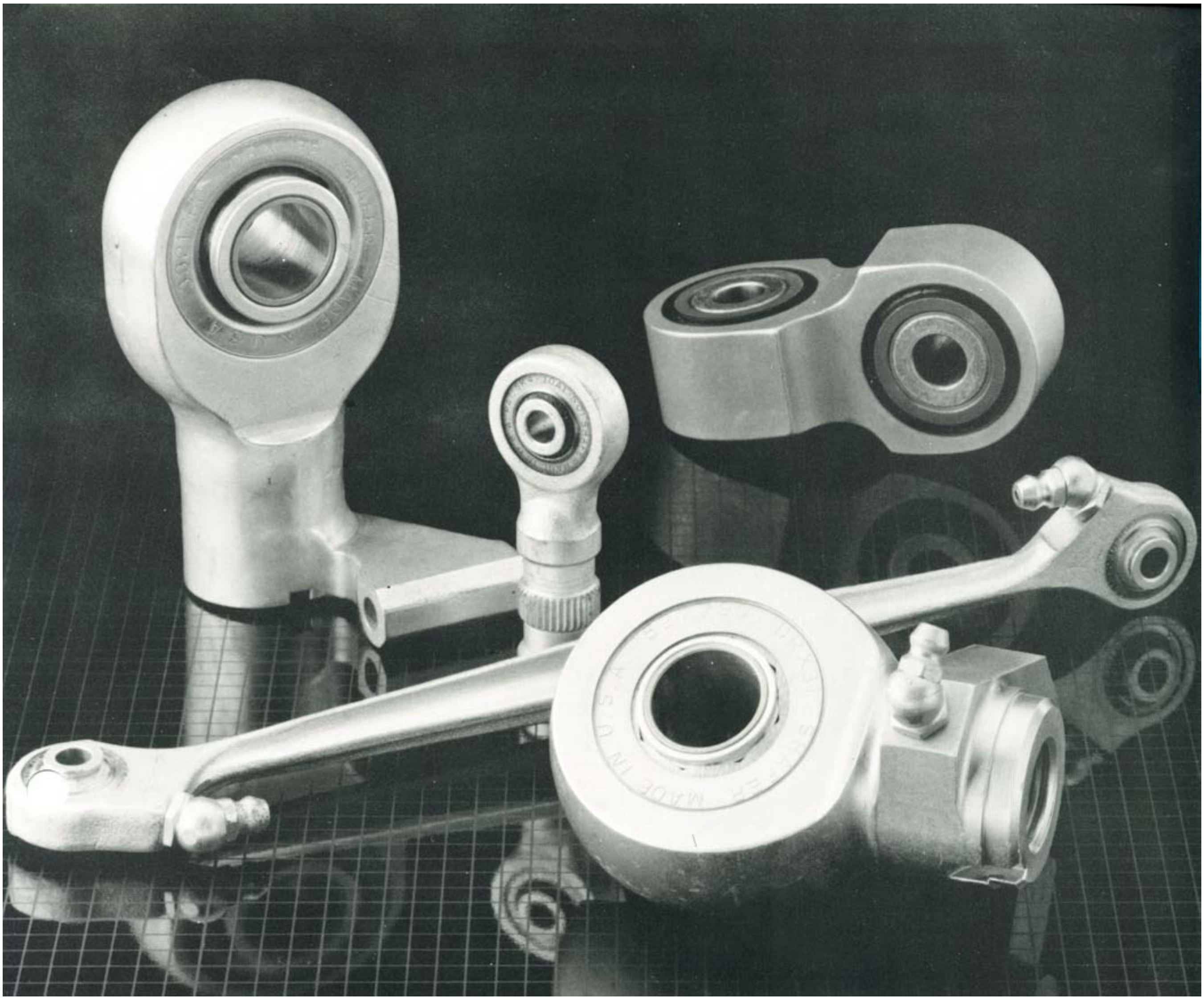

Shafer roller bearings

Special Shafer Roller bearing configurations are available or can be designed to suit many application needs. Although the standard bearing lines described in this section can satisfy most of these requirements, contact your Rexnord sales engineer or Shafer Bearing for design and application assistance if needed.

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Shafer roller bearings

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SHAFER ENGINEERING

DESIGN HIGHLIGHTS

For over 50 years, beginning with the DC-3, Shafer bearings have served the aerospace industry providing self-aligning bearings where aircraft design criteria demands extra performance under increasingly severe operating conditions.
Today, these control system bearings are specified at vital control points on all classes of fixed and rotary wing aircraft, both commercial and military.
With each new generation of aircraft, Shafer is there with advancing design concepts to meet the industry's needs.

The following paragraphs describe a number of the beneficial features of Shafer roller bearings that contribute to their popularity among engineers in the aerospace industry.

SELF-ALIGNMENT CAPABILITY

The inner ring can be freely misaligned within rated limits. Long term reliability, especially under dynamic misalignment conditions, is enhanced because the relative motion occurs on the rolling surfaces inside the bearing.

RADIAL AND THRUST CAPACITY

Single row bearings are designed primarily for radial load applications. They can, however, carry momentary or intermittent light thrust loads, but they are not designed for continuous thrust load applications. Refer to Figure 1.

In double row bearings, two rows of rollers are positioned around the radial centerline of the inner ring. It is possible for the double row bearing to carry pure radial or a combination of radial and thrust loads. Pure dynamic thrust is acceptable if the contact angle is at least 15°. The load carried by the rollers is evenly distributed on the race surface, for maximum capacity even under severe misalignment. The rollers align themselves naturally, eliminating roller end wear and race surface scuffing. End-thrust loading is taken on the full roller contact area, not on the inner ring shoulders or retaining ring surfaces. Refer to Figure 2.

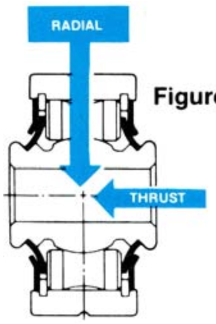


Figure 1

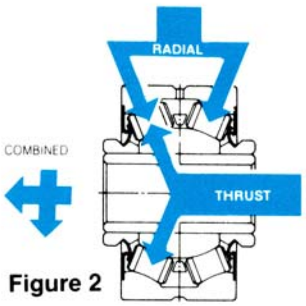


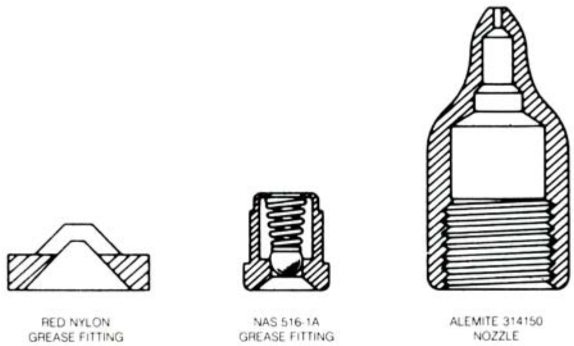
Figure 2

CLOSURES

The Shafer bearing is a self-contained unit which eliminates, in most cases, the necessity of auxiliary sealing devices. This design includes free-running seals and stainless steel shields, to provide corrosion protection by keeping the lubrication in the bearing and contaminants outside.

RELUBRICATION IN SERVICE

Both annular and rod end bearings can be relubricated through the outer ring without disassembly or removal of the bearing from the airframe structure. Relubrication of a rolling element bearing can definitely help to extend service life far beyond that of a bearing that is factory sealed and has no relubrication provisions.
The relubrication provisions for Shafer single row and double row bearings are such that lubricant is directed to the rolling contact surface area. See Figures 3-6. The spaces between the rollers are filled with grease. The grease from these reservoirs replenishes the lubricant film on contact surface areas.



Most rod end bearings shown in this catalog are equipped with the NAS516-1A fitting. When section size is too restricted, smaller nylon fittings are used. The Alemite 314150 nozzle can be used to relubricate through both ot these fittings. This nozzle will fit all standard grease guns and lubricating systems.

CORROSION RESISTANCE

Exposed surfaces of all standard series roller bearings are protected with a coating of cadmium in accordance with Federal Specification QQ-P-416 Type I, Class 2.

SHAFER ENGINEERING

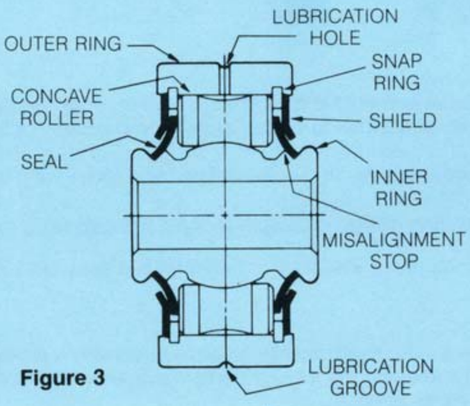


Figure 3

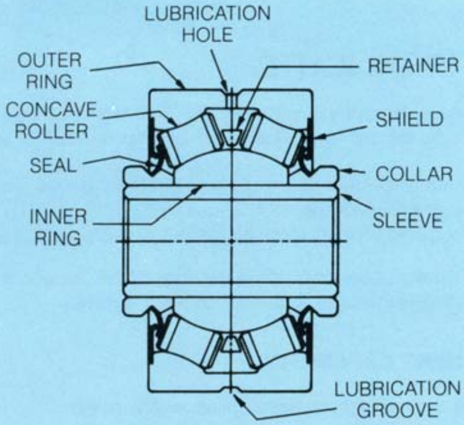
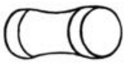


Figure 4

BEARING COMPONENTS

Figures 3 – 6 identify the various bearing components of the four basic styles of Shafer Roller Bearings.

ROLLERS



Bearing life is directly affected by the distribution of load on rolling elements. The "hourglass" or concave roller design provides a modified line contact between the races of the outer and inner rings and the roller race surface. The effects of edge loading on the ends of the rollers are minimized by the concave configuration. This permits uniform distribution of contact stresses over the entire length of the roller race surface, even in misalignment. The inner ring can be misaligned in any direction without reducing the load carrying capacity of the rollers.

OUTER RING

The outer ring contains the race surfaces on which the rollers ride. These surfaces are precision manufactured to provide optimum contour, hardness, and surface finish.

The outer ring is available in a variety of annular and rod end configurations, as indicated by the tabular listings.

Rod end shank threads are manufactured in accordance with MIL-S-8879.

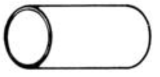
INNER RING

The inner ring is manufactured in one piece, and is fashioned as a segment of a true sphere to assure compensation for misalignment.

RETAINER

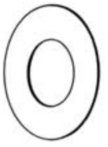
A retainer is used in double row bearings to provide proper guidance and separation of the rollers.

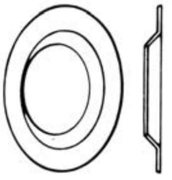
SLEEVE AND COLLARS



A number of the double row bearings utilize a sleeve and two collars to facilitate mounting the inner ring. Both components are hardened. The collars serve as spacers for the inner ring, and also provide misalignment stops, to avoid possible damage to the seals. The inner ring and collars are assembled on the sleeve. This type of construction offers the advantage of easy installation in applications where spacers are required between the inner ring and mounting clevis.

SEALS AND SHIELDS





Shafer bearings are designed with light contact seals made of various materials. Standard seals are designed to permit bearing relubrication without seal removal or disassembly of the bearing. Special design features permit purging the lubricant without damaging or "blowing" the seals. Full bearing misalignment can be achieved without affecting sealing performance. The stainless steel shields retain and protect the seals while helping to prevent contaminants from entering the bearing cavity.

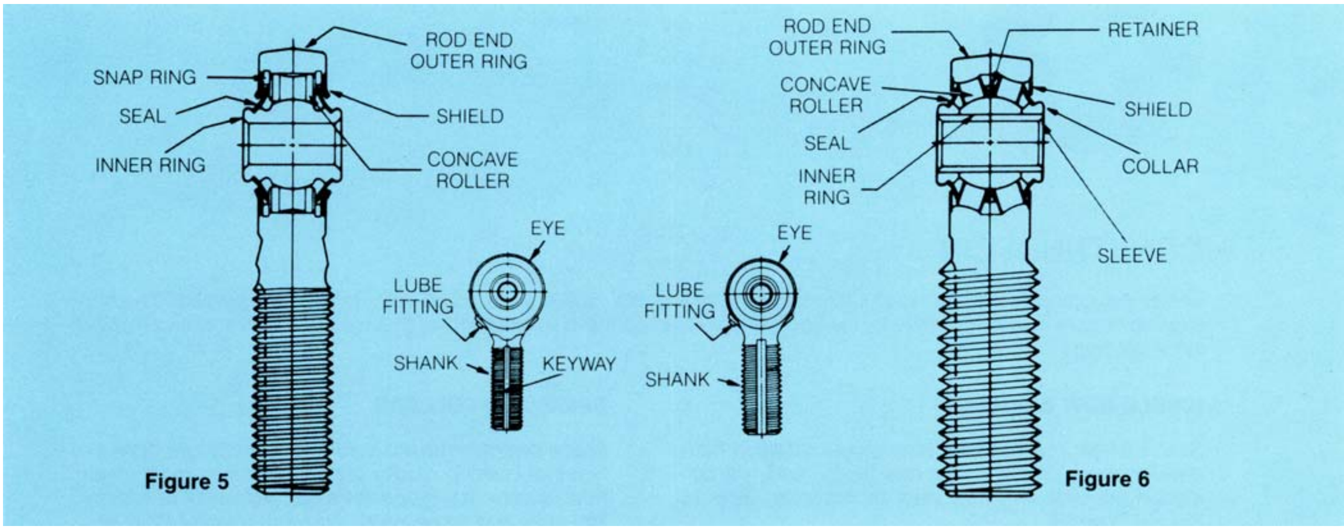
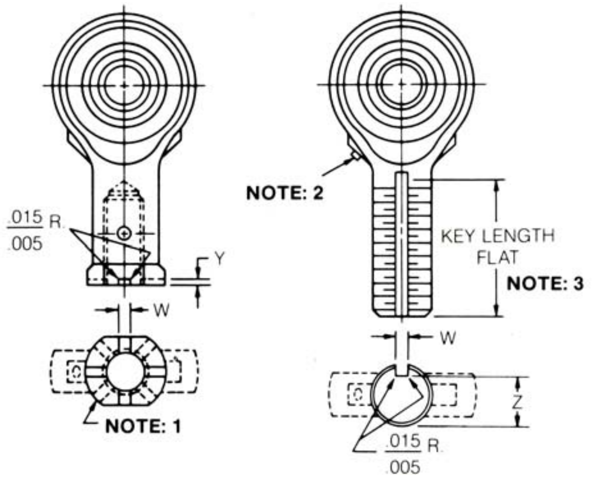


Figure 5 **Figure 6**

KEYWAYS AND KEYSLOTS

All rod ends shown in this catalog (except SMD and DMD types) can be supplied with keyways and/or keyslots which will accept NAS-513 lock washers. The bearing listings for each bearing type provide the necessary information for specifying a keyway or a keyslot.

All keyslots (internal threads) and keyways (external threads) utilize the slot dimensions set forth by NAS-513 (washer-rod end locking). However, NAS-559 (lock-rod end key type) is often referenced in regard to keyways since it specifies not only slot size, but breakout radius and the length of the keyway flat. This defines keyway flat length as a specific amount beyond full thread length and is related to use of NAS-509 (nuts-drilled jam) lock nuts.



Note 1 – NAS-513 requires two slots on washer sizes -4, -5, and -6. It is common practice to utilize 4 slots at 90°, on all other sizes. An option of 8 slots, at 45°, is available for some of the larger sizes.

Note 2 – On rod end designs incorporating a single lubrication fitting, it is standard practice to locate the fitting to the left of the keyway.

