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PLASTICS INDUSTRY
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INDUSTRY GUIDELINES
POP007

Metal Backing Flanges for Use with Polyethylene (PE) Pipe Flange Adaptors

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Metal Backing Flanges for use with Polyethylene (PE) Pipe Flange Adaptors

The primary aim of this document is to provide guidance relating to the geometric specification of metal backing flanges suitable for the use with PE flange adaptors in the sizes DN20 through to DN1000 and flanges in accordance with AS 2129, ANSI/ASTM B16.5, AS/NZS 4331.1 (ISO 7005-1) and AS/NZS 4087.

Also included are references to corrosion protection, marking, temperature rerating, gasket selection and installation – including bolt tensioning. This guidance is not a selection guide for these aspects but rather highlights areas that a specifier of a PE flange joint should consider when making an informed choice about flange joint assemblies.

NOTE: The thicknesses for backing flanges noted in the tables are applicable to steel. Different metals demand different thicknesses for the same performance, so for metals other than steel, consideration should be given to thickness.

Although Tables 4, 5, 6 and 7 in these guidelines make reference to pressure ratings (PN/Class), these pressure ratings are nominal only, and advice from the flange manufacturer should be sought to clarify the actual pressure rating of the assembly.

BACKGROUND

Where there is a need to join polyethylene pipe to pipe of another material or ancillary equipment such as valves and pumps then mechanical flanges may be used. They provide not only a means of transition but a fully end load resistant joint that can also be disassembled for maintenance purposes.

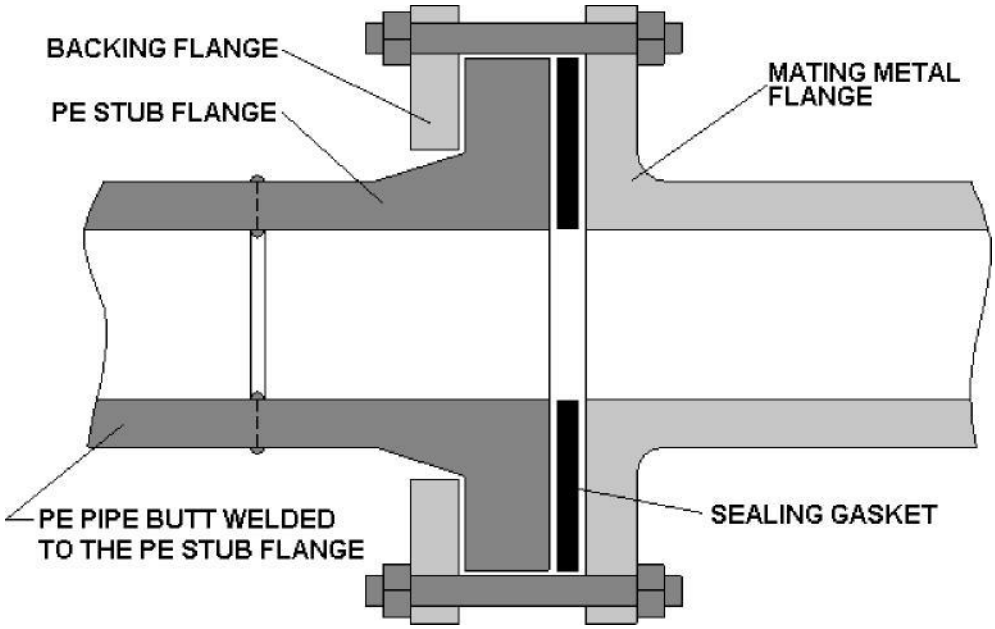

FIGURE 1

NON-CONFORMING FLANGES

The flange dimensions listed in this guideline conform to the Standards nominated.

Metal backing flanges with reduced thickness are used by industry for non-critical, low performance applications and are not recommended by PIPA.

The following information applies to the ensuing tables in the document:

As per ISO 9624: "The inside diameter of the loose backing flange shall conform to the design of the flange adaptor. In some applications, values of the inside diameter of the loose backing flange differing from those given in the tables may be used."

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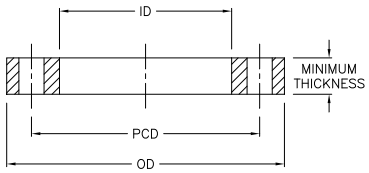
Table 1
Steel Backing Flanges AS2129: Table D (Max. 700kPa and 50°C, ≤DN900)



As the mating dimensions for Table D flanges are smaller than or equal to DN80 (3") are identical to those of Table E flanges, it is common to substitute a Table E flange for a Table D flange.

