Vacuum Table Specification

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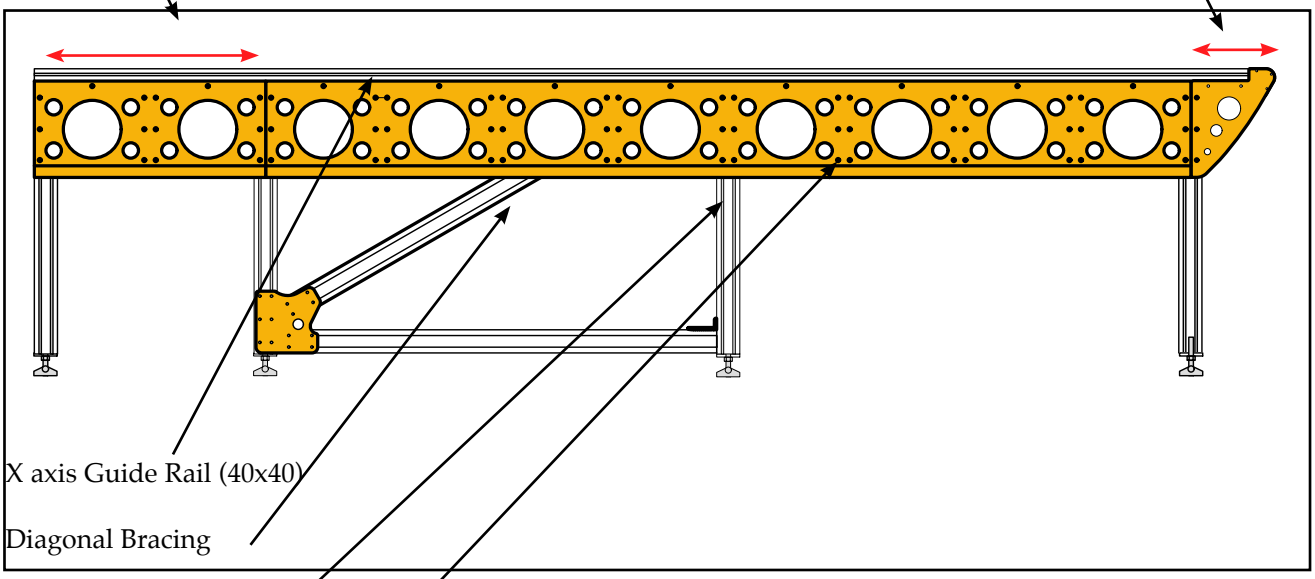
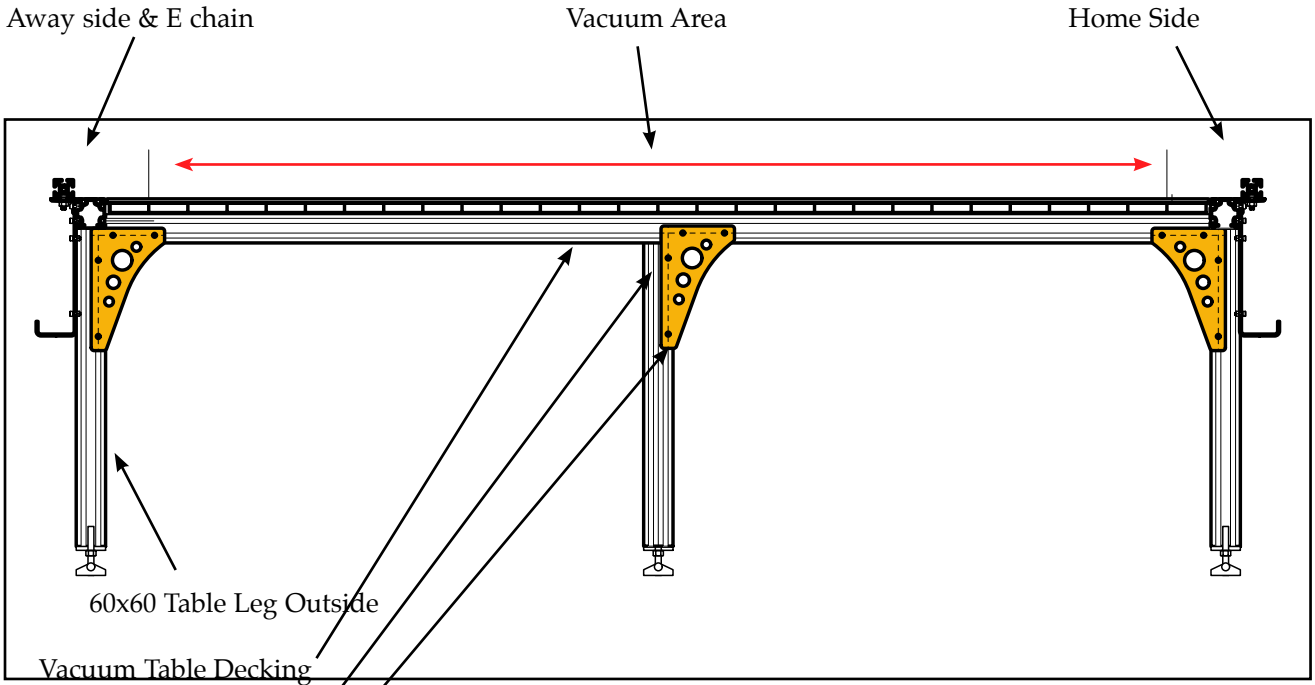