TABLE I
KEYWAY &
KEYSLOT DIMENSIONS

WASHER DASH No. (REF)	TERMINAL THREAD	W + .005 - .000	Y + .005 - .000	Z + .000 - .005
4	2500-28UNJF-3A	.062	.056	.201
5	.3125-24UNJF-3A	.062	.056	.260
6	.3750-24UNJF-3A	.093	.056	.311
7	.4375-20UNJF-3A	.093	.069	.370
8	.5000-20UNJF-3A	.093	.069	.436
9	.5625-18UNJF-3A	.125	.077	.478
10	.6250-18UNJF-3A	.125	.077	.541
12	.7500-16UNJF-3A	.125	.077	.663
14	.8750-14UNJF-3A	.156	.086	.777
16	1.0000-14NS-3A	.156	.094	.900
18	1.1250-12UNJF-3A	.187	.094	1.010
20	1.2500-12UNJF-3A	.187	.116	1.136
22	1.3750-12UNJF-3A	.250	.116	1.236
24	1.5000-12UNJF-3A	.250	.116	1.361
26	1.6250-12UNJ-3A	.250	.129	1.477
28	1.7500-12UNJ-3A	.312	.129	1.589
30	1.8750-12UNJ-3A	.312	.129	1.714
32	2.0000-12UNJ-3A	.312	.129	1.839
34	2.1250-12UNJ-3A	.312	.129	1.955
36	2.2500-12UNJ-3A	.312	.129	2.080

Note 3 – Many rod end designs are developed on the premise of obtaining maximum thread length in a particular size and configuration. Thus, not all external threaded rod ends have adequate shank length to accommodate the NAS-559 length beyond thread requirement. However, keyway length always exceeds thread length and will allow positive locking when used with NAS-513 lock washers. The keyway and keyslot dimensions corresponding to the NAS-513 lock washer are shown in Table I.

CONSTRUCTION

Shafer designs provide high load carrying capacity and low friction even under substantial misalignment. The self-aligning feature is accomplished by the hourglass shaped concave rollers aligning themselves on the spherical race of the inner ring.

SINGLE ROW BEARINGS

Shafer single row aircraft bearings are made in both annular outer ring and rod end types, and are designed primarily for radial load applications. Refer to Figures 3 and 5.

The inner ring of single row bearings is designed to serve as a raceway, and also to provide misalignment stops which prevent damage to the seals. Refer to Figure 3.

DOUBLE ROW BEARINGS

Shafer double row aircraft bearings are also available in both annular outer ring and rod end types. Both incorporate a double row outer ring, two sets of rollers with a prong type retainer and a spherical inner ring. Several double row styles are available in the bearing listings; selection depends upon the requirements of the application and the installation. Refer to Figures 4 and 6.

SPECIAL DESIGNS

Because of the demanding needs of the aerospace industry, a great number of special bearing configurations have been designed. If the aerospace designer is unable to find a bearing configuration fulfilling his requirements, he should consult his Rexnord sales engineer.

MATERIALS

Materials used in the manufacturing of Shafer bearings can be selected to meet bearing performance requirements over a wide range of conditions.

STANDARD TEMPERATURES

Roller bearings listed in this catalog are designed with materials suitable for continuous operation at temperatures between -65°F. and + 180°F., and intermittent operation up to 200°F.

However, standard modifications to catalog bearings can be used in temperature applications up to + 300°F. Refer to Table II for materials used throughout the temperature range of -65°F. to + 300°F.

RINGS AND ROLLERS

These components are made from one of two general types of bearing quality steel. Both types must meet rigid quality assurance tests for uniformity of micro-structure and other metallurgical properties. The two types commonly used are: (1) a through-hardened, high carbon, chrome alloy steel; and (2) a case hardened, carburizing grade of low alloy steel. Examples of these materials are AISI E52100 and 9310 bearing quality steel.

Processing of the rings and rollers includes heat treating in atmospherically controlled furnaces to insure fatigue and wear resistance, toughness, and dimensional stability needed in normal operating conditions.

ROD ENDS

Rod ends are generally made from a carburizing grade alloy steel. Examples of this type material are AISI 4620, 8620 and 9310. The inside of the eye is case hardened.

RETAINER

Retainer material for double row bearings normally is beryllium copper, SAE 660, or equivalent. These materials provide the required physical properties in the temperature range of -65°F to +300°F

SLEEVE AND COLLARS

The material selected to provide the required structural strength for these components is AISI 4140 steel or equivalent.

SEALS AND SHIELDS

The seal material used in the standard line of bearings is Buna-N. In addition, Hytrel* and TFE-impregnated fiberglass seal materials are available where better resistance to fluids such as "Skydrol" is required. The TFE-impregnated fiberglass seal can also be used in elevated temperature applications.

Shields are normally made from 400 series stainless steel.

ELEVATED TEMPERATURES

The bearings in this catalog, when equipped with TFE-impregnated fiberglass seals, can be operated at temperatures exceeding 300°F, providing they have been properly stabilized for those temperatures. However, at such temperatures, the rated bearing capacity must be reduced. Contact Rexnord for other material recommendations for operating temperatures above 300°F

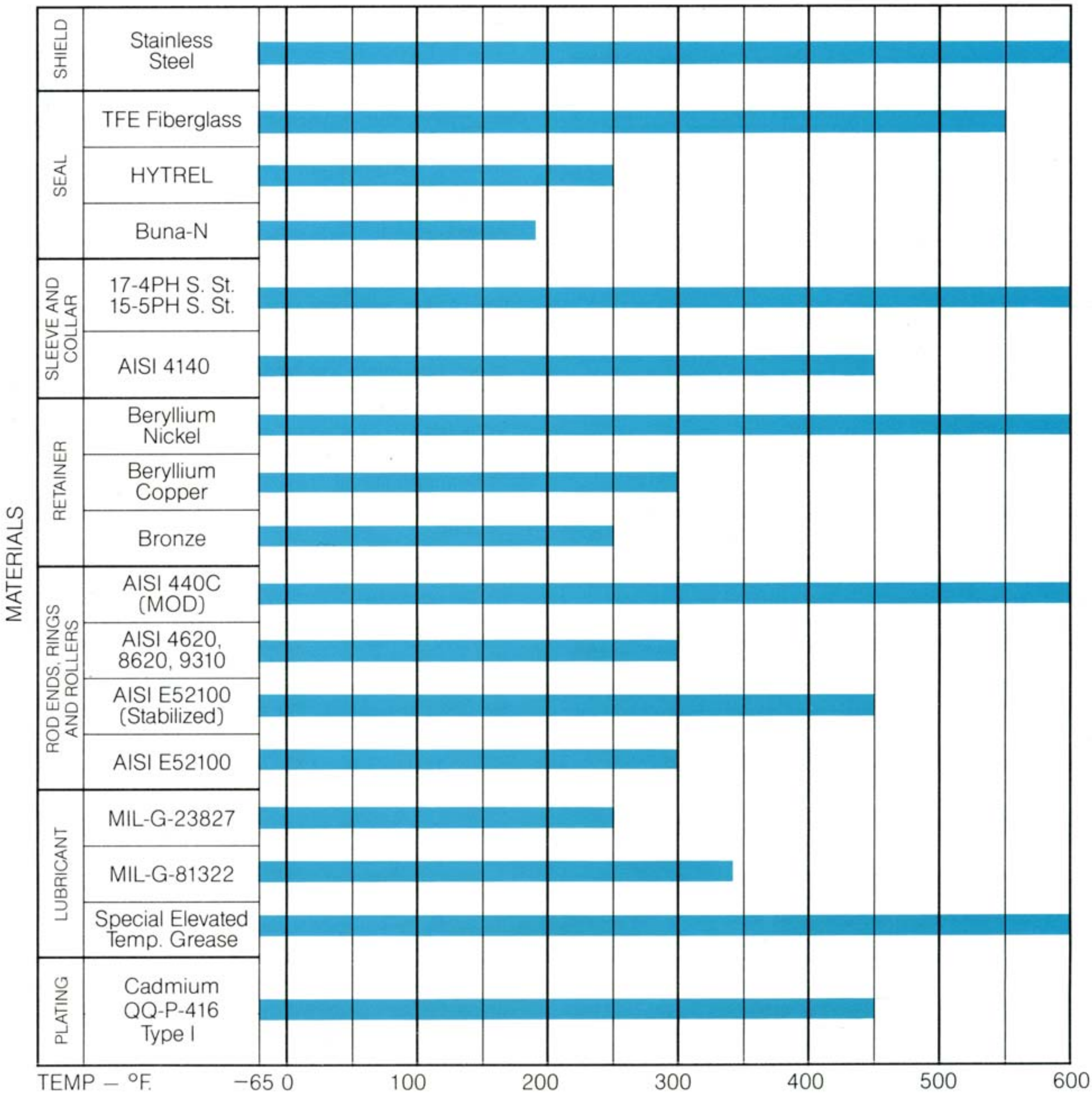
Special materials have been used in bearings operating in high temperature applications. An annular outer ring series of elevated temperature bearings has been developed for continuous duty up to 550°F. These bearings are dimensionally interchangeable with the standard catalog bearings and, by virtue of special processing techniques, the capacity ratings are the same. Refer to Table II for materials used throughout the temperature range of + 300°F. to + 600°F.

A typical material selection for a special elevated temperature application is shown below:

Rings – 440C Modified
Roller – 440C Modified
Retainers – Beryllium Nickel
Sleeves – 17-4 PH Stainless
Collars – 17-4 PH Stainless
Seals – TFE – Fiberglass
Shields – 430 Stainless
Lubrication – Special Elevated Temperature Grease

Because of the variety of conditions that can exist, such as extreme vibration, etc., materials listed for elevated temperature bearings may not be acceptable in all high temperature applications. Consult your local Rexnord sales engineer for additional information concerning catalog bearings, or special materials to be used in high temperature applications.

Table II
MATERIALS USED AT TEMPERATURES FROM -65°F. TO +600°F.



LOAD RATINGS

The roller bearings listed in this catalog are normally used on flight control systems where oscillation is the primary type of bearing motion. Therefore, the dynamic ratings listed are based on oscillatory rather than full rotational service.

Three load ratings are pertinent to anti-friction airframe bearings: limit load, dynamic load, and ultimate load either radial or axial.

LIMIT LOAD RATING

The basic load rating for a Shafer roller bearing is the limit load. This is defined as the maximum static load that can be applied to the bearing without seriously affecting the predicted life or performance. Loading the bearing beyond the limit load accelerates failure. When overloading occurs, the expected life of the bearing is no longer predictable.

DYNAMIC LOAD RATING

The dynamic rated load is the unidirectional load that can be carried by a bearing for an average of 10,000 cycles (or L10 = 4,000cy) of 90° oscillation before spalling (evidence of contact fatigue) occurs. The angle of oscillation is defined as 180° of angular travel within an included arc of 90°. Refer to oscillation angle Figures 9 and 10.

ULTIMATE LOAD RATING

The ultimate load rating, a function of the limit load rating, is defined as the load which can be applied and held for three minutes without structural failure of the bearing. Actual fracture usually occurs at a load level substantially higher than the ultimate load rating.

The ultimate load rating is calculated as the limit load rating multiplied by a factor of 1.5. In application, brinelling will occur on the race surface if subjected to a load equal to the ultimate load rating. The bearing will still be operative even though the races may be brinelled, but the bearing should be replaced.

DESIGN CONSIDERATIONS

LOAD-LIFE RELATIONSHIP

As defined earlier, the dynamic load rating for Shafer roller bearings is that load which results in an average life (L50) of 10,000 cycles at 90° oscillation. In most aerospace applications, the dynamic (applied) operating load is much less than the rated load for the bearing. It is then necessary to determine bearing life based on the applied load. The load-life equation listed below can be used to calculate bearing life at any load (Pe).

Average bearing life L_{50} signifies that 50% of a given group of bearings will survive 10,000 cycles at the rated dynamic load. In cases where higher performance reliability is required, L_{10} is often used. The L_{10} life means that of a given group of bearings, 90% are expected to survive. The relationship between L_{50} and L_{10} is approximately 2½ to 1. Therefore, if the L_{50} life is 10,000 cycles, the L10 life would be 4,000 cycles, at the rated dynamic load.

$L_{50} = (D.L./P_e)^{3.67}$ x 10.000 cycles
$L_{10} = (D.L./P_e)^{3.67}$ x 4,000 cycles
where: D.L. = The dynamic load rating.
P_e = The effective dynamic operating load.

FRICTION AND TORQUE

The coefficient of friction varies with load, motion, lubrication, and temperature. However, for the purpose of calculating torque it is normally acceptable to use a constant value. The coefficient of friction for roller bearings listed in this catalog will vary between .006 and .011. The majority, however, have a coefficient of friction of approximately .009.

The following mechanical and environmental considerations can affect the amount of starting and running torque of bearings in given aerospace applications.

1) Bearing configuration and internal geometry
2) Seal arrangement and material. 3) Bearing internal fit.
4) Housing and shaft fits. 5) Load
6) Motion
7) Lubricant
8) Temperature

Starting (breakaway) torque on a loaded bearing is a function of the coefficient of friction, the applied load and the roller pitch radius. The following equation can be used to estimate the starting and running torque under load:

$$T = \mu \times P_e \times \frac{(\text{Bore} + \text{O.D.})}{4}$$

where:

T = Torque (inch pounds)
μ = Coefficient of friction (.011 for a single bearing system and .009 for a multiple bearing system).
P_e = Equivalent Radial Load (lb.)

The no-load torque for a standard clearance type bearing is due primarily to seal friction and grease resistance. Single row bearings generally have 3 in. – oz. maximum at room temperature.

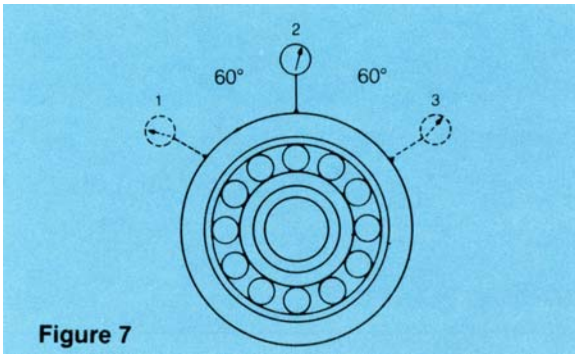


Figure 7

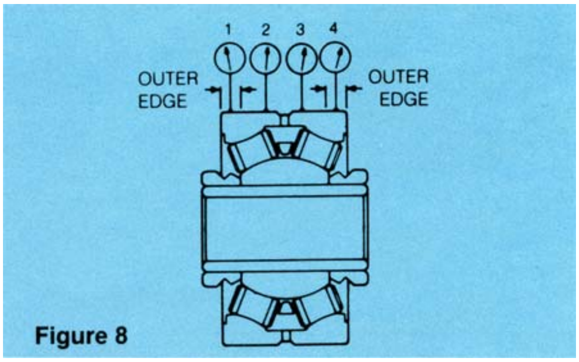


Figure 8

NOTE: Multiple measurements (1, 2, 3) should be taken to determine actual diameter sizes, then averaged to determine mean diameter

NOTE: Measurements in the outer edge area (positions 1 and 4) must meet the D_{min} and D_{max} limits only. Measurements at positions 2 and 3 must meet the limits of D_{min} and D_{max} and must average within the listed Mean Diameter tolerance.

BEARING DIAMETER ROUNDNESS LIMITS

Shafer aerospace roller bearing tolerances are patterned after RBEC-1 tolerance class of AFBMA standards. The inspection practices mentioned below are in accordance with this standard.

It is commonly accepted by bearing users and manufacturers that a slight out-of-roundness may develop during manufacture or assembly of annular rolling element bearings, particularly on bearings having a thin cross-section. This out-of-roundness means that a single diameter measurement cannot be used to determine whether or not the diameter meets the specified limits shown in the bearing listings. Instead, the following inspection procedure should be used.
The diameter of the bearing should be measured at three equally spaced points around the circumference of the bearing in order to establish the minimum and maximum measured diameter (see Figure 7). Similar measurements should be made in several radial planes across the width of the bearing (see Figure 8).

The mean (average) diameter can be determined from the minimum and maximum measured diameters by using the following formula:

$$D_{mean} = \frac{D_{min} + D_{max}}{2}$$

The calculated mean diameter should be within the specified diameter limits shown in both the bearing listings and in Table III. The maximum and minimum measured single point diameters in a given plane may be outside the mean diameter limits by the accepted amount shown in Table III.

