

## Technical Note PP 811-TN PE Flange Connections

### Flange Connection

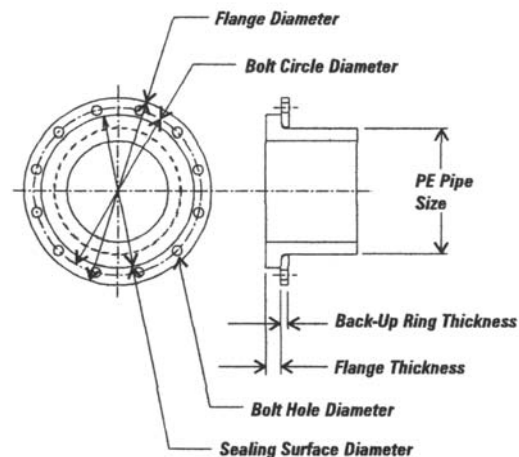
Flanged joints are made using a DriscoPlex® Flange Adapter that is fused to the pipe then joined to a mating flange adapter or a mating appurtenance flange. A back-up ring is fitted behind the flange adapter's sealing surface flange as shown in Figure 2-1 and bolted to the mating flange. DriscoPlex® Flange Adapters have a serrated sealing surface. At lower pressure, typically 100 psi or less, a gasket is usually not required. At greater pressure, the serrations help hold the gasket in place.

The back-up ring is required for polyethylene flange joints in order to develop uniform pressure around the entire sealing surface. Without a back-up ring, a polyethylene flange will leak between the bolts. Standard back-up rings are convoluted ductile iron with AWWA C207 150 lb drilling. Other available back-up ring materials are steel, primer-coated steel; epoxy coated steel, stainless steel or fiberglass. In below ground service, coatings and cathodic protection may be needed to protect metal back-up rings from corrosion. One edge of the back-up ring bore must be radiused or chamfered. This edge fits against the back of the sealing surface flange.

**Service pressure ratings for back-up ring designs and materials will vary. Consult the back-up ring supplier for the maximum recommended rating. The service pressure rating for the back-up ring should meet or exceed the service pressure of the pipe.** Typically, back-up rings are ANSI Class 125 for gravity applications, ANSI Class 150 or AWWA C207 for pressures up to 267 psi (200 psi for 20" to 24" sizes), and ANSI Class 300 for higher pressure.

Flange adapters are long enough so that they can be clamped in a fusion machine like a pipe end. The back-up ring is fitted to the flange adapter before fusion, so external fusion bead removal is not required.

Figure 2-1 Flange Adapter and Back-Up Ring

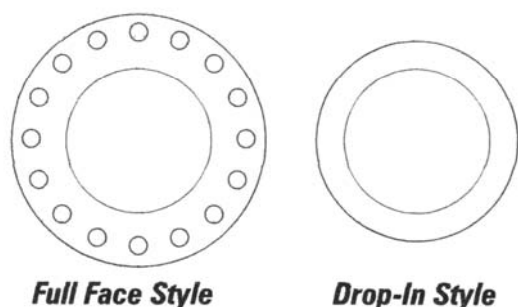


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## Flange Gasketing

Typically, a flange gasket is not necessary between polyethylene flanges at 100 psi or less. Gaskets may be needed for higher pressures or for connections between polyethylene and non-polyethylene flanges. **Gasket materials should be chemically and thermally compatible with the internal fluid and the external environment, should be of appropriate hardness, thickness, and style, and should be recommended by the gasket manufacturer for use with polyethylene pipe flanges.** Elevated temperature applications may require higher temperature capability. Gasket materials are not limited to those shown in Table 2-1. Other materials may also be suitable. Gasket thickness and durometer are typically 1/8"-3/16" (3-5 mm) and 55-75 Type A hardness per ASTM D2240, respectively. Too soft or too thick gaskets may blow out under pressure. Overly hard gaskets may not seal. When joining mating polyethylene flange adapters, cut gaskets to an ID equal to the polyethylene pipe ID. When joining polyethylene to other materials cut gaskets to the larger of the two ID's, which will generally be the ID of the non-polyethylene pipe material. (Using standard, "off the shelf" cut gaskets may reduce the gasket sealing area and the effectiveness of the seal.)

