Installation Handbook DeltaV-Seal™ 304L

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- EN 1092-1 ASTM A182 F304L UNS S30403 Flanges
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- DN200-DN600 PN16
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Installation Procedure

Gasket installation shall always be conducted by qualified personnel, according to EN 1591-4 or equivalent.

1. Check that the flanges are made of UNS Designation S30403; Type 304L stainless steel and marked with correct size and pressure class. Ensure that the pipe schedule matches the flange weld neck wall thickness.
2. Check the flanges for damage and ensure that no defects are outside of the tolerances as defined for 'Hard-Faced Gaskets' in ASME PCC-01–2022 Appendix D. Repair or replace if necessary.
3. Clean all contact surfaces and clear for impurities and debris. Use a wire brush and a rag with solvent.
4. Check to verify that the bolts are the correct quality made of material grade A2-70, in accordance with EN ISO 3506-1, unless otherwise specified, refer to Table 3-16.
5. Grease bolts sufficiently with Molykote® G-Rapid Plus so that all threads and contact surfaces between nuts and flanges are covered with lubricant as shown in Figure 1.

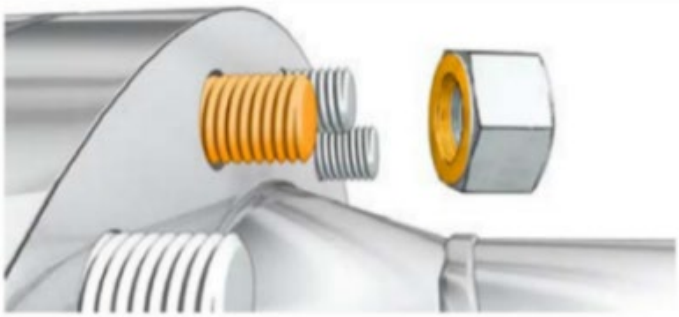

Figure 1: Lubrication (also refer to Note 3)

6. Before installation of the DeltaV-Seal, the flange joint alignment shall be verified. The following four verification methods and tolerances shall be applied:

   - Centreline (CL) tolerance shall be measured at four locations, each approximately 90° apart on the flange. Hold a straight edge parallel to the axis of one flange and flush with the outside diameter (O.D.). Extend the straight edge to the adjoining flange and measure the distance from the straight edge surface to the same surface on the adjoining flange, see Figure 2.

   - Gap (GP) tolerance is a measurement of the spacing between the seating surfaces, see Figure 3.

   - Parallelism (PRL) tolerance is a measurement defining the uniformity of distance between the sealing surfaces of two flange faces. PRL tolerance shall be calculated as the difference between the largest and smallest distance between the two sealing surfaces at the sealing surface O.D., see Figure 4.

- Rotational two-hole (RTH) ensures that the flange holes are rotationally aligned to one another such that the fasteners can be installed perpendicular to both flanges. Measure RTH by confirming that the hole centres are aligned, see Figure 5.

