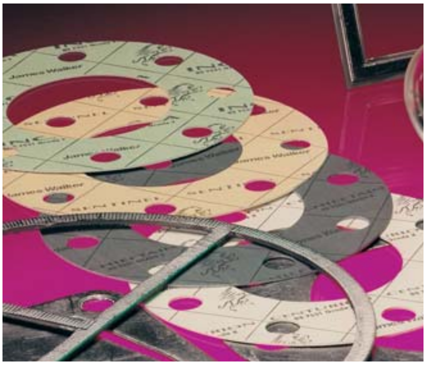
James Walker® Moorflex

Gasket Technology



Understanding gaskets & dimensional guidebook

As a leading manufacturer of static seals and gaskets, ***James Walker Moorflex*** has gained a wealth of experience and knowledge in industrial sealing applications. This has enabled us to compile this manual to assist engineers in the selection, design and use of the wide range of sealing products available.

This document should be read in conjunction with the ***James Walker Moorflex*** Product Range manual, which includes comprehensive product information.

James Walker® Moorflex

Understanding Gaskets

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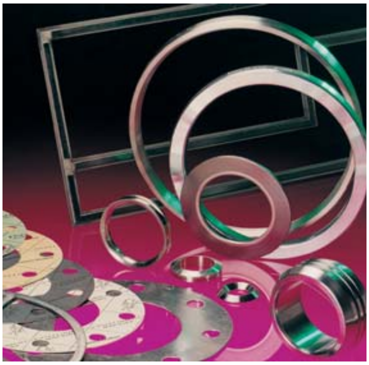


Section 1

Introduction

What is a gasket?

For years, many different types of gasket have been used to seal bolted connections. Few people in industry give them much thought until problems arise. This document is intended to promote a clearer understanding of how gaskets work, and how to avoid common pitfalls in their use.

Let us first define what a gasket is – imagine writing a technical dictionary and needing to define what a gasket is or does. One might simply suggest that it is something for sealing flanges on pipe-work or process equipment. The James Walker Moorflex definition should help the reader to picture how the gasket functions:

> "A device for sealing two surfaces, by storing energy between them"

Thus the gasket has to react to the forces generated by the bolts, and therefore the work and energy imparted to the bolted joint becomes 'stored' within the gasket itself.

Gaskets can be classified into three main categories:

- **Non-Metallic**
  (Elastomers, Cork, Compressed Fibre, Graphite, PTFE etc.)
- **Semi-Metallic**
  (Spiral-Wound, Clad Joints, Kammprofile, etc.)
- **Metallic**
  (API Ring Joints, Lens Rings etc.)

Each has its own advantages, and these will be described further in this manual. The maximum service conditions (operating pressure for example) for semi-metallic gaskets will be higher than for non-metallic, and fully metallic joints are likely to be used at even higher operating conditions.

Bolted Joint Assemblies

There are two main types of bolted joint assembly, which can be considered to be *'floating'* and *'rigid'* in their basic characteristics.

A *'floating'* assembly is one where there is no metal to metal contact after bolting the flanges. This would be the commonly encountered raised face flange having a fibre-based material gasket. Here, for an increase in system pressure a higher gasket stress would be required. However, with increasing bolt force the gasket undergoes greater compression. Additionally the bending moment on the flanges is increased, so that the bolts, flanges and gasket could all be considered to be 'spring elements' within the system. (Though the gasket is often a highly non-linear element in its load-recovery behaviour.)

A *'rigid'* assembly, is where metal to metal contact occurs after bolting. An example of a *'rigid'* assembly can be illustrated by an O-ring in a recess. Once the flanges have achieved a metal-to-metal contact, then further tightening of the bolts against the system pressure has no further effect upon the sealing element. As an O-ring is self-energising, then the degree of sealing should be good, provided no extrusion gap exists between the flanges.

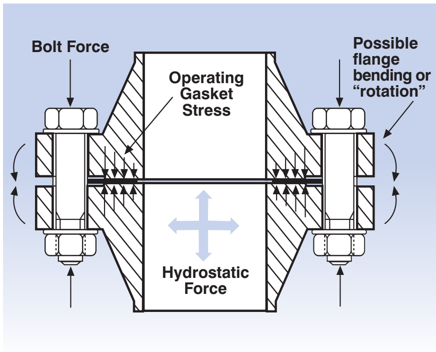
Forces Acting in a Bolted Joint Assembly

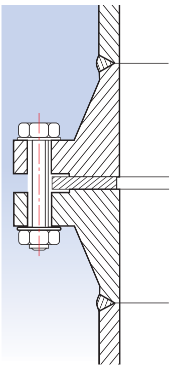
The *initial bolt load* generated upon tightening is transferred to the gasket via the flanges. This *initial seating stress* compresses the gasket and tightens it within itself. The *hydrostatic force* generated by the *system pressure,* tends to 'unload' and reduce the stress on the gasket.

The stress remaining on the gasket is considered to be the *'operating'* or *'residual'* stress. It is this degree of stress, or energy left in the joint that will determine the degree of tightness achieved in the system.

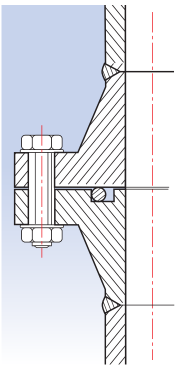
It should be noted that on a raised face assembly such as the one shown here, there will be some deflection of the flanges themselves *('flange 'rotation')*. This is a function of the load applied, the flange material and the geometry of the flanges. Thus, the operational stress towards the outside edge of the gasket tends to be greater than on the inside edge.

The mechanics concerning *flange rotation* are altered with flat-faced flanges. The overall contact area of a full-face joint can be typically twice as much as an inside bolt circle (IBC gasket).





'FLOATING' ASSEMBLY



'RIGID' ASSEMBLY

Section 2

Gasket Behaviour

a Stress Relaxation

The stress relaxation performance or the stress retention property of a gasket is vital in maintaining the level of energy stored in the joint, which effects the seal. Relaxation can occur at the flange-gasket interface as well as within the gasket material itself. This characteristic is particularly relevant in relation to non-metallic sheet jointing materials, where there are internationally recognised test procedures for examining relaxation effects. These involve stressing the gasket to a pre-determined amount and subjecting it to elevated temperatures for a given time (16 hours at 300°C for example). At the end of the test the remaining stress level is measured, where materials giving the higher readings are generally considered to be more successful.

Materials having a high rubber/elastomer content for example, may be expected to relax significantly as the rubber/elastomer decays at temperature.

It should be well noted that for fibre sheet jointing materials, that thick materials exhibit increased relaxation over thin ones. Thus, the thinnest gasket possible should always be used, and need only be sufficiently thick to take up any flange distortion and misalignment.

b Tensile Strength

Tensile strength is not necessarily the most important function of a gasket material. Expanded graphite for example is relatively weak, though it performs very well as a gasket material, with a high degree of sealability in a wide range of media. If a gasket is adequately loaded on a flange with the correct surface finish, then the clamping forces resist the tendency for the joint to 'blow-out' at pressure. However, if the joint is relatively thick (i.e. with a significant area exposed to the system pressure) and inadequately compressed, then the internal pressure forces on the inside edge have to be resisted by the tensile strength of the gasket. Again, the thinner the gasket the less relaxation will occur internally as well as exposing less area to the system pressure that is trying to force the gasket from between the flanges.

c Effect of Flange Surface Finish

Normally, standard piping flanges are supplied with a light gramophone-finish groove across the gasket seating face. (See following table for typical values.) These values are suitable for non-metallic and semi-metallic gaskets, whereas values for metallic gaskets are specified within relevant international standards, e.g., API 6A for ring joint gaskets. This finish tends to 'grip' the gasket material and thereby limits the creep across the flange faces. Note that the surface finish should not be so rough as to allow a leak path under the gasket, where the gasket is unable to deform effectively to fill the gramophone groove. The use of pastes on the gasket surface may actually worsen sealing performance as these can fill-in the surface finish allowing stress relaxation to occur. Any flange damage (e.g. steam cutting etc.) should be rectified before a joint is re-made.

The spirally grooved, "gramophone" surface finishes as specified in common flange

standards such as BS 1560, generally provide a good surface for most gasket types.

These usually recommend that the flange faces be machined with a spiral groove in accordance with the table below.

Individual attention should be given to applications involving searching gases or high vacuum sealing. As a general rule we prefer flange finishes of between 3.2 and 6.3 µm Ra as being the recommended surface for use with spiral-wound gaskets, and 6.3 to 12.5 µm Ra for compressed fibre materials, though both types should give acceptable performance over the complete range of finish shown.

Note: Wherever possible, the mating flanges should be of the same material and machined identically. It is also important that the flange surfaces are flat, free of imperfections, and as far as practicable are parallel.

d Load-Sealability

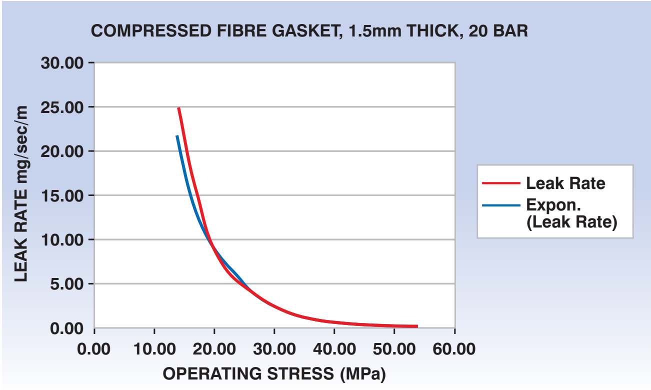
It is a fact that all gaskets leak to varying degrees. For example, whilst an assembly may be built and hydro-tested successfully, if it were pressurised with helium for example and the flange encapsulated, it may be possible to detect a small mass-leak rate of the helium, after a period of time, using a mass-spectrometer.

This leak-rate might otherwise be considered undetectable in general industrial terms, though the load-sealability tests that are conducted by gasket manufacturers and research bodies are invaluable when looking at critical sealing applications.

Method of Machining	Approximate depth of serration	Approximate radius of tool nose	Approximate pitch of serration	Rz µm		Ra µm	
				min	max	min	max
Turning	0.05 mm	1.6 mm	0.8 mm	12.5	50	3.2	12.5
Other than turning	-	-	-	12.5	25	3.2	6.3

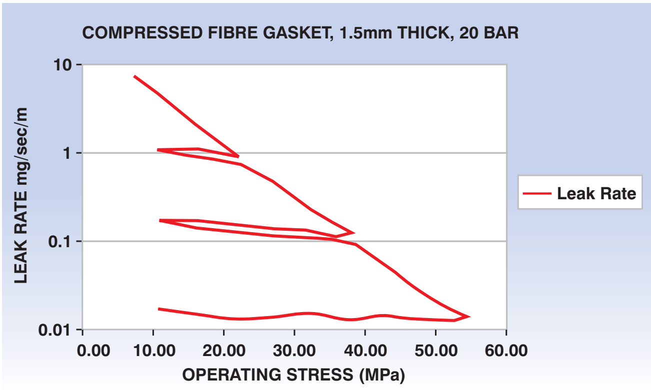
We must assume that in the free, uncompressed state, that a non-metallic gasket may have some internal porosity, as when manufactured, the material may not be perfectly homogenous. Thus, any micro-porosity holes in the structure will allow leakage until the applied seating stress causes them to close.

As the gasket densifies under load, such porosity becomes increasingly less and the joint continues to tighten becoming progressively more dense. Therefore, a load-leakage test on a gasket will tend to produce an exponential-decay curve format thus:



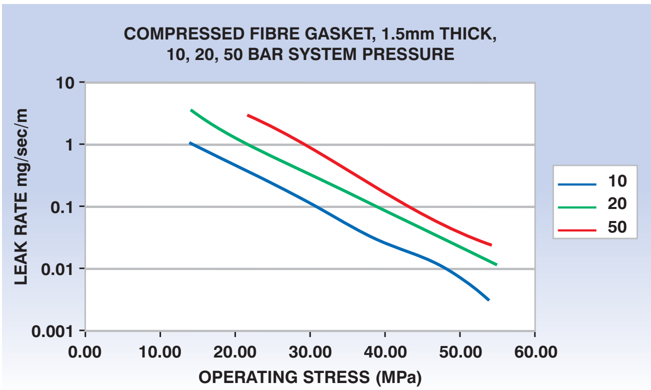
A curve of the load-compression characteristics will be very similar, again showing how the material densifies under increasing stress as any micro-porosity is closed within the material structure. The gasket becomes increasingly hard to compress with increasing applied stress.

Most gasket sealing tests are done on a loading-unloading cycle to see the effects of leakage as the gasket stress is reduced (by the hydrostatic force for example), after being loaded to a higher value. It is usually better to create a log-linear plot of the load-sealability results. If this is done, then a reasonably straight line is produced as per the example adjacent:



Note from this graph that as the gasket densifies, then the slope of the unloading-leakage data lines changes. Thus, the sealing properties are quite complex, depending upon the initial and operational stress levels that are likely to occur in service. Note that flange rotation effects will further complicate the theoretical stress levels upon the gasket element.

For a given operating stress on a gasket, the leak-rate will increase with increasing system pressure, as indicated in the graph adjacent:



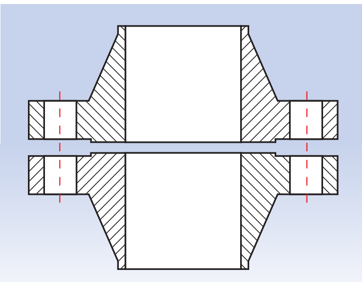
Similarly, for a sheet gasket material, the leak-rate increases with material thickness, roughly in a proportional manner, (i.e. double the gasket thickness produces double the leak rate).

Flange Types & Standards

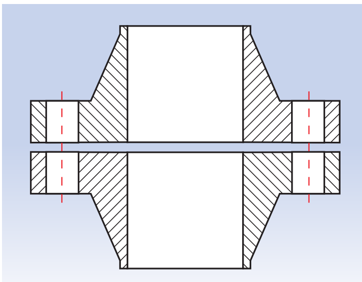
Flange standards

There are many common flange standards available, though perhaps the most widely used are ASME, DIN and BS. There are of course a large number of other national standards in all countries around the world, though many have their origins in the ASME or DIN series flanges.

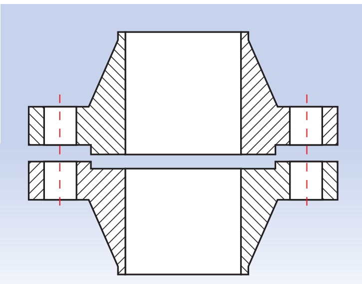
There are a wide variety of flange styles, configurations and applicable standards as shown herewith, though in general industry the raised face flange is perhaps the most common type regularly employed.



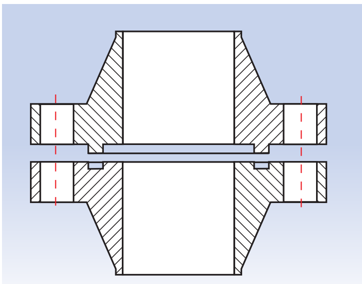
RAISED FACE



FLAT FACE



MALE & FEMALE



SPIGOT & RECESS

a ASME

The ASME B 16.5 flanges are in widespread use all around the world on power stations, refineries, chemical plants and most other major industrial facilities. This standard covers flanges from 1/2" to 24" nominal bore, which are classified in pressure ratings in pounds per square inch (p.s.i.), such as classes 150, 300, 600, 900, 1500, and 2500. Note that these are pressure ratings at elevated temperatures, as for example a class 150 flange is rated to 290 p.s.i. (20 bar) at ambient.

Large diameter ASME flanges (above 24" and up to 60" N.B.) are covered by the ASME B 16.47 standard. This has two main categories – Series A and Series B. The Series A covers flanges formerly known as MSS-SP44 (Manufacturers Standardisation Society) whereas Series B covers those from API 605 (American Petroleum Institute), which tend to be more compact. There are other large diameter flange standards such as the Taylor Forge classes 175 and 350, as well as the American Water Works Association (AWWA) flanges.

Heat exchangers are commonly produced having male & female flanges of class 150, 300, or 600 etc., but manufactured to TEMA (Tubular Equipment Manufacturers Association) dimensions.

b DIN

By comparison to the ASME flanges, the DIN series are rated with PN numbers which indicate the nominal pressure rating in bar. These for example are PN 6, PN10, PN16, PN25, and PN 40 where, unlike the ASME flanges, the pressure ratings relate to ambient temperature. This metric series of flanges are now covered by pan-European standards such as EN1092, for these PN rated flanges.

c BS

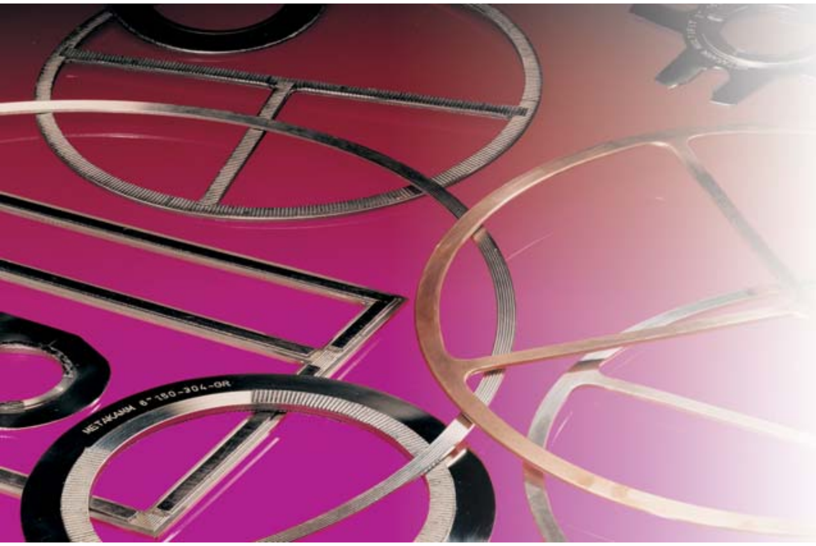
The BS10 flange standard is rarely used, though of course many of these flanges still remain in service at a large number of industrial sites. These flanges are classified by a letter system, for example Table E, Table H, Table J etc. in increasing order of service pressure rating.

d Relevant Gasket Standards

For ASME flanges, then cut gaskets from non-metallic sheet materials, are covered by ASME B 16.21 or BS EN 12560 part 1 (formerly BS7076 pt.1). Spiral wound joints for these are made in accordance with ASME B 16.20 (formerly to API 601), or to BS 3381 or BS EN 12560 part 2. The ASME B 16.20 standard also covers metal-jacketed gaskets and API ring joints. For DIN series flanges, gaskets are cut from sheet materials in accordance with EN 1514 part 1, with spiral wound joints being made to EN 1514 part 2. The BS EN 12560 and BS EN 1514 have additional sections covering other gasket types such as PTFE envelopes and corrugated metallic gaskets in parts 3 and 4 respectively. As for BS 10 flanges, the cut gasket dimensions are given in BS 3063.

In terms of gasket material testing standards, then compressed sheet materials are often tested in accordance with standards such as BS 7531, or DIN 3535 and ASTM F36, where these standards require testing of material properties such as stress relaxation, compression, recovery and gas permeability amongst others.

Gasket Types



The types of gasket can best be described by the materials of construction and classified as non-metallic, semi-metallic and metallic.

a Non-Metallic

Generally low to moderate pressure, wide chemical service including acids and alkalis up to moderate temperatures and miscellaneous low duty applications.

- **Elastomers**

Elastomer gaskets are generally only used for relatively low pressure applications as at high seating stresses a rubber gasket may extrude from between the flanges. (Note that rubber in itself is incompressible and has to displace.)

There is a vast range of elastomeric materials available from James Walker. These include natural, nitrile, neoprene, butyl, ethylene-propylene, fluorocarbon and silicone to name but a few. Thus, a wide range of chemicals can be catered for, both in specification grade and commercial quality materials. Our technical specialists are on hand to advise the most suitable grade for your application.

- **Elastomer-Cork**

Nebar® is the James Walker brand of cork-elastomer jointing. There are a variety of grades available, and are mainly used on low pressure duties such as oil covers and applications where the available bolting is relatively low.

- **Compressed Fibre**

Materials such as ***Sentinel®, Centurion®*** and ***Chieftain®*** are James Walkers mainstream sheet fibre jointings. These are made using aramid, glass and carbon fibres.

This type of gasket material is most likely to be utilised on relatively low duties, such as water, air, oil and low pressure steam. Note that these materials are not 'equivalents' to the formerly used asbestos products, but should be considered simply as alternatives. In every case, the thinnest possible material should be used. Further information is available on these materials in the James Walker Moorflex Product Range Manual.

- **Graphite**

Supagraf® is the name of James Walkers range of expanded graphite sealing materials. Graphite is a good high temperature material with wide chemical resistance. It should not however, be used on oxidizing media (e.g. Nitric or Sulphuric acids for example.) It is softer and more compressible than sheet fibre jointing, as well as providing a higher level of sealing tightness at a given gasket stress. However, graphite is readily damaged, so requires more care in handling and storage. It is generally supplied with reinforcing layers to increase its strength and rigidity. Note that the strongest grades generally have a tanged stainless steel layer, which can present very sharp edges if press cut, or cut with tinsnips, etc. Thus, for health and safety reasons, we would recommend that gaskets in this material should be specified as being cut by abrasive water-jet method wherever possible, as this avoids sharp edges.

