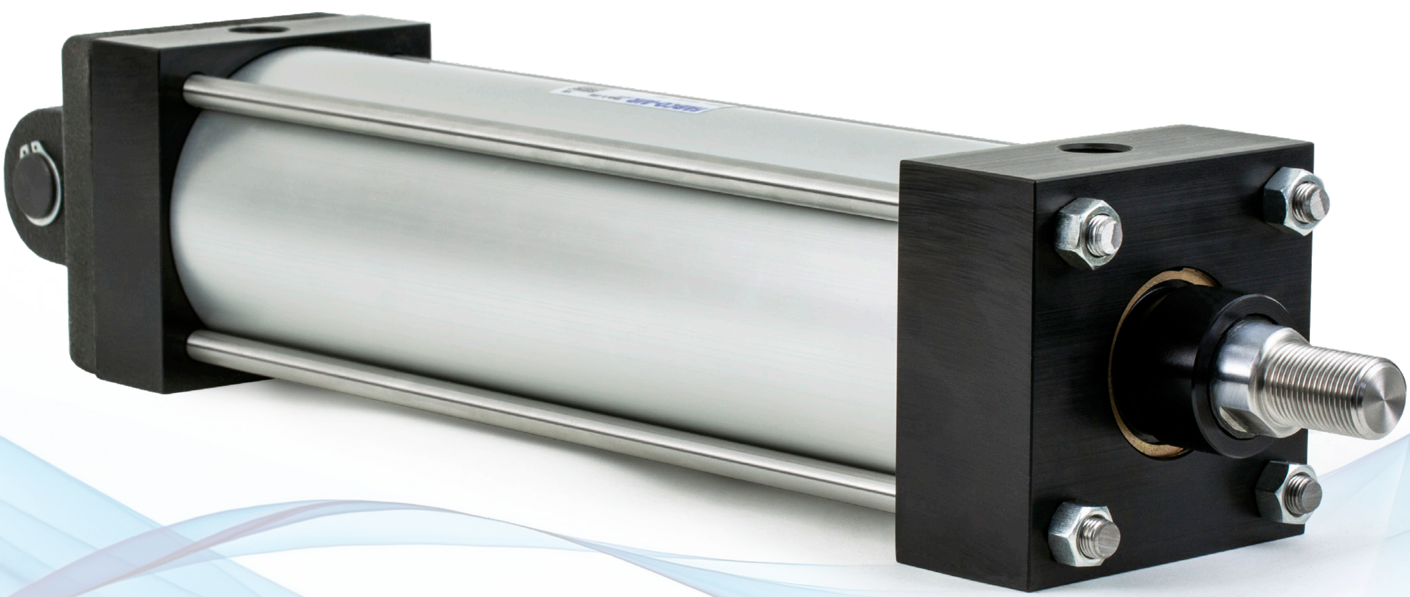
HOW TO SPECIFY

PNEUMATIC CYLINDERS



Focus on these four design aspects to avoid having to customize your model.

FABCO-AIR
A member of Festo Group

With the range of styles, sizes and shapes of pneumatic cylinders on the market today, it can sometimes be difficult to specify the type of cylinder you need for your application. As the number of standard options available on the market grows, you may feel spoiled for choice due to the sheer amount of products that may fit within your specifications. But how often is "good enough" actually good enough?

Sometimes it's easier to choose a custom cylinder, but that choice is often costly and quickly becomes cost-prohibitive if you need to work with many cylinders at once. How do you specify a pneumatic cylinder for a specific application without resorting to a custom option? To start, consider these four aspects:

- **Task**
- **Force**
- **Distance**
- **Speed**

Once you know what you'll need to work with, you will be on track to specifying the right air cylinder that meets your needs.

TASK

The first and possibly easiest step is to determine the cylinder's task. Is the cylinder intended to move horizontally or vertically? Is it supposed to push or pull? Beyond simple directions, we must also consider whether the cylinder will need to rotate the load or maintain a specific orientation. What tasks will occur in conjunction with the cylinder? Will it be compressing a rivet or clamping parts together while separate machine operations take place?

Beyond movement, you must also remember the weight and the distribution of that weight. Will the cylinder be fighting an overhung load situation? How much will the cylinder need to carry? With the cylinder's function in mind, you can begin the process of specifying what cylinder you need.

FORCE

To specify the size of your cylinder, it's essential to determine the force needed. Once you know the force, you can specify the bore size or the power factor of the cylinder by using this calculation:

Force = (Pressure Available) × (Power Factor)

Or restated: Power Factor = (Pressure Available) ÷ (Force)

This calculation does not take safety factors into account, but we will use a 50 percent safety factor as a starting point. In this case, we multiply our cylinder power factor by 1.5 and use the result to calculate the size of the bore by this calculation:

(Cylinder Power Factor) × 1.5 = π (Bore) 2 ÷ 4

You can also find the appropriate bore size using force factor tables in the manufacturing catalogs, as shown below. Sizing Guide A shows the piston area and the extended forces obtainable from various air pressures.