Figure E-2-1
Centerline High/Low

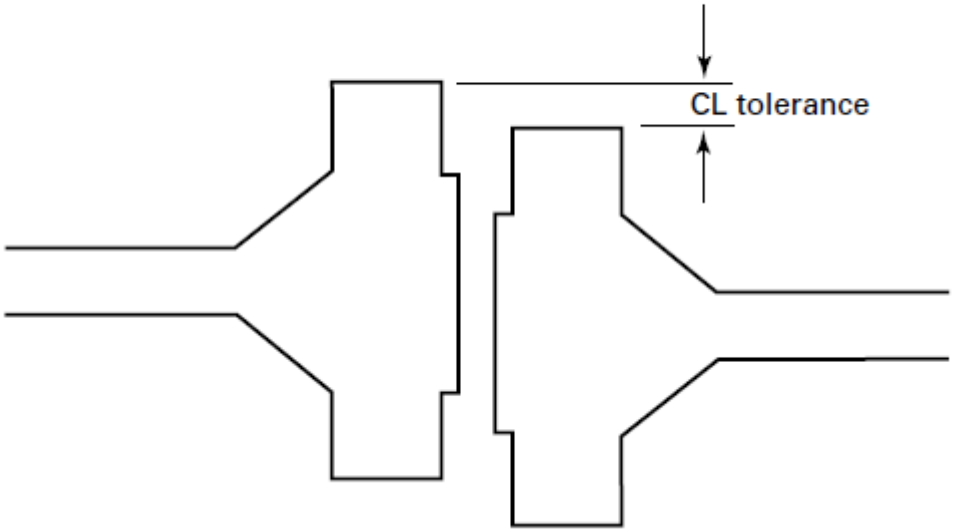

Figure 2

Figure E-2-2
Excessive Spacing Gap

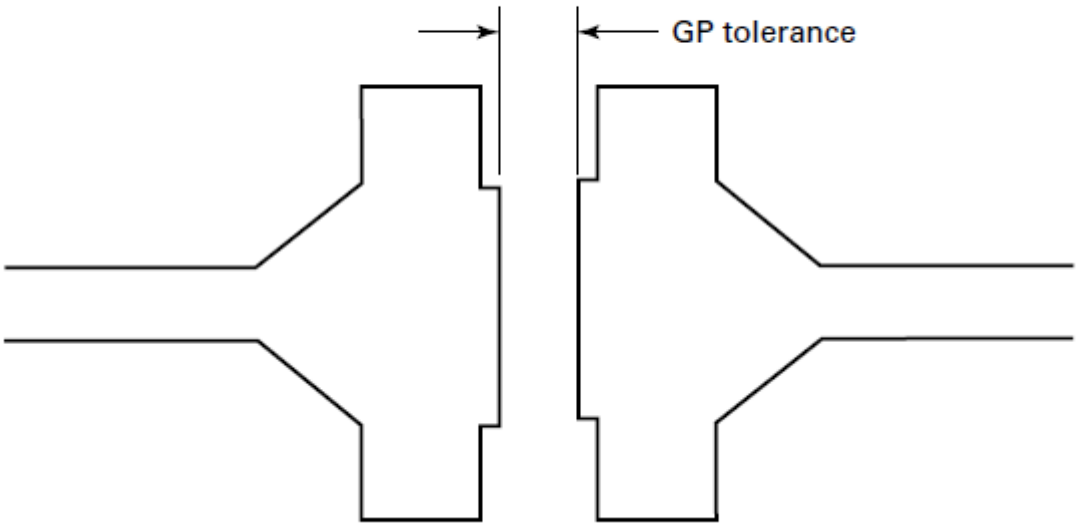

Figure 3

Figure E-2-3
Parallelism

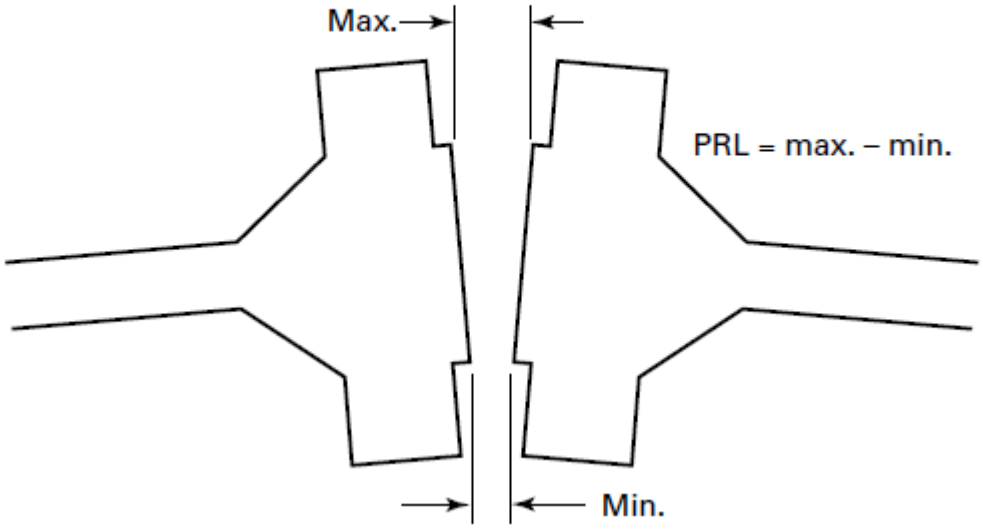

Figure 4

Figure E-2-4
Rotational Two-Hole

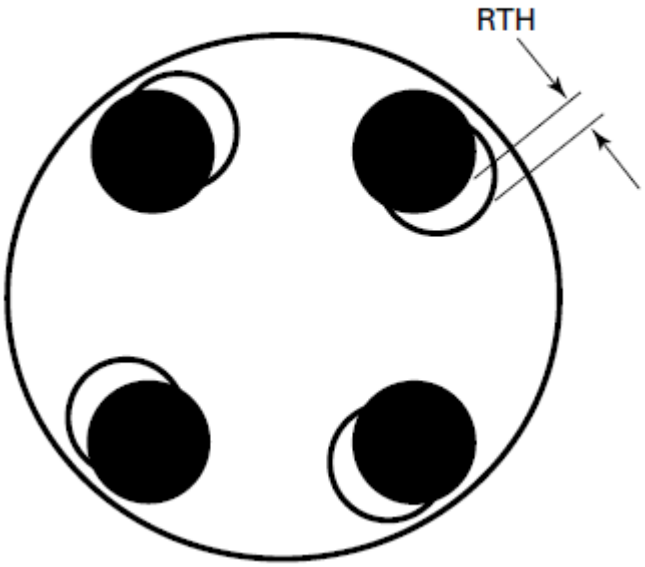

Figure 5

The alignment tolerances shall comply with Table 1.

Table E-2-1	
Flange Alignment Tolerances	
Property	Maximum Tolerance, mm (in.)
CL	1.5 ($^1/_{16}$)
GP	7.6 ($^1/_4$)
PRL	0.8 ($^1/_{32}$)
RTH	3 ($^1/_8$)

Table 1

Proper tools and methods for correcting misaligned flanges shall be applied, e.g. Equalizer™ FA4TM and FA9TE Flange Alignment Tools or similar.

When external alignment devices are used, flanges should be brought into uniform contact with the uncompressed gasket face using a maximum of 10% of the total target assembly bolt load, refer to Table 4, 6 and 8. No single bolt should be tightened above 20% of the single target bolt load.

When no external alignment devices are used, flanges should meet the alignment tolerances for PRL and GP using a maximum of 20% of the total target assembly bolt load.

7. For horizontal pipework, insert the two bottom bolts and attach nuts, so that the DeltaV-Seal™ can be centred.
