for the 22500 series roller bearing units found in the Browning catalog assume that the bearing unit is base loaded. For any application where there is load carried through the cap of the housing, EPT Mounted Bearing Technical Support (see page 256) should be contacted.**

Table 36

Recommended Shaft Tolerance	
Nominal Shaft Size (Inches)	Shaft Tolerance (Inches)
2 7/16 to 2 1/2	+.000/-.003
2 9/16 to 4	+.000/-.004
4 1/16 to 6	+.000/-.005
6 1/16 to 8	+.000/-.006

Table 37

Recommended Reduction In Internal Clearance (Feeler Gage Method)		
Housing Series	Reduction in Diametrical Clearance	
	Min. (Inches)	Max. (Inches)
515	.0018	.0022
516	.0018	.0022
517	.0018	.0022
518	.0018	.0022
520	.0020	.0025
522	.0020	.0025
524	.0020	.0025
526	.0026	.0032
528	.0026	.0032
530	.0026	.0032
532	.0032	.0040
534	.0032	.0040
536	.0032	.0040
538	.0032	.0040
540	.0032	.0040
544	.0040	.0050

Table 38

Recommended Shaft Tolerance				
Shaft Dia. (Inches)	'C' dim. (Inches)	'R' dim. (Inches)	Preferred 'L' @ 15 (Inches)	Preferred 'L' @ 30 (Inches)
2 7/16 to 3 15/16	.093	.188	.313	.156
4 3/16 to 6 15/16	.125	.250	.438	.218
7 3/16 to 7 15/16	.188	.375	.702	.323

Table 39

Recommended Cap Bolt Torque		
Housing Series	Recommended Cap Bolt Torque (Ft-Lbs)	
	Min.	Max.
515	43	48
516	86	95
517	86	95
518	86	95
520	86	95
522	153	169
524	153	169
526	153	169
528	153	169
530	246	272
532	222	245
534	222	245
536	222	245
538	314	347
540	443	490
544	443	490

Inner Seal Mounting

- Clean the shaft free of burrs. Check that shaft diameter is within specifications.
  For Standard Labyrinth Seal: Slide the seal on shaft.
  For Taconite Seal Arrangement: Coat the shaft with oil. Make sure that the end of the shaft has the proper chamfer, and slide the V-ring seal on the shaft keeping the lip of the seal towards the bearing. Apply grease to the bore of the Taconite seal assembly. Place the seal in position on the shaft.

22500 Adapter Mounting

- After installing the inner seal, coat the bore and O.D. of the Adapter Sleeve with a light film of oil. Place the adapter sleeve on the shaft at the desired location.
- Measure and record the internal clearance built into the bearing by inserting the feeler gage at the bottom of the bearing between the outer race and a roller. Do not roll over the feeler gage to get a reading, only use a sliding motion on the gage to get a reading.
- Seat the bearing hand tight on the adapter by pushing it up the taper
- Install the locknut, without washer, hand-tight against the bearing.
- Mark the location of the nut with respect to the adapter.
- Tighten the locknut until the measured internal clearance between the bottom of the bearing's outer race and roller is reduced by the amount shown in the table on the following page.
- If the measured reduction in internal clearance exceeds that recommended in the table, rotate the outer race to seat the rollers and remeasure by inserting the feeler gage between the outer race and rollers. If after several tries, you are convinced that the clearance removed in the assembly process is greater than that recommended, back off the locknut and repeat the procedure.
- If the measured reduction in internal clearance is within the recommended specifications, back off the locknut and then securely re-install it with the lockwasher in place.
- Bend the lockwasher tab into the slot in the locknut.

Press Fit Mounting

- After installing the inner seal, fit the bearing on to the shaft.
  For smaller bearings, apply a light film of oil or micronized graphite to the shaft and bore of the bearing.
  - Make sure that the bearing is square on the shaft and use either an arbor press or a hammer, in conjunction with a clean pipe pressed against the edge of the inner race, to press the bearing in to place.

  For larger bearings, bring the bearing up to a maximum temperature of 250° F. This may be accomplished by one of the following methods.
  - Place the bearing in an oil bath consisting of either clean oil or a 15% emulsion of oil which is soluble. This should last for 30 minutes to an hour.
  - Place the bearing in a temperature controlled oven for no longer than 4 hours, and preferably only long enough to assist with the size of the bore.
  - Use an induction heater long enough to bring the bore of the bearing up to the necessary size. Once again, make sure that this does not go on for more than 4 hours total time.
    (In any case, an open flame should never be used on the bearing.)
  - After getting the bearing bore up to size quickly mount the bearing on the shaft and immediately continue to the following steps.

Ball Bearing Inserts Spherical O.D.

Browning® Engineering

SPHERICAL OD BEARING INSERT REMOVAL AND REPLACEMENT
BALL BEARING UNITS

Ball bearing spherical OD Insert removal and replacement procedure. Browning inserts are selectively fit into castings, therefore Browning recommends replacing the entire housed unit.

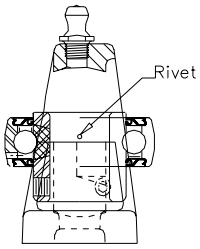
REMOVAL:

❶ REMOVE BEARING FROM SHAFT

- Loosen set screws.
- Slide bearing off shaft.
- Do not hammer bearing off of shaft.
- Use flat punch to flatten set screw marks

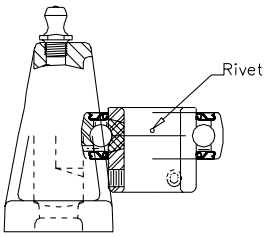
❷ ROTATE BEARING

- Rotate bearing 90° relative to housing.
- A lever can be used to aid in the insert removal.



❸ REMOVEINSERT

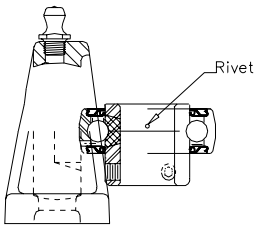
- Push bearing through load slots.