Note: These pictures are for illustration purposes only. Your table may be longer, wider, have more less, no diagonal bracing etc.

Vacuum Table Configurations

Aeronaut vacuum tables are almost all made-to-measure. They may vary in length from 1.2 metres long to over 40 metres long, so the configuration of elements like vacuum plumbing, blast gates, vacuum pumps etc., varies from table to table.

Table length

Aeronaut vacuum tables have a vacuum cell length of 1200 mm. Every 1200 along the table there is a separate vacuum cell. This may be divided up width-ways into separate vacuum zones which are controlled by blast gates to section the vacuum areas.

At the home and the away end of the table there are normally 150 and 600 mm dead zones where the plotter "parks" to allow the full vacuum area to be plotted. Where space is tight, the dead zones may be not fitted. In this case part of the vacuum area is lost due to the parking zones.

Blast gates & vacuum plumbing

On small tables the zones are normally controlled by small blast gates fitted under the collection channels under each vacuum cell. On large tables the vacuum zones may be controlled by several larger blast gates fitted to the main vacuum plumbing.

On small tables the vacuum plumbing may all go to the one vacuum pump. On larger tables where there is more than one pump, each pump may only serve a part of the table, so the vacuum over the length of the table is controlled by switching pumps as well as the blast gates.

Vacuum pumps

Depending on the material which is being cut on a table, Aeronaut may specify different types of vacuum pump. The main types of vacuum pumps suitable for vacuum hold down are either side channel blowers or centrifugal blowers. Side channel blowers generally give a better pressure drop, but a lower air flow than centrifugal blowers.

Long vacuum tables are normally fitted with more than one vacuum pump. Vacuum pumps normally have three phase motors. Single phase versions are of smaller size pumps are available, and where power is limited, several single phase pumps may be fitted.

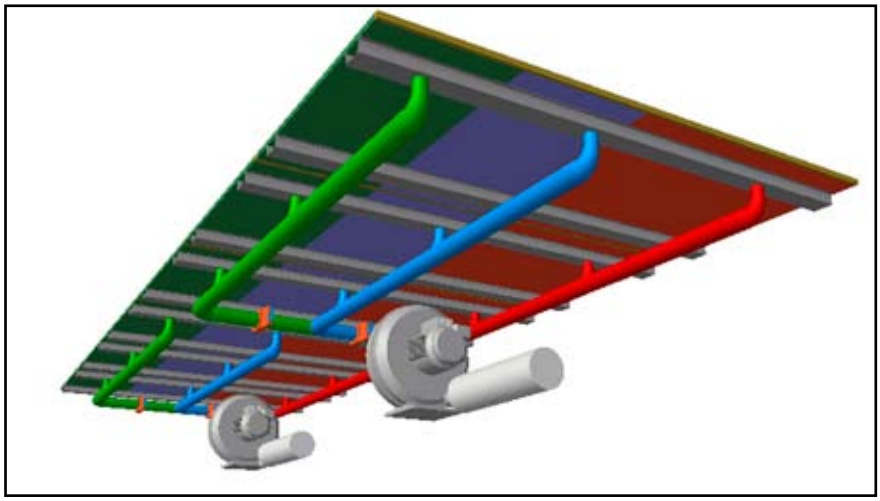
Although pumps seldom draw their rated current when used on vacuum tables, they are high voltage, high current devices and the pumps and associated switch gear should be wired and commissioned by suitably qualified electricians. Aeronaut do not offer this service.

