Click here to visit the MAIN Manufacturing Website

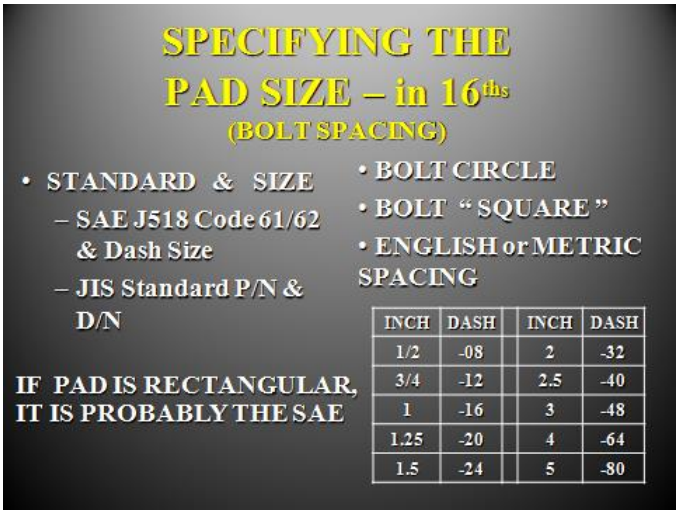
HOW TO SPECIFY HYDRAULIC FLANGES

MAIN Manufacturing Products, Inc. has been designing and manufacturing hydraulic flanges and components for more than 55 years. Over this time, MAIN has helped customers solve many of the same issues we have encountered ourselves. This paper will help users specify hydraulic flanges for pipe and tube connections and gives tips to avoid some of these issues.

Users need to address the following parameters to specify the right flange for the application: pad size; bolt hole size or tapped hole size and thread; flange type; connection type and size; geometry; material; pressure; and extras. Information on the screw (length and thread) and O-ring (size and material) is needed to determine the mounting kit.

PAD SIZE (bolt spacing)

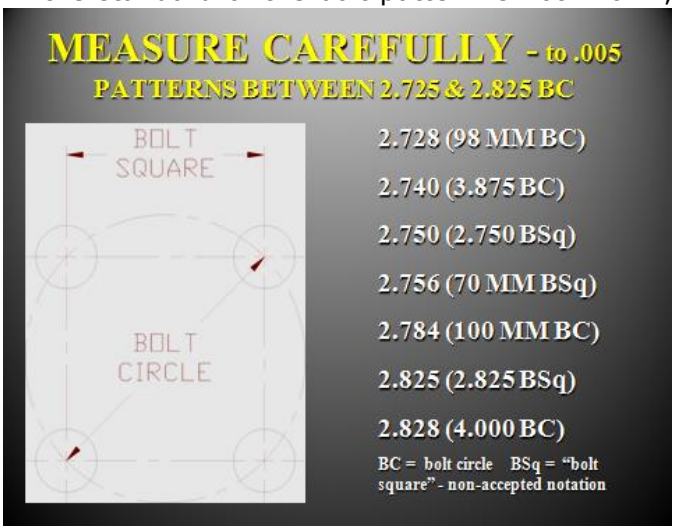
Specifying a flange usually starts with matching the flange to the mounting pattern (pad) on the equipment. The item that the flange is attaching to might list the standard and size or bolt hole pattern. Knowing the origin of the equipment can be helpful. Knowing the outside dimensions of the flange is often not helpful, as there are variations. Many international standards use the abbreviations DN (nominal diameter) and PN (nominal pressure) as part of the size designation. Don't confuse nominal and actual. Nominal means name and is used to designate convenient groupings. Also don't confuse DN with DIN, the German standards organization. If the pattern is rectangular, chances are it conforms to either SAE J518-1 (Code 61) or SAE J518-2 (Code 62). These two standards are commonly used around the world but have different bolt patterns and different maximum rated pressures. A number of Code 62 patterns are similar to Code 61 patterns one size larger. Flange size is designated by dash number or DN number. The dash number is the maximum center hole size in 16ths of an inch (for example, a –32 flange has a



INCH	DASH	INCH	DASH
1/2	-08	2	-32
3/4	-12	2.5	-40
1	-16	3	-48
1.25	-20	4	-64
1.5	-24	5	-80

2-inch nominal through hole size). SAE J518-1 (Code 61) flanges are sometimes nominally referred to as "3000 psi flanges" even though the maximum rated working pressure varies from 5000 psi to 500 psi depending on size.

