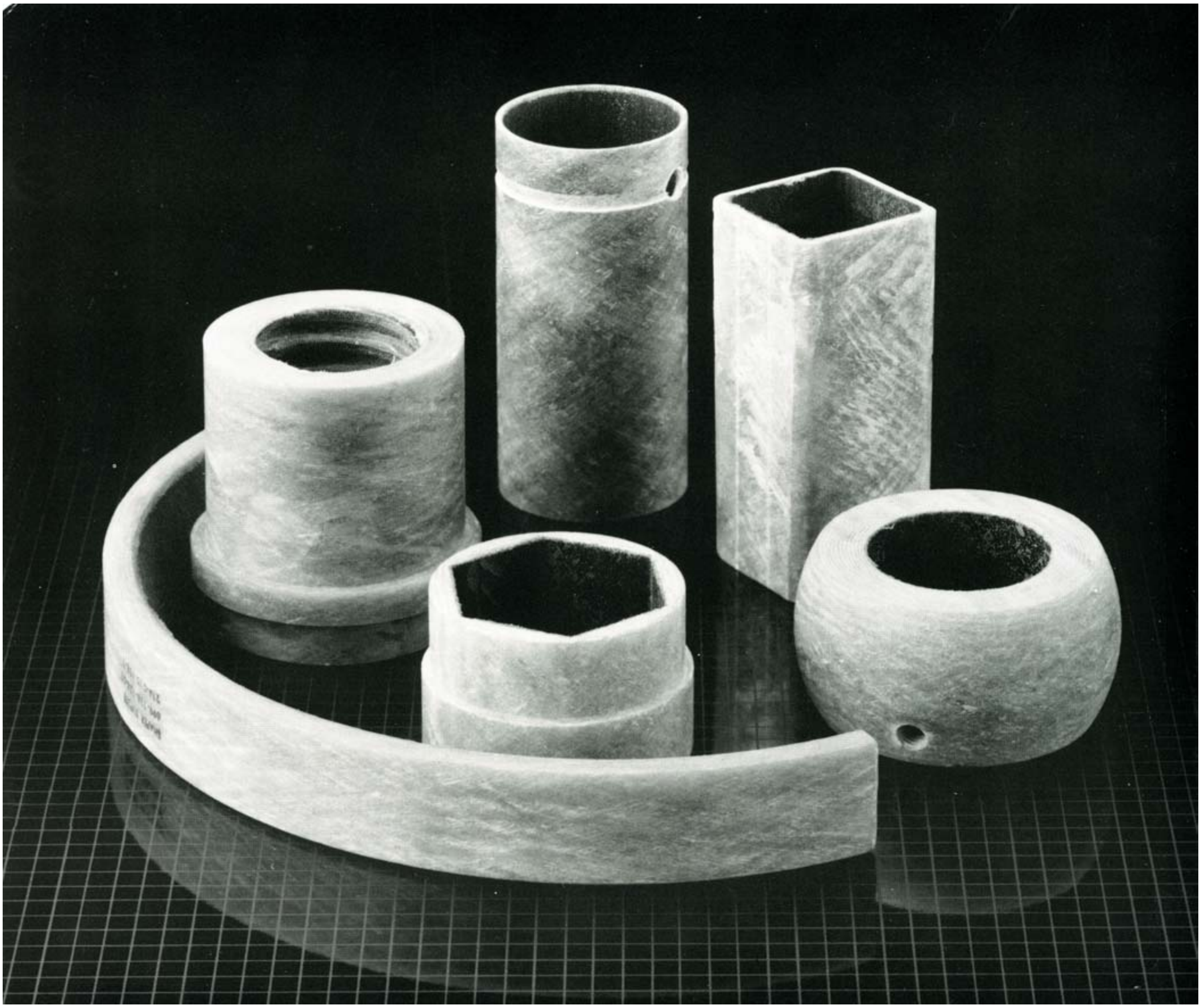

Tuflite

composite bearings

Rexnord can provide Tuflite composite bearings with unique journal bearing bores and other special configurations. The standard Tuflite bearing lines described in this section will answer most application needs. For additional engineering assistance, contact your Rexnord sales engineer or Tuflite Bearings.

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Tuflite
composite bearings

2324 Curtis Street
Downers Grove, IL 60515
(708) 969-1770
Facsimile 708/969-8752

TUFLITE® ENGINEERING

DESIGN HIGHLIGHTS

Tufljte composite bearings, on the market since 1969, provide the aerospace industry with the technology to overcome the limitations of metal bearings in hard to lubricate or contaminated environments. Teflon* and Dacron* fibers in woven form, combined with filament-wound fiberglass in an epoxy resin matrix, act as the support structure. This provides aircraft designers with new lighter, corrosion-resistant bearing materials — ones that can be adapted to many different shapes Result greater design freedom and innovation within the aerospace industry itself.

MIL-B-85560 QUALIFICATION

Tuflite bearings have successfully met the requirements of MIL-B-85560, the general specification for fiber reinforced plastic self-lubricating plain and flanged sleeve bearings. Tuflite dimensional listings of these bearings are shown on Pages B14 and B15.

FEATURES AND BENEFITS

FEATURE	BENEFITS
Self-Lubricating Teflon and Dacron Woven Liner	Resist seizing & galling; need no complex lubrication systems; minimize slipstick; minimum maintenance; permit operation above & below temperature ranges of ordinary lubricants; operate at loads that would squeeze out ordinary lubricants; low sliding friction; accommodate rotary, oscillatory and sliding motions.
High Strength	Operates self-lubricated up to 30,000 psi dynamically; ultimate strength 77,000 psi.
Light Weight	77% weight saving vs. steel; 30% vs. aluminum.
Unique Manufacturing Process	High predictability part to part; product uniformity; facilitates unusual configurations.
Non-Metallic Materials (Fiberglass/Epoxy Matrix)	Resist chemical corrosion; resist galvanic corrosion from dissimilar metals.
Non-Conductive Materials	Act as electrical insulator.
Non-Outgassing Materials	Material and bearing properties retained in a vacuum.

USAGE AND APPLICATIONS

Tuflite is typically applied in control system areas. On private and commercial aircraft, Tuflite bearings are used in applications such as U-joints, damper controls, hinge lines and anti-fretting static joints. On helicopters Tuflite bearings are used in the main rotor and tail rotor assemblies. They are also utilized in the landing gear linkage of general aviation and rotary wing aircraft.

In non-aviation applications, Tuflite's resistance to chemical, galvanic and fretting corrosion, as well as its thermal and electrical insulating properties, make it attractive in marine and ordnance applications. Its lightweight and high strength are also important pluses.

Aerospace
- Pivoting linkages
- Anti-fretting static joints
- Flight controls
- Missile flight control surfaces
- U-joints
- Damper controls
- Hinge lines
- Rotary wing main and tail rotor assemblies
- Satellite actuator assemblies

Non-Aviation
- Ground support equipment
- Marine application surface ships and submerged vessels
- Missile launchers and trackers
- Tracked vehicles

- Registered trademarks of E.I. DuPont de Nemours & Co., Inc.

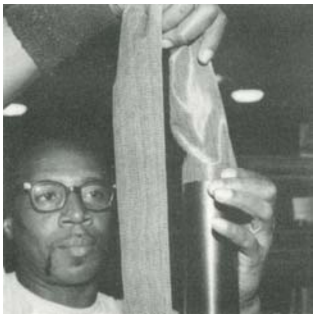
MATERIALS

Tuflite composite bearings are manufactured from a unique combination of advanced materials.
Teflon and Dacron fibers are woven together in tubular form to become a low-friction liner for the bearings.
Fiberglass filaments are precisely wound around the liner to achieve exceptional strength.
Epoxy resin unifies the fiber components into a strong backup matrix.