When shields or internal snap rings are inserted into the outer ring they exert radial pressure against the edges, creating an oversize and out-of-round condition. This condition is elastic; therefore it is not objectionable, since the outer ring of the bearing will assume the shape of the housing when installed. The outer edge (located at each face and extending inwardly a distance equal to 3.5 times the size of the chamfer or corner radius -- see Figure 8) is not subject to the mean diameter requirements. Only the minimum/ maximum diameter tolerances should be applied.

Although the values shown in Table III are primarily concerned with annular outer ring bearings, the bore limits should be applied to rod end bearings also.

Table III
BEARING ROUNDNESS LIMITS

			BORE LIMITS				O.D. LIMITS			
			Roundness Acceptance Limits				Roundness Acceptance Limits			
BEARING TYPE	BASIC (NOMINAL) DIAMETER			Mean Diameter (From Bearing Listings)				Mean Diameter (From Bearing Listings)		
	Over	Incl.	D_{min}	Low	High	D_{max}	D_{min}	Low	High	D_{max}
Other Than Torque Tube		2.0000	- .0005	- .0005	+ .0000	+ .0001	- .0008	- .0005	+ .0000	+ .0003
	2.0000	4.0000	- .0007	- .0007	+ .0000	+ .0002	- .0012	- .0007	+ .0000	+ .0005
	4.0000	7.0000	- .0010	- .0010	+ .0000	+ .0003	- .0018	- .0010	+ .0000	+ .0008
	7.0000	10.0000					- .0024	- .0013	+ .0000	+ .0011
Torque Tube		1.0000	- .0008	- .0005	+ .0000	+ .0003				
	1.0000	2.0000	- .0011	- .0008	+ .0000	+ .0003	- .0020	- .0010	+ .0000	+ .0010
	2.0000	4.0000	- .0014	- .0011	+ .0000	+ .0003	- .0021	- .0011	+ .0000	+ .0010
	4.0000	7.0000	- .0016	- .0012	+ .0000	+ .0004	- .0022	- .0012	+ .0000	+ .0010
	7.0000	10.0000	- .0018	- .0013	+ .0000	+ .0005	- .0025	- .0013	+ .0000	+ .0012
	10.0000	13.0000	- .0020	- .0014	+ .0000	+ .0006	- .0028	- .0014	+ .0000	+ .0014

Table IV
INTERNAL BEARING FIT – STANDARD BEARINGS

BEARING TYPE	BEARING O.D.		RADIAL CLEARANCE		RADIAL PRELOAD
	OVER	INCL.	STANDARD	REDUCED	
ANNULAR BRGS. Other Than Torque Tube Type	–	2.0000	.0006-.0014	.0002-.0010	3% - 7% of Radial Limit Load Rating
	2.0000	4.0000	.0008-.0016	.0004-.0012	
	4.0000	7.0000	.0010-.0020	.0006-.0016	
	7.0000	10.0000	.0013-.0023	.0009-.0019	
ANNULAR Torque Tube Type	All Sizes		.0004-.0010	.0002-.0006	–
ROD ENDS	All Sizes		.0002-.0010	ZERO-.0006	4% - 8% of Radial Limit Load Rating

All dimensions in inches

BEARING INTERNAL FIT – UNMOUNTED

The internal fit of a bearing describes the amount of freedom (clearance) and/or restriction of the rollers between the inner and outer rings. Generally, when bearings are mounted in a housing, there is a reduction in the amount of clearance within the bearing. Standard internal clearances for annular outer ring bearings have been selected so that when they are mounted in accordance with recommended housing bore tolerances, they will have the proper operating fits for most applications.

Rod ends have the same internal construction as annular bearings. However, because they have a self-contained housing, there is no need to compensate for a reduction in the amount of internal clearance. Consequently, radial clearances are slightly less for rod end bearings.

Preload refers to a condition where, in the absence of an external load, the rollers are under compression between the inner and outer rings. A preload is recommended to minimize the effects of vibration and to reduce internal displacement of the bearing under reverse loading conditions. It should be noted that it is normal for a preloaded bearing to feel rougher than a clearance fit bearing when rotated by hand.

Table IV specifies the numerical limits of radial internal clearances and preload for various sizes and configurations of Shafer roller bearings.

USEFUL LIFE

The useful life of anti-friction bearings under dynamic rating conditions (oscillation at 90° included angle) is limited by surface contact fatigue, commonly referred to as spalling. Most airframe applications tolerate extensive spalling due to slow oscillatory motion and good guidance of the hourglass rollers. Initial spalling correlates to an equivalent "wear" of about .003 inch in a given load direction.

If the lubricant film degenerates for any reason, deterioration of the race surfaces will likely occur. In this situation surface wear increases rapidly, with wear debris accumulating within the bearing. This type of failure, called fretting, usually occurs because the lubricant film has not been replenished due to insufficient bearing motion.

Some degree of fretting is found in most airframe roil- ing element bearings when they have reached the end of their expected life. Fretting may sometimes be referred to as false brinelling, because of the visual resemblance to brinelling.

LUBRICATION

Bearing lubrication serves many functions, such as: reducing wear, friction and fretting, and minimizing chemical corrosion. The roller bearings shown in this catalog are pre-packed with grease that conforms to Specification MIL-G-23827. Other types of greases are available for special applications. For example, MIL-G- 81322 dramatically reduces fretting above +20°F.

INSTALLATION

The method of bearing installation and the preparation of the housing can have a direct influence on bearing performance. Please refer to the Installation section for information on housing bore tolerance and roundness recommendations.

FACTORS AFFECTING BEARING PERFORMANCE

LOAD

Aerospace bearings rarely experience a constant unidirectional load. The direction and magnitude of the load may vary in an infinite number of combinations. The selection procedure on Page A10 will enable the designer to evaluate his application for the proper bearing selection.

All load ratings are based on pure radial or pure axial capacity. When radial and axial loads occur simultaneously, they must be combined to produce an equivalent radial load. This value is then used in making the bearing selection.

MOTIONS

Bearing life, based on race surface contact fatigue -- the assumed mode of failure – is a function of the number and magnitude of contact stresses at any given point on the race surface. Since the internal design of the bearing and the angle of oscillation determine the number of contact stresses, it becomes necessary to evaluate the effects of the degree of oscillatory motion upon the rated bearing life. Basically, the evaluation of the effect of the oscillation angle can be divided into two categories, separated by the fretting threshold angle:

1. **Angles of oscillation above 25° included angle.** Failure is usually due to contact fatigue, in which case the life of the bearing is predictable. Generally speaking, bearing life expectancy will increase as the angle of oscillation approaches 25°, from the rated oscillation of 90° included angle.

2. **Angles of oscillation below 25° included angle.** Ordinarily failure is due to fretting, in which event bearing life is less predictable. At these lower angles of oscillation, adjacent roller paths do not overlap. Therefore there is less opportunity for adequate redistribution of grease, and eventually the oil film will starve, resulting in metal-to-metal contact between the roller and the raceways. Fretting is primarily wear.

It is advantageous to relubricate the bearing frequently to avoid possible fretting. Also, circulation of grease in the bearing can be greatly assisted if the oscillation angles under 25° are interspersed with angles of motion above 25°.

OSCILLATION ANGLE (DUTY CYCLE)

In many areas of the catalog the term "cycle" is used to express either a rated or required bearing life. For roller bearings a rated cycle is defined as 180° of angular travel within a fixed included arc of 90°. The angular travel can be generated in the manner shown in either Figure 9 or 10.

A required cycle or duty cycle can experience variances in load and movement, depending upon the application. To properly select the bearing, the designer must clearly define the duty cycle and the relationship between the bearing movement (angle of oscillation) and the applied load. This information is necessary in order to accurately determine the effects of load and motion on bearing life. Figures 11 and 12 represent typical duty cycles and show the method used in explaining the relationship between load and motion in a given application.

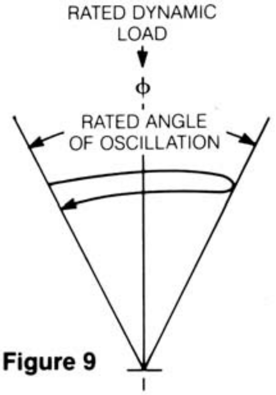


Figure 9

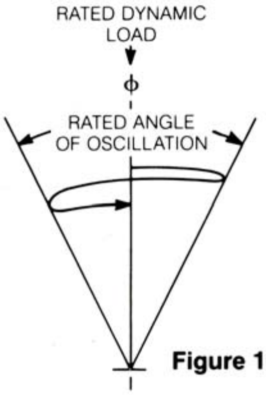
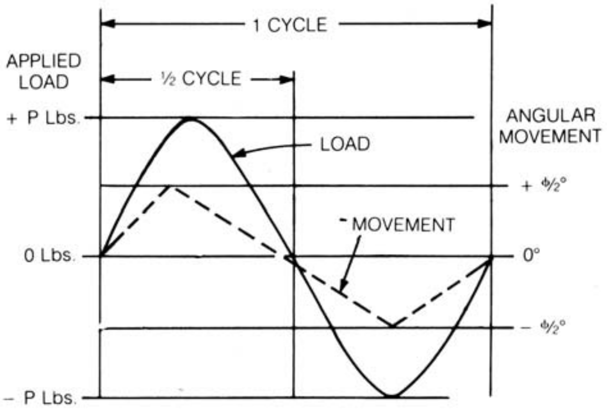
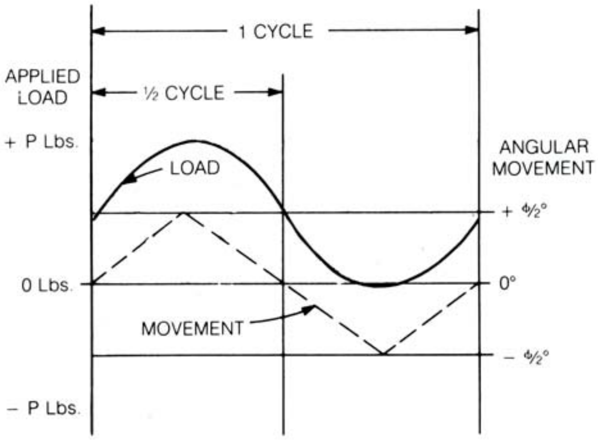


Figure 10



One cycle involves a reversing load and 2φ° angular travel within an included arc of φ°.

Figure 11



One cycle involves a non-reversing load and 2φ° angular travel within an included arc of φ°.

Figure 12

SELECTION PROCEDURE

The following selection procedure is recommended for determining the minimum required radial dynamic load rating. Once this value has been determined, the appropriate bearing listings may be examined to find the smallest bearing to do the job.

The procedure can also be used to calculate the required dynamic radial rating of rod end roller bearings. Whenever there is any question on the fatigue requirements of the rod end structure, consult your local Rexnord sales engineer.

Symbols:

- C_y = Total cycles required
- $D.L._r$ = Radial dynamic load rating — lbs.
- F_a = Applied axial load — lbs.
- F_r = Applied radial load — lbs
- K_o = Oscillation factor — see Figure 13
- $L.L._a$ = Axial limit load rating — lbs.
- $L.L._r$ = Radial limit load rating — lbs.
- P = Equivalent radial dynamic load at 90° oscillation — lbs.
- P_1 = Individual equivalent radial dynamic load representing one condition in the spectrum — lbs.
- P_c = Equivalent radial dynamic load, mean value from combining F_a and F_r — lbs.
- P_e = Equivalent radial dynamic load representing the various loads in the spectrum — lbs.
- f = Number of cycles, at one condition, divided by the total spectrum cycles.
- φ = Included angle of oscillation — degrees.

STEP 1. DETERMINE THE EQUIVALENT RADIAL DYNAMIC LOAD

$$P_C = F_r + 2.5\,F_a$$

This equation combines thrust and radial loads. If the thrust component is more than 30% of the radial load, consult your local Rexnord sales engineer. Single row bearings can carry momentary or intermittent thrust loads, but are not designed for continuous thrust. Therefore, for applications involving dynamic thrust loads, use double row bearings.

Note: If multiple operating conditions exist, they should be considered separately under Steps 1 and 2, and then summarized in Step 3.

STEP 2. DETERMINE EQUIVALENT RADIAL DYNAMIC LOAD AT 90° OSCILLATION

$$P = K_o\,P_c$$

When oscillation is restricted to less than 20° included angle, lubrication may become a limiting factor, in which case fretting damage can shorten useful bearing life. The K_o values, on the low oscillation range of Figure 13, are intended for initial selection. Refer to Duty Cycle, Page A9, for a description of the angle of oscillation. Actual performance in this range of small motions may vary considerably with each application.

STEP 3. DETERMINE EQUIVALENT RADIAL DYNAMIC LOAD REPRESENTING SPECTRUM LOADING (IF APPLICABLE)

$$P_e = (P_1^{3.67}\,f_1 + P_2^{3.67}\,f_2 + \ldots . P_n^{3.67}\,f_n)^{.273}$$

This equation is used only when various load levels exist. If only one dynamic load level occurs, then P becomes P_e and Step 4 can be completed.

STEP 4. DETERMINE THE REQUIRED RADIAL DYNAMIC LOAD RATING

$$D.L._r \geq P_e\,(C_y \div 10{,}000)^{.273}$$

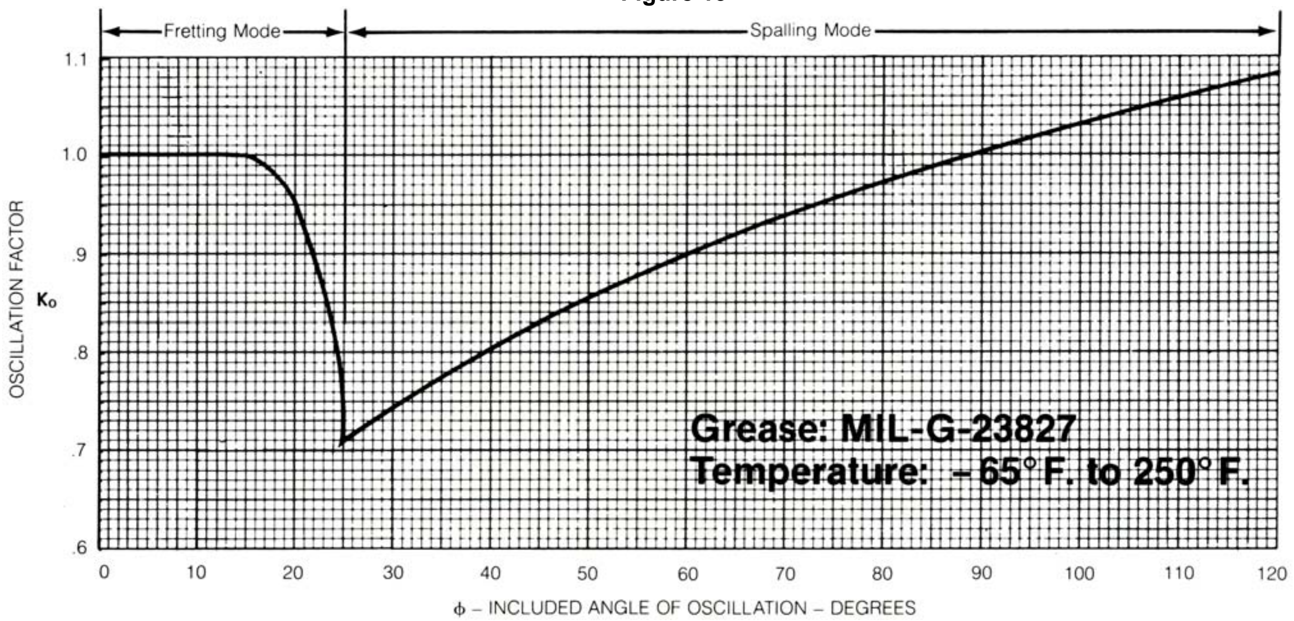
Average life (L_{50}) is assumed here. If a 90% (L_{10}) survival is desired, then substitute 4,000 for 10,000 in the equation.