Width-ways vacuum zones

Most vacuum pumps used on Aeronaut vacuum tables are of European manufacture. Although there are Chinese and Taiwanese versions, they are generally not as powerful as the equivalent European pump.

With export orders we frequently specify a vacuum pump, but do not always supply the actual pumps to save on freight and double handling. That being said, our buying power is often better than our customers, and in some countries the cost of sales is high enough that we can export pumps back to Europe for less than the local cost.

Most Aeronaut vacuum tables are supplied with baffles set to divide the width of each vacuum panel into zones. Normally you would have a few "standard" fabric widths, for example 914 mm and 1372 mm (36" and 54"). In this case, there can be a baffle fitted at about 950 mm so you don't need to put plastic over the table to shut off open areas.



The above illustration shows a vacuum table fitted with two pumps. Each pump connects with several vacuum panels, and each panel is divided width-ways into several cells allowing a wide range of variations to the active vacuum area. The air flow is switched by blast gates (coloured orange) and by the switching the pumps themselves.

Positioning vacuum pumps

Vacuum pumps are normally positioned under the cutting table and fitted with a silencer on the exhaust. The exhaust air is still relatively noisy (not normally too noticeable in a factory environment) and slightly warm. Vacuum pumps can be positioned remote from the vacuum table. Normally Aeronaut do not offer this service when installing vacuum tables, but we can give advice as to the plumbing requirements involved.

Dead zones

The plotter occupies about 450 mm of the vacuum table length. Normally the table is extended about 150 at the head of the table, and 600 mm at the away end of the table to allow the plotter to be able to cut the full vacuum area of the table, and park in the clear. The picture below shows the extent of the home end dead zone.

If you do not have enough space to allow for dead zones, the vacuum table can be made without dead zones. In this case you lose about 50 mm from the home end of the table and the parking distance of the plotter (about 450 mm) from the away end of the table. These areas can be masked off so you minimise vacuum "leaks".

Table Height

The cutting surface of Aeronaut vacuum tables is about 800 mm high on most tables. This is normally high enough to fit a vacuum pump under the table, and low enough to conveniently work on a wide table.

The vacuum table legs are fitted with levelling feet which allow about 50mm height adjustment on tables and to accommodate uneven floors.

If your requirements are different, please discuss this before ordering a vacuum table. It is easy and no-cost to alter the working height of a table before it is made. The same cannot be said about raising or lowering an existing table.

The size and Positioning of your vacuum table

The amount of space a vacuum table takes up in your work area is very important. In theory you need to be able to walk all around your table. In practice this is not always possible, and we have installed many tables in lofts where access was very tight, under sloping roofs and close to pillars.

Normally you will have a vacuum table which is a little wider than your widest fabric… always bearing in mind that fabric seems to come in wider widths ever year… but the length of your table can vary due to budget, workroom space, and pattern size.

Make sure you have allowed enough access for everything like the vacuum pump, the computer and table, feed rollers, waste bins etc.

The X axis drive assemblies extend slightly beyond the table frame. If there are pillars in the work space, make sure you allow for the full width of the machine and that the positioning of the machine and table complies with machine safety directives in your country.

Nesting and Framing

When planning the size of a cutting table in your work area remember that the plotting software can almost always split a plot into "frames". This means that long patterns can still be cut on a small vacuum table.