REPLACEMENT:

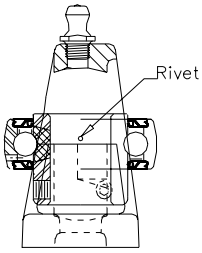
❶ LOAD INSERT

- Clean and Check Bore for Debris.
- Rotate bearing 90° relative to housing.
- With locking side pointed down, push bearing into load slots with rivet in the grease fitting side of housing (Left Hand Side).



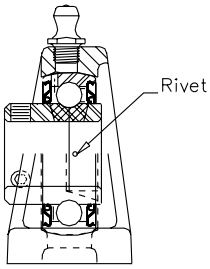
❷ ROTATE BEARING

- Rotate bearing back 90° relative to housing.
- Do not hammer bearing into housing.



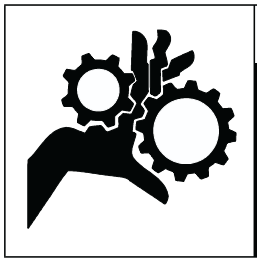
❸ ALIGN BEARING WITH HOUSING

- Align insert with housing to assure proper lubrication.



Monitor operating bearing during first 48 hours for unusual vibration or temperatures.

⚠WARNING
Failure to observe safety precautions could cause personal injury or equipment damage.



⚠WARNING
Do not operate without guards. Turn off power to install or service

⚠CAUTION
High voltage and rotating parts may cause serious or fatal injury. Turn off power to install or service.

See page 152 for trademark acknowledgments.

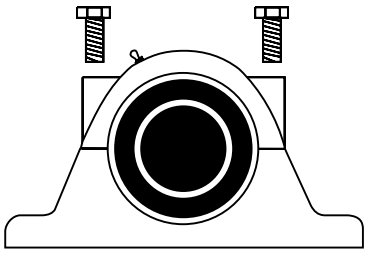
Tapered Roller Bearings

TAPERED ROLLER INSERT REMOVAL AND REPLACEMENT

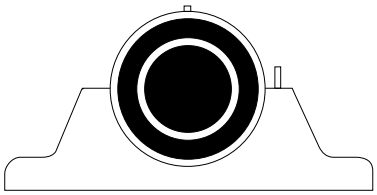
950 / 970 tapered roller insert/cartridge removal and replacement procedures.

REMOVAL

❶ REMOVE CAP BOLTS



❷ REMOVE TOP HALF OF HOUSING



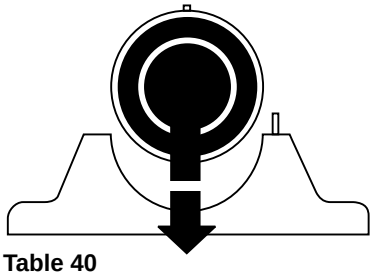
❸ REMOVE BEARING FROM SHAFT

- Loosen Set Screws.
- Slide bearing off shaft.
- Do not hammer bearing off of shaft.

REPLACEMENT

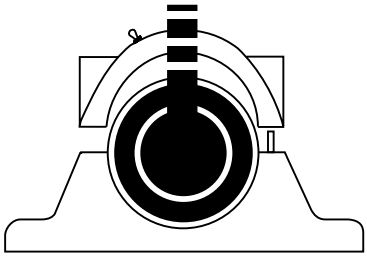
❶ LOAD NEW INSERT

- Place cartridge into housing.



❷ REPLACE TOP HOUSING HALF

- Align location pin with location hole.
- Be sure the lock pin is not put into the lubrication hole.



❸ REPLACE CAP BOLTS

- Tighten down to recommended torque (Refer to table.)

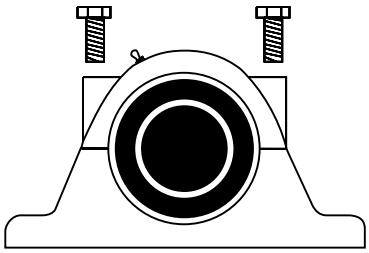


Table 40

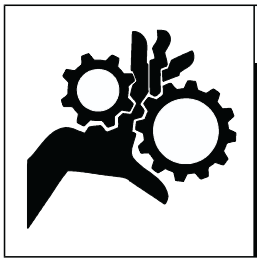
Housing Cap Bolt Torques 950 and 970 Series Pillow Blocks		
Shaft Size (Inches)	Housing Cap Bolt Torques	
	(Ft-Lbs)	(In-Lbs)
1 3/8, 1 7/16	30-35	360-400
1 1/2, 1 11/16	40-45	465-515
1 3/4, 1 15/16, 2	50-55	615-680
2 3/16	70-75	815-900
2 1/4, 2 7/16, 2 1/2	70-80	860-950
2 11/16, 2 15/16, 3	90-100	1100-1215
3 3/16, 3 7/16, 3 1/2	170-190	2040-2250
3 15/16, 4	265-295	3190-3525
4 7/16, 4 1/2	120-135	1470-1620
4 15/16, 5	195-220	2360-2610

Table 41

Housing Cap Bolt Torques 950 and 970 Series Flanged Housings		
Shaft Size (Inches)	Housing Cap Bolt Torques	
	(Ft-Lbs)	(In-Lbs)
1 3/8, 1 7/16	30-35	365-405
1 1/2, 1 11/16	40-45	465-515
1 3/4, 1 15/16, 2	50-55	615-680
2 3/16	65-75	810-895
2 1/4, 2 7/16, 2 1/2	70-80	855-945
2 11/16, 2 15/16, 3	90-100	1095-1210
3 3/16, 3 7/16, 3 1/2	170-190	2040-2255
3 15/16, 4	265-295	3190-3530
4 7/16, 4 1/2	325-360	3910-4320
4 15/16, 5	505-560	6065-6705

⚠WARNING

Failure to observe safety precautions could cause personal injury or equipment damage.



⚠WARNING

Do not operate without guards. Turn off power to install or service

⚠CAUTION

High voltage and rotating parts may cause serious or fatal injury. Turn off power to install or service.