STEP 5. SELECT A BEARING MEETING THE DYNAMIC LOAD REQUIREMENTS FROM THE BEARING LISTINGS

STEP 6. CHECK STATIC LOAD RATINGS OF BEARING SELECTED

The limit load ratings shown on the bearing listings must be equal to or larger than the maximum applied static loads. Both radial and axial limit load ratings ($L.L._{r}$ and $L.L._{a}$) must be considered.
The ultimate load rating is calculated as 1.5 times the limit load rating ($L.L._{r}$ or $L.L._{a}$).

Figure 13



SAMPLE PROBLEM

GIVEN:

The bearing will experience a unidirectional steady load of 5,000 pounds radial (no thrust), oscillating through an included angle of 60° at 20 cycles per minute. An annular bearing, with the inner ring extended for mounting purposes, is desired. The bearing will be located in a protected environment, subject to ambient temperatures of -65°F. to 180°F. Grease relubrication will be required. The maximum misalignment in the application will be 6°. The largest static load which will occur in normal service is 7,000 pounds, but the bearing must not fracture under a load of 9,500 pounds. It is required that 90% of the bearings should provide a minimum life of 150,000 cycles. The mini- mum bolt size is ½”.

SOLUTION

(1) Since there is no thrust, P_c = 5,000 lbs.

(2) $P = K_oP_c$ = (.9) (5,000) = 4,500 lbs.
Note: K_o from Figure 13.

(3) Since there is only one dynamic load, P_e = 4,500 lbs.

(4) $D.L._{r} \geq P_e \quad (C_y \div 4000)^{.273}$

Note: 4,000 cycles is used to predict 90% survival.

$D.L._{r}$ (4,500) $(150{,}000 \div 4{,}000)^{.273}$ = 12,100 lbs.

(5) From the bearing listings, the bearing meeting both the radial dynamic load rating ($D.L._{r}$) and the configuration requirements is DAS8-32A. Refer to Page A21 of the roller bearing listings.

(6) The limit load rating ($L.L._{r}$) is greater than or equal to 7,000 lbs. The ultimate load rating ($U.L._{r}$) is greater than or equal to 9,500 lbs.

Table V

ITEM	APPLICATION REQUIREMENTS	DAS 8-32A
Dynamic load rating ($D.L._{r}$)	12,100 lbs.	15,800 lbs.
Limit load rating ($L.L._{r}$)	7,000 lbs.	19,100 lbs.
Ultimate load rating ($U.L._{r}$)	9,500 lbs.	28,600* lbs.
Self-Alignment	+ 6°	+ 10°
Boundary	½ ” Min. Bore	.5000
Mounting	Extended Inner RIng	O.K.
Temperature	- 65° F. to 180° F.	Standard Brg. O.K.
Contamination	Clean	
Weight	—	.73 lbs.

* 1.5 X $L.L._{r}$

COMPLEX LOAD-MOTION APPLICATIONS

Many applications involve a mix of loads and motions. As an example, primary flight control systems experience continuously changing forces and angular motions. Figure 14 shows a flight simulation example, oversimplified but helpful in illustrating one method of specifying load-motion spectra. Once such a spectrum is defined by the airframe designer, Rexnord can determine the dynamic load requirements for the bearing.

An equally acceptable method for specifying the Figure 14 load-motion spectrum is shown in Figure 15 as duty cycles. In either approach it is necessary to define the applied forces on the bearing as it is moved through angular motion. The primary control surface angle vs. resistance movement is, in itself, not sufficient detail to describe the bearing job.

Figure 16 graphically shows the relationship between the load and angular motion of the application in Figure 14. It is clear that the pull side of the bearing is more demanding than the push side. The concept of push and pull load directions is important also for the structural design aspects of rod ends.

The required DL_r for a bearing in this application to last one complete airplane life is 44 KIPS on an L10 basis. This takes into account the mix of motions which produce both spalling and fretting damage. Without the advantage of the large sweeping motions, condition 1, the required DL_r > 63 KIPS.

Figure 17 shows the effect of both load and angular motion on the required DL_r. Note that halving all the angles of oscillation is actually more demanding (about 70 KIPS) in this case, than doubling all the angles. This is due to the increased influence of fretting at the smaller motions.

Such complex load-motion spectra should be referred to Rexnord for bearing sizing and life estimates.

Figure 14

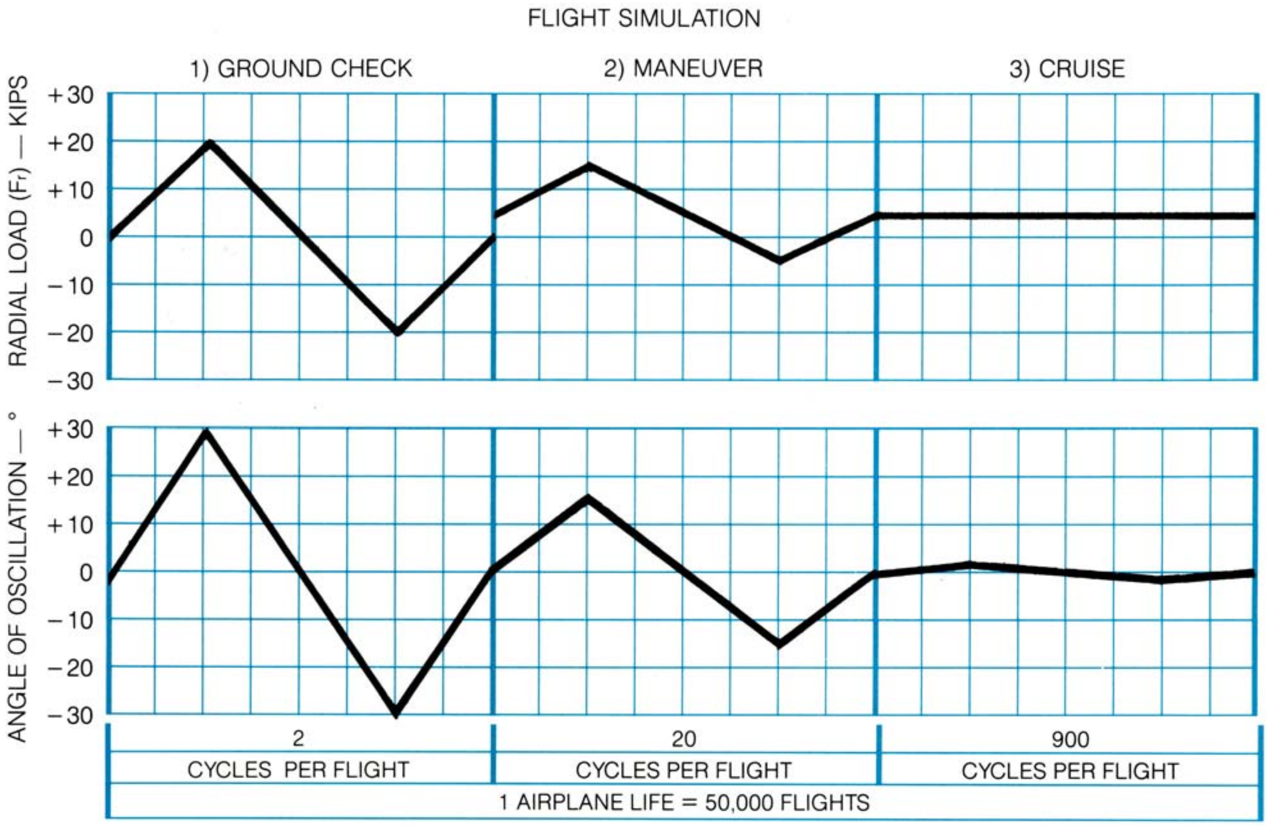


Figure 15

DUTY CYCLES FROM FIGURE 14			
Condition	Load Kips	Angle φ°	Cycles
1	+ 20 / - 20	+ 30 / - 30	100,000
2	+ 15 / - 5	+ 15 / - 15	1,000,000
3	+ 5 / + 5	+ 2 / - 2	45,000,000

One Airplane Life = 46,100,000 Cycles

Figure 16

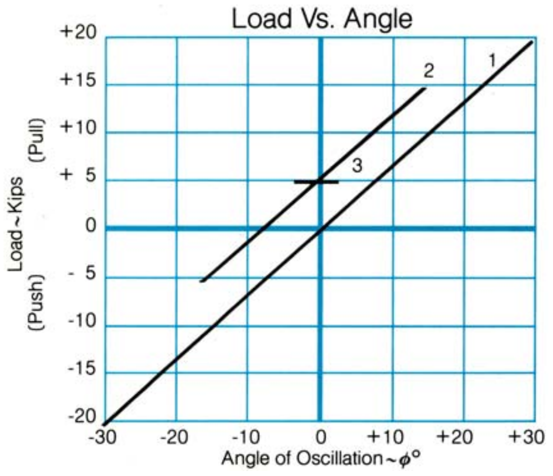
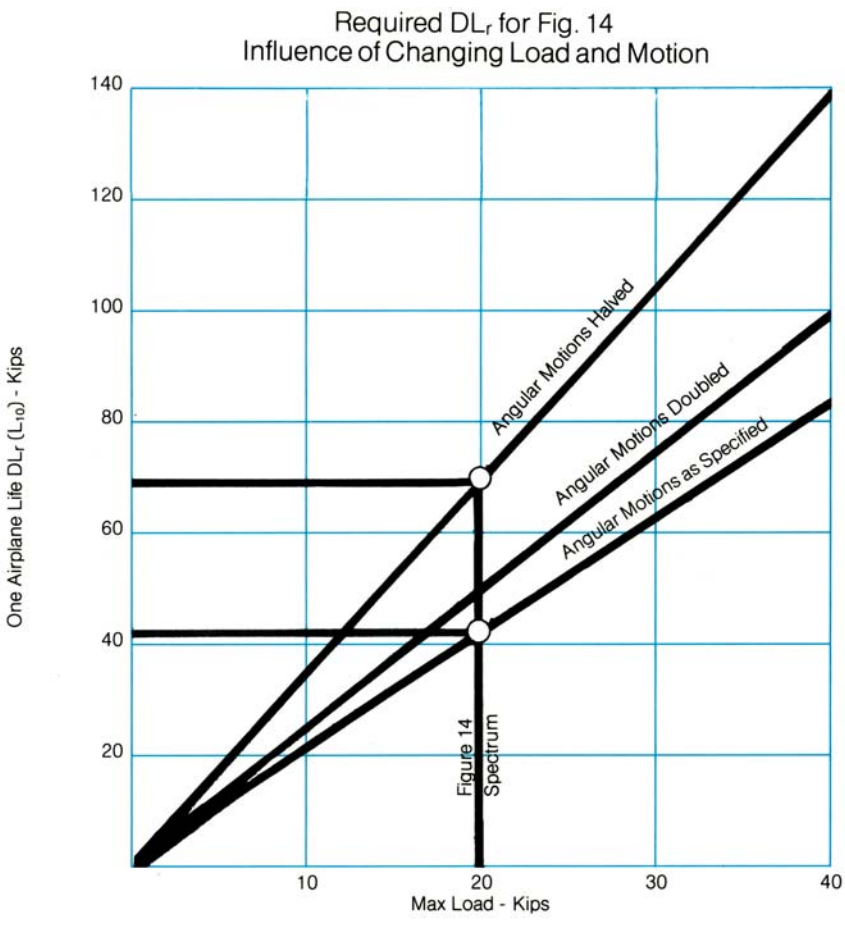


Figure 17



INSTALLATION

Bearing performance can be greatly affected by installation techniques and procedures. The following four items represent good practice for any type bearing:

(1) The installation area should be kept clean so that contaminants do not come into contact with the bearing.

(2) Assembly tools and fixtures should be maintained in good working condition.

(3) Bearings should be kept in their protective packaging until time of installation.

(4) The housing bore should be free from all metal chips, filings and other foreign material.

It should be noted that while the following installation recommendations can be used for most aircraft applications, it is generally the responsibility of the airframe manufacturer to establish the basic installation methods and techniques.

Airframe roller bearings for oscillatory service are customarily mounted with a clearance fit between the shaft or pin and the bore of the inner ring. With the exception of torque tube bearings (DAT series), the outer ring is press-fit into the housing and retained in the axial direction by swaging or other mechanical means. The axial restraint is especially significant when light alloy housings are used, due to the difference in thermal properties between the bearing and housing materials.

The roller contact angle of torque tube DAT series bearings is extremely low because of their narrow width. This results in a very low unmounted internal clearance. Therefore, press-fits should be avoided when mounting either the inner or outer rings in order to prevent a reduction in the already small amount of internal clearance.

The housing bore tolerances recommended in Table VI will usually result in a satisfactory installation when used in conjunction with the internal clearances shown in the bearing listings. It should be noted, however, that the final running fit within the bearing is dependent on many factors, such as the individual housing design, housing material, operating temperature, method and degree of axial restraint and the amount of interference or press between bearing and housing. Careful consideration should be given to all of these factors in order to obtain a suitable running fit within the bearing.

The outer ring sections of many annular bearings are thin enough to be distorted easily during factory assembly or installation. The final shape of these bearings depends largely on the roundness of the housing bore. See Table VI for recommended roundness of housing bores.

The normal fit-up practice for non-press or loose fits between the bearing and the housing requires that the tolerance range for the bearing O.D. be on the minus side of the nominal diameter and that the tolerance range for the housing bore be on the plus side of the nominal diameter. Thus, the resulting fit-up range is line-to-line to slightly loose. These tolerance ranges should be adjusted accordingly for those installations requiring a press-fit, and caution exercised when pre- loaded bearings are involved.

The normal fit-up between the inner ring bore and the shaft member should be no greater than line-to-line. The tolerances on standard NAS bolts will allow the proper fit-up conditions. In cases where NAS bolts are not used, the size tolerance on the shaft or pin should be equal to or smaller than the bearing bore tolerance shown in the bearing listings.

Table VI
HOUSING BORE TOLERANCE AND ROUNDNESS (IN INCHES)
FOR ANNULAR OUTER RING ROLLER BEARINGS

BEARING			HOUSING BORE		
STYLE	OUTSIDE DIAMETER		TOLERANCES*		ROUNDNESS (T.I.R.)
	OVER	INCL.	STEEL	LIGHT ALLOY	
Other Than Torque Tube Type	—	2.0000	-.0005 -.0010	-.0009 -.0014	.0004
	2.0000	4.0000	-.0007 -.0014	-.0011 -.0018	.0005
	4.0000	7.0000	-.0010 -.0020	-.0014 -.0024	.0006
Torque Tube Type (DAT Series)	—	2.0000	+.0008 -.0000	+.0006 -.0000	.0004
	2.0000	4.0000	+.0009 -.0000	+.0007 -.0000	.0005
	4.0000	7.0000	+.0010 -.0000	+.0008 -.0000	.0006
	7.0000	10.0000	+.0011 -.0000	+.0009 -.0000	.0007

* These tolerances should be applied to the nominal bearing O.D.

INSPECTION & MAINTENANCE

Routine inspection of Shafer roller bearings includes:

1. Visual
2. Roughness of rotation
3. Backlash or internal play

The allowables for Items 2 and 3 above are normally established by the airframe manufacturer, and may vary substantially depending on the requirements of individual applications.

Purge relubrication is recommended for most airframe applications, since the speeds of operation are relatively slow. Such procedure removes some dirty grease from the bearing cavity and tends to maximize the amount of grease left inside. The purpose of this type of relubrication is to maintain internal corrosion protection as much as to sustain a low friction.

The maximum interval between relubrications depends mostly on the application's exposure to fluids. A general rule is to relubricate every 4,000 flight hours or annually, whichever occurs first – as a minimum. Additional relubes may be necessary in some cases due to exposure. Small bearings have a smaller reservoir of grease and therefore usually need a shorter interval between relubes. Over-lubrication is essentially no threat to Shafer bearing performance in airframe service. However, caution should be used to limit the flow rate of greasing to .65 pounds of MIL-G-23827 per minute, to avoid building up excessive instantaneous pressure against the closures in the internal cavity. This flow rate is easily checked by weighing the discharged grease from the relube equipment involved for a measured period of time.

MARKING AND PACKAGING

The shields of Shafer Roller Bearings are marked with "Shafer," model number, and customer or military specification number, if applicable/space permitting. The bearings are sealed in a vented polyethylene bag and individually boxed. The boxes are marked with "Shafer," model number, grease type, assembly order number, date of lubrication and customer or military specification number, if applicable.