As the thicknesses of these flanges differ, and therefore the pressure rating of the flange, care should be taken to ensure the pressure rating of the flange used is suitable for the system which it is being used on

NOMINAL PIPE OD	FLANGE SIZE	OD	ID	MINIMUM THICKNESS	PCD	BOLD HOLE NO. X DIA.	BOLT SIZE
20	**15**	95	28	5	67	4X14	M12
25	**20**	100	34	5	73	4X14	M12
32	**25**	115	42	5	83	4X14	M12
40	**32**	120	51	6	87	4X14	M12
50	**40**	135	62	6	98	4X14	M12
63	**50**	150	78	8	114	4X18	M16
75	**65**	165	92	8	127	4X18	M16
90	**80**	185	108	10	146	4X18	M16
110	**100**	215	128	10	178	4X18	M16
125	**100**	215	135	10	178	4X18	M16
125	**125**	255	140	13	210	8X18	M16
140	**125**	255	158	13	210	8X18	M16
160	**150**	280	178	13	235	8X18	M16
180	**150**	280	188	13	235	8X18	M16
200	**200**	335	235	13	292	8X18	M16
225	**200**	335	238	13	292	8X18	M16
250	**250**	405	288	16	356	8X22	M20
280	**250**	405	294	16	356	8X22	M20
315	**300**	525	376	22	470	12X26	M20
400	**400**	580	430	22	521	12X26	M24
450	**450**	640	470	25	584	12X26	M24
500	**500**	705	533	29	641	16X26	M24
560	**550**	760	618	29	699	16X30	M27
630	**600**	825	645	32	756	16X30	M27
710	**700**	910	740	35	845	20X30	M27
800	**800**	1060	843	41	984	20X36	M33
900	**900**	1175	947	64	1092	24X36	M33
1000	**1000**	1255	1050	67	1175	24X39	M36

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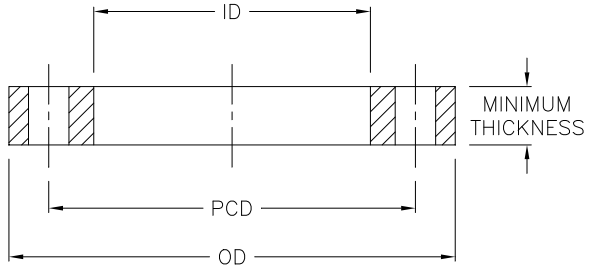
Table 2
Steel Backing Flanges AS 2129: Table E (Max. 1400kPa and 50°C)



NOMINAL PIPE OD	FLANGE SIZE	OD	ID	MINIMUM THICKNESS	PCD	BOLD HOLE NO. X DIA.	BOLT SIZE
20	**15**	95	28	6	67	4X14	M12
25	**20**	100	34	6	73	4X14	M12
32	**25**	115	42	7	83	4X14	M12
40	**32**	120	51	8	87	4X14	M12
50	**40**	135	62	9	98	4X14	M12
63	**50**	150	78	10	114	4X18	M16
75	**65**	165	92	11	127	4X18	M16
90	**80**	185	108	11	146	4X18	M16
110	**100**	215	128	13	178	8x18	M16
125	**100**	215	135	13	178	8X18	M16
125	**125**	255	140	14	210	8X18	M16
140	**125**	255	158	14	210	8X18	M16
160	**150**	280	178	17	235	8x22	M20
180	**150**	280	188	17	235	8x22	M20
200	**200**	335	235	19	292	8x22	M20
225	**200**	335	238	19	292	8x22	M20
250	**250**	405	288	22	356	12x22	M20
280	**250**	405	294	22	356	12x22	M20
315	**300**	455	338	25	406	12x26	M24
400	**400**	580	430	32	521	12X26	M24
450	**450**	640	470	35	584	16x26	M24
500	**500**	705	533	38	641	16x26	M24
560	**550**	760	618	44	699	16X30	M27
630	**600**	825	645	48	756	16x33	M30
710	**700**	910	740	51	845	20x33	M30
800	**800**	1060	843	54	984	20X36	M33
900	**900**	1175	947	64	1092	24X36	M33
1000	**1000**	1255	1050	67	1175	24X39	M36