See page 152 for trademark acknowledgments.

Ball Bearing Lubrication

Table 42 Ball Bearing Grease

Thickener	Lithium Complex
Oil	Petroleum
Thickness	NLGI 2
Operating Temperature	-20 F to 200 F Intermittent to 250 F

Consult EPT Mounted Bearing Tech Support for current grease specification.

Grease compatibility is critical. Relubricate with a grease that is compatible with grease supplied from the factory. Consult your grease supplier for compatibility.

Frequency of Lubrication

Frequency of lubrication depends upon operating conditions. The following chart gives the frequency of relubrication based upon continuous operation for various operating conditions and can be used as a guide for determining when Browning ball bearings should be relubricated.

Recommended Relubrication Schedule

Table 43 Ball Bearings

Speed	Temperature	Cleanliness	Greasing Interval
100 RPM	-20 F to 125 F	Clean	4-10 months
500 RPM	-20 F to 150 F	Clean	1-4 months
1000 RPM	-20 F to 200 F	Clean	1 week to 1 month
1500 RPM	-20 F to 200 F	Clean	Biweekly
1500 to Maximum Catalog Rating	Up to 150 F	Dirty	Daily to 1 week
	150 F to 200 F	Dirty	Daily to 1 week
	-20 F to 200 F	Very Dirty	Daily to 1 week
	-20 F to 200 F	Extreme Conditions	Daily to 1 week

Table 44 Ball Bearings

Ball Bearings	
Shaft Size (Inches)	**Grease Charge (Ounces)**
1/2 to 3/4	0.03
7/8 to 1 3/16	0.10
1 1/4 to 1 1/2	0.15
1 11/16 to 1 15/16	0.20
2 to 2 7/16	0.30
2 1/2 to 2 15/16	0.50
3 to 3 7/16	0.85
3 1/2 to 4	1.50

These charts are general recommendations. Experience and testing may be required for specific applications. For speeds, temperatures, and conditions not listed in these tables, please contact EPT Mounted Bearing Tech Support (see page 256).

Tapered Roller Bearing Lubrication

Table 45 Tapered Roller Bearing Grease

Thickener	Lithium 12 Hydroxy Stearate
Oil	Petroleum
Thickness	NLGI 2
Operating Temperature	-20 F to 200 F Intermittent to 250 F
EP Additive	Yes

Consult EPT Mounted Bearing Tech Support for current grease specification.

Grease compatibility is critical. Relubricate with a grease that is compatible with grease supplied from the factory. Consult your grease supplier for compatibility.

Frequency of Lubrication

Table 46 Recommended Relubrication Schedule - Tapered Roller Bearings

Speed	Temperature	Cleanliness	Greasing Interval
100 RPM	-20 F to 125 F	Clean	1-4 months
500 RPM	-20 F to 150 F	Clean	1 week to 1 month
1000 RPM	-20 F to 210 F	Clean	1-2 weeks
1500 to Maximum Catalog Rating	-20 F to 150 F	Dirty	Daily to 1 week
	150 F to 200 F	Dirty	Daily to 1 week
	-20 F to 200 F	Very Dirty *	Daily to 1 week
	-20 F to 200 F	Extreme Conditions *	Daily to 1 week

Table 47 920/970 Tapered Roller Bearings

Spherical Roller Bearings	
Shaft Size (Inches)	**Grease Charge (Ounces)**
1 3/16 to 1 1/4	0.10
1 3/8 to 1 7/16	0.22
1 1/2 to 1 11/16	0.32
1 3/4 to 2	0.50
2 to 2 3/16	0.55
2 1/4 to 2 1/2	0.65
2 11/16 to 3	0.85
3 3/16 to 3 1/2	1.25
3 15/16 to 4	2.50
4 7/16 to 4 1/2	3.10

900/950 Series Tapered Roller Bearings

900 and 950 Series tapered roller bearings utilize a labyrinth seal design which requires frequent relubrication to maintain maximum effectiveness. Grease should be added to fully purge and fill the grease cavity.

In dry, contaminated environments, daily relubrication is required for 900 and 950 series bearings. For moist, wet or contaminated environments consider 920 or 970 Series products.*

These charts are general recommendations. Experience and testing may be required for specific applications. For speeds, temperatures, and conditions not listed in these tables, please contact EPT Mounted Bearing Tech Support (see page 256).

Spherical Roller Bearing Lubrication

Table 48 Tapered Roller Bearing Grease

Thickener	Lithium 12 Hydroxy Stearate
Oil	Petroleum
Thickness	NLGI 2
Operating Temperature	-20 F to 200 F Intermittent to 250 F
EP Additive	Yes

Consult EPT Mounted Bearing Tech Support for current grease specifications.

Grease compatibility is critical. Relubricate with a grease that is compatible with grease supplied from the factory. Consult your grease supplier for compatibility.

Frequency of Lubrication

Recommended Relubrication Schedule

Table 49 Spherical Roller Bearings

Speed	Temperature	Cleanliness	Greasing Interval
100 RPM	-20 F to 125 F	Clean	1-4 months
500 RPM	-20 F to 150 F	Clean	1 week to 1 month
1000 RPM	-20 F to 210 F	Clean	1-2 weeks
1500 to Maximum Catalog Rating	Up to 150 F	Dirty	Daily to 1 week
	Over 150 F	Dirty	Daily to 1 week
	Up to 250 F	Very Dirty *	Daily to 1 week
	Up to 250 F	Extreme Conditions *	Daily to 1 week

Table 50 Spherical Roller Bearings w/Contact Seal

Spherical Roller Bearings	
Shaft Size (Inches)	**Grease Charge (Ounces)**
1 3/16 to 1 1/4	0.10
1 3/8 to 1 7/16	0.22
1 1/2 to 1 11/16	0.32
1 3/4 to 2	0.50
2 to 2 3/16	0.55
2 1/4 to 2 1/2	0.65
2 11/16 to 3	0.85
3 3/16 to 3 1/2	1.25
3 15/16 to 4	2.50
4 7/16 to 4 1/2	3.10
4 15/16 to 5	4.75

Spherical Roller Bearings w/Labyrinth Seals

1000 and 1100 series spherical roller bearings utilize a labyrinth seal design which requires frequent relubrication to maintain maximum effectiveness. Therefore, grease should be added to fully purge and fill the seal cavity.

