HP Bearings

High-Performance Thermoplastic Bearings

HP Bearing

Specialty Designs

Greene Tweed has developed a unique range of thermoplastic bearing materials that provide excellent tribological properties. Our bearings are machined to ensure ease of assembly, protect against particle contaminants, and provide cost-effective bearing solutions while withstanding temperatures up to 500°F (260°C).

In addition, our bearings:

- Reduce build-up of tolerances with inherent reduced eccentricity and run out
- Closely control hardware interfaces
- Provide minimal static and dynamic friction
- Provide nonaggressive materials when running against mating hardware surfaces

Features and Benefits

- High load bearing capacities allow for superior performance in demanding conditions
- Low friction helps maintain consistent squeeze levels of seal components
- Contaminant-resistant materials prevent particles from reaching critical systems
- Excellent chemical resistance prevents material degradation in harsh substances
- Specialty designs to suit customer specifications

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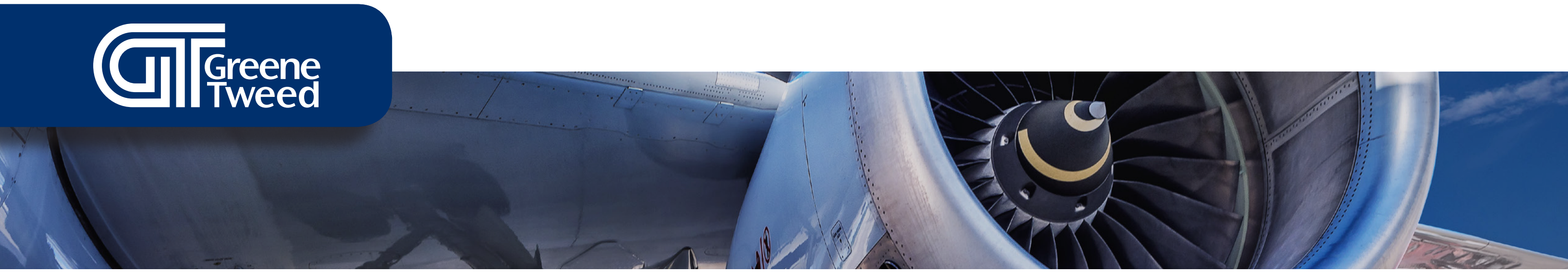
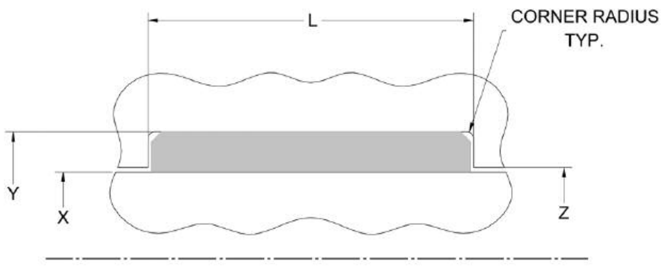
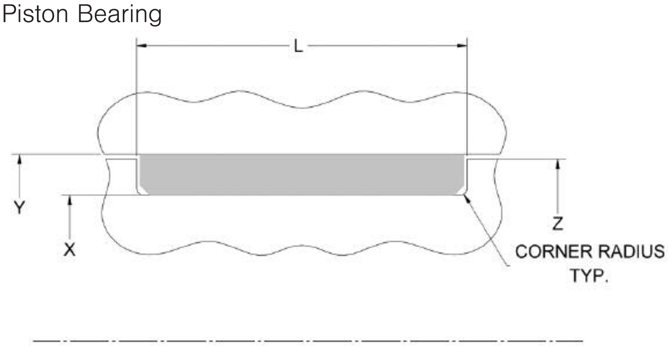


Hardware Designs (Typical)

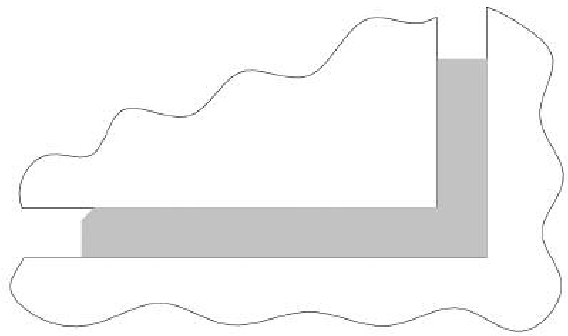
Rod Bearing



Piston Bearing



Flange Bearing



Note: For rod flange bearings please refer to Greene Tweed engineering.