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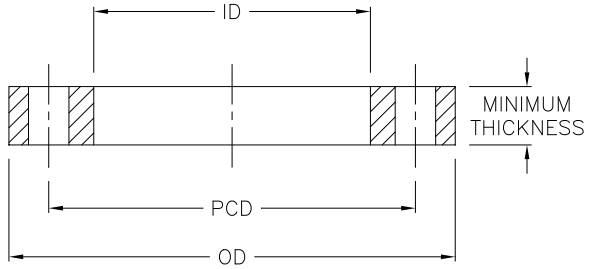
Table 3
Steel Backing Flanges A.N.S.I. 150



NOMINAL PIPE OD	FLANGE SIZE	OD	ID	MINIMUM THICKNESS	PCD	BOLD HOLE NO. X DIA.	BOLT SIZE
20	½"	90	28	11.2	60.5	4x16	M14
25	¾'	98	34	12.8	70	4X16	M14
32	1"	108	42	14.2	79.5	4X16	M14
40	1 ¼"	117	51	15.7	89	4X16	M14
50	1 ½"	127	62	17.5	98.5	4X16	M14
63	2"	152	78	19.0	120.5	4X20	M18
75	2 ½"	178	92	22.3	139.5	4X20	M18
90	3"	191	108	23.9	152	4X20	M18
110	4"	229	128	23.9	190.5	8X20	M18
125	5"	254	135	23.9	216	8X22	M20
140	5"	254	158	23.9	216	8X22	M20
160	6"	279	178	25.4	241	8X22	M20
180	6"	279	188	25.4	241	8X22	M20
200	8"	343	235	28.4	298.5	8X22	M20
225	8"	343	238	28.4	298.5	8X22	M20
250	10"	406	288	30.2	362	12X26	M24
280	10"	406	294	30.2	362	12X26	M24
315	12"	482	338	31.8	432	12X26	M24
355	14"	533	376	35.0	476	12X30	M27
400	16"	600	430	36.6	540	16X30	M27
450	18"	635	470	39.6	578	16X33	M30
500	20"	700	533	43.0	635	20X33	M30
630	24"	815	645	47.8	750	20X36	M33

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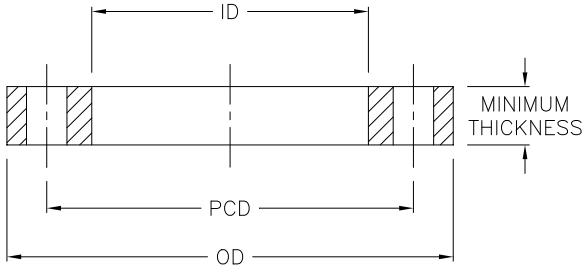
Table 4
Steel Backing Flanges AS/NZS 4331.1 (ISO 7005-1)
Table 10 PN10



NOMINAL PIPE OD	FLANGE SIZE	OD	ID	MINIMUM THICKNESS	PCD	BOLD HOLE NO. X DIA.	BOLT SIZE
20	15	Refer to Table 5					
25	20						
32	25						
40	32						
50	40						
63	50						
75	65						
90	80						
110	100						
125	100						
140	125						
160	150						
180	150						
200	200	340	235	24	295	8X22	M20
225	200	340	238	24	295	8X22	M20
250	250	395	288	26	350	12X22	M20
280	250	395	294	26	350	12X22	M20
315	300	445	338	28	400	12X22	M20
355	350	505	376	30	460	16X22	M20
400	400	565	430	32	515	16X26	M24
450	450	615	470	35	565	20X26	M24
450	500	670	517	38	620	20X26	M24
500	500	670	533	38	620	20X26	M24
560	600	780	618	42	725	20X29.5	M27
630	600	780	645	42	725	20X29.5	M27
710	700	895	740	-	840	24X29.5	M27
800	800	1015	843	-	950	24X32.5	M30
900	900	1115	947	-	1050	28X32.5	M30
1000	1000	1230	1050	-	1160	28X35.5	M33