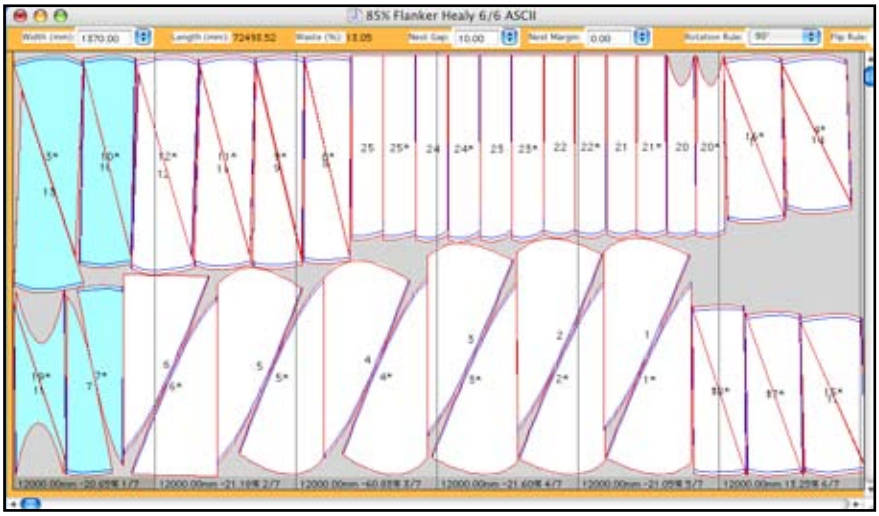
There is always a small error when lining up panels between frames, and although this may be less than 1 mm, many people choose a vacuum table that will fit the majority of their patterns within a table or frame length.

So if your longest normal pattern is 9 metres long, then a 9.6 table might be OK. And if you get 12 metre patterns then you cut them in frames.

Most software supports three options when nesting and plotting.

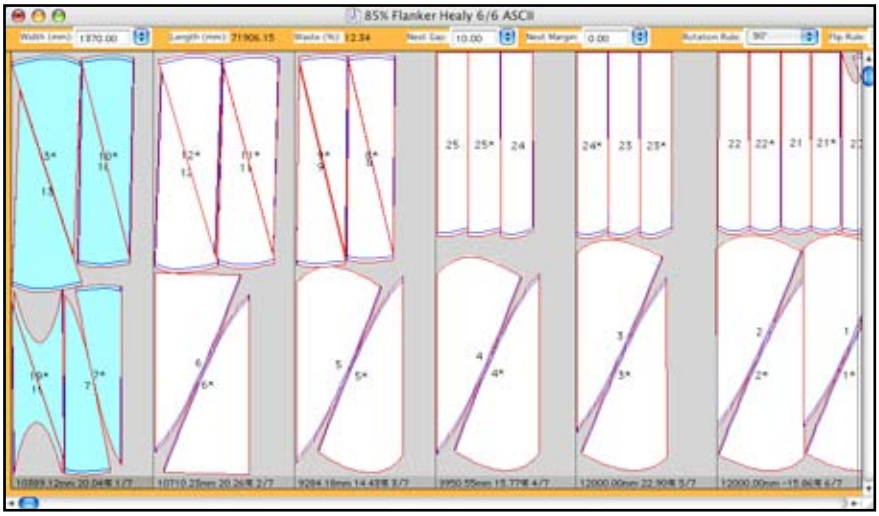
• Nest and Plot across frames. This is the fastest and most economical way of working. Every time the plotter has done a frame, it draws alignment marks on the fabric at the end of the table. You pull the fabric down the table and plot another set of alignment marks to check the fabric position. If this is OK then you re-start the plot.

• Nest across frames and Plot within frames. This is more accurate but not quite as fast. When you start a plot, the plotter does all the panels which fit entirely within the frame. When the cut panels are removed from the table, you pull down the fabric and align the cut end to the home position and re-start the plot. Very little of the fabric is wasted at the head.



The picture above shows a 75 metre nest for a 12 metre table. The first 8 panels, highlighted, will fit in the first frame. If we select plot across frames, the plotter will plot the entire queue, frame by frame. If we select No plotting across frames, then the plotter will only plot these first 12 frames. The user then pulls the uncut edge of the fabric down to home.

• Nest and Plot within frames. This is the most accurate, and the most wasteful of fabric. With this method, you nest so only patterns which fit completely into a frame are nested in each frame. After each cut, the fabric is pulled down to the home position and any excess fabric at the head is wasted.



