Planning Your Power Workholding System...

Successful powered workholding does not just happen. Like any other manufacturing process, it must be carefully planned. But that does not mean that you need to be a hydraulics engineer to implement a powered workholding system. Designing a system involves nothing more than the common-sense application of a few basic workholding concepts.

Applications for power workholding fall into two categories: retrofits to replace and upgrade clamping on existing fixtures; and new fixtures designed from the outset with power workholding. In both cases it is imperative that you keep in mind the forces that can be generated by power workholding devices. A single device, small enough to hold in your hand, can generate 26 kN of clamping force. If you are replacing existing manual bolt and nut clamping or toggle clamps, make sure that the fixture or machine tool base will withstand the forces.

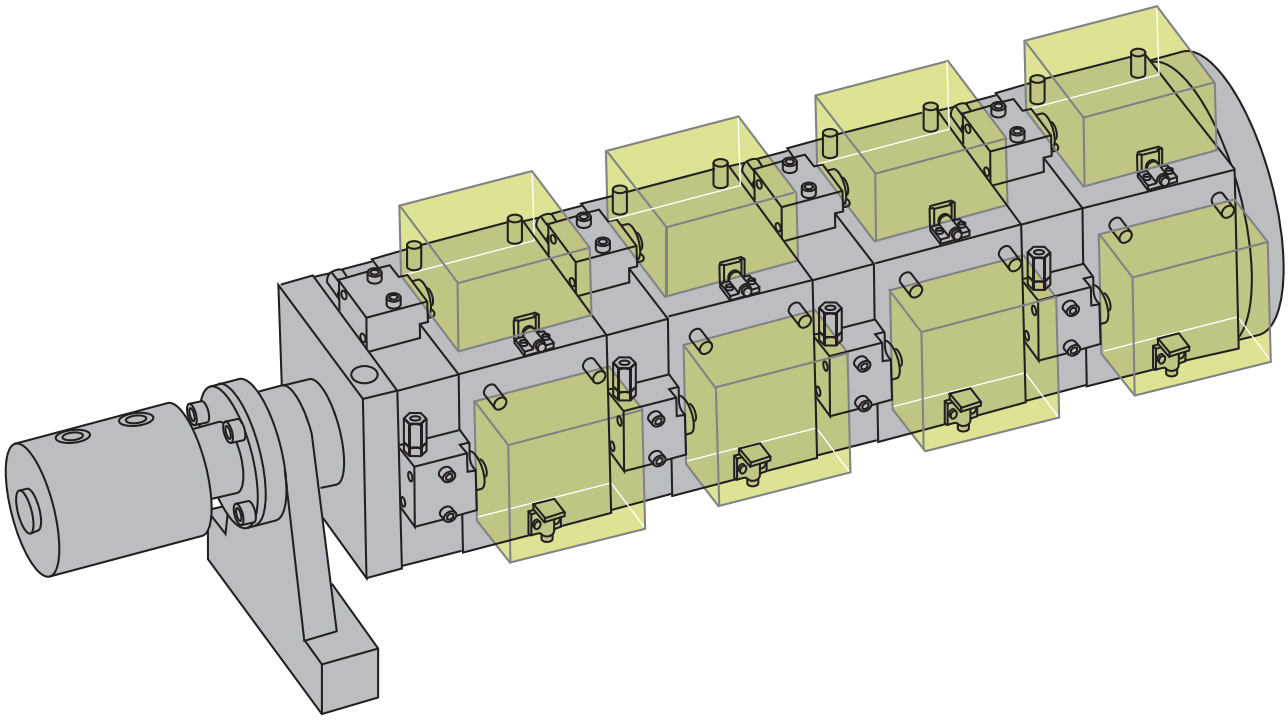
Using power workholding does not in any way invalidate the principles of sound fixture design. The 3-2-1 concept as it relates to the location of the work piece in three planes is just as applicable when using power workholding devices as when using manual methods. Workholding devices should be positioned in such a way as to ensure firm contact between the work piece and locating buttons, pins, or surfaces.

Begin the planning process by asking yourself the following:

- What do you want your system to accomplish?
- What sort of operation is going to use this system?
- What clamping "speed" is appropriate for the speed at which your production line runs?

You should select "realistic" cycle times . . . the shorter the cycle time, the larger the power source required. For example, a pump with a 1/3-hp electric motor may be satisfactory to reach clamping pressure on a given system in three seconds. However, to accomplish the same task in one second may require a pump with a 1-hp electric motor — at a considerable increase in both initial expense and operating costs. So before you specify "instantaneous" cycling, be sure the increased clamping speed is really worth the higher costs for your particular installation. Ask yourself if you can productively utilize the seconds saved.

