KiK|MPi
Kennis- en innovatiecentrum Maintenance Procesindustrie

BEMAS

Interreg
EUROPESE UNIE
Vlaanderen-Nederland
Europees Fonds voor Regionale Ontwikkeling

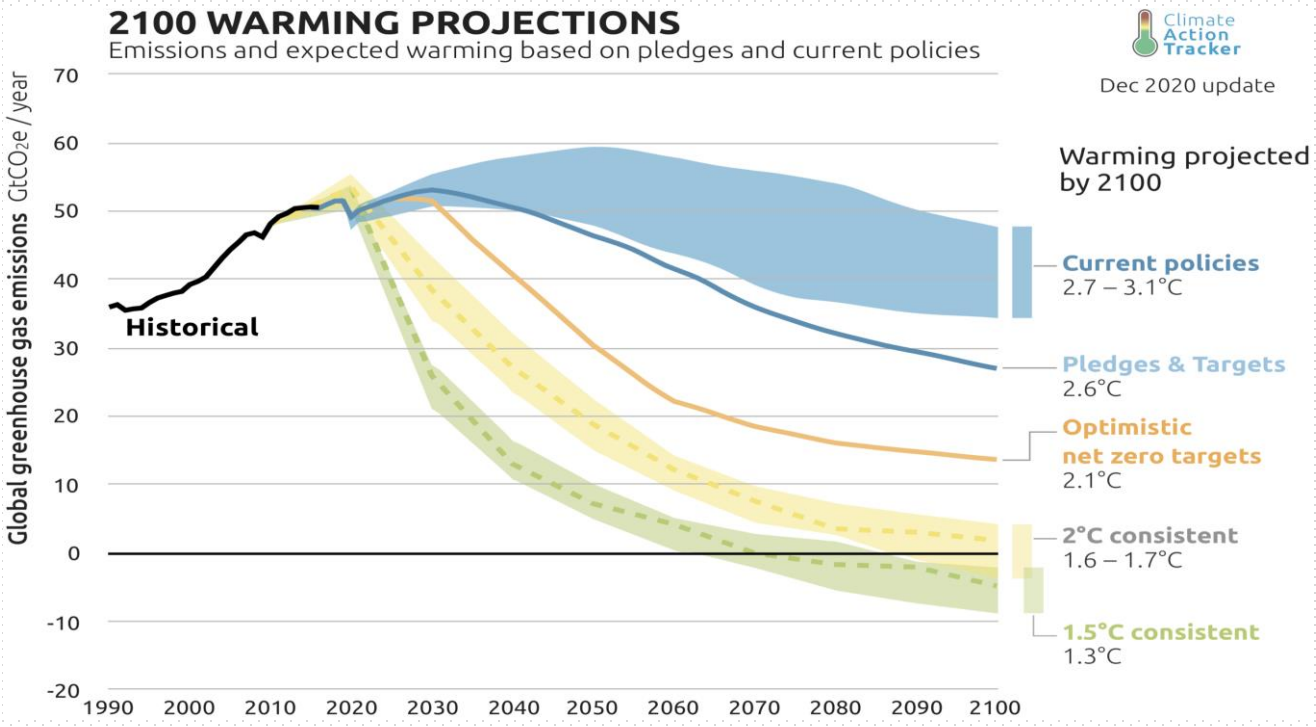
Circulair Onderhoud

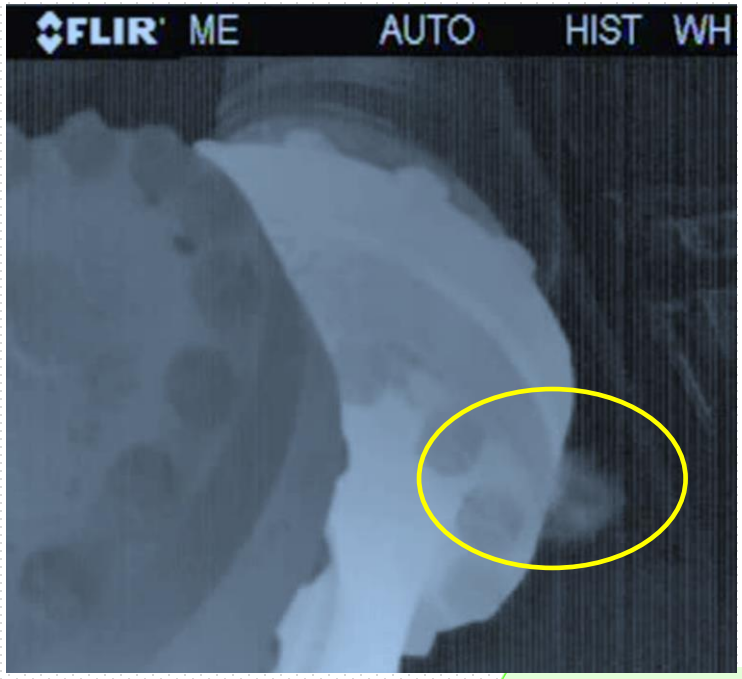
WORKSHOP 27.10.2022

De nauwkeurigheid van diverse flens aanhaalmethoden berekend op basis van de gemeten boutkrachten

Presentatie: Peter Dijkgraaf

Reductie 'green house gasses'





<u>Elke flens lekt!!</u>

- Een flens is technisch dicht als de diffusie voldoet aan de vereiste lekkage klasse.

<u>Diffuse emissie te meten met bijv. gas detectie camera</u>

- Via 'witte rookpluimen' wordt de diffuse emissie zichtbaar gemaakt.

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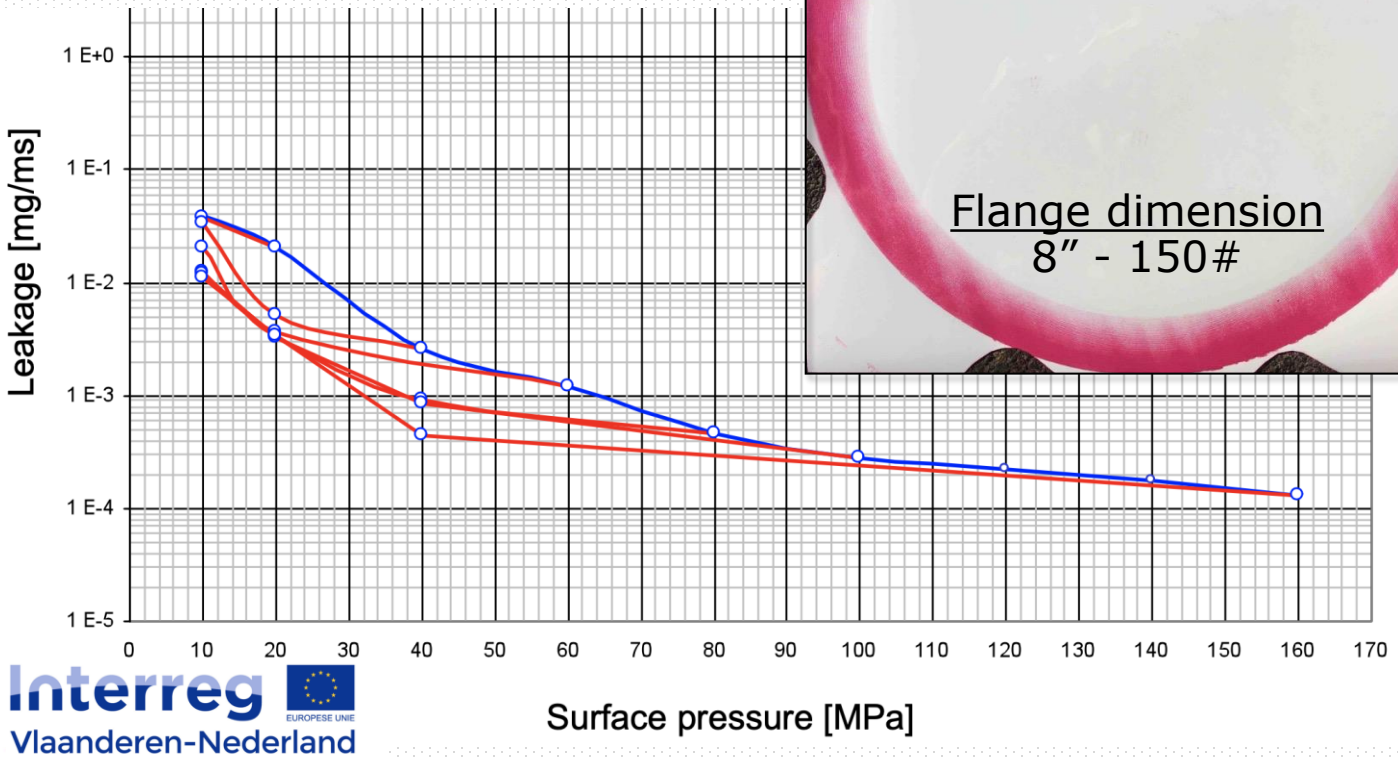
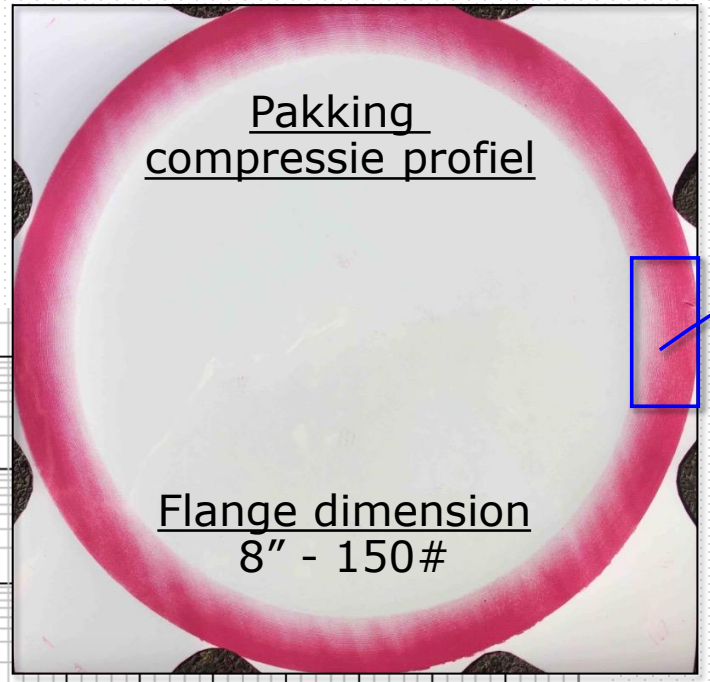
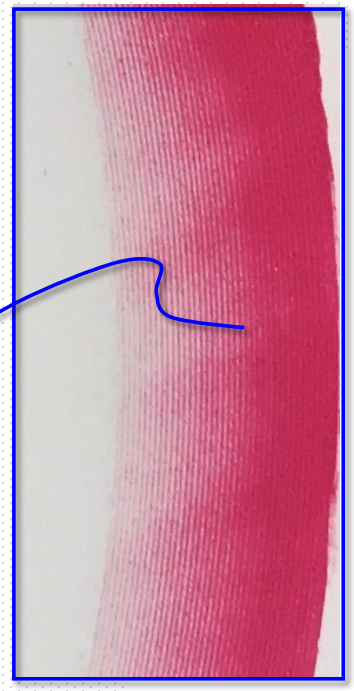
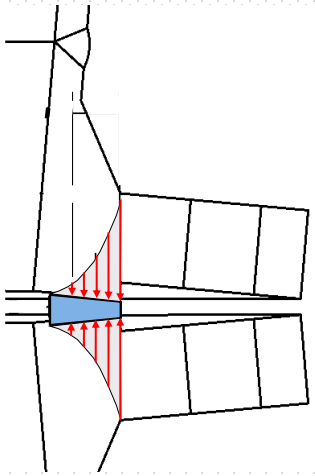
Vereiste voor 'low emission' flensverbinding