- **PTFE**

PTFE is generally used because of its outstanding chemical resistance. Note that it can be prone to relaxation and creep. Therefore, expanded or filled grades such as ***Fluolion®* Integra** are often employed to overcome some of these effects. PTFE can be used as a cover around the inside edge of a fibre joint, to produce what is known as a PTFE envelope gasket, as well as being used as a filler in spiral-wound gaskets, and as a covering surface layer for Kammprofile gaskets.

- **Flange Insulation Sets**

In conditions where a galvanic corrosion cell could exist (e.g. the joining of stainless and carbon steel flanges in an assembly), then an insulating gasket system is often required. In these systems a rubber-faced phenolic material is commonly used for the gasket, and to avoid electrical conduction through the bolts, these too are insulated using phenolic washers and insulating sleeves.

b Semi-Metallic

Combination of non-metallic filler for compressibility and metal for strength, resilience and chemical resistance. Used typically at higher temperatures and pressures than non-metallic types.

• Spiral-Wound

The ***Metaflex***® range of spiral-wound gaskets are widely used on high pressure joints throughout industry world-wide. These are generally used for higher temperatures and pressures. A variety of metals are available for the winding strip as well as for the support rings. The standard pipeline gaskets are nominally 4.5 mm thick and compressed to a working thickness of 3.2 / 3.45 mm.

At large diameters (typically over 1.2 metres) then a thicker gasket of 7.3mm thickness is generally used.

On raised face flanges, the gaskets have an outer support ring which locates inside the bolt PCD, and they can also be supplied with an inner ring. (These are usually for the higher pressure systems, or processes having high flow rates or abrasive media, as the inner ring reduces turbulence at the pipe bore.

On spigot / recess flanges a simple sealing element gasket is usually used with no additional support rings, and the flanges are dimensioned to achieve the correct gasket compression when metal to metal contact is reached. In these cases the gaskets should be designed having the correct inner and outer clearances for the recess used. If in doubt, consult our technical advisory service.

• Metal Jacketed

Single and double-jacketed metal clad gaskets have mostly been traditionally used as heat exchanger gaskets. Metals such as soft iron, carbon steel and stainless are used to encase a soft filler material, usually a non-asbestos millboard. It should be noted that some heat exchanger flanges have stress-raising 'nubbins' on one face, and the non-seamed side of a double jacketed gasket is intended to go against this face, so it is important that the joint is fitted the correct way around in the assembly.

• Kammprofile

The James Walker ***Metakamm***® gasket type is generally a solid metal ring having a serrated tooth form profile on each side. A covering layer of graphite or PTFE is applied, which becomes compressed into the serrated surface when the gasket is loaded. These gaskets have a good level of sealing tightness and are frequently used to replace metal-jacketed joints on heat exchangers. They can also be provided with a slot-leg locating ring as a 'Multi-Fit' design (see Metal Trap gaskets below), to reduce stores inventory.

Metaflex® **SPIRAL-WOUND GASKET COMPRESSION**

NOMINAL THICKNESS	COMPRESSED THICKNESS
2.5mm (0.098")	1.9/2.1mm (0.075/0.85")
3.2mm (0.125")	2.4/2.6mm (0.095/0.105")
4.5mm (0.175")	3.2/3.45mm (0.125/0.135")
7.3mm (0.285")	5.00/5.25 (0.197/0.207")

• Metal 'trap' gaskets

In these gaskets, a thin sheet steel gasket has recesses formed into it, where a bead of sealing material (graphite or PTFE) is located in either side. The recess traps the material, preventing it from being extruded under load. These James Walker ***Metcom***® gaskets are often supplied with a slot-leg, Multi-Fit' design, so that one gasket will fit flanges from class 150, 300 etc. Note that the sealing elements are relatively narrow, so this type of gasket should not be used on badly damaged flanges (e.g. those having 'steam cuts' etc.).

c Metallic

Manufactured from one metal or a combination of metals in a variety of shapes and sizes for high temperature or pressure use. Due to the high pressures involved, the seating stresses are necessarily large to give sufficient gasket deformation to overcome any flange surface imperfections and to overcome the high system pressure forces.

• Oval & Octagonal

These are commonly used on oilfield applications, and details of these joints are given in well recognised standards ASME B 16.20 and API 6A. The gaskets sit in a recess in the flange face, which has 23° angled walls. Some stand-off exists between the flanges, though PTFE inner spacers can be supplied to reduce the effects of erosion and the build-up of dirt on the flange face inside the gasket. Similarly, sponge rubber protectors are sometimes used to keep the area clean outboard of the gaskets and around the bolts. For hydro-testing purposes, rubber-covered ring joint gaskets are available, to avoid damaging the flange recesses.

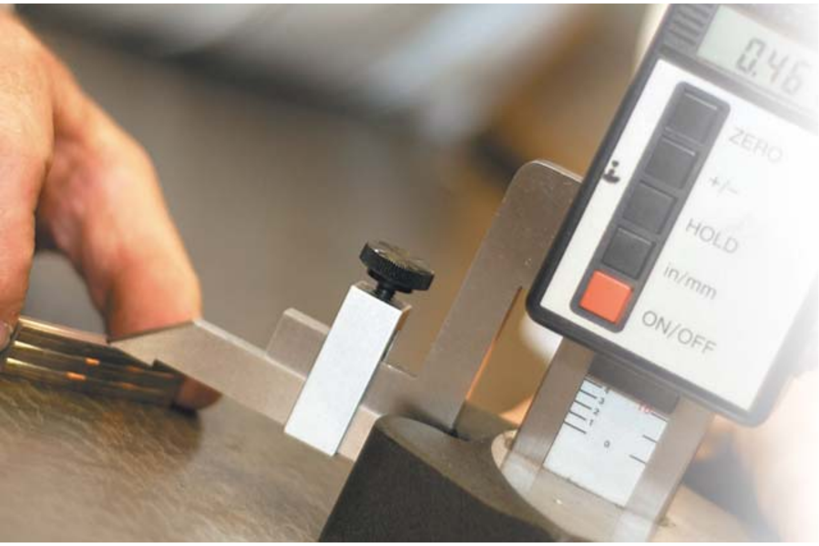
• RX & BX

The RX joints are an unequal bevel octagonal ring, and are considered to be a pressure-energised or pressure-assisted seal. The BX is also octagonal, though shorter in profile and designed to go into a recess that comes metal-to-metal when the flanges are tightened. These are used on very high pressure flanges up to 20,000 p.s.i. rating.

• Other metallic gaskets

There is a wide range of solid metallic gaskets available from James Walker Moorflex, eg., items such as lens rings, wedge rings (Bridgeman joints), convex metal gaskets, and weld ring gaskets can be manufactured in a variety of alloys, with full quality assurance and material traceability to national and international standards.

Calculation Methods



As stated in section 2, the load-sealability characteristics of a gasket are quite complex. Incorporating these effects into a reliable flange design method has been the objective of designers for many years, and a number of flange design codes are now well recognised.

The ASME VIII and DIN 2505 codes are well established and successfully in use. However, certain limitations in these codes have lead to research and development of alternatives, such as the PVRC and CEN methods.

James Walker Moorflex recognises both the merits and limitations of all the methods which have been summarised and commented upon in the following paragraphs.

Individual design parameters will dictate the most appropriate method and for further advice on gasket selection and relevant load sealability requirements, please contact our technical specialists.

a ASME VIII

The ASME code has been used for many years to design flanges, though has a number of recognised flaws when it comes to determining a suitable bolt load with regard to gasket sealing. Calculations are performed to determine greater of either the operating or initial forces using the following formulae.

1 Initial load requirement

$$W_{m1} = \pi b G y$$

2 Operating load requirement

$$W_{m2} = \frac{\pi G^2 P}{4} + 2b\pi\, GmP$$

The factors ‘m’ and ‘y’ are the ‘gasket factor’ and initial seating stress values respectively. One problem is that the code does not utilise the whole gasket contact area in the calculation. In the formulae above, the “effective width” is ‘b’ and the “effective diameter” is ‘G’. The system pressure is designated as ‘P’ in these equations.

If we consider a common raised-face flange, then the contact width of the gasket element (from the raised face outside diameter to the gasket inside diameter) is designated as ‘N’. The basic width is then calculated as being $^1/_2$ this value and called b_o. The “effective width” then depends upon the value of b_o being greater or less than $^1/_4$”, though in the majority of cases this is likely. If b_o is greater than $^1/_4$”, then the effective width is calculated as :-

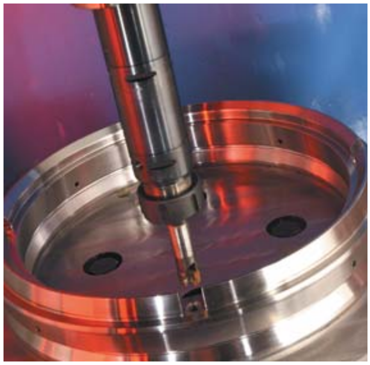
$$b = \sqrt{\frac{b_o}{2}}$$

(or for cases where b_o is equal or less than $^1/_4$”, then $b = b_o$)

The effective diameter ’G’ is simply the outside contact diameter less 2 x b_o

Therefore, the actual gasket contact area is usually far greater in reality than the calculated figure by this method.

Note also that the gasket factor ’m’ is effectively a multiplier of the system pressure as an operating stress. However, as shown in section 2, the actual sealing performance of a gasket is more realistically a 3-dimensional, exponential decay curve, rather than a single number.



Again, as per section 2, we know that it is the operational stress that defines gasket sealability. There seems to be no real reason to try and link initial gasket seating loads, (i.e. for compression purposes, to take up flange flatness etc.) with the 'm' factor which is related to the operating stress requirement for a given system pressure. However, when originally devised in the 1930's and 1940's, the relationship existed between the factors of :-

$$\mathbf{(2m\text{-}1)^2 \times 180 = y}$$

(using y in units of p.s.i., and rounding-off the m factor to the nearest 0.25)

Thus, for compressed fibre gaskets, a lower y value was determined for the thicker materials, presumably because they would deform more readily to make a crude seal against whatever flange distortion existed. Thus, from the relationship above, the thicker materials also gained a lower m factor, suggesting that they would give better sealing performance. However, again as per section 2 of this manual we know that thicker materials not only have a greater tendency to stress-relax, but also have a greater number of micro-porosity channels where leakage can occur. Indeed, in searching gas sealability tests, then a 3 mm thick compressed fibre jointing material tends to leak at approximately twice the rate of a 1.5 mm sample of the same material at a given operating stress.

b DIN 2505

This method also employs gasket factors that are used to determine the bolt load requirement. There are the maximum and minimum stress levels for installation at ambient temperature, as well as a maximum stress at elevated temperature

$(\sigma \mathbf{vu}, \sigma \mathbf{vo}, \sigma \mathbf{Bu}, \sigma \mathbf{Bo})$.

The maximum initial gasket stress allowable is a function of the width to thickness ratio to avoid crushing effects on soft materials. This method also has an 'm' factor, though uses the actual contact width of the gasket in the calculations. Thus, this method is less likely to produce insufficient gasket stress than by ASME VIII, especially as the minimum initial gasket stress values given in the code are fairly conservative.

Another popular European design method used to determine bolt load requirements is the AD-Merkblatt B7, where again the initial and operating bolt load requirements are determined using gasket factors. These are k1, k0 and KD, which relate to the effective widths and deformation resistance of the gaskets concerned.

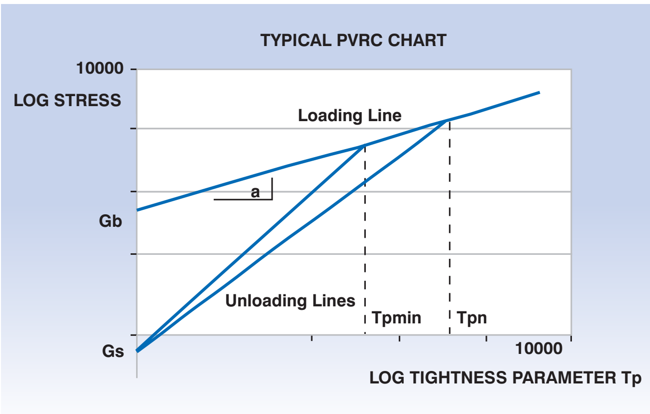
Note that both of the above methods are now generally tending to be replaced by the new EN 1591 design method.

c PVRC

For a number of years the Pressure Vessel Research Council has recognised some of the inadequacies of the ASME code and sought to provide a better means of calculating the required gasket loading. The proposed calculation requires gasket data to be developed from a series of loading and unloading leak tightness tests in order to obtain coefficients to describe the sealing performance of the gasket.

This method uses the concept of 'Tightness Parameter', where the gasket sealability is related to a dimensionless number thus:

$$\mathbf{Tp} = \frac{\mathbf{P}}{\mathbf{P'}}\left(\frac{\mathbf{L'}}{\mathbf{L}}\right)^{0.5}$$



This formula essentially relates the test pressure to atmospheric pressure, and the measured leak rate against a unitary leak rate measured in mg/sec/mm diameter of gasket. The index of 0.5 suggests that doubling the system pressure will in fact produce a fourfold increase in leak rate, though this is perhaps a worst-case scenario for most gaskets.

The coefficients used in the calculation are G_b, a, and G_s and are derived from the sealablility test as shown in the Typical PVRC Chart.

There is some debate about the reliability and repeatability of the coefficients as they are derived from the log-log plot of an assumed square-law relationship, so relatively minor changes in leak rate during the test could affect the final data reduction.

However, the coefficients are at least derived from actual tightness testing, so the calculation becomes realistic in terms of typical in-service performance of the gasket.

d CEN

Like the PVRC method, this uses loading-unloading gasket sealing tests to determine the gasket performance characteristics. They are used in a flange calculation method (EN 1591) which is quite iterative and complex in nature. As a gasket is loaded, some flange rotation may occur, changing the effective stress on the gasket from the inside to outside contact position (as described previously in section 1).

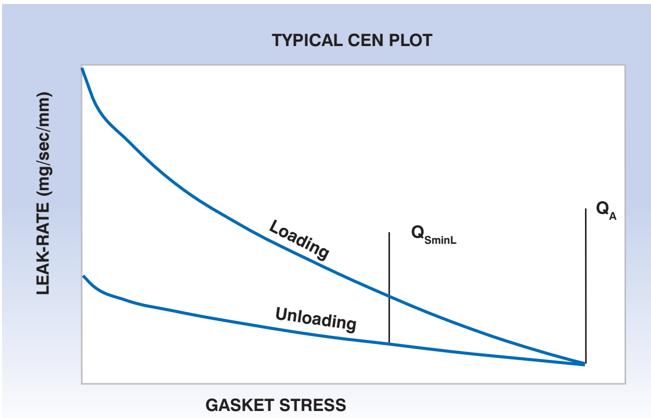
The gasket seals differently in the unloading phase of the test compared to the loading cycle. If we consider that a gasket is loaded to point Q_A initially, and unloaded by the hydrostatic to the operating stress Q_{SminL} as shown in the diagram below, then we can see that the sealability decreases slightly between these two points. However, the sealability is generally better than when this stress level was applied during the loading phase.

As mentioned in section 1, the unloading modulus of the gasket changes with increased initial stress. Therefore, the change in sealability between Q_A and Q_{SminL} will change depending upon the actual value of Q_A applied. This standard uses the unloading modulus of the gasket in the calculations to examine the stiffness of the gasket as a part of the overall joint stiffness.

The EN 1591 method looks at the required sealability from loading-unloading tests. By knowing the degree of unloading on the joint from the hydrostatic forces and the tightness level desired, it is possible to calculate the flange deflection and effective gasket stress for a given bolt load. Therefore, changes to the flange geometry and applied bolt load will determine the amount of flange rotation, the change in gasket stress across the sealing element, both in the initial and operating conditions, and therefore the degree of tightness achieved.

The problem with this method is that it can be quite iterative and complex, though computer programmes are becoming available which will make the calculation method easier to perform.

The degree of gasket testing required can also be considerable, and work is underway to look at combining the methodologies of both the CEN and PVRC testing to harmonise the test protocols.



Section 6

Gasket Installation

Best Practice

a Do's and Don'ts

✔ 1 Mating flanges should be of the same type and correctly aligned.

✔ 2 Fasteners should be selected to ensure that they do not exceed their elastic limit at the required tension.

✘ 3 Do not re-torque elastomer bound compressed non-asbestos gaskets after exposure to elevated temperatures. (They may well have hardened and are at risk of cracking.)

✔ 4 Ensure that fasteners show no signs of corrosion, which might affect their load bearing capacity.

✔ 5 Nuts should have a specified proof load 20% greater than the UTS of the fastener.

✔ 6 Hardened steel washers of the same material as the nuts should always be used.

✔ 7 A thread lubricant or anti-galling compound should be used on bolting as appropriate, but only a thin, uniform coating should be applied. Where stainless steel is used, it should be ensured that such coatings are suitable for use.

✘ 8 Fasteners and/or gaskets should never be re-used.

✔ 9 Good quality gaskets should always be procured from reputable suppliers only.

✔ 10 Gaskets should be kept as thin as possible.

✘ 11 Gaskets should never be 'hammered-out' against the flange. Not only can this cause damage to the flange, it will also damage the gasket material and thereby reduce gasket performance.

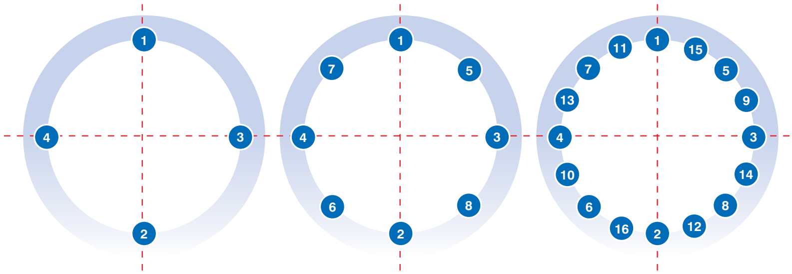
✔ 12 When cutting full-face gaskets, the bolt holes should be cut first, followed by the gasket outer and inner diameters. Note that if the bolt holes are fairly close to the gasket O/D, then punching-out the holes last may produce enough stress to crack the gasket at this point.

✔ 13 Gaskets should be stored in a cool dry place, away from heat, humidity, direct sunlight, ozone sources, water, oil and chemicals. They should also be stored flat (i.e. not hung on hooks).

✘ 14 Avoid the use of Jointing Compounds and pastes – these can lubricate the flange-gasket interface and encourage stress-relaxation effects.

b Bolt Tightening

Gaskets should be tightened evenly in at least three, or even four stages using an opposed-pattern as illustrated here. Be aware that "cross-talk" exists between bolts during the tightening process so that as one tightens and the gasket compresses, another bolt may loosen. Therefore, a final pass around all of the bolts at the end is suggested to ensure that all remain tight.



c Troubleshooting

PROBLEM	IMMEDIATE LEAKAGE ON START-UP	LEAKAGE EXPERIENCED AFTER A SHORT PERIOD OF OPERATION	LEAKAGE EXPERIENCED WITHIN A FEW HOURS OR DAYS
POSSIBLE CAUSE	INSUFFICIENT OR EXCESSIVE STRESS, OR UNEVEN STRESS DISTRIBUTION	LOSS OF STRESS DUE TO RELAXATION IN THE GASKET OR BOLTS. IS THERE ANY THERMAL OR PRESSURE CYCLING?	CHEMICAL ATTACK OF GASKET BY MEDIA, OR POSSIBLE MECHANICAL EROSION
REMEDY	CAREFULLY FIT A NEW GASKET. CHECK FLANGE ALIGNMENT, SURFACE FINISH AND BOLT TIGHTENING PROCEDURE.	CHECK FLANGE FINISH AND APPLIED BOLT LOAD. REVIEW GASKET TYPE AND MATERIAL SELECTION	CHECK CHEMICAL COMPATIBILITY AT MEDIA CONCENTRATION AND TEMPERATURE. REVIEW GASKET TYPE AND MATERIAL SELECTION

Bolting

Having determined the gasket loading requirement, consideration must be given to the best materials and tightening methods to achieve this loading. As mentioned previously the overall joint integrity is essentially a function of three main criteria:

Correct gasket selection to suit the operating conditions and the overall bolted joint strength / stiffness

Quality of the joint components – the gasket manufacture, flange and bolt materials etc.

Installation competence – ensuring that the gasket is fitted correctly, with the design seating stress applied both accurately and evenly.

a Materials

Commonly used bolting materials and standards include BS 4882 and ASTM A193.

It should be noted that stainless fasteners (e.g. "B8") have a significantly lower strength than alloy steel materials ("B7"). Care should be taken to select a bolt material having sufficient yield strength so as to be able to apply adequate gasket stress whilst retaining a margin of safety, bearing in mind the variance of torque-tension scatter that may be possible during tightening.

Note also, that especially with some exotic bolt materials and at elevated temperatures, the true onset of yield may be below the theoretical value. Bolt material standards such as those mentioned above should be consulted for details of maximum recommended stresses and operating temperatures.

b Tightening Methods

Torque vs. Tension

Whilst torque is often recommended as a method for loading bolts in order to achieve a reasonable gasket stress, it should be noted that because of the variance in nut and thread friction which is particularly difficult to control, then the theoretical relationship is not particularly accurate.

$$T = \frac{F}{4}\left(\mu_h(A + D) + \mu_t\,(2d_e \sec\theta) + \frac{2p}{\pi}\right)$$

Here, F is the axial load requirement, A is the across-flats dimension of the nut (i.e. the outside diameter of nut and washer contact), and D is the washer inside diameter. The friction coefficients under the head of the nut, and on the thread (μ_h, μ_t) will almost certainly be difficult to determine. The effective diameter ($\mathbf{d_e}$), the pitch of the threads (p), and half the thread form angle (θ), are all readily available in engineering manuals for common thread forms.