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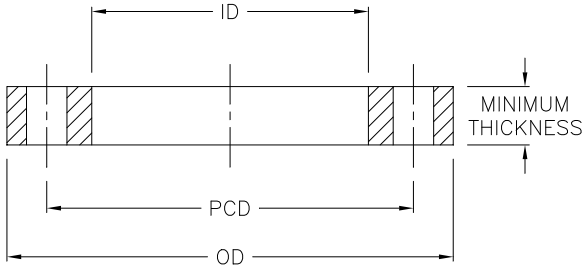
Table 5
Steel Backing Flanges AS/NZS 4331.1 (ISO 7005-1) – Table 11 PN16



NOMINAL PIPE OD	FLANGE SIZE	OD	ID	MINIMUM THICKNESS	PCD	BOLD HOLE NO. X DIA.	BOLT SIZE
20	**15**	95	28	14	65	4X14	M12
25	**20**	105	34	16	75	4X14	M12
32	**25**	115	42	16	85	4X14	M12
40	**32**	140	51	18	100	4X18	M16
50	**40**	150	62	18	110	4X18	M16
63	**50**	165	78	20	125	4X18	M16
75	**65**	185	92	20	145	8X18	M16
90	**80**	200	108	20	160	8X18	M16
110	**100**	220	128	22	180	8X18	M16
125	**100**	220	135	22	180	8X18	M16
140	**125**	250	158	22	210	8X18	M16
160	**150**	285	178	24	240	8X22	M20
180	**150**	285	188	24	240	8X22	M20
200	**200**	340	235	26	295	12X22	M20
225	**200**	340	238	26	295	12X22	M20
250	**250**	405	288	28	355	12X26	M24
280	**250**	405	294	28	355	12X26	M24
315	**300**	460	338	32	410	12X26	M24
355	**350**	520	376	35	470	16X26	M24
400	**400**	580	430	38	525	16X29.5	M27
450	**450**	640	470	42	585	20X29.5	M27
500	**500**	715	533	46	650	20X32.5	M30
560	**600**	840	618	52	770	20X35.5	M33
630	**600**	840	645	52	770	20X35.5	M33
710	**700**	910	740	-	840	24X35.5	M33
800	**800**	1025	843	-	950	24X39	M36
900	**900**	1125	947	-	1050	28X39	M36
1000	**1000**	1255	1050	-	1170	28X42	M39

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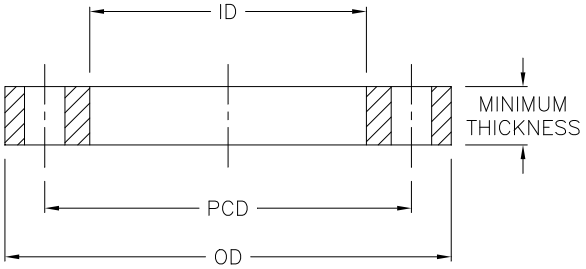
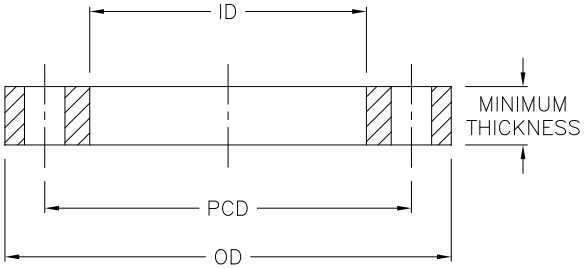
Table 6
Steel Backing Flanges AS/NZS 4087 – Figure B7 PN16 (Max. 80°C)



NOMINAL PIPE OD	FLANGE SIZE	OD	ID	MINIMUM THICKNESS	PCD	BOLD HOLE NO. X DIA.	BOLT SIZE
63	**50**	150	78	11	114	4X18	M16
75	**65**	165	92	11	127	4X18	M16
90	**80**	185	108	11	146	4X18	M16
110	**100**	215	128	13	178	4X18	M16
160	**150**	280	178	13	235	8X18	M16
200	**200**	335	235	19	292	8X18	M16
225	**225**	370	238	19	324	8X18	M16
250	**250**	405	288	19	356	8X22	M20
315	**300**	455	338	23	406	12X22	M20
355	**350**	525	376	30	470	12X26	M24
n/a	**375**	550	n/a	30	495	12X26	M24
400	**400**	580	430	30	521	12X26	M24
450	**450**	640	470	30	584	12X26	M24
500	**500**	705	533	38	641	16X26	M24
630	**600**	825	645	48	756	16X30	M27
710	**700**	910	740	56	845	20X30	M27
n/a	**750**	995	n/a	56	927	20X33	M30
800	**800**	1060	843	56	984	20X36	M33
900	**900**	1175	947	66	1092	24X36	M33
1000	**1000**	1255	1050	66	1175	24X36	M33
1200	**1200**	1490	-	76	1410	32X36	M33

Note: This table has bolting compatibility with AS 2129 Table D flanges.