Lekkage curve SWG (graphite filler)









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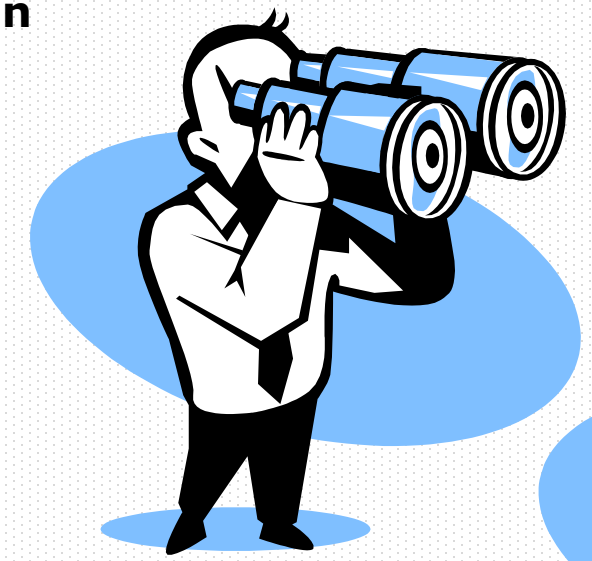
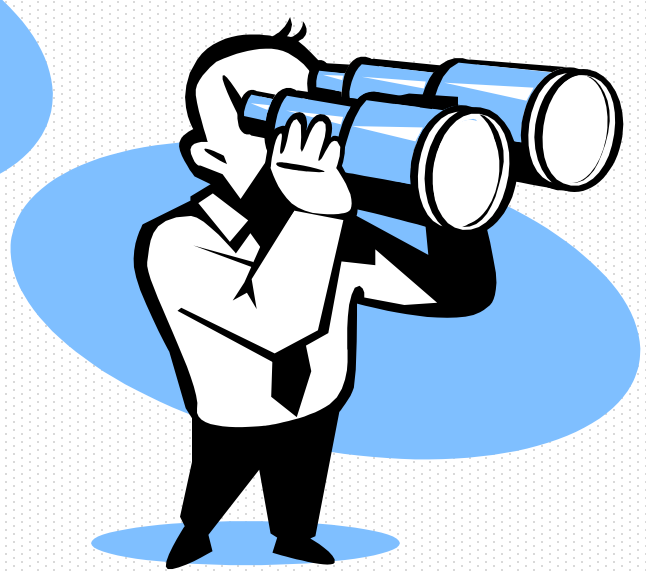
Bewustzijn





Kijken met 'andere ogen'

Een flens is een complexe 'high technology' verbinding!

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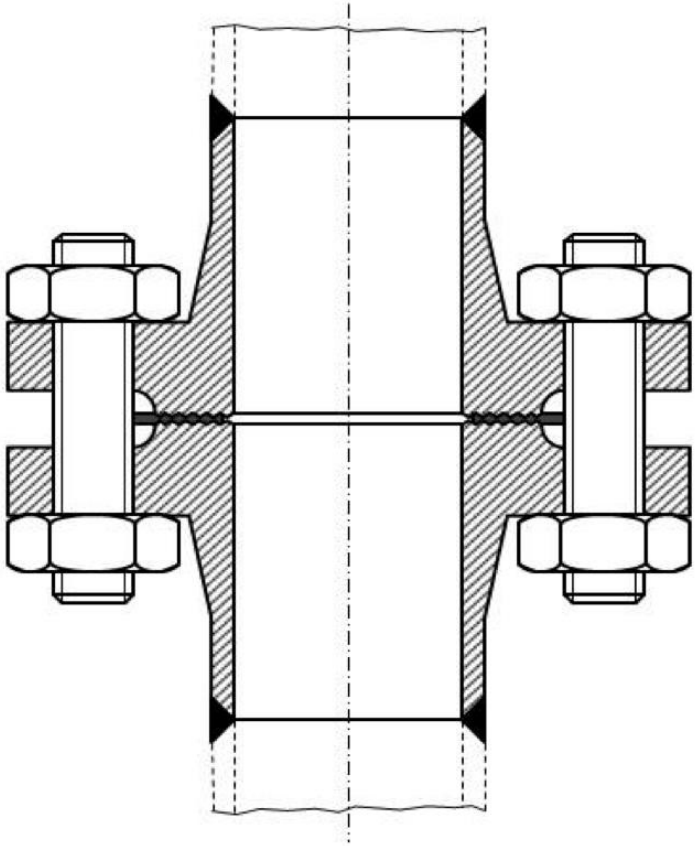
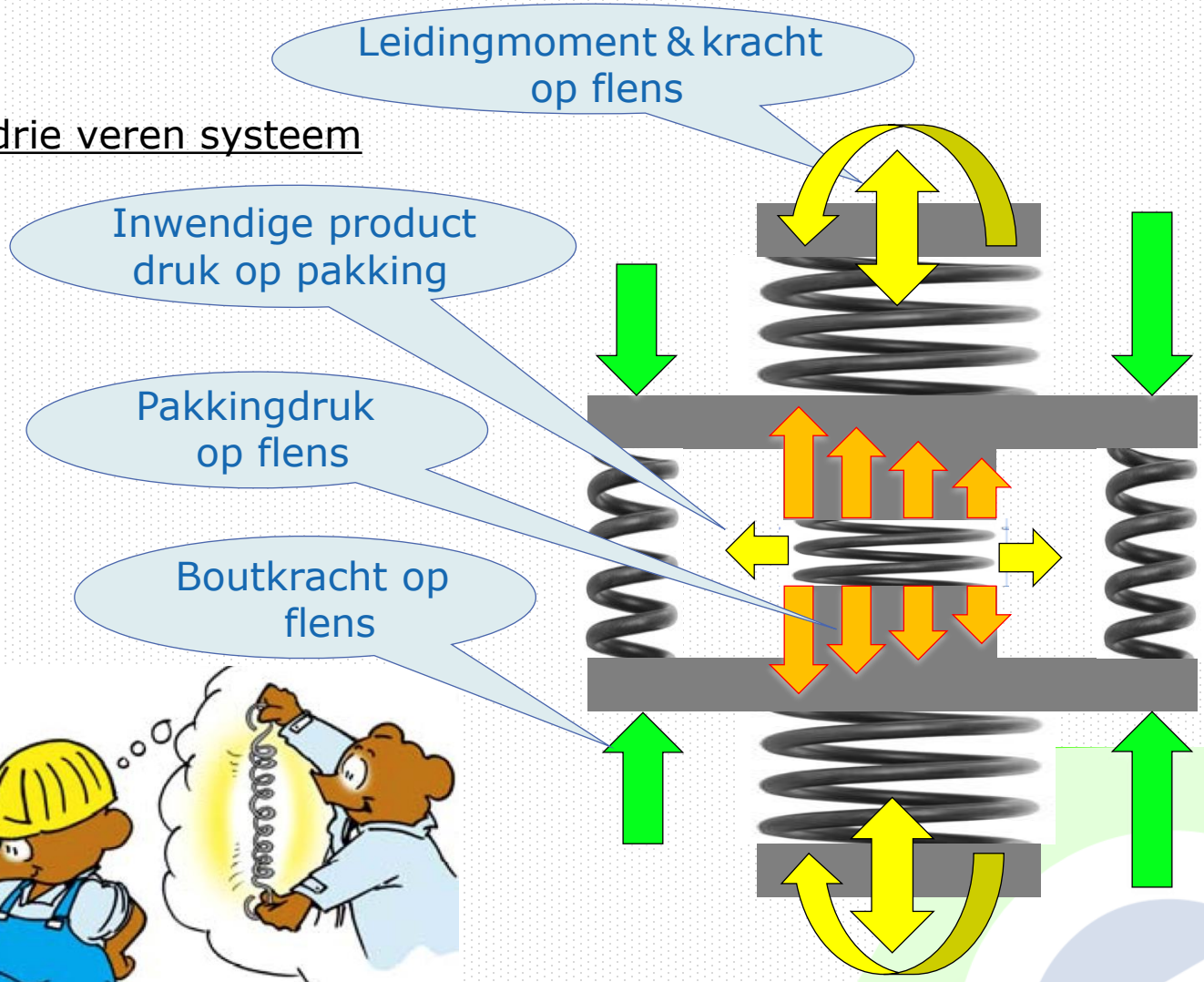
Flensverbinding

Een flensverbinding is een geïntegreerd drie veren systeem





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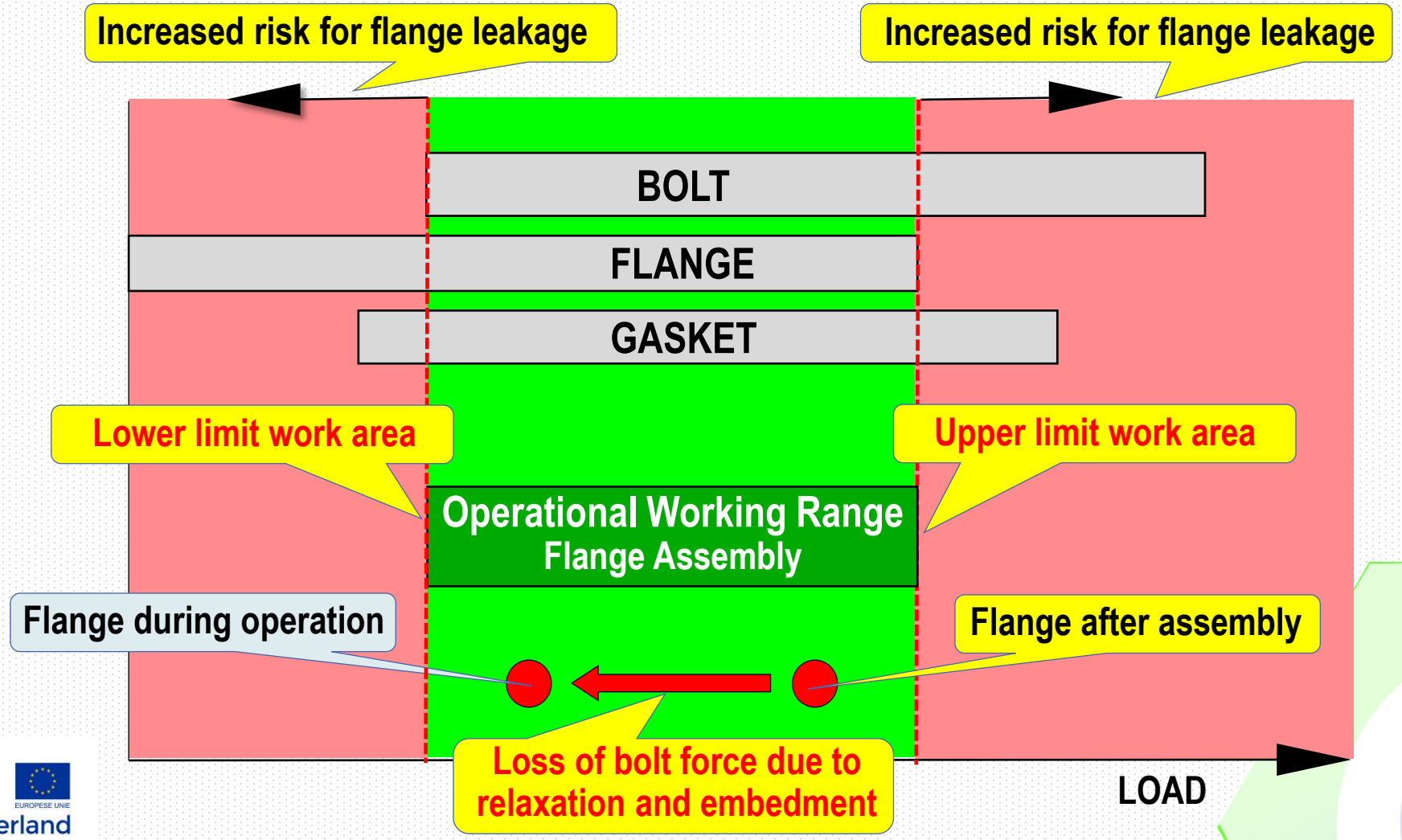
Functioneel werkgebied van flensverbinding