**Figure 2-2 Flange Gasket Styles**



**Table 2-1 Typical Gasket Materials**

<i>Gasket Material</i>	<i>Generally Suitable Chemicals*</i>
Brown Rubber (cloth reinforced)	Water (hot or cold)
Neoprene	Water, weak acids
Nitrile	Water, oils
SBR (Red Rubber) (cloth or wire reinforced)	Air, water
PTFE gasket with micro-cellular layers outside & hard center	Strong caustics, strong acids, and hydrocarbons
Hard, compressed Nitrile bound Aramid fiber	Water, oils, aliphatic hydrocarbons

\*Consult Gasket Supplier for specific recommendation.

Common gasket styles are full-face or drop-in. Full-face style gaskets are usually applied to larger sizes, because flange bolts will hold a flexible gasket in place while fitting the components together. Drop-in style gaskets are usually applied to smaller pipe sizes. See Figure 2-2.

## Flange Bolting

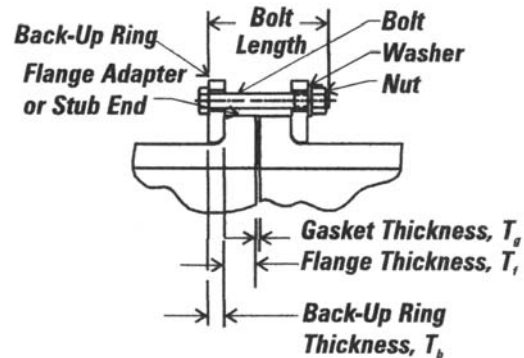
Mating flanges are usually joined together with hex head bolts and hex nuts, or threaded studs and hex nuts. Generally, hex head and stud bolts are SAE Grade 2 or ASTM A307 Grade B when used to joining flanges with rubber gaskets. When using non-rubber gaskets or when using Class 300 back-up rings, higher strength bolts may be required to provide sufficient clamping force to seal the gaskets. Check with the gasket supplier. Corrosion resistant materials should be considered for underground, underwater or other corrosive environments. Flange bolts are typically sized 1/8" smaller than the bolthole diameter. Flat washers should be used between the nut and the back-up ring.

**Table 2-2 Flange Dimensions (Inch Sized) ANSI B16.5 Class 150<sup>1</sup>**

IPS Pipe Size	Flange OD	Bolt Circle Diameter	Bolt Hole Diameter	No. of Bolts
1-1/2	5.00	3.88	0.63	4
2	6.00	4.75	0.75	4
3	7.50	6.00	0.75	4
4	9.00	7.50	0.75	8
6	11.00	9.50	0.88	8
8	13.50	11.75	0.88	8
10	16.00	14.25	1.00	12
12	19.00	17.00	1.00	12
14	21.00	18.75	1.12	12
16	23.50	21.25	1.12	16
18	25.00	22.75	1.25	16
20	27.50	25.00	1.25	20
22	29.50	27.25	1.38	20
24	32.00	29.50	1.38	20

<sup>1</sup>ASME/ANSI B16.5 - 1996 Pipe Flanges And Flanged Fittings

**Figure 2-3 Bolt Length parameters** [www.performancepipe.com](http://www.performancepipe.com)



Flange bolts must span the entire width of the flange joint, and provide sufficient thread length to fully engage the nut. (See Figure 2-3.) Dimensions for DriscoPlex<sup>®</sup> Flange Adapters, and Back-Up Rings are found in Performance Pipe product literature and are located on Performance Pipe's web site ([www.performancepipe.com](http://www.performancepipe.com)) on the "Technical Library" page at the link "Fittings". The minimum bolt length required for joining two DriscoPlex<sup>®</sup> Flange Adapters may be determined using the following:

$$L_B = 2(T_b + T_f) + T_g + d_B \quad (2-1)$$

Where

- $L_B$  = minimum bolt length, in
- $T_b$  = back-up ring thickness, in
- $T_f$  = flange adapter flange thickness, in
- $T_g$  = gasket thickness, in
- $d_b$  = bolt diameter, in