With this in mind, let's proceed step by step through a plan of attack for designing your system.



Planning

Steps 1-11

Step 1:

First, determine the nature of the operation to be performed, the number of parts to be processed per cycle, and whether operations will be performed on more than one surface of each part. Also determine the time that should be allowed for part loading, unloading, and clamping the part.

Consult your machine tool file to determine the available work space on the machine table, bed, or other surface, as applicable. Be sure that the space available will accommodate the part or quantity of parts to be processed according to your manufacturing work-flow. If not, revise your plan.

In the initial phases of system planning, include adequate measures and devices to ensure the safety of workers and equipment.

Step 2:

Prepare an outline of the sequence of events that will take place during the manufacturing cycle. This will assist you in determining the types of special sequencing valves that you might need, as well as any external control (such as a tie-in with machine controls) that your application may require.

Step 3:

Calculate the cutting forces generated in the machining process and note the direction that these forces tend to act on the work piece. If you are planning a retrofit of a manual clamping system, you may use the torques presently being used. However, it is recommended that cutter forces be calculated as a precaution in such a case to ensure that workholding devices are sized to provide an adequate margin of safety. The operation manuals of many machine tools contain tables that list machining forces or simple formulas for calculating these forces.

Step 4:

Plan your fixture(s) with positive fixed stops to resist the majority of cutting forces and to ensure correct location of the work piece using the primary part locating features.

Step 5: (Optional)

Normally you need to calculate the forces required to overcome work piece weight and friction and to move the part into position against fixture stops if you are using positioning cylinders as your first hydraulic operation of your fixture.

Step 6:

After you have determined the machine cutting forces, it is easy to calculate the clamping force required to hold the work piece on the fixture or machine table. Again, a simple formula is all you need to arrive at an answer for the materials you'll be working. Give us a call if you need help.

Step 7:

Determine where clamps should contact the part to hold or support it securely and to avoid interference with machine operations. If clamps cannot be located so as to avoid interference with manufacturing operations, it will be necessary to use an external control device to move the clamps out of the way as the need arises during the manufacturing sequence. This will require that electrically actuated valves be used to control the offending devices separately.

Step 8:

Determine the type and number of workholding devices you need based on the total clamping force required and clamping positions you've selected; on the size, strength and shape of the part; and on the machine operation.

Step 9:

To help determine the capacity of the power source you'll need, add the total oil displacement requirements for the devices you have selected. Then choose a power source with equal or greater capacity and determine if it will operate the system within your clamping time constraints by working out the following formulas:

$$(\text{Device Cap.}) \div (\text{L. P. Flow}) = \text{Position Time}$$

Where . . .

"L.P." flow is low pressure pump oil volume expressed in cubic centimeters/minute. "Device Cap." is total device oil capacity expressed in cubic centimeters (cm^3). Position time is time to position expressed in decimal parts of a minute.

Where . . .

If total estimated clamping time is not within the cycle time requirements you've targeted but is within device limitations, a larger power source is required — one with greater capacity. Select such a source and repeat the above calculations to ensure that it will provide the clamping cycle times required.

If the total estimated clamping time in the initial calculation is significantly less than the time allowed, your initial power source selection may have been too large. In such a case, select a smaller power source and repeat the above calculations to ensure that it still provides the clamping cycle times desired. If a smaller power supply is not possible, a flow control may be used to limit the speed of device positioning. This will help devices perform correctly and not "bounce" or become damaged by excessive flow.

Additional factors you should consider when selecting a power source include shop floor plan and/or machine layout and your own preference for the type of power source (shop air vs. electric).

If desired, large electrical power sources may be used to supply several workholding systems, each operating independently at several machines. In this case, the timing and sequence of operations for each individual system must be calculated as shown above in order to arrive at a size for the power source.

Step 10:

Select valves and other control components to accomplish the sequence of operations you outlined in Step 2. See the valve section of this catalog for guidance.

Step 11:

Select appropriate safety control mechanisms. All VektorFlo® electrical power modules have a hydraulic pressure switch as standard equipment to ensure that consistent forces are maintained at all times. However, when a power source is used to power several separate individual systems, each system should also have its own pressure monitor.

Step 12:

Finally, select the plumbing components required to connect the power source to the valves and devices. Review your system specifications and layout to determine what you need in terms of ratings, sizes, and lengths.