CONSTRUCTION

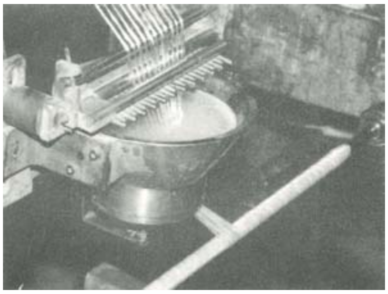
The woven Teflon/Dacron fiber liner, in tubular form, is heat shrunk over an appropriately sized mandrel and fully impregnated with epoxy resin. On a precision filament winding machine, the backup matrix is constructed by running continuous strands of fiberglass through a resin bath then helically around the liner in overlapping layers. Winding the fiberglass over the mandrel at precise angles and specified tension achieves optimum strength characteristics. When the proper thickness of fiberglass has been built up, the strands are cut and the wound mandrel is removed. Selective heat treatments are used to cure the resin. This produces optimum bearing and structural properties. The tubular composite is then machined, ground and cut.

Woven fabric placed over mandrel.

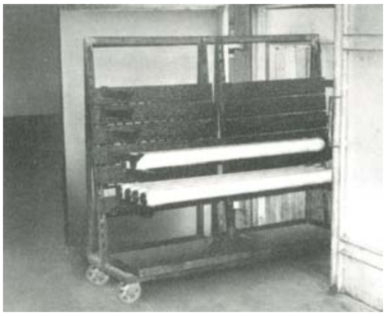


Fabric heat shrunk on mandrel.

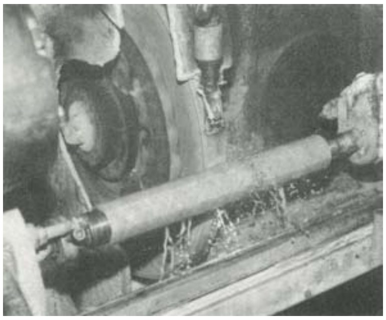
Epoxy coated fiberglass filaments helically wound in overlapping layers.



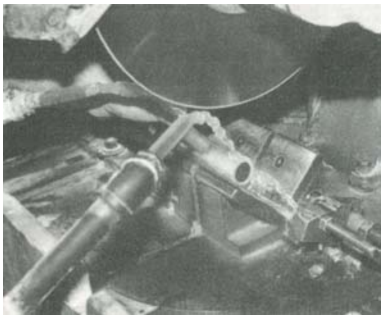
Oven curing cycle.



Finish grind on centers.

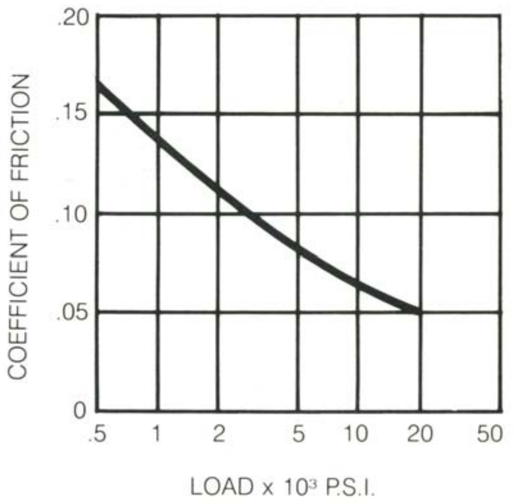


Cutt off.



TUFLITE PROPERTIES

Friction. Tuflite bearings offer low-friction operation. Coefficient of friction varies from .16 to .05 depending on the load level. Increased loading results in a significant decrease in coefficient of friction, as shown below.



Mechanical. These properties are derived from the modulus of elasticity of the individual materials in the filament-wound backup composite. The values in Table I were developed by using standard tests for cylindrical shapes.

Table I

	Modulus (PSI)	**Ultimate Strength (PSI)**
Axial Compression	.8x10^{6}	20,000
Hoop Tension	2.7x10^{6}	35,000
Bending	1.5x10^{6}	25,000
Torsion(45° helix angle)	1.5x10^{6}	27,000
Interlaminar Shear	—	3,000-5,000

Impact resistance (notch) . . .	41 ft. lb/in.
Specific gravity . . .	1.9
Spring rate . . .	3.467x10^{6} lb/in.
Ultimate Strength (Sleeve Configuration) . . .	77,000 psi

Note: Values are applicable in temperatures from — 650F. to + 2500F. Bearing wall thickness was .125” in these tests; varying that dimension and/or the helical winding angle will alter the values.

Thermal. Coefficients of expansion and thermal conductivity for Tuflite, aluminum and steel are shown in Table II. Note the similarity in expansion for Tuflite and steel, in the hoop direction. Tuflite expands more in the axial direction because of the orientation of the fiberglass filaments.

Table II

Thermal Properties	Tuflite	Aluminum	Steel
1. Expansion (In/In/F°)			
Axial Direction	15.0x10^{-6}	13.3x10^{-6}	6.0x10^{-6}
Hoop Direction	7.0x10^{-6}	13.3x10^{-6}	6.0x10^{-6}
2. Conductivity			
(BTU In/Ft^{2}F° Hr)	1.4	610-1100	95-185

Electrical. The Tuflite material is an electrical insulator, with a dielectric strength of about 300 volts per mil. Therefore electrolytic or galvanic action will not occur between it and the housing or the shaft.

Vacuum. Tuflite bearings were tested for 24 hours at 125°C. and 10^{-5} torr pressure per ASTM STD E595, and were considered stable and acceptable for space use.

Water Absorption. After 3 years immersion in sea water, Tuflite bearings showed a weight increase of 1.15%. No significant change in size was noted.

LOAD RATINGS

Static Radial Yield Load: The maximum static load that can be applied while still retaining a linear relationship between load and bearing deflection.

Static Radial Ultimate Load: The static load that can be applied and held for three minutes without fracture or structural failure of the components.

Dynamic Load Rating (based on oscillatory motion): A unidirectional load that will yield an average life of a certain number of cycles under a specified angle of oscillation. Normally, life is determined by the number of cycles run to .006” wear in the bearing (fabric liner thickness is .010” to .012”).

DESIGN CONSIDERATIONS

Configurations: Tuflite bearings come in a variety of configurations, allowing you to optimize your design by applying the bearing that best suits your application.

Plain Journal Bearings (501 Series)
- For oscillatory, rotary and linear applications.
- To support radial loads.

Unlined Flanged Journal Bearings (502 Series)
- When axial retention is required.
- To support radial loads.

Lined Flanged Journal Bearings (503 Series)
- To support combinations of radial and axial loads.
- When there is relative motion between the flange face and mating surface under axial load.
- When axial retention is required.
- When spacer capability is required.

Special Bore Configurations
- When torque transmission is required.
- To resist rotation of shaft.
- For linear applications.

Useful life: The life of a sliding bearing is determined by the wearing away of the load carrying surface. This increases the radial clearance between the pin and the bearing bore. Traditionally the industry value for evaluating wear life is .006 in. This is based on early work involving Teflon fabric liners, which changed in composition as wear progressed, causing significant changes in wear rate, torque, etc. However, since wear does not change the composition of the Tuflite liner, significant wear life is available beyond .006 in.

Load-Life relationship: Since accumulated wear terminates the useful life of a properly selected Teflon-lined bearing, the Tuflite selection procedure is based on the use of Bearing Area Factors (BAF), rather than load ratings, to meet the combined load-life requirements of the application. The BAF is a numerical index of a bearing's dynamic performance ability, and is based on effective bearing area.

Tuflite bearings are rated on the basis of L_{10} life expectancy, which means that 90% of a given group of bearings will exceed the predicted life. The correlation of load and life is shown in the lower half of the Selection Chart which relates the BAF to life cycles. BAF values for bearings involving standard combinations of bore and length are shown in Table IV, Page B8.

Note? An L_{10} life rating is more conservative than an "average" (L_{50}) value.

Temperature: Normal operating temperature range for Tuflite bearings is — 65°F. to + 250°F. They can operate with limited exposure to temperatures up to +450°F. However, an increase in wear rates will result with continuous temperatures above 250°F. They have also been applied in cryogenic environments.