You can see in the above picture that where a plotted set of patterns end in a dogleg, and the next panels start in a straight line, the fabric between the dogleg and a straight line will be waste.

Vacuum Plumbing

Under each vacuum panel there is a collector extrusion which channels the air sucked through the table top into the plumbing and to the vacuum pump. So you can shut off sections of the table, there is normally a series of blast gates in the system which segment the vacuum panels width ways.

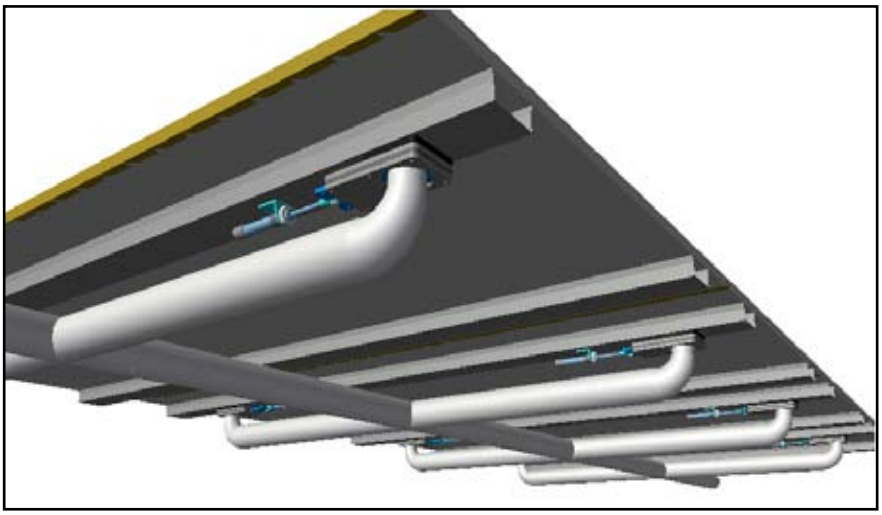
On smaller Aeronaut vacuum tables, the blast gates are normally fitted directly to the collection extrusion and there are normally two per panel. The blast gates can be operated either by hand using a simple rope-pull to open and shock chord to close.

Or blast gates can be operated pneumatically, which is rather more complex and considerably more expensive.

On larger vacuum tables, where big shapes are going to be cut, there is little point in having such complex systems, and the plumbing is made more straightforward. Usually there is more than one vacuum pump, so each pump services one area of the table.

The plumbing is connected directly to the bottom of the collector channels runs via 90˚ fittings into two or more main tubes running to the vacuum pump. A large blast gate is used to close off these tubes and the plumbing is arranged so that part or all of the vacuum panels to an area of the table can be opened or shut by this blast gate.

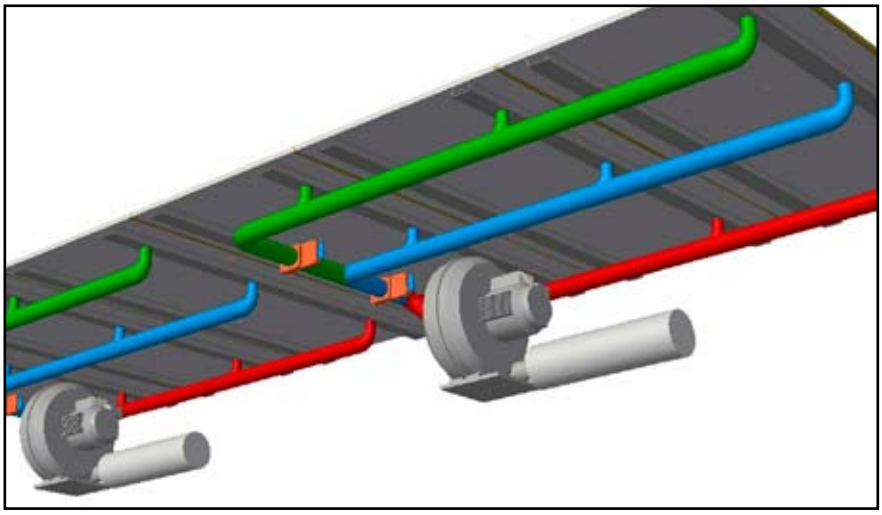
Vacuum Plumbing Layout



The above picture shows the general layout of a small table fitted with one vacuum pump and pneumatically operated blast gates. The main vacuum pipe runs down the centre line of the table, underneath the table decking.