SIZING GUIDE A - EXTEND FORCE (LBS)												
Bore	Piston Area	PRESSURE										
		40	50	60	70	80	90	100	125	150	175	200
1 1/2"	1.77	71	88	106	124	141	159	177	221	265	309	353
2"	3.14	126	157	188	220	251	283	314	393	471	550	628
2 1/2"	4.91	196	245	295	343	393	442	491	614	736	859	982
3 1/4"	8.30	332	415	498	581	664	747	830	1037	1244	1452	1659
4"	12.57	503	628	754	880	1005	1131	1257	1571	1885	2199	2513
5"	19.63	785	982	1178	1374	1517	1767	1963	2454	2945	3436	3927
6"	28.27	1131	1414	1696	1979	2262	2545	2827	3534	4241	4948	5655

Sizing Guide A.

CALCULATING PULLING FORCE

Pulling force, which you can calculate when the cylinder retracts, depends in part on the rod diameter. As shown in Figure 1, the rod blocks the center portion of the piston, meaning that air pressure can only act on the piston's part in retract mode. Thus, the retract power factor is calculated as an annular ring: (piston area) - (rod area).

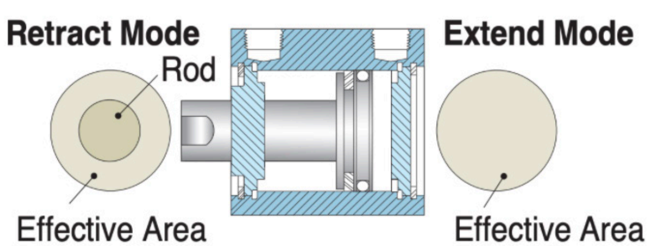


Figure 1. Effective piston areas.

As in the case of calculating the power factor, the manufacturer's tables are useful. For example, Sizing Guide B provides rod areas to more easily help you calculate pulling force.

SIZING GUIDE B - RETRACT FORCE DEDUCTION (LBS)												
Rod	Rod Area	PRESSURE										
		40	50	60	70	80	90	100	125	150	175	200
0.625	0.307	12	15	18	21	25	28	31	38	46	54	61
1.000	0.785	31	39	47	55	63	71	79	98	118	137	157
1.375	1.485	59	74	89	104	119	134	148	186	223	260	297
1.750	2.404	96	120	144	168	192	216	240	301	361	421	481

Sizing Guide B.

DISTANCE

Whatever your task, knowing the length of your stroke is an important step to identifying what type of air cylinder you need. When considering stroke length, air cylinders typically fall into four categories, but keep in mind that some cylinders may overlap in multiple categories—perhaps all of them.

- **Short Stroke, Compact Cylinders.** With strokes as short as 1⁄16 inch and bores down to ½ inch, compact, short stroke cylinders come in a variety of body styles. These cylinders are commonly used in applications like assembling, sorting, shaking, lifting, clamping, parts ejection and more.
- **Intermediate Stroke Cylinders.** Intermediate cylinders have a stroke up to 36 inches. After the factory production boom of World War II, fast-acting, light-duty automation applications became the standard, creating a need to use compressed air instead of heavier hydraulics. Constructed out of aluminum to manage weight and cut factory costs, the tie-rod cylinder became a popular model, creating this factory automation staple. Now, intermediate stroke cylinders are a good fit for pick-and-place, sorting and other automation applications.
- **Long Stroke Cylinders.** Long stroke cylinders are typically defined as air cylinders with strokes up to 99 inches. These cylinders are ideal for a variety of applications, including mining and drilling equipment, while boom-extend cylinders play an important role in cranes, motion systems and more.
- **Specialty Strokes.** Specialty cylinders, such as cable cylinders, refer to cylinders with strokes over 99 inches. These cylinders can have strokes over 25 feet and be located remotely from the workload.

SPEED

Cylinder speed is governed by the amount of air that can enter and exit the cylinder. Thus, cylinder port size and control valve size may become issues as you proceed with your design specifications. You'll want large cylinder ports and high-flow valves with adequate Cv levels if you are working with faster speeds. It's also important to keep in mind the inertial effects on your cylinder and any possible impact damage to the cylinder or your equipment. Bumpers, adjustable air cushions, shock absorbers or external stops are key to resolving most of these issues.

BUMPER OPTIONS

Bumpers are usually rubber doughnuts bonded to the cylinder head. They act as piston stops and absorb the "slap" of the piston. This function reduces noise and partially absorbs energy, minimizing damage to the cylinder and tooling due to pounding. The amount of rubber that extends beyond the piston stop is designed to compress and allow the full stroke of the cylinder at normal operating pressure.