Simplified Formula

In simplified form, for lubricated fasteners, washers, nuts etc, the approximate relationship between torque and fastener may be represented as:

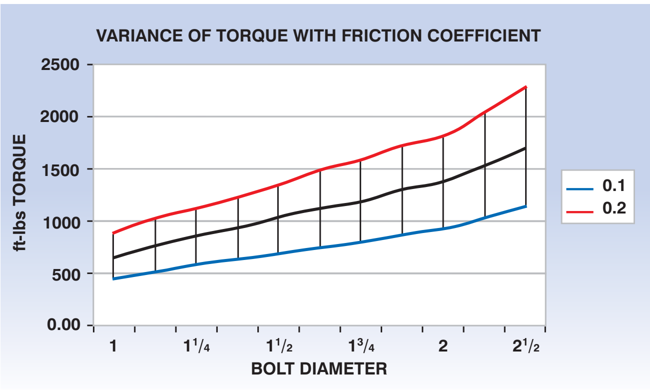
Torque = 0.2 x Load x Diameter

Obviously, the units used must be consistent with the system being used (for example if torque is required in ft-lbs, then for bolts in inches, the value must be divided by 12 etc.). Compared to the more complex formula given above, then the simplified formula shown here is often deemed sufficient for purpose, as accurately gauging the coefficient of friction can be extremely difficult. However – please note that the accuracy of applied torque vs. actual fastener tension achieved, can be typically +/- 60%.

The effect of the friction coefficient on the variance of the torque-tension relationship can readily be seen on the following graph. Here we use a nominal 0.15 as being the friction both on the thread and on the nut-washer interface on a conventional UNC threaded fastener. Using the more complex formula given above, we can see that a change of only ± 0.05 on the friction coefficient can vary the torque required by typically 30%.

Hydraulic Tensioning

Hydraulic tensioners have a number of advantages when it comes to tightening large bolts in particular, and can provide significant amounts of tightening power. They offer the ability to be linked together, so that a number of bolts may be tightened in unison. However, some compliance exists in the tensioner system (e.g. embedding of the nut and washer, and thread deflection etc.), so that some overload is required to compensate for the relaxation once the tensioner has been de-pressurised. The degree of torque imparted to the nut collar when the nut is 'run-down' the fastener, also has an effect on the amount of load-transfer relaxation that occurs when the tensioner is de-pressurised.



Ultrasound

Ultrasound – Whilst this can be a relatively accurate method for measuring the extension of the fastener, note that the fasteners should ideally be spot-faced for good contact with the signal probe. The bolts or studs also require calibration to the ultrasound equipment, as load-extension characteristics of fasteners may vary between batches. Note that this method requires a degree of operator skill and training, can be relatively time-consuming.

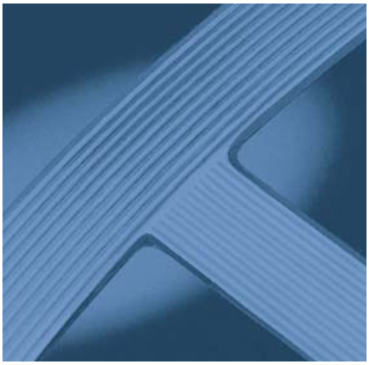
c Condition Monitoring - *RotaBolt®*

Load-monitored fasteners (***RotaBolt®***) – These are accurate, quick and easy to use. RotaBolts are a "state of the art" system where a modified bolt or stud has an indicator cap fitted at the end which locks when the required tensile load is attained. There is a small gap between the end of the bolt and the cap when the fastener is in the unstressed state. As the fastener is tightened it stretches and the gap closes. The gap setting depends upon the desired tension to be achieved, and once the cap locks-up, then this value has been attained. This method ensures rapid and easy installation as well as simple in-service condition monitoring of the fastener tension. The RotaBolt 2 system has dual indicators offering max and min settings to show a loading band for greater accuracy in situations where some overall joint relaxation might be anticipated. All fasteners are load tested to the desired design tension as an additional check of their material integrity.

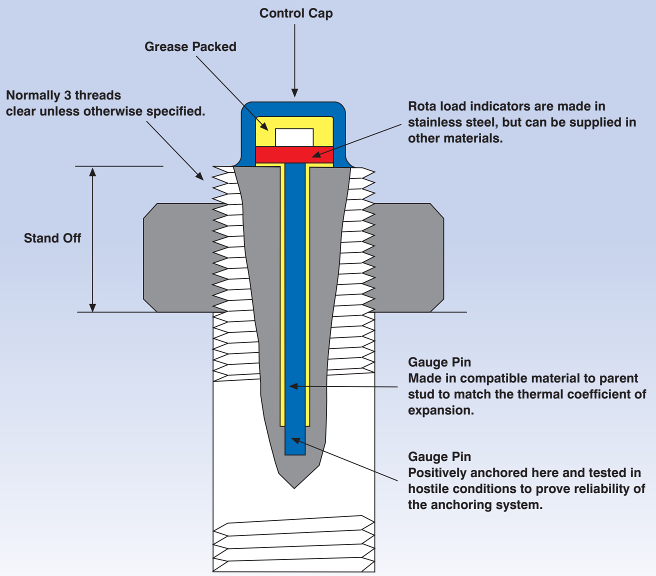
Note of course that each set of fasteners are factory pre-set to a load requested by the user. Thus, these should only be used with the vessel or piping that they are intended for, as a different piping system and gasket type may require a different load setting. This system is not suitable for small diameter fasteners (e.g. below 5/8" / M16).

RotaBolt®

Extensively used for critical flange jointing duties in many industries including, offshore, petrochemical, mining, defence and power generation.



Rotabolt converts existing or purpose-made studs.



Section 8

Dimensional Data

Bolting Data for ASME 16.5 - FLANGE DIMENSIONS

Nominal Bore	ASME Class 150							ASME Class 300						
	Flange O/D		No of Bolt Holes	Hole Diameter		Bolt PCD		Flange O/D		No of Bolt Holes	Hole Diameter		Bolt PCD	
	Inch	mm		Inch	mm	Inch	mm	Inch	mm		Inch	mm	Inch	mm
1/2	3 1/2	88.9	4	5/8	15.9	2 3/8	60.3	3 3/4	95.3	4	5/8	15.9	2 5/8	66.7
3/4	3 7/8	98.4	4	5/8	15.9	2 3/4	69.9	4 5/8	117.5	4	3/4	19.1	3 1/4	82.6
1	4 1/4	108.0	4	5/8	15.9	3 1/8	79.4	4 7/8	123.8	4	3/4	19.1	3 1/2	88.9
1 1/4	4 5/8	117.5	4	5/8	15.9	3 1/2	88.9	5 1/4	133.4	4	3/4	19.1	3 7/8	98.4
1 1/2	5	127.0	4	5/8	15.9	3 7/8	98.4	6 1/8	155.6	4	7/8	22.2	4 1/2	114.3
2	6	152.4	4	3/4	19.1	4 3/4	120.7	6 1/2	165.1	8	7/8	22.2	5	127.0
2 1/2	7	177.8	4	3/4	19.1	5 1/2	139.7	7 1/2	190.5	8	7/8	22.2	5 7/8	149.2
3	7 1/2	190.5	4	3/4	19.1	6	152.4	8 1/4	209.6	8	7/8	22.2	6 5/8	168.3
4	9	228.6	8	3/4	19.1	7 1/2	190.5	10	254.0	8	7/8	22.2	7 7/8	200.0
5	10	254.0	8	7/8	22.2	8 1/2	215.9	11	279.4	8	7/8	22.2	9 1/4	235.0
6	11	279.4	8	7/8	22.2	9 1/2	241.3	12 1/2	317.5	12	7/8	22.2	10 5/8	269.9
8	131/2	342.9	8	7/8	22.2	11 3/4	298.5	15	381.0	12	1	25.4	13	330.2
10	16	406.4	12	1	25.4	14 1/4	362.0	17 1/2	444.5	16	1 1/8	28.6	15 1/4	387.4
12	19	482.6	12	1	25.4	17	431.8	20 1/2	520.7	16	1 1/4	31.8	17 3/4	450.9
14	21	533.4	12	1 1/8	28.6	18 3/4	476.3	23	584.2	20	1 1/4	31.8	20 1/4	514.4
16	23 1/2	596.9	16	1 1/8	28.6	21 1/4	539.8	25 1/2	647.7	20	1 3/8	34.9	22 1/2	571.5
18	25	635.0	16	1 1/4	31.8	22 3/4	577.9	28	711.2	24	1 3/8	34.9	24 3/4	628.7
20	27 1/2	698.5	20	1 1/4	31.8	25	635.0	30 1/2	774.7	24	1 3/8	34.9	27	685.8
24	32	812.8	20	1 3/8	34.9	29 1/2	749.3	36	914.4	24	1 5/8	41.3	32	812.8

Bolting Data for ASME 16.5 - FLANGE DIMENSIONS

Nominal Bore	ASME Class 600							ASME Class 900						
	Flange O/D		No of Bolt Holes	Hole Diameter		Bolt PCD		Flange O/D		No of Bolt Holes	Hole Diameter		Bolt PCD	
	Inch	mm		Inch	mm	Inch	mm	Inch	mm		Inch	mm	Inch	mm
1/2	3 3/4	95.3	4	5/8	15.9	2 5/8	66.7	4 3/4	120.7	4	7/8	22.2	3 1/4	82.6
3/4	4 5/8	117.5	4	3/4	19.1	3 1/4	82.6	5 1/8	130.2	4	7/8	22.2	3 1/2	88.9
1	4 7/8	123.8	4	3/4	19.1	3 1/2	88.9	5 7/8	149.2	4	1	25.4	4	101.6
1 1/4	5 1/4	133.4	4	3/4	19.1	3 7/8	98.4	6 1/4	158.8	4	1	25.4	4 3/8	111.1
1 1/2	6 1/8	155.6	4	7/8	22.2	4 1/2	114.3	7	177.8	4	1 1/8	28.6	4 7/8	123.8
2	6 1/2	165.1	8	3/4	19.1	5	127.0	8 1/2	215.9	8	1	25.4	6 1/2	165.1
2 1/2	7 1/2	190.5	8	7/8	22.2	5 7/8	149.2	9 5/8	244.5	8	1 1/8	28.6	7 1/2	190.5
3	8 1/4	209.6	8	7/8	22.2	6 5/8	168.3	9 1/2	241.3	8	1	25.4	7 1/2	190.5
4	10 3/4	273.1	8	1	25.4	8 1/2	215.9	11 1/2	292.1	8	1 1/4	31.8	9 1/4	235.0
5	13	330.2	8	1 1/8	28.6	10 1/2	266.7	13 3/4	349.3	8	1 3/8	34.9	11	279.4
6	14	355.6	12	1 1/8	28.6	11 1/2	292.1	15	381.0	12	1 1/4	31.8	12 1/2	317.5
8	16 1/2	419.1	12	1 1/4	31.8	13 3/4	349.3	18 1/2	469.9	12	1 1/2	38.1	15 1/2	393.7
10	20	508.0	16	1 3/8	34.9	17	431.8	21 1/2	546.1	16	1 1/2	38.1	18 1/2	469.9
12	22	558.8	20	1 3/8	34.9	19 1/4	489.0	24	609.6	20	1 1/2	38.1	21	533.4
14	23 3/4	603.3	20	1 1/2	38.1	20 3/4	527.1	25 1/4	641.4	20	1 5/8	41.3	22	558.8
16	27	685.8	20	1 5/8	41.3	23 3/4	603.3	27 3/4	704.9	20	1 3/4	44.5	24 1/4	616.0
18	29 1/4	743.0	20	1 3/4	44.5	25 3/4	654.1	31	787.4	20	2	50.8	27	685.8
20	32	812.8	24	1 3/4	44.5	28 1/2	723.9	33 3/4	857.3	20	2 1/8	54.0	29 1/2	749.3
24	37	939.8	24	2	50.8	33	838.2	41	1041.4	20	2 5/8	66.7	35 1/2	901.7

Bolting Data for ASME 16.5 - FLANGE DIMENSIONS

Nominal Bore	ASME Class 1500							ASME Class 2500						
	Flange O/D		No of Bolt Holes	Hole Diameter		Bolt PCD		Flange O/D		No of Bolt Holes	Hole Diameter		Bolt PCD	
	Inch	mm		Inch	mm	Inch	mm	Inch	mm		Inch	mm	Inch	mm
1/2	4 3/4	120.7	4	7/8	22.2	3 1/4	82.6	5 1/4	133.4	4	7/8	22.2	3 1/2	88.9
3/4	5 1/8	130.2	4	7/8	22.2	3 1/2	88.9	5 1/2	139.7	4	7/8	22.2	3 3/4	95.3
1	5 7/8	149.2	4	1	25.4	4	101.6	6 1/4	158.8	4	1	25.4	4 1/4	108.0
1 1/4	6 1/4	158.8	4	1	25.4	4 3/8	111.1	7 1/4	184.2	4	1 1/8	28.6	5 1/8	130.2
1 1/2	7	177.8	4	1 1/8	28.6	4 7/8	123.8	8	203.2	4	1 1/4	31.8	5 3/4	146.1
2	8 1/2	215.9	8	1	25.4	6 1/2	165.1	9 1/4	235.0	8	1 1/8	28.6	6 3/4	171.5
2 1/2	9 5/8	244.5	8	1 1/8	28.6	7 1/2	190.5	10 1/2	266.7	8	1 1/4	31.8	7 3/4	196.9
3	10 1/2	266.7	8	1 1/4	31.8	8	203.2	12	304.8	8	1 3/8	34.9	9	228.6
4	12 1/4	311.2	8	1 3/8	34.9	9 1/2	241.3	14	355.6	8	1 5/8	41.3	10 3/4	273.1
5	14 3/4	374.7	8	1 5/8	41.3	11 1/2	292.1	16 1/2	419.1	8	1 7/8	47.6	12 3/4	323.9
6	15 1/2	393.7	12	1 1/2	38.1	12 1/2	317.5	19	482.6	8	2 1/8	54.0	14 1/2	368.3
8	19	482.6	12	1 3/4	44.5	15 1/2	393.7	21 3/4	552.5	12	2 1/8	54.0	17 1/4	438.2
10	23	584.2	12	2	50.8	19	482.6	26 1/2	673.1	12	2 5/8	66.7	21 1/4	539.8
12	26 1/2	673.1	16	2 1/8	54.0	22 1/2	571.5	30	762.0	12	2 7/8	73.0	24 3/8	619.1
14	29 1/2	749.3	16	2 3/8	60.3	25	635.0							
16	32 1/2	825.5	16	2 5/8	66.7	27 3/4	704.9							
18	36	914.4	16	2 7/8	73.0	30 1/2	774.7							
20	38 3/4	984.3	16	3 1/8	79.4	32 3/4	831.9							
24	46	1168.4	16	3 5/8	92.1	39	990.6							

Bolting Data for DIN/EN 1092 - FLANGE DIMENSIONS

Nominal Bore	DIN/EN 1092 PN 10							DIN/EN 1092 PN 16						
	Flange O/D		No of Bolt Holes	Hole Diameter		Bolt PCD		Flange O/D		No of Bolt Holes	Hole Diameter		Bolt PCD	
	mm	Inch		mm	Inch	mm	Inch	mm	Inch		mm	Inch	mm	Inch
10	90	3.54	4	14	0.55	60	2.36	90	3.54	4	14	0.55	60	2.36
15	95	3.74	4	14	0.55	65	2.56	95	3.74	4	14	0.55	65	2.56
20	105	4.13	4	14	0.55	75	2.95	105	4.13	4	14	0.55	75	2.95
25	115	4.53	4	14	0.55	85	3.35	115	4.53	4	14	0.55	85	3.35
32	140	5.51	4	18	0.71	100	3.94	140	5.51	4	18	0.71	100	3.94
40	150	5.91	4	18	0.71	110	4.33	150	5.91	4	18	0.71	110	4.33
50	165	6.50	4	18	0.71	125	4.92	165	6.50	4	18	0.71	125	4.92
65	185	7.28	4 or 8	18	0.71	145	5.71	185	7.28	4 or 8	18	0.71	145	5.71
80	200	7.87	8	18	0.71	160	6.30	200	7.87	8	18	0.71	160	6.30
100	220	8.66	8	18	0.71	180	7.09	220	8.66	8	18	0.71	180	7.09
125	250	9.84	8	18	0.71	210	8.27	250	9.84	8	18	0.71	210	8.27
150	285	11.22	8	22	0.87	240	9.45	285	11.22	8	22	0.87	240	9.45
200	340	13.39	8	22	0.87	295	11.61	340	13.39	12	22	0.87	295	11.61
250	405	15.94	12	22	0.87	350	13.78	405	15.94	12	26	1.02	355	13.98
300	460	18.11	12	22	0.87	400	15.75	460	18.11	12	26	1.02	410	16.14
350	520	20.47	16	22	0.87	460	18.11	520	20.47	16	26	1.02	470	18.50
400	580	22.83	16	26	1.02	515	20.28	580	22.83	16	30	1.18	525	20.67
450	640	25.20	20	26	1.02	565	22.24	640	25.20	20	30	1.18	585	23.03
500	715	28.15	20	26	1.02	620	24.41	715	28.15	20	33	1.30	650	25.59
600	840	33.07	20	30	1.18	725	28.54	840	33.07	20	36	1.42	770	30.31

Bolting Data for DIN/EN 1092 - FLANGE DIMENSIONS

Nominal Bore	DIN/EN 1092 PN 25							DIN/EN 1092 PN 40						
	Flange O/D		No of Bolt Holes	Hole Diameter		Bolt PCD		Flange O/D		No of Bolt Holes	Hole Diameter		Bolt PCD	
	mm	Inch		mm	Inch	mm	Inch	mm	Inch		mm	Inch	mm	Inch
10	90	3.54	4	14	0.55	60	2.36	90	3.54	4	14	0.55	60	2.36
15	95	3.74	4	14	0.55	65	2.56	95	3.74	4	14	0.55	65	2.56
20	105	4.13	4	14	0.55	75	2.95	105	4.13	4	14	0.55	75	2.95
25	115	4.53	4	14	0.55	85	3.35	115	4.53	4	14	0.55	85	3.35
32	140	5.51	4	18	0.71	100	3.94	140	5.51	4	18	0.71	100	3.94
40	150	5.91	4	18	0.71	110	4.33	150	5.91	4	18	0.71	110	4.33
50	165	6.50	4	18	0.71	125	4.92	165	6.50	4	18	0.71	125	4.92
65	185	7.28	8	18	0.71	145	5.71	185	7.28	8	18	0.71	145	5.71
80	200	7.87	8	18	0.71	160	6.30	200	7.87	8	18	0.71	160	6.30
100	235	9.25	8	22	0.87	190	7.48	235	9.25	8	22	0.87	190	7.48
125	270	10.63	8	26	1.02	220	8.66	270	10.63	8	26	1.02	220	8.66
150	300	11.81	8	26	1.02	250	9.84	300	11.81	8	26	1.02	250	9.84
200	360	14.17	12	26	1.02	310	12.20	375	14.76	12	30	1.18	320	12.60
250	425	16.73	12	30	1.18	370	14.57	450	17.72	12	33	1.30	385	15.16
300	485	19.09	16	30	1.18	430	16.93	515	20.28	16	33	1.30	450	17.72
350	555	21.85	16	33	1.30	490	19.29	580	22.83	16	36	1.42	510	20.08
400	620	24.41	16	36	1.42	550	21.65	660	25.98	16	39	1.54	585	23.03
450	670	26.38	20	36	1.42	600	23.62	685	26.97	20	39	1.54	610	24.02
500	730	28.74	20	36	1.42	660	25.98	755	29.72	20	42	1.65	670	26.38
600	845	33.27	20	39	1.54	770	30.31	890	35.04	20	48	1.89	795	31.30

