# Linear Bearing Selection Guide

Five key criteria to help ensure you design the best linear motion solution for your application









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# 01 Introduction

Look around you.

Virtually every man-made thing you see was manufactured or processed on a machine that uses linear bearings.

Bearings are a fundamental component in most types of industrial equipment, enabling lowfriction motion for operations such as positioning, transporting, and guiding loads.

The benefit for engineers and designers is that there are so many types, designs, and sizes of bearings that it's almost certain there will be a product that exactly fits their requirements. The challenge those designers and engineers face, however, is determining which products to consider in their initial design and sizing efforts.

The majority of linear motion applications use one of three types of linear bearings: plain bearings, cam rollers guides, or recirculating ball bearings. Of course, these are broad categories, and each one consists of many designs and variations with unique benefits. In this guide, we'll look at the technology behind each of the three main linear bearing types and compare the key performance criteria of each one.



# <u>02</u>

Linear Bearing Technology

## **Plain Bearings**

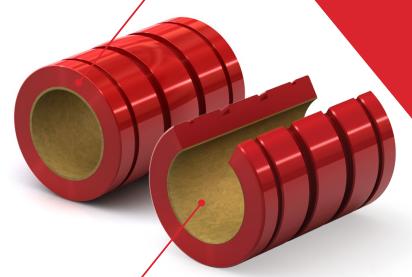
The basic premise of a linear bearing is to allow relative motion between two surfaces. Plain bearings accomplish this by relying on sliding contact between a softer bearing material, such as plastic, composite or bronze, and a relatively harder guide material, such as aluminum or steel. Plain bearing systems can consist of a round shaft with round bearings, or a square or angled rail (similar to a dovetail design) with a mating square or angled bearing.

The wide range of materials and profiles for plain bearings make them arguably the most diverse of all bearing types, and their relatively simple construction makes them easy to install, maintain, and replace when necessary. But don't let this simplicity fool you. Plain bearings are capable of carrying heavy loads, and advanced materials allow them to be used in environmental conditions that are often unsuitable for most other bearing types.

One key difference in round shaft, plain bearing construction lies in the bearing liners. While some bearing producers offer an injection-molded plastic liner, PBC Linear uses their patented Frelon liner, which is bonded to the inside of the cylindrical shell. While both are self-lubricating, the Frelon liner has shown superior performance in terms of total wear and PV value.

#### **Plain Bearing Profile**

- Close fit and wiping action cleans the shafting and eliminates the need for seals in 90% of applications
- Shock loads are absorbed without damage to components
- Reliable friction characteristics that do not increase over the life of the bearing
- Designed to virtually eliminate catastrophic failure



#### Patented Frelon® Liner

At break-in, Frelon deposits a microscopic film on the shaft, filling in valleys on the surface finish, and creating a Frelon-on-Frelon running condition that is considered true self-lubrication.



Shaft

#### **Learn More!**

Technical White Paper: Simplicity® Bearings from PBC Linear vs. DryLin® Bearing from Igus

## **Cam Rollers**

Cam roller guides (also referred to as cam followers) are essentially rollers that are mounted on radial ball bearings. (Cam roller guides can also be designed around roller bearings rather than ball bearings, but for the purposes of this discussion, we'll focus on ball bearing types.) In most applications, multiple cam roller guides are mounted inside a housing, although they can be used independently. In either case, the profile of the cam roller's outer surface determines what type of guide it rides on. Cam rollers with a flat outer diameter ride on flat, steel surfaces. If the outer surface of the roller has a concave groove, the cam roller will ride on a small-diameter shaft, and if the outer surface has a vee groove, the cam roller will ride on a v-shaped rail. The latter style is sometimes referred to as a "v-guide."

Radial ball bearings are known for their high-speed capabilities, and this characteristic extends to cam roller guides, with maximum speeds typically between 5 and 10 m/s (16.4 to 32.8 ft/s). Cam roller guides can be mounted on non-machined surfaces and are easy to maintain and replace.

