



# THE BEARING SELECTION PROCESS

Your essential guide



# Your essential guide to the bearing selection process

**Most sectors have consultants, who suggest how to do something, and contractors, who work to meet an already decided-upon specification. Consultants are incredibly knowledgeable, of course, as they decide how the end picture should look and the best ways of getting there. However, we must also commend the ability of contractors to make consultants' end visions a reality.**

For contractors, it's not always as simple as reading the specification and 'getting on with it'. Let's use the example of a design engineer who's working for a manufacturer of remote-control helicopters. The project — at least on paper — should result in a very competitive high speed, low maintenance RC helicopter. The specification is set. However, while the document defines the frictional coefficients of rotational elements inside the helicopter, it doesn't specify exactly which RC bearings should be purchased in order to make these ambitious parameters a reality.

So, it's down to the design engineer to solve this problem. They must source the best bearings for the job and do so within budget.

The consultant-contractor dynamic comes in many other forms, too; a coach and a pro skateboarder for example. The 'consultant' coach recommends a specification for the skateboarder's performance but, ultimately, it's down to the skateboarder to meet that specification. The skateboarder must have the right mentality and equipment to succeed — right down to maintaining their skateboard, which might include equipping it with high-quality bearings!

Whatever the nature of a project, the bearing selection process can be challenging. "What kind of bearings do I need?" is a more complex question than it first appears.

For project managers with ambitious specifications to meet, this decision cannot be taken lightly. This guide is intended to help you make the right decision, and talks you through some of the most important factors to consider when choosing bearings.

Of course, if you still have questions after reading this guide, then you can reach out to us at [sales@smbbearings.com](mailto:sales@smbbearings.com) or call +44 (0) 1993 842 555.

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**ENVIRONMENT**

**SIZE**

**SPEED**

**LOAD**

**TOLERANCES**

**LUBRICATION**

# WHAT IS THE BEARING DOING?

If you have no idea of the type of bearings you need, then your first question should be, “what is the bearing doing?” In what application or environment will it be used? This is a crucial starting point, as even the best quality bearings will not perform well in an ill-suited environment. It’s not just about load and speed. Factors like moisture, chemical exposure or temperature can be the biggest influencers on bearing choice.



For high moisture environments like marine applications, Full ceramic bearings are the go-to option for fully submersed applications. 316 grade stainless steel bearings are also commonly used in moving water or above the waterline. Also known as marine grade stainless steel, this material is an austenitic stainless steel, meaning it has very good corrosion resistance.

Full ceramic bearings have good load capacity and conform to standard bearing tolerances but 316 stainless steel, unlike 440 grade martensitic stainless steel, is not hardenable by heat treatment. As a result, 316 stainless steel has a much lower load capacity than the standard 440 grade stainless steels most commonly used for bearings.



This softer grade of steel is also more difficult to grind to very close tolerances than chrome steel or 440 stainless steel, so marine grade 316 bearings are semi-precision, and therefore less suited to high-precision automation and metrology applications.

# CORROSION RESISTANCE

For exposure to very weak acids and alkalis, the most common corrosion resistant bearings are made from 440 grade stainless steel. The grade can be supplied with chemically-resistant lubricants or food-approved lubricants for the pharmaceutical industry. For the most extreme ends of the pH scale, full ceramic or 316 grade stainless steel bearings are better suited to aggressive environments.



# HIGH TEMPERATURE APPLICATIONS

High temperature applications, such as furnaces, require careful thought as all bearings have temperature limits. Usually, the material weakens above a certain temperature and the bearing can no longer handle any meaningful load or speed. Provided that a suitable lubricant is used, chrome steel bearings can handle temperatures of up to 150 °C, while 440 grade stainless steel bearings can be used at up to 300 °C. Above these

temperatures, a change of material is required, such as a full ceramic bearing.

If your application is not moisture-facing, acidic or burning hot, then chrome steel bearings should be sufficient. These are the most commonly-requested workhorse bearings, and prove themselves time and time again in a range of applications.

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# SPEED, SIZE AND LOAD REQUIREMENTS OF THE BEARING

By this point, the more suitable bearing material for your requirements should be apparent — whether it's chrome steel, stainless steel, ceramic or another material. Next, you can begin to look at the speed, size and load requirements of the bearing.

## IT'S IMPORTANT TO MANAGE EXPECTATIONS OF SMALLER BEARINGS VERSUS LARGER BEARINGS



The size of a bearing is dictated by the size of its shaft and housing. Another important deciding factor on size is load requirements — if the bearing is expected to take on very heavy loads, then it will need to be relatively large.

While ultra-compact is often the preferred choice for design engineers, a bearing with a particular bore diameter will offer different load capabilities depending on the outer diameter. So, depending on load requirements, you may end up needing a larger bearing than first anticipated.



Information on a bearing's load capabilities should be supplied by the manufacturer, which means your bearing supplier should be able to point you in the right direction. Load ratings are used in life calculations and are not an indication of the load you should apply in real life. We look at this in more detail in the "Load" section.