The  $L_B$  term provides for a standard flat washer under the nut and full thread engagement into a standard nut. Bolt length should be rounded up to the nearest standard bolt length. Rounding down may result in bolts shorter than the required minimum length. A gasket may or may not be present so gasket thickness should be included only when a gasket is used.

If threaded studs are used, then nuts and washers are installed on both sides. For two DriscoPlex<sup>®</sup> Flange Adapters, stud length is determined by:

$$L_S = 2(T_b + T_f + d_B) + T_g \quad (2-2)$$

Where terms are as above and

- $L_S$  = minimum stud length, in

As with bolts, stud length should be rounded up to the nearest standard length.

## Bolt Tightening

Bolt tightening torque values are given in Table 2-3 and are typically sufficient for obtaining a seal. However, bolts should be tightened to the gasket manufacturer's recommended torque for the selected gasket and the particular application conditions. Generally, rubber gaskets require less assembly stress (contact stress) than gaskets made from other materials such as hard compressed non-asbestos materials. The effectiveness of the seal is strongly dependent on field assembly technique. Over tightening rubber gaskets may damage or extrude the gasket. Under tightening could result in blow outs or leakage. Flange connections should be left exposed until leak testing is complete. When using non-rubber gaskets with Performance Pipe supplied Convuluted Ductile Iron Back-up rings, the maximum torque value should be limited to that shown in Table 2-3. Other back-up rings may be suitable for higher torque. Check with the back-up ring supplier. Verify bolt capacity for higher torque. There are numerous conditions that can affect proper bolt tightening. They include bolt thread condition, thread cleanliness, previous usage of bolts, lubricants, and weather.

***Bolts should be lubricated.*** Dry bolts require higher torque to provide the same gasket clamping force as lubricated bolts. Lubricate with a non-fluid lubricant grease.

**Table 2-3. Bolt Torque Values (ft-lbs) for Lubricated Bolts using Performance Pipe supplied Convuluted Back-up Rings**

<i>Dia – tpi</i>	<i>Typical Torque*</i> <i>Homogeneous Rubber</i> <i>Gasket</i> <i>Lubricated Bolts</i> <i>Ft-lbs</i>	<i>Typical Torque</i> <i>No Gasket (PE to PE only)</i> <i>Maximum Pressure 100 psi</i> <i>Lubricated Bolts</i> <i>Ft-lbs</i>	<i>Maximum Torque**</i> <i>Non-rubber Gaskets*</i> <i>Lubricated Bolts</i> <i>Ft-lbs</i>
½-13	20	30	60
5/8 – 11	40	60	100
¾ – 10	65	100	125
7/8 – 9	120	150	150
1 – 8	150	150	200
1-1/8 – 8	160	160	250
1-1/4 – 8	220	220	300

Notes: \*Verify with the gasket supplier that the torque meets the minimum clamping force for the gasket.

\*\*Maximum torque based on Convuluted Ductile Iron Back-up Rings supplied by Performance Pipe. Other style back-up rings may have different torque limits.

## Flange Assembly

**Caution – Mating flanges must be aligned to each other *before* tightening. Tightening misaligned flanges can cause leakage or flange failure. Do not try to align flange faces by tightening bolts.**

**Caution – Improperly assembled flange connections may leak. The assembly for polyethylene flange connections is different from the assembly of metallic flange connections. It is important that the installer be aware of the differences. Retightening is essential in achieving a seal.**

Before fit-up, lubricate flange bolt threads, washers, and nuts with a non-fluid lubricant grease. Gasket and flange sealing surfaces must be clean and free of cuts or gouges. Fit the flange components together loosely. Tighten bolts by hand and recheck alignment. Adjust alignment if necessary. Flange bolts should be tightened to the appropriate torque value by turning the nut.