#### **Cam Roller Profile**

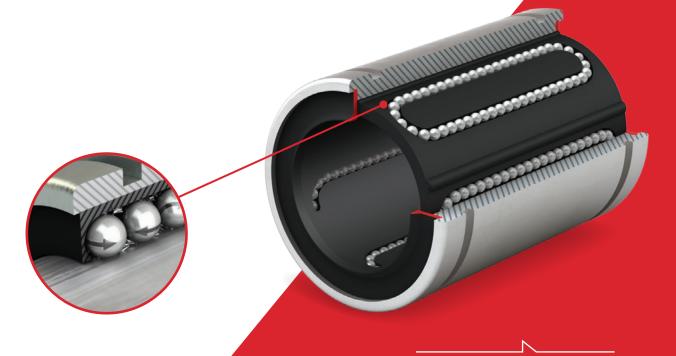
- Uses linear precision rails and sliders to provide high accuracy and high speed linear guidance in an economical solution
- Cam roller guides (also referred to as cam followers) are essentially rollers that are mounted on radial ball bearings

## Recirculating **Ball Bearings**

Linear recirculating ball bearings are broken down into two main types, characterized by the shape of the guide they ride on—round shaft and profiled rail. In both types, steel balls carry the load and recirculate through the bearing, from a load-carrying zone to a non-load-carrying zone known as the recirculation zone

Round shaft types were first commercialized in the 1940's and provide high capacity and good stiffness for industrial applications, especially when the guide shaft is fully supported. This supported design evolved into what we know today as the profiled rail bearing, which was introduced in the 1970's.

Round shaft ball bearings offer good load capacity and speed capability at a relatively low price point. Profiled rail linear bearings provide both higher load capacity especially for overhung loads – and higher stiffness, but have more stringent mounting requirements.



#### **Recirculating Linear Ball Bearing Profile**

- There are two types of linear recirculating ball bearings: round shaft and profiled rail
- In both types, steel balls carry the load and recirculate through the bearing, from a load-carrying zone to a nonload-carrying zone known as the recirculation zone

# 03

# **Key Performance Criteria**

When choosing a linear bearing for an application, several key criteria should be considered.

While many application requirements are based on quantitative factors such as load and speed, some aspects like maintenance requirements and the complexity of mounting are more difficult to quantify. However, when choosing between the three main types—plain bearing, cam roller, or recirculating bearing—there are five criteria that will help guide the process:

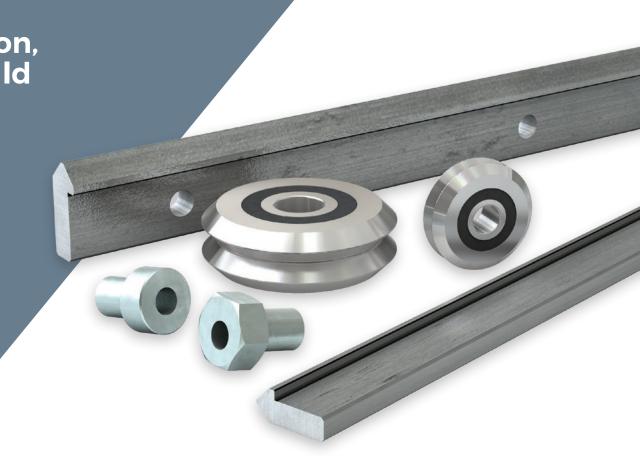
**O3.1** Environment

O3.2 Load & Life

O3.3 Speed Capability

**03.4** Precision

03.5 Installation & Maintenance



## 03.1 Environment

The environment that a bearing operates in may contain many hazards, including coarse or very fine particulates, liquid contamination, extremely high or low temperatures, or even radiation. The type of working environment can also dictate what materials or construction the bearing should be equipped with to run effectively.

One example is the washdown environment. Bearings used within these settings must be able to withstand an array of high-pressure sprays using caustic chemical solutions, and should have no sharp corners that could trap particulates. To prevent corrosion in washdown applications, we recommend our Simplicity plain bearings that are constructed with 316 stainless steel bearing

> housings and Frelon J or W liners, along with 316 stainless steel guide shafting.

Another example of environments that have specific requirements are cleanrooms, often found in semiconductor and electronics industries. Here. the amount of particulate that can be generated is specified by the "class" (or stringency) of the cleanroom environment. In these applications, unlubricated sliding friction is usually discouraged, which rules out fullcontact seals like those found on recirculating ball bearings. Conversely, grease and oil lubrication can degrade the cleanliness of the environment. This is where the diversity of materials available for plain bearings gives them a significant advantage over cam roller guides and recirculating ball bearings. The self-lubricating characteristics of Simplicity plain bearings, along with low outgassing and minimal particulate buildup, make them an excellent product for cleanrooms and vacuums.