For applications like punching or shearing, where high forces are built up and then released quickly, one way to "catch" the load is to adjust the position of the cylinder and tooling. At the point of breakthrough, the piston is very close to or touching the bumper. This positioning reduces the dynamic load absorbed by the piston and bumper. However, for high-force applications, we recommend that you consider shock absorbers.

ADJUSTABLE AIR CUSHION OPTIONS

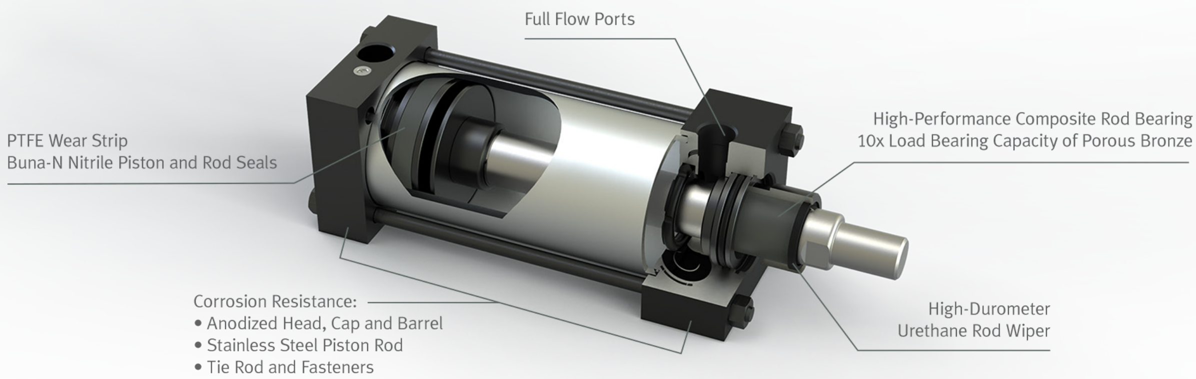
Adjustable cushions bring air cylinders to controlled stops. As a cylinder approaches the end of a stroke, the cushion blocks exhausting air and forces it through an adjustable restriction. One cushion design consists of a needle valve adjacent to the port, a spud attached to the piston and a lip-type seal that acts as both a seal and check valve. As the cylinder nears the end of a stroke, the spud enters the check seal, closing off the exhaust port and forcing the captured air through the adjustable needle valve, providing a smooth, controlled deceleration. On the return stroke, pressured air collapses the rim of the lip seal, allowing full airflow and providing a quick breakaway.

A long cushion spud allows you to adjust the cylinder to stop short of a full stroke while still having plenty of controlled cushioning. For slow speeds, you'll need to consider restricting the airflow leaving the cylinder using basic flow control valves. Restricting airflow into the cylinder can cause jerky, erratic motion.

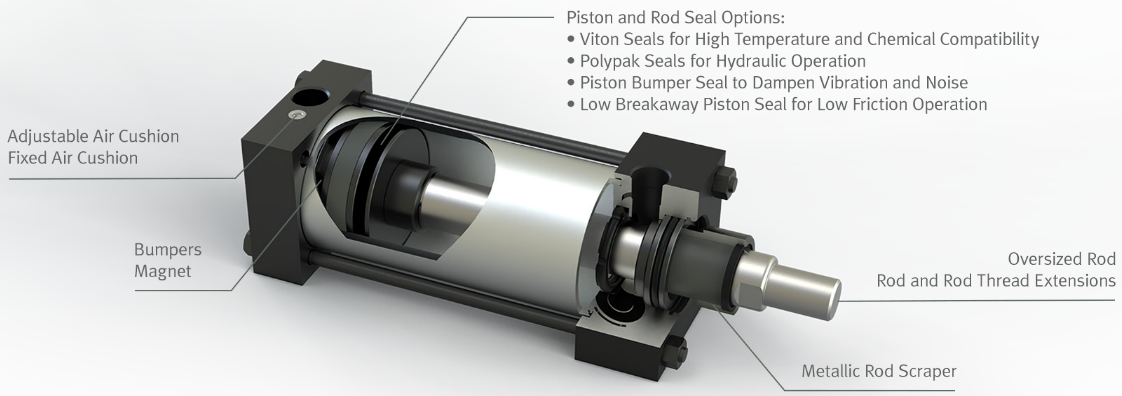
LEARN MORE

At Fabco-Air, we've attempted to take some of the guesswork out of specifying pneumatic cylinders. We've categorized shapes, types and sizes by tying them to standard options and alternative products that can sometimes help you avoid defaulting to custom models. However, if a standard product doesn't work—come to us for technical support and assistance.

STANDARD CONFIGURATIONS



OPTIONAL CONFIGURATIONS



Sorting through the many features and specifications of air cylinders from various manufacturers can be daunting. One good way to simplify this process is to consider NFPA style actuators, which adhere to a common set of standards, enabling you to standardize your design.

For more information, visit www.fabco-air.com.

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