SHAFER NOMENCLATURE

```
XXX     000-000       XXO -000     X
 A        B    C         D     E     F
    X = LETTER    0 = NUMBER
```

A) Prefix This section describes the bearing configuration; maximum of three letters.

B) Bore This section indicates the nominal dimension of the bore to the nearest 1/16 inch; maximum of three digits.

C) O.D. or Shank Dia. This section either indicates nominal annular O.D. to the nearest 1/16 inch or the nominal rod end thread diameter (shank diameter for plain shank rod ends) to the nearest $^{1}/_{16}$ inch; maximum of three digits.

D) Dimension Modification This section consists of a three position alphanumeric character. One or two non-significant alphabetic characters differentiate, dimensionally, between bearings which have the same **A**, **B**, and **C** identification. The numeric indicator, one digit, is added when customer requests approval rights over bearing design, marking and/or nomenclature.

E) Bearing Modification Suffix This section indicates standard and non-standard modification of a bearing using the same A, B, C and D such as seal change, clearance change, material change, etc. (See page A 16.)

F) Left Hand Thread This section is to be used only with external and internal threads. The only letter that can be used is "L." This stands for left hand threads. No other letter or number can be used in this position. (Do not use "R" for standard right-hand threads.)

Examples Model Nos.	A	B	C	D	E	F
DAS5-20A	DAS	5	20	A	—	—
	Double Row Annular With Sleeve & Collars	5/16 Bore (5/16” Bore)	20/16 O.D. (1¼” O.D.)	Basic Bearing	Not Needed	Not Needed
DA10-32A1-4	DA	10	32	A1	4	—
	Double Row Annular Without Sleeve & Collars	10/16 Bore (5/8” Bore)	32/16 O.D. (2” O.D.)	Basic Bearing Plus Cust. Approval Rights	Standard Modification	Not Needed
SM12-18C3-506L	SM	12	18	C3	506	L
	Single Row Externally threaded R.E.	12/16 Bore (3/4” Bore)	18/16 O.D. (1$^{1}/_{8}$” Thd.)	Same as Above	Non-Standard Modification	Left Hand Thread
DPH9-16AD	DPH	9	16	AD	—	—
	Double Row Plain R.E. With Hollow Shank	9/16 Bore (9/16” Bore)	16/16 O.D. (1” Thd.)	Dimensions Differ From Basic Bearing	Not Needed	Not Needed

STANDARD MODIFICATION SUFFIX CATEGORIES

The table below lists "Suffix" categories which incorporate standard modifications to base bearings.
Example:
Model #DAS5-20A = Base bearing as listed on page A20

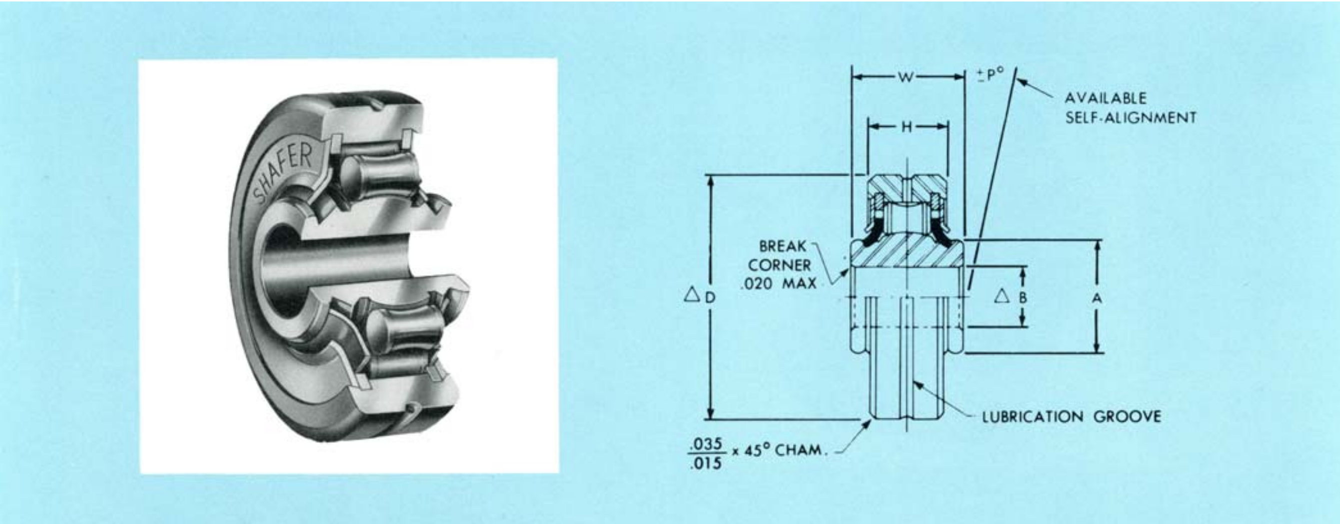
Model #DAS5-20A-7 = The "-7" suffix indicates this model includes a reduced internal bearing fit and TFE fiberglass seals.

While other modification combinations are possible, this table lists the most popular modifications.

Suffix Number	ROD ENDS & ANNULARS					ROD ENDS ONLY			
	Internal Brg Fit [*1]		TFE Fiber Glass Seal	Grease MIL-G-81322	Stainless Stl Slv	Two Lube Fittings [*2]	Keyway [*3]	Thd Rolled After H.T.	Thd Per MIL-S-8879
	Reduced	Preload							
1	■								
2		■							
3						■			
4			■						
5							■		
6	■					■			
7	■		■						
8	■						■		
9	■		■			■			
10	■					■	■		
11	■		■				■		
12	■		■			■	■		
13		■				■			
14		■	■						
15		■					■		
16		■	■			■			
17		■				■	■		
18		■	■				■		
19		■	■			■	■		
20			■			■			
21						■	■		
22			■				■		
23			■			■	■		
24			■			NONE	■		
25 [*4]			■			(1) Alemite 3019	■		
26	■		■			NONE	■		
27									■
28								■	
29								■	■
30			■			NONE	■	■	■
31			■			NONE			
32			■	■					
33			■	■		■			
34			■	■			■		
35			■	■		■	■		
36			■	■		NONE	■		
37			■	■		NONE	■	■	■
38			■	■		NONE			
39			■			■	■	■	■
40			■			■	■		■
41	■		■	■					
42				■					
43			■	■		NONE		■	■
44			■	■					■
45	■		■	■			■		
46	■			■					
47	■					NONE			
48			■		■				
49	■		■			NONE			
50	■			■		NONE			

[*1] Refer to Table IV Engineering Section.
[*2] Lube fittings located at junction of eye-to-shank (rod ends only).
[*3] Std. keyway will accept NAS 513 locking washer. See Figures 5 and 6. Engineering Section for standard location.
[*4] Applicable to double row rod ends over 1.500* eye O.D. only.

SA SINGLE ROW ANNULAR

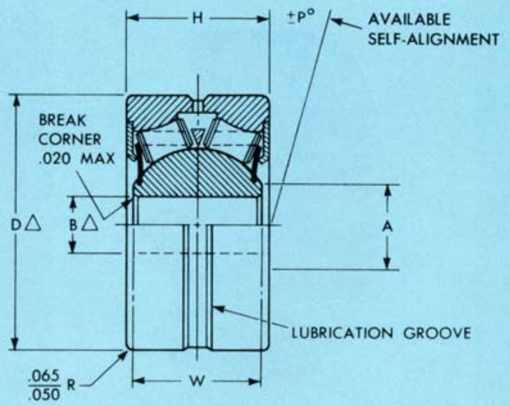


Model Number	MIL STD Identification: Model No. Suffix	MIL STD Identification: MS21431 Suffix	B +.0000 -.0005	D +.0000 -.0005	W +.000 -.005	H +.000 -.005	A □	P°	Internal Clearance Radial	Load Ratings – Lbs. Limit Radial	Load Ratings – Lbs. Limit Thrust	Load Ratings – Lbs. Dynamic Radial	Weight Lbs □.
SA3-16A	-32	-3	.1900	1.0000	.500	.344	.425	10	.0006-.0014	3,000	300	2,650	.07
SA4-14A	-32	-4A*	.2500	.9014.	.484	.335	.380	10	.0006-.0014	1,900	190	1,580	.05
SA4-14D	—	—	.2500	.8750	.313	.250	.520	5	.0006-.0014	2,060	200	1,710	.04
SA4-16A	-32	-4	.2500	1.0000	.500	.344	.425	10	.0006-.0014	3,000	300	2,650	.06
SA5-20A	-32	-5	.3125	1.2500	.558	.375	.550	10	.0006-.0014	4,210	420	3,490	.12
SA6-14A	-32	-6A*	.3750	.8750	.313	.250	.520	5	.0006-.0014	2,060	200	1,710	.04
SA6-23A	-32	-6	.3750	1.4375	.620	.469	.660	10	.0006-.0014	6,160	610	5,120	.17
SA6-24A	—	—	.3750	1.5000	.660	.578	.800	5	.0006-.0014	8,890	880	7,380	.16
SA7-24A	-32	-7	.4375	1.5000	.812	.625	.660	10	.0006-.0014	7,900	790	6,550	.30
SA8-26A	-32	-8	.5000	1.6250	.750	.687	.810	2.5	.0006-.0014	11,900	1,190	9,940	.37
SA9-26A	—	—	.5625	1.6250	.750	.687	.810	2.5	.0006-.0014	11,900	1,190	9,940	.35
SA10-18B	-32	-10 *	.6250	1.1250	.375	.315	.770	3.5	.0006-.0014	3,920	390	3,260	.06
SA16-32A	-32	-16 *	1.0000	2.0000	.812	.625	1.325	5	.0006-.0014	14,900	1,490	12,300	.48
SA22-44A	-32	-22 *	1.3750	2.7500 [1]	.650	.500	1.860	1	.0008-.0016	17,900	1,790	14,800	.64

Δ For roundness limits, refer to the engineering section
□ For reference only
* Pending MIL spec revision
Catalog dimensions may be subject to change or correction.
Please request certified prints for current and exact dimensions.

Size tolerance limits [1] +.0000 -.0007

DA DOUBLE ROW ANNULAR WITH SEAL GROOVES



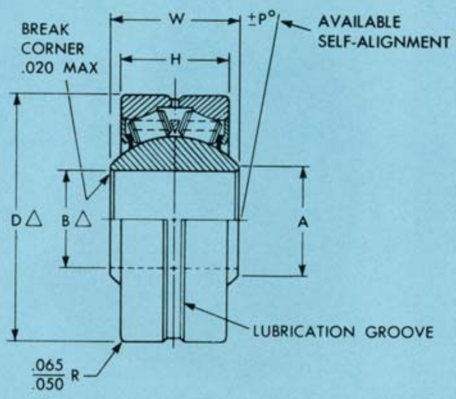
Model Number	B +.0000 -.0005	D +.0000 -.0005	W +.000 -.005	H +.000 -.005	A □	P° Mis.	Internal Clearance		Load Ratings – Lbs.			Weight Lbs. □
							Radial	Axial	Limit Radial	Limit Thrust	Dynamic Radial	
DA6-25A	.3750	1.5625	.766	.844	.540	5	.0006-.0014	.0016-.0036	12,300	7,100	10,200	.34
DA7-25A	.4375	1.5625	.766	.844	.540	5	.0006-.0014	.0016-.0036	12,300	7,100	10,200	.33
DA10-32A	.6250	2.0000	.875	1.000	.750	5	.0006-.0014	.0016-.0038	19,100	10,400	15,800	.63
DA12-38A	.7500	2.3750 [1]	1.062	1.125	.985	5	.0008-.0016	.0024-.0048	31,400	15,400	26,000	.97
DA14-42A	.8750	2.6250 [1]	1.125	1.250	1.050	5	.0008-.0016	.0025-.0049	38,300	18,600	31,700	1.31
DA17-48A	1.0625	3.0000 [1]	1.375	1.500	1.280	5	.0008-.0016	.0023-.0046	49,700	25,500	41,300	2.03
DA22-52A	1.3750	3.2500 [1]	1.250	1.125	1.735	5	.0008-.0016	.0036-.0072	57,600	19,000	47,800	1.92

∆ For roundness limits, refer to the engineering section
□ For reference only
Catalog dimensions may be subject to change or correction.
Please request certified prints for current and exact dimensions.

Size tolerance limits [1] +.0000 -.0007

DAL

DOUBLE ROW ANNULAR WITH SEAL FLATS

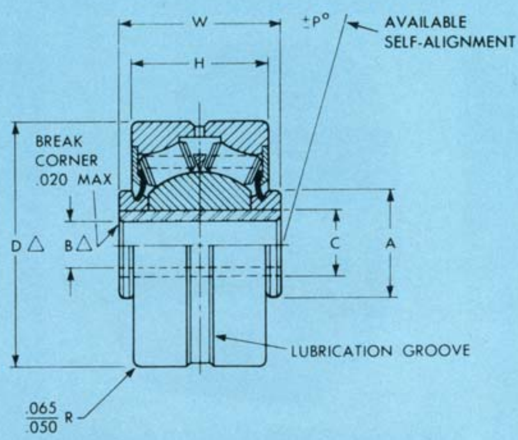


Model Number	B +.0000 -.0005	D +.0000 -.0005	W +.000 -.005	H +.000 -.005	A □	P° Mis.	Internal Clearance		Load Ratings – Lbs.			Weight Lbs. □
							Radial	Axial	Limit Radial	Limit Thrust	Dynamic Radial	
DAL7-32A	.4375	2.0000	1.000	1.060	.583	10	.0006-.0014	.0016-.0038	19,200	10,400	15,900	.90
DAL10-26A	.6250	1.6250	.775	.645	.807	16	.0006-.0014	.0025-.0058	7,150	2,560	5,940	.30
DAL10-26B	.6250	1.6250	.840	.645	.725	20	.0006-.0014	.0025-.0058	7,150	2,560	5,940	.31
DAL22-52A	1.3750	3.2500	1.250	1.125	1.735	5	.0008-.0016	.0036-.0072	57,600	19,000	47,800	1.92
DAL22-56A	1.3750	3.5000	1.630	1.570	1.558	2	.0008-.0016	.0026-.0052	76,800	35,000	63,700	3.53
DAL24-56A	1.5000	3.5000	1.570	1.570	1.611	2	.0008-.0016	.0026-.0052	76,600	34,900	63,600	3.40
DAL26-46A	1.6250	2.8510	1.125	1.005	1.740	5	.0008-.0016	.0036-.0072	42,900	14,200	35,600	1.24
DAL26-50A	1.6250	3.1250	1.125	1.000	1.925	5	.0008-.0016	.0041-.0082	50,900	14,700	42,200	1.35
DAL24-71A	2.1250 [1]	4.4380 [3]	2.000 [2]	2.000 [2]	2.481	4	.0010-.0020	.0031-.0061	99,100	48,000	82,300	4.50
DAL26-77A	2.5000 [1]	4.8000 [3]	1.655 [2]	1.655 [2]	2.855	2	.0010-.0020	.0047-.0093	124,000	39,300	102,000	5.88
DAL26-80A	3.0000 [1]	5.0000 [3]	2.060 [2]	1.995 [2]	3.290	2	.0010-.0020	.0037-.0075	126,000	50,400	104,000	6.72

∆ For roundness limits, refer to the engineering section
□ For reference only
Catalog dimensions may be subject to change or correction.
Please request certified prints for current and exact dimensions.