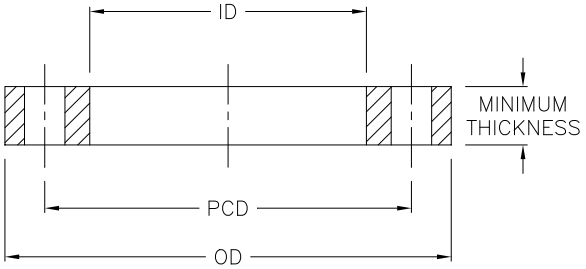
Table 7
Steel Backing Flanges AS/NZS 4087 – Figure B8 PN21 (Max. 80°C)



NOMINAL PIPE OD	FLANGE SIZE	OD	ID	MINIMUM THICKNESS	PCD	BOLD HOLE NO. X DIA.	BOLT SIZE
63	**50**	165	78	15	127	4X18	M16
75	**65**	185	92	15	146	8X18	M16
90	**80**	205	108	15	165	8X18	M16
110	**100**	230	128	19	191	8X18	M16
160	**150**	305	178	24	260	12X22	M20
200	**200**	370	235	24	324	12X22	M20
225	**225**	405	238	30	356	12X26	M24
250	**250**	430	288	30	381	12X26	M24
315	**300**	490	338	30	438	16X26	M24
355	**350**	550	376	30	495	16X30	M27
n/a	**375**	580	n/a	38	521	16X30	M27
400	**400**	610	430	38	552	20X30	M27
450	**450**	675	470	38	610	20X33	M30
500	**500**	735	533	48	673	24X33	M30
630	**600**	850	645	58	781	24X36	M33
710	**700**	935	740	58	857	24X36	M33
n/a	**750**	1015	n/a	58	940	28X36	M33
800	**800**	1060	843	68	984	28X36	M33
900	**900**	1185	947	68	1105	32X39	M36
1000	**1000**	1275	1050	78	1194	36X39	M36
1200	**1200**	1530	-	88	1441	40X42	M39

Note: This table has bolting compatibility with AS 2129 Table F & H flanges.

Table 8
Steel Backing Flanges AS/NZS 4087 – Figure B8 PN35 (Max. 80°C)



NOMINAL PIPE OD	FLANGE SIZE	OD	ID	MINIMUM THICKNESS	PCD	BOLD HOLE NO. X DIA.	BOLT SIZE
63	**50**	165	78	19	127	4X18	M16
75	**65**	185	92	19	146	8X18	M16
90	**80**	205	108	24	165	8X18	M16
110	**100**	230	128	24	191	8X18	M16
160	**150**	305	178	31	260	12X22	M20
200	**200**	370	235	31	324	12X22	M20
225	**225**	405	238	38	356	12X26	M24
250	**250**	430	288	38	381	12X26	M24
315	**300**	490	338	38	438	16X26	M24
355	**350**	550	376	48	495	16X30	M27
n/a	**375**	580	n/a	48	521	16X30	M27
400	**400**	610	430	48	552	20X30	M27
450	**450**	675	470	58	610	20X33	M30
500	**500**	735	533	58	673	24X33	M30
630	**600**	850	645	68	781	24X36	M33
710	**700**	935	740	78	857	24X36	M33
n/a	**750**	1015	n/a	78	940	28X36	M33
800	**800**	1060	843	84	984	28X36	M33
900	**900**	1185	947	94	1105	32X39	M36
1000	**1000**	1275	1050	98	1194	36X39	M36
1200	**1200**	1530	-	108	1441	40X42	M39

Note: This table has bolting compatibility with AS 2129 Table F & H flanges.

CORROSION PROTECTION

Flanges and fasteners should be coated in accordance with Australian standards or codes such as AS/NZS 4680 for galvanising. Alternatively, stainless steel flanges and fasteners may be used or flanges may be protected with polymeric coatings in accordance with AS/NZS 4158 and be used in conjunction with stainless steel fasteners.