In dry, contaminated environments, daily relubrication is required. For moist, wet or contaminated environments consider Contact Seal.*

These charts are general recommendations. Experience and testing may be required for specific applications. For speeds, temperatures, and conditions not listed in these tables, please contact EPT Mounted Bearing Tech Support (see page 256).

Fittings and Adapters

Table 51 Ball Bearings Units

BEARING UNIT SERIES	SHAFT SIZE			
	1/2 to 1 1/4S	1 1/4 to 2 15/16	1	1 3/16 to 3 15/16
VF2B - 200	1641B	1610B		
VF2B - 300			1641B	1610B
VF2E - 100, 200	1641B	1610B		
VF2E - 100M	1641B	1641B		
VF2S - 100, 200	1641B	1610B		
VF2S - 300			1641B	1610B
VF2S - 100M	1641B	1641B		
VF3E - 100M	1641B	1641B		
VF3S - 100M	1641B	1641B		
VF4B - 200	1641B	1610B		
VF4B - 300			1641B	1610B
VF4E - 100, 200	1641B	1610B		
VF4S - 100, 200	1641B	1610B		
VF4S - 300			1641B	1610B
VFCB - 200	1641B (to 2 3/16)	1610B (2 1/4 up)		
VFCB - 300			1641B	1610B
VFCS - 200	1641B (to 2S)	1610B (2 up)		
VFCS - 300			1641B (to 2)	1610B (2 3/16 up)
VPE - 100, 200	1641B	1610B		
VPE - 100M	1641B	1641B		
VPLB - 200	1641B	1610B		
VPLE - 100, 200	1641B	1610B		
VPLS - 100, 200	1641B	1610B		
VPB - 200	1641B	1610B		
VPB - 300			1641B	1610B
VPS - 100, 200	1641B	1610B		
VPS - 300			1641B	1610B
VPS - 100M	1641B	1641B		
VTBE - 200	1641B	1610B		
VTBE - 100	1641B	1610B		
VTBS - 100, 200	1641B	1610B		
VTWE - 100, 200	1911B	1613B		
VTWS - 100, 200	1911B	1613B		
VTWS - 300			1911B	1613B

Table 52 Tapered Roller and Spherical Roller Bearings Units

900	1610B - All PB, FB, FC	1612B - All TU
920	1610B - All PBE, FBE	1613B - All TUE
950	1610B - All	
970	1610B - All	
1000 - Thru 4"	1610B - All SPB, SFB	1641B - All SFC
SPB1000F - 4 7/16 - 41 5/16	1627B - 1/4 PTF	
1100	1610B - All	
22200	PLUGGED	
22500	PLUGGED	

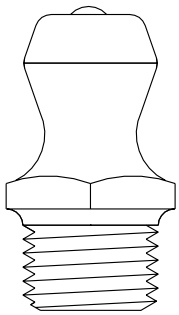
See page 152 for trademark acknowledgments.

Browning Fittings/Adapters

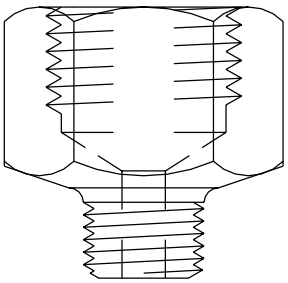
Table 53

Fitting Or Adapter		Fitting Or Adapter		Fitting	Fitting	Fitting
1641B …-28 NF	51942 …-28 Male NF to 1/8 NPT Fem	1610B 1/8 NPT THD	43761 1/8 NPT Male to 1/8 NPT Fem	1911b …-28 NF	1613B 1/8 PTF	1612B 1/8 PTF

1641B **Or** **51942**

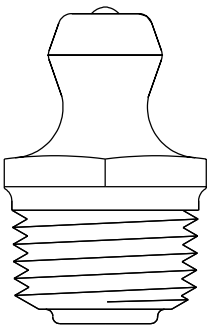


1/4-28 NF

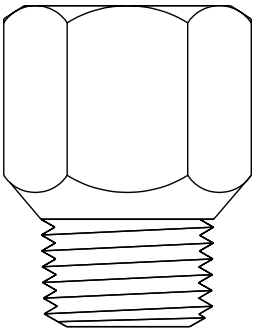


1/4-28 Male NF to 1/8 NPT Female

1610B **Or** **43761**

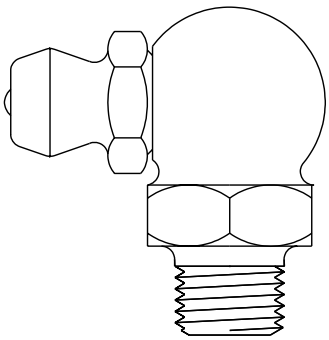


1/8 NPT THD



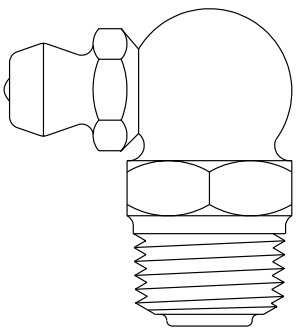
1/8 NPT Male to 1/8 NPT Female

1911B



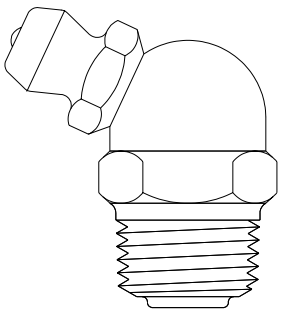
1/4-28 NF

1631B



1/8 PTF

1612B



1/8 PTF

See page 152 for trademark acknowledgments.