Hardware Design (in inches)

Bearing Cross-Section		Rod		Piston		Groove Length (L)	Corner Radius
		Y Dia.	Z* Dia.	X Dia.	Z* Dia.		
A	1/32 in.	X Dia. +0.064	X Dia. +0.015	Y Dia. -0.064	Y Dia. -0.015	Bearing Length +0.010/ +0.020	0.005/ 0.015
B	1/16 in.	X Dia. +0.126	X Dia. +0.015	Y Dia. -0.126	Y Dia. -0.015	Bearing Length +0.010/ +0.020	0.005/ 0.015
C	3/32 in.	X Dia. +0.188	X Dia. +0.015	Y Dia. -0.188	Y Dia. -0.015	Bearing Length +0.010/ +0.020	0.005/ 0.015
D	1/8 in.	X Dia. +0.250	X Dia. +0.017	Y Dia. -0.250	Y Dia. -0.017	Bearing Length +0.010/ +0.020	0.010/ 0.025
E	5/32 in.	X Dia. +0.314	X Dia. +0.017	Y Dia. -0.314	Y Dia. -0.017	Bearing Length +0.010/ +0.020	0.010/ 0.025
F	3/16 in.	X Dia. +0.376	X Dia. +0.017	Y Dia. -0.376	Y Dia. -0.017	Bearing Length +0.010/ +0.020	0.020/ 0.035
G	7/32 in.	X Dia. +0.438	X Dia. +0.017	Y Dia. -0.438	Y Dia. -0.017	Bearing Length +0.010/ +0.020	0.020/ 0.035
H	1/4 in.	X Dia. +0.500	X Dia. +0.017	Y Dia. -0.500	Y Dia. -0.017	Bearing Length +0.010/ +0.020	0.020/ 0.035

**The clearance gap could affect other seal assemblies. Contact Greene Tweed engineering for specific information.*

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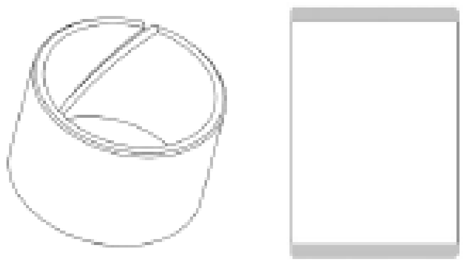
Plastic Bearing Types

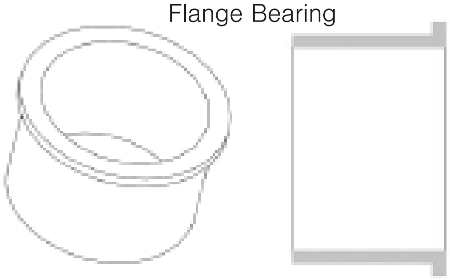
Split bearings are recommended to minimize the potential undesirable effects at extreme temperatures. Most materials tend to expand as temperature increases and contract as temperature decreases. The dimensional changes caused by thermal expansion will affect the performance of plastic bearings. At high temperature, the bearing cross-section may grow to the point of having interference fit, causing excessive wear and friction. At cryogenic temperatures, the bearings will shrink, tightening around the shaft and causing increased friction.

The use of solid bearings is only recommended in cases where press-fit is the only way to install and contain the bearing in place. Contact Greene Tweed engineering for more information.