MARKING

Flanges should be permanently and legibly marked either on the rim or on the back of the flange between the rim and the pitch circle diameter.

Marking, at a minimum, should include:

- Standard of the flange (AS 2129 / AS/NZS 4087 etc)
- Size of the flange (DN) (DN50 or 2" etc)
- Rating of the flange (Table D/PN16 etc)
- Material Grade
- Manufacturer's name or trademark
- Identification, such as the heat or batch number, correlating the material test certificate of the flange with the certificate of analysis of the material.

The height of the lettering should be not less than 3mm for flanges less than 10mm thickness, or 5mm for other flanges.

Where the marking is indented, low-stress (e.g., round nosed) stamps shall be used.

TEMPERATURE DERATING

Standards such as AS 2129, AS/NZS 4087 and ANSI B16.5 provide guidance as to the working pressure of the backing flange at various temperatures. If the temperature is outside the range listed in these standards, material pressure derating guidance can be gained from standards such as ASME B31.1 and ASME B31.3.

GASKETS

This guidance document is not a selection guide for gaskets but rather highlights areas that a specifier of a PE flange joint should consider when making an informed choice about which gasket (if any) should be used. It is recommended that specifiers consult with the gasket supplier.

The following list highlights elements of the application and joint assembly that should be considered when selecting a suitable gasket. This list does not attempt to cover all aspects and hence specifiers should not be limited to only those the aspects raised below.

Aspects to consider in gasket selection:

- Operating pressure, including surge allowance.
- The ability of the gasket to seal at the clamping pressure imposed and resist blow-out without suffering excessive stress relaxation.
- Operating temperature
- Materials of mating flanges and the potential impact of surface finish, flatness, surface roughness and coatings.
- Compatibility of the gasket materials with the medium being transported within the pipe at the operating temperatures and pressures. For flanged joints intended for use with potable water the gasket material should conform to AS/NZS 4020.

Gaskets may not be necessary when using PE flanges provided sufficient compressive load can be applied (i.e. sufficient bolt torque) and the sealing surfaces are not excessively rough or damaged.

"In theory gaskets are not necessary to provide a seal with PE flanges since the viscoelastic and creep properties of the polymer will ensure that the flange face is forced into parallelism with its opposite number even under modest long term bolting loads, and that the PE will "flow" into any surface imperfections and thus seal off potential leakage paths" (High Integrity Polyethylene Stub Flange Connections, A.L Headford, Stewarts and Lloyds Plastics).

Non-gasketed joints are commonplace in the US and to a lesser extent in the UK and Europe. Historical Australian practice has been to use gaskets.

INSTALLATION

Caution - Since polyethylene pipe systems are end load bearing, care should be taken where connection is made to pipe of another material, to prevent pull-out of any non-end-load bearing joints.

1. Ensure the backing flange is placed over the pipe before the stub flange is fused to the pipe.
2. Ensure the mating faces are clean and free for contamination and damage.
3. Pipework configuration shall be such that the mating faces are in true alignment and butted square to each other prior to bolting up.
4. The gasket should be centred properly between the two flanges before tightening commences.
5. The nuts and bolts should be progressively tightened and as uniformly possible in a diagonally opposite sequence.

BOLT TORQUE

The range of application conditions, bolt types, use or otherwise of lubricants and combination of possible gasket and non-gasketed PE flange assemblies make it impractical to nominate bolt torques that are applicable for all applications.

The bolt torque to be specified for a specific installation is an aspect that is highly dependent on the gasket type being used (or indeed no gasket if that option is appropriate) and its dimensions.

In practice bolt torque is the most commonly used method of quantifying the applied sealing force. There are however, many variables in terms of achieving the required sealing force on the joint using torque control as the indicator.

In operation, the tightening process exerts an axial pre-load tension on the bolt. This tension load is equal and opposite to the compression force applied on the assembled components. Over tightening bolts to the point where the compressive stress on the flange causes yield is a common cause of flange joint leakage, especially where PE stub adaptor flanges are used in conjunction with compressed fibre gaskets.