8. Insert the DeltaV-Seal™ between the flanges and then insert all bolts and attach nuts.
9. Hand-tighten all bolts evenly making sure the flange faces are parallel.
10. Select a star tightening pattern in accordance with the sequence as given in Table 3 for the applicable number of bolts for any given flange. Always start the bolt-numbering on the bolt where it is widest between the flange faces (12 o'clock position). Always use a calibrated torque wrench, or another form of calibrated torque control.

ASME PCC-1 - 2022, APPENDIX 7: TABLE F-6.1.1.1-1
STAR PATTERN SEQUENCING

NO. OF BOLTS	Bolt-Numbering Sequence to Be Marked Clockwise on the Flange
4	1, 3, 2, 4
8	1, 5, 3, 7, 2, 6, 4, 8
12	1, 9, 5, 3, 11, 7, 2, 10, 6, 4, 12, 8
16	1, 9, 5, 13, 3, 11, 7, 15, 2, 10, 6, 14, 4, 12, 8, 16
20	1, 17, 9, 5, 13,3, 19, 11, 7, 15, 2, 18, 10, 6, 14, 4, 20, 12, 8, 16
24	1, 17, 9, 5, 13, 21, 3, 19, 11, 7, 15, 23, 2, 18, 10, 6, 14, 22, 4, 20, 12, 8, 16, 24

Table 2

Following the sequence numbers as marked per Table 2, tighten each bolt as described in Table 3-16. These incremental loading and tightening steps lead to the assembly target bolt load and torque as stated in Table 3-16, see also Figure 6.