The main pipe branches under each panel and connects to blast gates fitted to the vacuum collection extrusion. Two, or in the cases of very wide tables, three blast gates and outlets can be fitted to each panel. Baffles within the collection extrusion divide the panel widthways.

On larger tables with more than one vacuum pump the vacuum is done slightly differently. Each pump only operates on one section of the table. The plumbing is arranged with two or more large pipes running down the length of the table.



The home side pipe is normally open, and the away side pipe(s) are connected via blast gates to each vacuum pump. The vacuum table is sectioned by the blast gates and switching the pumps themselves.

Vacuum Pumps

There are at least two types of pumps commonly fitted to vacuum tables, their suitability depending on the type of fabric you are cutting. Apart from the basic mechanical design, vacuum pumps vary in electrical power requirements, maxiumum airflow, maximum pressure differential, noise level etc.

The size and number of pumps you use depends on all sorts of factors including budget, acceptable power use, noise, acceptable hold-down etc. I have seen saimakers use a 750 KVA pump on a 13 metre table, and have seen a 1.5 KVA on a 16 metre table which worked fine. On the other hand, too much vacuum is never too much for most people.

Almost all vacuum table and plotter manufacturers will tell you to get the biggest pumps since it makes their vacuum tables look good. Many low-end manufacturers will suggest a couple of vacuum cleaner motors will do. The expensive manufacturers don't offer that much detail but you will often see 7.5 and 10 KVA pumps being specified for 3-4 metre long tables and as high as 75 KVA used in some cases.

We take a middle ground, and suggest what pumps are best, and what you can get away with for now, and how you can add more pumps later when you have recovered from buying the plotter and have more experience.

Number of Pumps

It is quite easy to buy a pump, and add a second one later if it is needed. (You should never connect two pumps to the same section of table.) Break the main vacuum tube in the middle and have one pump serving a section of the table.

In most cases, we'd suggest a minimum of one good pump per 15 square metres of table surface.

Fabric Porosity

Porosity is a relative term. Almost all PVC commonly used to build inflateable boats allows air to pass through. The holes are very small, and impervious to water, but the fabric does allow the passage of some air.

Materials such as leather, cardboard, particle board etc. are quite porous on a vacuum table, and you can easily hold down two sheets of twin cushion cardboard, one above the other, or a sheet of metal with air being sucked through an un-drilled MDF table top.

Even materials sold as wind-proof and zero-porosity will allow the passage of *some* air. This may not be enough to affect their normal use in wind-proof clothing or parachutes, but it may be enough to allow you to put more than one layer on a vacuum table and hold them down with a sheet of plastic over the top.

How Much Vacuum is required?

You are never going to generate a vacuum. You are just generating a pressure difference between the outside air (1 Bar) and the inside of the vacuum table.

Air pressure is very powerful and only a small pressure difference can generate enormous force over area. In practice, it is surprising how small a difference in pressure is necessary to hold firmly.

Of course, if you are up a mountain, or work in a high-altitude area, you have less pressure to work with in the first place, so your vacuum pump specification will have to be more careful.

At a normal atmospheric pressure of 1 Bar, the air pressure inside the vacuum table and pressing down on the vacuum table is about 1 kg per cm^2. Since the pressure on both sides is the same, there is no hold down. If you reduce the pressure inside the table only by 10%, you generate a force of 0.1 kg per cm^2.

Using water gauges

When evaluating vacuum tables, pumps, and pressure difference on a daily basis it is a help to have some standard units. There are dozens to choose from, but for the amount of pressure difference we are talking about, millimetres of water works well. I don't think you have to be too accurate either. We've used soft drink instead of coloured water in emergencies.

The amount of pressure difference on the table can be measured quite easily using a water gauge. You drill a hole in the vacuum collection channel under the table, and connect this via a small clear air line or plastic tube to a bottle of coloured water sitting on the floor.