Size tolerance limits
[1] +.0000 -.0007
[2] +.000 -.008
[3] +.0000 -.0010

DAS DOUBLE ROW ANNULAR WITH SLEEVE & COLLARS



Model Number	MIL STD Identification: Model No. Suffix	MS28913 Suffix	MS28914 Suffix	B +.0000 -.0005	D +.0000 -.0005	W +.000 -.005	H +.000 -.005	A +.005 -.005	C □	P° Mis	Internal Clearance: Radial	Axial	Load Ratings – Lbs.: Limit Radial	Limit Thrust	Dynamic Radial	Weight Lbs.
DAS4-14A	-41	-4C	—	.2500	.9014	.625	.464	.450	.310	10	.0006-.0014	.0016-.0043	3,080	1,690	2,560	.06
DAS4-20A	-41	—	-4C	.2500	1.2500	1.0000	.750	.490	.380	10	.0006-.0014	.0014-.0039	7,590	4,300	6,300	.20
DAS4-20B	—	—	—	.2500	1.2500	1.125	.750	.490	.380	10	.0006-.0014	.0014-.0039	7,590	4,300	6,300	.21
DAS5-20A	-41	-5C	—	.3125	1.2500	.8120	.656	.520	.380	10	.0006-.0014	.0016-.0037	7,590	4,300	6,300	.17
DAS5-20C	—	—	—	.3125	1.2500	1.125	.750	.500	.380	8	.0006-.0014	.0014-.0034	7,590	4,300	6,300	.20
DAS5-25A	—	—	—	.3125	1.5625	1.125	.844	.670	.540	10	.0006-.0014	.0016-.0036	12,300	7,100	10,200	.37
DAS5-25B	-41	—	-5C	.3125	1.5625	1.187	.844	.670	.540	10	.0006-.0014	.0016-.0036	12,300	7,100	10,200	.38
DAS5-25C	—	—	—	.3125	1.5625	1.250	.844	.670	.540	10	.0006-.0014	.0016-.0036	12,300	7,100	10,200	.39
DAS6-23A	-41	-6C	—	.3750	1.4375	.937	.750	.610	.440	10	.0006-.0014	.0016-.0036	10,100	5,790	8,390	.25
DAS6-23B	-41	—	-6AC *	.3750	1.4375	1.000	.750	.610	.440	10	.0006-.0014	.0016-.0036	10,100	5,790	8,390	.26
DAS6-23C	—	—	—	.3750	1.4375	1.265	.750	.610	.440	10	.0006-.0014	.0016-.0036	10,100	5,790	8,390	.28
DAS6-25B	-41	—	-6C	.3750	1.5625	1.187	.844	.670	.540	10	.0006-.0014	.0016-.0036	12,300	7,100	10,200	.37
DAS6-25C	-41	—	-6BC *	.3750	1.5625	1.312	.844	.670	.540	10	.0006-.0014	.0016-.0036	12,300	7,100	10,200	.37
DAS6-26A	—	—	—	.3750	1.6250	1.000	1.000	.735	.500	2	.0006-.0014	.0013-.0031	16,580	11,600	13,760	.44
DAS7-32A	-41	—	-7C	.4375	2.0000	1.500	1.000	.920	.620	10	.0006-.0014	.0016-.0038	19,100	10,400	15,800	.74
DAS8-27A	-41	-8C	—	.5000	1.6875	1.000	.812	.820	.620	10	.0006-.0014	.0018-.0042	12,700	6,380	10,600	.40

∆ For roundness limits, refer to the engineering section
□ For reference only
* Pending MIL spec revision
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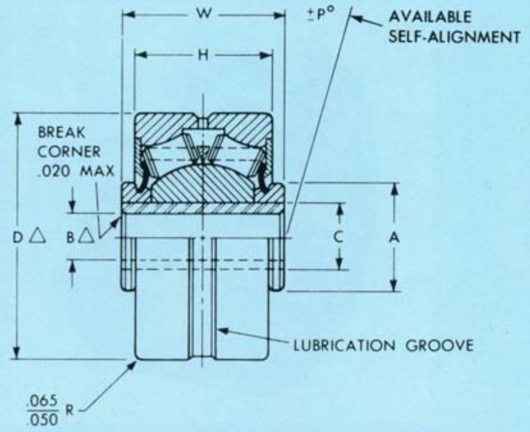
Please request certified prints for current and exact dimensions.

Size tolerance limits [1] +.0000 -.0007

DAS DOUBLE ROW ANNULAR WITH SLEEVE & COLLARS



Model Number	MIL STD Identification: Model No. Suffix	MS28913 Suffix	MS28914 Suffix	B +.0000 -.0005	D +.0000 -.0005	W +.000 -.005	H +.000 -.005	A +.005 -.005	C □	P° Mis	Internal Clearance: Radial	Axial	Load Ratings – Lbs.: Limit Radial	Limit Thrust	Dynamic Radial	Weight Lbs. □
DAS8-27B	-41	—	-8AC *	.5000	1.6875	1.500	.812	.820	.620	10	.0006-.0014	.0018-.0042	12,700	6,380	10,600	.60
DAS8-32A	-41	—	-8C	.5000	2.0000	1.500	1.000	.920	.620	10	.0006-.0014	.0016-.0038	19,100	10,400	15,800	.73
DAS8-32B	—	—	—	.5000	2.0000	1.625	1.000	.920	.620	10	.0006-.0014	.0016-.0038	19,100	10,400	15,800	.74
DAS9-38A	-41	—	-9C	.5625	2.3750[1]	1.687	1.125	1.000	.910	10	.0008-.0016	.0024-.0048	31,400	15,400	26,000	1.15
DAS9-38B	—	—	—	.5625	2.3750[1]	1.750	1.125	1.000	.910	10	.0008-.0016	.0024-.0048	31,400	15,400	26,000	1.16
DAS10-26A	-41	-10AC *	—	.6250	1.6250	.775	.645	.960	.750	10	.0006-.0014	.0025-.0058	7,160	2,560	5,940	.31
DAS10-26B	—	—	—	.6250	1.6250	.840	.645	.960	.750	10	.0006-.0014	.0016-.0036	7,160	2,560	5,940	.32
DAS10-31A	-41	-10C	—	.6250	1.9375	1.125	.937	.940	.750	10	.0006-.0014	.0018-.0042	18,900	9,450	15,700	.59
DAS10-38B	-41	—	-10C	.6250	2.3750[1]	1.687	1.125	1.000	.813	10	.0008-.0016	.0024-.0048	31,400	15,400	26,000	1.14
DAS12-30A	—	—	—	.7500	1.8750	1.000	.969	.955	.850	4	.0006-.0014	.0017-.0041	22,000	11,300	18,200	.50
DAS12-32A	—	—	—	.7500	2.0000	1.250	.875	1.050	.830	8	.0006-.0014	.0020-.0046	21,600	9,720	17,900	.56
DAS12-38A	-41	-12C	—	.7500	2.3750[1]	1.312	1.125	1.120	.910	10	.0008-.0016	.0024-.0048	31,400	15,400	26,000	1.04
DAS12-42A	-41	—	-12C	.7500	2.6250[1]	1.875	1.250	1.230	1.000	10	.0008-.0016	.0025-.0049	38,300	18,600	31,700	1.50
DAS14-48A	-41	—	-14C	.8750	3.0000[1]	2.000	1.500	1.350	1.130	10	.0008-.0016	.0024-.0048	59,100	29,500	49,000	2.28
DAS16-48A	-41	—	-16C *	1.0000	3.0000[1]	2.000	1.500	1.350	1.125	10	.0008-.0016	.0024-.0048	59,100	29,500	49,000	2.25

∆ For roundness limits, refer to the engineering section
□ For reference only
* Pending MIL spec revision
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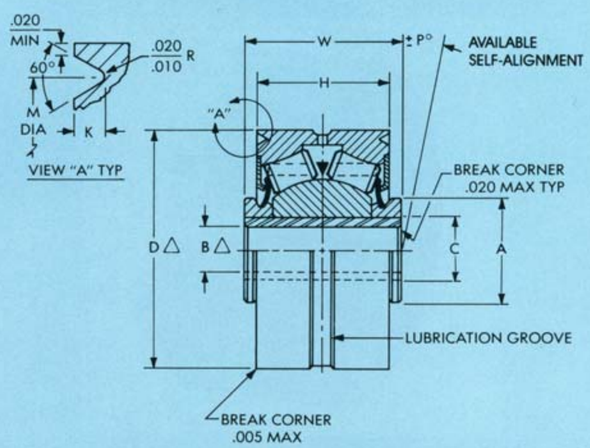
Size tolerance limits [1] +.0000 / -.0007

DAS

DOUBLE ROW ANNULAR WITH SLEEVE & COLLARS/SWAGEABLE

See Shafer Tri-Roller Swaging Tool, Section D



Model Number	B +.0000 -.0005	D +.0000 -.0005	W +.000 -.005	H +.000 -.005	A +.005 -.005	C □	P° Mis.	K +.000 -.015	M +.000 -.010	Internal Clearance Limit Radial	Internal Clearance Limit Thrust	Load Ratings – Lbs. Limit Radial	Load Ratings – Lbs. Limit Thrust	Load Ratings – Lbs. Dynamic Radial	Weight Lbs. □
DAS6-16AG	.2500	1.0000	.625	.464	.450	.310	10	.040	.902	.0006-.0014	.0016-.0043	3,080	1,690	2,560	.6
DAS5-20AG	.3125	1.2500	.812	.656	.520	.380	10	.040	1.152	.0006-.0014	.0016-.0037	7,590	4,300	6,300	.17
DAS6-23AG	.3750	1.4375	.937	.750	.610	.440	10	.040	1.339	.0006-.0014	.0016-.036	10,100	5,790	8,390	.25
DAS8-27AG	.5000	1.6875	1.000	.812	.820	.620	10	.040	1.589	.0006-.0014	.0018-.0042	12,700	6,380	10,600	.40
DAS10-31AG	.6250	1.9375	1.125	.937	.940	.750	10	.040	1.839	.0006-.0014	.0018-.0042	18,900	9,450	15,700	.59
DAS12-31AG	.7500	1.9375	1.000	.969	.955	.850	4	.060	1.815	.0006-.0014	.0024-.0048	22,000	11,300	18,200	.50
DAS14-48AG	.8750	3.0000 [1]	2.000	1.500	1.350	1.130	10	.060	2.878	.0008-.0016	.0024-.0048	59,100	29,500	49,000	2.28
DAS16-40AG	1.0000	2.5000 [1]	1.375	1.125	1.250	1.250	3	.060	2.378	.0008-.0016	.0024-.0048	39,800	17,900	33,000	1.20

∆ For roundness limits, refer to the engineering section
□ For reference only
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Size tolerance limits [1] +.0000 -.0007

DAT DOUBLE ROW TORQUE TUBE

	MIL STD Identification								Internal Clearance		Load Ratings – Lbs.			
Model Number	Model no. Suffix	MS28915 Suffix	B	D	W	H	A □	P° Mis	Radial	Axial	Limit Radial	Limit Thrust	Dynamic Radial	Weight Lbs. □
STRAIGHT														
DAT16-26A	-41	-16C	1.0000 [1]	1.6250 [3]	.500 [5]	.450 [5]	1.120	2	.0004-.0010	.0028-.0070	3,500	440	1,700	.16
DAT20-30A	-41	-20C	1.2500 [2]	1.8750 [3]	.500 [5]	.450 [5]	1.1390	2	.0004-.0010	.0032-.0081	4,300	490	2,230	.19
DAT27-43B	-41	-27AC *	1.6830 [2]	2.6880 [4]	.730 [5]	.580 [5]	1.910	5	.0004-.0010	.0035-.0087	9,000	890	4,320	.51
DAT28-43A	-41	-28C	1.7500 [2]	2.6880 [4]	.670 [5]	.580 [5]	1.980	2	.0004-.0010	.0035-.0087	9,000	890	4,320	.49
DAT33-48A	-41	-33C	2.0630 [4]	3.0000 [4]	.670 [6]	.580 [6]	2.300	2	.0004-.0010	.0039-.0098	10,200	950	5,250	.54
DAT49-64A	-41	-49C	3.0630 [4]	4.0000 [4]	.670 [6]	.580 [6]	3.330	2	.0004-.0010	.0056-.0141	13,700	1,150	8,980	.78
DAT62-78A	-41	-62C *	3.8750 [4]	4.8750 [7]	.710 [6]	.650 [6]	4.180	2	.0004-.0010	.0061-.0151	19,000	1,510	12,700	1.16
CONCAVE														
DAT28-40A	-41	-28AC *	1.7190 [2]	2.5310 [4]	.825 [5]	.710 [5]	1.830	5	.0004-.0010	.0023-.0059	15,100	3,780	12,500	.45
DAT37-56A	-41	-37AC *	2.3130 [4]	3.5000 [4]	.875 [6]	.875 [6]	2.515	2	.0004-.0010	.0026-.0065	38,000	8,740	31,500	1.34
DAT48-64A	-41	-48C *	3.0000 [4]	4.0000 [4]	1.130 [6]	1.130 [6]	3.130	1.5	.0004-.0010	.0024-.0060	65,600	16,300	54,400	1.55
DAT52-72A	—	—	3.2815 [4]	4.5000 [7]	1.125 [6]	1.000 [6]	3.45	2	.0004-.0010	.0032-.0081	76,500	14,000	63,500	2.10
DAT56-76A	-41	-56C *	3.5000 [4]	4.7500 [7]	1.125 [6]	1.125 [6]	3.780	2	.0004-.0010	.0030-.0076	90,700	17,800	75,300	2.40
DAT64-82A	-41	-64C *	4.0000 [4]	5.1250 [7]	1.047 [6]	.950 [6]	4.245	2	.0004-.0010	.0038-.0095	48,100	7,550	39,900	1.95
DAT72-90A	-41	-72C *	4.5000 [7]	5.6250 [7]	1.005 [8]	.905 [8]	4.760	2	.0004-.0010	.0043-.0107	72,800	8,400	60,400	2.05

∆ For roundness limits, refer to the engineering section
□ For reference only
* Pending MIL spec revision
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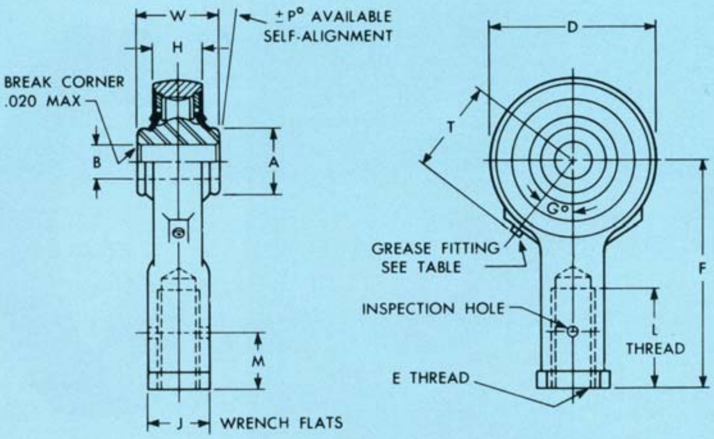
Size tolerance limits

[1] +.0000 / -.0005	[2] +.0000 / -.0008	[3] +.0000 / -.0010	[4] +.0000 / -.0011
[5] +.000 / -.005	[6] +.000 / -.008	[7] +.0000 / -.0012	[8] +.000 / -.010