Retention Methods: Tuflite bearings are normally installed with a press fit. However, they can be bonded to the support structure, or retained with mechanical fastening devices. Refer to Page B10 for suggested methods.

Clearance: When the bearing is retained in the housing by a press fit, the bearing I.D. is reduced by the amount of interference between bearing O.D. and housing I.D. However, when the bearing is bonded into the housing, a clearance between bearing O.D. and housing I.D. is required, for proper adhesive film thickness. In this case bearing I.D. does not change after assembly.

Diametric clearance is necessary between pin O.D. and bearing I.D. to permit assembly of the pin into the bearing, and for satisfactory bearing performance. Minimum clearance is dictated by the number of bearings per pin and the spacing between bearings. As a rule of thumb, a minimum of .001"is required for assembly. A .0005" clearance can be held if bearings are bonded into the housing, using the pin as a curing fixture to keep the bearings concentric.

Vibration: Oscillations of an included angle less than 5° can cause fretting of the pin surface. Selection of the proper pin material will minimize this and the resultant corrosion. For assistance consult with Rexnord engineers.

Value Analysis: When analyzing overall bearing costs, it is important to look beyond initial price. Maintenance costs and life expectancy are also major factors. And in both these aspects, as well as others, Tuflite bearings have achieved significant reductions in overall bearing life cycle costs

FACTORS AFFECTING PERFORMANCE

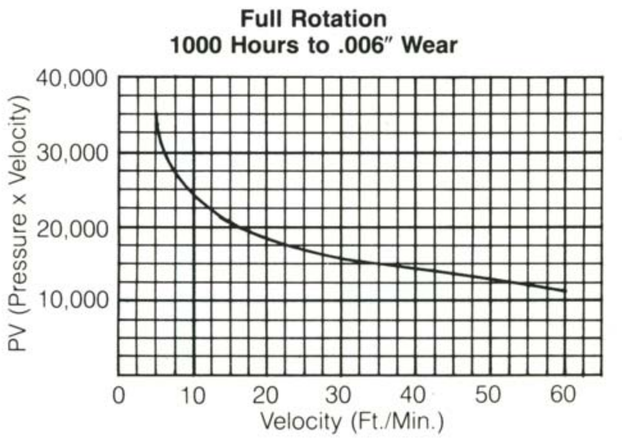
Shafting:
Since the shaft surface significantly affects the operation of a journal bearing design, its selection in regard to material, hardness, coating and surface roughness is crucial. High loads require smooth surfaces with hardened and heat treated shafts. With stress levels of 8,000 to 30,000 psi shafting should have a surface finish of 8 micro inch or better to achieve optimum performance. However, tests have been run on 25-30 micro inch finishes with 55 R_c shafts at 4,000 psi with acceptable results.

A number of shaft materials have been used successfully with Tuflite bearings?
- 52100 high carbon steel
- 4140 chrome and nickel plated steel
- 300 and 400 series stainless steel
- Monel
- Precipitation-hardened grades 17-4PH, 15-5PH, 13-8PH moly chrome and nickel plated stainless steel
- 2000 and 7000 series aluminum grades hard anodized
- Low to high carbon steels

Motion: Tuflite bearings can withstand varying degrees of motion, depending on speed and load. They will operate under all degrees of motion normally encountered. The degree of oscillation can affect bearing performance, and must be taken into account when selecting a bearing, as shown in Figure 2, Page B9.

In lab tests, Tuflite journal bearings have operated successfully at low speed/high load conditions (90 cpm/30,000 psi) typical of fixed-wing aircraft ... and at high-speed/low load conditions (300 cpm/4000 psi) found in rotary-wing aircraft.

Full rotation can be accommodated without additional lubrication if load and speed are below the curve in the accompanying graph. See reference formula for pressure and velocity.



Load: Tuflite journal bearings can accommodate static radial load levels up to 60,000 psi on the projected bearing area. The load/deflection relationships of Tuflite journal bearings and metal backed Teflon-lined bearings are very similar. The yield point and ultimate strength of Tuflite are approximately equal. This complex relationship is incorporated in the radial yield load factor shown in Table III.

Tuflite journal bearings are rated on the basis of their radial yield load capacity, which is a function of the radial yield load factor and the length. This factor is indicated for each bearing diameter in Table III. The capacity can be calculated with the following formula:

$$\text{Radial Yield Load Capacity} = \text{Radial Yield Load Factor} \times (\text{Journallength} - .090)$$

Application loading should not exceed the radial yield load capacity.

For information on reversing loads, contact Rexnord engineers.

Speed: Tuflite bearings have shown their ability to function successfully at speeds up to 300 cycles per minute. However, permissible speeds vary inversely with the load imposed on the bearing. As loads increase, the speeds must be decreased.

Table III
Radial Yield Load Factor

Bore Designation	Bore Size +.0000/-.0010	Radial Yield Load Factor Lbs./In
04	.2515	16,593
05	.3140	20,853
06	.3765	24,846
07	.4390	28,977
08	.5015	33,098
09	.5640	37,219
10	.6265	41,351
11	.6890	45,472
12	.7515	49,604
14	.8765	57,846
16	1.0015	66,098
18	1.1265	74,351
20	1.2515	82,604
22	1.3765	90,846
24	1.5015	99,098
26	1.6265	107,351
28	1.7515	115,604
32	2.0015	132,087

Environmental and Chemical: Tuflite bearings are resistant to most environmental elements encountered in aerospace applications. Predictable wear lives have been obtained when bearings were operated in these fluids:

- JP-4 jet fuel
- MIL-L-7808 lubricating oil
- MIL-H-5606 hydraulic oil
- MIL-A-8243 anti-icing fluid
- MIL-H-83282 hydraulic fluid
- Distilled water
- Sea water

Although Tuflite bearings are typically chemical-resistant, due to the wide range of exposures specific test or evaluation is recommended. Consult with a Rexnord engineer.

REFERENCE FORMULAS

These formulas may aid in the selection of Tuflite bearings. Note: All dimensions are in inches, all angles are in degrees.

1. Bearing pressure

$$\text{PSI} = \frac{\text{Load Lbs.}}{\text{I.D. x L}}$$

$$\text{PSIE} = \frac{\text{Load Lbs.}}{\text{I.D. x (L - .090)}}$$

2. Speed (surface velocity)

A. Full rotation
Surface velocity (ft/mm) = .262 x I.D. x RPM

B. Oscillatory motion

$$\text{Surface Velocity (ft/min)} = \frac{\text{ID. x 2 x included angle x CPM}}{1.38 \times 10^{3}}$$

3. Bearing area factor

BAF — I.D.$^{.491}$ x (L - .090)
I.D. = Bearing Inner Diameter
L = Bearing Length

TUFLITE BEARING SELECTION

The Tuflite selection procedure is restricted to those applications described by the following parameters.

1. Speed not exceeding 60 cycles per minute.
2. Pressures not exceeding 25,000 psie.
3. Oscillation up to 9Q0 included angle.

For application requirements exceeding these parameters, consult your local Rexnord sales engineer.

SYMBOLS

A	=	Area
C	=	Cycles specified in application
C6	=	Cycles to .006" total wear
Pe	=	Equivalent radial dynamic load –lbs
W	=	Total wear allowed in the application –in.

STEP 1: CONVERT APPLICATION LOADS TO EQUIVALENT RADIAL DYNAMIC LOAD (P_e)

This selection procedure assumes that the journal bearings will carry only radial loads. Therefore, the equivalent radial load (P_e) is considered equal to the maximum applied dynamic radial load.