If the standard of the bolt pattern is not known, the pattern must be measured. Because of the number of possible patterns, it is important to measure the pattern to +/- .005 inches (+/- 0.1 mm). Standards are written with inch or metric dimensions in mind. Four bolts may be dimensioned as a circle, where the diagonal distance between bolts is considered, or a square, where the distance between adjacent bolts is key. For example, there are seven "standard" patterns between 2.725" and 2.825" bolt squares; flanges conforming to one of these "standards" do not function properly with the other patterns because of tolerancing issues, differences in bolt sizes, and differences in O-ring sizes.



If a flange has been installed with socket head cap screws, an easy method of measuring the pattern is to use digital calipers. Measure the screw head (which is also used to calculate the screw size), zero the calipers on the screw head, and then measure the distance from the outside of one screw head to the outside of another. This is the center-to-center distance between the bolt holes.

BOLT HOLE (size & thread) (inch/metric)

Measure carefully. Because metric bolts and inch bolts have similar diameter/lead combinations, it is possible to screw them into the wrong hole, resulting in incomplete thread engagement. The bolts in the picture to the right are essentially the same length and have been threaded into the wrong holes. Clearance holes that are too large will not locate the O-ring flange on the pad close enough to avoid the potential of the O-ring getting "nibbled" by the port hole. Clearance holes made too small will not accommodate the tolerance stack ups possible. New designs should be metric.

FLANGE TYPE

There are two types of solid hydraulic flanges: O-ring style and flat faced style, which is also known as a companion. O-ring flanges have a groove for an O-ring and clearance bolt holes. Flat faced flanges have a flat sealing surface and generally have tapped bolt holes. The combination of a flange head with either a flange clamp or two split-flange clamps is generally the same as an O-ring flange. A union is formed by connecting a flat faced flange type to an O-ring flange type or a flanged head with split flanges.

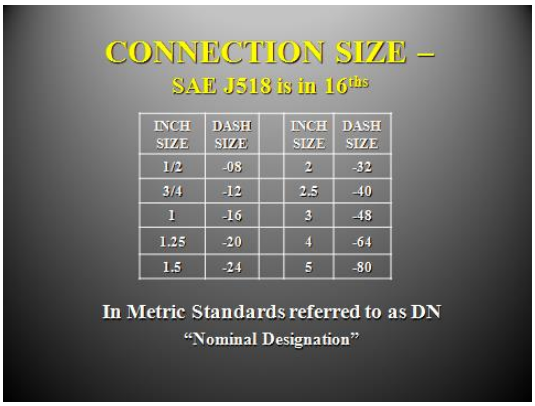
However, O-ring flanges are often attached to equipment that has flat faced pads.

CONNECTION TYPE

Many connection types are available: welded (socket and butt weld), threaded (SAE straight thread, NPTF, BSPP, BSPT, and ISO 6149), flange port, and others. Socket-welded connections have a socket that is larger than the tubing or pipe; MAIN's standard for pipe (welded) socket is about .03" (0.8 mm) larger than the pipe. Tube sockets (brazed/soldered) are generally .005"-.010" (0.15 mm-0.25 mm) larger than the tube. This helps accommodate tolerancing of the pipe or tube and any damage to the end during storage and transport. As a standard practice, MAIN adds a chamfer on the socket; this allows easier insertion and allows a fillet-reinforced groove weld that reduces the footprint for the same size weld. The through hole generally follows the SAE J518 port sizing and tolerance. Butt welds are sized by the nominal pipe/tube sizes and schedule or wall thickness. The configuration of MAIN's butt weld hub generally follows the ANSI standards.