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# SPEED

At SMB Bearings, we've had instances in the past where customers have sought bearings with a speed rating far higher than anything we supply — or that we know anyone else can supply! Some of the smallest miniature bearings can run at 150,000 revolutions per minute (rpm) but this is not achievable with something much larger and, as with load capacity, pushing a bearing beyond its speed limit is ill-advised.

Different materials offer their own speed capabilities, alongside other benefits, and choosing a bearing is about weighing these up. For example, while plastic bearings are non-magnetic and corrosion resistant, running a plastic bearing at several thousand rpm is not advised. For contractors requiring these speeds, a fully hardened steel bearing is generally the better option. For very high speeds, these may need to be supplied with a high-speed cage or ceramic balls or both!

Full ceramic bearings have speed limitations because of their brittleness. A full ceramic bearing may be required to endure extremely acidic conditions without corroding. On the other hand, the bearing cannot run at high speeds without cracking. That isn't say a resolution cannot be found, but it might entail using a stainless steel bearing and accepting a shorter lifespan.

## **WHATEVER YOUR APPLICATION, IT'S IMPORTANT TO RESPECT THE SPEED RATING PROVIDED BY THE MANUFACTURER.**

Speed ratings are also used in life calculations so, the higher the speed, the shorter the life. Pushing bearings to higher levels of performance than their design intends will not pay-off.



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# LOAD

Load capabilities are related closely to bearing size. Generally speaking, a small bearing can take on a small load while a large bearing can take on a large load. Makes sense, right?

However, contractors can expect too much from small bearings, and applying too high a load can wear them out in a matter of days. As a supplier that frequently receives requests for bearings that can last longer than 100,000 hours, SMB Bearings understands the important balance between load and speed!

**IT IS VERY IMPORTANT TO UNDERSTAND THAT THE ACTUAL LOADS IN AN APPLICATION SHOULD BE SIGNIFICANTLY LESS THAN A BEARING'S MAXIMUM LOAD RATING.**

The maximum dynamic load rating is what a bearing can endure for one million revolutions. If you applied that load to a bearing rotating at 10,000 rpm, it would only last 100 minutes. We can supply theoretical life calculations for different loads to help a customer decide if a particular bearing will do the job. Any advised maximum load should be adhered to, as pushing a bearing beyond its capabilities will result in early failure.

By all means, check the bearing load ratings provided by the manufacturer as long as you only use these in a life calculation. It is better to find out, at the design stage, that your ideal size will not offer anywhere near the required life and a larger bearing is necessary.



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# DON'T FORGET ABOUT SHAFT QUALITY

With all this talk about bearings, it is easy to neglect the vital component that supports the bearing — the shaft. There have been cases where bearings have failed because the shaft wasn't up to standard.

**AT FIRST GLANCE, IT CAN LOOK AS IF THE BEARINGS HAVE FAILED DUE TO THEIR OWN LIMITATIONS WHEN, IN FACT, THE ACTUAL ISSUES ARE POOR SHAFT TOLERANCES AND QUALITY.**

The shaft or housing must be machined to the correct tolerance, to ensure a suitable fit and to keep the internal clearance of the bearing within acceptable limits. Poorly machined shafts can also greatly increase bearing noise. A tight shaft or housing fit will reduce a bearing's internal clearance so shaft and housing tolerances must be carefully controlled while also paying attention to the expansion coefficient of the shaft material if it happens to be different to the bearing material. A tight fit is needed in applications with a lot of vibration, as this prevents the vibration from causing the bearing to move within its mountings. Tight fits can provide extra support to

the inner or outer ring if the bearing is subjected to a very heavy load. Tighter-than standard-fits are also recommended when accurate rotation is needed.

If we assume that the shaft and housing are manufactured to the same tolerance as the bearing, then tighter bearing tolerances have several advantages. They can improve mating between the shaft and the bearing, improve noise and vibrational levels, and reduce torque. If these qualities are important to your application, then check the tolerances quoted by your bearing manufacturer and shaft manufacturer.

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So, we have reached the point where you've chosen the best bearing for the job, and a shaft that matches the bearing. But it's still possible to undo this hard work. How? By filling a bearing with the wrong kind or quantity of lubricant. Getting this decision right means, once again, assessing the end application.

For bearings used in cleanrooms for example, dry lubricants or specialist cleanroom lubricants are likely the best option as they remove risks of outgassing. Similarly, bearings that are used in the food and beverage sector will require a food-grade lubricant. For higher temperature applications, a designated high temperature lubricant should be used.

It's not an exaggeration to say that choosing the right lubricant is as important as choosing the right bearing. This can mean purchasing bearings with standard lubricant, and then having them cleaned out and refilled with specialist lubricant. This process is called relubrication, and is a service that SMB Bearings offers in-house using our bespoke equipment. Give us a call if you require lubricated bearings, even in a small quantity.



# FREQUENTLY ASKED QUESTIONS

Still confused? You're in  
the right place for answers.



# CAN BALL BEARINGS RUST?

Steel ball bearings can rust. Bearings made of chrome steel will rust easily which is why they leave the factory with the outer surfaces coated with a protective oil. Stainless steel bearings are much more corrosion resistant but will still rust when coming into contact with certain substances.