Bolting Data for BS 10 - FLANGE DIMENSIONS

Nominal Bore	BS 10 TABLE D							BS 10 TABLE E						
	Flange O/D		No of Bolt Holes	Hole Diameter		Bolt PCD		Flange O/D		No of Bolt Holes	Hole Diameter		Bolt PCD	
	Inch	mm		Inch	mm	Inch	mm	Inch	mm		Inch	mm	Inch	mm
1/2	3 3/4	95.3	4	9/16	14.3	2 5/8	66.7	3 3/4	95.3	4	9/16	14.3	2 5/8	66.7
3/4	4	101.6	4	9/16	14.3	2 7/8	73.0	4	101.6	4	9/16	14.3	2 7/8	73.0
1	4 1/2	114.3	4	9/16	14.3	3 1/4	82.6	4 1/2	114.3	4	9/16	14.3	3 1/4	82.6
1 1/4	4 3/4	120.7	4	9/16	14.3	3 7/16	87.3	4 3/4	120.7	4	9/16	14.3	3 7/16	87.3
1 1/2	5 1/4	133.4	4	9/16	14.3	3 7/8	98.4	5 1/4	133.4	4	9/16	14.3	3 7/8	98.4
2	6	152.4	4	11/16	17.5	4 1/2	114.3	6	152.4	4	11/16	17.5	4 1/2	114.3
2 1/2	6 1/2	165.1	4	11/16	17.5	5	127.0	6 1/2	165.1	4	11/16	17.5	5	127.0
3	7 1/4	184.2	4	11/16	17.5	5 3/4	146.1	7 1/4	184.2	4	11/16	17.5	5 3/4	146.1
3 1/2	8	203.2	4	11/16	17.5	6 1/2	165.1	8	203.2	8	11/16	17.5	6 1/2	165.1
4	8 1/2	215.9	4	11/16	17.5	7	177.8	8 1/2	215.9	8	11/16	17.5	7	177.8
5	10	254.0	8	11/16	17.5	8 1/4	209.6	10	254.0	8	11/16	17.5	8 1/4	209.6
6	11	279.4	8	11/16	17.5	9 1/4	235.0	11	279.4	8	7/8	22.2	9 1/4	235.0
7	12	304.8	8	11/16	17.5	10 1/4	260.4	12	304.8	8	7/8	22.2	10 1/4	260.4
8	13 1/4	336.6	8	11/16	17.5	11 1/2	292.1	13 1/4	336.6	8	7/8	22.2	11 1/2	292.1
9	14 1/2	368.3	8	11/16	17.5	12 3/4	323.9	14 1/2	368.3	12	7/8	22.2	12 3/4	323.9
10	16	406.4	8	7/8	22.2	14	355.6	16	406.4	12	7/8	22.2	14	355.6
12	18	457.2	12	7/8	22.2	16	406.4	18	457.2	12	1	25.4	16	406.4
13	19 1/4	489.0	12	7/8	22.2	17 1/4	438.2	19 1/4	489.0	12	1	25.4	17 1/4	438.2
14	20 3/4	527.1	12	1	25.4	18 1/2	469.9	20 3/4	527.1	12	1	25.4	18 1/2	469.9

Bolting Data for BS 10
- FLANGE DIMENSIONS

Nominal Bore	BS 10 TABLE F							BS 10 TABLE H						
	Flange O/D		No of Bolt Holes	Hole Diameter		Bolt PCD		Flange O/D		No of Bolt Holes	Hole Diameter		Bolt PCD	
	Inch	mm		Inch	mm	Inch	mm	Inch	mm		Inch	mm	Inch	mm
1/2	3 3/4	95.3	4	9/16	14.3	2 5/8	66.7	4 1/2	114.3	4	11/16	17.5	3 1/4	82.6
3/4	4	101.6	4	9/16	14.3	2 7/8	73.0	4 1/2	114.3	4	11/16	17.5	3 1/4	82.6
1	4 3/4	120.7	4	11/16	17.5	3 7/16	87.3	4 3/4	120.7	4	11/16	17.5	3 7/16	87.3
1 1/4	5 1/4	133.4	4	11/16	17.5	3 7/8	98.4	5 1/4	133.4	4	11/16	17.5	3 7/8	98.4
1 1/2	5 1/2	139.7	4	11/16	17.5	4 1/8	104.8	5 1/2	139.7	4	11/16	17.5	4 1/8	104.8
2	6 1/2	165.1	4	11/16	17.5	5	127.0	6 1/2	165.1	4	11/16	17.5	5	127.0
2 1/2	7 1/4	184.2	8	11/16	17.5	5 3/4	146.1	7 1/4	184.2	8	11/16	17.5	5 3/4	146.1
3	8	203.2	8	11/16	17.5	6 1/2	165.1	8	203.2	8	11/16	17.5	6 1/2	165.1
3 1/2	8 1/2	215.9	8	11/16	17.5	7	177.8	8 1/2	215.9	8	11/16	17.5	7	177.8
4	9	228.6	8	11/16	17.5	7 1/2	190.5	9	228.6	8	11/16	17.5	7 1/2	190.5
5	11	279.4	8	7/8	22.2	9 1/4	235.0	11	279.4	8	7/8	22.2	9 1/4	235.0
6	12	304.8	12	7/8	22.2	10 1/4	260.4	12	304.8	12	7/8	22.2	10 1/4	260.4
7	13 1/4	336.6	12	7/8	22.2	11 1/2	292.1	13 1/4	336.6	12	7/8	22.2	11 1/2	292.1
8	14 1/2	368.3	12	7/8	22.2	12 3/4	323.9	14 1/2	368.3	12	7/8	22.2	12 3/4	323.9
9	16	406.4	12	1	25.4	14	355.6	16	406.4	12	1	25.4	14	355.6
10	17	431.8	12	1	25.4	15	381.0	17	431.8	12	1	25.4	15	381.0
12	19 1/4	489.0	16	1	25.4	17 1/4	438.2	19 1/4	489.0	16	1	25.4	17 1/4	438.2
13	20 3/4	527.1	16	1 1/8	28.6	18 1/2	469.9	20 3/4	527.1	16	1 1/8	28.6	18 1/2	469.9
14	21 3/4	552.5	16	1 1/8	28.6	19 1/2	495.3	21 3/4	552.5	16	1 1/8	28.6	19 1/2	495.3

Bolting Data for BS 10
- FLANGE DIMENSIONS

Nominal Bore	BS 10 TABLE J							BS 10 TABLE K						
	Flange O/D		No of Bolt Holes	Hole Diameter		Bolt PCD		Flange O/D		No of Bolt Holes	Hole Diameter		Bolt PCD	
	Inch	mm		Inch	mm	Inch	mm	Inch	mm		Inch	mm	Inch	mm
1/2	4 1/2	114.3	4	11/16	17.5	3 1/4	82.6	4 1/2	114.3	4	11/16	17.5	3 1/4	82.6
3/4	4 1/2	114.3	4	11/16	17.5	3 1/4	82.6	4 1/2	114.3	4	11/16	17.5	3 1/4	82.6
1	4 3/4	120.7	4	11/16	17.5	3 7/16	87.3	5	127.0	4	11/16	17.5	3 3/4	95.3
1 1/4	5 1/4	133.4	4	11/16	17.5	3 7/8	98.4	5 1/4	133.4	4	11/16	17.5	3 7/8	98.4
1 1/2	5 1/2	139.7	4	11/16	17.5	4 1/8	104.8	6	152.4	4	7/8	22.2	4 1/2	114.3
2	6 1/2	165.1	4	7/8	22.2	5	127.0	6 1/2	165.1	8	11/16	17.5	5	127.0
2 1/2	7 1/4	184.2	8	7/8	22.2	5 3/4	146.1	7 1/4	184.2	8	7/8	22.2	5 3/4	146.1
3	8	203.2	8	7/8	22.2	6 1/2	165.1	8	203.2	8	7/8	22.2	6 1/2	165.1
3 1/2	8 1/2	215.9	8	7/8	22.2	7	177.8	9	228.6	8	1	25.4	7 1/4	184.2
4	9	228.6	8	7/8	22.2	7 1/2	190.5	9 1/2	241.3	8	1	25.4	7 3/4	196.9
5	11	279.4	8	1	25.4	9 1/4	235.0	11	279.4	12	1	25.4	9 1/4	235.0
6	12	304.8	12	1	25.4	10 1/4	260.4	12	304.8	12	1	25.4	10 1/4	260.4
7	13 1/4	336.6	12	1	25.4	11 1/2	292.1	13 1/2	342.9	12	1 1/8	28.6	11 1/2	292.1
8	14 1/2	368.3	12	1	25.4	12 3/4	323.9	14 1/2	368.3	12	1 1/8	28.6	12 1/2	317.5
9	16	406.4	12	1 1/8	28.6	14	355.6	16	406.4	16	1 1/8	28.6	14	355.6
10	17	431.8	12	1 1/8	28.6	15	381.0	17	431.8	16	1 1/8	28.6	15	381.0
12	19 1/4	489.0	16	1 1/8	28.6	17 1/4	438.2	19 1/4	489.0	16	1 1/4	31.8	17	431.8
13	20 3/4	527.1	16	1 1/4	31.8	18 1/2	469.9	21 1/2	546.1	16	1 3/8	34.9	19	482.6
14	21 3/4	552.5	16	1 1/4	31.8	19 1/2	495.3	22 1/2	571.5	16	1 3/8	34.9	20	508.0

Non Metallic Flat Gaskets for Pipe flanges - GASKET DIMENSIONS

SUITABLE FOR BS 1560/ASME B 16.5 CLASS 150 FLANGES SUPPLIED IN ACCORDANCE WITH BS EN 12560 PT. 1 (FORMERLY BS 7076 PT.1)								
Nominal Bore		Gasket I/D	IBC Gasket OD	Full Face Dimensions				Bolt Circle Diameter
				O/D	Holes			
					No.	Diameter		
NPS	DN					mm	inch	
1/2	15	22	47.5	89	4	15.9	5/8	60.3
3/4	20	27	57	98	4	15.9	5/8	69.8
1	25	34	66.5	108	4	15.9	5/8	79.4
1 1/4	32	43	76	117	4	15.9	5/8	88.9
1 1/2	40	49	85.5	127	4	15.9	5/8	98.4
2	50	61	104.5	152	4	19.0	3/4	120.6
2 1/2	65	73	124	178	4	19.0	3/4	139.7
3	80	89	136.5	190	4	19.0	3/4	152.4
4	100	115	174.5	229	8	19.0	3/4	190.5
5	125	141	196.5	254	8	22.2	7/8	215.9
6	150	169	222	279	8	22.2	7/8	241.3
8	200	220	279	343	8	22.2	7/8	298.4
10	250	273	339.5	406	12	25.4	1	362.0
12	300	324	409.5	483	12	25.4	1	431.8
14	350	356	450.5	533	12	28.6	1 1/8	476.2
16	400	407	514	597	16	28.6	1 1/8	539.8
18	450	458	549	635	16	31.8	1 1/4	577.8
20	500	508	606.5	698	20	31.8	1 1/4	635.0
24	600	610	717.5	813	20	34.9	1 3/8	749.3

Non Metallic Flat Gaskets for Pipe flanges - GASKET DIMENSIONS

SUITABLE FOR BS 1560/ASME B 16.5 CLASS 300, 600 AND 900 FLANGES SUPPLIED IN ACCORDANCE WITH BS EN 12560 PT. 1 (FORMERLY BS 7076 PT.1)								
Nominal Bore		Gasket I/D*	Gasket Outside Diameter			Spigot & Recess Gasket O/D	Tongue & Groove Gasket	
	DN		Class 300	Class 600	Class 900		I/D	O/D
1/2	15	22	54	54	63.5	35	25.5	35
3/4	20	27	66.5	66.5	69.5	43	33.5	43
1	25	34	73	73	79	51	38.0	51
1 1/4	32	43	82.5	82.5	89	64	47.5	64
1 1/2	40	49	95.0	95	98	73	54	73
2	50	61	111	111	142.5	92	73	92
2 1/2	65	73	130	130	165	105	85.5	105
3	80	89	149	149	168	127	108	127
4	100	115	181	193.5	206	157	132	157
5	125	141	216	241	247.5	186	160.5	186
6	150	169	251	266.5	289	216	190.5	216
8	200	220	308	320.5	358.5	270	238	270
10	250	273	362	400	435	324	286	324
12	300	324	422	457	498.5	381	343	381
14	350	356	485.5	492	520.5	413	374.5	413
16	400	407	539.5	565	574.5	470	425.5	470
18	450	458	597	612.5	638	533	489	533
20	500	508	654	682.5	698.5	584	533.5	584
24	600	610	774.5	790.5	838	692	641.5	692

Except for tongue & groove gaskets

Non-Metallic Flat Gaskets for Pipe flanges - GASKET DIMENSIONS

SUITABLE FOR BS EN 1092 (FORMERLY BS4504) / DIN SERIES FLANGES SUPPLIED IN ACCORDANCE WITH BS EN 1514 PART 1						
		IBC Gasket O/D				
DN	Gasket I/D	PN6	PN10	PN16	PN25	PN40
10	18	39	46	46	46	46
15	22	44	51	51	51	51
20	27	54	61	61	61	61
25	34	64	71	71	71	71
32	43	76	82	82	82	82
40	49	86	92	92	92	92
50	61	96	107	107	107	107
65	77	116	127	127	127	127
80	89	132	142	142	142	142
100	115	152	162	162	168	168
125	141	182	192	192	194	194
150	169	207	218	218	224	224
200	220	262	273	273	284	290
250	273	317	328	329	340	352
300	324	373	378	384	400	417
350	356	423	438	444	457	474
400	407	473	489	495	514	546
450	458	528	539	555	564	571
500	508	578	594	617	624	628
600	610	679	695	734	731	747
700	712	784	810	804	833	
800	813	890	917	911	942	
900	915	990	1017	1011	1042	
1000	1016	1090	1124	1128	1154	
1100	1120		1231	1228	1254	
1200	1220	1307	1341	1342	1364	
1400	1420	1524	1548	1542	1578	
1600	1620	1724	1772	1764	1798	
1800	1820	1931	1972	1964	2000	
2000	2020	2138	2182	2168	2230	
2200	2220	2348	2384			
2400	2420	2558	2594			
2600	2620	2762	2794			
2800	2820	2972	3014			
3000	3020	3172	3228			
3200	3220	3382				
3400	3420	3592				
3600	3620	3804				

Non-Metallic Flat Gaskets for Pipe flanges - GASKET DIMENSIONS

SUITABLE FOR BS 10 FLANGES SUPPLIED IN ACCORDANCE WITH BS 3063					
		IBC Gasket O/D			
NB	Gasket I/D	Table E	Table F	Table H	Table J
1/2	0.84375	2.0625	2.0625	2.5	2.5625
3/4	1.0625	2.3125	2.3125	2.5	2.5625
1	1.34375	2.6875	2.6875	2.6875	2.75
1.1/4	1.6875	2.875	3.125	3.125	3.1875
1.1/2	1.90625	3.3125	3.375	3.375	3.4375
2	2.375	3.75	4.25	4.25	4.125
2.1/2	3	4.25	5	5	4.875
3	3.5	5	5.75	5.75	5.625
3.1/2	4	5.75	6.25	6.25	6.125
4	4.5	6.25	6.75	6.75	6.625
5	5.5	7.5	8.375	8.375	8.25
6	6.625	8.375	9.375	9.375	9.25
7	7.625	9.375	10.625	10.625	10.5
8	8.625	10.625	11.875	11.875	11.75
9	9.625	11.875	13	13	12.875
10	10.75	13.125	14	14	13.875
12	12.75	15	16.25	16.25	16.125
13	14	16.25	17.375	17.375	17.25
14	15	17.5	18.375	18.375	18.25
15	16	18.5	19.375	19.375	19.25
16	17	19.5	20.625	20.625	20.5
17	18	20.75	21.875	21.875	21.75
18	19	22	22.75	22.75	22.625
19	20	23	24	24	23.875
20	21	24.25	25.25	25.25	25.125
21	22	25.375	26.25	26.25	26.125
22	23	26.375	27.25	27.25	27.125
23	24	27.375	28.375	28.375	28.25
24	25	28.5	29.375	29.375	29.25

Dimensions in inches

Metaflex Type SG suitable for BS 1560/ASME B 16.5 flanges - Metric Dimensions - GASKET DIMENSIONS

SUPPLIED IN ACCORDANCE WITH ASME B 16.20														
Nominal Bore	Sealing Element							Centring Ring Outside Diameter						
	Inside Diameter					Outside Diameter		Class Rating						
	150-300	400-600	900	1500	2500	150-600	900-2500	150	300	400	600	900	1500	2500
1/2	19.1	19.1	19.1	19.1	19.1	31.8	31.8	47.6	54.0	54.0	54.0	63.5	63.5	69.9
3/4	25.4	25.4	25.4	25.4	25.4	39.7	39.7	57.2	66.7	66.7	66.7	69.9	69.9	76.2
1	31.8	31.8	31.8	31.8	31.8	47.6	47.6	66.7	73.0	73.0	73.0	79.4	79.4	85.7
1 1/4	47.6	47.6	39.7	39.7	39.7	60.3	60.3	76.2	82.6	82.6	82.6	88.9	88.9	104.8
1 1/2	54.0	54.0	47.6	47.6	47.6	69.9	69.9	85.7	95.3	95.3	95.3	98.4	98.4	117.5
2	69.9	69.9	58.7	58.7	58.7	85.7	85.7	104.8	111.1	111.1	111.1	142.9	142.9	146.1
2 1/2	82.6	82.6	69.9	69.9	69.9	98.4	98.4	123.8	130.2	130.2	130.2	165.1	165.1	168.3
3	101.6	101.6	95.3	92.1	92.1	120.7	120.7	136.5	149.2	149.2	149.2	168.3	174.6	196.9
4	127.0	120.7	120.7	117.5	117.5	149.2	149.2	174.6	181.0	177.8	193.7	206.4	209.6	235.0
5	155.6	147.6	147.6	142.9	142.9	177.8	177.8	196.9	215.9	212.7	241.3	247.7	254.0	279.4
6	182.6	174.6	174.6	171.5	171.5	209.6	209.6	222.3	250.8	247.7	266.7	288.9	282.6	317.5
8	233.4	225.4	222.3	215.9	215.9	263.5	257.2	279.4	308.0	304.8	320.7	358.8	352.4	387.4
10	287.3	274.6	276.2	266.7	269.9	317.5	311.2	339.7	362.0	358.8	400.1	435.0	435.0	476.3
12	339.7	327.0	323.9	323.9	317.5	374.7	368.3	409.6	422.3	419.1	457.2	498.5	520.7	549.3
14	371.5	362.0	355.6	362.0		406.4	400.1	450.9	485.8	482.6	492.1	520.7	577.9	
16	422.3	412.8	412.8	406.4		463.6	457.2	514.4	539.8	536.6	565.2	574.7	641.4	
18	474.7	469.9	463.6	463.6		527.1	520.7	549.3	596.9	593.7	612.8	641.4	704.9	
20	525.5	520.7	520.7	514.4		577.9	571.5	606.4	654.1	647.7	682.6	698.5	755.7	
24	628.7	628.7	628.7	616.0		685.8	679.5	717.6	774.7	768.4	790.6	838.2	901.7	

Metaflex Type SG suitable for BS 1560/ASME B 16.5 flanges - Imperial Dimensions - GASKET DIMENSIONS

SUPPLIED IN ACCORDANCE WITH ASME B 16.20														
Nominal Bore	Sealing Element							Centring Ring Outside Diameter						
	Inside Diameter					Outside Diameter		Class Rating						
	150-300	400-600	900	1500	2500	150-600	900-2500	150	300	400	600	900	1500	2500
1/2	0.75	0.75	0.75	0.75	0.75	1.25	1.25	1.88	2.13	2.13	2.13	2.50	2.50	2.75
3/4	1.00	1.00	1.00	1.00	1.00	1.56	1.56	2.25	2.63	2.63	2.63	2.75	2.75	3.00
1	1.25	1.25	1.25	1.25	1.25	1.88	1.88	2.63	2.88	2.88	2.88	3.13	3.13	3.38
1 1/4	1.88	1.88	1.56	1.56	1.56	2.38	2.38	3.00	3.25	3.25	3.25	3.50	3.50	4.13
1 1/2	2.13	2.13	1.88	1.88	1.88	2.75	2.75	3.38	3.75	3.75	3.75	3.88	3.88	4.63
2	2.75	2.75	2.31	2.31	2.31	3.38	3.38	4.13	4.38	4.38	4.38	5.63	5.63	5.75
2 1/2	3.25	3.25	2.75	2.75	2.75	3.88	3.88	4.88	5.13	5.13	5.13	6.50	6.50	6.63
3	4.00	4.00	3.75	3.63	3.63	4.75	4.75	5.38	5.88	5.88	5.88	6.63	6.88	7.75
4	5.00	4.75	4.75	4.63	4.63	5.88	5.88	6.88	7.13	7.00	7.63	8.13	8.25	9.25
5	6.13	5.81	5.81	5.63	5.63	7.00	7.00	7.75	8.50	8.38	9.50	9.75	10.00	11.00
6	7.19	6.88	6.88	6.75	6.75	8.25	8.25	8.75	9.88	9.75	10.50	11.38	11.13	12.50
8	9.19	8.88	8.75	8.50	8.50	10.38	10.13	11.00	12.13	12.00	12.63	14.13	13.88	15.25
10	11.31	10.81	10.88	10.50	10.63	12.50	12.25	13.38	14.25	14.13	15.75	17.13	17.13	18.75
12	13.38	12.88	12.75	12.75	12.50	14.75	14.50	16.13	16.63	16.50	18.00	19.63	20.50	21.63
14	14.63	14.25	14.00	14.25		16.00	15.75	17.75	19.13	19.00	19.38	20.50	22.75	
16	16.63	16.25	16.25	16.00		18.25	18.00	20.25	21.25	21.13	22.25	22.63	25.25	
18	18.69	18.50	18.25	18.25		20.75	20.50	21.63	23.50	23.38	24.13	25.25	27.75	
20	20.69	20.50	20.50	20.25		22.75	22.50	23.88	25.75	25.50	26.88	27.50	29.75	
24	24.75	24.75	24.75	24.25		27.00	26.75	28.25	30.50	30.25	31.13	33.00	35.50	

Metaflex Type SG suitable for ASME B 16.47 Series A flanges - Metric Dimensions - GASKET DIMENSIONS