STEP 2: CONVERSION TO .006" TOTAL WEAR

This selection procedure is based on the allowance of .006" total wear. If the allowable wear is less than .006" in a specified number of cycles, then the number of cycles to .006" wear (C_6) must be calculated for use in step 3.

$$C_6 = C \frac{(.0045)}{(W-.0015)}$$

NOTE: If the application allows .006" total wear,

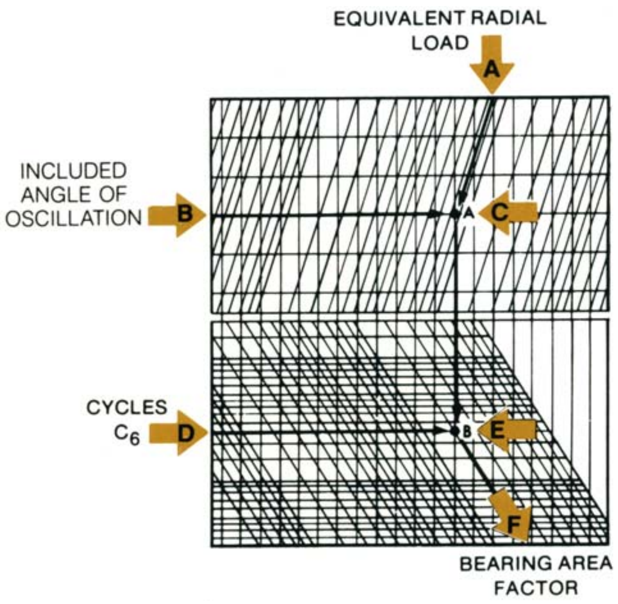
Then $\frac{(.0045)}{(W-.0015)}$ Becomes 1 and $C_6 = C$

STEP 3: DETERMINE THE REQUIRED BEARING AREA FACTOR (BAF)

The example in Figure 1 illustrates the procedure to be followed when using the Tuflite selection chart, Figure 2, for determining the Bearing Area Factor.

EXAMPLE:

A. Locate the equivalent radial load, as determined in Step 1.
B. Locate the required oscillation angle.
C. Locate point "A", where the inclined load line intersects the horizontal line from the desired oscillation angle.
D. Locate C_6, as determined in Step 2.
E. Locate point "B", where the vertical line from point "A" intersects the horizontal line from C_6.
F. Determine the bearing area factor by following the inclined line from point "B".



STEP 4: SELECT A BEARING HAVING A BAF EQUAL TO OR GREATER THAN THATOBTAINED IN STEP 3.

The required BAF, shown in Table IV, Page B8, should be located for that bearing most closely conforming to the configuration and dimensional requirements of the application.

NOTE: The radial yield load factor of the bearing selected should be recorded for use in Step 6.

STEP 5: CHECK THE EFFECTIVE PRESSURE (PSIE) FOR THE BEARING SELECTED

The maximum effective pressure to which this procedure applies is 25,000 psie. The effective pressure is calculated from the following equation:

$$\frac{P_e}{A} = \frac{\text{Equivalent Radial Load}}{(\text{Journal Bore Dia.})(\text{Journal Lgth.} — .090)}$$

IF THE EFFECTIVE PRESSURE EXCEEDS 25,000 PSIE A LARGER BEARING MUST BE SELECTED.

Once the 25,000 psie criterion has been met by a larger bearing, that bearing will wear less than the original allowable wear amount used for selection. To find the new amount of wear, use the selection verification procedure outlined below.

STEP 6: DETERMINE STATIC CAPACITY OF THE BEARING SELECTED

The maximum applied static radial load anticipated in the application must not exceed the radial yield load capacity of the bearing selected.

The radial yield load factor was noted in Step 4. The radial yield capacity is equal to the radial yield load factor times (Journal length - .090). Also, the applied ultimate load should not exceed 1.5 times the radial yield load capacity.

A LARGER BEARING IS REQUIRED IF EITHER THE STATIC RADIAL LOAD OR THE ULTIMATE LOAD REQUIREMENTS OF THE APPLICATION EXCEED THE CAPACITY OF THE BEARING SELECTED.

SELECTION VERIFICATION PROCEDURE

TO CALCULATE SIZE (KNOWN LOAD AND LIFE)

Load: (A) 13,200 lbs., maximum applied static radial load.
(B) 7,000 lbs., dynamic radial load.
Life: 450,000 cycles, to .005” wear.
Pin size: 0.750 inches.
Speed: 10 cycles per minute.
Oscillation: ±200 (400 total included angle).
Configuration: Plain journal bearing.

SOLUTION:

STEP 1:

$P_e = 7{,}000$

STEP 2:

$$C_6 = C\,\frac{(.0045)}{(W - .0015)}$$

$$C_6 = 450{,}000\,\frac{(.0045)}{(.005 - .0015)} = 578{,}571 \text{ cycles}$$

STEP 3:

The BAF from the Tuflite selection chart, Figure 2, equals .38 minimum.

STEP 4:

From the BAF table, Page B8, and the bearing listings, Pages B16 and B17, the bearing meeting the configuration requirements is 501-0012-020.

STEP 5:

$$\frac{P_e}{A} = \frac{P_e}{(\text{Journal Bore Dia.})(\text{Journal Lgth} - .090)}$$

$$\frac{P_e}{A} = \frac{7{,}000}{A(.7515)(.625 - .090)} = 17{,}411 \text{ psie}$$

The effective pressure on the 501-0012-020 is below the maximum acceptable level.

STEP 6:

The radial yield load capacity of 501-0012-020 =

(Radial Yield Load Factor) x (Length - .090)

49,604 (.625 - .090) 26,538 lbs.

This exceeds the maximum applied static radial load of13,200 lbs.

CONCLUSION:

The 501-0012-020 meets the application requirements and is within the allowable psie range. Therefore, this bearing is acceptable for use in the application.

TO CALCULATE LIFE (KNOWN LOAD AND SIZE)

Load: (A) 16,700 lbs., maximum applied static radial load.
(B) 11,600 lbs., dynamic radial load.
Bore size: 1.000 inch.
O.D. size: 1.250 inch maximum.
Bearing Length: .500 inch minimum.
1.000 maximum.
Speed: 25 cycles per minute.
Oscillation: ±25~ (500 total included angle).
Configuration: Plain journal bearing.

SOLUTION:

STEP 1:

Pe =11,600 lbs.

STEP 2:

From the BAF table, Page 88, and the bearing listings, Pages B16 and 817, the bearing meeting the configuration requirements is 501-001 6-016.

Step 3:

$$\frac{P_e}{A} = \frac{P_e}{(\text{Journal Bore Dia.})\ (\text{Journal Lgth - .090})}$$

$$\frac{P_e}{A} = \frac{11{,}600}{(1.000)\ (.500 - .090)} = 28{,}292 \text{ psie}$$

This exceeds the maximum allowable 25,000 psie. Therefore, the next length increment, 501-0016-020, should be checked.

$$\frac{P_e}{A} = \frac{11{,}600}{(1.000)\ (.625 - .090)} = 21{,}682 \text{ psie}$$

The radial yield load capacity of 501-0016-020 =

(Radial Yield Load Factor) x (Length - .090)

66,098 (.625 - .090) = 35,362 lbs.

This exceeds the maximum applied static radial load of 16,700 lbs.

STEP 5:

Determine number of cycles, C_6 to .006" wear from Tuflite selection chart, Figure 2.

A. Locate radial load (11,600 lbs.)
B. Locate required oscillation angle (500).
C. Using lines defined in Steps A and B, locate point A where the load (inclined) intersects with the oscillation angle (horizontal).
D. Locate BAF for bearing selected (.535)
E. Locate point B by drawing a vertical line from point A to the BAF (inclined) line.
F. Determine C6, cycles to .006" wear (275,000 cycles).