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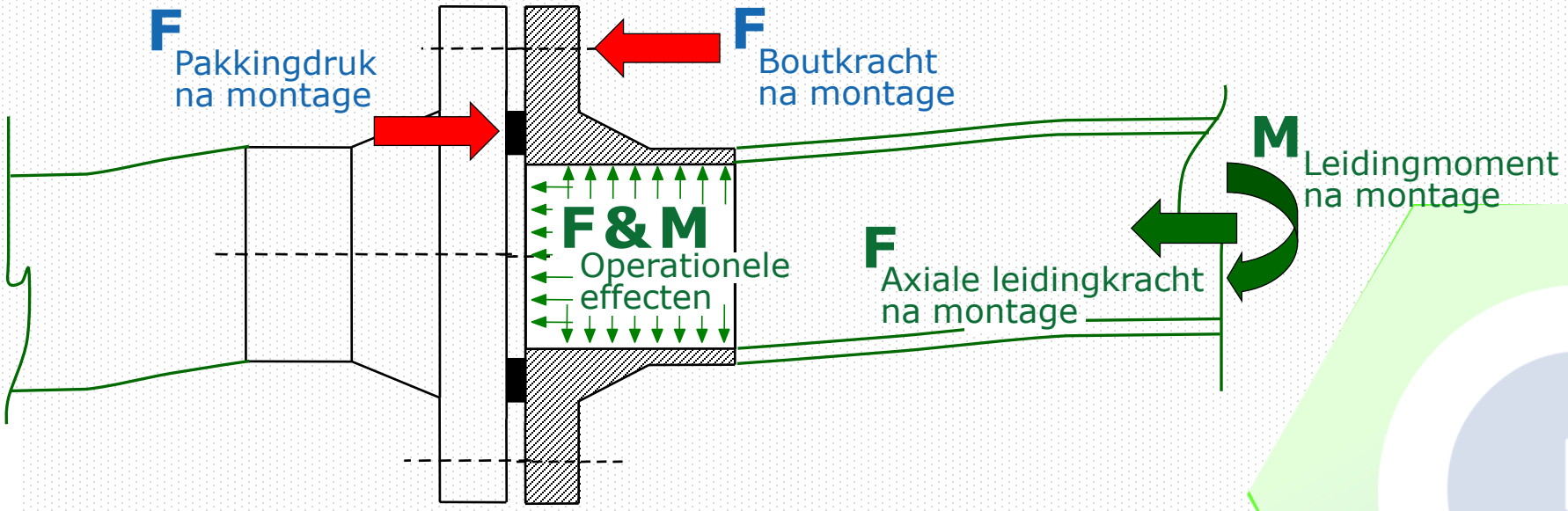
BEPERKING LEKVERLIEZEN FLENSVERBINDINGEN

Veelheid van invloedsfactoren m.b.t. (diffuse) lekverliezen flensverbindingen

Flange/Piping Design	Material Qualities	Flange Procedure	Tightening Method	QA/QC Process	Execution Quality	Operational Conditions

Boutkracht is eveneens bepaald door veelheid van invloedsfactoren

- Boutkracht na montage ≠ pakkingdruk na montage
- Boutkracht na montage ≠ boutkracht tijdens bedrijf



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Test: flens aanhaalmethoden / gereedschappen

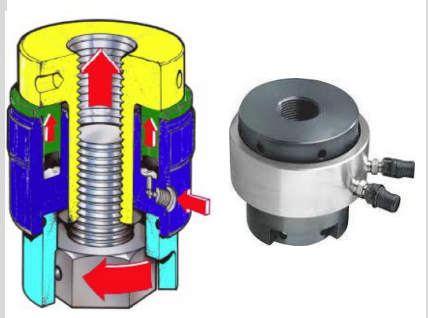
Interreg testen beperkt zich tot het bepalen van de nauwkeurigheid van de volgende gereedschappen

Hand torquing (single)

Electric torquing (single)

Hydraulic Torquing (single)

Hydraulic Tensioning



Electric torquing (Multi)

Hydraulic Torquing (multi)

(50% - 50%)

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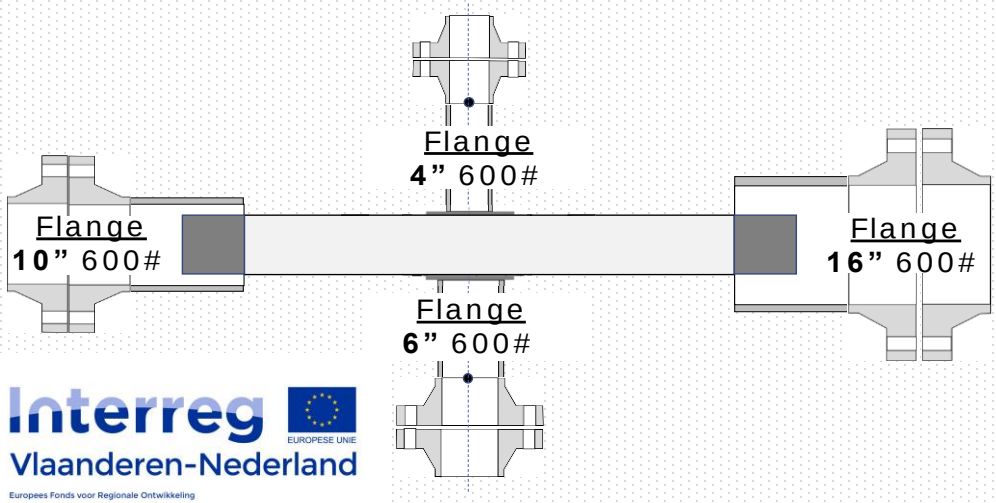
BEPERKING LEKVERLIEZEN FLENSVERBINDINGEN

Test skid: type flenzen & aanhaalmomenten

Viertal flenzen	Test aanhaalmoment	Boutkracht: μ(t) = 0,12 & μ(n) = 0,14
4" 600# (studbolts 8 x 7/8")	M(torque)= 400. [Nm]	F(bolt) = 102,13 [kN]
6" 600# (studbolts 12 x 1")	M(torque)= 600. [Nm]	F(bolt) = 134,70 [kN]
10" 600# (studbolts 16 x 1.1/4")	M(torque)= 1200. [Nm]	F(bolt) = 220,20 [kN]
16" 600# (studbolts 20 x 1.1/2")	M(torque)= 2200. [Nm]	F(bolt) = 341,35 [kN]

Gemiddelde range M(torque) in industrie

4" 600# M(torque)= 330. - 460. [Nm]
6" 600# M(torque)= 530. - 690. [Nm]
10" 600# M(torque)= 1100. - 1420. [Nm]
16" 600# M(torque)= 2000. - 2320. [Nm]



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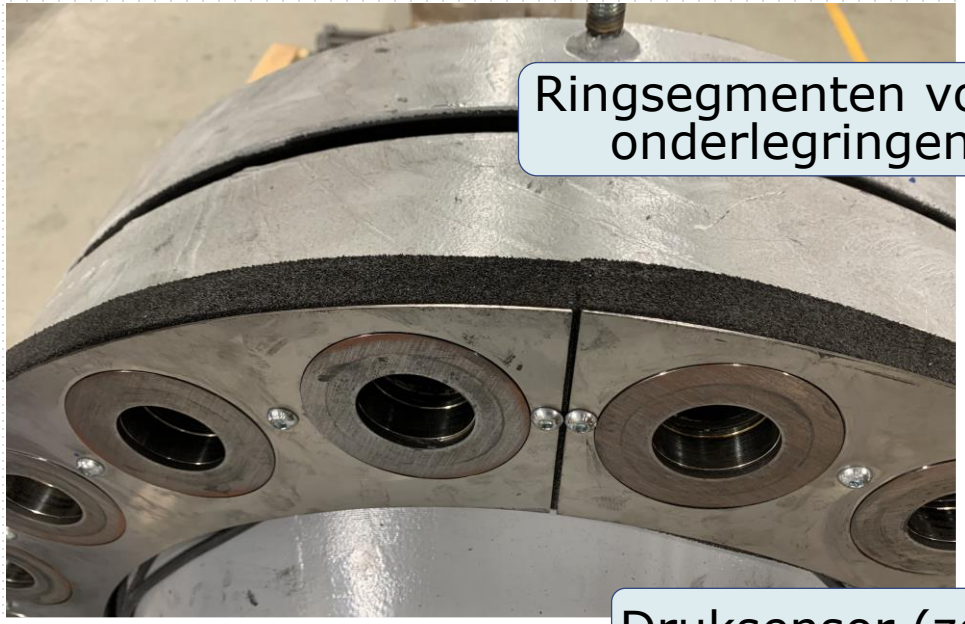
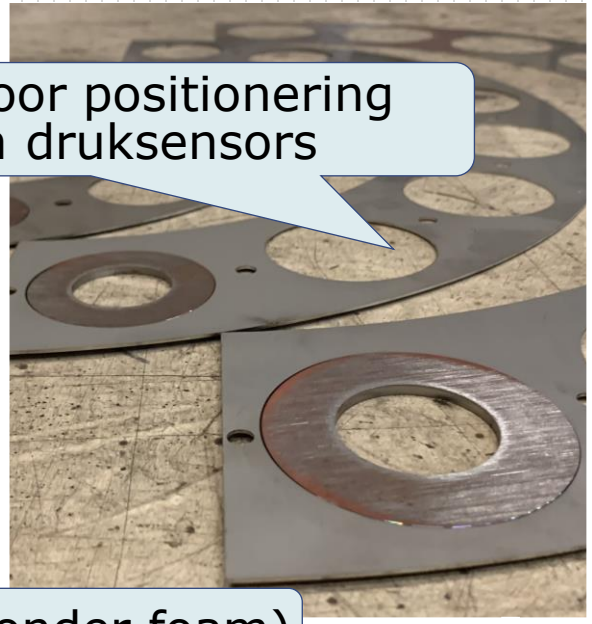
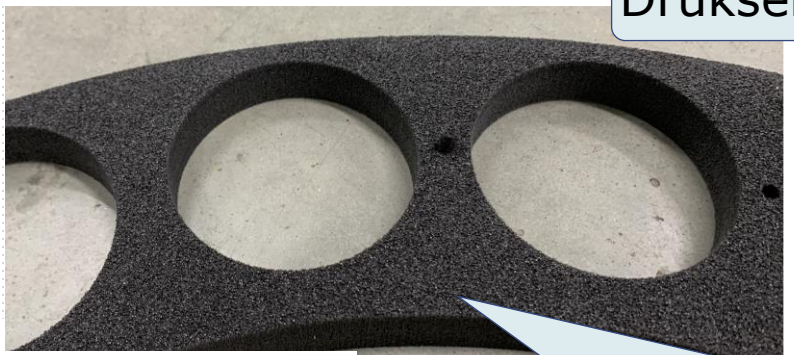
Druksensoren fixatie systeem