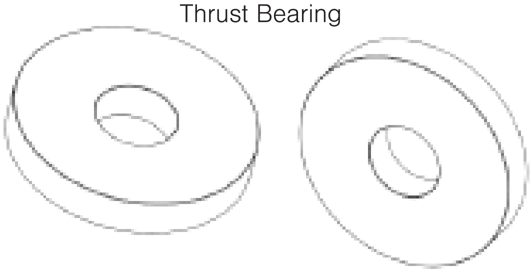
Split Bearing



Flange Bearing



Thrust Bearing



Design Considerations

When choosing the correct bearing material, wear, friction requirements, load bearing capacity, temperature, pressure, and running velocity all must be considered. The most common choice of Arlon® grades is Arlon® 1555 (035 code). Greene Tweed's standard recommendation for Avalon® PTFEs would be our Avalon® 69, a thermoplastic and carbon-filled PTFE compound (079 code). We recommend that a range of materials is tested as the performance limits given are based on ideal operating conditions and an independent test of each factor. Unknown parameters or operating conditions could limit the validity of these performance limits. Specific material compatibility should be evaluated on each application.

As a general guide, consider the following:

- If wear and load bearing capability is paramount, consider Arlon® materials.
- If friction is paramount, consider Avalon® materials.

Selecting the Appropriate Bearing

To select the appropriate bearing a number of criteria must be established. The following questions should be considered when selecting the appropriate materials with Greene Tweed engineering.

- Is this a rotary, static, oscillating, or reciprocating application?
- What velocity and lubrication will be present?
- What are the desired temperature and load requirements?
- What are the shaft material, surface finish, and hardness?
- Is the bearing exposed to abrasive, erosive, or chemically aggressive conditions?

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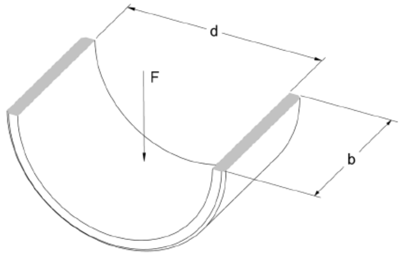
Load Capacity

An estimated load requirement can be made using a calculation based on the failure load of the weakest dynamic member. Bearing load depends on factors such as diametrical tolerances, rod deflection, and bearing deformation. Direct external loads and other forces, such as the weight of the component, nonconcentric axial loads, and rod deflection, must be considered.

It is important to maintain the lowest possible unit load on the bearing. We assume that the load distribution is constant over the projected bearing area. The projected area is a function of the bearing contact diameter and the axial length whereby: Bearing Area (A) $in.^2$ = Bearing Inside Contact Diameter (d) in. x Bearing Length (b) in.

Once the force-load requirement and the projected bearing area is determined the overall unit load can be calculated by dividing the total force load by the projected area. This gives the compressive stress or load bearing pressure in psi required in the application. The load bearing pressure calculation is:

Bearing Design



P = F/A = F/(d x b), where:

P = Load bearing pressure (compressive stress required) (psi)

F = Overall force load (Normal force) (lb)

A = Projected bearing area ($in.^2$) (refer to the above "Bearing Area" calculation)

d = Bearing inside contact diameter (in.)

b = Bearing axial length (in.)

Determining Axial Length of the Bearing

1. Determine the maximum total load to be supported by the bearing.
2. Calculate the projected bearing area by multiplying the bearing diameter by an initial axial length.
3. Divide the total load by the projected area to arrive at the application compressive stress (also called load bearing pressure). The required compressive strength (see Greene Tweed typical properties sheet for these values) is calculated by multiplying the compressive stress by a factor of safety (see "Material Selection and Design Validation" for more information.)
4. Modify the axial length accordingly to result in a required compressive strength that will not exceed the candidate materials available compressive strength.

Material Selection and Design Validation

Once the application's bearing pressure is calculated, a Greene Tweed bearing material can be selected that exceeds the stress requirements. We recommend an FS (Factor of Safety) of 2 to 3 in design. This FS takes into account the creep and deformation under load characteristics of plastic materials and also accounts for the design "unknowns."

When referring to the typical properties sheet for the materials listed in the Material Designator Tables, determine if the materials have a compressive strength in excess of the safety stress calculated above. If the required load exceeds the capability of the available materials then the projected bearing area in design should be increased, if possible. This is accomplished by increasing the axial length of the bearing as defined in number 3 of the "Determining Axial Length of the Bearing" section (above). Reiterate the calculations until the required safety load falls within the capacity of the suggested materials.