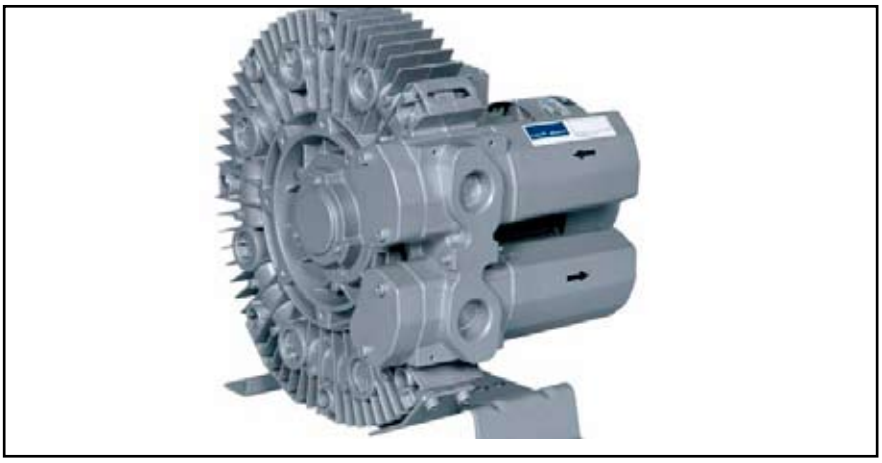
Turn on the vacuum pump, and measure the height of the water level in the tube over the height of the water in the bottle with the table fully open, closed, and with various materials on the table. Some people use these gauges connected to the table all the time and don't plot unless they get a good figure.

Different types of table top will give different readings. When cutting cardboard and some other fairly rigid materials, a porous rubber table top is often used. Air flow through the rubber is quite low compared with drilled plastic sheet, and this means the vacuum pump is always working… too much air cannot flow through so the vacuum pump is unable develop some pressure difference.

Depending on the size of your patterns, we've found that anything over 250mms of water is going to be useable. Anything below 100mms of water is going to be hit and miss.

Vacuum Pump Designs

The two main types of pump used on vacuum tables are side channel blowers and centrifugal blowers.



Side Channel

Side channel blowers come in single and dual stage types. Adding the second stage reduces the air flow, but increases the maximum pressure drop.

Side channel blowers give a large pressure drop at a relatively low flow. Side channel blowers will still give a good pressure drop when the vacuum table is completely closed and there is zero airflow through the pump, though they are normally fitted with a suitable pressure relief valve.

We commonly use single stage side channel blowers on cardboard cutting tables and occasionally on tables where carbon fibre and some plastics are cut.

Centrifugal

Centrifugal blowers give a high flow, and a relatively low pressure drop. A well designed centrifugal blower will give a good pressure drop when the vacuum inlet is fully closed, or the vacuum table is fully sealed by a non-porous fabric.

A badly designed centrifugal blower will stall if the air flow is close to zero.

In the above pictures the pumps have cast alloy bodies. You can make a centrifugal blower from sheet metal, but generally these pumps have very poor performance when working at low flow rates due to the poor fit between the pump vane and the housing.

I have seen these types of pumps used successfully but my guess is that there were probably enough leaks in the vacuum table to guarantee some air flow at all times.

As air flows through the fabric into the system, the pressure difference falls, and if the air flow capacity of the pump is not enough, then the pressure difference on the vacuum table will fall rapidly.

For this reason, centrifugal blowers are normally recommended for most fabric other than 100% non-porous PVC and plastics.

Where you are working with PVC and materials such as cardboard which does not let air through so easily and usually covers the working area of the table, a single or dual stage side channel blower might be used.

Graphs

The best method of evaluating vacuum pumps is getting one and trying it. Most manufacturers should be prepared to let you have a pump to evaluate.

The second best method is to have a look at the graphs supplied by the manufacturers and see what the pumps can do at their lowest and highest rated airflows.

If a manufacturer does not give proper graphs on their blowers, or the graphs stop well before zero airflow, or fall off dramatically then look at the pumps with a degree of suspicion.