Star Pattern; 24-Bolt Basic Example: (Steps 1-9): (outer numbers indicate the tightening sequence)

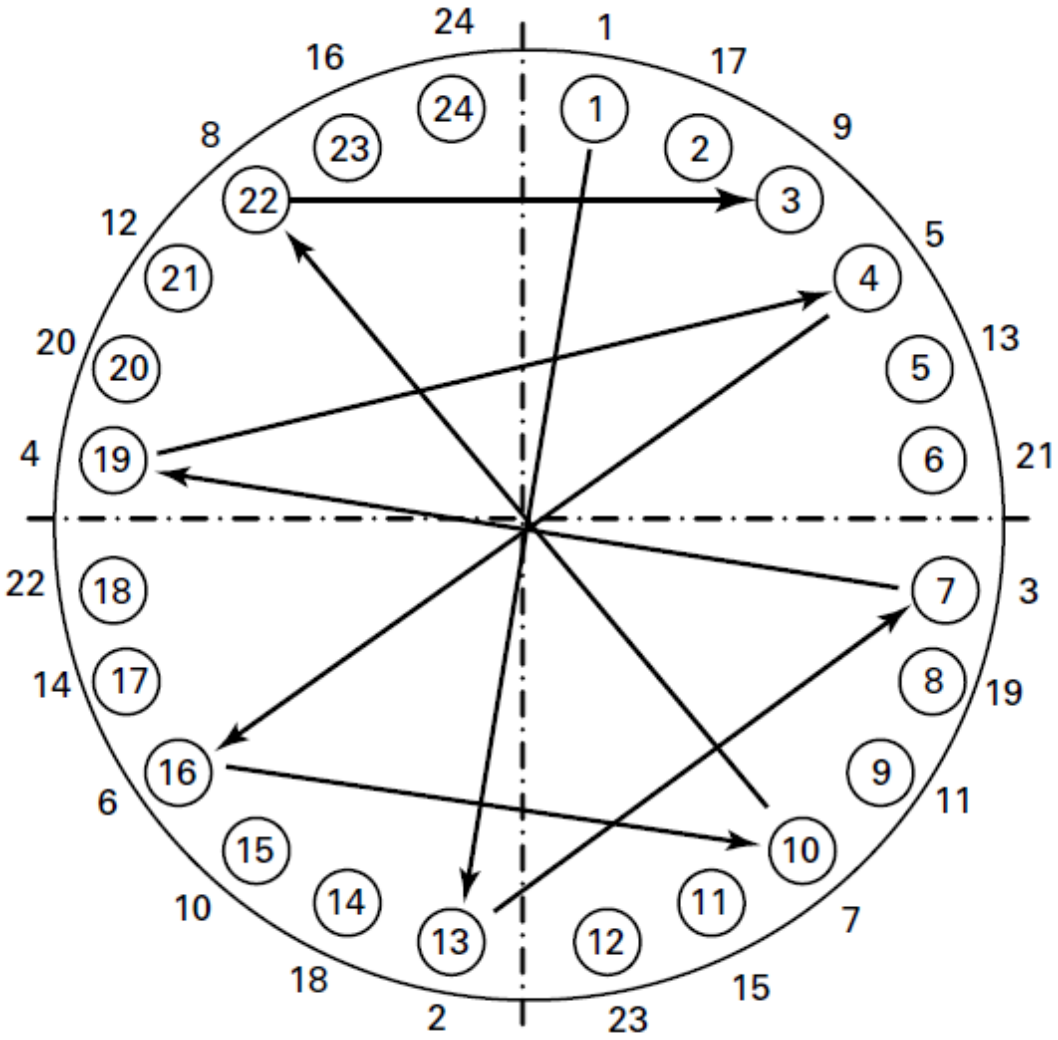

Figure 6

11. Make one last round with 100% torque going clockwise, or counter-clockwise, from bolt to bolt around the entire flange (circular tightening).