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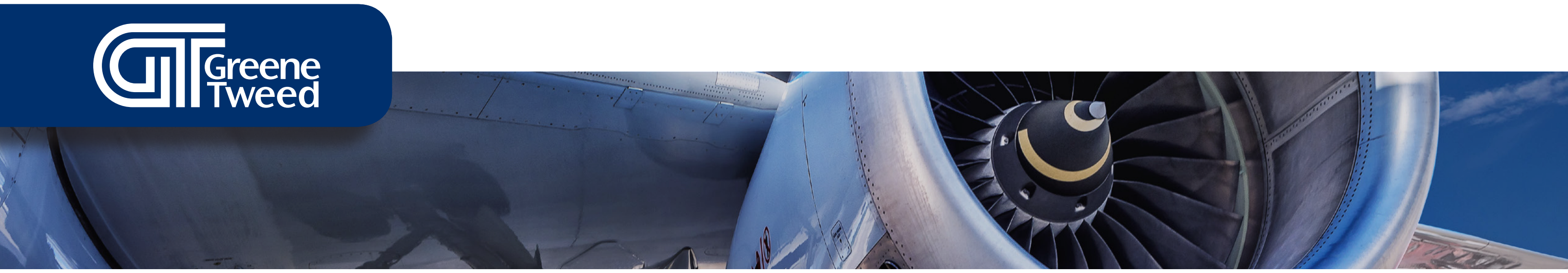


Bearing PV Limits

Dynamic applications require tribological properties that resist wear and the negative effects of frictional heat. Having oil film lubrication, in the absence of particle contamination, will prolong the life of a dynamic load bearing system. In design, "worst case" wear conditions are considered by determining the effect of running surface speed for a given load bearing pressure. This relationship is referred to as the "PV" limits of a material, assuming "dry" conditions. Calculation of the required PV is recommended for rotary applications and thrust bearings. The values calculated are intended to provide the user with an estimate of the dynamic load capacity of the bearing before practical testing and direct utilization have begun. The operational limits can be defined by PV as:

PV = Load Bearing Pressure (psi) x Velocity (ft/min.)

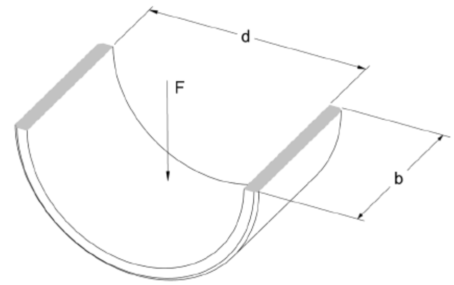
The surface speed or running velocity can be calculated as follows:

For rotary applications, V = (d x π x n)/12
For reciprocating applications, V = (LS x C x 2)/12
For thrust bearings, V = (0.52 x n)(0.6r_1 + 0.4r_2)
Where:
V = Velocity ft/min.
d = Bearing inside diameter (inches)
LS = Length of stroke (inches)
C = Cycles per minute (extend & retract)
r_1 = Radius of the thrust bearing ID (inches)
r_2 = Radius of the thrust bearing OD (inches)
n = RPM

Example Application Review

The ability to support a load is directly proportional to the surface area. Improperly designed bearings will result in premature seal failure and possible hardware damage. Below is a calculation to determine the load bearing pressure that will indicate which materials are applicable. Velocity is a critical design factor that should be considered during the selection process using PV values.

Proper Bearing Design



Example (Rotary Application)
F = 255 lb
n = 600 rpm
d = 0.750 in.
b = 0.875 in.
A = d x b = 0.750 x 0.875 = 0.656 in.^{2}
P = F/A = 255/0.656 = 389 psi
Required compressive strength of material =
P x Factor of Safety = 389 x 2 = 778 psi
Velocity = V = (n x d x π) /12 = (600 x 0.750 x π) /12 = 118 fpm
PV Value, P x V = 778 x 118 = 45900 psi.fpm

Bearing Media

The Avalon® bearings have almost unlimited chemical compatibility. Thermoplastic and composite bearings have wide chemical compatibility, except for use with acids and strong oxidizing agents.

Bearing Lubrication

PTFE bearings are designed to run without any lubrication; however, lubricated bearings will exhibit lower coefficient of friction and longer life.