## **STAINLESS STEEL BEARINGS ARE CORROSION RESISTANT OR VERY CORROSION RESISTANT DEPENDING ON THE GRADE OF STEEL.**

440 grade stainless steel bearings have good resistance to moisture, water and many weak chemicals which is why they are very popular in the food and beverage industries. They will rust quickly if exposed to many strong chemicals, acids, alkalis and salt water.

The “marine grade” stainless steel is 316 grade. This is much more corrosion resistant than 440 grade but, as it cannot be hardened by heat treatment, it is much softer. 316 stainless steel bearings can only support much lower loads and speeds than 440 grade bearings but are suitable for many marine applications.

## **FULL CERAMIC BEARINGS HAVE EXCELLENT CORROSION RESISTANCE AND CAN BE USED WITH SEAWATER AND MANY AGGRESSIVE CHEMICALS.**

# WHAT MAKES A QUIET BEARING?

Noise in a bearing is caused by a number of factors that increase vibration. Rough or damaged balls or raceways, poor ball/raceway roundness, contamination inside the bearing, inadequate lubrication, incorrect shaft or housing tolerances and incorrect radial play can all contribute to noise.

A good quality, low noise bearing will have excellent surface finish on balls and raceways and the roundness of the balls and bearing rings will be very closely controlled. Specifying a radial play or using an axial preload that allows the bearing to operate with almost zero radial play when in use will help to control noise. If the shaft or housing tolerances are incorrect, the bearing can be too tight leading to excessive noise while poor shaft or housing roundness can distort the bearing rings, also causing the bearings to be noisy.

**IN A GOOD QUALITY BEARING, A LOW NOISE LUBRICANT IS RECOMMENDED AS FINELY FILTERED GREASES WILL ALLOW THE BEARING TO RUN QUIETLY DUE TO THE ABSENCE OF LARGER SOLID PARTICLES.**

Poor fitting practices can cause dents in the bearing raceways which will greatly increase vibration. Finally, a low noise bearing must be free of contaminants so, if the bearing is not used in a very clean environment, protection against dirt, such as contact seals, should be considered.



# WHAT ARE THE ADVANTAGES OF CERAMIC BEARINGS?

Ceramic bearings might be more expensive than steel, but these bearings provide reduced friction, reduced weight and have the potential to last much longer than the traditional stainless-steel offering in many harsh environments. That said, the application needs to warrant the increased price.

**FULL CERAMIC BEARINGS ARE GENERALLY USED IN ENVIRONMENTS THAT ARE TOO HOSTILE FOR STEEL BEARINGS SUCH AS TEMPERATURE EXTREMES OR USE WITH CORROSIVE CHEMICALS OR LIQUIDS.**

Consider bearings for marine applications as an example. Ceramic bearings can provide excellent resistance to salt water, prolonging the lifespan of the bearing in ocean environments. However, full ceramic options are not recommended where heavy shock loads are likely, due to the bearings risk of cracking. In these instances, 316 stainless steel bearings might be a better option as long as the load is low.





# WHAT ARE THE ADVANTAGES OF PLASTIC BEARINGS?

Plastic bearings are ideal if you need corrosion resistant bearings. Where some metal bearings would corrode over time, plastic bearings will stay intact. They are also much lighter than steel bearings.

**AS A RESULT, PLASTIC BEARINGS CAN BE A GREAT OPTION FOR APPLICATIONS THAT EXPOSE BEARINGS TO REGULAR WASHDOWNS, LIKE EQUIPMENT IN THE FOOD INDUSTRY.**

Similarly, plastic bearings are suitable for applications requiring non-magnetic bearings. It is important to note that plastic bearings are made to looser tolerances than our precision bearings and are referred to as "semi-precision".

Of course, we can't mention the advantages of plastic, without mentioning the reasons other materials might be better suited for your application.

**PLASTIC BEARINGS ARE GENERALLY MADE FROM ACETAL RESIN RINGS AND NYLON CAGES, WHICH ARE SOFTER THAN STEEL.**

Therefore, these bearings are intended for light loads and low speeds. Additionally, the maximum temperature for the acetal bearings with a nylon cage combination is 100°C. But if you swap both materials for PEEK, this raises the temperature resistance up to 250°C.

# THE ADVANTAGES OF STAINLESS STEEL BEARINGS

Stainless steel bearings are used where there is a risk of corrosion. Chrome steel bearings will rust easily so in the presence of moisture or chemicals, for example in the food/beverage industry, stainless steel is recommended.

**440 GRADE STAINLESS STEEL IS ONLY SLIGHTLY SOFTER THAN CHROME STEEL SO LOAD AND SPEED RATINGS ARE NOT MUCH LOWER.**

440 grade is magnetic and is affected by stronger chemicals and salt water. In these conditions, the softer 316 stainless steel can be used although at much lower loads and speeds. High nitrogen steel bearings offer increased corrosion resistance and excellent load/speed ratings but these are usually made to order and are relatively expensive.

Another advantage of stainless steel is the upper working temperature. 440 grade stainless steel bearings are suitable for temperatures as high as 300°C while 316 stainless steel can cope with much higher temperatures.



# ANY OTHER QUESTIONS?

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