Browning Ball Bearings - Vibration Analysis

The following is the procedure to be followed in calculating the fundamental frequencies for Browning ball bearings.

1. If the Browning insert number is known, proceed to step 2. For housed units, identify the bearing insert number by looking up the unit in the Browning Catalog, then proceed to step 2.
2. Find your Browning insert number in Table 54 below and identify the series.
3. Select the vibration geometry information (O, I, B, F) from Table 54 based on bearing series.
4. Use this information to calculate the fundamental bearing frequencies by multiplying the factor in Table 55 by the shaft speed (in RPM).

Outer Ball Pass Freq. (Hz)	=	O x RPM
Inner Ball Pass Freq. (Hz)	=	I x RPM
Ball Spin Freq. (Hz)	=	B x RPM
Fundamental Train Freq. (Hz)	=	F x RPM

TABLE 54 BROWNING INSERT SERIES

SERIES	VALULINE INSERT							
L-10	X-108	X-110	X-208	X-210				
2-012	X-112	X-212						
2-015	X-114	X-115	X-116	X-214	X-215	X-216		
2-13	X-118	X-119	X-120S	X-218	X-219	X-220S	X-316	
2-17	X-120	X-122	X-123	X-220	X-222	X-223	X-319	X-320
2-19	X-124	X-224	X-323					
2-111	X-126	X-127	X-128	X-226	X-227	X-228	X-324	
2-115	X-130	X-131	X-132S	X-230	X-231	X-232S	X-327	X-328
2-23	X-132	X-134	X-135	X-232	X-234	X-235	X-331	X-332
2-27	X-236	X-239	X-335	X-336				
2-211	X-240	X-243	X-339	X-340				
2-215	X-247	X-343						
2-33	X-347	X-348						
2-38	X-355	X-356						
2-43	X-363							

Where X denotes one of: LE, LS, RUBRE, RUBRS, SLE, LRE, LRS, SLS, VB, VE, VER, VS,

Browning Ball Bearings - Vibration Analysis

TABLE 55 VIBRATION INFORMATION

SERIES	Pitch Diameter (in) dM	Number of Balls N	BallDiameter (in) D	Factor For Outer Ball Pass O	Factor For Inner Ball Pass I	Factor For Ball Spin B	Factor For Fund. Train F
L-10	1.138	9	1/4	0.0585	0.0915	0.0361	0.0065
2-012	1.345	9	9/32	0.0593	0.0907	0.0381	0.0066
2-015	1.544	10	9/32	0.0682	0.0985	0.0442	0.0068
2-13	1.812	9	3/8	0.0595	0.0905	0.0385	0.0066
2-17	2.115	9	7/16	0.0595	0.0905	0.0386	0.0066
2-19	2.362	9	1/2	0.0591	0.0909	0.0376	0.0066
2-111	2.596	10	1/2	0.0673	0.0994	0.0417	0.0067
2-115	2.763	10	1/2	0.0683	0.0984	0.0445	0.0068
2-23	3.051	10	9/16	0.0680	0.0987	0.0437	0.0068
2-27	3.356	10	5/8	0.0678	0.0989	0.0432	0.0068
2-211	3.846	10	11/16	0.0684	0.0982	0.0451	0.0068
2-215	4.045	11	11/16	0.0761	0.1072	0.0476	0.0069
2-33	4.362	11	3/4	0.0759	0.1074	0.0470	0.0069
2-37	4.627	11	25/32	0.0762	0.1071	0.0479	0.0069
2-38	4.922	10	7/8	0.0685	0.0981	0.0454	0.0069
2-43	5.808	10	1-1/16	0.0681	0.0986	0.0440	0.0068

Browning 900 & 950 Tapered Roller Bearings - Vibration Analysis

The following is the procedure which should be followed in calculating the fundamental frequencies for Browning 900 and 950 tapered roller bearings.

1. The bore size for each bearing to be analyzed must be known.
2. Once the bore size is known the appropriate vibration factors (O,I,B and F) can be chosen from Table 56.
3. These factors can then be used to calculate the fundamental bearing frequencies as follows:

Roller Spin Frequency (Hz)	=	O	x	RPM
Inner Race Pass Frequency (Hz)	=	I	x	RPM
Outer Race Pass Frequency (Hz)	=	B	x	RPM
Fundamental Train Frequency (Hz)	=	F	x	RPM

Table 56 Vibration information

SHAFT SIZE (INCHES)	FACTOR FOR ROLLER SPIN O	FACTOR FOR INNER ROLLER PASS I	FACTOR FOR OUTER ROLLER PASS B	FACTOR FOR FUND. TRAIN F
1	0.1197	0.1794	0.1373	0.0072
1 3/16 1 1/4 1 3/8	0.1136	0.1616	0.1218	0.0072
1 7/16 1 1/2	0.1195	0.1795	0.1372	0.0072
1 5/8 1 11/16 1 3/4	0.1284	0.1873	0.1460	0.0073
1 7/8 1 15/16 2 2 1/8	0.1216	0.1792	0.1375	0.0072
2 3/16	0.1345	0.1958	0.1542	0.0073
2 1/4 2 7/16 2 1/2	0.1397	0.2043	0.1623	0.0074
2 11/16 2 3/4 2 15/16	0.1578	0.2202	0.1798	0.0075
3 3 3/16	0.1535	0.2116	0.1718	0.0075
3 7/16 3 1/2	0.1706	0.2368	0.1966	0.0076
3 15/16 4	0.2258	0.3035	0.2631	0.0077
4 7/16 4 1/2	0.2204	0.2953	0.2547	0.0077
4 15/16 5	0.2324	0.3210	0.2790	0.0078

See page 152 for trademark acknowledgments.

Browning 920 & 970 Series Tapered Roller Bearings - Vibration Analysis

The following is the procedure which should be followed in calculating the fundamental frequencies for Browning 920 and 970 tapered roller bearings.