SUPPLIED IN ACCORDANCE WITH ASME B 16.20															
Nominal Bore	Sealing Element										Centring Ring Outside Diameter				
	150		300		400		600		900		Class Rating				
	I/D	O/D	I/D	O/D	I/D	O/D	I/D	O/D	I/D	O/D	150	300	400	600	900
26	673.1	704.9	685.8	736.6	685.8	736.6	685.8	736.6	685.8	736.6	774.7	835.0	831.9	866.8	882.7
28	723.9	755.7	736.6	787.4	736.6	787.4	736.6	787.4	736.6	787.4	831.9	898.5	892.2	914.4	946.2
30	774.7	806.5	793.8	844.6	793.8	844.6	793.8	844.6	793.8	844.6	882.7	952.5	946.2	971.6	1009.7
32	825.5	860.4	850.9	901.7	850.9	901.7	850.9	901.7	850.9	901.7	939.8	1006.5	1003.3	1022.4	1073.2
34	876.3	911.2	901.7	952.5	901.7	952.5	901.7	952.5	901.7	952.5	990.6	1057.3	1054.1	1073.2	1136.7
36	927.1	968.4	955.7	1006.5	955.7	1006.5	955.7	1006.5	958.9	1009.7	1047.8	1117.6	1117.6	1130.3	1200.2
38	977.9	1019.2	977.9	1016.0	971.6	1022.4	990.6	1041.4	1035.1	1085.9	1111.3	1054.1	1073.2	1104.9	1200.2
40	1028.7	1070.0	1022.4	1070.0	1025.5	1076.3	1047.8	1098.6	1098.6	1149.4	1162.1	1114.4	1127.1	1155.7	1251.0
42	1079.5	1124.0	1073.2	1120.8	1076.3	1127.1	1104.9	1155.7	1149.4	1200.2	1219.2	1165.2	1177.9	1219.2	1301.8
44	1130.3	1177.9	1130.3	1181.1	1130.3	1181.1	1162.1	1212.9	1206.5	1257.3	1276.4	12395.2	1231.9	1270.0	1368.4
46	1181.1	1228.7	1177.9	1228.7	1193.8	1244.6	1212.9	1263.7	1270.0	1320.8	1327.2	1273.2	1289.1	1327.2	1435.1
48	1231.9	1279.5	1235.1	1285.9	1244.6	1295.4	1270.0	1320.8	1320.8	1371.6	1384.3	1324.0	1346.2	1390.7	1485.9
50	1282.7	1333.5	1295.4	1346.2	1295.4	1346.2	1320.8	1371.6			1435.1	1378.0	1403.4	1447.8	
52	1333.5	1384.3	1346.2	1397.0	1346.2	1397.0	1371.6	1422.4			1492.3	1428.8	1454.2	1498.6	
54	1384.3	1435.1	1403.4	1454.2	1403.4	1454.2	1428.8	1479.6			1549.4	1492.3	1517.7	1555.8	
56	1435.1	1485.9	1454.2	1505.0	1454.2	1505.0	1479.6	1555.8			1606.6	1543.1	1568.5	1612.9	
58	1485.9	1536.7	1511.3	1562.1	1505.0	1555.8	1536.7	1587.5			1663.7	1593.9	1619.3	1663.7	
60	1536.7	1587.5	1562.1	1612.9	1568.5	1619.3	1593.9	1644.7			1714.5	1644.7	1682.8	1733.6	

Metaflex Type SG suitable for ASME B 16.47 Series A flanges - Imperial Dimensions - GASKET DIMENSIONS

SUPPLIED IN ACCORDANCE WITH ASME B 16.20															
Nominal Bore	Sealing Element										Centring Ring Outside Diameter				
	150		300		400		600		900		Class Rating				
	I/D	O/D	I/D	O/D	I/D	O/D	I/D	O/D	I/D	O/D	150	300	400	600	900
26	26.50	27.75	27.00	29.00	27.00	29.00	27.00	29.00	27.00	29.00	30.50	32.88	32.75	34.13	34.75
28	28.50	29.75	29.00	31.00	29.00	31.00	29.00	31.00	29.00	31.00	32.75	35.38	35.13	36.00	37.25
30	30.50	31.75	31.25	33.25	31.25	33.25	31.25	33.25	31.25	33.25	34.75	37.50	37.25	38.25	39.75
32	32.50	33.88	33.50	35.50	33.50	35.50	33.50	35.50	33.50	35.50	37.00	39.63	39.50	40.25	42.25
34	34.50	35.88	35.50	37.50	35.50	37.50	35.50	37.50	35.50	37.50	39.00	41.63	41.50	42.25	44.75
36	36.50	38.13	37.63	39.63	37.63	39.63	37.63	39.63	37.75	39.75	41.25	44.00	44.00	44.50	47.25
38	38.50	40.13	38.50	40.00	38.25	40.25	39.00	41.00	40.75	42.75	43.75	41.50	42.25	43.50	47.25
40	40.50	42.13	40.25	42.13	40.38	42.38	41.25	43.25	43.25	45.25	45.75	43.88	44.38	45.50	49.25
42	42.50	44.25	42.25	44.13	42.38	44.38	43.50	45.50	45.25	47.25	48.00	45.88	46.38	48.00	51.25
44	44.50	46.38	44.50	46.50	44.50	46.50	45.75	47.75	47.50	49.50	50.25	48.00	48.50	50.00	53.88
46	46.50	48.38	46.38	48.38	47.00	49.00	47.75	49.75	50.00	52.00	52.25	50.13	50.75	52.25	56.50
48	48.50	50.38	48.63	50.63	49.00	51.00	50.00	52.00	52.00	54.00	54.50	52.13	53.00	54.75	58.50
50	50.50	52.50	51.00	53.00	51.00	53.00	52.00	54.00			56.50	54.25	55.25	57.00	
52	52.50	54.50	53.00	55.00	53.00	55.00	54.00	56.00			58.75	56.25	57.25	59.00	
54	54.50	56.50	55.25	57.25	55.25	57.25	56.25	58.25			61.00	58.75	59.75	61.25	
56	56.50	58.50	57.25	59.25	57.25	59.25	58.25	61.25			63.25	60.75	61.75	63.50	
58	58.50	60.50	59.50	61.50	59.25	61.25	60.50	62.50			65.50	62.75	63.75	65.50	
60	60.50	62.50	61.50	63.50	61.75	63.75	62.75	64.75			67.50	64.75	66.25	68.25	

Metaflex Type SG suitable for ASME B 16.47 Series B flanges - Metric Dimensions - GASKET DIMENSIONS

SUPPLIED IN ACCORDANCE WITH ASME B 16.20															
Nominal Bore	Sealing Element										Centring Ring Outside Diameter				
	150		300		400		600		900		Class Rating				
	I/D	O/D	I/D	O/D	I/D	O/D	I/D	O/D	I/D	O/D	150	300	400	600	900
26	673.1	698.5	673.1	711.2	666.8	698.5	663.6	714.4	692.2	749.3	725.5	771.5	746.1	765.2	838.2
28	723.9	749.3	723.9	787.4	714.4	749.3	704.9	755.7	743.0	800.1	776.3	825.5	800.1	819.2	901.7
30	774.7	800.1	774.7	812.8	765.2	806.5	777.9	830.3	806.5	857.3	827.1	885.8	857.3	879.5	958.9
32	825.5	850.9	825.5	863.6	812.8	860.4	831.9	882.7	863.6	914.4	881.1	939.8	911.2	933.5	1016.0
34	876.3	908.1	876.3	914.4	866.8	911.2	889.0	939.8	920.8	717.6	935.0	993.8	962.0	997.0	1073.2
36	927.1	958.9	927.1	965.2	917.6	965.2	939.8	990.6	946.2	997.0	987.4	1047.8	1022.4	1047.8	1124.0
38	974.7	1009.7	1009.7	1047.8	971.6	1022.4	990.6	1041.4	1035.1	1085.9	1044.6	1098.6	1073.2	1104.9	1200.2
40	1022.4	1063.6	1060.5	1098.6	1025.5	1076.3	1047.8	1098.6	1098.6	1149.4	1095.4	1149.4	1127.1	1155.7	1251.0
42	1079.5	1114.4	1111.3	1149.4	1076.3	1127.1	1104.9	1155.7	1149.4	1200.2	1146.2	1200.2	1177.9	1219.2	1301.8
44	1124.0	1165.2	1162.1	1200.2	1130.3	1181.1	1162.1	1212.9	1206.5	1257.3	1197.0	1251.0	1231.9	1270.0	1368.4
46	1181.1	1224.0	1216.0	1254.1	1193.8	1244.6	1212.9	1263.7	1270.0	1320.8	1255.7	1317.6	1289.1	1327.2	1435.1
48	1231.9	1270.0	1263.7	1311.3	1244.6	1295.4	1270.0	1320.8	1320.8	1371.6	1306.5	1368.4	1346.2	1390.7	1485.9
50	1282.7	1325.6	1317.6	1355.7	1295.4	1346.2	1320.8	1371.6			1357.3	1419.2	1403.4	1447.8	
52	1333.5	1376.4	1368.4	1406.5	1346.2	1397.0	1371.6	1422.4			1408.1	1470.0	1454.2	1498.6	
54	1384.3	1422.4	1403.4	1454.2	1403.4	1454.2	1428.8	1479.6			1463.7	1530.4	1517.7	1555.8	
56	1444.6	1478.0	1479.6	1524.0	1454.2	1505.0	1479.6	1530.4			1514.5	1593.9	1568.5	1612.9	
58	1500.2	1528.8	1535.1	1573.2	1505.0	1555.8	1536.7	1587.5			1579.6	1655.8	1619.3	1663.7	
60	1557.3	1585.9	1589.1	1630.4	1568.5	1619.3	1593.9	1644.7			1630.4	1706.6	1682.8	1733.6	

Metaflex Type SG suitable for ASME B 16.47 Series B flanges - Imperial Dimensions - GASKET DIMENSIONS

SUPPLIED IN ACCORDANCE WITH ASME B 16.20															
Nominal Bore	Sealing Element										Centring Ring Outside Diameter				
	150		300		400		600		900		Class Rating				
	I/D	O/D	I/D	O/D	I/D	O/D	I/D	O/D	I/D	O/D	150	300	400	600	900
26	26.50	27.50	26.50	28.00	26.25	27.50	26.13	28.13	27.25	29.50	28.56	30.38	29.38	30.13	33.00
28	28.50	29.50	28.50	31.00	28.13	29.50	27.75	29.75	29.25	31.50	30.56	32.50	31.50	32.25	35.50
30	30.50	31.50	30.50	32.00	30.13	31.75	30.63	32.69	31.75	33.75	32.56	34.88	33.75	34.63	37.75
32	32.50	33.50	32.50	34.00	32.00	33.88	32.75	34.75	34.00	36.00	34.69	37.00	35.88	36.75	40.00
34	34.50	35.75	34.50	36.00	34.13	35.88	35.00	37.00	36.25	38.25	36.81	39.13	37.88	39.25	42.25
36	36.50	37.75	36.50	38.00	36.13	38.00	37.00	39.00	37.25	39.25	38.88	41.25	40.25	41.25	44.25
38	38.38	39.75	39.75	41.25	38.25	40.25	39.00	41.00	40.75	42.75	41.13	43.25	42.25	43.50	47.25
40	40.25	41.88	41.75	43.25	40.38	42.38	41.25	43.25	43.25	45.25	43.13	45.25	44.38	45.50	49.25
42	42.50	43.88	43.75	45.25	42.38	44.38	43.50	45.50	45.25	47.25	45.13	47.25	46.38	48.00	51.25
44	44.25	45.88	45.75	47.25	44.50	46.50	45.75	47.75	47.50	49.50	47.13	49.25	48.50	50.00	53.88
46	46.50	48.19	47.88	49.38	47.00	49.00	47.75	49.75	50.00	52.00	49.44	51.88	50.75	52.25	56.50
48	48.50	50.00	49.75	51.63	49.00	51.00	50.00	52.00	52.00	54.00	51.44	53.88	53.00	54.75	58.50
50	50.50	52.19	51.88	53.38	51.00	53.00	52.00	54.00			53.44	55.88	55.25	57.00	
52	52.50	54.19	53.88	55.38	53.00	55.00	54.00	56.00			55.44	57.88	57.25	59.00	
54	54.50	56.00	55.25	57.25	55.25	57.25	56.25	58.25			57.63	60.25	59.75	61.25	
56	56.88	58.19	58.25	60.00	57.25	59.25	58.25	60.25			59.63	62.75	61.75	63.50	
58	59.07	60.19	60.44	61.94	59.25	61.25	60.50	62.50			62.19	65.19	63.75	65.50	
60	61.31	62.44	62.56	64.19	61.75	63.75	62.75	64.75			64.19	67.19	66.25	68.25	

Metaflex Type SG suitable for BS 1560/ASME B 16.5 flanges - GASKET DIMENSIONS

SUPPLIED IN ACCORDANCE WITH BS 3381											
Nominal Bore	Sealing Element				Centring Ring Outside Diameter						
	Inside Diameter			Outside Diameter	Class Rating						
	150	300-1500	2500	150-600	150	300	600	900	1500	2500
1/2	18.7	18.7	18.7	32.2	47.6	54	54	63.5	63.5	69.9
3/4	26.6	25	25	40.1	57.2	66.7	66.7	69.9	69.9	76.2
1	32.9	31.4	31.4	48	66.7	73	73	79.4	79.4	85.9
1 1/4	45.6	44.1	39.3	60.7	76.2	82.6	82.6	88.9	88.9	104.8
1 1/2	53.6	50.4	47.2	70.3	85.7	95.3	95.3	98.4	98.4	117.5
2	69.5	66.3	58.3	86.1	104.8	111.1	111.1	142.9	142.9	146.1
2 1/2	82.2	79	69.5	98.8	123.8	130.2	130.2	165.1	165.1	168.3
3	101.2	94.9	91.7	121.1	136.5	149.2	149.2	168.3	174.6	196.9
4	126.6	120.3	117.1	149.6	174.6	181	193.7	206.4	209.6	235
5	153.6	147.2	142.5	178.2	196.9	215.9	241.3	247.7	254	279.4
6	180.6	174.2	171.1	210	222.3	250.8	266.7	288.9	282.6	317.5
8	231.4	225	215.5	263.9	279.4	308	320.7	358.8	352.4	387.4
10	286.9	280.6	269.5	317.9	339.7	362	400.1	435	435	476.3
12	339.3	333	323.5	375.1	409.6	422.3	457.2	498.5	520.7	549.6
14	371.1	364.7		406.8	450.9	485.8	492.1	520.7	577.9	
16	421.9	415.5		464	514.4	539.8	565.2	574.7	641.4	
18	475.9	469.5		527.5	549.3	596.9	612.8	638.2	704.9	
20	526.7	520.3		578.3	606.4	654.1	682.6	698.5	755.7	
24	631.4	625.1		686.2	717.6	774.7	790.6	838.2	901.7	

Dimensions in mm

Metaflex Type SG suitable for DIN/EN 1092 flanges - GASKET DIMENSIONS

Up to 40 Bar dimensions in accordance with EN 1514-2

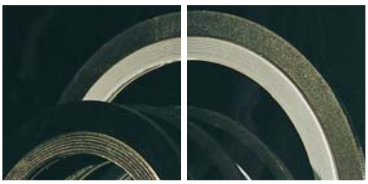
Nominal Bore	Sealing Element				Centring Ring Outside Diameter						
	10 bar - 40 bar		64 bar - 160 bar		10 bar	16 bar	25 bar	40 bar	64 bar	100 bar	160 bar
	I/D	O/D	I/D	O/D	DIN 2632	DIN 2633	DIN 2634	DIN 2635	DIN 2636	DIN 2637	DIN 2638
10	24	36	24	36	48	48	48	48	58	58	58
15	28	40	28	40	53	53	53	53	63	63	63
20	34	47	34	48	63	63	63	63	74	74	74
25	41	55	41	56	73	73	73	73	84	84	84
32	50	66	50	67	84	84	84	84	90	90	90
40	56	72	56	74	94	94	94	94	105	105	105
50	68	86	68	88	109	109	109	109	115	121	121
65	84	103	81	102	129	129	129	129	140	146	146
80	97	117	97	120	144	144	144	144	150	156	156
100	123	144	120	142	164	164	170	170	176	183	183
125	148	170	148	174	194	194	196	196	213	220	220
150	177	200	177	205	220	220	226	226	250	260	260
175	200	224	200	231	250	250	256	268	280	290	287
200	229	255	225	256	275	275	286	293	312	327	327
250	283	310	283	319	330	331	343	355	367	394	391
300	332	360	332	369	380	386	403	420	427	461	461
350	375	405	375	413	440	446	460	477	489	515	
400	426	458	426	466	491	498	517	549	546	575	
450	477	512			541	558	567	574			
500	528	566	528	572	596	620	627	631	660	708	
600	635	675	635	683	698	737	734	750	768	818	
700	735	778	735	785	813	807	836	855	883	956	
800	836	879	836	886	920	914	945	978	994		
900	934	980	934	989	1020	1014	1045	1088	1114		

Section 8 continued

Metaflex Type SG suitable for BS 10 Welded Neck flanges - GASKET DIMENSIONS

Nominal Bore	Sealing Element		Centring Ring		Sealing Element		Centring Ring					Sealing Element						Centring Ring	
	Tables D, E		Table D	Table E	Tables F, H, J, K, R		Table F	Table H	Table J	Table K	Table R	Table S (1931)		Table S (1962)		Table T		Table S	Table T
	I/D	O/D	O/D	O/D	I/D	O/D	O/D	O/D	O/D	O/D	O/D	I/D	O/D	I/D	O/D	I/D	O/D	O/D	O/D
1/2	1.03	1.47	2.13	2.13	1.03	1.53	2.13	2.63	2.63	2.63	2.63	0.75	1.25	0.75	1.25	0.75	1.25	2.75	3.25
3/4	1.25	1.69	2.38	2.38	1.25	1.75	2.38	2.63	2.63	2.63	2.63	1.00	1.56	1.00	1.56	1.00	1.56	2.75	3.25
1	1.56	2.06	2.75	2.75	1.56	2.19	2.81	2.81	2.81	3.13	3.13	1.25	1.88	1.25	1.88	1.25	1.88	3.25	3.50
1 1/4	1.88	2.38	2.94	2.94	1.88	2.50	3.25	3.25	3.25	3.25	3.25	1.50	2.19	1.50	2.19	1.63	2.31	3.50	3.88
1 1/2	2.13	2.63	3.38	3.38	2.13	2.75	3.50	3.50	3.50	3.75	3.75	1.75	2.50	1.75	2.50	1.88	2.63	4.00	4.50
2	2.63	3.13	3.88	3.88	2.63	3.25	4.38	4.38	4.25	4.38	4.38	2.25	3.00	2.25	3.13	2.38	3.25	4.50	5.00
2 1/2	3.25	3.88	4.38	4.38	3.25	4.00	5.13	5.13	5.00	5.00	5.00	2.75	3.50	2.88	3.75	3.00	3.88	5.00	5.63
3	3.81	4.44	5.13	5.13	3.81	4.56	5.88	5.88	5.75	5.75	5.75	3.25	4.00	3.38	4.25	3.50	4.50	5.63	6.50
3 1/2	4.31	4.94	5.88	5.88	4.31	5.06	6.38	6.38	6.25	6.38	6.38	3.75	4.50	3.88	4.75	4.00	5.13	6.63	7.38
4	4.88	5.50	6.38	6.38	4.88	5.63	6.88	6.88	6.75	6.88	6.88	4.25	5.00	4.38	5.38	4.50	5.63	7.00	8.13
4 1/2	5.38	6.00	6.88	6.88	5.38	6.25	7.50	7.50	7.38	7.38	7.38	4.75	5.50	4.88	5.88	5.00	6.25	7.50	9.00
5	5.88	6.50	7.63	7.63	5.88	6.75	8.50	8.50	8.38	8.38	8.38	5.25	6.00	5.38	6.38	5.50	6.75	8.38	9.63
6	6.88	7.50	8.63	8.50	6.88	7.75	9.50	9.50	9.38	9.38	9.38	6.25	7.00	6.38	7.38	6.50	7.75	9.75	11.25
7	7.88	8.63	9.63	9.50	7.88	8.88	10.75	10.75	10.63	10.50	10.50	7.38	8.25	7.38	8.63	7.50	9.00	11.38	13.13
8	8.88	9.63	10.88	10.75	8.88	9.88	12.00	12.00	11.88	11.50	11.75	8.38	9.25	8.38	9.63	8.50	10.00	12.75	14.50
9	9.88	10.63	12.13	12.00	9.88	10.88	13.13	13.13	13.00	13.00	13.00	9.38	10.25	9.50	10.75	9.63	11.25	14.13	16.13
10	10.88	11.63	13.25	13.25	11.00	12.00	14.13	14.13	14.00	14.00	14.25	10.38	11.25	10.50	11.88	10.63	12.25	15.50	17.75
11	11.88	12.63	14.25	14.25	12.00	13.00	15.13	15.13	15.00	15.13	15.88	11.38	12.50	11.50	12.88	11.63	13.25	17.13	19.25
12	12.88	13.75	15.25	15.13	13.00	14.13	16.38	16.38	16.25	15.88	16.88	12.38	13.63	12.63	14.00	12.75	14.50	18.50	20.75
13	14.50	15.38	16.50	16.38	14.25	15.38	17.50	17.50	17.38	17.75	18.25	13.38	14.63	13.63	15.13	13.75	15.50	19.75	22.00
14	15.50	16.38	17.63	17.63	15.25	16.38	18.50	18.50	18.38	18.75	19.50	14.38	15.75	14.63	16.13			21.25	
15	16.50	17.38	18.63	18.63	16.25	17.38	19.50	19.50	19.38	20.00	20.50	15.38	16.88	15.75	17.25			22.88	
16	17.50	18.38	19.63	19.63	17.50	18.75	20.75	20.75	20.63	21.00	21.75	16.38	17.88	16.75	18.38			24.25	
17	18.63	19.63	20.88	20.75	18.50	19.88	22.00	22.00	21.88	22.25	22.75								
18	19.63	20.63	22.13	22.13	19.50	20.88	22.88	22.88	22.75	24.38	25.13								
19	20.63	21.63	23.13	23.13	20.63	22.13	24.13	24.13	24.00										
20	21.63	22.63	24.38	24.38	21.63	23.13	25.38	25.38	25.25	26.50	27.25								
21	22.63	23.75	25.63	25.50	22.63	24.38	26.38	26.38	26.25										
22	23.63	24.75	26.50	26.50	23.63	25.38	27.38	27.38	27.25	28.75	29.75								
23	24.63	25.75	27.50	27.50	24.63	26.38	28.50	28.50	28.38										
24	25.63	26.75	28.75	28.63	25.63	27.38	29.50	29.50	29.38										