Understanding the difference between pipe and tube sizing is important. Pipe size is designated by its *nominal* inside diameter and schedule, which refers to the pipe's wall thickness. To make matters complicated, pipe of the same *nominal* size designation has the same outside diameter (e.g. ½" pipe has an actual OD of .866"), independent of the schedule. There is no dimension of 2" on any 2" nominal pipe size in any wall schedule. Nominal tube size designations generally relate to the actual outside diameter. Nominal size designation of metric tubes varies from country to country. A 40 mm tube does not necessarily have a 40 mm OD, but the common specification practice is to list the actual nominal OD and the wall thickness in millimeters.

MAIN offers many female threaded port connection options. The fluid power industry recommends connections that use elastomeric seals (O-rings, etc.) such as the SAE straight thread, ISO 1179 (BSPP), and ISO 6149 (metric), which are designed not to leak after repeated assembly. The use of NPT/NPTF threads is not recommended because they are designed for a one-time assembly and will leak if reassembled. A NPT thread has two helical holes between the roots and the crests of the thread that under pressure forms a leak path. The "F" in NPTF means fuel and was referred to as the "dry seal;" the NPTF thread is crushed to eliminate these holes. The BSPT has similar characteristics. MAIN can provide other thread forms.



CONNECTION SIZE

The connection size can differ from the pad size. Generally a connection that is smaller than the pad size, called a reducer, can be priced the same as one in which the pad and connection sizes are the same. Increasers, where the connection size is larger than the pad size, might not be physically possible or might cost significantly more.

GEOMETRY

Geometry, or the shape, is generally easy to determine and describe. There are in-line, elbow, tee (both run and branch), Y, and cross. MAIN uses the largest O-ring face as the starting point of its numbering system. On a tee, if there is a port opposite the largest O-ring face (referred to as "on the run"), the connector is a run tee. If the largest O-ring face is 90° from the port face (referred to as "on the branch"), it is a branch tee. A side outlet elbow has three connection ends that are 90° from each other. If a connector has an asymmetric shape,

it may have a hand, and it might be necessary to describe it in terms of "right hand or "left hand". For example, if the asymmetric feature points left, it is described as a having a "left hand".

MATERIAL

Many materials are available. MAIN offers flanges made from AISI 1018 CF, ASTM A516-70 PVQ, AISI 11L17 and AISI 1020 as stock items and can turn around any commercially available material quickly. Most of our AISI 1018 and AISI 11L17 material is bought from the mill to MAIN's special requirements. This allows for improved material traceability and certification.

Stainless steel flanges are stocked in 304L grade with many stocked in 316L grade as well. The "L" in stainless grades stands for extra low carbon and aids in welding. Welding non "L" grades can result in an area that is not stainless steel in the heat affected zone and will rust. Other options such as aluminum, nickel, and cuprous-nickel and any commercially available material are available quickly. Some installations might require the use of specific material to meet applicable codes. Know these codes and who will inspect and approve the part; sometimes one agency is required to inspect to another's code with conflicting requirements.

PRESSURES

It is useful to know the pressure the flange will see, including spikes and intensified pressures caused by a cylinder in the hydraulic circuit, both of which can sometimes be above system pressure.

EXTRAS

Other options available include counterbored bolt holes, offset ports, mounting holes, "chopped blocks", and gauge/sampling ports. The flange is one of the least expensive locations for a gauge or sampling port.

MOUNTING KITS

SCREWS -size & type (inch/metric and socket/hex)

To mount the O-ring flange to the pad, a mounting kit consisting of 4 screws, 4 washers, and an O-ring is used. Unlike ANSI and API flanges, hydraulic flanges generally join metal to metal without a flat gasket between the surfaces; sealing is achieved by means of an O-ring that is compressed in a groove. This reduces fatigue issues and allows full torque to be applied to the bolts. High strength fasteners are generally used (SAE grade 8 hex head, ANSI B18.3 socket head, ISO grade 10.9 hex head or socket head or better). The screw size is determined by the tapped holes and normally has a coarse thread.