Tighten each flange nut according to the sequential number patterns in Figure 2-4. Tighten completely through the pattern before changing to a higher torque. Establish an initial sealing surface pressure by tightening to an initial torque value of 5 ft-lbs; then increase tightening torque in increments of about 15 ft-lbs or less. Tighten bolts to the torque value recommended by the gasket manufacturer. The final tightening torque value can be less than the suggested values in Table 2-3, especially with large diameter piping systems, with systems operating at low pressures and where experience shows that a sufficiently tight joint can be obtained with a lower torque value.

**Caution – Retightening. Polyethylene and the gasket (if used) will undergo some compression set that may loosen the bolts. About an hour or so after the first tightening to the final torque value, retighten each flange bolt nut to the final torque value. As before, retighten in pattern sequence and in increments of 15 ft-lbs or less. For 12” and smaller flange adapters a second retightening after 4 hours is recommended. For flange adapters greater than 12”, environmentally sensitive, or critical pipelines, the second retightening is recommended after an additional 12 to 24 hours.**

### Flange Installation

Surface and above grade flanges must be properly supported to avoid bending stresses. See Chapters 5 and 6 in the *Performance Pipe Engineering Manual, Book 2 System Design* for support design recommendations.

Below grade flange connections to heavy appurtenances such as valves or hydrants or to metal pipes require a support foundation of compacted, stable granular soil (crushed stone), compacted cement stabilized granular backfill, or reinforced concrete as illustrated in Figure 2-5.

Flange connections adjacent to pipes passing through structural walls must be structurally supported to avoid shear and bending loads as illustrated in Figure 2-6.

### Special Cases

When flanging to brittle materials such as cast iron, accurate alignment and careful tightening are necessary. Polyethylene flange adapters and stub ends are not full-face, so tightening places a bending stress across the flange face. Over-tightening, misalignment, or uneven tightening can break brittle material flanges.

### Butterfly Valves

When joining a polyethylene flange adapter to a flanged butterfly valve, the inside diameter of the pipe flange should be checked for valve disk rotation clearance. The open valve disk may extend into the pipe flange. Valve operation may be restricted if the pipe flange interferes with the disk. If disk rotation clearance is a problem, a Beveled Flange Adapter having sufficient clearance to allow the complete opening of some standard valves may be obtained from Performance Pipe. Alternately, a tubular spacer may be installed between the mating flanges. Increase the length of the flange bolt or stud,  $L_B$  or  $L_S$  (Formulas 2-1 and 2-2), by the length of the spacer.

Butterfly valves must be centered in the flange for proper operation. Installing a butterfly valve with the disk rotated open may assist with alignment. After fitting up and tightening flange bolts to the 5 ft-lbs initial torque value, operate the valve to insure that the valve disk can rotate without interference. Realign if necessary, then tightened up.