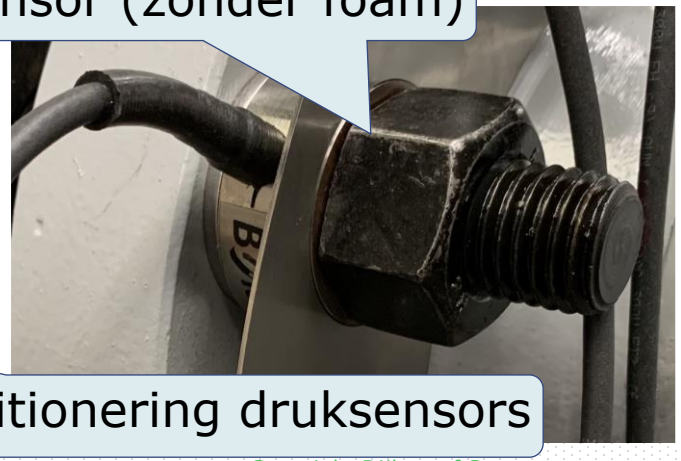
Ringsegmenten voor positionering onderlegringen druksensors



Back-up ringsegmenten



Druksensor (zonder foam)



Foam voor positionering druksensors

Onderlegring druksensor

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BEPERKING LEKVERLIEZEN FLENSVERBINDINGEN

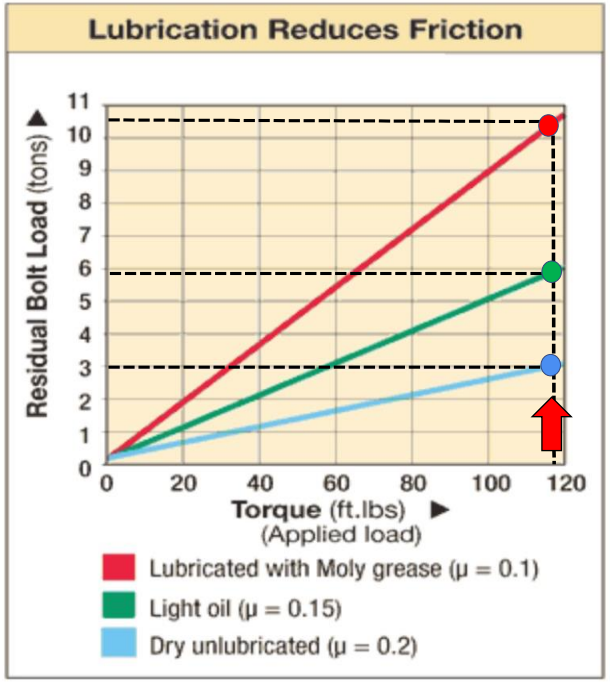
Wrijving: 'complexe' variabele m.b.t. boutkracht

Molykote grafieken voor P37: bij M = 160. [Nm]

Ongesmeerd	Geolied	Gesmeerd P37
μ = 0,20	μ = 0,15	μ = 0,10
$F_{(bout)}$ = 29,4 [kN]	$F_{(bout)}$ = 57,9 [kN]	$F_{(bout)}$ = 104,0 [kN]

Interreg testresultaten

Wrijvingsverschil (gesmeerd - ongesmeerd):
➡ ± 15% hogere boutkracht door smering P37



Praktijk invloedsfactoren:
o.a. ruwheid / draadtoleranties / vervuiling / onderlegringen / coating

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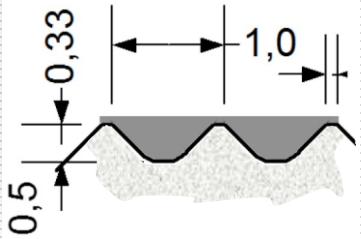
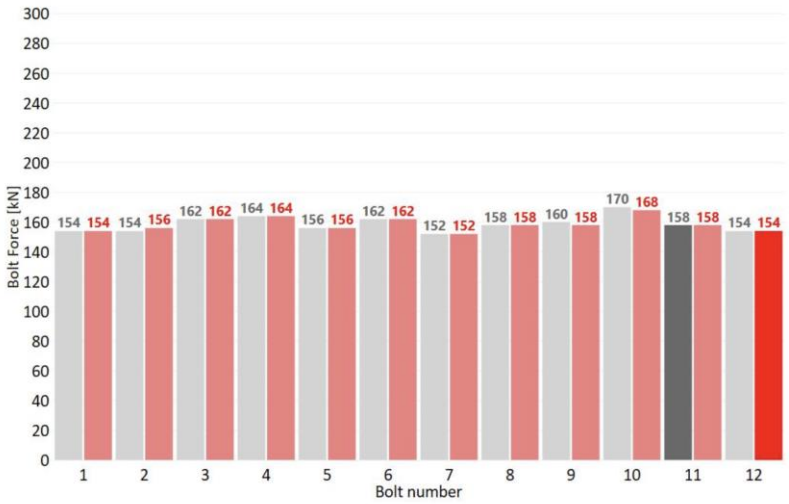
Effect type pakking: KAM – SPW



Kamprofiel volgens EN 1514-6

Test id	F6-HY-T45
Torqueing / Tensioning	Torqueing
Tool(s)	1
Equip. manufacturer	Hytorc
Equip. technology	Hydraulic
Equip. type	st2 slw41
Final torque	600 [Nm]
Current torque	100% = 600 [Nm]
Total steps	96
Current step	60
Current bolt(s)	12
Gasket type	Kamprofiel
Bolt diamter	1
Bolt condition	New
Lubricant	P37

Boltforce [kN]	
1	154
2	156
3	162
4	164
5	156
6	162
7	152
8	158
9	158
10	168
11	158
12	154
Average [kN]	
158	
Scatter [kN]	
16	



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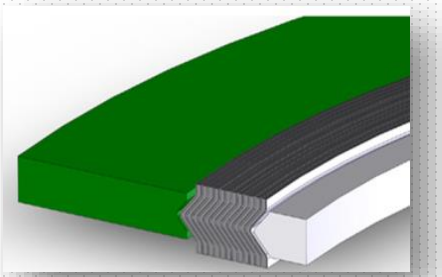
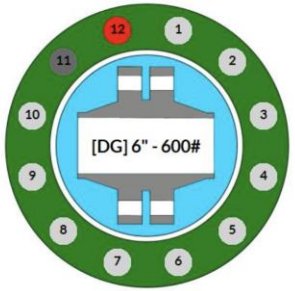
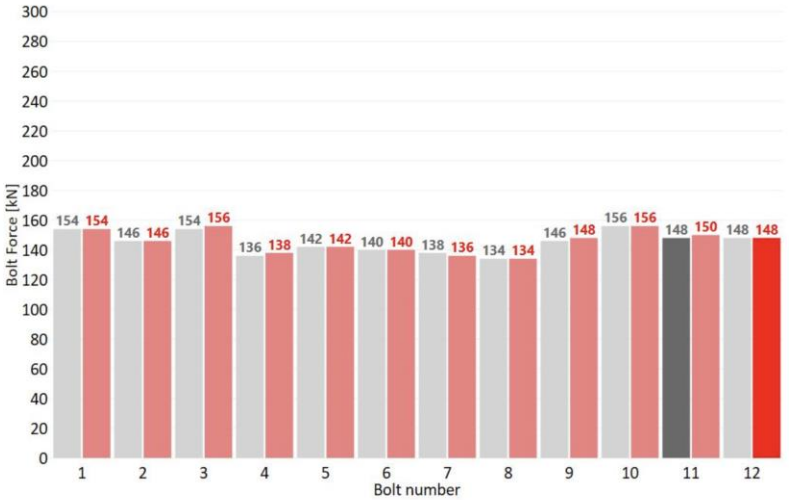


Spiral Wound Gasket



Test id	F6-HY-T39
Torqueing / Tensioning	Torqueing
Tool(s)	1
Equip. manufacturer	Hytorc
Equip. technology	Hydraulic
Equip. type	st2 slw41
Final torque	600 [Nm]
Current torque	100% = 600 [Nm]
Total steps	96
Current step	60
Current bolt(s)	12
Gasket type	SPW/Graphite
Bolt diamter	1
Bolt condition	New
Lubricant	P37

Boltforce [kN]	
1	154
2	146
3	156
4	138
5	142
6	140
7	136
8	134
9	148
10	156
11	150
12	148
Average [kN]	
146	
Scatter [kN]	
22	