Shafts and rails for plain bearings can be aluminum, steel, or stainless steel, and can be coated to withstand specific types of contamination, such as salts or other corrosives. And the bearings themselves can be bronze, aluminum, stainless steel or lined with plastic or composite to provide additional resistance to contaminants, such as Simplicity plain bearings.

For a comparison of Simplicity bearing materials and their suitability for use with specific chemicals, or more on washdown applications, check these out:



#### **Learn More!**

**Download The Chemical Reaction Chart** and the Technical White Paper for Linear Motion in Washdown Applications

## Washdown

applications include bottling, food processing, and pharmaceuticals. The goal of these washdown operations is to kill and eliminate bacteria or other micro-organisms that can cause and spread disease.

#### Outgassing in Cleanrooms

Testing has been done on the Frelon® materials in accordance with ASTM E-595-90 with acceptable maximums of 1.00% TML and .10% CVCM.

MATERIAL	%TML	%CVCM
FrelonGOLD®	0.00	0.00
Frelon J	0.18	0.01

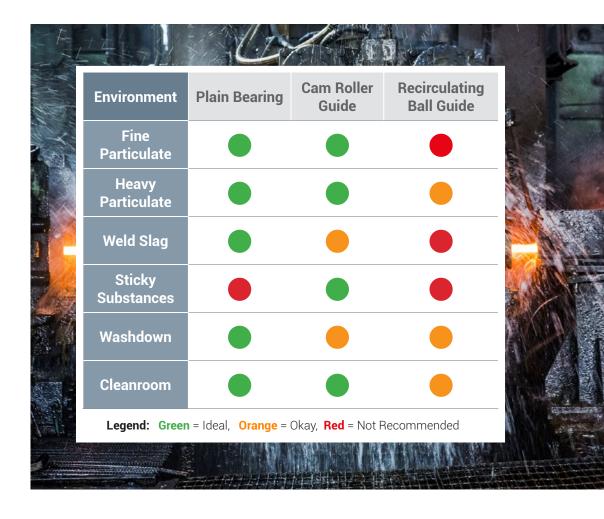
TML = Total Mass Loss CVCM = Collected Volatile Condensable Materials

### 03.1 Environment

#### Consider Seals for your Bearing

Recirculating ball bearings can be, and often are, used with seals to prevent contamination from getting inside the bearing housing. But seals are not perfect—especially for very fine particulates and liquid contamination. And seals add friction to the bearing assembly, which increases heat generation and requires more force to move the system. Recirculating ball bearings are also susceptible to corrosion and are generally not suitable for washdown environments.

Cam roller guides can be made of either aluminum or steel, with aluminum versions able to withstand some types of liquid contamination. They're also a good choice for applications with either fine or large particles, as the rollers tend to wipe particulates from the guide rail.





Which linear bearing is best depends on the type of environmental contamination. The chart above shows the relative suitability of each bearing type for some of the most common environmental conditions.

One of the first things to consider when choosing a linear bearing is, "Can it carry the required payload? And if so, what life expectancy will the bearing have under this payload?"

#### Static & Dynamic Load

There are two types of loading for bearing assemblies: static and dynamic. As their names imply, static load is any load that the bearing encounters when it is not moving, and dynamic load is the load it sees when it is moving. The load can be a pure force, such as a downward force directly over the bearing, or it can be a moment, such as an overhung load to the side of the bearing.

For rolling element bearings such as cam roller guides and recirculating ball types, the sustainability of a bearing to carry the required load is most commonly determined by the L10 bearing life equation, which is based on the bearing's dynamic load capacity. The L10 bearing life is a statistical prediction of the distance (or number of revolutions) that a bearing can travel before it reaches the end of its useful life. But it's important to note that the L10 life is based on the magnitude of the load applied to the bearing under ideal conditions, meaning it does not take into account other factors such as shock loads, vibrations, or contamination—all of which can affect the bearing's useful life.

Per the international standard, all lifetimes are calculated to an L10 life of 100 km (105 meters). The L10 Life Formulas are a statistical probability formula with a success rate of 90%., meaning that 10% of the population has failed upon traveling that distance. Lower and higher success rates are designated by different L-Values. For example, L50 is equal to a reliability of 50%, while L1 is equal to a reliability of 99.0%.