Figures

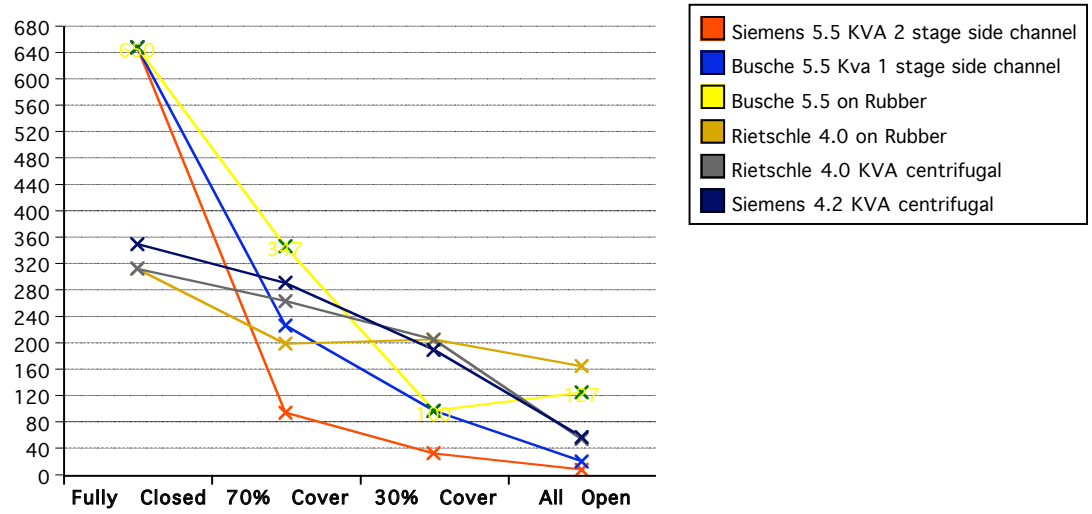
Typically, you should expect to get flow rates in the range of 200 - 400 M^3 per hour from a side channel blower, and up to 3,600 M^3 per hour from a centrifugal blower of about 4-5.5 KVA. So the centrifugal version is pumping as much as 10 times more air.

The pressure differential for a side channel blower can be up to 500 mbar and for a centrifugal blower up to 350 mbar.

Generally, for a fabric table we would suggest using a centrifugal blower of 4.2 to 5.5 KVA, and for a table cutting corrugated carboard or carbon fibre, a single stage side channel blower of 4-5.5 KVA.

All these pumps are three phase. It is possible to work with single phase versions, but you will need at least twice the number of vacuum pumps.

Pump Type	Condition: Fully Closed	Low porosity Fabric 70% Cover	Woven Canvas 30% Cover	All Open
Siemens 5.5 KVA 2 stage side channe	650	95	34	10
Busche 5.5 Kva 1 stage side channel	650	227	100	22
Busche 5.5 on Rubber	**650**	**347**	**100**	**127**
Rietschle 4.0 on Rubber	**315**	**200**	**205**	**165**
Rietschle 4.0 KVA centrifugal	315	265	205	56
Siemens 4.2 KVA centrifugal	350	292	190	57



The graph above was done on our demo table using some commonly available vacuum pumps in both side channel and centrifugal styles. The pressure differential was tested when the table was completely covered, and completely uncovered, and in two stages in between.

You can see that with the table completely covered, the side channel blowers work really well and generate a high pressure difference… in fact they suck the fluid out of the bottles!

However, when the table is covered with fabric in a more real world test the pressure drops very quickly.

Compare the performance of the centrifugal blowers. They do not generate as much pressure difference when the table is closed, but as the surface of the vacuum table is progressively opened, their performance does not drop as rapidly, and even when the table is open, they generate useful pressure difference.

Additional Equipment

Aeronaut vacuum tables can be supplied with a range of additioanl equipment including fabric support rollers, computer stands and light boxes.

Farbric Rollers

Fabric support rollers are normally fitted to the away end of the cutting table. There are two sets of three rollers. The upper set can be used for fabric or sacrificial plastic used to hold down porous material.

Computer Stands

Aeronaut computer stands are a conventient way to have a computer close to the plotter without the space of a table and chair.

Light Boxes

Light boxes can be fitted into the away dead zone of cutting tables to enable fabric to be inspected as it is pulled down the table before cutting.