CONCLUSION:

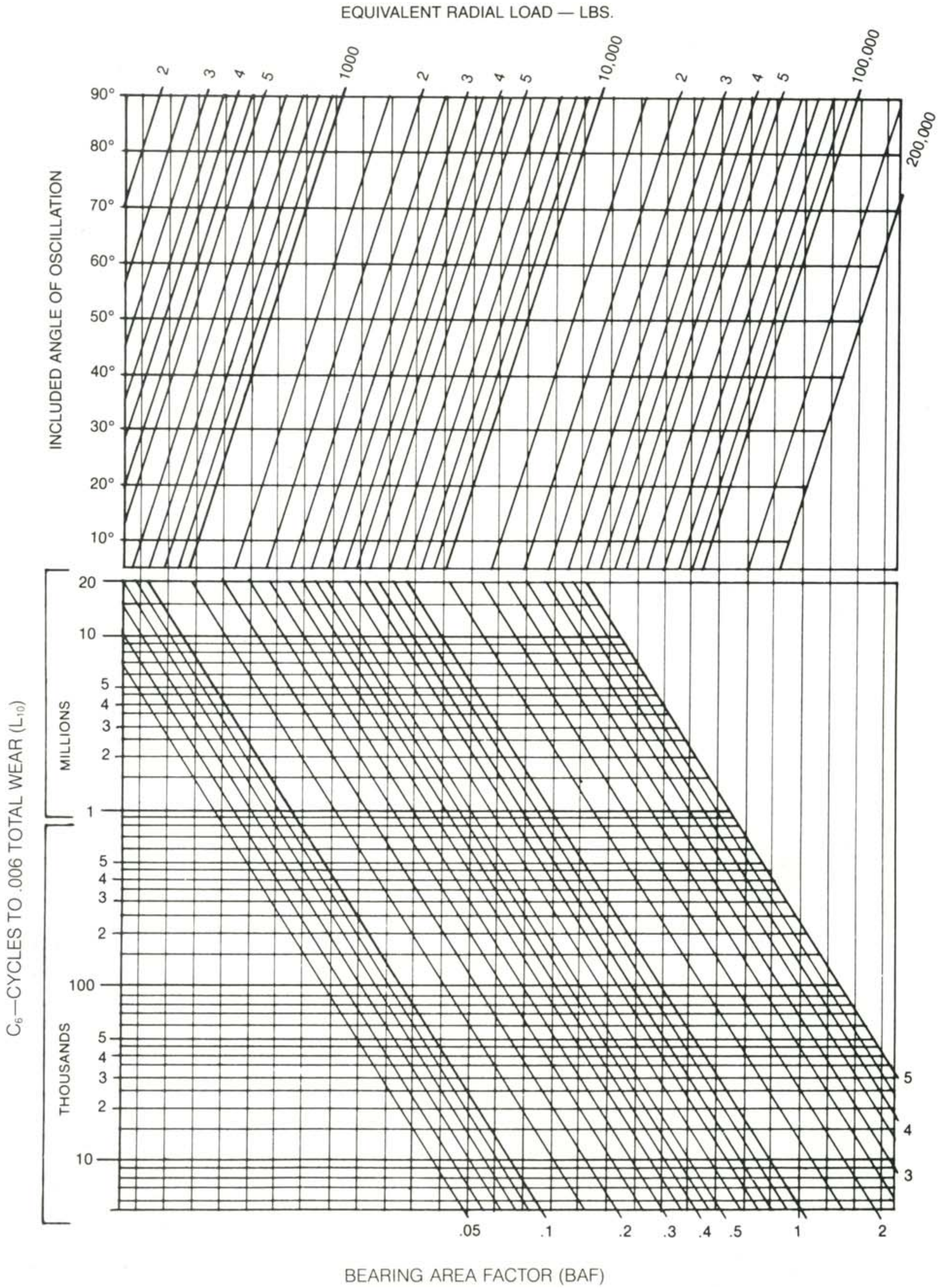
The 501-0016-020 meets the dimensional limits, application requirements, and is within the allowable psie range. The predicted life to .006" wear is 275,000 cycles.

TABLE IV — BEARING AREA FACTOR (BAF) by Length and Bore Designations.

Length Suffix

Bore (1/16 in.)	008	009	010	011	012	014	016	018	020	022	024	028	032	036	040	044	048	052	056	060	064	068	072	076	080	088	096
04	.081	.097	.113	.129	.144	.177																					
05	.090	.108	.126	.144	.161	.197	.232	.267																			
06	.099	.118	.138	.157	.176	.215	.253	.292	.331	.370																	
07	.107	.128	.148	.170	.190	.232	.273	.315	.357	.399	.440	.524															
08	.114	.136	.158	.181	.203	.248	.292	.336	.381	.426	.470	.559															
09	.121	.144	.168	.192	.215	.263	.309	.356	.403	.451	.498	.593	.686	.781													
10	.127	.152	.177	.202	.226	.277	.326	.375	.425	.475	.524	.624	.723	.823	.921	1.021											
11	.133	.159	.185	.212	.237	.290	.341	.393	.445	.498	.549	.654	.757	.862	.965	1.070	1.173	1.278									
12	.139	.166	.193	.221	.248	.302	.356	.410	.465	.520	.573	.682	.790	.900	1.007	1.117	1.224	1.334									
14	.150	.179	.208	.238	.267	.326	.384	.442	.501	.561	.618	.736	.852	.970	1.086	1.204	1.321	1.439									
16	.160	.191	.223	.254	.285	.348	.410	.472	.535	.598	.660	.786	.910	1.036	1.160	1.286	1.410	1.536	1.660	1.786							
18			.236	.269	.302	.369	.434	.500	.567	.634	.669	.832	.964	1.097	1.229	1.362	1.494	1.627	1.759	1.892							
20					.318	.388	.458	.527	.597	.668	.736	.876	1.015	1.156	1.294	1.435	1.573	1.714	1.852	1.993	2.131	2.272					
22					.333	.407	.479	.552	.626	.700	.772	.918	1.064	1.211	1.356	1.503	1.649	1.796	1.941	2.008	2.233	2.381					
24					.348	.425	.500	.576	.653	.730	.805	.958	1.111	1.264	1.416	1.569	1.721	1.874	2.026	2.179	2.331	2.484	2.636	2.790	2.941	3.248	
26							.520	.599	.679	.759	.838	.997	1.155	1.314	1.472	1.632	1.790	1.949	2.107	2.266	2.424	2.584	2.742	2.901	3.059	3.378	3.695
28							.540	.622	.704	.787	.869	1.034	1.198	1.363	1.527	1.692	1.856	2.021	2.185	2.351	2.514	2.680	2.843	3.009	3.172	3.503	3.830
32							.576	.664	.752	.841	.928	1.104	1.279	1.455	1.630	1.807	1.982	2.158	2.333	2.510	2.684	2.861	3.036	3.213	3.387	3.740	4.090

(For [BAF] definition see reference formula Page B5)

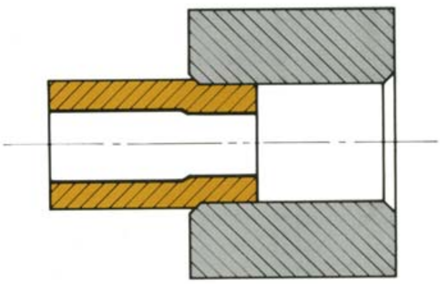


EQUIVALENT RADIAL LOAD — LBS.
2
3
4
5
1000
2
3
4
5
10,000
2
3
4
5
100,000
200,000
INCLUDED ANGLE OF OSCILLATION
90°
80°
70°
60°
50°
40°
30°
20°
10°
C_6—CYCLES TO .006 TOTAL WEAR (L_{10})
MILLIONS
20
10
5
4
3
2
1
THOUSANDS
5
4
3
2
100
5
4
3
2
10
5
4
3
.05
.1
.2
.3
.4
.5
1
2
BEARING AREA FACTOR (BAF)

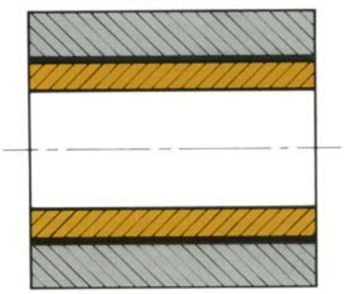
TUFLITE BEARING RETENTION METHODS

The standard method of sleeve bearing retention is a “press” or interference fit. For Tuflite, this recommended range is from .0002” to .0022” press; however, to avoid shearing the back-up material, the interference should not exceed .007”. NOTE: Bore diameter will be reduced an amount equal to housing interference. This fact must be taken into consideration when determining proper pin size. A clearance fit of .0005” to .0015” is normally used between the shaft and the bearing bore. There are alternate retention methods as shown below. Consult with Rexnord engineers for recommendations.