Dimensions in inches



Metaflex Type SG/IR suitable for BS 1560/ASME B 16.5 flanges - Metric Dimensions - GASKET DIMENSIONS

SUPPLIED IN ACCORDANCE WITH ASME B 16.20																			
Nominal Bore	Inner Ring					Sealing Element							Centring Ring Outside Diameter						
	Inside Diameter					Inside Diameter					Outside Diameter		Class Rating						
	150-300	400-600	900	1500	2500	150-300	400-600	900	1500	2500	150-600	900-2500	150	300	400	600	900	1500	2500
1/2	14.3	14.3	14.3	14.3	14.3	19.1	19.1	19.1	19.1	19.1	31.8	31.8	47.6	54.0	54.0	54.0	63.5	63.5	69.9
1/2	20.6	20.6	20.6	20.6	20.6	25.4	25.4	25.4	25.4	25.4	39.7	39.7	57.2	66.7	66.7	66.7	69.9	69.9	76.2
1	27.0	27.0	27.0	27.0	27.0	31.8	31.8	31.8	31.8	31.8	47.6	47.6	66.7	73.0	73.0	73.0	79.4	79.4	85.7
1 1/4	38.1	38.1	33.3	33.3	33.3	47.6	47.6	39.7	39.7	39.7	60.3	60.3	76.2	82.6	82.6	82.6	88.9	88.9	104.8
1 1/2	44.5	44.5	41.3	41.3	41.3	54.0	54.0	47.6	47.6	47.6	69.9	69.9	85.7	95.3	95.3	95.3	98.4	98.4	117.5
2	55.6	55.6	52.4	52.4	52.4	69.9	69.9	58.7	58.7	58.7	85.7	85.7	104.8	111.1	111.1	111.1	142.9	142.9	146.1
2 1/2	66.7	66.7	63.5	63.5	63.5	82.6	82.6	69.9	69.9	69.9	98.4	98.4	123.8	130.2	130.2	130.2	165.1	165.1	168.3
3	81.0	78.7	78.7	78.7	78.7	101.6	101.6	95.3	92.1	92.1	120.7	120.7	136.5	149.2	149.2	149.2	168.3	174.6	196.9
4	106.4	102.6	102.6	97.8	97.8	127.0	120.7	120.7	117.5	117.5	149.2	149.2	174.6	181.0	177.8	193.7	206.4	209.6	235.0
5	131.8	128.3	128.3	124.5	124.5	155.6	147.6	147.6	142.9	142.9	177.8	177.8	196.9	215.9	212.7	241.3	247.7	254.0	279.4
6	157.2	154.9	154.9	147.3	147.3	182.6	174.6	174.6	171.5	171.5	209.6	209.6	222.3	250.8	247.7	266.7	288.9	282.6	317.5
8	215.9	205.7	196.9	196.9	196.9	233.4	225.4	222.3	215.9	215.9	263.5	257.2	279.4	308.0	304.8	320.7	358.8	352.4	387.4
10	268.3	255.3	246.1	246.1	246.1	287.3	274.6	276.2	266.7	269.9	317.5	311.2	339.7	362.0	358.8	400.1	435.0	435.0	476.3
12	317.5	307.3	292.1	292.1	292.1	339.7	327.0	323.9	323.9	317.5	374.7	368.3	409.6	422.3	419.1	457.2	498.5	520.7	549.3
14	349.3	342.9	320.7	320.7		371.5	362.0	355.6	362.0		406.4	400.1	450.9	485.8	482.6	492.1	520.7	577.9	
16	400.1	389.9	374.7	368.3		422.3	412.8	412.8	406.4		463.6	457.2	514.4	539.8	536.6	565.2	574.7	641.4	
18	449.3	438.2	425.5	425.5		474.7	469.9	463.6	463.6		527.1	520.7	549.3	596.9	593.7	612.8	638.2	704.9	
20	500.1	489.0	482.6	476.3		525.5	520.7	520.7	514.4		577.9	571.5	606.4	654.1	647.7	682.6	698.5	755.7	
24	603.3	590.6	590.6	577.9		628.7	628.7	628.7	616.0		685.8	679.5	717.6	774.7	768.4	790.6	838.2	901.7	

Metaflex Type SGIR suitable for BS 1560/ASME B 16.5 flanges - Imperial Dimensions - GASKET DIMENSIONS

SUPPLIED IN ACCORDANCE WITH ASME B 16.20																			
Nominal Bore	Inner Ring					Sealing Element							Centring Ring Outside Diameter						
	Inside Diameter					Inside Diameter					Outside Diameter		Class Rating						
	150-300	400-600	900	1500	2500	150-300	400-600	900	1500	2500	150-600	900-2500	150	300	400	600	900	1500	2500
1/2	0.56	0.56	0.56	0.56	0.56	0.75	0.75	0.75	0.75	0.75	1.25	1.25	1.88	2.13	2.13	2.13	2.50	2.50	2.75
3/4	0.81	0.81	0.81	0.81	0.81	1.00	1.00	1.00	1.00	1.00	1.56	1.56	2.25	2.63	2.63	2.63	2.75	2.75	3.00
1	1.06	1.06	1.06	1.06	1.06	1.25	1.25	1.25	1.25	1.25	1.88	1.88	2.63	2.88	2.88	2.88	3.13	3.13	3.38
1 1/4	1.50	1.50	1.31	1.31	1.31	1.88	1.88	1.56	1.56	1.56	2.38	2.38	3.00	3.25	3.25	3.25	3.50	3.50	4.13
1 1/2	1.75	1.75	1.63	1.63	1.63	2.13	2.13	1.88	1.88	1.88	2.75	2.75	3.38	3.75	3.75	3.75	3.88	3.88	4.63
2	2.19	2.19	2.06	2.06	2.06	2.75	2.75	2.31	2.31	2.31	3.38	3.38	4.13	4.38	4.38	4.38	5.63	5.63	5.7
2 1/2	2.62	2.62	2.50	2.50	2.50	3.25	3.25	2.75	2.75	2.75	3.88	3.88	4.88	5.13	5.13	5.13	6.50	6.50	6.63
3	3.19	3.10	3.10	3.10	3.10	4.00	4.00	3.75	3.63	3.63	4.75	4.75	5.38	5.88	5.88	5.88	6.63	6.88	7.75
4	4.19	4.04	4.04	3.85	3.85	5.00	4.75	4.75	4.63	4.63	5.88	5.88	6.88	7.13	7.00	7.63	8.13	8.25	9.25
5	5.19	5.05	5.05	4.90	4.90	6.13	5.81	5.81	5.63	5.63	7.00	7.00	7.75	8.50	8.38	9.50	9.75	10.00	11.00
6	6.19	6.10	6.10	5.80	5.80	7.19	6.88	6.88	6.75	6.75	8.25	8.25	8.75	9.88	9.75	10.50	11.38	11.13	12.50
8	8.50	8.10	7.75	7.75	7.75	9.19	8.88	8.75	8.50	8.50	10.38	10.13	11.00	12.13	12.00	12.63	14.13	13.88	15.25
10	10.56	10.05	9.69	9.69	9.69	11.31	10.81	10.88	10.50	10.63	12.50	12.25	13.38	14.25	14.13	15.75	17.13	17.13	18.75
12	12.50	12.10	11.50	11.50	11.50	13.38	12.88	12.75	12.75	12.50	14.75	14.50	16.13	16.63	16.50	18.00	19.63	20.50	21.63
14	13.75	13.50	12.63	12.63		14.63	14.25	14.00	14.25		16.00	15.75	17.75	19.13	19.00	19.38	20.50	22.75	
16	15.75	15.35	14.75	14.50		16.63	16.25	16.25	16.00		18.25	18.00	20.25	21.25	21.13	22.25	22.63	25.25	
18	17.69	17.25	16.75	16.75		18.69	18.50	18.25	18.25		20.75	20.50	21.63	23.50	23.38	24.13	25.13	27.75	
20	19.69	19.25	19.00	18.75		20.69	20.50	20.50	20.25		22.75	22.50	23.88	25.75	25.50	26.88	27.50	29.75	
24	23.75	23.25	23.25	22.75		24.75	24.75	24.75	24.25		27.00	26.75	28.25	30.50	30.25	31.13	33.00	35.50	

Inner RIng Inside Diameters for Spiral Wound Gaskets
- GASKET DIMENSIONS

USED IN ASME B16.47 SERIES A FLANGES					
Flange Size	Pressure Class				
(NPS)	150	300	400	600	900 (1,2)
26	25.75	25.75	26.00	25.50	26.00
28	27.75	27.75	28.00	27.50	28.00
30	29.75	29.75	29.75	29.75	30.25
32	31.75	31.75	32.00	32.00	32.00
34	33.75	33.75	34.00	34.00	34.00
36	35.75	35.75	36.13	36.13	36.25
38	37.75	37.50	37.50	37.50	39.75
40	39.75	39.50	39.38	39.75	41.75
42	41.75	41.50	41.38	42.00	43.75
44	43.75	43.50	43.50	43.75	45.50
46	45.75	45.38	46.00	45.75	48.00
48	47.75	47.63	47.50	48.00	50.00
50	49.75	49.00	49.50	50.00	
52	51.75	52.00	51.50	52.00	
54	53.50	53.25	53.25	54.25	
56	55.50	55.25	55.25	56.25	
58	57.50	57.00	57.25	58.00	
60	59.50	60.00	59.75	60.25	

GENERAL NOTES: a. The inner ring thickness shall be 0.117 ins to 0.131 ins b. The inside diameter tolerance is +/- 0.12 ins
c. Rings are suitable for use with pipe wall 0.38 ins or thicker

NOTES: 1. Inner rings are required for Class 900 gaskets 2. There are no Class 900 flanges NPS 50 and larger

Inner RIng Inside Diameters for Spiral Wound Gaskets
- GASKET DIMENSIONS

USED IN ASME B16.47 SERIES B FLANGES					
Flange Size	Pressure Class				
(NPS)	150	300	400	600	900 (1,2)
26	25.75	25.75	25.75	25.38	26.25
28	27.75	27.75	27.63	27.00	28.25
30	29.75	29.75	29.63	29.63	30.75
32	31.75	31.75	31.50	31.25	33.00
34	33.75	33.75	33.50	33.50	35.25
36	35.75	35.75	35.38	35.50	36.25
38	37.75	38.25	37.50	37.50	39.75
40	39.75	40.25	39.38	39.75	41.75
42	41.75	42.75	41.38	42.00	43.75
44	43.75	44.25	43.50	43.75	45.50
46	45.75	46.38	46.00	45.75	48.00
48	47.75	48.50	47.50	48.00	50.00
50	49.75	49.88	49.50	50.00	
52	51.75	51.88	51.50	52.00	
54	53.75	53.75	53.25	54.25	
56	56.00	56.25	55.25	56.25	
58	58.19	58.44	57.25	58.00	
60	60.44	61.31	59.75	60.25	

GENERAL NOTES: a. The inner ring thickness shall be 0.117 ins to 0.131 ins b. The inside diameter tolerance is +/- 0.12 ins
c. Rings are suitable for use with pipe wall 0.375 ins or thicker

NOTES: 1. Inner rings are required for Class 900 gaskets. 2. There are no NPSS 50 and larger Class 900 flanges.
3. See pages 22 and 23 for Sealing element and guide ring dimensions.

Metaflex Type SGIR suitable for BS 1560/ASME B 16.5 flanges - GASKET DIMENSIONS

SUPPLIED IN ACCORDANCE WITH BS 3381											
Nominal Bore	Inner ring	Sealing Element				Centring Ring Outside Diameter					
	I/D Minimum	Inside Diameter			Outside Diameter	Class Rating					
		150	300-1500	2500	150-2500	150	300	600	900	1500	2500
½	14.3	18.7	18.7	18.7	32.2	47.6	54	54	63.5	63.5	69.9
¾	20.6	26.6	25	25	40.1	57.2	66.7	66.7	69.9	69.9	76.2
1	27	32.9	31.4	31.4	48	66.7	73	73	79.4	79.4	85.9
1¼	34.9	45.6	44.1	39.3	60.7	76.2	82.6	82.6	88.9	88.9	104.8
1½	41.3	53.6	50.4	47.2	70.3	85.7	95.3	95.3	98.4	98.4	117.5
2	52.4	69.5	66.3	58.3	86.1	104.8	111.1	111.1	142.9	142.9	146.1
2½	63.5	82.2	79	69.5	98.8	123.8	130.2	130.2	165.1	165.1	168.3
3	77.8	101.2	94.9	91.7	121.1	136.5	149.2	149.2	168.3	174.6	196.9
4	103.2	126.6	120.3	117.1	149.6	174.6	181	193.7	206.4	209.6	235
5	128.5	153.6	147.2	142.5	178.2	196.9	215.9	241.3	247.7	254	279.4
6	154	180.6	174.2	171.1	210	222.3	250.8	266.7	288.9	282.6	317.5
8	203.2	231.4	225	215.5	263.9	279.4	308	320.7	358.8	352.4	387.4
10	254	286.9	280.6	269.5	317.9	339.7	362	400.1	435	435	476.3
12	303.22	339.3	333	323.5	375.1	409.6	422.3	457.2	498.5	520.7	549.6
14	342.99	371.1	364.7		406.8	450.9	485.8	492.1	520.7	577.9	
16	393.7	421.9	415.5		464	514.4	539.8	565.2	574.7	641.4	
18	444.5	475.9	469.5		527.5	549.3	596.9	612.8	638.2	704.9	
20	495.3	526.7	520.3		578.3	606.4	654.1	682.6	698.5	755.7	
24	596.9	631.4	625.1		686.2	717.6	774.7	790.6	838.2	901.7	

Metaflex Type SGIR suitable for DIN/EN 1092 flanges - GASKET DIMENSIONS

Up to 40 Bar dimensions in accordance with EN 1514-2

Nominal Bore	Inner ring	Sealing Element				Centring Ring Outside Diameter						
	I/D Minimum	10 bar - 40 bar		64 bar - 160 bar		10 bar	16 bar	25 bar	40 bar	64 bar	100 bar	160 bar
		I/D	O/D	I/D	O/D	DIN 2632	DIN 2633	DIN 2634	DIN 2635	DIN 2636	DIN 2637	DIN 2638
10	15	24	36	24	36	48	48	48	48	58	58	58
15	19	28	40	28	40	53	53	53	53	63	63	63
20	24	34	47	34	48	63	63	63	63	74	74	74
25	30	41	55	41	56	73	73	73	73	84	84	84
32	39	50	66	50	67	84	84	84	84	90	90	90
40	45	56	72	56	74	94	94	94	94	105	105	105
50	56	68	86	68	88	109	109	109	109	115	121	121
65	72	84	103	81	102	129	129	129	129	140	146	146
80	84	97	117	97	120	144	144	144	144	150	156	156
100	108	123	144	120	142	164	164	170	170	176	183	183
125	133	148	170	148	174	194	194	196	196	213	220	220
150	160	177	200	177	205	220	220	226	226	250	260	260
175	184	200	224	200	231	250	250	256	268	280	290	287
200	209	229	255	225	256	275	275	286	293	312	327	327
250	262	283	310	283	319	330	331	343	355	367	394	391
300	311	332	360	332	369	380	386	403	420	427	461	461
350	355	375	405	375	413	440	446	460	477	489	515	
400	406	426	458	426	466	491	498	517	549	546	575	
450	452	477	512			541	558	567	574			
500	508	528	566	528	572	596	620	627	631	660	708	
600	610	635	675	635	683	698	737	734	750	768	818	
700	710	735	778	735	785	813	807	836	855	883	956	
800	811	836	879	836	886	920	914	945	978	994		
900	909	934	980	934	989	1020	1014	1045	1088	1114		

Section 8 continued

Metaflex Type SG/IR suitable for BS 10 Welded Neck flanges - GASKET DIMENSIONS *Dimensions in inches*

Nominal Bore	Inner Ring		Sealing Element		Centring Ring		Sealing Element		Centring Ring									Centring Ring	
	Tables D-R	Tables S, T	Tables D, E		Table D	Table E	Tables F, H, J, K, R		Table F	Table H	Table J	Table K	Table R	Table S (1962)		Table T		Table S	Table T
	I/D	I/D	I/D	O/D	O/D	O/D	I/D	O/D	O/D	O/D	O/D	O/D	O/D	I/D	O/D	I/D	O/D	O/D	O/D
1/2	0.56	0.63	1.03	1.47	2.13	2.13	1.03	1.53	2.13	2.63	2.63	2.63	2.63	1.06	1.56	1.06	1.56	2.75	3.25
3/4	0.81	0.88	1.25	1.69	2.38	2.38	1.25	1.75	2.38	2.63	2.63	2.63	2.63	1.38	1.88	1.38	1.88	2.75	3.25
1	1.06	1.13	1.56	2.06	2.75	2.75	1.56	2.19	2.81	2.81	2.81	3.13	3.13	1.63	2.19	1.63	2.19	3.25	3.50
1 1/4	1.31	1.38	1.88	2.38	2.94	2.94	1.88	2.50	3.25	3.25	3.25	3.25	3.25	1.88	2.50	1.88	2.50	3.50	3.88
1 1/2	1.56	1.63	2.13	2.63	3.38	3.38	2.13	2.75	3.50	3.50	3.50	3.75	3.75	2.13	2.81	2.13	2.81	4.00	4.50
2	2.06	2.13	2.63	3.13	3.88	3.88	2.63	3.25	4.38	4.38	4.25	4.38	4.38	2.63	3.44	2.63	3.44	4.50	5.00
2 1/2	2.56	2.63	3.25	3.88	4.38	4.38	3.25	4.00	5.13	5.13	5.00	5.00	5.00	3.13	3.94	3.25	4.06	5.00	5.63
3	3.06	3.13	3.81	4.44	5.13	5.13	3.81	4.56	5.88	5.88	5.75	5.75	5.75	3.63	4.44	3.75	4.69	5.63	6.50
3 1/2	3.56	3.63	4.31	4.94	5.88	5.88	4.31	5.06	6.38	6.38	6.25	6.38	6.38	4.13	4.94	4.25	5.31	6.63	7.38
4	4.06	4.13	4.88	5.50	6.38	6.38	4.88	5.63	6.88	6.88	6.75	6.88	6.88	4.75	5.69	4.75	5.81	7.00	8.13
4 1/2	4.56	4.63	5.38	6.00	6.88	6.88	5.38	6.25	7.50	7.50	7.38	7.38	7.38	5.25	6.13	5.25	6.38	7.50	9.00
5	5.06	5.13	5.88	6.50	7.63	7.63	5.88	6.75	8.50	8.50	8.38	8.38	8.38	5.75	6.63	5.75	6.88	8.38	9.63
6	6.06	6.13	6.88	7.50	8.63	8.50	6.88	7.75	9.50	9.50	9.38	9.38	9.38	6.75	7.63	6.75	7.88	9.75	11.25
7	7.06	7.13	7.88	8.63	9.63	9.50	7.88	8.88	10.75	10.75	10.63	10.50	10.50	7.75	8.88	7.75	9.13	11.38	13.13
8	8.06	8.13	8.88	9.63	10.88	10.75	8.88	9.88	12.00	12.00	11.88	11.50	11.75	8.88	10.00	8.88	10.25	12.75	14.50
9	9.06	9.13	9.88	10.63	12.13	12.00	9.88	10.88	13.13	13.13	13.00	13.00	13.00	9.88	11.00	9.88	11.38	14.13	16.13
10	10.06	10.13	10.88	11.63	13.25	13.25	11.00	12.00	14.13	14.13	14.00	14.00	14.25	10.88	12.13	10.88	12.38	15.50	17.75
11	11.06	11.13	11.88	12.63	14.25	14.25	12.00	13.00	15.13	15.13	15.00	15.13	15.88	11.88	13.13	11.88	13.38	17.13	19.25
12	12.06	12.13	12.88	13.75	15.25	15.13	13.00	14.13	16.38	16.38	16.25	15.88	16.88	12.88	14.13	12.88	14.63	18.50	20.75
13	13.06	13.13	14.50	15.38	16.50	16.38	14.25	15.38	17.50	17.50	17.38	17.75	18.25	13.88	15.25	13.88	15.63	19.75	22.00
14	14.06	14.13	15.50	16.38	17.63	17.63	15.25	16.38	18.50	18.50	18.38	18.75	19.50	14.88	16.25			21.25	
15	15.06	15.13	16.50	17.38	18.63	18.63	16.25	17.38	19.50	19.50	19.38	20.00	20.50	15.88	17.25			22.88	
16	16.06	16.13	17.50	18.38	19.63	19.63	17.50	18.75	20.75	20.75	20.63	21.00	21.75	16.88	18.38			24.25	
17	17.06		18.63	19.63	20.88	20.75	18.50	19.88	22.00	22.00	21.88	22.25	22.75						
18	18.06		19.63	20.63	22.13	22.13	19.50	20.88	22.88	22.88	22.75	24.38	25.13						
19	19.06		20.63	21.63	23.13	23.13	20.63	22.13	24.13	24.13	24.00								
20	20.06		21.63	22.63	24.38	24.38	21.63	23.13	25.38	25.38	25.25	26.50	27.25						
21	21.06		22.63	23.75	25.63	25.50	22.63	24.38	26.38	26.38	26.25								
22	22.06		23.63	24.75	26.50	26.50	23.63	25.38	27.38	27.38	27.25	28.75	29.75						
23	23.06		24.63	25.75	27.50	27.50	24.63	26.38	28.50	28.50	28.38								
24	24.06		25.63	26.75	28.75	28.63	25.63	27.38	29.50	29.50	29.38								