Should another form of assembly method be applied e.g., hydraulic tensioner, ensure that the listed values for total installation force ($F_{B0,Nom}$) are reached, as shown in Table 4, 6, 8, 10, 12, 14 and 16.

Table 3 – EN PN10 Torque Table

EN PN10 – Maximum operating temperature 200°C									
Nominal Diameter (mm)	**No. of Bolts**	**Type of Bolt**	**Torque [Nm]**						**Notes**
			Initial Step	**10%**	**20%**	**40%**	**80%**	**100%**	
200	8	M20 x 2.5	Hand Tighten	15	31	62	123	154	
250	12	M20 x 2.5		11	22	44	89	111	
300	12	M20 x 2.5		12	23	47	94	117	
350	16	M20 x 2.5		11	22	43	86	108	
400	16	M24 x 3		18	36	72	145	181	
450	20	M24 x 3		15	30	60	119	149	
500	20	M24 x 3		11	23	45	90	113	
600	20	M27 x 3		15	30	60	120	150	

Table 4 – EN PN10 Installation Forces (corresponding to Table 3)

EN PN10 – Maximum operating temperature 200°C									
Nominal Diameter (mm)	**No. of Bolts**	**Type of Bolt**	**Force [kN]**						**Total inst. force FB0,Nom (kN) (100% x No. bolts)**
			Initial Step	**10%**	**20%**	**40%**	**80%**	**100%**	
200	8	M20 x 2.5	Hand Tighten	7	14	28	55	69	551
250	12	M20 x 2.5		5	10	20	40	50	598
300	12	M20 x 2.5		5	10	21	42	52	629
350	16	M20 x 2.5		5	10	19	39	48	772
400	16	M24 x 3		7	14	27	54	68	1084
450	20	M24 x 3		6	11	22	45	56	1114
500	20	M24 x 3		4	8	17	34	42	841
600	20	M27 x 3		5	10	20	40	50	1003

Table 5 – EN PN16 Torque Table

EN PN16 – Maximum operating temperature 200°C									
Nominal Diameter (mm)	**No. of Bolts**	**Type of Bolt**	**Torque [Nm]**						**Notes**
			Initial Step	**10%**	**20%**	**40%**	**80%**	**100%**	
200	12	M20 x 2.5	Hand Tighten	9	18	36	73	91	
250	12	M24 x 3		13	25	51	102	127	
300	12	M24 x 3.5		18	36	73	146	182	
350	16	M24 x 3		21	41	83	166	207	
400	16	M27 x 3		19	38	76	151	189	
450	20	M27 x 3		20	41	82	163	204	
500	20	M30 x 3.5		25	50	100	201	251	
600	20	M33 x 3.5		36	71	142	284	355	

Table 6 – EN PN16 Installation Forces (corresponding to Table 5)

EN PN16 – Maximum operating temperature 200°C									
Nominal Diameter (mm)	**No. of Bolts**	**Type of Bolt**	**Force [kN]**						**Total inst. force FB0,Nom (kN) (100% x No. bolts)**
			Initial Step	**10%**	**20%**	**40%**	**80%**	**100%**	
200	12	M20 x 2.5	Hand Tighten	4	8	16	33	41	488
250	12	M24 x 3		5	9	19	38	47	569
300	12	M24 x 3.5		7	14	27	54	68	815
350	16	M24 x 3		8	15	31	62	77	1238
400	16	M27 x 3		6	13	25	51	63	1014
450	20	M27 x 3		7	14	27	54	68	1352
500	20	M30 x 3.5		8	15	30	60	75	1503
600	20	M33 x 3.5		10	20	39	78	98	1960