Figure 2-4 Flange Bolt Tightening Patterns

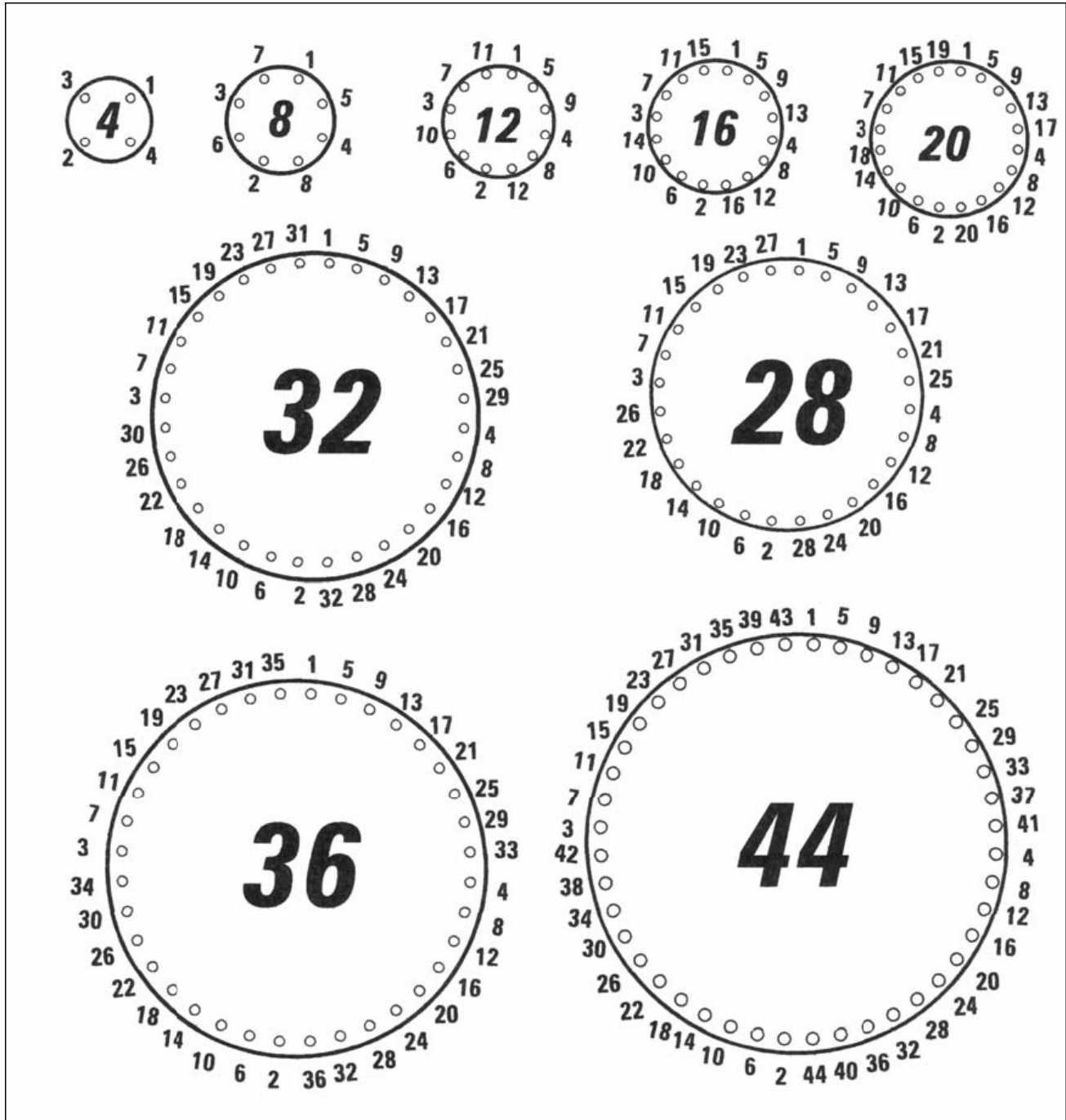


Figure 2-5 Buried Appurtenance Flange Foundation

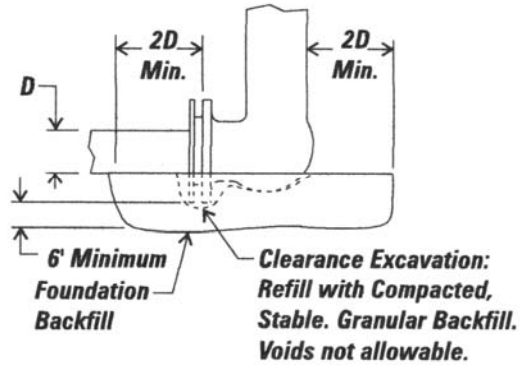


Figure 2-6 Flange Support at Wall