Metaflex Type C for BS 1560/ASME B 16.5 large male-female, and spigot-recess flanges, - GASKET DIMENSIONS

Dimensions in inches

	Class 150-1500		Sealing element for Class 2500 flanges
Nominal Bore	Gasket I/D	Gasket O/D	Gasket I/D
1/4	1/2	1	
1/2	1	1 3/8	13/16
3/4	1 5/16	1 11/16	1 1/16
1	1 1/2	2	1 1/4
1 1/4	1 7/8	2 1/2	1 5/8
1 1/2	2 1/8	2 7/8	1 7/8
2	2 7/8	3 5/8	2 3/8
2 1/2	3 3/8	4 1/8	3
3	4 1/4	5	3 3/4
4	5 3/16	6 3/16	4 3/4

	Class 150-1500		Sealing element for Class 2500 flanges
Nominal Bore	Gasket I/D	Gasket O/D	Gasket I/D
5	6 5/16	7 5/16	5 3/4
6	7 1/2	8 1/2	6 3/4
8	9 3/8	10 5/8	8 3/4
10	11 1/4	12 3/4	10 3/4
12	13 1/2	15	13
14	14 3/4	16 1/4	
16	16 3/4	18 1/2	
18	19 1/4	21	
20	21	23	
24	25 1/4	27 1/4	

Note - element O/D's are the same as for the 150-1500 series gaskets

JW Chart 522A - Metaflex Type WG/IR suitable for TEMA heat exchanger flanges - GASKET DIMENSIONS *Dimensions in inches*

Nominal I/D of Shell	150 Class C								300 Class C							
	Shell to Cover				Shell - Tubeplate, Tubeplate - Channel				Shell to Cover				Shell - Tubeplate, Tubeplate - Channel			
	I/D Inner Ring	Sealing Element		O/D Wound Guide	I/D Inner Ring	Sealing Element		O/D Wound Guide	I/D Inner Ring	Sealing Element		O/D Wound Guide	I/D Inner Ring	Sealing Element		O/D Wound Guide
		I/D	O/D			I/D	O/D			I/D	O/D			I/D	O/D	
6	10 3/8	10 15/16	11 11/16	12 3/32	6 1/4	6 13/16	7 9/16	7 31/32	10 3/8	10 15/16	11 11/16	12 3/32	6 1/4	6 13/16	7 9/16	7 31/32
8	12 3/8	12 15/16	13 11/16	14 3/32	8 1/4	8 13/16	9 9/16	9 31/32	12 3/8	12 15/16	13 11/16	14 3/32	8 1/4	8 13/16	9 9/16	9 31/32
10	13 7/16	14	14 7/8	15 11/32	10 3/8	10 15/16	11 11/16	12 3/32	13 7/16	14	14 7/8	15 11/32	10 3/8	10 15/16	11 11/16	12 3/32
12	15 7/16	16	16 7/8	17 11/32	12 3/8	12 15/16	13 11/16	14 3/32	15 7/16	16	16 7/8	17 11/32	12 3/8	12 15/16	13 11/16	14 3/32
13	17 1/2	18 1/8	19	19 15/32	13 7/16	14	14 7/8	15 11/32	17 1/2	18 1/8	19	19 15/32	13 7/16	14	14 7/8	15 11/32
15	19 1/2	20 1/8	21	21 19/32	15 7/16	16	16 7/8	17 11/32	19 1/2	20 1/8	21	21 15/32	15 7/16	16	16 7/8	17 11/32
17	21 9/16	22 1/4	23 1/8	23 19/32	17 1/2	18 1/8	19	19 15/32	21 9/16	22 1/4	23 1/8	23 19/32	17 1/2	18 1/8	19	19 15/32
19	23 9/16	24 1/4	25 1/8	25 19/32	19 1/2	20 1/8	21	21 15/32	23 9/16	24 1/4	25 1/8	25 19/32	19 1/2	20 1/8	21	21 15/32
21	25 3/4	26 1/2	27 3/8	27 27/32	21 9/16	22 1/4	23 1/8	23 19/32	26	26 3/4	27 5/8	28 3/32	21 9/16	22 1/4	23 1/8	23 19/32
23	27 3/4	28 1/2	29 3/8	29 27/32	23 9/16	24 1/4	25 1/8	25 19/32	28 1/8	28 7/8	29 3/4	30 7/32	23 9/16	24 1/4	25 1/8	25 19/32
25	29 5/8	30 3/8	31 3/8	31 27/32	25 3/4	26 1/2	27 3/8	27 27/32	29 3/4	30 3/4	31 3/4	32 7/32	26	26 3/4	27 5/8	28 3/32
27	31 5/8	32 3/8	33 3/8	33 27/32	27 3/4	28 1/2	29 3/8	29 27/32	32	33	34	34 15/32	28 1/8	28 7/8	29 3/4	30 7/32
29	33 5/8	34 3/8	35 3/8	35 27/32	29 5/8	30 3/8	31 3/8	31 27/32	34	35	36	36 15/32	29 3/4	30 3/4	31 3/4	32 7/32
31	35 1/2	36 3/8	37 1/2	37 31/32	31 5/8	32 3/8	33 3/8	33 27/32	35 7/8	36 7/8	38	38 15/32	32	33	34	34 15/32
33	37 1/2	38 3/8	39 1/2	39 31/32	33 5/8	34 3/8	35 3/8	35 27/32	38 1/8	39 1/8	40 1/4	40 23/32	34	35	36	36 15/32
35					35 1/2	36 3/8	37 1/2	37 31/32					35 7/8	36 7/8	38	38 15/32
37					37 1/2	38 3/8	39 1/2	39 31/32					38 1/8	39 1/8	40 1/4	40 23/32
35	39 1/4	40 1/4	41 1/2	41 31/32					40	41	42 1/4	42 23/32				
37	42 1/2	43 1/2	44 3/4	45 7/32					43 3/8	44 3/8	45 5/8	46 3/32				
39	43 1/2	44 1/2	45 3/4	46 7/32	39 1/4	40 1/4	41 1/4	41 31/32	44 3/8	45 3/8	46 5/8	47 3/32	40	41	42 1/4	42 23/32
42	46 1/2	47 1/2	48 3/4	49 7/32	42 1/2	43 1/2	44 3/4	45 7/32	47 3/8	48 3/8	49 5/8	50 3/32	43 3/8	44 3/8	45 5/8	46 3/32
43					43 1/2	44 1/2	45 3/4	46 7/32					44 3/8	45 3/8	46 5/8	47 3/32
44																
46					46 1/2	47 1/2	48 3/4	49 7/32					47 3/8	48 3/8	49 5/8	50 3/32
47																

Nominal I/D of Shell	450 Class C and R								600 Class C and R							
	Shell to Cover				Shell - Tubeplate, Tubeplate - Channel				Shell to Cover				Shell - Tubeplate, Tubeplate - Channel			
	I/D Inner Ring	Sealing Element		O/D Wound Guide	I/D Inner Ring	Sealing Element		O/D Wound Guide	I/D Inner Ring	Sealing Element		O/D Wound Guide	I/D Inner Ring	Sealing Element		O/D Wound Guide
		I/D	O/D			I/D	O/D			I/D	O/D			I/D	O/D	
6	10 7/8	11 7/16	12 3/16	12 19/32	6 5/8	7 3/16	7 15/16	8 11/32	10 3/4	11 5/16	12 1/16	12 15/16	6 5/8	7 3/16	7 15/16	8 11/32
8	12 7/8	13 7/16	14 3/16	14 19/32	8 3/4	9 5/16	10 1/16	10 15/32	12 7/8	13 7/16	14 3/16	14 19/32	8 5/8	9 3/16	9 15/16	10 11/32
10	13 15/16	14 1/2	15 3/8	15 27/32	10 7/8	11 7/16	12 3/16	12 19/32	14 1/16	14 5/8	15 1/2	15 31/32	10 3/4	11 5/16	12 1/16	12 15/32
12	15 3/4	16 1/2	17 3/8	17 27/32	12 7/8	13 7/16	14 3/16	14 19/32	15 7/8	16 5/8	17 1/2	17 31/32	12 7/8	13 7/16	14 3/16	14 19/32
13	17 3/4	18 1/2	19 3/8	19 27/32	13 15/16	14 1/2	15 3/8	15 27/32	17 7/8	18 5/8	19 1/2	19 31/32	14 1/16	14 5/8	15 1/2	15 31/32
15	20	20 3/4	21 5/8	22 3/32	15 3/4	16 1/2	17 3/8	17 27/32	20 1/8	20 7/8	21 3/4	22 7/32	15 7/8	16 5/8	17 1/2	17 31/32
17	22	22 3/4	23 5/8	24 3/32	17 3/4	18 1/2	19 3/8	19 27/32	22 1/8	22 7/8	23 3/4	24 7/32	17 7/8	18 5/8	19 1/2	19 31/32
19	23 7/8	24 5/8	25 5/8	26 3/32	20	20 3/4	21 5/8	22 3/32	24 1/8	24 7/8	25 7/8	26 11/32	20 1/8	20 7/8	21 3/4	22 7/32
21	26 7/8	27 5/8	28 5/8	29 3/32	22	22 3/4	23 5/8	24 3/32	27 1/4	28	29	29 15/32	22 1/8	22 7/8	23 3/4	24 7/32
23	28 7/8	29 5/8	30 5/8	31 3/32	23 7/8	24 5/8	25 5/8	26 1/16	29 1/4	30	31	31 15/32	24 1/8	24 7/8	25 7/8	26 11/32
25	30 3/4	31 3/4	32 7/8	33 11/32	26 7/8	27 5/8	28 5/8	29 3/32	31 1/2	32 1/2	33 5/8	34 3/32	27 1/4	28	29	29 15/32
27	32 3/4	33 3/4	34 7/8	35 11/32	28 7/8	29 5/8	30 5/8	31 3/32	33 1/2	34 1/2	35 5/8	36 3/32	29 1/4	30	31	31 15/32
29	34 7/8	35 7/8	37	37 15/32	30 3/4	31 3/4	32 7/8	33 11/32	35 3/4	36 3/4	37 7/8	38 11/32	31 1/2	32 1/2	33 5/8	34 3/32
31	37 1/8	38 1/8	39 3/8	39 27/32	32 3/4	33 3/4	34 7/8	35 11/32	38	39	40 1/4	40 23/32	33 1/2	34 1/2	35 5/8	36 3/32
33	39 3/8	40 3/8	41 5/8	42 3/32	34 7/8	35 7/8	37	37 15/32	40	41	42 1/4	42 23/32	35 3/4	36 3/4	37 7/8	38 11/32
35					37 1/8	38 1/8	39 3/8	39 27/32					38	39	40 1/4	40 23/32
37					39 3/8	40 3/8	41 5/8	42 3/32					40	41	42 1/4	42 23/32
35	41 1/4	42 1/4	43 3/4	44 7/32					42 1/8	43 1/8	44 5/8	45 3/32				
37	44 3/8	45 3/8	46 7/8	47 11/32					45 1/8	46 1/8	47 5/8	48 3/32				
39	46 5/8	47 5/8	49 1/8	49 19/32	41 1/4	42 1/4	43 3/4	44 7/32	47 1/2	48 1/2	50	50 15/32	42 1/8	43 1/8	44 5/8	45 3/32
42	49 3/4	50 3/4	52 1/4	52 23/32	44 3/8	45 3/8	46 7/8	47 11/32	50 3/4	51 3/4	53 1/4	53 23/32	45 1/8	46 1/8	47 5/8	48 3/32
43																
44					46 5/8	47 5/8	49 1/8	49 19/32					47 1/2	48 1/2	50	50 15/32
46																
47					49 3/4	50 3/4	52 1/4	52 23/32					50 3/4	51 3/4	53 1/4	53 23/32

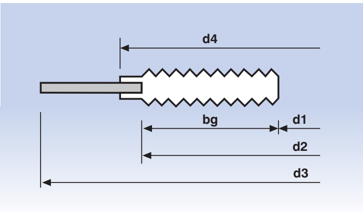
JW Chart 522A - Metaflex Type WG/IR suitable for TEMA heat exchanger flanges continued - GASKET DIMENSIONS *Dimensions in inches*

Nominal I/D of Shell	150 Class R								300 Class R							
	Shell to Cover				Shell - Tubeplate, Tubeplate - Channel				Shell to Cover				Shell - Tubeplate, Tubeplate - Channel			
	I/D Inner Ring	Sealing Element		O/D Wound Guide	I/D Inner Ring	Sealing Element		O/D Wound Guide	I/D Inner Ring	Sealing Element		O/D Wound Guide	I/D Inner Ring	Sealing Element		O/D Wound Guide
		I/D	O/D			I/D	O/D			I/D	O/D			I/D	O/D	
8	12 11/16	13 1/4	14 1/8	14 19/32	8 11/16	9 3/4	10	10 15/32	12 11/16	13 1/4	14 1/8	14 19/32	8 11/16	9 3/4	10	10 15/32
10	13 15/16	14 1/2	15 3/8	15 27/32	10 13/16	11 3/8	12 1/8	12 19/32	13 15/16	14 1/2	15 3/8	15 27/32	10 13/16	11 3/8	12 1/8	12 19/32
12	15 15/16	16 1/2	17 3/8	17 27/32	12 11/16	13 1/4	14 1/8	14 19/32	15 15/16	16 1/2	17 3/8	17 27/32	12 11/16	13 1/4	14 1/8	14 19/32
13	17 7/8	18 1/2	19 3/8	19 27/32	13 15/16	14 1/2	15 3/8	15 27/32	17 7/8	18 1/2	19 3/8	19 27/32	13 15/16	14 1/2	15 3/8	15 27/32
15	20 1/8	20 3/4	21 5/8	22 3/32	15 15/16	16 1/2	17 3/8	17 27/32	20 1/8	20 3/4	21 5/8	22 3/32	15 15/16	16 1/2	17 3/8	17 27/32
17	22 1/16	22 3/4	23 5/8	24 3/32	17 7/8	18 1/2	19 3/8	19 27/32	22 1/16	22 3/4	23 5/8	24 3/32	17 7/8	18 1/2	19 3/8	19 27/32
19	24 1/16	24 3/4	25 5/8	26 3/32	20 1/8	20 3/4	21 5/8	22 3/32	24 1/16	24 3/4	25 5/8	26 3/32	20 1/8	20 3/4	21 5/8	22 3/32
21	25 1/2	26 1/4	27 1/8	27 19/32	22 1/16	22 3/4	23 5/8	24 3/32	26 3/8	27 1/8	28	28 15/32	22 1/16	22 3/4	23 5/8	24 3/32
23	27 7/8	28 5/8	29 1/2	29 31/32	24 1/16	24 3/4	25 5/8	26 3/32	28 1/4	29 1/4	30 1/8	30 19/32	24 1/16	24 3/4	25 5/8	26 3/32
25	29 3/4	30 1/2	31 1/2	31 31/32	25 1/2	26 1/4	27 1/8	27 19/32	30 1/8	31 1/8	32 1/8	32 19/32	26 3/8	27 1/8	28	28 15/32
27	31 3/4	32 1/2	33 1/2	33 31/32	27 7/8	28 5/8	29 1/2	29 31/32	32 1/8	33 1/8	34 1/8	34 19/32	28 1/4	29 1/4	30 1/8	30 19/32
29	33 3/4	34 1/2	35 1/2	35 31/32	29 3/4	30 1/2	31 1/2	31 31/32	34 3/8	35 3/8	36 3/8	36 27/32	30 1/8	31 1/8	32 1/8	32 19/32
31	35 1/2	36 3/8	37 1/2	37 31/32	31 3/4	32 1/2	33 1/2	33 31/32	36 1/4	37 1/4	38 3/8	38 27/32	32 1/8	33 1/8	34 1/8	34 19/32
33	37 7/8	38 3/4	39 7/8	40 11/32	33 3/4	34 1/2	35 1/2	35 31/32	38 3/8	39 3/8	40 1/2	40 31/32	34 3/8	35 3/8	36 3/8	36 27/32
35					35 1/2	36 3/8	37 1/2	37 31/32					36 1/4	37 1/4	38 3/8	38 27/32
37					37 7/8	38 3/4	39 7/8	40 11/32					38 3/8	39 3/8	40 1/2	40 31/32
35	39 5/8	40 5/8	41 7/8	42 11/32					40 3/8	41 3/8	42 5/8	43 3/32				
37	42 5/8	43 5/8	44 7/8	45 11/32					43 3/8	44 3/8	45 5/8	46 3/32				
39	44 5/8	45 5/8	46 7/8	47 11/32	39 5/8	40 5/8	41 7/8	42 11/32	45 5/8	46 5/8	47 7/8	48 11/32	40 3/8	41 3/8	42 5/8	43 3/32
42	47 7/8	48 7/8	50 1/8	50 19/32	42 5/8	43 5/8	44 7/8	45 11/32	48 5/8	49 5/8	50 7/8	51 11/32	43 3/8	44 3/8	45 5/8	46 3/32
44					44 5/8	45 5/8	46 7/8	47 11/32					45 5/8	46 5/8	47 7/8	48 11/32
47					47 7/8	48 7/8	50 1/8	50 19/32					48 5/8	49 5/8	50 7/8	51 11/32

Kammprofiles to suit - ASME B16.5/BS 1560 flanges - GASKET DIMENSIONS

NPS	Sealing Element (mm)			Location ring - d3 (mm) Class					
	d1	d2	d4	150	300	600	900	1500	2500
1/2”	23.0	33.3	37.3	48	54	54	64	64	70
3/4”	28.6	39.7	43.7	57	67	67	70	70	76
1”	36.5	47.6	51.6	66	73	73	79	79	86
1 1/4”	44.4	60.3	64.3	76	83	83	89	89	105
1 1/2”	52.4	69.8	73.8	86	95	95	98	98	118
2”	69.8	88.9	92.9	105	111	111	143	143	146
2 1/2”	82.5	101.6	105.6	124	130	130	165	165	168
3”	98.4	123.8	127.8	136	149	149	168	175	197
4”	123.8	154.0	158.0	175	181	194	206	210	235
5”	150.8	182.6	186.6	197	216	241	248	254	279
6”	177.8	212.7	216.7	222	250	267	289	283	318
8”	228.6	266.7	270.7	279	308	321	359	352	387
10”	282.6	320.7	324.7	340	362	400	435	435	476
12”	339.7	377.8	381.8	410	422	457	499	521	550
14”	371.5	409.6	413.6	451	486	492	521	578	581
16”	422.3	466.7	470.7	514	540	565	575	641	644
18”	479.4	530.2	534.2	549	597	613	638	705	
20”	530.2	581.0	585.0	606	654	683	699	756	
24”	631.8	682.6	686.6	718	755	791	838	902	

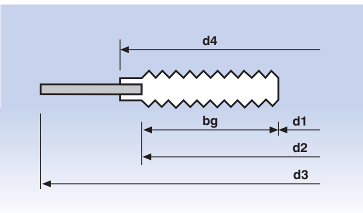
Metakamm gasket dimensions (1/2” to 24” NPS)