It is also important to consider how a customer defines failure. Depending on the application, a customer's definition of failure could range anywhere from catastrophic to a worn gap that has widened to the point where system performance is no longer acceptable. Some suppliers may choose to rate their bearings based upon a useful life of less than 100 km or a probability of success less than 90%. This causes their bearings to falsely appear to have a higher static and dynamic load capacity. If a catalog does not specifically note L10 = 100 km, caution should be used when comparing load capacity or life values between suppliers.

# Consider This Scenario

A backpacker may be able to carry
a 20-pound pack for 8 miles before
he tires, but he can only carry a
40-pound pack for 3 miles before tiring.



#### Shock Load Facts & Figures

Shock loads, which are a type of static load, can be especially problematic for recirculating ball bearings. This is because the impact from the shock load can cause brinelling (indentations) to the balls and raceways of the bearing, which leads to premature failure. Plain bearings are much more capable of withstanding shock loads, since the load is spread across the bearing surface and not localized to a select number of load-carrying balls.

L10 life for recirculating bearings is determined by the following equation:

$$L = (\frac{c}{F})^3 \times 10^5$$

#### Where:

L = statistical bearing life

C = dynamic load capacity of bearing

F = load applied to bearing

Notice the cubic relationship between the load ratio (C/F) and the bearing life. This means that if the load ratio is doubled, the bearing life will increase by eight times!

The load ratio can be increased by either increasing the dynamic load capacity (C) or reducing the applied load (F). In the real world, it's rarely an option to decrease the applied load, so the most practical way to increase life is to choose a bearing with higher load capacity (C)—in other words, up-size the bearing.

#### Here's an example:

An application has an applied load (F) of 5000 N, and the selected bearing has a rated dynamic load capacity (C) of 15,000 N. The life of the bearing will be:

$$L = (\frac{15,000}{5,000})^3 \times 10^5$$

$$L = 2.700.000$$

If the required bearing life is 6,000,000 m, then the selected bearing will not be sufficient. So let's choose the next larger bearing, with a rated dynamic load capacity of 20,000 N. Now, the bearing life will be:

$$L = \left(\frac{20,000}{5,000}\right)^3 \times 10^5$$

$$L = 6,400,000$$

A 33 percent increase in bearing rated load capacity (from 15,000 N to 20,000 N) resulted in more than twice the bearing life (2.37 times, to be exact)!

Of course, in order to achieve this, we had to select a larger bearing, which adds cost, weight, friction, and inertia to the system.

To learn more about how to calculate bearing life, check out our white paper:



There are three key determining factors to review in the proper selection of a plain bearings suitability for a particular application. P (Pressure), V (Velocity) and PV (Pressure x Velocity). Pressure must first be calculated by taking the applied dynamic load / effective surface area of the bearing. All three criteria must be met for a plain bearing to be properly sized for an application.

The final determination of a plain bearing's suitability for a particular load is its PV rating, which is the maximum pressure (dynamic load) applied to the bearing, multiplied by the bearing's maximum velocity. Manufacturers determine a bearing's PV rating through empirical testing and real-world experience.

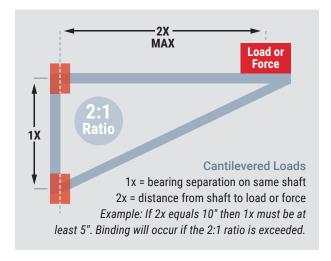
PV = Pressure (P) x Velocity (V)

To learn more about how PV and surface area affect a plain bearing's load and life performance, check out the blog:



When the application involves overhung loads, there is a limitation to how much offset load a plain bearing assembly can move. This limit can be quantified by the 2:1 ratio, also referred to as the "binding" ratio, which is defined as the maximum ratio of moment arm length to bearing length, which will not cause binding (prevent motion).

For plain bearings, the generally recommended ratio of 2:1 means that the moment arm distance should not be more than two times the length of the bearing. If two bearings are used, the bearing length is defined as the center-to-center distance *between* the two bearings.



than plain bearings. Profiled rail recirculating bearings are the best choice for high moment loads.



# GOOD BETTER BEST Cam roller guides generally have lower moment load capacities than plain or recirculating heavy loads – higher than round shaft recirculating capacities that are similar to or greater

bearings. But keep the 2:1 ratio in mind for

overhung loads. For applications with shock loads, plain bearings are the best choice.

ball bearings.

#### Binding Ratio Facts & Figures

The binding ratio is not unique to plain bearings.