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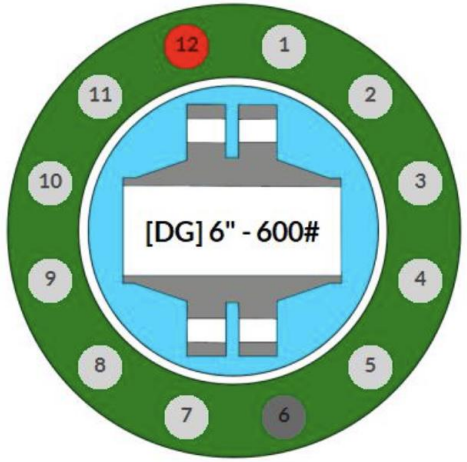
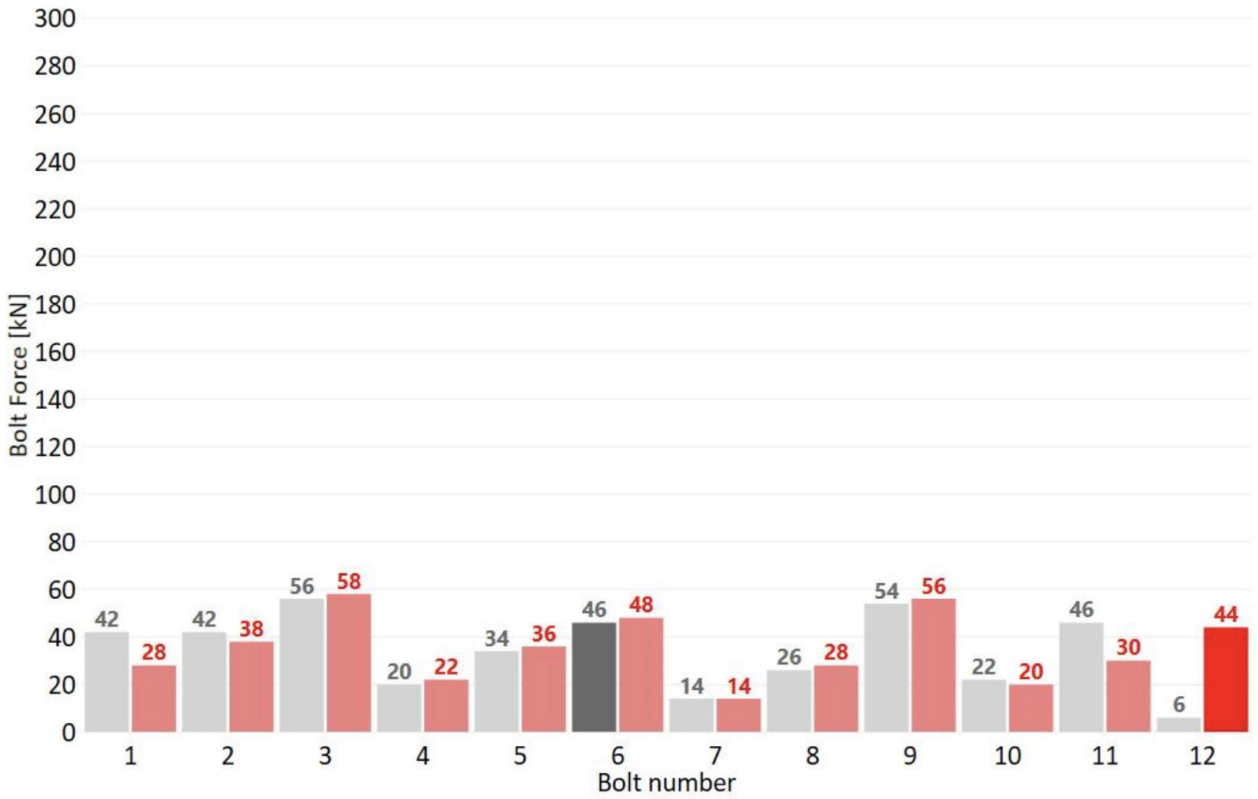
Screenshots test 6" flange – Gasket SPW – Greased P37

Bolt loads after 30% final torque cross-wise (step 12)



Test id	F6-HY-T39
Torqueing / Tensioning	Torqueing
Tool(s)	1
Equip. manufacturer	Hytorc
Equip. technology	Hydraulic
Equip. type	st2 slw41
Final torque	600 [Nm]
Current torque	30% = 180 [Nm]
Total steps	96
Current step	12
Current bolt(s)	12
Gasket type	SPW/Graphite
Bolt diamter	1
Bolt condition	New
Lubricant	P37

Boltforce [kN]	
1	28
2	38
3	58
4	22
5	36
6	48
7	14
8	28
9	56
10	20
11	30
12	44
Average [kN]	
35	
Scatter [kN]	
44	



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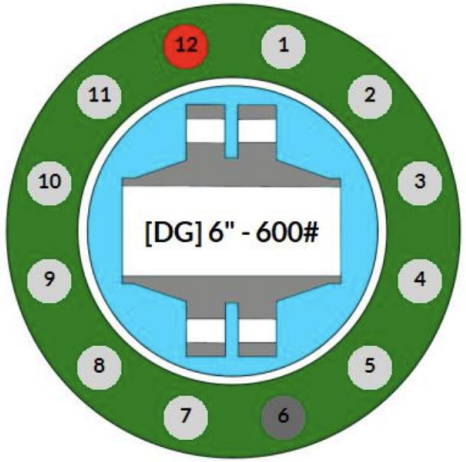
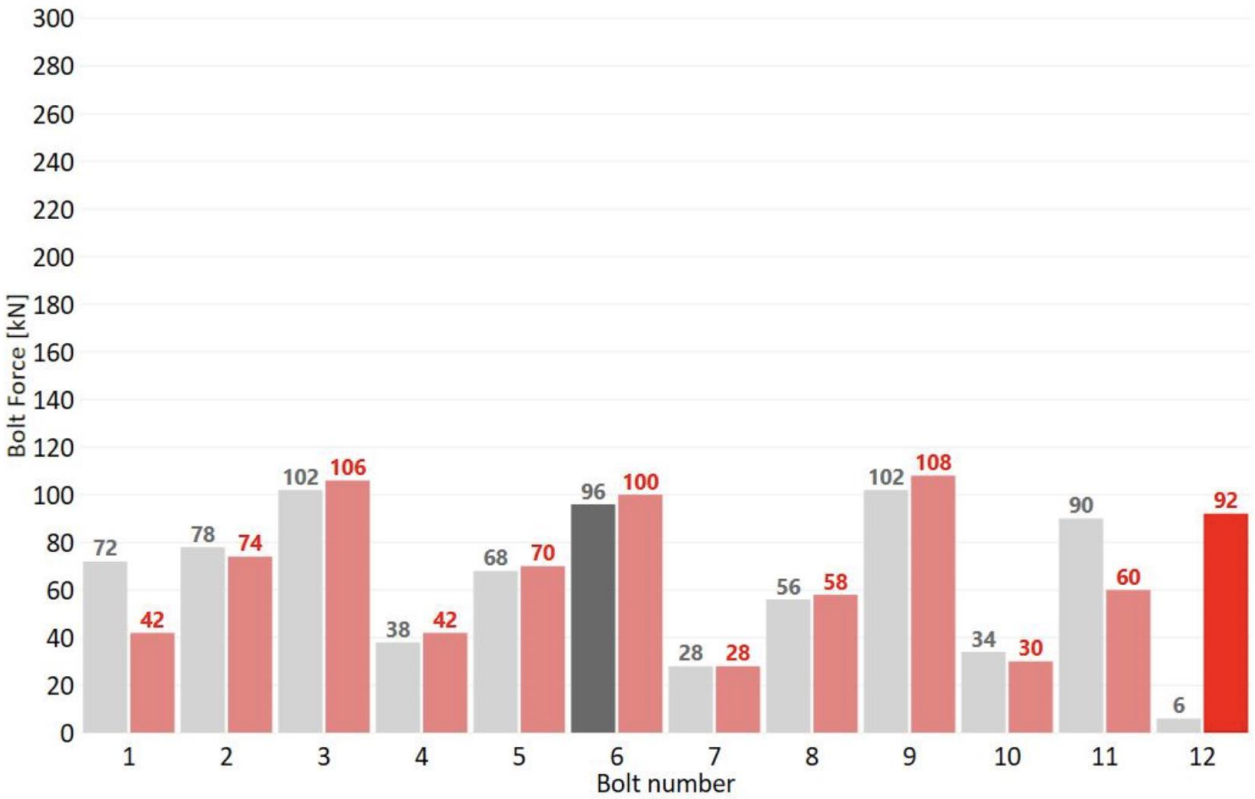
Screenshots test 6" flange – Gasket SPW – Greased P37

Bolt loads after 60% final torque cross-wise (step 24)



Test id	F6-HY-T39
Torqueing / Tensioning	Torqueing
Tool(s)	1
Equip. manufacturer	Hytorc
Equip. technology	Hydraulic
Equip. type	st2 slw41
Final torque	600 [Nm]
Current torque	60% = 360 [Nm]
Total steps	96
Current step	24
Current bolt(s)	12
Gasket type	SPW/Graphite
Bolt diamter	1
Bolt condition	New
Lubricant	P37

Boltforce [kN]	
1	42
2	74
3	106
4	42
5	70
6	100
7	28
8	58
9	108
10	30
11	60
12	92
Average [kN]	
68	
Scatter [kN]	
80	



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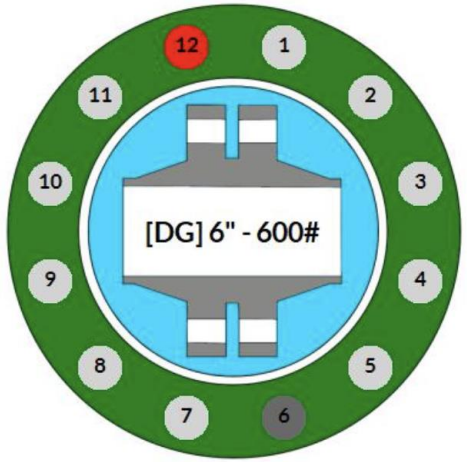
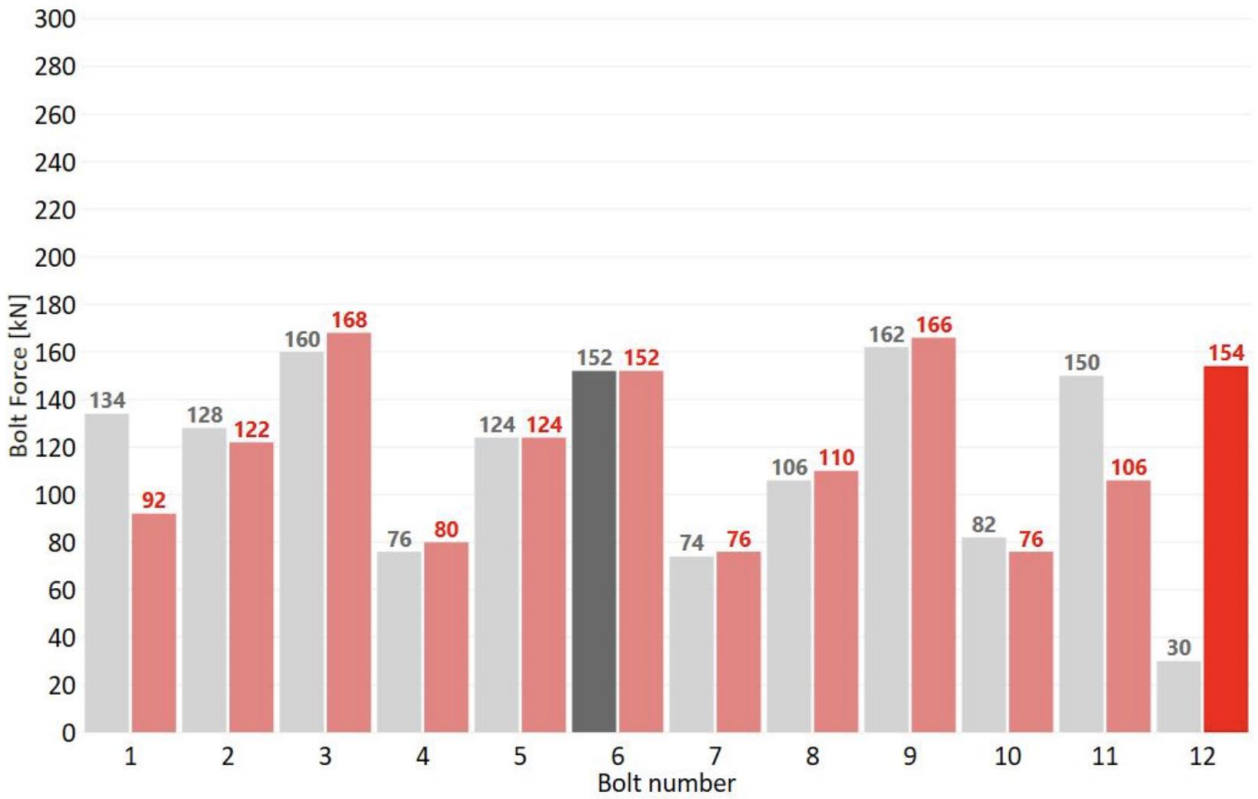
Screenshots test 6" flange – Gasket SPW – Greased P37