Kammprofiles to suit - ASME B16.47 Series A flanges - GASKET DIMENSIONS

Class 150					Class 300				
NPS	Sealing element (mm)			Ring	NPS	Sealing element (mm)			Ring
	d1	d2	d4	d3		d1	d2	d4	d3
26”	673.1	704.8	708.8	774.7	26”	685.8	736.6	740.6	835.1
28”	723.9	755.7	759.7	831.1	28”	736.6	787.4	791.4	898.6
30”	774.7	806.5	810.5	882.6	30”	793.8	844.6	848.6	952.5
32”	825.5	860.6	864.6	939.8	32”	850.9	901.7	905.7	1006.6
34”	876.3	911.4	915.4	990.6	34”	901.7	952.5	956.5	1057.4
36”	927.1	968.5	972.5	1047.7	36”	955.8	1006.6	1010.6	1117.6
38”	977.9	1019.3	1023.3	1111.2	38”	977.9	1016.0	1020.0	1054.1
40”	1028.7	1070.1	1074.1	1162.0	40”	1022.4	1070.1	1074.1	1114.5
42”	1079.5	1124.0	1128.0	1219.2	42”	1073.2	1120.9	1124.9	1165.3
44”	1130.3	1178.1	1182.1	1276.3	44”	1130.3	1181.1	1185.1	1219.2
46”	1181.1	1228.9	1232.9	1327.1	46”	1178.1	1228.9	1232.9	1273.3
48”	1231.9	1279.7	1283.7	1384.3	48”	1235.2	1286.0	1290.0	1324.1
50”	1282.7	1333.5	1337.5	1435.1	50”	1295.4	1346.2	1350.2	1377.9
52”	1333.5	1384.3	1388.3	1492.2	52”	1346.2	1397.0	1401.0	1428.7
54”	1384.3	1435.1	1439.1	1549.4	54”	1403.4	1454.2	1458.2	1492.2
56”	1435.1	1485.9	1489.9	1606.5	56”	1454.2	1505.0	1509.0	1543.0
58”	1485.9	1536.7	1540.7	1663.7	58”	1511.3	1562.1	1566.1	1593.8
60”	1536.7	1587.5	1591.5	1714.5	60”	1562.1	1612.9	1616.9	1644.6

Metakamm gasket dimensions (above 24” NPS)

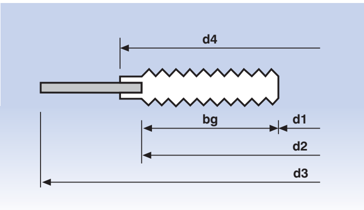


Dimensions as per Spiral Wound gasket sizes in ASME B16.20, table 10, to suit Series A flanges

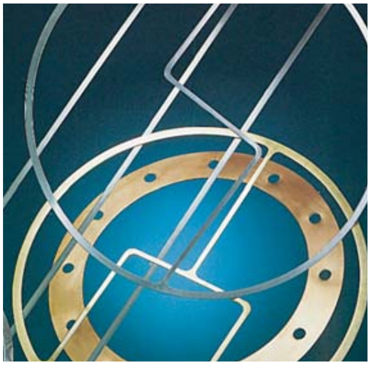
Kammprofiles to suit - ASME B16.47 Series A flanges continued - GASKET DIMENSIONS

Class 600					Class 900				
NPS	Sealing element (mm)			Ring	NPS	Sealing element (mm)			Ring
	d1	d2	d4	d3		d1	d2	d4	d3
26”	685.8	736.6	740.6	866.9	26”	685.8	736.6	740.6	882.6
28”	736.6	787.4	791.4	914.4	28”	736.6	787.4	791.4	946.1
30”	793.8	844.6	849.6	971.5	30”	793.8	844.6	849.6	1009.6
32”	850.9	901.7	905.7	1022.3	32”	850.9	901.7	905.7	1073.1
34”	901.7	952.5	956.5	1073.1	34”	901.7	952.5	956.5	1136.6
36”	955.8	1006.6	1010.6	1130.3	36”	958.9	1009.7	1013.7	1200.1
38”	990.6	1041.4	1045.4	1104.9	38”	1035.1	1085.9	1089.9	1200.1
40”	1047.8	1098.6	1102.6	1155.7	40”	1098.6	1149.4	1153.4	1250.9
42”	1104.9	1155.7	1159.7	1219.2	42”	1149.4	1200.2	1204.2	1301.7
44”	1162.1	1212.9	1216.9	1270.0	44”	1206.5	1257.3	1261.3	1368.5
46”	1212.9	1263.7	1267.7	1327.1	46”	1270.0	1320.8	1324.8	1435.1
48”	1270.0	1320.8	1324.8	1390.6	48”	1320.8	1371.6	1375.6	1485.9
50”	1320.8	1371.6	1375.6	1447.8	50”				
52”	1371.6	1422.4	1426.4	1498.6	52”				
54”	1428.8	1479.6	1483.6	1555.7	54”				
56”	1479.6	1530.4	1534.4	1612.9	56”				
58”	1536.7	1587.5	1591.5	1663.7	58”				
60”	1593.9	1644.7	1648.7	1733.5	60”				

Metakamm gasket dimensions (above 24” NPS)



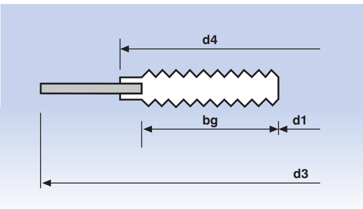
Dimensions as per Spiral Wound gasket sizes in ASME B16.20, table 10, to suit Series A flanges



Kammprofiles- DIN/BS EN 1092 flanges - GASKET DIMENSIONS

DN	d1	d4			Location ring OD d3									
		PN 10	PN 64/ 160	PN 250/ 400	PN 10	PN 16	PN 25	PN 40	PN 64	PN 100	PN 160	PN 250	PN 300	PN 400
10	22	36	36	36	46	46	46	46	56	56	56	67	67	67
15	26	42	42	42	51	51	51	51	61	61	61	72	72	
20	31	47	47	47	61	61	61	61						
25	36	52	52	52	71	71	71	71	82	82	82	83	92	104
32	46	62	62	66	82	82	82	82						
40	53	69	69	73	92	92	92	92	103	103	103	109	119	135
50	65	81	81	87	107	107	107	107	113	119	119	124	134	150
65	81	100	100	103	127	127	127	127	137	143	143	153	170	192
80	95	115	115	121	142	142	142	142	148	154	154	170	190	207
100	118	138	138	146	162	162	168	168	174	180	180	202	229	256
125	142	162	162	178	192	192	194	194	210	217	217	242	274	301
150	170	190	190	212	217	217	224	224	247	257	257	284	311	348
175	195	215	215	245	247	247	254	265	277	287	284	316	358	402
200	220	240	248	280	272	272	284	290	309	324	324	358	398	442
250	270	290	300	340	327	328	340	352	364	391	388	442	488	
300	320	340	356	400	377	383	400	417	424	458	458	536		
350	375	395	415		437	443	457	474	486	512				
400	426	450	474		489	495	514	546	543	572				
450	480	506			539	555		571						
500	530	560	588		594	617	624	628	657	704				
600	630	664	700		695	734	731	747	764	813				
700	730	770	812		810	804	833	852	879	950				
800	830	876	886		917	911	942	974	988					
900	930	982	994		1017	1011	1042	1084	1108					
1000	1040	1098	1110		1124	1128	1154	1194	1220					
1200	1250	1320	1334		1341	1342	1364	1398	1452					
1400	1440	1522			1548	1542	1578	1618						
1600	1650	1742			1772	1764	1798	1830						
1800	1850	1914			1972	1964	2000							
2000	2050	2120			2182	2168	2230							
2200	2250	2328			2384	2378								
2400	2450	2512			2594									
2600	2650	2728			2794									
2800	2850	2952			3014									

Metakamm gasket dimensions (above 24” NPS)



Dimensions taken from EN 1514 for EN 1092 flanges

Bolting - UNC/UNF:
- THREAD DIMENSIONS

Bolt Diameter INCH	Pitch TPI	Effective Diameter INCH	Root Diameter INCH	Stress Area IN^2	Stress Area mm^2
UNC					
1/2	13	0.450	0.406	0.144	92.73
9/16	12	0.508	0.460	0.184	118.87
5/8	11	0.566	0.514	0.229	147.62
3/4	10	0.685	0.627	0.338	218.15
7/8	9	0.803	0.739	0.467	301.01
1	8	0.919	0.847	0.612	394.81
1.1/8	8	1.044	0.972	0.798	514.54
1.1/4	8	1.169	1.097	1.008	650.11
1.3/8	8	1.294	1.222	1.242	801.51
1.1/2	8	1.419	1.347	1.502	968.75
1.5/8	8	1.544	1.472	1.785	1151.83
1.3/4	8	1.669	1.597	2.094	1350.73
1.7/8	8	1.794	1.722	2.426	1565.48
2	8	1.919	1.847	2.784	1796.05
2.1/4	8	2.169	2.097	3.572	2304.71
2.1/2	8	2.419	2.347	4.459	2876.71
2.3/4	8	2.669	2.597	5.444	3512.04
3	8	2.919	2.847	6.527	4210.72
UNF					
1/2	20	0.468	0.439	0.161	104.03
9/16	18	0.526	0.494	0.205	131.98
5/8	18	0.589	0.557	0.258	166.28
3/4	16	0.709	0.673	0.375	242.19
7/8	14	0.829	0.787	0.513	330.81
1	12	0.946	0.898	0.667	430.60
1.1/8	12	1.071	1.023	0.861	555.30
1.1/4	12	1.196	1.148	1.079	695.83
1.3/8	12	1.321	1.273	1.321	852.19
1.1/2	12	1.446	1.398	1.588	1024.39
1.5/8	12	1.571	1.523	1.879	1212.42
1.3/4	12	1.696	1.648	2.195	1416.29
1.7/8	12	1.821	1.773	2.536	1635.99
2	12	1.946	1.898	2.901	1871.53
2.1/4	12	2.196	2.148	3.705	2390.10
2.1/2	12	2.446	2.398	4.607	2972.02
2.3/4	12	2.696	2.648	5.607	3617.27
3	12	2.946	2.898	6.705	4325.87

Bolting - BSW/BSF:
- THREAD DIMENSIONS

Bolt Diameter INCH	Pitch TPI	Effective Diameter INCH	Root Diameter INCH	Stress Area IN^2	Stress Area mm^2
BSW					
1/2	12	0.447	0.393	0.138	89.34
9/16	12	0.509	0.456	0.18	117.92
5/8	11	0.567	0.509	0.227	146.50
11/16	11	0.629	0.571	0.283	182.54
3/4	10	0.686	0.622	0.336	216.73
7/8	9	0.804	0.733	0.464	299.14
1	8	0.920	0.840	0.608	392.39
1.1/8	7	1.034	0.942	0.766	494.37
1.1/4	7	1.159	1.067	0.972	627.41
1.1/2	6	1.393	1.287	1.410	909.78
1.3/4	5	1.622	1.494	1.906	1229.73
2	4.5	1.858	1.715	2.507	1617.29
2.1/4	4	2.090	1.930	3.173	2046.84
2.1/2	4	2.340	2.180	4.011	2587.72
2.3/4	3.5	2.567	2.384	4.813	3105.15
3	3.5	2.817	2.634	5.834	3764.00
BSF					
1/2	16	0.460	0.420	0.152	98.10
9/16	16	0.523	0.483	0.198	127.95
5/8	14	0.579	0.534	0.243	156.90
11/16	14	0.642	0.596	0.301	194.12
3/4	12	0.697	0.643	0.352	227.39
7/8	11	0.817	0.759	0.487	314.40
1	10	0.936	0.872	0.642	414.09
1.1/8	9	1.054	0.983	0.814	525.47
1.1/4	9	1.179	1.108	1.027	662.39
1.3/8	8	1.295	1.215	1.237	798.08
1.1/2	8	1.420	1.340	1.496	964.97
1.5/8	8	1.545	1.465	1.779	1147.71
1.3/4	7	1.659	1.567	2.043	1317.93
2	7	1.909	1.817	2.725	1758.19
2.1/4	6	2.143	2.037	3.431	2213.24
2.1/2	6	2.393	2.287	4.300	2774.41
2.3/4	6	2.643	2.537	5.268	3398.91
3	5	2.872	2.744	6.192	3994.89

Bolting - Metric:
- THREAD DIMENSIONS

Bolt Diameter mm	Pitch mm	Effective Diameter mm	Root Diameter mm	Stress Area IN^2	Stress Area mm^2
8	1.25	7.07	6.30	0.054	35.06
10	1.5	8.89	7.97	0.086	55.79
12	1.75	10.71	9.64	0.126	81.30
14	2	12.54	11.31	0.173	111.68
16	2	14.54	13.31	0.236	152.28
18	2.5	16.20	14.67	0.290	187.11
20	2.5	18.20	16.67	0.370	238.74
22	2.5	20.20	18.67	0.460	296.66
24	3	21.85	20.01	0.533	343.91
27	3	24.85	23.01	0.697	449.59
30	3.5	27.51	25.36	0.851	548.76
33	3.5	30.51	28.36	1.055	680.39
36	4	33.16	30.71	1.242	801.13
39	4	36.16	33.71	1.486	958.71
42	4.5	38.83	36.07	1.707	1101.30
45	4.5	41.83	39.07	1.991	1284.83
48	5	44.44	41.41	2.243	1447.33
52	5	48.44	45.41	2.681	1729.61
56	5.5	52.14	48.77	3.099	1999.10
60	5.5	56.14	52.77	3.609	2328.66
64	6	59.80	56.12	4.089	2638.23
68	6	63.80	60.12	4.673	3014.96

Conversion factors:

To convert:	Into:	Multiply by:
ft-lbs	Nm	1.356
Nm	ft-lbs	0.7375
p.s.i	MPa	0.006897
MPa	p.s.i.	145
p.s.i	bar	0.06897
bar	p.s.i.	14.5
lbs	Kg	0.4536
kg	lbs	2.2046

Temperatures:

°C	°F
-200	-328
-50	-58
0	32
20	68
38	100
50	122
100	212
150	302
200	392
250	482
260	500
300	572
316	600
350	662
371	700
400	752
427	800
450	842
500	932
538	1000

Ring Joint Gasket Metals

Metal	Maximum hardness identification Rockwell B
Soft Iron	56 (90 BHN) D
Low Carbon Steel	68 (120 BHN) S
F5 Alloy Steel (4.6% Cr, 1/2% Mo)	72 (130 BHN) F5
410 Alloy Steel (11/13% Cr)	86 (170 BHN) S410
304 Stainless Steel	83 (160 BHN) S304
304L Stainless Steel	83 (160 BHN) S304L
316 Stainless Steel	83 (160 BHN) S316
316L Stainless Steel	83 (160 BHN) S3161
347 Stainless Steel	83 (160 BHN) S347
321 Stainless Steel	83 (160 BHN) S321
825 Nickel Alloy	93 (200 BHN) 825

Spiral wound gaskets to ASME B 16.20 can be identified by the colour coding on the outside of the guide ring. The solid colour denotes the grade of winding material, and coloured stripes identify the filler material used.

Material	Colour
Carbon Steel	Silver
304	Yellow
304L	No colour
316L	Green
347	Blue
321	Turquoise
Monel 400	Orange
Nickel 200	Red
Titanium	Purple
Hastelloy B	Brown
Inconel 600 or 625	Gold
Incoloy 800 or 825	White

Filler	Stripe Colour
PTFE	White
Mica-graphite	Pink
Flexible graphite	Grey
Ceramic	Light green

Bolt Material Strengths:

Bolt Grade	0.2% Proof Stress (MPa)	Proof Load Stress (MPa)	Max. Suggested Bolt Stress (MPa)
ISO 898 Grade 8.8	640	600	510
ISO 898 Grade 10.9	900	830	706
ISO 898 Grade 12.9	1080	970	825
ASTM A194 Grade B7/L7	725	640	540
ASTM A194 Grade B7M/L7M	550	484	340
ASTM A194 Grade B16	725	640	540
ASTM A194 Grade B8	205	144	126
BS 6105 Stainless A1/A2/A4 Grade 50	210	147	107
BS 6105 Stainless A1/A2/A4 Grade 70	450	315	230
BS 6105 Stainless A1/A2/A4 Grade 70	600	420	286

Notes:- 1) Proof loads for stainless steels and "B" grades are approximate values and based upon experience.

2) Maximum bolt stresses for "B" and "A" grades are specified in BS 4882 and BS 6105. Values for the stainless steels (e.g. B8 and the "A" grades) must be adhered to. The "B" grade low alloy steels can safely be loaded to the values listed above.

3) The maximum values for the "B" steels (except B8) and ISO steels are based upon approximately 85% of the listed proof load, as the true onset of yield can often be detected at a slightly lower than theoretical stress point.

Metallic Materials:

Material	Trade Name	Description	Temperature range	Comments
Low Carbon Steel	-	Sheet forged or rolled steel, sometimes referred to as Soft Iron or Armco	-50 to 540°C	For general applications only
316	-	An 18-12 chromium/nickel austenitic stainless steel, containing approximately 2% molybdenum content for high temperature strength	815°C max	Excellent corrosion resistance, but subject to stress corrosion cracking and intergranular corrosion with certain media. Carbide precipitation may occur above 540°C
316L	-	Variation of 316, carbon content reduced to 0.03% maximum	815°C max	Reduced stress corrosion cracking and intergranular corrosion due to reduced carbon content
304	-	An 18-8 chromium/nickel austenitic stainless steel	540°C max	Excellent corrosion resistance, but subject to stress corrosion cracking and intergranular corrosion at elevated temperatures
304L	-	Variation of 304. Carbon content reduced to 0.03% maximum	540°C max	Reduced stress corrosion cracking and intergranular corrosion due to reduced carbon content
321	-	An 18-10 chromium/nickel austenitic stainless steel, with a titanium addition	870°C max	Subject to stress corrosion. Reduced possibilities of intergranular corrosion
347	-	An 18-10 chromium/nickel austenitic stainless steel with the addition of columbium (niobium)	870°C max	Similar properties as 321. High temperature resistance
317	-	An 18-13 chromium/nickel 3% molybdenum austenitic stainless steel	815°C max	Reduced stress corrosion cracking and intergranular corrosion due to reduced carbon content
410	-	A 13% chromium, 0.15% carbon martensitic alloy steel	850°C max	Excellent high temperature strength/corrosion properties. Excellent resistance to oxidation, nitriding and carbonisation
Titanium	Titanium	High purity titanium material	1095°C max	Excellent high temperature corrosion resistance and outstanding in oxidizing medias
Alloy 600	Inconel 600®	A 70% nickel, 15% chromium, 8% iron alloy steel	1095°C max	Excellent high temperature strength/corrosion properties. Excellent resistance to oxidation, nitriding and carbonisation
Alloy 625	Inconel 625®	A nickel/chromium alloy, with substantial additions of molybdenum and columbium (niobium)	1095°C max	Outstanding corrosion resistance in a wide range of acid, neutral and alkaline environments
Alloy 800	Incoloy 800®	A 32% nickel, 20% chromium, 46% iron alloy steel	1095°C max	Excellent high temperature resistance
Alloy 825	Incoloy 825®	A nickel, chromium, iron, molybdenum, and copper alloy steel	1095°C max	High resistance to hot acid conditions and outstanding resistance to stress corrosion cracking
Alloy 200	Nickel 200	Commercially pure (99.6%) wrought nickel	760°C max	High resistance to various reducing chemicals and caustic alkalies
Alloy 400	Monel® 400	A 67% nickel/30% copper alloy steel	820°C max	High resistance to hydrofluoric acid
Alloy B2	Hastelloy® B2	A nickel/molybdenum alloy steel	1095°C max	Excellent chemical resistance to hydrochloric acid, sulphuric, acetic and phosphoric acids
Alloy C276	Hastelloy® C276	A nickel/chromium/molybdenum alloy steel	1095°C max	Excellent corrosion resistance to both oxidizing and reducing media
Alloy 20	Carpenter 20	An iron/chromium/iron alloy steel	760°C max	Specifically developed for applications requiring resistance to sulphuric acid
Alloy X-750	Inconel® X-750	A nickel/chromium/iron alloy steel	1095°C max	Precipitation hardened, high resistance steel
Aluminium	-	Commercially pure wrought aluminium	425°C max	Excellent ductility and workability
Brass	-	Commercial copper/zinc alloy	260°C max	General corrosion resistance
Copper	-	Commercially pure copper	315°C max	General corrosion resistance

Section 8 continued

Worldwide equivalents for stainless steel materials:

UK	USA	DIN	FRANCE	ITALY	SPAIN	SWEDEN	JAPAN
BS	AISI/SAE	DIN/W.Nr	AFNOR	UNI	UNE	SS	JIS
304S15	304	X5CrNi 18 9/1.4301	Z6CN18.09	X5cRnI18 10	XX5CrNi18 10	2332	SUS 304
304S12	304L	X2CrNi 18 9/1.4306	Z2CN18.10	X2cRnI18 11	X2CrNi19 10	2352	SUS 304L
309S24	309	X15CrNiSi2012/1.4828	Z15CNS20.12	X15CrNiSi2012	2333	SUH 309	
-	310	XX15CrNiSi25 20/1.4841	Z12CNS25.20	X16CrNiSi25 20	X15CrNiSi25 20	-	SUH 310
316S16	316	X5CrNiMo18 10/1.4401	Z6CND17.11	X5CrNiMo17 12	X5CrNiM17 12	-	SUS 316
316S11 316S12	316L	X2CrNiMo18 10/1.4404	Z2CND18.13	X2CrMo17 12	X2CrNiMo17 12	2347	SUS 316L
320S31 320S17	316Ti	X10CrNiMoTi18 10/1.4571	Z6CNDT17.12	X6CrNiMoTi17 12	X6CrNiMoTi17 12	2350	-
321S12	321	X10CrNiTi18 9/1.4541	Z6CNT18.10	X6CrTi18 11	X7CrNiTi18 11	2337	SUS 321
347S51	347	X10CrNiNb18 9/1.4550	Z6CNNb18.10	X6CrNiNb18 11	X7CrNiNb18 11	2338	SUS 347
410S21	410	X10Cr13/1.4006	Z12C13	Xx12Cr13	X12Cr13	2302	SUS 410

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James Walker Moorflex

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