Recirculating ball bearings also have a binding ratio, but it is rarely a consideration in recirculating bearing applications. This is because the primary factor in determining the binding ratio is the bearing's coefficient of friction – the lower the coefficient of friction, the larger the binding ratio.

The coefficient of friction,  $\mu$ , for plain bearings can generally be stated as 0.1, whereas the coefficient of friction for recirculating bearings is typically in the neighborhood of 0.01 (with seals and light preload).

Comparing the coefficients of friction of two bearings demonstrates the difference in their binding ratios. Using the example above, the recirculating bearing has a coefficient of friction that's 10 times lower than the plain bearing's ( $\mu$  = 0.01 for recirculating bearings vs.  $\mu$  = 0.1 for plain bearings). Therefore, the binding ratio of the recirculating bearing will be 10 times larger, at 20:1, then the binding ratio of the plain bearing (2:1).

To see how the relationship between coefficient of friction and binding ratio is derived, and to learn when it's ok to break the 2:1 rule, check out the white paper.



Static coefficient of friction is also important when sizing the drive mechanism (such as a belt, screw, or rack and pinion) and motor. Static friction – that is, the friction that a load experiences when it's at standstill – can have a significant influence on the overall system. In order to break the static coefficient of friction, which is typically slightly higher than the dynamic coefficient of friction, we use the static factors ( $\mu$ ) of 0.15 for plain bearings and 0.015 for recirculating ball bearings. Using these conservative estimates, we can compare the maximum force needed to propel a plain or recirculating ball bearing from a static position forward. See the chart to the right.

This may not seem like a significant difference, but if the load is 1000 lb, the force to break static friction with a plain bearing is 150 lb, whereas only 15 lb of force is needed when a recirculating bearing is used. The lower coefficient of friction of the recirculating bearing makes it possible to use a smaller drive mechanism, gearbox, motor, and other related components.

#### Force to Overcome Static Friction (lb)

Load on Bearing (lb)	Plain Bearing (μ = 0.15)	Recirculating Bearing (μ = 0.015)
10	1.50	0.15
25	3.75	.375
50	7.50	0.75
100	15	1.50
500	75	7.50
700	105	10.5
1000	150	15.0
1500	225	22.5

## 03.3 Precision

The term "precision" is used in many different contexts, but when discussing linear bearings it often refers to the bearing's rigidity, which is a function of the clearance or "play" between the bearing and the guideway.

Plain bearings, by design, require some clearance between the bearing and the guide in order for the carriage to move. This running clearance is not adjustable, and depending on the bearing materials, design, and application, the clearance may increase over time as the bearing wears.

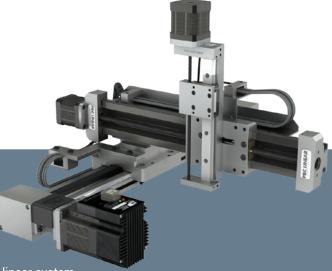
Cam roller guides and recirculating ball bearings also have clearance, but both bearing types can be preloaded to remove the clearance and improve rigidity. With cam roller guides, clearance is removed by adjusting eccentric cams via screws on the top or the side of the carriage. The side-adjustment method, patented by PBC Linear, allows users to set an accurate preload without the need to disassemble the machine or remove any external equipment attached to the carriage.

To see how the patented side-adjustment method works, check out the Technical Short video:

Recirculating ball bearings are preloaded by using balls with a diameter that's slightly larger than the space between the bearing and rail raceways. This method allows the manufacturer to achieve a very precise amount of preload, typically anywhere from 2 to 8 percent of the dynamic load capacity.

Two other common uses for the term "precision" actually refer to travel accuracy or to repeatability. Travel accuracy specifies how the bearing behaves as it travels along the guideway. In other words, does it move side-to-side or up-and-down as it travels?





## **Regardless of** the specification

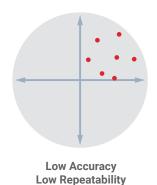
-precision, travel accuracy, or repeatability-there are many other factors that influence the performance of a linear system.

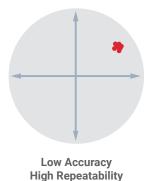
Along with linear bearings, contributing parts include the mounting surface and alignment, the drive mechanism, the type of motor and controller used, and even secondary components such as couplings and mounting brackets.