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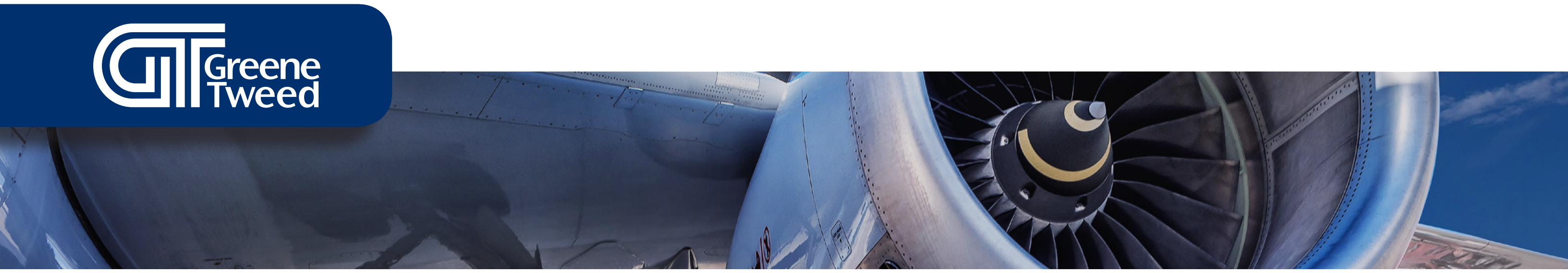

HP Bearing Part Numbering System

The part numbering system requires the use of the material designator tables found in the next column. For nonstandard designs, contact Greene Tweed engineering.

2 7 | X | X | X X X X X | X X | X | X X X

- **2 7** – Bearing series
- **X** – R = Rod; P = Piston
- **X** – Cross Section (in.)
  - A = 1/32
  - B = 1/16
  - C = 3/32
  - D = 1/8
  - E = 5/32
  - F = 3/16
  - G = 7/32
  - H = 1/4
- **X X X X X** – Diameter (in.) to 3 decimal places x 1000
  - Maximum Rod diameter for rod bearings
  - Minimum bore diameter for piston bearings
- **X X** – Length (in.)
  - 01 = 1/16
  - 02 = 2/16 (1/8)
  - 03 = 3/16
  - 04 = 4/16 (1/4)
  - 05 = 5/16
  - 06 = 6/16 (3/8)
  - 07 = 7/16
  - 08 = 8/16 (1/2)
  - 09 = 9/16
  - 10 = 10/16 (5/8)
  - 11 = 11/16
  - 12 = 12/16 (3/4)
  - 13 = 13/16
  - 14 = 14/16 (7/8)
  - 15 = 15/16
  - 16 = 16/16 (1)
  - …
  - 99 = 99/16 (6 3/16)
- **X** – – = Standard; A–Z = Nonstandard
- **X X X** – Bearing material designator

Part Numbering Examples

2 7 | R | A | 0 0 9 9 8 | 0 2 | – | 0 3 5

- R – Rod
- A – 1/32 in. Cross-section
- 00998 – 0.998 in. maximum Rod diameter
- 02 – 2/16 in. (1/8 in.) length
- – – Standard
- 035 – Arlon® 1555, Split

2 7 | P | D | 0 3 9 9 3 | 0 5 | – | 0 7 9

- P – Piston
- D – 1/8 in. Cross-section
- 03993 – 3.993 in. minimum Bore diameter
- 05 – 5/16 in. length
- – – Standard
- 079 – Avalon® 69

Contact your local Greene Tweed representative for specific recommendations to suit higher performance requirements.

Material Designator Tables

Arlon® Proprietary GT Reinforced PEEK™ (Polyetheretherketone) Materials	
Code	**Material Name**
411	Arlon® 1261
190	Arlon® 1263
193	Arlon® 1286
038	Arlon® 1330
035	Arlon® 1555
410	Arlon® 1580

Avalon® Proprietary GT Reinforced PTFE (Polytetrafluoroethylene) Materials	
Code	**Material Name**
001	Avalon® 01
042	Avalon® 07
044	Avalon® 44
073	Avalon® 50
057	Avalon® 57
079	Avalon® 69
089	Avalon® 89

More information on the above materials can be found in the Thermoplastics section in Capabilities.

See Greene Tweed Surface Finish guidelines.

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