Table 7 – EN PN25 Torque Table

EN PN25 – Maximum operating temperature 200°C									
Nominal Diameter (mm)	**No. of Bolts**	**Type of Bolt**	**Torque [Nm]**						**Notes**
			Initial Step	**10%**	**20%**	**40%**	**80%**	**100%**	
200	12	M24 x 3	Hand Tighten	17	34	68	137	171	
250	12	M27 x 3		19	38	76	152	190	
300	16	M27 x 3		18	35	70	140	175	
350	16	M30 x 3.5		26	52	104	209	261	
400	16	M33 x 3.5		35	70	140	279	349	
450	20	M33 x 3.5		35	69	139	278	347	
500	20	M33 x 3.5		35	70	139	278	348	
600	20	M36 x 4		45	91	182	363	454	

Table 8 – EN PN25 Installation Forces (corresponding to Table 7)

EN PN25 – Maximum operating temperature 200°C									
Nominal Diameter (mm)	**No. of Bolts**	**Type of Bolt**	**Force [kN]**						**Total inst. force FB0,Nom (kN) (100% x No. bolts)**
			Initial Step	**10%**	**20%**	**40%**	**80%**	**100%**	
200	12	M24 x 3	Hand Tighten	6	13	26	51	64	767
250	12	M27 x 3		6	13	25	51	64	764
300	16	M27 x 3		6	12	23	47	59	937
350	16	M30 x 3.5		8	16	31	63	78	1250
400	16	M33 x 3.5		10	19	38	77	96	1538
450	20	M33 x 3.5		10	19	38	77	96	1917
500	20	M33 x 3.5		10	19	39	77	96	1925
600	20	M36 x 4		11	23	46	91	114	2286

Table 9 – EN PN10-40 Torque Table

EN PN10-40 – Maximum operating temperature 200°C									
Nominal Diameter (mm)	**No. of Bolts**	**Type of Bolt**	**Torque [Nm]**						**Notes**
			Initial Step	**10%**	**20%**	**40%**	**80%**	**100%**	
10	4	M12 x 1.75	Hand Tighten	4	7	14	29	36	
15	4	M12 x 1.75		4	7	14	28	35	
20	4	M12 x 1.75		4	7	14	29	36	
25	4	M12 x 1.75		4	7	14	29	36	
32	4	M16 x 2		8	16	33	66	82	
40	4	M16 x 2		8	16	32	64	80	
50	4	M16 x 2		9	18	35	70	88	
65	8	M16 x 2		7	14	27	54	68	
80	8	M16 x 2		8	17	33	66	83	

Table 10 – EN PN10-40 Installation Forces (corresponding to Table 9)

EN PN10-40 – Maximum operating temperature 200°C									
Nominal Diameter (mm)	**No. of Bolts**	**Type of Bolt**	**Force [kN]**						**Total inst. force FB0,Nom (kN) (100% x No. bolts)**
			Initial Step	**10%**	**20%**	**40%**	**80%**	**100%**	
10	4	M12 x 1.75	Hand Tighten	3	5	10	21	26	104
15	4	M12 x 1.75		3	5	10	20	26	102
20	4	M12 x 1.75		3	5	10	21	26	104
25	4	M12 x 1.75		3	5	11	21	26	105
32	4	M16 x 2		5	9	18	37	46	183
40	4	M16 x 2		4	9	18	36	45	179
50	4	M16 x 2		5	10	20	39	49	195
65	8	M16 x 2		4	8	15	30	38	304
80	8	M16 x 2		5	9	18	37	46	368

Table 11 – EN PN10-16 Torque Table

EN PN10-16 – Maximum operating temperature 200°C									
Nominal Diameter (mm)	**No. of Bolts**	**Type of Bolt**	**Torque [Nm]**						**Notes**
			Initial Step	**10%**	**20%**	**40%**	**80%**	**100%**	
100	8	M16 x 2	Hand Tighten	7	14	29	58	72	
125	8	M16 x 2		8	17	34	67	84	
150	8	M20 x 2.5		10	21	42	83	104	

Table 12 – EN PN10-16 Installation Forces (corresponding to Table 11)