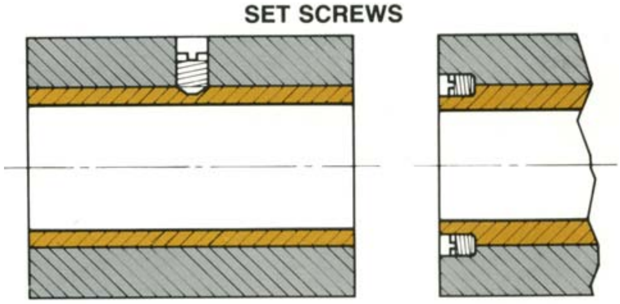
PRESS FIT



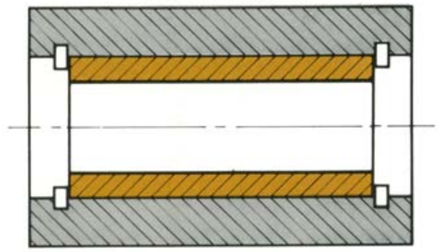
BONDING



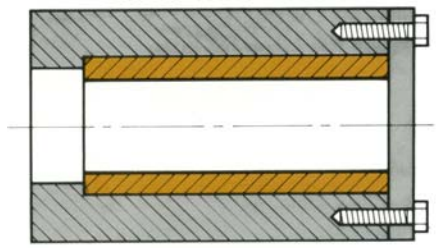
SET SCREWS



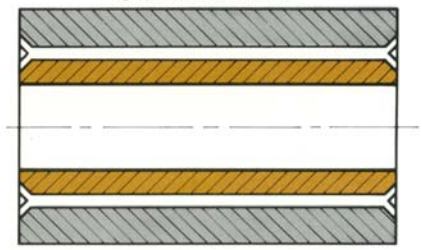
SNAP RINGS



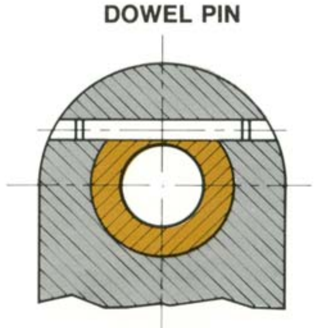
BOLTS THRU WASHER



STAKING RING



DOWEL PIN



SPECIAL DESIGNS

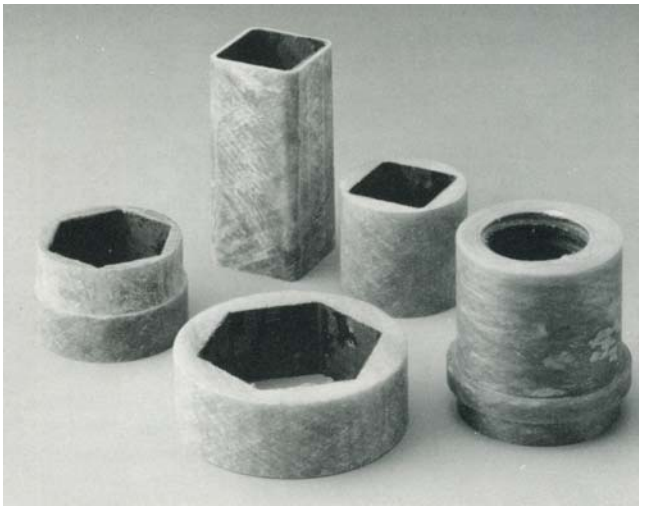
Spherical Bearings: Designed for applications combining both misaligning and oscillatory motions under dynamic conditions. Metallic inner race and composite outer race produce a lightweight, corrosion-resistant bearing. Near-perfect conformance of outer race I.D. and inner race O.D. assures consistent bearing performance and long life.

Properties of Tuflite Outer Race

1.	Ultimate Strength (Non-Supported)	48,000 PSI
2.	Inter-laminar Shear	3,000-5,000 PSI
3.	Thermal Expansion (in/in/F°)	
	Axial Direction	15x106
	Hoop Direction	7.0x106
4.	Electrical Dielectric Strength	300V/Mil.

Acme Nuts: The same basic filament-winding process used to produce Tuflite bearings is applied in the manufacture of Acme nuts. The Teflon fabric is the bearing surface, and the fiberglass-epoxy matrix is the support structure. Acme or modified Acme thread forms as small as 1/2” major diameter, 6 lead, have been wound successfully. Tuflite Acme nuts can replace ball screw and jack screw shaft assemblies, in both vane and flap actuators.

Special Bores: Square, hexagonal and other unusual bore configurations are produced easily and inexpensively with the filament winding technique used in manufacturing Tuflite bearings. These shapes offer many advantages and benefits not found in conventional metallic bearings. For example, bearings with non-round bores can transmit torque, and at the same time allow linear motion of the shaft within the bore.



Tuflite eliminates the need for costly splines or balland-roller slip assemblies. In addition, Tuflite can reduce total parts and assembly costs, eliminate need for lubrication, minimize space requirements, resist corrosion, galling and scoring, absorb vibration and lower maintenance costs. Overall design and cost savings often result from the configuration flexibility. Contact Rexnord for assistance in developing innovative configurations for unique applications.

COMPETITIVE NON-LUBED BEARINGS

GENERAL

A vast number of metallic and non-metallic, lined and unlined sliding bearings are available. The various combinations of materials and construction, as well as performance characteristics and cost, can present quite a dilemma for the engineer faced with selection of a bearing.

Characteristics such as static capacity or ultimate strength must be considered from a structural standpoint and control some selections. Wear life or dynamic performance capabilities are the prime concern in others. Temperature limits may be a factor in regard to the liner or lubrication. A wide range of chemical capabilities, electrical conductivity, and other properties can be the key in still other applications.

General groupings of friction bearings include molded plastic materials, metallic bearings with liner strips, powdered metal with oil impregnation, Teflon lined with fiberglass backing, and Teflon fabric lined with metal backing.

Within the group of fiberglass-backed bearings, those made from chopped fibers or braided filaments have lower strength than those of filament-wound construction. Filament-wound bearings rank high in static structural capacity and are also often tops in dynamic performance or wear-rate considerations.

Powdered metal bearings with oil impregnation — if relubricated — offer high dynamic ratings, but are subject to wear if the oil is lost. There are also high load and temperature limitations.

Metallic backed parts with strip liners offer better wear life, but have only modest static capacity and temperature resistance. Molded plastic bearings can offer temperature advantages, but frequently have very low static capacity ratings.

COMPETITIVE TESTING

To gain insight into basic performance capabilities and provide general application guidance, Rexnord has tested a variety of bearings under two basic conditions: first, a low load/high speed test typical of a rotary wing application, and second, a high load/low speed test typical of a fixed wing application. In low load testing, while results vary dramatically, the mode of failure is "wear". However, in the high load test, many styles experience an "ultimate strength" failure. The chart below indicates the results.

TEST CONDITIONS

Low load test (typical rotary wing application)
Load: 4000 psi Speed: 168 cpm Oscillation: ±10°

High load test (typical fixed wing application)
Load: 20,000 psi Speed: 90 cpm Oscillation: ±25°.

All test pins were 4140-50 R~-8 rms polished. Test bearings were 1.5" I.D., 0.5" wide.