1. The bore size for each bearing to be analyzed must be known.
2. Once the bore size is known the appropriate vibration factors (O,I,B, and F) can be chosen from Table 57.
3. These factors can then be used to calculate the fundamental bearing frequencies as follows:

Roller Spin Frequency (Hz)	= O x RPM		
Inner Race Pass Frequency (Hz)	= I x RPM		
Outer Race Pass Frequency (Hz)	= B x RPM		
Fundamental Train Frequency (Hz)	= F x RPM	- shaft rotation	

Table 57 Vibration Information

SHAFT SIZE (INCHES)	FACTOR FOR ROLLER SPIN O	FACTOR FOR INNER ROLLER PASS I	FACTOR FOR OUTER ROLLER PASS B	FACTOR FOR FUND. TRAIN F
1 3/16 1 1/4	0.1258	0.1782	0.1384	0.0073
1 3/8 1 7/16	0.1173	0.1892	0.0442	0.0072
1 1/2 1 11/16	0.1132	0.1710	0.1290	0.0072
1 3/4 1 15/16 2	0.1083	0.1626	0.1207	0.0071
2 3/16	0.1216	0.1792	0.1375	0.0072
2 1/4 2 7/16 2 1/2	0.1345	0.1958	0.1542	0.0073
2 11/16 2 15/16 3	0.1578	0.2202	0.1798	0.0075
3 3/16 3 7/16 3 1/2	0.1706	0.2368	0.1966	0.0076
3 15/16 4	0.1645	0.2376	0.1958	0.0075
4 7/16 4 1/2	0.1600	0.2289	0.1878	0.0075
4 15/16 5	0.1587	0.2292	0.1875	0.0075

See page 152 for trademark acknowledgments.

Browning 1000/1100 Series Spherical Roller Bearings - Vibration Analysis

The following is the procedure which should be followed in calculating the fundamental frequencies for Browning 1000/1100 spherical roller bearings.

1. The bore size for each bearing to be analyzed must be known.
2. Once the bore size is known the appropriate vibration factors (O,I,B, and F) can be chosen from Table 58.
3. These factors can then be used to calculate the fundamental bearing frequencies as follows:

Roller Spin Frequency (Hz)	= O x RPM	
Inner Race Pass Frequency (Hz)	= I x RPM	
Outer Race Pass Frequency (Hz)	= B x RPM	
Fundamental Train Frequency (Hz)	= F x RPM	- shaft rotation

Table 58 Vibration Information

SHAFT SIZE (INCHES)	FACTOR FOR ROLLER SPIN O	FACTOR FOR INNER ROLLER PASS I	FACTOR FOR OUTER ROLLER PASS B	FACTOR FOR FUND. TRAIN F
1 1/8 1 3/16 1 1/4 1 7/16 1 1/2	0.0989	0.1548	0.1118	0.0070
1 11/16 1 3/4	0.1075	0.1628	0.1205	0.0071
1 15/16 2	0.1161	0.1803	0.1363	0.0072
2 3/16	0.1114	0.1717	0.1283	0.0071
2 7/16 2 1/2	0.1140	0.1807	0.1360	0.0072
2 11/16 2 3/4 2 15/16 3	0.1268	0.1974	0.1526	0.0073
3 3/16 3 7/16 3 1/2	0.1213	0.1889	0.1444	0.0072
3 11/16 3 15/16 4	0.1185	0.1799	0.1367	0.0072
4 7/16	0.1162	0.1803	0.1364	0.0072
4 15/16	0.1186	0.1798	0.1368	0.0072

See page 152 for trademark acknowledgments.

Browning 22500 Series Spherical Roller Bearings - Vibration Analysis

The following is the procedure which should be followed in calculating the fundamental frequencies for Browning 22500 series spherical roller bearings.

1. The bore size for each bearing to be analyzed must be known.
2. Once the bore size is known the appropriate vibration factors (O,I,B and F) can be chosen from Table 59.
3. These factors can then be used to calculate the fundamental bearing frequencies as follows:

Roller Spin Frequency (Hz)	= O x RPM	
Inner Race Pass Frequency (Hz)	= I x RPM	
Outer Race Pass Frequency (Hz)	= B x RPM	
Fundamental Train Frequency (Hz)	= F x RPM	- shaft rotation

Table 59 Vibration Information

SHAFT SIZE (INCHES)	FACTOR FOR ROLLER SPIN O	FACTOR FOR INNER ROLLER PASS I	FACTOR FOR OUTER ROLLER PASS B	FACTOR FOR FUND. TRAIN F
2 7/16" 2 1/2"	0.1268	0.1786	0.1381	0.0073
2 11/16" 2 3/4"	0.1253	0.1788	0.1378	0.0073
2 15/16" 3"	0.1209	0.1701	0.1299	0.0072
3 3/16"	0.1213	0.17	0.13	0.0072
3 7/16" 3 1/2"	0.1185	0.1799	0.1366	0.0072
3 11/16" 3 15/16" 4"	0.1162	0.1803	0.1364	0.0072
4 3/16"	0.1173	0.1801	0.1366	0.0072
4 7/16" 4 1/2"	0.1186	0.1798	0.1368	0.0072
4 15/16" 5"	0.1189	0.1798	0.1369	0.0072
5 3/16"	0.1154	0.1804	0.1362	0.0072
5 7/16" 5 1/2"	0.1157	0.1804	0.1363	0.0072
5 15/16" 6"	0.1155	0.1804	0.1363	0.0072
6 7/16" 6 1/2"	0.1194	0.1892	0.1442	0.0072
6 15/16" 7"	0.1180	0.1800	0.1367	0.0072
7 3/16"	0.1155	0.1804	0.1363	0.0072
7 1/2" 7 15/16" 8"	0.1155	0.1803	0.1364	0.0072

See page 152 for trademark acknowledgments.