Step 13:

Call us for help. Our application engineers do not design fixtures. Their job is to help you use hydraulic clamps successfully. Whether you are retrofitting existing fixtures, need a concept for clamping a new part or want a quick review of your design we stand ready to help VektorFlo® customers.

Tuffcam™ Swing Clamps (See Section C)

Outside the USA, call:

+001-913-365-1045

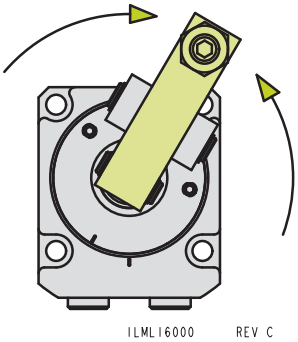
...for everything you need in workholding. Discover how easy, economical, and efficient power workholding can be — with one call. We'll be glad to answer your questions, provide concepts or advice, and give you a quote.

Please visit us at:
www.vektek.com
to download our
most current CAD files.

Clevis Plunger (Section C)

Rotary Lug feature delivers 360º of lever positioning (See Section E)

TuffLink 360™



VEKTEK®

Planning

Frequently Asked Questions

This list of questions was developed by listening to customers just like you when they asked, "Why didn't I know that?" Before you order devices, build your fixture or even consider your design complete, we suggest that you run through this checklist to identify some common problems you might encounter.

What is the advantage of double acting cylinders?

Double acting cylinders will assure full cylinder retraction on a timely basis even in systems where restrictions such as small orifices or long tubing runs have been introduced. The use of double acting cylinders is especially important when "return" time is critical (as in some CNC systems).

What should I watch for when selecting fittings, tubing and hoses ?

Some fittings and hoses which are locally available (not from Vektek) have extremely small orifices which restrict flow. The use of G 1/8 or similar size fittings can have this effect on a system. This restriction is even more pronounced when introduced at a main feed line. This can happen with some fittings and many hoses.

Excessive tubing length can create a column of oil which is very long. Friction created by moving oil through tubing and hose will slow response times because of the inertia of the column of oil and increased back pressure of returning oil.

Proper sizing of fittings for main feed lines and device supply lines will normally be accomplished by using an appropriate fluid distribution manifold. Device fittings are G 1/4 or G 1/8. Main feed lines should be at least 8 mm to avoid restrictions.

Is my plumbing free of obstructions and contaminants?

Tubing must always be flushed after cutting. Even if not cut in your shop, it was cut before it came to you. Chips, burrs, dirt and other contaminants have collected inside your tubing and drilled passages. These contaminants can cut device seals, damage valve sealing surfaces, cause erratic operation and reduce service life if not cleaned prior to fixture start up.

The use of improper fittings can also cause obstructions and restrictions. Be sure you haven't created obstructions by using non-standard parts.

Is my pump of appropriate size? It is rated for_____l/min, or _____cm^3 per minute? My devices require a total of _____cc. of oil to actuate.

For most normal size fixtures, a pump rated over 8 l/min. (Liters per minute) is not recommended. If your pump is rated much more than 4 l/min, call us, we'd rather give you sound advice now than have you damage clamps and have to sell you replacements. Be sure that you do not exceed the recommended flow rates for your system. If you aren't sure, ask us.

My pump runs continuously. Is it the right type of pump?

Call us. It can often be made to work. Some modifications will probably be necessary.

I've been using a dump pump (builds to pressure, shuts off and releases pressure automatically). Is this pump suitable for workholding?

It can be. It will work if the circuitry is properly designed. It may require special circuit modifications to work properly.

I want several sequenced operations to happen on my fixture. Can I put three or four sequence valves in series?

We do not recommend it. Our sequence valves operate better if run directly from the main hydraulic supply line and set at different pressures. We recommend at least 1 MPa differential.

When I use a dial indicator on my part, it bends when it is clamped. Why?

Clamps should be positioned directly opposite a fixed locator, hydraulic support or other supporting element. This element may be a part of the fixture, a solid portion of a rigid part or a properly sized floating locator such as a hydraulic work support. If your clamp is putting force into your part which is not transmitted directly into a solid stop, it may distort the part. Clamping on draft angles or "mushrooming" the part with excessive force can also cause part distortion.

I hold all four corners of my part on solid locators. When unclamped, it seems to "spring" back into a different shape. Why?