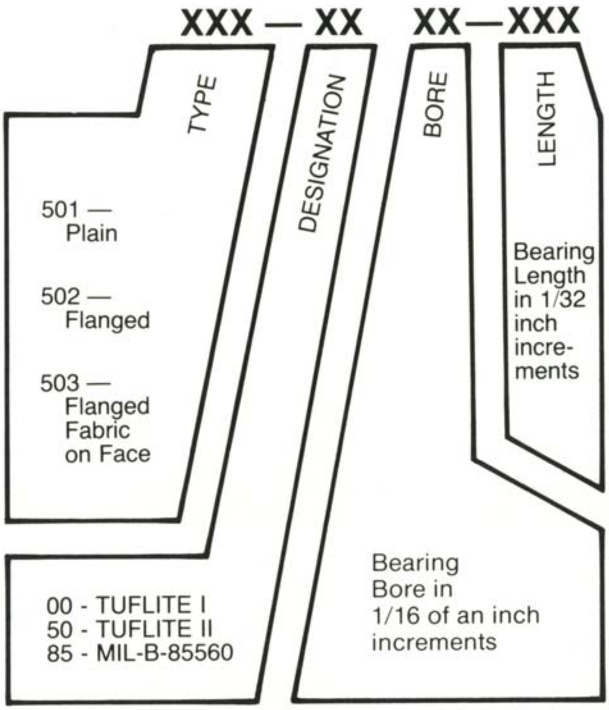
L_{10} LIFE IN CYCLES TO .006 IN. WEAR

Bearing Type	Low Load Test	High Load Test
Rexnord Tuflite Bearing	25.2×10^6	1.00×10^6
Powdered Bronze	70,000	0
Strip Overlay(Teflon, Bronze, Steel Backed)	$.58 \times 10^6$	14,000
Strip Overlay (Tape, Steel Backed)	30,000	220
Fiberglass Backed (Nomex, Teflon)	$.40 \times 10^6$	$.20 \times 10^6$
Braided Fiberglass Backed (Teflon)	1.6×10^6	0
Filament Wound Composite (Nomex, Teflon)	9.4×10^6	$.58 \times 10^6$
Filament Wound Composite (Tape Liner)	1.0×16^6	12,000
Laminated Phenolic	Less than 7,000	0
Phenolic Backed (Teflon Fabric)	$.50 \times 10^6$	100
Molded Compounded Teflon	0	0
Oil Filled Molded Plastic	58,000	0
Molybdenum Disulfide Filled Nylon	900	0

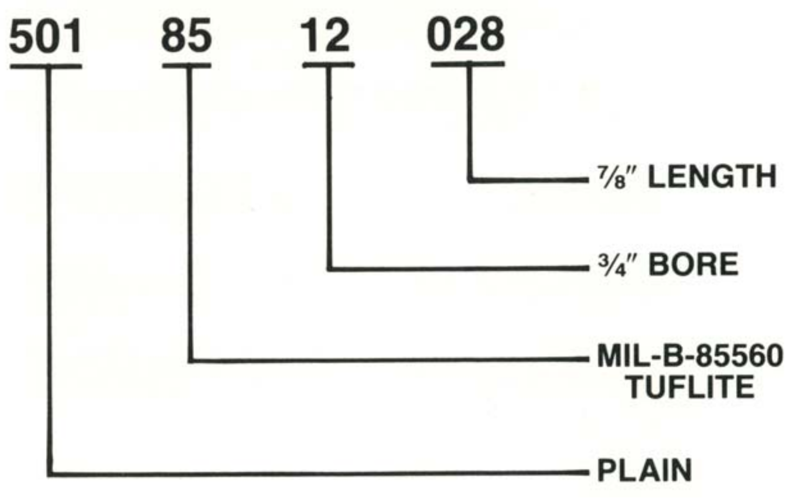
MARKING AND PACKAGING

As size permits, Tuflite bearings are individually marked specified. with Tuflite, model number, and customer or military specification, if applicable. The bearings are bulk packaged per industry standards unless otherwise specified. Outer containers are marked with Tuflite" model number, and customer or military specification number, if applicable.

TUFLITE NOMENCLATURE



EXAMPLE: 501-8512-028



TUFLITE® (MIL-B-85560)

- **Qualified to MIL-B-85560**
- **Type 501 meets the requirements of MIL-B-85560/1**
- **Type 503 meets the requirements of MIL-B-85560/2**
- **MIL-B-85560 does not specify Type 502 Bearings.**
- **Length Tolerance** = +.000 / -.010"
- Type 503 contains a .062" long by .005" max deep undercut at the flange back face to barrel O.D. junction

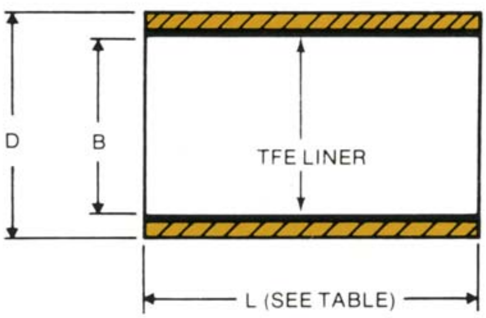
- **Load Ratings:**
  TYPE 501
  Radial Static Limit Load = 50,000 x B x (L - 0.1) lbs.
  Dynamic Radial Limit Load = 25,000 x B x (L - 0.1) lbs.
  TYPE 503
  Radial Static Limit Load = 50,000 x B x (L + F - 0.13) lbs.
  Dynamic Radial Limit Load = 25,000 x B x (L + F - 0.13) lbs.

Tuflite (MIL-B-85560)

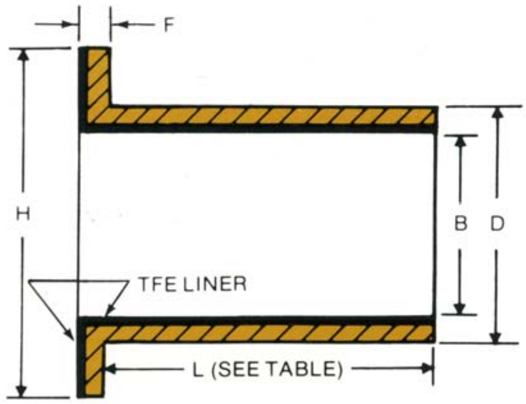
Model Number	B Dia +.0000 -.0010	D Dia. +.0005 -.0005	F +.0000 -.0050	H Dia +.000+ -.020
50X-8504-XXX	.2515	.3760	.0625	.750
50X-8505-XXX	.3140	.4386	.0625	.812
50X-8506-XXX	.3765	.5012	.0625	.875
50X-8507-XXX	.4390	.5638	.0625	.937
50X-8508-XXX	.5015	.6265	.0625	1.000
50X-8509-XXX	.5640	.6892	.0625	1.125
50X-8510-XXX	.6265	.8142	.0625	1.250
50X-8511-XXX	.6890	.8767	.0625	1.375
50X-8512-XXX	.7515	.9393	.0625	1.500
50X-8514-XXX	.8765	1.0645	.0625	1.625
50X-8516-XXX	1.0015	1.1898	.0625	1.750
50X-8518-XXX	1.1265	1.3148	.0937	1.875
50X-8520-XXX	1.2515	1.4398	.0937	2.000
50X-8522-XXX	1.3765	1.5648	.0937	2.125
50X-8524-XXX	1.5015	1.7523	.0937	2.250
50X-8526-XXX	1.6265	1.8773	.0937	2.375
50X-8528-XXX	1.7515	2.0023	.0937	2.500
50X-8532-XXX	2.0015	2.2523	.0937	2.750

Catalog dimensions may be subject to change or correction. Please request certified prints for current and exact dimensions.