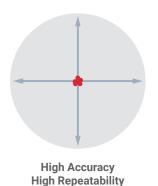
#### 03.3 Precision

Depending on the application, travel accuracy can be an important factor in selecting a linear guide. Of the three technologies discussed here—plain bearings, cam roller guides, and recirculating ball guides—only profiled rail recirculating ball guides have a standard specification for travel accuracy. But keep in mind that the accuracy of any linear guide is influenced by the surface to which it's mounted. So using a high accuracy linear guide on an aluminum plate or a piece of unmachined steel will erode the travel accuracy of the guide.

Repeatability refers to the ability of a system to return to a given location over and over again. It most often applies to the drive mechanism—screw, belt and pulley, or pneumatic cylinder, for example. But deflection in the linear bearing, due to a lack of stiffness, can also influence a system's repeatability.









GOOD	BETTER	BEST	
Plain bearings have slight clearance between the bearing and the guide. When a load is applied during motion, this clearance is removed in the direction of the load and the bearing will perform similar to a preloaded system.	Cam roller guides have adjustable preload, which allows the user to reduce or eliminate clearance and improve precision.	Recirculating ball bearings can be preloaded to an exact specification for high stiffness and the highest precision. Keep in mind, however, that the preload of a recirculating bearing is not adjustable.	

# **03.4** Speed In most cases, any linear bearing type will be capable of meeting the application's speed requirements, and the limiting component becomes the drive mechanismscrew, belt and pulley, pneumatic cylinder, linear motor, or rack and pinion. But forces due to acceleration increase the dynamic load on the bearing, which can reduce the maximum speed and cycle time of the system. A unique feature of plain bearings is their ability to provide both linear and rotary motion. For example, in packaging equipment, a filling machine requires linear motion to move bags along the production line to be filled and sealed, and then rotary motion to unload the finished bags and transfer them to the next operation.

Cam roller guides can typically reach maximum speeds up to 39.4 ft/s (12 m/s) when preloaded, and are very common for long length, high-speed applications, such as belt driven actuators.

The maximum speed for recirculating ball guides is commonly 16.4 ft/s (5 m/s), limited by the recirculation of the balls within the bearing housing. The combination of

high load capacity, relatively high speed, and high travel accuracy make recirculating bearings a good fit for linear motor assemblies and applications such as machining and measuring.

Plain bearings are usually catalog-rated for speeds up to 6.6 ft/s (2 m/s), but their PV rating is critical for determining the maximum load and speed that

can be achieved. Plain bearings excel in short-stroke applications, whereas recirculating bearings require a minimum stroke length (typically two times the length of the bearing) to ensure that all of the recirculating elements are receiving adequate lubrication.

	GOOD	DETTER	DEST
Verdict	Recirculating ball guides meet the speed requirements of most applications, with a maximum speed of 16.4 ft/s (5 m/s).	Plain bearings are generally rated for 6.6 ft/s (up to 1.5 m/s without lube and 4 m/s with lube).  Depending on the bearing's PV value, higher speeds might be possible. They are ideal for short stroke applications and can provide both linear and rotary motion.	Cam roller guides have the highest speed capabilities at 39.4 ft/s (12 m/s), but they must be preloaded in order to achieve higher speeds.

## 03.5 Installation & Maintenance

#### Installation

Beyond the standard application criteria, the complexity of installation and maintenance can be significant factors in choosing a linear bearing. A tedious installation process adds cost and time to the system, and laborious maintenance requirements are unlikely to be followed, resulting in a system that fails prematurely.



The traditional linear bearing application consists of two guide rails (or shafts) in parallel, mounted to a supporting structure, with two bearings on each rail (shaft).

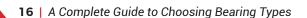
Installation considerations include how precise the mounting surface should be, the level of parallelism required for the guideways, and the labor required for actual mounting of the guides and bearings. In general, the higher the precision of the linear bearing, the more stringent these requirements will be. For example, profiled rail linear guides require mounting surfaces that are ground and finished to a high level of precision in order to maintain their high accuracy and rigidity. Mounting the guide rail to a machined reference edge ensures straightness, and the use of mounting screws every 2 to 3 inches ensure flatness to maintain travel accuracy.

Round shaft assemblies, both recirculating ball types and plain bearing types, have less demanding requirements for mounting surface accuracy and parallelism between shafts. This is because the bearings can compensate for slight misalignment without degrading the bearing life.