Bolt loads after 100% final torque cross-wise (step 36)



Test id	F6-HY-T39
Torqueing / Tensioning	Torqueing
Tool(s)	1
Equip. manufacturer	Hytorc
Equip. technology	Hydraulic
Equip. type	st2 slw41
Final torque	600 [Nm]
Current torque	100% = 600 [Nm]
Total steps	96
Current step	36
Current bolt(s)	12
Gasket type	SPW/Graphite
Bolt diamter	1
Bolt condition	New
Lubricant	P37

Boltforce [kN]	
1	92
2	122
3	168
4	80
5	124
6	152
7	76
8	110
9	166
10	76
11	106
12	154
Average [kN]	
119	
Scatter [kN]	
92	



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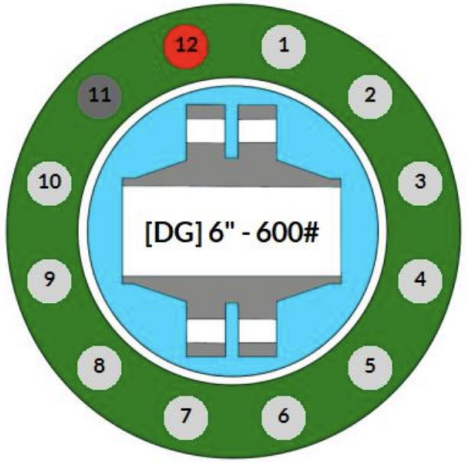
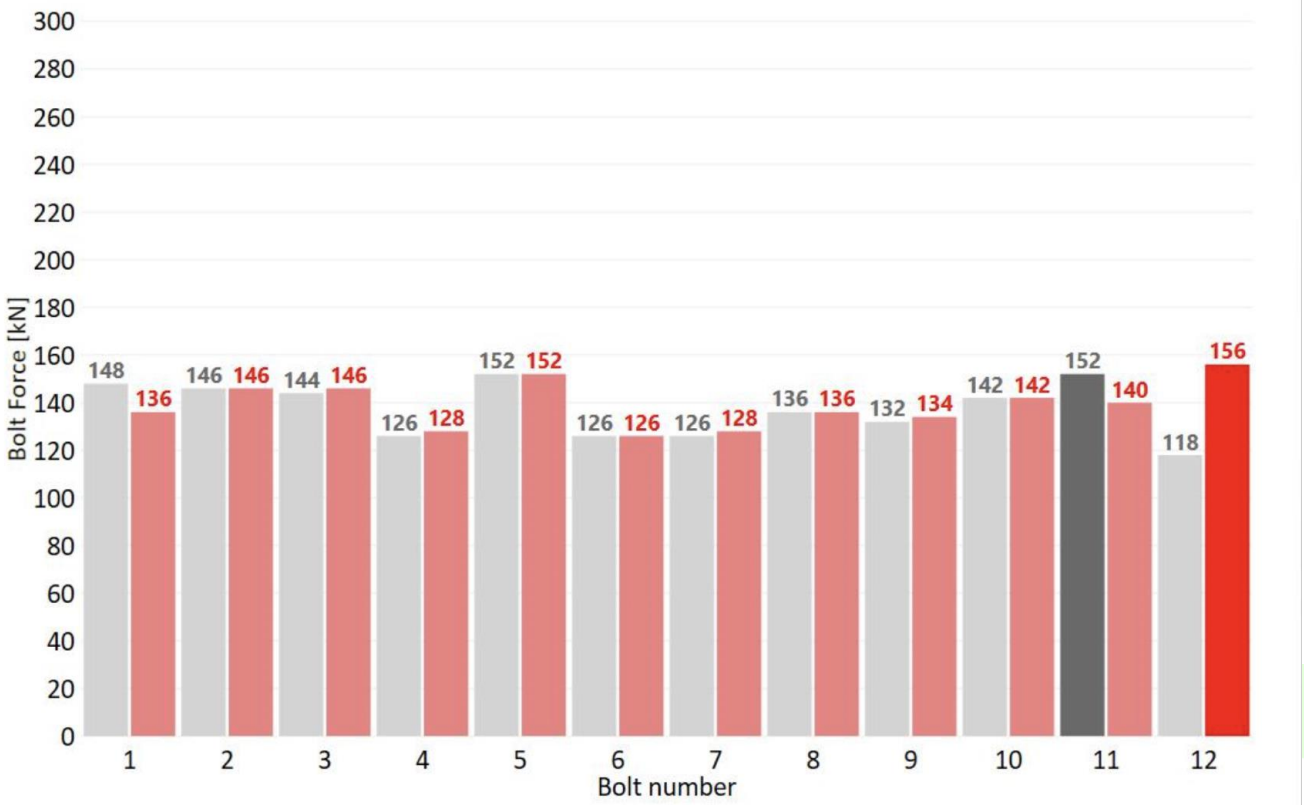
Screenshots test 6" flange – Gasket SPW – Greased P37

Bolt loads after 100% final torque clock-wise 1st round (step 48)



Test id	F6-HY-T39
Torqueing / Tensioning	Torqueing
Tool(s)	1
Equip. manufacturer	Hytorc
Equip. technology	Hydraulic
Equip. type	st2 slw41
Final torque	600 [Nm]
Current torque	100% = 600 [Nm]
Total steps	96
Current step	48
Current bolt(s)	12
Gasket type	SPW/Graphite
Bolt diamter	1
Bolt condition	New
Lubricant	P37

Boltforce [kN]	
1	136
2	146
3	146
4	128
5	152
6	126
7	128
8	136
9	134
10	142
11	140
12	156
Average [kN]	
139	
Scatter [kN]	
30	



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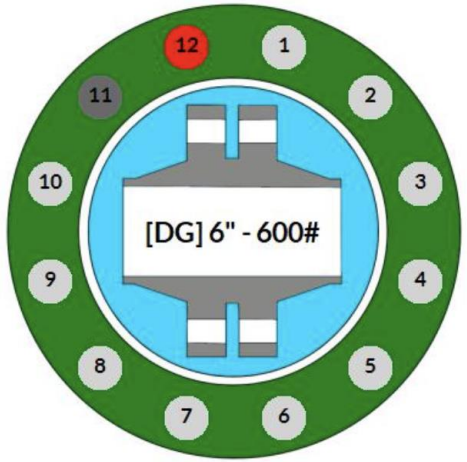
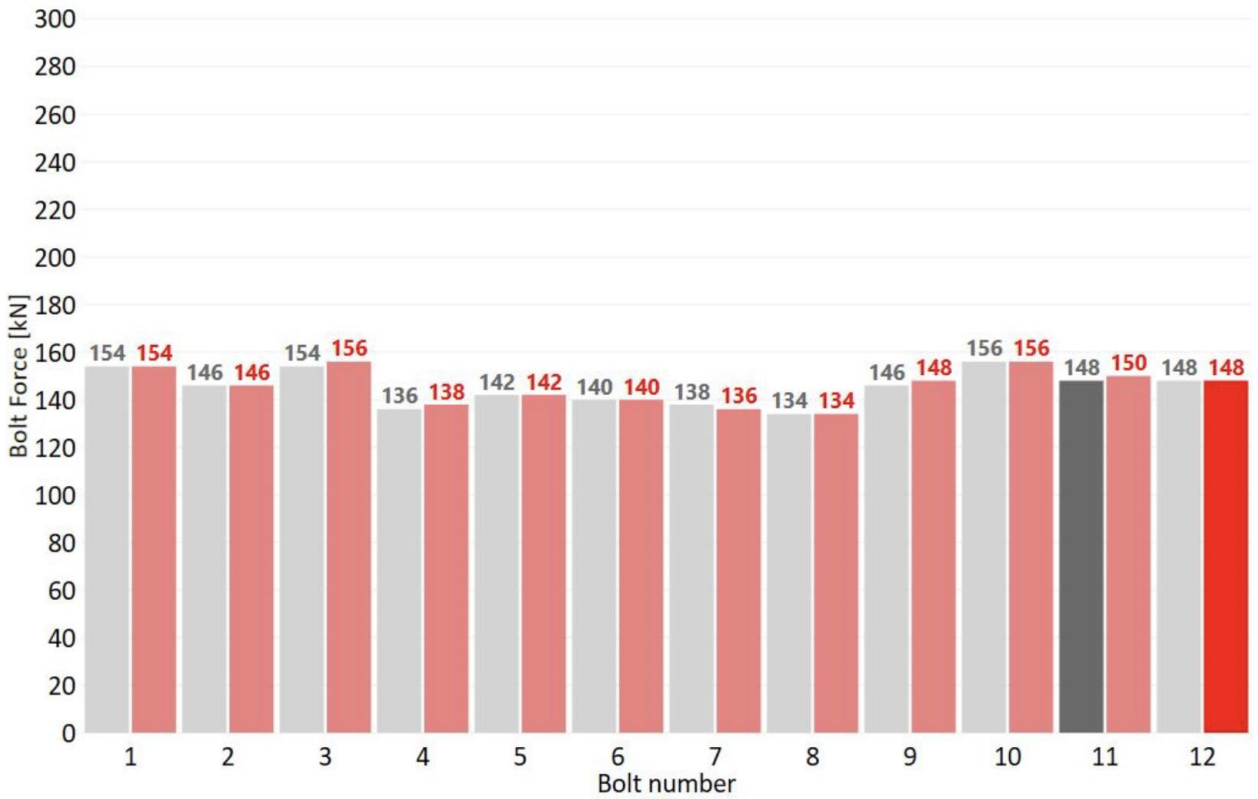
Screenshots test 6" flange – Gasket SPW – Greased P37

Bolt loads after 100% final torque clock-wise 2nd round (step 60)



Test id	F6-HY-T39
Torqueing / Tensioning	Torqueing
Tool(s)	1
Equip. manufacturer	Hytorc
Equip. technology	Hydraulic
Equip. type	st2 slw41
Final torque	600 [Nm]
Current torque	100% = 600 [Nm]
Total steps	96
Current step	60
Current bolt(s)	12
Gasket type	SPW/Graphite
Bolt diamter	1
Bolt condition	New
Lubricant	P37