First, holding all four locating points in exactly the same plane on your fixture is virtually impossible. (See your favorite text on fixture design for an explanation of 3-2-1 fixture building principles.) Second, because your part can't have all four of these points in the same plane, your part is distorting when clamped. Other factors such as stress relief may cause the part to change its "free" shape after machining.

I want to limit the pressure into a sequenced hydraulic circuit. Which valve would I install first?

We recommend that you avoid putting one special function valve behind another if possible. If you must, put the pressure limiting valve after the sequence valve. This avoids the limiting valve being shut off before the sequenced circuit is fully actuated.

I want to make a cut directly against (into) a clamp. Is this possible?

Yes, it is but it will require special design considerations. We encourage that cutter forces always be directed toward a fixed stop. A fixed stop is designed to prevent part movement. A clamp is designed to position and force a part against a fixed stop. In order to machine "into" a clamp, the clamp must be sufficiently sized to resist all cutter and machine forces or the part will tend to shift.

My company uses a lot of brass on our product. Can I use these to connect my 7MPa hydraulic clamps?

Yes, brass fittings and some aluminum or steel fittings are for lower pressures. Be sure that locally sourced fittings are rated for 7 MPa (70 bar) operation.

We run a fixture for 3 months, store it for 6 months, then bring it back on line. How can we keep everything working?

Preventive maintenance. Before you store your fixtures, be sure that they are free of coolants, coolant buildup, clean and dry. A light coating of corrosion protection may help. Be sure to store in a cool, dry, clean environment.

Our clamps are used for cast iron grinding. Our coolants also seem to be corrosive (our fixture plates rust). Will your clamps stand up to this?

Nothing is going to be 100% foolproof. Our extensive use of hard chrome plating, stainless steel and our corrosion resistant BHC™ will give you the best possible resistance to corrosion. Our processes will allow our clamps to run longer with fewer problems even in this destructive environment.

Preventive maintenance is essential to keep hydraulic systems and components running at peak performance through millions of cycles. Be sure to flush your entire system at least once a year and more frequently in high contamination environments.

When I look at my clamps, there are threaded holes in them. What do the labels "P" "ADVANCE" "RETRACT" mean?

These threaded holes are called ports. The label "P" or "ADVANCE" ports are normally used to clamp the part, "RETRACT" indicates the port normally used to unclamp or retract the clamp.

I need some type of retractable locator. After my part is loaded, I want it to "disappear". Do you have anything to do this?

Any double acting cylinder may be used in this way. If a highly precise location is required, please be sure to use a guide bushing to provide more precise location.

My local chemical representative has recommended the use of "water-glycol" hydraulic fluid. What are the benefits of this fluid and should I use it?

Water-glycol is a non-traditional hydraulic fluid. This fluid was developed for use where petroleum based fluids are not allowed. They are commonly used in areas requiring "flameproof" fluid. They often cause problems with device seals, valves and pumps. We do not recommend water-glycol fluids. We may in some cases be able to provide devices with seal compounds acceptable for use in this environment.

How hot is too hot to run hydraulic fluid?

Anything above 177°C is considered too hot for most hydraulic fluids and seals. Our standard seals are rated to operate at temperatures from 4°C to 71°C. Even seals made of fluorocarbon are not recommended above 177°C. For advice on high heat applications, please contact Vektek's Engineering Department who stand ready to help.

I have my cylinder hooked up to a pump. It extended but won't retract. What have I done wrong?

Is there a directional control valve in the circuit? If not, one is required. Can you provide a photo, schematic or simple hand sketch for us to troubleshoot? We are glad to help.

How do I read my gauge and what does it mean?

First, release all pressure on the system. Check the gauge for proper operation. Check to be sure that the gauge is returning to "zero". Pressurize the system and read the gauge. The current reading from the gauge indicates the pressure your clamping system operates at when clamped unless there is a pressure limited circuit branch. (The entire system equalizes at this pressure, Δ P is negligible when under static clamping conditions.)

I need a clamp just like your L1-4025-00L except it needs a 150 mm long rod. Can you help me?

Maybe. We do entertain specials from time to time. Please ask us. We often find that "special" requests coincide with our ongoing new product development. If you have a special need, it is worth asking. We may decide to do your special as a development project. We may not be able to produce it (actually you may not want it) because of cost. It may be something we have done before and will be relatively easy.

The danger involved in using "specials" is that we do not stock replacements on custom parts. When your machine crashes (when, not if) and you need a rush spare, custom parts have to be made from scratch. You will need to order spares at the time of the original order. The cost of a single replacement on a complicated special can often be 5-10 times the cost paid in the beginning. A little foresight will be very beneficial if you must have a special.