The use of corrosion-resistant bolts presents separate issues. In general, what makes bolts stronger also makes bolts less corrosion resistant. Finding 10.9 metric grade bolts in stainless steel might not be possible, and they can be quite expensive. The SAE standard for Grade 8 screws specifies a material other than stainless steel. Bolts made from a corrosion-resistant material might not be able to match both the tensile strength and yield strengths of the bolts specified in the relevant flange standard, so application-specific accommodations have to be made.

O-RING

Most hydraulic flanges use an O-ring for sealing. Many different materials and some different designs are available but the most common material used is Buna "N". The material to be used is determined by the temperature and the fluid. The fluid supplier should be consulted for the appropriate O-ring material.

In addition to material and size, O-rings are specified by stiffness (durometer). For many years 70 durometer O-rings were used, but in the last 20 years or more 90 durometer O-rings have been used. If a SAE J518 flange is being used within specifications, it is many people's opinion that it should not make a difference.

CONCLUSION

While care needs to be taken in all the aspects of selection described above, MAIN has seen many users struggle because they have not

- measured the bolt pattern to an adequate degree of precision,
- used the right bolts,
- considered the flange type (O-ring or flat faced),
- considered the geometry, or
- considered taking advantage of a reducer or gauge port adapter.

We hope that this paper will reduce the number of issues users see. Fill out the "Flange Specification" page below and send to info@mainmfg.com or fax to 810.953.1385

THE FLANGE YOU NEED - NOW

MAIN®
manufacturing products

Rev 6/2/2016

MAIN®
manufacturing products
Developers and Manufacturers of
Hydraulic Flanges & Components

HYDRAULIC FLANGE SPECIFICATION SHEET

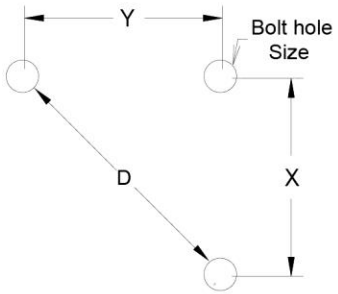
NAME: _____ TITLE/DEPT._____

COMPANY: _____

PHONE: _____ E-mail: _____ DATE: _____

PAD SIZE: (BOLT SPACING)

X: _____ & Y: _____ OR D: _____ BOLT CIRCLE (mm or inch) --->



BOLT HOLE SIZE AND TYPE: _____
INCH OR METRIC &/OR THREAD SIZE

FLANGE TYPE: _____
'O' RING OR FLAT FACED [COMPANION])

CONNECTION TYPE(S): _____
ST-THD, NPTF, SOCKET WELD PIPE OR TUBE, BUTTWELD, BSPP, BSPT, ETC.

CONNECTION SIZE(S): _____ GEOMETRY: _____
IN-LINE, EL, BRANCH TEE, RUN TEE, CROSS

MATERIAL: _____ MAX. OPERATING PRESSURE: _____
(CARBON STEEL, STAINLESS STEEL [STOCK OR SPECIFIED], OTHER)

EXTRAS: _____
(i.e.; GAGE PORT & SIZE [1/4 NPTF, # 4 SAE ST. THD, ETC.], CHOPPED CORNERS, OTHER)

SKETCH/NOTES

MOUNTING KIT

SCREW TYPE: _____ 'O'RING MATERIAL: _____
(i.e.; 8 BOLTS 1/2 - 13 X 4 SOCKET HEAD, Carbon steel.) (i.e.; BUNA 'N', VITON, OTHER)

QUANTITY OF PARTS NEEDED: _____

APPLICATION: _____

_____5/2015 ☒

3181 TRI-PARK DR. ☒ GRAND BLANC, MI 48439 ☒ 800-521-7918 ☒ 810-953-1380 ☒ FAX 810-953-1385 ☒ INFO@MAINMFG.COM