Boltforce [kN]	
1	154
2	146
3	156
4	138
5	142
6	140
7	136
8	134
9	148
10	156
11	150
12	148
Average [kN]	
146	
Scatter [kN]	
22	



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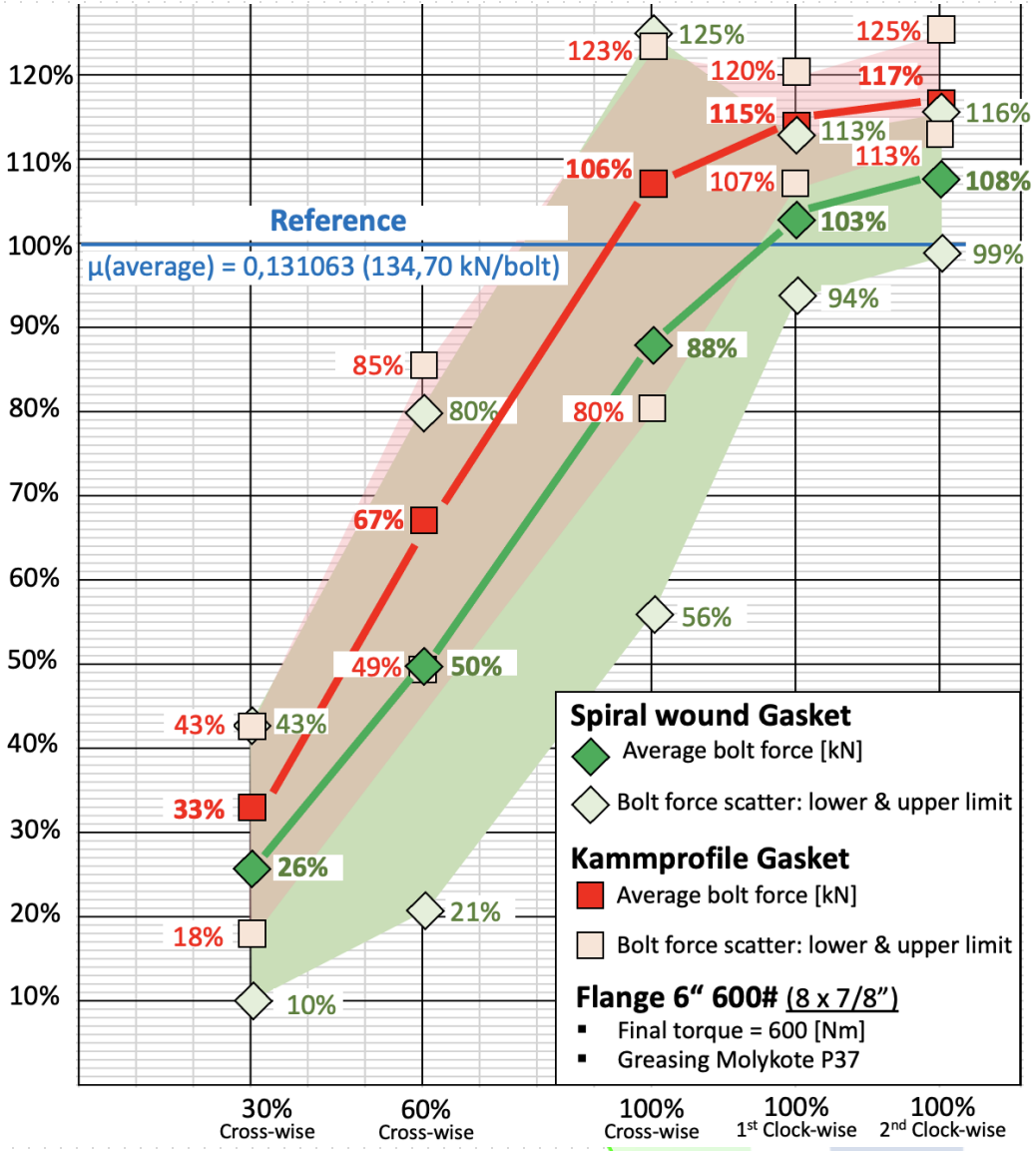
BEPERKING LEKVERLIEZEN FLENSVERBINDINGEN

Test resultaten: KAM – SPW

Flang configuration & Tightening Pattern					
Flange	Bolt	Diameter	Tighening Pattern	Torque [Nm]	Step
6" 600#	Non-coated	7/8"	30% cross	180	12
6" 600#	Non-coated	7/8"	60% cross	360	24
6" 600#	Non-coated	7/8"	100% cross	600	36
6" 600#	Non-coated	7/8"	100% clock (1st)	600	48
6" 600#	Non-coated	7/8"	100% clock (2nd)	600	60

Kammprofile Gastket	Test: F6-HY-T45 KAM P37			Reference μ(average) = 0,131063 => 134,70 kN / bolt			
Average kN	**Average % Ref.**	Lowest kN	**Lowest % Ref.**	Highest kN	**Highest % Ref.**	Scatter kN	**Scatter % Ref.**
45	**33%**	24	**18%**	58	**43%**	34	**25%**
90	**67%**	66	**49%**	114	**85%**	48	**36%**
143	**106%**	108	**80%**	166	**123%**	58	**43%**
155	**115%**	144	**107%**	162	**120%**	18	**13%**
158	**117%**	152	**113%**	168	**125%**	16	**12%**

Spiral Wound Gasket	Test: F6-HY-T39 SPW P37			Reference μ(average) = 0,131063 => 134,70 kN / bolt			
Average kN	**Average % Ref.**	Lowest kN	**Lowest % Ref.**	Highest kN	**Highest % Ref.**	Scatter kN	**Scatter % Ref.**
35	**26%**	14	**10%**	58	**43%**	44	**33%**
68	**50%**	28	**21%**	108	**80%**	80	**59%**
119	**88%**	76	**56%**	168	**125%**	92	**68%**
139	**103%**	126	**94%**	152	**113%**	26	**19%**
146	**108%**	134	**99%**	156	**116%**	22	**16%**



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Samenvatting testresultaten

Test Code	Flange	Boltforce Reference [kN]	Tools Type	Tools Quantity	Steps	Average Boltload [kN]	Average Boltload [%] Ref.	Scatter Lower [kN]	Scatter Lower [%] Ref.	Scatter Upper [kN]	Scatter Upper [%] Ref.	Scatter Total [kN]	Scatter Total [%] Ref.
F4-HT-T2	4" 600"	102,13	Hand torque	Single	40	122	119%	110	108%	148	145%	38	37%
F4-EL-T7	4" 600"	102,13	Accu torque	Single	40	112	110%	96	94%	128	125%	32	31%
F4-EL-T27	4" 600"	102,13	Accu torque	Multi 2x	36	104	102%	90	88%	116	114%	26	25%
F4-HY-T21	4" 600"	102,13	Hydr. Torque	Single	40	124	121%	114	112%	140	137%	26	25%
F4-HY-T52	4" 600"	102,13	Hydr. Torque	Multi 2x	28	122	119%	112	110%	156	153%	44	43%
F4-HY-T54	4" 600"	102,13	Hydr. Torque	Multi 4x	22	125	122%	114	112%	136	133%	22	22%
F6-HT-T23	6" 600"	134,70	Hand torque	Single	60	142	105%	124	92%	162	120%	38	28%
F6-EL-T34	6" 600"	134,70	Accu torque	Single	60	131	97%	114	85%	152	113%	38	28%
F6-EL-T47	6" 600"	134,70	Accu torque	Multi 2x	42	125	93%	116	86%	134	99%	18	13%
F6-HY-T39	6" 600"	134,70	Hydr. Torque	Single	60	146	108%	134	99%	156	116%	22	16%
F6-HY-T56	6" 600"	134,70	Hydr. Torque	Multi 4x	33	153	114%	120	89%	172	128%	52	39%
F10-EL-T35	10" 600#	220,20	Accu torque	Single	80	231	105%	190	86%	285	129%	95	43%
F10-HY-T63	10" 600#	220,20	Hydr. Torque	Single	80	255	116%	215	98%	275	125%	60	27%
F10-HY-T55	10" 600#	220,20	Hydr. Torque	Multi 4x	44	208	94%	185	84%	235	107%	50	23%
F10-TE- T66	10" 600#	220,20	Hydr. Tensioning	50%-50%	6	184	84%	135	61%	245	111%	110	50%
F10-TE- T66	10" 600#	220,20	Hydr. Tensioning	B(A) P(B)	1	197	89%	170	77%	220	100%	50	23%
F16-HY-T41	16" 600#	341,35	Hydr. Torque	Single	100	366	107%	300	88%	435	127%	135	40%
F16-HY- T60	16" 600#	341,35	Hydr. Torque	Multi 2x	60	343	100%	280	82%	395	116%	115	34%
F16--HY-T53	16" 600#	341,35	Hydr. Torque	Multi 4x	55	349	102%	265	78%	395	116%	130	38%
F16-TE-T68	16" 600#	341,35	Hydr. Tensioning	50%-50%	6	259	76%	175	51%	350	103%	175	51%
F16-TE-T68	16" 600#	341,35	Hydr. Tensioning	B(A) P(B)	1	275	81%	180	53%	350	103%	170	50%

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Nauwkeurigheid handmomentsleutel

Praktijk - Theorie

Test Code	Flange	Boltforce Reference [kN]	Tools Type	Tools Quantity	Steps	Average Boltload [kN]	Average Boltload [%] Ref.	Scatter Lower [kN]	Scatter Lower [%] Ref.	Scatter Upper [kN]	Scatter Upper [%] Ref.	Scatter Total [kN]	Scatter Total [%] Ref.
F4-HT-T2	4" 600"	102,13	Hand torque	Single	40	122	119%	110	108%	148	145%	38	37%
F6-HT-T23	6" 600"	134,70	Hand torque	Single	60	142	105%	124	92%	162	120%	38	28%

Break-loose metingen
Final torque = 200. Nm

BL(01)	BL(02)	BL(03)	BL(04)	BL(05)	BL(06)	BL(07)	BL(08)	BL(average)	BL(scatter)
240	224	213	210	283	232	229	230	233	73
298	281	270	219	229	221	218	217	244	81
293	288	289	291	292	289	344	299	298	56
305	174	277	244	194	227	215	218	232	131
228	224	219	243	256	241	218	244	234	38
205	198	211	204	200	205	202	439	233	241
274	280	320	284	300	291	294	291	292	46
249	240	314	264	329	351	266	356	296	116
206	195	194	206	296	196	237	205	217	102
229	230	211	232	213	228	275	235	232	64
231	240	249	236	233	237	227	218	234	31
231	242	235	200	236	223	316	211	237	116
286	243	267	270	276	264	270	268	268	43
217	232	203	228	231	221	222	217	221	29
215	207	235	233	367	230	213	209	239	160
229	245	232	226	221	236	243	227	232	24
215	201	231	203	252	234	241	205	223	51
276	203	209	282	285	480	280	229	281	277
178	190	95	199	215	205	203	229	189	134
254	247	222	245	240	271	267	221	246	50
231	219	208	208	221	272	231	255	231	64
241	264	227	244	215	221	217	277	238	62
243	212	206	190	206	400	250	410	265	220
91	106	176	180	104	242	175	141	152	151
233	246	231	244	289	243	400	223	264	177
96	44	89	0	71	0	205	86	74	205
229	222	316	287	260	255	216	275	258	100
203	242	221	237	222	225	239	218	226	39
224	220	209	220	215	226	234	245	224	36
237	237	225	226	222	214	240	221	228	26