If you have questions you'd like answered, call, write, fax or email us. We would be glad to help you use VektorFlo® products more effectively.

+1-913-365-1045
1334 East 6th Avenue
Emporia, KS 66801 USA
Fax: +1-816-364-0471

internationalsales@vektek.com

A-6

VektorFlo® Hydraulic Fixture Setup Documentation and Troubleshooting Worksheet

Fixture Designed By: _____

Fixture Built By: _____

Built For: _____

Fixture Serial # _____

1. All pressure gauges reading checked and verified at "0" operating pressure. ☐ Yes ☐ No
2. Main system operating pressure read from the gauge mounted on the clamping system pump _____ MPa (bar) or inlet air pressure from air gauge on boosters _____ MPa (bar), booster ratio _____:_____.
3. Pump restart pressure checked. Pump restarts at _____ MPa (bar).
4. Fixture operating pressure read at fixture gauge _____ MPa (bar), side A and _____MPa (bar), side B
5. Pressure limit circuits pressure checked:
   - Side A _____ MPa (bar) Components & location: _____
   - Side A _____ MPa (bar) Components & location: _____
   - Side A _____ MPa (bar) Components & location: _____
   - Side B _____ MPa (bar) Components & location: _____
   - Side B _____ MPa (bar) Components & location: _____
   - Side B _____ MPa (bar) Components & location: _____
6. Sequence operations set to:
   - Side A _____ MPa (bar) Components & location: _____
   - Side A _____ MPa (bar) Components & location: _____
   - Side A _____ MPa (bar) Components & location: _____
   - Side B _____ MPa (bar) Components & location: _____
   - Side B _____ MPa (bar) Components & location: _____
   - Side B _____ MPa (bar) Components & location: _____
7. Fittings checked, secure, no leaks, proper type, not restrictive. Yes No
8. Schematic diagram attached. Yes No
9. Bill of materials (hydraulic components) attached. Yes No

For troubleshooting assistance contact your Designer/Builder or, complete steps 1-9 above and fax this sheet with all additional pages to +1-816-364-0471. We are pleased to be of service.

General Tips

- When Manifold mounting VektorFlo® components, the mating surface must be flat within 0.08 mm, with a maximum surface roughness of 1.6 μm R_a for proper sealing (unless otherwise noted in the catalog).
- Unless otherwise noted in our catalog, VektorFlo® 7 MPa devices require a minimum pressure of 1.0 MPa (10 bar)
- Maximum system flow rate is 5.7 l/m for all VektorFlo® special function valves, unless noted otherwise. Excess flow voids warranty.
- De-burring of pockets or cavities is extremely important to avoid leaks from damaged seals.
- Fluid filtration to catch chips will prevent leaks and extend the life of your components.
- Preventive maintenance is essential to keep hydraulic systems and components running at peak performance through millions of cycles. Be sure to flush your entire system at least once a year and more frequently in high contamination environments.
- To extend the life of your hydraulic components:
  - * Hydraulic fluid should be changed and the reservoir cleaned out annually
  - * If you operate a full production schedule (one shift daily): change fluid twice annually
  - * Two shifts daily: change fluid three times annually
  - * Three shifts: four times annually
  - * In very dirty conditions (foundries): change hydraulic fluid monthly
  - * Devices and seals are rated to operate from 4 - 71° C.

Work Support Tips

- Install with a six point socket only. Other types of wrenches may damage the work support.

Swing Clamp Tips

- Never allow swing clamp arm to contact the work piece during arm rotation.
- Swing Restrictors are available in 30, 45 and 60 degree angles, Order from your Vektek Sales Representative or Order Entry Specialist. Other swing restricting angles are available upon request as a special.

Arms/Levers

- When installing a swing clamp arm, restrict the arm to prevent rotational torque to the plunger and potential internal cam damage. You may then tighten the locking features to specification without damage to your clamp.

Plumbing Tips

- Use of standard rubber hoses and end fittings can hamper the action of many devices due to excessive end fitting restrictions. If you choose to purchase hoses locally, choose diameters and end fittings that are not causing excessive restrictions.