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All sales are made on our STANDARD TERMS AND CONDITIONS OF SALE in effect at the time a customer's order is accepted. The current Terms and Conditions are set forth below:

STANDARD TERMS AND CONDITIONS OF SALE (March 19, 1999)

These Terms and Conditions, the attendant quotation or acknowledgment and all documents incorporated by specific reference therein, will be the complete and exclusive statement of the terms of the agreement governing the sale of goods ("Goods") by **Emerson Power Transmission Corporation** and its divisions and subsidiaries ("Seller") to Customer ("Buyer"). Buyer's acceptance of the Goods will manifest Buyer's assent to these Terms and Conditions. If these Terms and Conditions differ in any way from the terms and conditions of Buyer's order, or other documentation, this document will be construed as a counteroffer and will not be deemed an acceptance of Buyer's terms and conditions which conflict herewith.

1. PRICES: Unless otherwise specified in writing by Seller, Seller's price for the goods shall remain in effect for thirty (30) days after the date of Seller's quotation or acknowledgment of Buyer's order for the Goods, whichever occurs first, provided an unconditional, complete authorization for the immediate shipment of the Goods is received and accepted by Seller within such time period. If such authorization is not received by Seller within such thirty (30) day period, Seller shall have the right to change the price for the Good to Seller's price for the Goods at the time of shipment.

2. TAXES: Any tax or governmental charge or increase in same hereafter becoming effective increasing the cost to Seller of producing, selling or delivering the Goods or of procuring material used therein, and any tax now in effect or increase in same payable by the Seller because of the manufacture, sale or delivery of the Goods, may at Seller's option, be added to the price.

3. TERMS OF PAYMENT: Subject to the approval of Seller's Credit Department, terms are net thirty (30) days from date of Seller's invoice in U.S. currency. If any payment owed to Seller is not paid when due, it shall bear interest, at a rate to be determined by Seller, which shall not exceed the maximum rate permitted by law, from the date on which it is due until it is paid. Seller shall have the right, among other remedies, either to terminate the Agreement or to suspend further performance under this and/or other agreements with Buyer in the event Buyer fails to make any payment when due. Buyer shall be liable for all expenses, including attorneys' fees, relating to the collection of past due amounts.

4. SHIPMENT AND DELIVERY: Shipments are made F.O.B. Seller's shipping point. Any claims for shortages or damages suffered in transit shall be submitted by the Buyer directly to the carrier. While Seller will use all reasonable commercial efforts to maintain the delivery date acknowledged or quoted by Seller, all shipping dates are approximate. Seller reserves the right to make partial shipments and to segregate "specials" and made-to-order Goods from normal stock Goods. Seller shall not be bound to tender delivery of any Goods for which Buyer has not provided shipping instructions.

5. QUANTITY: Buyer agrees to accept overruns of up to ten percent (10%) of the order on "made-to-order" Goods, including parts. Any such additional items shall be priced at the price per item charged for the specific quantity ordered.

6. LIMITED WARRANTY: Subject to the limitations of Section 7, Seller warrants that the Goods will be free from defects in material and workmanship under normal use, service and maintenance for a period of one year (unless otherwise specified by Seller in writing) from the date of shipment of the Goods by Seller. **THIS IS THE SOLE AND EXCLUSIVE WARRANTY GIVEN BY SELLER WITH RESPECT TO THE GOODS AND IS IN LIEU OF AND EXCLUDES ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, ARISING BY OPERATION OF LAW OR OTHERWISE, INCLUDING WITHOUT LIMITATION, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE WHETHER OR NOT THE PURPOSE OR USE HAS BEEN DISCLOSED TO SELLER IN SPECIFICATIONS, DRAWINGS OR OTHERWISE, AND WHETHER OR NOT SELLER'S PRODUCTS ARE SPECIFICALLY DESIGNED AND/OR MANUFACTURED BY SELLER FOR BUYER'S USE OR PURPOSE.**

This warranty does not extend to any losses or damages due to misuse, accident, abuse, neglect, normal wear and tear, unauthorized modification or alteration, use beyond rated capacity, or improper installation, maintenance or application. To the extent that Buyer or its agents has supplied specifications, information, representation of operating conditions or other data to Seller in the selection or design of the Goods and the preparation of Seller's quotation, and in the event that actual operating conditions or other conditions differ from those represented by Buyer, any warranties or other provisions contained herein which are affected by such conditions shall be null and void. If within thirty (30) days after Buyer's discovery of any warranty defects within the warranty period, Buyer notifies Seller thereof in writing, Seller shall, at its option, repair or replace F.O.B. point of manufacture, or refund the purchase price for, that portion of the goods found by Seller to be defective. Failure by Buyer to give such written notice within the applicable time period shall be deemed an absolute and unconditional waiver of Buyer's claim for such defects. Goods repaired or replaced during the warranty period shall be covered by the foregoing warranty for the remainder of the original warranty period or ninety (90) days, whichever is longer. Buyer assumes all other responsibility for any loss, damage, or injury to persons or property arising out of, connected with, or resulting from the use of Goods, either alone or in combination with other products/components.

SECTIONS 6 AND 7 APPLY TO ANY ENTITY OR PERSON WHO MAY BUY, ACQUIRE OR USE SELLER'S GOODS, INCLUDING ANY ENTITY OR PERSON WHO BUYS THE GOODS FROM SELLER'S DISTRIBUTOR AND SUCH ENTITY OR PERSON SHALL BE BOUND BY THE LIMITATIONS THEREIN.