EN PN10-16 – Maximum operating temperature 200°C									
Nominal Diameter (mm)	**No. of Bolts**	**Type of Bolt**	**Force [kN]**						**Total inst. force FB0,Nom (kN) (100% x No. bolts)**
			Initial Step	**10%**	**20%**	**40%**	**80%**	**100%**	
100	8	M16 x 2	Hand Tighten	4	8	16	32	40	322
125	8	M16 x 2		5	9	19	37	47	373
150	8	M20 x 2.5		5	9	19	37	47	372

Table 13 – EN PN25-40 Torque Table

EN PN25-40 – Maximum operating temperature 200°C									
Nominal Diameter (mm)	**No. of Bolts**	**Type of Bolt**	**Torque [Nm]**						**Notes**
			Initial Step	**10%**	**20%**	**40%**	**80%**	**100%**	
100	8	M20 x 2.5	Hand Tighten	12	24	49	98	122	
125	8	M24 x 3		17	33	67	134	167	
150	8	M24 x 3		20	41	81	162	203	

Table 14 – EN PN25-40 Installation Forces (corresponding to Table 13)

EN PN25-40 – Maximum operating temperature 200°C									
Nominal Diameter (mm)	**No. of Bolts**	**Type of Bolt**	**Force [kN]**						**Total inst. force FB0,Nom (kN) (100% x No. bolts)**
			Initial Step	**10%**	**20%**	**40%**	**80%**	**100%**	
100	8	M20 x 2.5	Hand Tighten	5	11	22	44	55	436
125	8	M24 x 3		6	13	25	50	63	500
150	8	M24 x 3		8	15	30	61	76	607

Table 15 – EN PN40 Torque Table

EN PN40 – Maximum operating temperature 200°C									
Nominal Diameter (mm)	**No. of Bolts**	**Type of Bolt**	**Torque [Nm]**						**Notes**
			Initial Step	**10%**	**20%**	**40%**	**80%**	**100%**	
200	12	M27 x 3	Hand Tighten	19	38	76	151	189	
250	12	M30 x 3.5		26	52	104	207	259	
300	16	M30 x 3.5		26	52	104	207	259	
350	16	M30 x 3.5		35	70	140	280	350	
400	16	M36 x 4		45	91	182	363	454	
450	20	M36 x 4		45	89	178	357	446	
500	20	M39 x 4		58	116	231	462	578	
600	20	M45 x 4.5		90	181	361	722	903	

Table 16 – EN PN40 Installation Forces (corresponding to Table 15)

EN PN40 – Maximum operating temperature 200°C									
Nominal Diameter (mm)	**No. of Bolts**	**Type of Bolt**	**Force [kN]**						**Total inst. force FB0,Nom (kN) (100% x No. bolts)**
			Initial Step	**10%**	**20%**	**40%**	**80%**	**100%**	
200	12	M27 x 3	Hand Tighten	6	13	25	51	63	760
250	12	M30 x 3.5		8	16	31	62	78	930
300	16	M30 x 3.5		8	16	31	62	78	1241
350	16	M33 x 3.5		10	19	39	77	97	1549
400	16	M36 x 4		11	23	46	91	114	1829
450	20	M36 x 4		11	22	45	90	112	2242
500	20	M36 x 4		14	27	54	108	135	2709
600	20	M45 x 4.5		18	37	74	147	184	3680

Notes to Installation Procedure

1. Stated torque values are only applicable for A2-70 bolting. For other bolting, contact Pipeotech for custom-made torque values.
2. External forces/moments must be controlled, contact Pipeotech for custom-made torque values.
3. Torque values are only applicable to Molykote® G-Rapid Plus lubricant. For other lubricants, contact Pipeotech for custom-made torque values.
4. All torque values are calculated by $M_{t,nom} = k_B \times \frac{F_{B0nom}}{n_B}$ in accordance with EN 1591-1 equation B.4. k_B is the calculated "nut factor" from the coefficients of friction in the threads and underhead from the bolts/nuts, F_{B0nom} is the total installation force whilst n_B is the number of bolts. The F_{B0nom} - value is marked on each gasket as given in Table 4, 6, 8, 10, 12, 14 and 16 (if applicable).
5. All torque and force values in Table 3-16 are rounded off to the nearest Nm/kN.