Speed Control

- Flow controls are often required to make swing clamps and work supports function at appropriate speeds. Swing clamps may be damaged by swinging large mass arms at a greater distance from the clamp centerline than recommended on the catalog pages. Work supports may advance with speed faster than expected, bounce off of the intended part surface and become locked before the spring can mechanically re-extend them.
- In cases where speed control is necessary, all workholding devices should be flow controlled with “meter-in” devices like our in-line or in-port flow controls with free-flow returns. Needle valves or “meter-out” flow controls as are often used in pneumatics should not be used to prevent a pressure intensification which may occur on “meter-out” hydraulic applications.

Website

- Visit www.vektek.com for extensive fixture building tips.
- Check our Tech Tips and Maintenance Videos for convenient on-line help.

7 MPa Work Supports

Frequently Asked Questions

Why do I need to use work supports?

The basics of 3-2-1 fixture building require that three points define the plane of part location. When machining, a floating location support (work support) is an easy solution to a part requiring additional support for more than the three basic locators. You can use a work support anywhere a "screw jack" can be used. It adjusts faster, without distortion and without dependence on the operator's "feel".

A work support will provide solid adjustable support for parts ranging from fragile circuit boards to massive airplane spars, without inducing distortion. They provide "automatic" adjustment and lock-up giving repeatable, predictable results without the risk of "forgetting" a clamp or the time of manually adjusted alternatives.

What is required to use work supports?

Work supports will work in most applications where part distortion, chatter, ringing or poor surface finish results are present. Work supports can decrease most of the problems caused by part movement during machining. All you need to use them is an application, space to insert the support, power supply and plumbing. They can work wonders to improve part quality and reduce scrap and rework. Work supports are often used on fixtures where parts are manually clamped but require support.

After the plunger is advanced, hydraulic pressure engages a clamping mechanism which locks the plunger and holds it securely against the part. It then becomes a solid support holding the part with the capacity indicated on the appropriate chart (page B-2).

Can I use work supports without other hydraulic clamps?

Yes, work supports are often used when manual clamps are used. They reduce the dependence on "operator feel," speed operations by locking multiples with a single adjustment and speed load time dramatically even when used with manual clamps to secure the part. In fact, one of Vektek's most effective applications was one where the part was bolted in place over a tower equipped with several work supports. They supported the inside of a case while the outside was being machined. Our work supports reduced the part loading time from over five hours to just under one hour in this application.

Explain the difference in the two advance types and why I might want to use one over the other.

Spring advance is typically used when the part is heavy enough to depress the spring loaded plungers. This can be used on most applications.

Fluid advance is used to prevent interference during part load and insures part is properly seated before clamping.

What is the "breather port" and can I plug it or use it for my hydraulic connection?

All 7 MPa work supports require the exchange of air. They will work consistently when allowed to exchange air to and from the atmosphere.

What type of part will typically need work supports? Are there any I should avoid?

Parts with thin webs, unusual shapes or unsupported structures that must be held within a plane are likely candidates for work supports. There are no parts to be avoided. Cast iron and aluminum parts produce large quantities of fines that can infiltrate cavities and reduce work support life.

What about deflection?

Deflection is based on Elastic Deformation of materials when loads are applied. All material elastically deforms and it is important to understand that this deflection is not caused by the support slipping or failing. Vektek work supports are designed with selected materials to minimize elastic deformation. Other factors that may affect deflection include: Surface finish, material and contact area of part being supported. In cases were special contact bolts are made, it is important to understand how the shape of the contact surface along with the material selected will affect deflection. Deformation values advertised are based on Vektek contact bolts only.

Can I lay my work support on its side?

Normally, yes. As long as you are not using a heavy end effector or unusually side loading your support, the physical orientation should not affect performance. If you have a question about a specific application, please give us a call.

I have an interrupted cut that is going to take place over the top of a work support. The forces involved are transmitted directly down on the support. The cutter is a large straddle milling cutter and the cut is interrupted because I am sawing through webs on a cast part. How do I size the work support for this application?

Work Support capacities shown in provided charts and formulas are based on static loading. Because of unknown variables (examples: dull tool factors; mild hydraulic pressure fluctuation; cutter vibrations; etc.) work supports selection should be made so that the capacity at specified pressure is a minimum of 1.5 times the sum of applied clamping force and machining force. Interrupted machining cuts and pressure spikes can apply severe dynamic loading to the work supports. In cases where dynamic loading is present you should use a support capacity minimum of 2 times the sum of applied clamping force and machining force.

Do I need to use a torque wrench and socket when installing cartridge work supports?

Yes, a torque wrench and a 6 point socket is required. If you use an open end, adjustable or box end wrench you increase the chances of damaging the work support. Please use an appropriate socket, torque wrench and care when installing cartridge work supports.