JOURNAL SERIES PLAIN TYPE 501



JOURNAL SERIES FLANGED LINED TYPE 503



	BEARING LENGTH AND MODEL NUMBER SUFFIX																										
Bore (1/16 In)	**.250**	**.281**	**.312**	**.344**	**.375**	**.438**	**.500**	**.562**	**.625**	**.688**	**.750**	**.875**	**1.000**	**1.125**	**1.250**	**1.375**	**1.500**	**1.625**	**1.750**	**1.875**	**2.000**	**2.125**	**2.250**	**2.375**	**2.500**	**2.750**	**3.000**
04	008	009	010	011	012	014																					
05	008	009	010	011	012	014	016	018																			
06	008	009	010	011	012	014	016	018	020	022																	
07	008	009	010	011	012	014	016	018	020	022	024	028															
08	008	009	010	011	012	014	016	018	020	022	024	028															
09	008	009	010	011	012	014	016	018	020	022	024	028	032	036													
10	008	009	010	011	012	014	016	018	020	022	024	028	032	036	040	044											
11	008	009	010	011	012	014	016	018	020	022	024	028	032	036	040	044	048	052									
12	008	009	010	011	012	014	016	018	020	022	024	028	032	036	040	044	048	052									
14	008	009	010	011	012	014	016	018	020	022	024	028	032	036	040	044	048	052									
16	008	009	010	011	012	014	016	018	020	022	024	028	032	036	040	044	048	052	056	060							
18			010	011	012	014	016	018	020	022	024	028	032	036	040	044	048	052	056	060							
20					012	014	016	018	020	022	024	028	032	036	040	044	048	052	056	060	064	068					
22					012	014	016	018	020	022	024	028	032	036	040	044	048	052	056	060	064	068					
24					012	014	016	018	020	022	024	028	032	036	040	044	048	052	056	060	064	068	072	076	080	088	
26							016	018	020	022	024	028	032	036	040	044	048	052	056	060	064	068	072	076	080	088	096
28							016	018	020	022	024	028	032	036	040	044	048	052	056	060	064	068	072	076	080	088	096
32							016	018	020	022	024	028	032	036	040	044	048	052	056	060	064	068	072	076	080	088	096

Catalog dimensions may be subject to change or correction. Please request certified prints for current and exact dimensions.

TUFLITE I AND TUFLITE II

TUFLITE I

- Length Tolerance = +.000 / -.010”
- Types 502 & 503 contain a .020 max flange back face to barrel O.D. fillet radius.
- Bearings marked with an asterisk (*) are dimensionally interchangeable with MIL-B-81934 Bearings.

Tuflite I
Extra Precision Bearings

Model Number	B Dia +.0000 -.0010	D Dia. +.0005 -.0005	F +.0000 -.0050	H Dia +.000+ -.020
50X-0004-XXX	.2515	.4389	.0625	.750
50X-0005-XXX	.3140	.5012	.0625	.812
50X-0006-XXX	.3765	.5638	.0625	.875
50X-0007-XXX	.4390	.6265	.0625	.937
50X-0008-XXX	.5015	.6892	.0625	1.000
50X-0009-XXX	.5640	.7517	.0625	1.125
***50X-0010-XXX**	.6265	.8142	.0625	1.250
***50X-0011-XXX**	.6890	.8767	.0625	1.375
***50X-0012-XXX**	.7515	.9393	.0625	1.500
***50X-0014-XXX**	.8765	1.0645	.0625	1.625
***50X-0016-XXX**	1.0015	1.1898	.0625	1.750
***50X-0018-XXX**	1.1265	1.3148	.0937	1.875
***50X-0020-XXX**	1.2515	1.4398	.0937	2.000
***50X-0022-XXX**	1.3765	1.5648	.0937	2.125
***50X-0024-XXX**	1.5015	1.7523	.0937	2.275
***50X-0026-XXX**	1.6265	1.8773	.0937	2.375
***50X-0028-XXX**	1.7515	2.0023	.0937	2.500
***50X-0032-XXX**	2.0015	2.2523	.0937	2.750

TUFLITE II

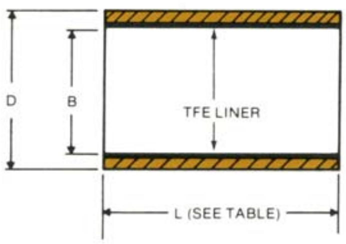
- Length Tolerance = +.000 / -.025”
- Types 502 & 503 contain a .030 max flange back face to barrel O.D. fillet radius.

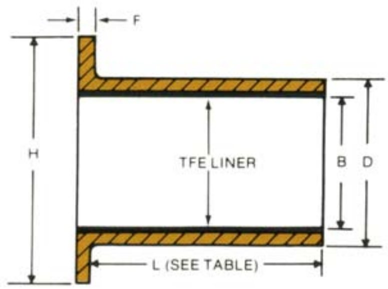
Tuflite II
Extra Precision Bearings

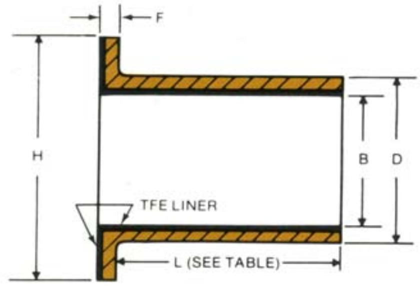
Model Number	B Dia +.0000 -.0010	D Dia. +.0005 -.0005	F +.0000 -.0050	H Dia +.000+ -.020
50X-0004-XXX	.2515	.4389	.0937	.688
50X-0005-XXX	.3140	.5012	.0937	.750
50X-0006-XXX	.3765	.5638	.1250	.812
50X-0007-XXX	.4390	.6265	.1250	.875
50X-0008-XXX	.5015	.6892	.1250	.938
50X-0009-XXX	.5640	.7517	.1250	1.000
50X-0010-XXX	.6265	.8142	.1250	1.062
50X-0011-XXX	.6890	.8767	.1250	1.125
50X-0012-XXX	.7515	.9393	.1250	1.188
50X-0014-XXX	.8765	1.0645	.1250	1.312
50X-0016-XXX	1.0015	1.1898	.1562	1.438
50X-0018-XXX	1.1265	1.3148	.1562	1.562
50X-0020-XXX	1.2515	1.4398	.1562	1.688
50X-0022-XXX	1.3765	1.5648	.1562	1.812
50X-0024-XXX	1.5015	1.7523	.1562	2.000
50X-0026-XXX	1.6265	1.8773	.1562	2.125
50X-0028-XXX	1.7515	2.0023	.1875	2.250
50X-0032-XXX	2.0015	2.2523	.1875	2.500

Catalog dimensions may be subject to change or correction. Please request certified prints for current and exact dimensions.
Load Ratings: Refer to Table III, Page B5.

JOURNAL SERIES PLAIN TYPE 501	JOURNAL SERIES FLANGED UNLINED TYPE 502	JOURNAL SERIES FLANGED LINED TYPE 503







BEARING LENGTH AND MODEL NUMBER SUFFIX

Bore (1/16 In)	.250	.312	.375	.500	.625	.750	1.000	1.250	1.500	1.750	2.000	2.250	2.500	3.000
04	008	010	012											
05	008	010	012	016										
06	008	010	012	016	020									
07	008	010	012	016	020	024								
08	008	010	012	016	020	024								
09	008	010	012	016	020	024	032							
10*	008	010	012	016	020	024	032	040						
11*	008	010	012	016	020	024	032	040	048					
12*	008	010	012	016	020	024	032	040	048					
14*	008	010	012	016	020	024	032	040	048					
16*	008	010	012	016	020	024	032	040	048	056				
18*		010	012	016	020	024	032	040	048	056				
20*			012	016	020	024	032	040	048	056	064			
22*			012	016	020	024	032	040	048	056	064			
24*			012	016	020	024	032	040	048	056	064	072		
26*				016	020	024	032	040	048	056	064	072	080	096
28*				016	020	024	032	040	048	056	064	072	080	096
32*				016	020	024	032	040	048	056	064	072	080	096

* Dimensionally interchangeable with MIL-B-81934 bearings.
Catalog dimensions may be subject to change or correction. Please request certified prints for current and exact dimensions.