SF SINGLE ROW ROD END FEMALE THREADED



	MIL STD Identification																				
Model Number	Model No. Suffix	MS21220 Suffix	B +.0000 -.0005	D +.000 -.050	W +.000 -.005	H +.000 -.015	A +.005 -.005	P° Mis	T Max.	G° □	F +.015 -.015	L +.060 -.000	E Thread Size UNJF-3B	J □	M □	Internal Clearance Radial	Grease Fitting	Load Ratings – Lbs. Limit Radial	Limit Thrust	Dynamic Radial	Weight Lbs. □
SF3-4A	—	—	.1900	.800	.437	.350	.330	10	.484	45	1.380	.750	.2500-28	.437	.375	.0002-.0010	t	2,020	200	1,670	.06
SF3-5A	-44	-3G *	.1900	.800	.437	.350	.330	10	.484	45	1.380	.750	.3125-24	.437	.468	.0002-.0010	t	2,020	200	1,670	.06
SF4-4A	-44	-4AG *	.2500	.800	.437	.350	.380	10	.484	45	1.380	.750	.2500-28	.437	.375	.0002-.0010	t	1,910	190	1,580	.06
SF4-4AA	—	—	.2500	.800	.375	.350	.380	4	.484	45	1.380	.750	.2500-28	.437	.375	.0002-.0010	t	1,910	190	1,580	.06
SF4-4B	—	—	.2500	1.080	.500	.360	.425	10	.641	45	1.660	.810	.2500-28	.500	.375	.0002-.0010	tt	3,000	300	2,650	.12
SF4-5A	-44	-4B *	.2500	.800	.437	.350	.376	10	.484	45	1.380	.750	.3125-24	.437	.468	.0002-.0010	t	1,910	190	1,580	.06
SF4-5B	—	—	.2500	.800	.593	.350	.376	10	.484	45	1.380	.750	.3125-24	.437	.468	.0002-.0010	t	1,910	190	1,580	.06
SF4-5D	—	—	.2500	1.020	.500	.360	.435	10	.610	45	1.500	.750	.3125-24	.437	.468	.0002-.0010	tt	2,710	270	2,240	.10
SF4-5G	—	—	.2500	1.080	.500	.360	.425	10	.641	45	1.660	.810	.3125-24	.500	.468	.0002-.0010	tt	3,000	300	2.650	.11
SF4-6A	-44	-4G	.2500	1.080	.500	.360	.425	10	.641	45	1.660	.810	.3750-24	.500	.562	.0002-.0010	tt	3,000	300	2,650	.11
SF5-6A	-44	-5AG *	.3125	1.350	.593	.340	.580	10	.800	40	1.910	.810	.3750-24	.500	.562	.0002-.0010	tt	3,900	390	3,230	.17
SF5-8B	-44	-5G	.3125	1.410	.687	.460	.560	10	.812	40	2.340	1.31 t	.5000-20	.688	.750	.0002-.0010	tt	4,970	490	4,120	.27
SF6-7A	—	—	.3750	1.660	.812	.480	.660	10	.906	40	2.180	1.000	.4375-20	.625	.656	.0002-.0010	tt	6,180	610	5,130	.31
SF6-10A	-44	-6G	.3750	1.660	.812	.550	.660	10	.938	40	3.090	1.750	.6250-18	.875	.938	.0002-.0010	tt	7,910	790	6,570	.53

□ For reference only
* Pending MIL spec revision
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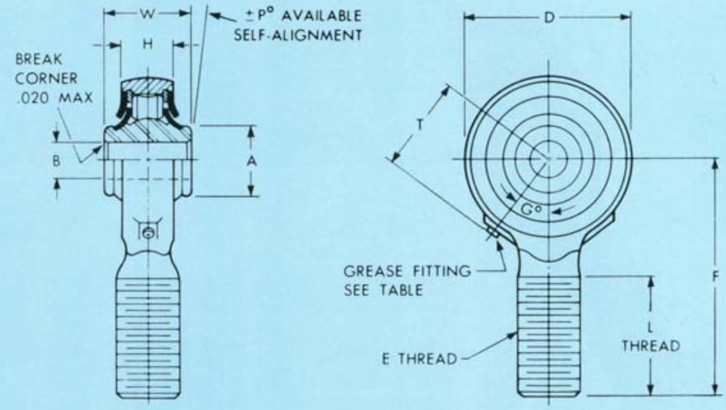
t Plastic Flush Type Grease Fitting
tt NAS 516-1A Grease Fitting

SM SINGLE ROW ROD END MALE THREADED



Model Number	MIL STD Identification			B +.0000 -.0005	D +.000 -.050	W +.000 -.005	H +.000 -.015	A +.005 -.005	P° Mis	T Max.	G° □	F +.015 -.015	L +.060 -.000	E Thread Size UNJF-3A	Internal Clearance	Grease Fitting	Load Ratings – Lbs.			Weight Lbs. □
	Model No. Suffix	MS21221 Suffix	MS21223 Suffix												Radial		Limit Radial	Limit Radial	Limit Radial	
SM3-4A	-44	—	-3G *	.1900	.800	.437	.350	.330	10	.484	45	1.380	.750	.2500-28	.0002-.0010	t	2.020	200	1,670	.06
SM3-6A	—	—	—	.1900	.800	.437	.350	.330	10	.484	45	1.380	.750	.3750-24	.0002-.0010	t	2.020	200	1,670	.06
SM3-6F	-44	-3G *	—	.1900	1.080	.500	.360	.425	10	.672	35	1.84	1.000	.3750-24	.0002-.0010	tt	3.000	300	2,650	.11
SM3-6G	—	—	—	.1900	.800	.437	.350	.380	10	.484	45	1.890	1.250	.3750-24	.0002-.0010	t	1.910	190	1,580	.08
SM4-4C	—	—	—	.2500	.800	.437	.350	.380	10	.484	45	1.880	1.250	.2500-28	.0002-.0010	t	1.910	190	1,580	.06
SM4-4J	—	—	—	.2500	1.020	.593	.360	.430	10	.625	40	1.688	.940	.2500-28	.0002-.0010	tt	2.710	270	2,240	.10
SM4-4R	—	—	—	.2500	.800	.437	.350	.380	10	.484	45	1.250	.630	.2500-28	.0002-.0010	t	1.910	190	1,580	.05
SM4-5A	—	—	—	.2500	.800	.437	.350	.380	10	.484	45	1.380	.750	.3125-24	.0002-.0010	t	1.910	190	1,580	.06
SM4-5B	-44	—	-4BG *	.2500	.800	.437	.350	.380	10	.484	45	1.500	.940	.3125-24	.0002-.0010	t	1.910	190	1,580	.06
SM4-5C	—	—	—	.2500	.800	.515	.350	.380	13	.484	45	1.880	.900	.3125-24	.0002-.0010	t	1.910	190	1,580	.08
SM4-5D	-44	-4BG *	—	.2500	1.020	.593	.360	.430	10	.625	40	1.688	.940	.3125-24	.0002-.0010	tt	2.710	270	2,240	.10

□ For reference only
* Pending MIL spec revision
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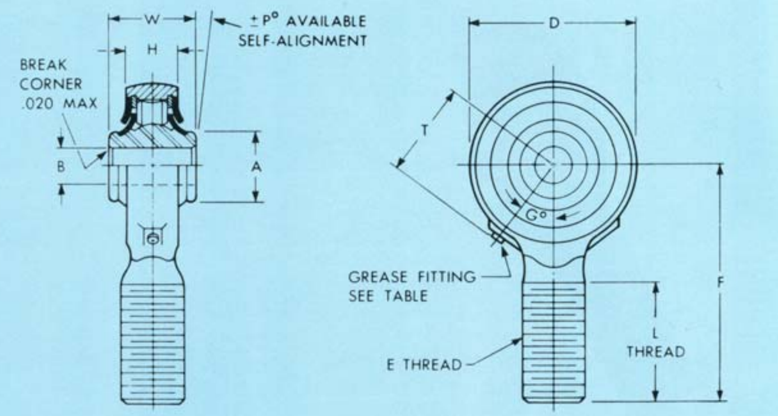
t Plastic Flush Type Grease Fitting

tt NAS 516-1A Grease Fitting

SM

SINGLE ROW ROD END MALE THREADED



	MIL STD Identification																Load Ratings – Lbs.			
Model Number	Model No. Suffix	MS21221 Suffix	MS21223 Suffix	B +.0000 -.0005	D +.000 -.050	W +.000 -.005	H +.000 -.015	A +.005 -.005	P° Mis	T Max.	G° □	F +.015 -.015	L +.060 -.000	E Thread Size UNJF-3A	Internal Clearance Radial	Grease Fitting	Limit Radial	Limit Radial	Limit Radial	Weight Lbs. □
SM4-6B	—	—	—	.2500	.800	.437	.350	.380	10	.484	45	1.380	.750	.3750-24	.0002-.0010	t	1,910	190	1,580	.06
SM4-6D	-44	—	-4DG *	.2500	.800	.437	.350	.380	10	.484	45	1.750	1.125	.3750-24	.0002-.0010	t	1,910	190	1,580	.07
SM4-6E	—	—	—	.2500	.800	.593	.350	.380	10	.484	45	1.750	1.125	.3750-24	.0002-.0010	t	1,910	190	1,580	.07
SM4-6F	—	—	—	.2500	.800	.437	.350	.380	10	.484	45	1.880	.900	.3750-24	.0002-.0010	t	1,910	190	1,580	.07
SM4-6G	—	—	—	.2500	.800	.593	.350	.380	10	.484	45	1.880	1.250	.3750-24	.0002-.0010	t	1,910	190	1,580	.08
SM4-6H	—	—	—	.2500	.800	.500	.350	.380	10	.484	45	2.150	1.330	.3750-24	.0002-.0010	t	1,910	190	1,580	.08
SM4-6J	—	—	—	.2500	.800	.593	.350	.380	10	.484	45	2.150	1.330	.3750-24	.0002-.0010	t	1,910	190	1,580	.05
SM4-6M	-44	—	4G	.2500	1.020	.500	.360	.435	10	.625	40	1.880	1.060	.3750-24	.0002-.0010	tt	2,710	270	2,240	.10
SM4-6N	-44	-4DG *	—	.2500	1.020	.593	.360	.430	10	.625	40	1.880	1.060	.3750-24	.0002-.0010	tt	2,710	270	2,240	.12
SM4-6P	—	—	—	.2500	1.020	.625	.360	.430	10	.625	40	1.880	1.060	.3750-24	.0002-.0010	tt	2,710	270	2,240	.12
SM4-6T	-44	-4G	—	.2500	1.080	.500	.360	.425	10	.672	35	1.840	1.0000	.3750-24	.0002-.0010	tt	3,000	300	2,650	.11

□ For reference only
* Pending MIL spec revision
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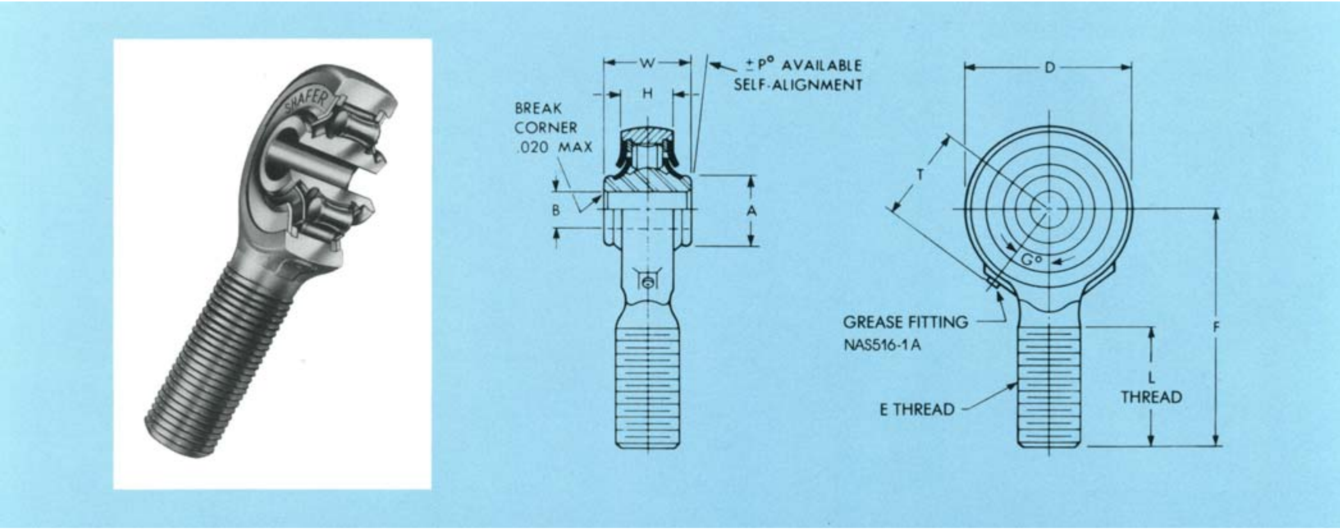
Please request certified prints for current and exact dimensions.

t Plastic Flush Type Grease Fitting

tt NAS 516-1A Grease Fitting

SM

SINGLE ROW ROD END MALE THREADED



	MIL STD Identification															Load Ratings – Lbs.			
Model Number	Model No. Suffix	MS21221 suffix	MS21223 Suffix	B +.0000 -.0005	D +.000 -.050	W +.000 -.005	H +.000 -.015	A +.005 -.005	P° Mis	T Max.	G° □	F +.015 -.015	L +.060 -.000	E Thread Size UNJF-3A	Internal Clearance Radial	Limit Radial	Limit Thrust	Dynamic Radial	Weight Lbs. □
SM4-6W	—	—	—	.2500	1.080	.593	.360	.420	10	.672	45	2.100	1.260	.3750-24	.0002-.0010	3,000	300	2,650	.12
SM4-6Z	—	—	—	.2500	1.080	.500	.360	.425	10	.672	45	2.360	1.500	.3750-24	.0002-.0010	3,000	300	2,650	.14
SM5-6A	-44	—	-5AG *	.3125	1.280	.870	.400	.560	10	.719	40	2.450	1.530	.3750-24	.0002-.0010	4,170	410	3,460	.15
SM5-6B	—	—	—	.3125	1.350	.593	.340	.580	10	.828	40	1.935	1.100	.3750-24	.0002-.0010	3,900	390	3,230	.13
SM5-6C	—	—	—	.3125	1.350	.500	.340	.600	10	.828	40	2.250	1.230	.3750-24	.0002-.0010	3,900	390	3,230	.14
SM5-7A	-44	-5AG *	—	.3125	1.280	.870	.400	.560	10	.719	40	2.450	1.530	.4375-20	.0002-.0010	4,170	410	3,460	.17
SM5-7C	-44	—	-5G	.3125	1.350	.593	.340	.580	10	.828	40	1.910	.800	.4375-20	.0002-.0010	3,900	390	3,230	.13
SM5-7D	—	—	—	.3125	1.350	.593	.340	.580	10	.828	40	2.200	1.110	.4375-20	.0002-.0010	3,900	390	3,230	.17
SM5-7E	—	—	—	.3125	1.350	.593	.340	.580	10	.828	40	2.320	1.240	.4375-20	.0002-.0010	3,900	390	3,230	.19

□ For reference only
* Pending MIL spec revision
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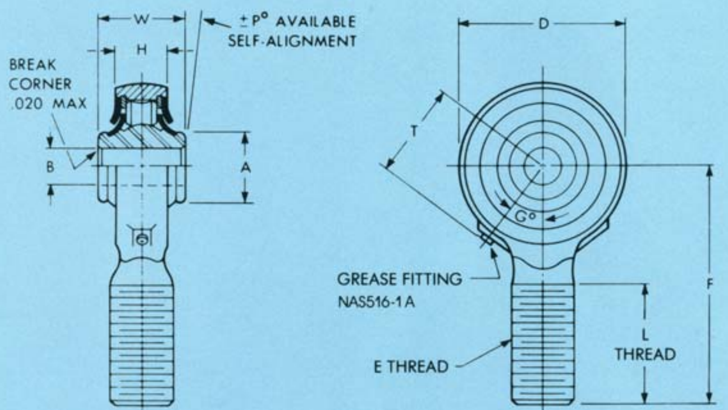
SM

SINGLE ROW ROD END MALE THREADED



Model Number	MIL STD Identification: Model No. Suffix	MS21221 suffix	MS21223 Suffix	B +.0000 -.0005	D +.000 -.050	W +.000 -.005	H +.000 -.015	A +.005 -.005	P° Mis	T Max.	G° □	F +.015 -.015	L +.060 -.000	E Thread Size UNJF-3	Internal Clearance Radial	Load Ratings – Lbs. Limit Radial	Limit Thrust	Dynamic Radial	Weight Lbs. □
SM5-8C	-44	-5G	—	.3125	1.410	.687	.460	.560	10	.858	40	2.410	1.310	.5000-20	.0002-.0010	4,970	490	4,120	.27
SM5-8E	—	—	—	.3125	1.410	.687	.460	.560	10	.858	40	3.010	1.860	.5000-20	.0002-.0010	4,970	490	4,120	.30
SM6-6C	—	—	—	.3750	1.660	.812	.480	.660	10	.960	30	2.560	1.310	.3750-24	.0002-.0010	6,180	610	5,130	.31
SM6-7A	-44	—	-6G	.3750	1.660	.812	.480	.660	10	.960	30	2.560	1.310	.4375-20	.0002-.0010	6,180	610	5,130	.31
SM6-10A	—	—	—	.3750	1.660	.812	.550	.660	10	.999	40	2.640	1.360	.6250-18	.0002-.0010	7,910	790	6,570	.44
SM6-10B	-44	-6G	—	.3750	1.660	.812	.550	.660	10	.968	40	3.030	1.750	.6250-18	.0002-.0010	7,910	790	6,570	.47
SM8-12A	-44	-8BG *	—	.5000	2.270	1.062	.720	.860	10	1.281	40	4.030	2.310	.7500-16	.0002-.0010	14,000	1,400	11,700	1.13
SM8-14B	-44	-8G	—	.5000	2.270	1.062	.720	.860	10	1.281	40	4.030	2.310	.8750-14	.0002-.0010	14,000	1,400	11,700	1.13
SM10-16B	-44	-10CG *	—	.6250	2.800	1.250	.850	1.050	10	1.560	40	4.660	2.560	1.000-14†	.0002-.0010	22,100	2,210	18,400	1.94