7. LIMITATION OF REMEDY AND LIABILITY: **THE SOLE AND EXCLUSIVE REMEDY FOR BREACH OF ANY WARRANTY HEREUNDER (OTHER THAN THE WARRANTY PROVIDED UNDER SECTION 13) SHALL BE LIMITED TO REPAIR, REPLACEMENT OR REFUND OF THE PURCHASE PRICE UNDER SECTION 6. SELLER SHALL NOT BE LIABLE FOR DAMAGES CAUSED BY DELAY IN PERFORMANCE AND IN NO EVENT, REGARDLESS OF THE FORM OF THE CLAIM OR CAUSE OF ACTION (WHETHER BASED IN CONTRACT, INFRINGEMENT, NEGLIGENCE, STRICT LIABILITY, OTHER TORT OR OTHERWISE), SHALL SELLER'S LIABILITY TO BUYER AND/OR ITS CUSTOMERS EXCEED THE PRICE TO BUYER OF THE SPECIFIC GOODS PROVIDED BY SELLER GIVING RISE TO THE CLAIM OR CAUSE OF ACTION. BUYER AGREES THAT IN NO EVENT SHALL SELLER'S LIABILITY TO BUYER AND/OR ITS CUSTOMERS EXTEND TO INCLUDE INCIDENTAL, CONSEQUENTIAL OR PUNITIVE DAMAGES. THE TERM "CONSEQUENTIAL DAMAGES" SHALL INCLUDE, BUT NOT BE LIMITED TO, LOSS OF ANTICIPATED PROFITS, LOSS OF USE, LOSS OF REVENUE, COST OF CAPITAL AND DAMAGE OR LOSS OF OTHER PROPERTY OR EQUIPMENT.**

It is expressly understood that any technical advice furnished by Seller with respect to the use of the Goods is given without charge, and Seller assumes no obligation or liability for the advice given, or results obtained, all such advice being given and accepted at Buyer's risk.

GOODS AND/OR SERVICES SOLD HEREUNDER ARE NOT FOR USE IN ANY NUCLEAR AND RELATED APPLICATIONS. Buyer accepts goods and/or services with the foregoing understanding, agrees to communicate the same in writing to any subsequent purchaser or users and to defend, indemnify and hold harmless Seller from any claims, losses, suits, judgments and damages, including incidental and consequential damages, arising from such use, whether the cause of action be based in tort, contract or otherwise, including allegations that the Seller's liability is based on negligence or strict liability.

8. EXCUSE OF PERFORMANCE: Seller shall not be liable for delays in performance or for non-performance due to acts of God, acts of Buyer, war, riot, fire, flood, other severe weather, sabotage, or epidemics; strikes or labor disturbances; governmental requests, restrictions, laws, regulations, orders or actions; unavailability of or delays in transportation; default of suppliers; or unforeseen circumstances or any events or causes beyond Seller's reasonable control. Deliveries may be suspended for an appropriate period of time as a result of the foregoing. If Seller determines that its ability to supply the total demand for the Goods, or to obtain material used directly or indirectly in the manufacture of the Goods, is hindered, limited or made impracticable due to causes addressed in this Section 8, Seller may allocate its available supply of the Goods or such material (without obligation to acquire other supplies of any such Goods or material) among itself and its purchasers on such basis as Seller determines to be equitable without liability for any failure of performance which may result therefrom. Deliveries suspended or not made by reason of this section may be canceled by Seller upon notice to Buyer without liability, but the balance of the agreement shall otherwise remain unaffected.

9. CANCELLATION: The Buyer may cancel orders only upon written notice and upon payment to Seller of cancellation charges which include, among other things, all costs and expenses incurred and commitments made by the Seller and a reasonable profit thereon.

10. CHANGES: Buyer may request changes or additions to the Goods consistent with Seller's specifications and criteria. In the event such changes or additions are accepted by Seller, Seller may revise the price and delivery schedule. Seller reserves the right to change designs and specifications for the Goods without prior notice to Buyer, except with respect to Goods being made-to-order for Buyer.

11. TOOLING: Tool, die, and pattern charges, if any, are in addition to the price of the Goods and are due and payable upon completion of the tooling. All such tools, dies and patterns shall be and remain the property of Seller. Charges for tools, dies, and patterns do not convey to Buyer, title, ownership interests in, or rights to possession or removal, nor prevent their use by Seller for other purchasers, except as otherwise expressly provided by Seller and Buyer in writing with reference to this provision.

12. ASSIGNMENT: Buyer shall not assign its rights or delegate its duties hereunder or any interest therein or any rights hereunder without the prior written consent of the Seller, and any such assignment, without such consent, shall be void.

13. PATENTS AND COPYRIGHTS: Subject to Section 7, Seller warrants that the Goods sold, except as are made specifically for Buyer according to Buyer's specifications, do not infringe any valid U.S. patent or copyright in existence as of the date of delivery. This warranty is given upon the condition that Buyer promptly notify Seller of any claim or suit involving Buyer in which such infringement is alleged, and, that Buyer cooperate fully with Seller and permit Seller to control completely the defense or compromise of any such allegation of infringement. Seller's warranty as to use only applies to infringements arising solely out of the inherent operation (i) of such Goods, or (ii) of any combination of Goods in a system designed by Seller. In the event such Goods, singularly or in combination, are held to infringe a U.S. patent or copyright in such suit, and the use of such Goods is enjoined, or in the case of a compromise by Seller, Seller shall have the right, at its option and expense, to procure for Buyer the right to continue using such Goods, or replace them with non-infringing Goods; or modify same to become non-infringing; or grant Buyer a credit for the depreciated value of such Goods and accept return of them.

14. MISCELLANEOUS: These terms and conditions set forth the entire understanding and agreement between Seller and Buyer, and supersede all other communications, negotiations and prior oral or written statements regarding the subject matter of these terms and conditions. No change, modification, rescission, discharge, abandonment, or waiver of these terms and conditions of Sale shall be binding upon the Seller unless made in writing and signed on its behalf by an officer of the Seller. No conditions, usage or trade, course of dealing or performance, understanding or agreement purporting to modify, vary, explain, or supplement these Terms and Conditions shall be binding unless hereafter made in writing and signed by the party to be bound, and no modification shall be affected by the acceptance of purchase orders or shipping instruction forms containing terms at variance with or in addition to those set forth herein. No waiver by Seller with respect to any breach or default or any right or remedy and no course of dealing, shall be deemed to constitute a continuing waiver of any other breach or default or of any other right or remedy, unless such waiver be expressed in writing and signed by the party to be bound. Seller is not responsible for typographical or clerical errors made in any quotation, orders or publications. All such errors are subject to correction. The validity, performance, and all other matters relating to the interpretation and effect of this contract shall be governed by the law of the state of New York.