Cam roller guides benefit from dual guideways that are spaced far apart, but maintaining good parallelism between the guides is important to prevent uneven loading on the cam rollers. One solution is to use a single wider cam roller rail guideway with raceways on each side, which provides many of the benefits of a two-rail, four-bearing system, but in a much smaller envelope. The advantages include pre-installed alignment with greatly reduced installation costs.

#### **Dual Shaft Alignment (Parallelism)**

Misalignment can lead to increased co-efficient of friction, premature wear, and possibly binding that results in catastrophic failure.



#### 03.5 Installation & Maintenance

#### Maintenance

Beyond the standard application criteria, the complexity of installation and maintenance can be a significant factor in choosing a linear bearing. A tedious installation process adds cost and time to the system, and laborious maintenance requirements are unlikely to be followed, resulting in a system that fails prematurely.

The most important aspect of linear bearing maintenance is lubrication, and because lubrication is critical to any linear bearing, the maintenance process should be as simple as possible. When evaluating ease of maintenance, the two factors to consider are "How difficult is it to lubricate the bearing? And how often should it be done?" In this regard, plain bearings have the advantage over all other types, due to their self-lubricating properties.

To learn more about debunking the myths of "lubed for life", check out the white paper:



#### **Learn More!**

Technical White Paper: The Science of Self-Lubrication in Linear Motion



## Important Fact...

Regardless of the bearing type, material, or application, all bearings need lubrication. It reduces wear and stress on the contact surfaces, reduces friction (which in turn, reduces heat buildup), and protects against corrosion.

For more information on linear bearing lubrication, see the white paper:



#### **Learn More!**

Lubrication for Linear Roller
Bearings and Raceways

#### 03.5 Installation & Maintenance

#### Maintenance

Lack of lubrication is one of the primary causes of bearing failure for recirculating ball bearings. Most bearings with metal-on-metal contact can be lubricated with either grease or oil, and the choice of which to use depends on the bearing type and application parameters.

Prior to the usage of ball bearings, lubricants should be applied directly inside the linear bearing and shaft, and re-lubricated periodically according to the operating conditions. Some systems from PBC Linear are sealed to block dust out and seal lubricant in If used in a harsh or corrosive environment a protective cover should be used

Some manufacturers offer "lubed for life" linear recirculating bearings, but users should be aware of how "life" is defined. If the application exceeds the

manufacturer's specified life for the lubrication, it will be necessary to re-lubricate the bearing. This often requires stopping the machine or process to manually apply lubrication, but it can also be done via an automatic lubrication system, depending on the machine's design. To truly be self-lubricating, a bearing system must provide its own lubrication throughout the entire life of the system without the aid of some external source.

Simplicity plain bearings from PBC Linear offer selflubrication for the entire life of the bearing. The interaction of the Frelon® material with the shaft works to fill in pits and valleys on the mating surface, creating a film that provides lubrication and reduces friction over the length of the rail or shaft. This transfer creates the true selflubricating condition of Frelon riding on Frelon.

Cam roller guides can also be lubricated with either grease or oil. When running at speeds greater than 16.4 ft/s (5 m/s), oil lubrication is typically recommended. Cam roller designs often have felt wipers or oil-filled polymer lubricators to minimize the external lubrication that must be applied.

Most cam roller products from PBC Linear are lubricated internally and sealed against the operating environments. For the raceways, a thin film of lubrication is recommended to ensure long life. Over time, proper lubrication maintenance should be applied dependent on the operating and environmental conditions. As a general guideline, PBC LInear recommends re-lubrication every 1000 km, 50000 cycles, or every six months.



GOOD

raceways on a single rail, can provide accuracy similar to profiled rail recirculating bearings without the stringent mounting requirements. Cam roller guide maintenance is minimized when internal lubricators are used.

**BETTER** 



**BEST** 

Plain bearings are simple to install and align, and require virtually no maintenance.

# 04

# **Summary**

While each case is unique and some applications require linear bearings that can meet multiple performance challenges, the following guidelines can help you narrow the field of options during initial design and sizing of a linear bearing system.

Environment	Plain Bearing	Cam Roller Guide	Recirculating Ball Guide
Fine Particulate			
Heavy Particulate			
Weld Slag			
Sticky Substances			
Washdown			
Cleanroom (electronics/semiconductor)			

Key Performance Criteria	Plain Bearing	Cam Roller Guide	Recirculating Ball Guide
Load & Life			
Precision			
Speed			
Installation & Maintenance			

**Legend:** Green = Ideal, Orange = Okay, Red = Not Recommended