"When using torque control as the method for establishing flange assembly pre-load, one must understand there is a measurable variance between applied torque and theoretical bolt tension. Typically, only about 10% to 20 % of the applied torque is actually transmitted into bolt elongation. From tests, it is known that about 50% of the bolt torque is consumed by friction from the bolt-head contact face or the nut-face being rotated against its mating part. About 10% is used up in reversible twist of the bolt length. About another 30% is dissipated to overcome the friction in the bolt/nut threads. When more torque is needed to overcome friction, then less remains for bolt extension pre-load. Hence, small changes to reduce friction on the bolt-threads and under the rotating nut-face, will significantly increase the torque transmitted to bolt-extension pre-load "(Bolt Torque for Polyethylene Flanged Joints TN-38 July 2011 – Plastic Pipe Institute).

For a given nominal torque value, the deviation in the final tightening load of the bolt can vary between +/-20% even when conditions are good (SKF Bolt Tightening Handbook). This wide range is due to the combination of multiple factors including accuracy of the torque wrench, the presence or otherwise of geometric defects, variations in surface roughness on the threads and the bearing surfaces of the fastener components along with the presence or otherwise of lubrication on any or all of the bearing surfaces.

BOLT TIGHTENING SEQUENCE

When tightening pipe flange bolts the aim is achieve even compression of the PE flange face. The accepted way of achieving this is by progressing through several levels to achieve the final torque value. The USA PPI TN-38 document recommends that for flanges less than 450mm diameter this progression should be in three stages with the first applying 30% of the final torque, the second stage 60% of the final torque and finishing with the final torque value. For each progression the nuts should be tightened in a diametric sequence to ensure the load is applied evenly.

For large flanges the TN-38 recommendation is for four stages beginning with 25% and increasing the torque by a further 25% at each stage. Again, the nuts should be tightened in a diametric sequence.

RE-TORQUING BOLTS

The initial bolt torque will slowly decline to a residual level of about 35% of the initial bolt torque. This long term level of engineered torque is sufficient to seal the joint assembly by providing the minimum torque necessary to seal the flange joint, with reserve included for surge pressure and other variables. The high initial torque provides seating stress with the residual torque providing the long term sealing stress.

The polyethylene flange and the gasket (if used) will undergo some stress relaxation that decreases the bolt torque. About four hours or so after the first tightening to the target torque value, retighten

each bolt to the final target torque value. As before, retighten in a diametric sequence and in small increments, followed by a final rotational round, to raise the torque back to its target value (recommendation given in PPI TN-38). Re-torquing compensates for partial seating of the plastic face and relaxation of the bolts, nut embedment, nut dilation, thread stretch, thread surface smoothing, torsional relaxation, bolt-creep, and initial gasket stress relaxation (if gaskets are used).

BOLT TORQUE GUIDANCE

Variables including flange type, face and gasket dimensions (sealing area), gasket material, operating and test pressure, number, size, grade and condition of bolts all have a significant impact on the required bolt torque.

The gasket manufacturer may be consulted to provide bolt torque guidance.

In critical infrastructure or fuel gas applications, a suitably qualified engineer should be consulted to determine bolt torque appropriate for the specific installation.

For standardised water industry applications, Appendix E of WSA109-2011 published by the Water Services Association of Australia, provides bolt torque guidance for flanges ranging in size from DN80 to DN1200.

REFERENCED DOCUMENTS

AS 2129	"Flanges for pipes, valves and fittings"
AS/NZS 4087	"Metallic flanges for waterworks purposes"
ASME B31.1	"Power Piping"
ASME B31.3	"Process Piping Design
ANSI B16.5	"Pipe Fittings and Flanged Fittings"
AS/NZS 4020	"Testing of products for use in contact with drinking water"
AS/NZS 4158	"Thermal-bonded polymeric coatings on valves and fittings for water industry purposes"
AS/NZS 4331.1	"Metallic flanges Part 1: Steel flanges" (identical to ISO 7005-1)
AS/NZS 4680	"Hot-dip galvanized (zinc) coatings on fabricated ferrous articles"
ANSI/ASTM B16.5	"Pipe Flanges and Flanged Fittings"
ISO 9624	"Thermoplastics pipes for fluids under pressure – Mating dimensions of flange adaptors and loose backing flanges"
TN-38	"Bolt Torque for Polyethylene Flanged Joints" Plastics Pipe Institute, July 2011

SKF Bolt Tightening Handbook

"High Intensity Polyethylene Stub Flange Connections", A.L. Headford, Stewarts and Lloyds Plastics

WSA 109-2011 "Flange Gaskets and O-Rings", Water Services Association of Australia, December 2011

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