□ For Reference only
* Pending MIL spec revision
† 1.000-14 NS-3A Thread per MIL-S-7742
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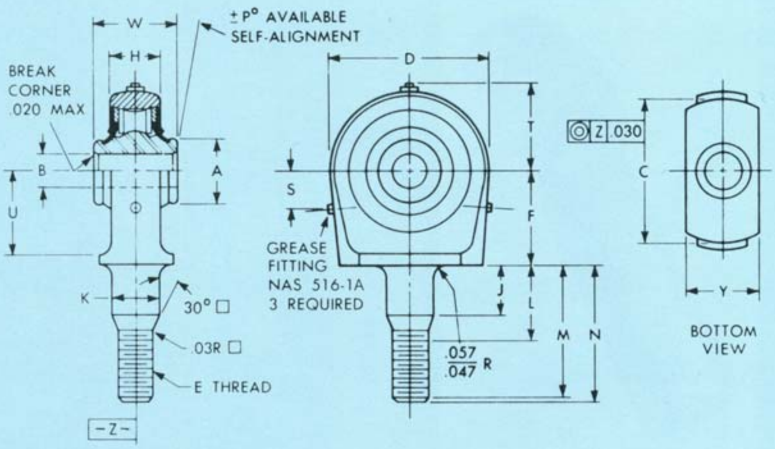
SMD SINGLE ROW ROD END MALE EYEBOLT



Model Number	B +.0000 -.0005	D +.000 -.050	W +.000 -.005	H +.000 -.015	A +.005 -.005	T Max.	P° Mis.	S □	F +.005 -.005	L Max.	E Thread Size UNJF-3A	U □	J □	M □	N +.000 -.030	K +.0000 -.0010	C +.000 -.050	Y +.000 -.020	Internal Clearance Radial	Load Ratings – Lbs. Limit Radial	Limit Thrust	Dynamic Radial	Weight Lbs. □
SMD5-5D	.3125	1.050	.625	.480	.490	.660	10	.340	.625	.768	.3125-24	.490	.584	1.126	1.278	.3431	.915	.630	.0002-.0010	3,600	360	2,990	.21
SMD5-5E	.3125	1.050	.625	.480	.490	.660	10	.340	.625	.488	.3125-24	.490	.304	.846	.998	.3431	.915	.630	.0002-.0010	3,600	360	2,990	.17
SMD5-5F	.3125	1.050	.625	.480	.490	.660	10	.340	.625	.329	.3125-24	.490	.209	.736	.779	.3431	.915	.630	.0002-.0010	3,600	360	2,990	.14
SMD5-5K	.3125	1.050	.625	.480	.490	.660	10	.340	.625	.333	.3125-24	.490	.149	.736	.779	.3431	.915	.630	.0002-.0010	3,600	360	2,990	.14

□ For reference only
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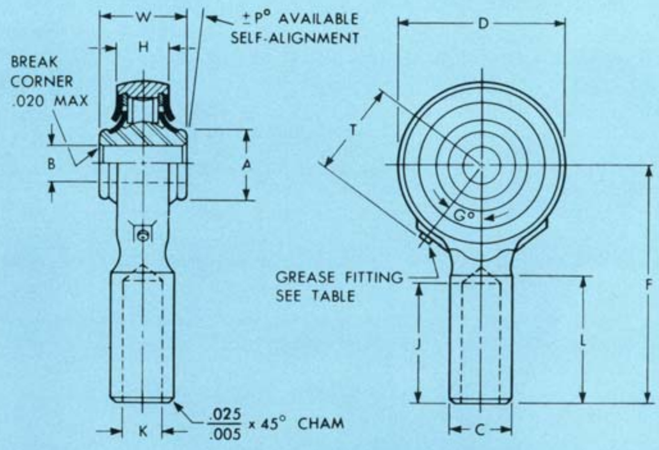
SPH SINGLE ROW ROD END PLAIN SHANK HOLLOW



Model Number	B +.0000 -.0005	D +.000 -.050	W +.000 -.005	H +.000 -.015	A +.005 -.005	P° Mis.	T Max.	G° □	F +.015 -.015	L Min.	C +.000 -.002	J Max.	K □	Internal Clearance	Grease Fitting	Load Ratings – Lbs.			Weight Lbs. □
														Radial		Limit Radial	Limit Thrust	Dynamic Radial	
SPH4-6B	.2500	.800	.437	.350	.380	10	.484	45	1.500	1.040	.375	1.047	.250	.0002-.0010	t	1,910	190	1,580	.05
SPH4-10B	.2500	.970	.593	.360	.420	15	.625	45	1.875	1.219	.625	1.285	.386	.0002-.0010	tt	2,710	270	2,240	.12
SPH4-10C	.2500	1.080	.500	.360	.425	10	.641	45	1.875	1.043	.625	1.031	.375	.0002-.0010	tt	3,000	300	2,650	.16
SPH4-10D	.2500	1.080	.500	.360	.425	10	.641	45	2.030	1.100	.625	1.025	.386	.0002-.0010	tt	3,000	300	2,650	.15
SPH5-8A	.3125	1.350	.558	.340	.580	9	.781	40	2.645	1.105	.500	1.050	.375	.0002-.0010	tt	3,900	390	3,230	.16
SPH5-10B	.3125	1.350	.593	.340	.580	10	.781	40	2.040	1.140	.625	1.000	.437	.0002-.0010	tt	3,900	390	3,230	.14

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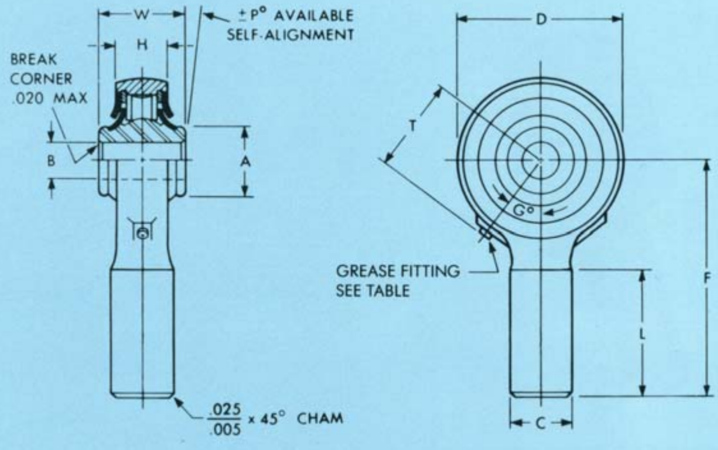
t Plastic Type Grease Fitting
tt NAS 516-1A Grease Fitting

SPS SINGLE ROW ROD END PLAIN SHANK SOLID



Model Number	B +.0000 -.0005	D +.000 -.050	W +.000 -.005	H +.000 -.015	A +.005 -.005	P° Mis.	T Max.	G° □	F +.015 -.015	L Min.	C +.000 -.002	Internal Clearance Radial	Grease Fitting	Load Ratings – Lbs. Limit Radial	Limit Thrust	Dynamic Radial	Weight Lbs. □
SPS3-7A	.1900	.800	.437	.350	.330	10	.484	45	1.891	1.250	.445	.0002-.0010	t	2,020	200	1,670	.10
SPS4-6A	.2500	1.020	.500	.360	.435	10	.625	40	1.580	.847	.376	.0002-.0010	tt	2,710	270	2,240	.08
SPS4-6D	.2500	.970	.593	.360	.420	15	.600	45	1.875	1.220	.372	.0002-.0010	tt	2,710	270	2,240	.11
SPS4-7A	.2500	.800	.500	.350	.380	10	.484	45	1.891	1.250	.430	.0002-.0010	t	1,910	190	1,580	.09
SPS4-7B	.2500	.800	.437	.350	.380	10	.484	45	1.891	1.250	.445	.0002-.0010	t	1,910	190	1,580	.10
SPS4-7C	.2500	.800	.484	.350	.380	10	.484	45	1.891	1.250	.445	.0002-.0010	t	1,910	190	1,580	.10
SPS4-10A	.2500	.970	.593	.360	.420	15	.620	45	1.875	1.190	.620	.0002-.0010	tt	2,710	270	2,240	.18
SPS5-10A	.3125	1.280	.870	.400	.563	10	.750	40	2.440	1.540	.625	.0002-.0010	tt	4,170	410	3,460	.24

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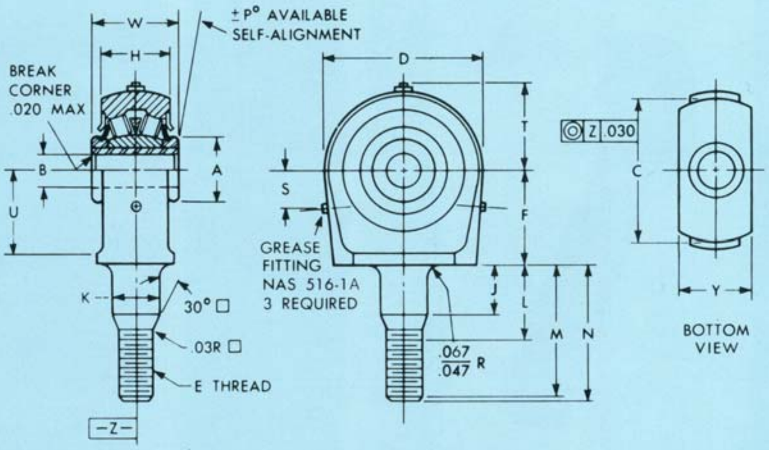
t Plastic Type Grease Fitting
tt NAS 516-1A Grease Fitting

DMD DOUBLEROW ROD END MALE EYEBOLT



Model Number	B +.0000 -.0005	D +.000 -.050	W +.000 -.005	H +.000 -.015	A +.005 -.005	T Max.	P° Mis	S □	F +.005 -.005	L Max.	E Threaded Size UNJF-3A	U □	J □	M □	N +.000 -.030	K +.0000 -.0010	C +.000 -.050	Y +.000 -.020	Internal Clearance	Load Ratings – Lbs. Limit Radial	Limit Thrust	Dynamic Radial	Weight Lbs. □
DMD5-5B	.3125	1.050	.625	.480	.463	.660	10	.340	.625	.800	.3125-24	.490	.616	1.126	1.278	.3431	.915	.630	1	3,450	1,690	2,860	.13
DMD5-F5	.3125	1.050	.625	.480	.463	.660	10	.340	.625	.396	.3125-24	.486	.212	.846	.998	.3431	.915	.610	1	3,450	1,690	2,860	.15
DMD6-6A	.3750	1.410	.750	.661	.578	.810	5	.370	.745	.657	.3750-24	.570	.429	1.118	1.205	.4426	1.275	.720	2	8,010	4,550	6,650	.32
DMD6-7C	.3750	1.410	.750	.661	.578	.810	5	.370	.745	.887	.4375-20	.610	.679	1.823	2.015	.4426	1.275	1.100	2	8,010	4,550	6,650	.35
DMD6-7E	.3750	1.410	.750	.661	.578	.810	5	.105	.750	.617	.4375-20	.560	.429	1.168	1.327	.4426	1.275	.698	2	8,010	4,550	6,650	.34
DMD6-9A	.3750	1.880	.937	.760	.610	1.110	10	.500	1.000	.699	.5625-18	.830	.481	1.397	1.612	.5646	1.500	.885	2	10,600	6,100	8,840	.66
DMD10-12A	.6250	2.188	1.125	.942	.940	1.200	10	.630	1.312	.976	.7500-16	1.092	.741	1.970	2.315	.7513	2.085	1.190	1	18,900	9,450	15,700	1.08
DMD10-12B	.6250	2.188	1.125	.942	.940	1.200	10	.630	1.312	.976	.7500-16	1.092	.741	1.970	2.315	.7513	2.085	1.095	1	18,900	9,450	15,700	1.38
DMD12-12B	.7500	2.375	1.312	.942	1.385	1.297	5	.630	1.625	.900	.7500-16	1.345	.750	1.835	2.070	.8100	2.250	1.280	3	25,800	10,900	21,400	1.50
DMD14-18B	.8750	3.125	1.810	1.125	1.870	1.675	5	.750	2.000	1.484	1.1250-12	1.720	1.250	2.968	3.070	1.1870	3.125	1.78	4	46,000	18,200	38,100	3.89
DMD14-18D	.8750	3.125	1.810	1.125	1.870	1.675	5	.750	2.000	1.684	1.1250-12	1.720	1.450	3.344	3.554	1.1870	3.125	1.780	4	46,000	18,200	38,100	4.03
DMD25-9A	1.5625	2.750	.850	.755	1.760	1.505	5	.940	1.590	.709	.5625-18	1.420	.491	1.386	1.600	.5636	1.500	1.135	5	19,900	5,370	16,500	.75

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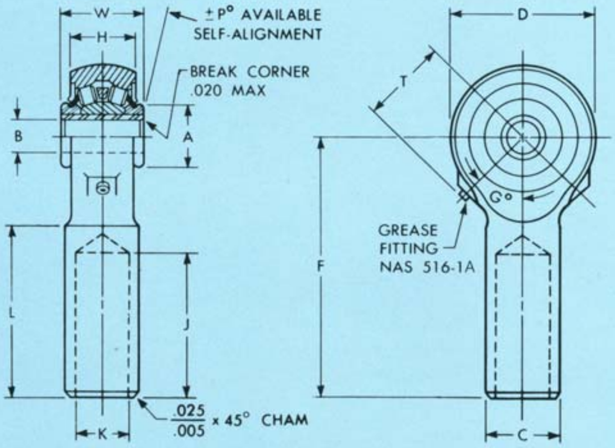
Internal Clearance

1	Radial	.002-.0010	Axial	.0006-.0030
2	Radial	.0002-.0010	Axial	.0005-.0026
3	Radial	.0002-.0010	Axial	.0007-.0035
4	Radial	.0002-.0010	Axial	.0007-.0038
5	Radial	.0002-.0010	Axial	.0011-.0055

DPH DOUBLE ROW ROD END PLAIN SHANK HOLLOW



Model Number	B +.0000 -.0005	D +.000 -.050	W +.000 -.005	H +.000 -.015	A +.005 -.005	P° Mis	T Max.	G° □	F +.015 -.015	J Max.	C +.000 -.002	K □	L Min.	Internal Clearance		Load Ratings – Lbs.			Weight Lbs. □
														Radial	Axial	Limit Radial	Limit Thrust	Dynamic Radial	
DPH4-10A	.2500	1.073	.625	.480	.450	10	.670	45	2.340	1.380	.625	.438	1.500	.0002-.0010	.0005-.0027	3,080	1,690	2,560	.20
DPH5-12A	.3125	1.440	.812	.665	.520	10	.900	45	3.110	1.840	.750	.563	2.000	.0002-.0010	.0005-.0026	8,010	4,550	6,650	.39
DPH6-14A	.3750	1.760	.937	.760	.610	10	1.055	45	3.500	2.060	.875	.656	2.250	.0002-.0010	.0005-.0026	10,600	6,100	8,840	.65
DPH8-10A	.5000	1.720	1.000	.695	.780	10	.982	45	3.030	1.650	.625	.440	1.802	.0002-.0010	.0007-.0033	9,530	4,250	7,910	.48
DPH8-12A	.5000	1.720	.875	.695	.780	10	.938	45	3.290	2.000	.750	.565	2.060	.0002-.0010	.0007-.0033	9,530	4,250	7,910	.58

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