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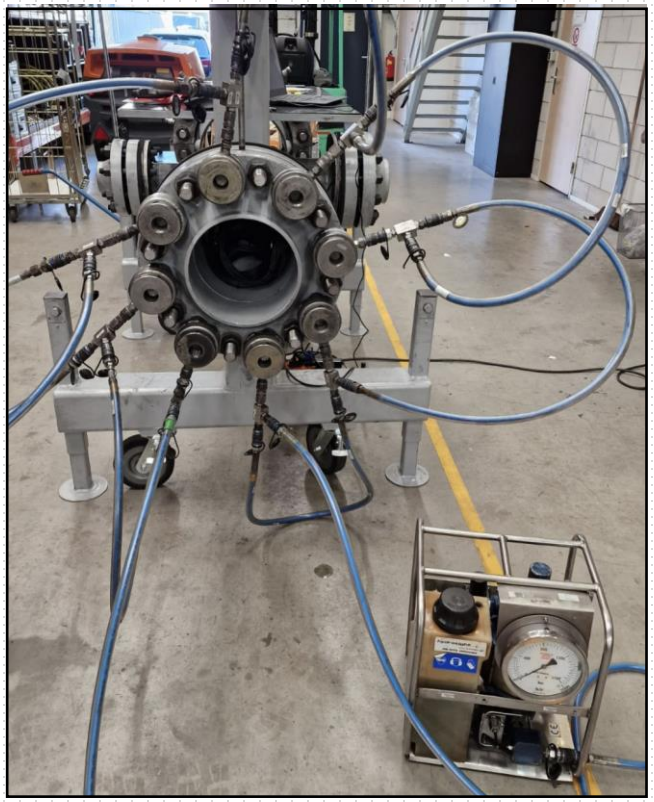
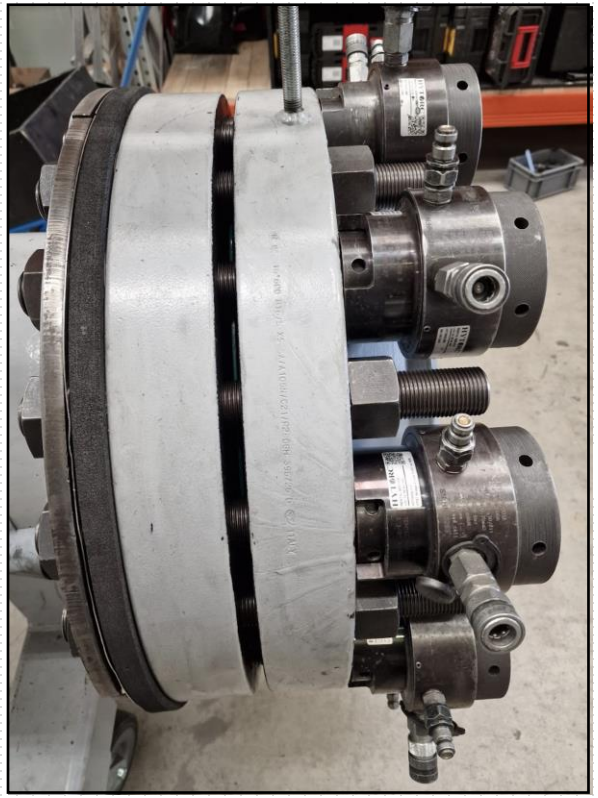
Nauwkeurigheid hydraulic tensioning

Praktijk - Theorie

Test Code	Flange	Boltforce Reference [kN]	Tools Type	Tools Quantity	Steps	Average Boltload [kN]	Average Boltload [%] Ref.	Scatter Lower [kN]	Scatter Lower [%] Ref.	Scatter Upper [kN]	Scatter Upper [%] Ref.	Scatter Total [kN]	Scatter Total [%] Ref.
F10-HY-T55	10" 600#	220,20	Hydr. Torque	Multi 4x	44	208	94%	185	84%	235	107%	50	23%
F10-TE- T66	10" 600#	220,20	Hydr. Tensioning	50%-50%	6	184	84%	135	61%	245	111%	110	50%
F10-TE- T66	10" 600#	220,20	Hydr. Tensioning	B(A) P(B)	1	197	89%	170	77%	220	100%	50	23%





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Voorbeeld: hydraulic tensioning procedure

50% bolt tensioning (half of the bolts alternately)

a. Fit the tensioning equipment and apply the A-pressure on 50% of the bolts (equipment installed on each alternate bolt);
b. Allow sufficient time for the flanged connection to "settle" (at least 2 minutes);
c. Tighten nuts and then release the pressure;
d. Repeat Steps a. through c. twice (2x).
e. Fit the tensioning equipment to the other half of the bolts and apply the B-pressure;
f. Allow sufficient time for the flanged connection to "settle" (at least 2 minutes);
g. Tighten nuts and then release the pressure;
h. Repeat Steps e. through g. twice (2x).
i. Determine the break-loose pressure on minimum four A-bolts. The break-loose pressure shall be within -5% en +10% of the B-pressure. Record the break-loose pressure on the flange protocol. If the break-loose pressure is lower than the specified value, all A-bolts shall be tensioned again at the B-pressure. The break-loose check shall be carried out within 48 hours.

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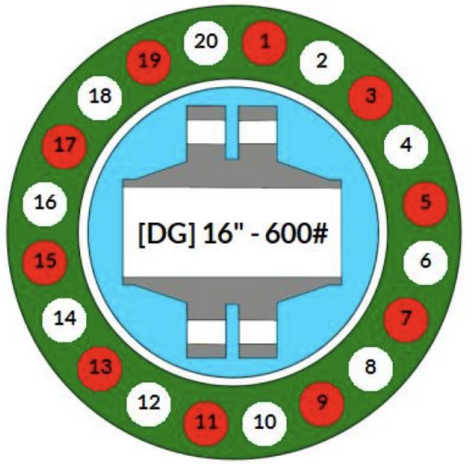
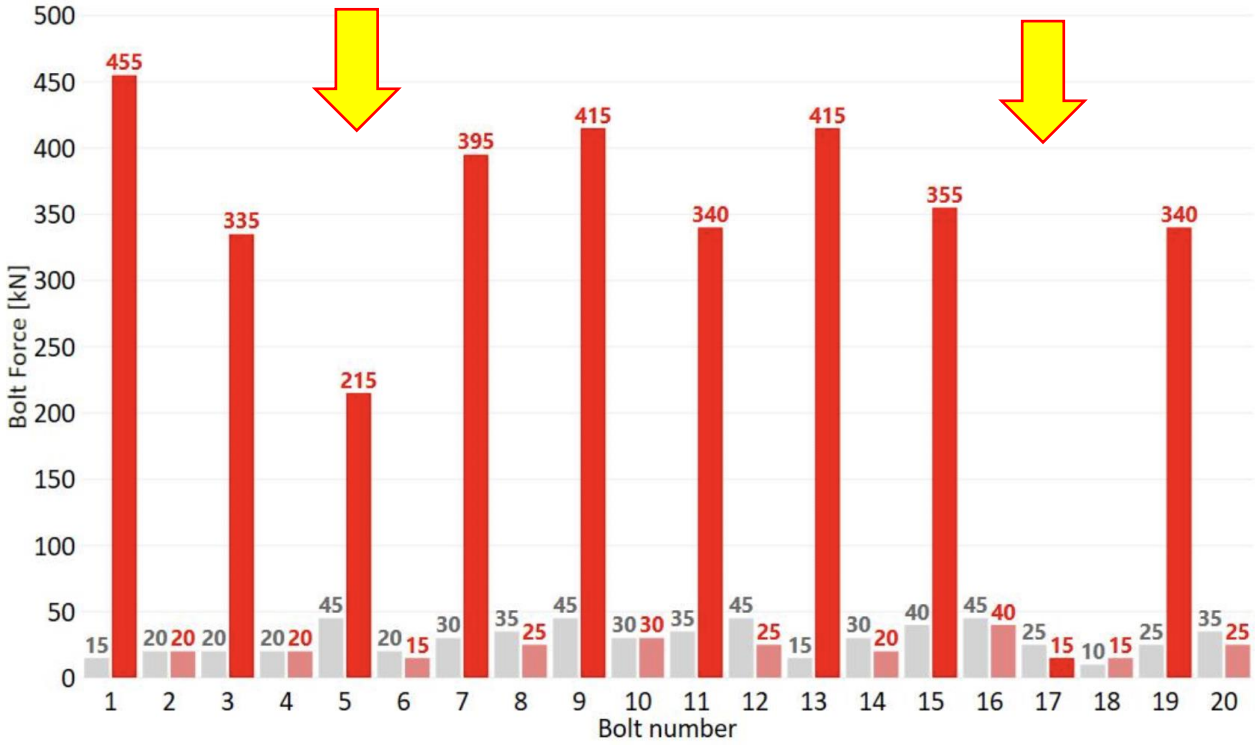
Grootste afwijking bij Hydraulic Tensioning 16" flange



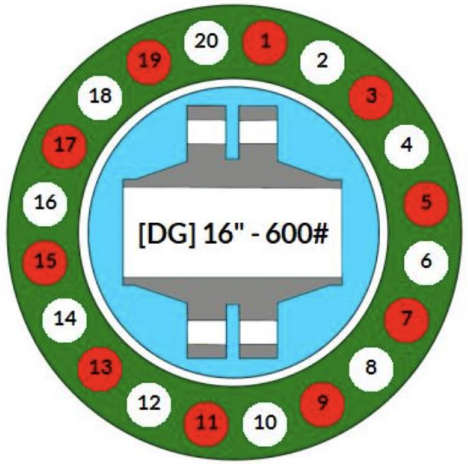
Test id	F16-TE-T68
Torqueing / Tensioning	Tensioning
Tensioners	10
Equip. manufacturer	Hytorq
Equip. technology	Hydraulic
Equip. type	tentec no:3
Final boltforce	341 [kN]
Current boltforce	125% = 426 [kN]
Total steps	7
Current step	1
Current bolt(s)	19,17,15,13,11,9,7,5
Gasket type	SPW/Graphite
Bolt diamter	1-1/2
Bolt condition	New
Lubricant	None
Bolting Sequence	16"-tensioning

Boltforce [kN]	
1	455
2	20
3	335
4	20
5	215
6	15
7	395
8	25
9	415
10	30
11	340
12	25
13	415
14	20
15	355
16	40
17	15
18	15
19	340
20	25
Average [kN]	
176	
Scatter [kN]	
440	



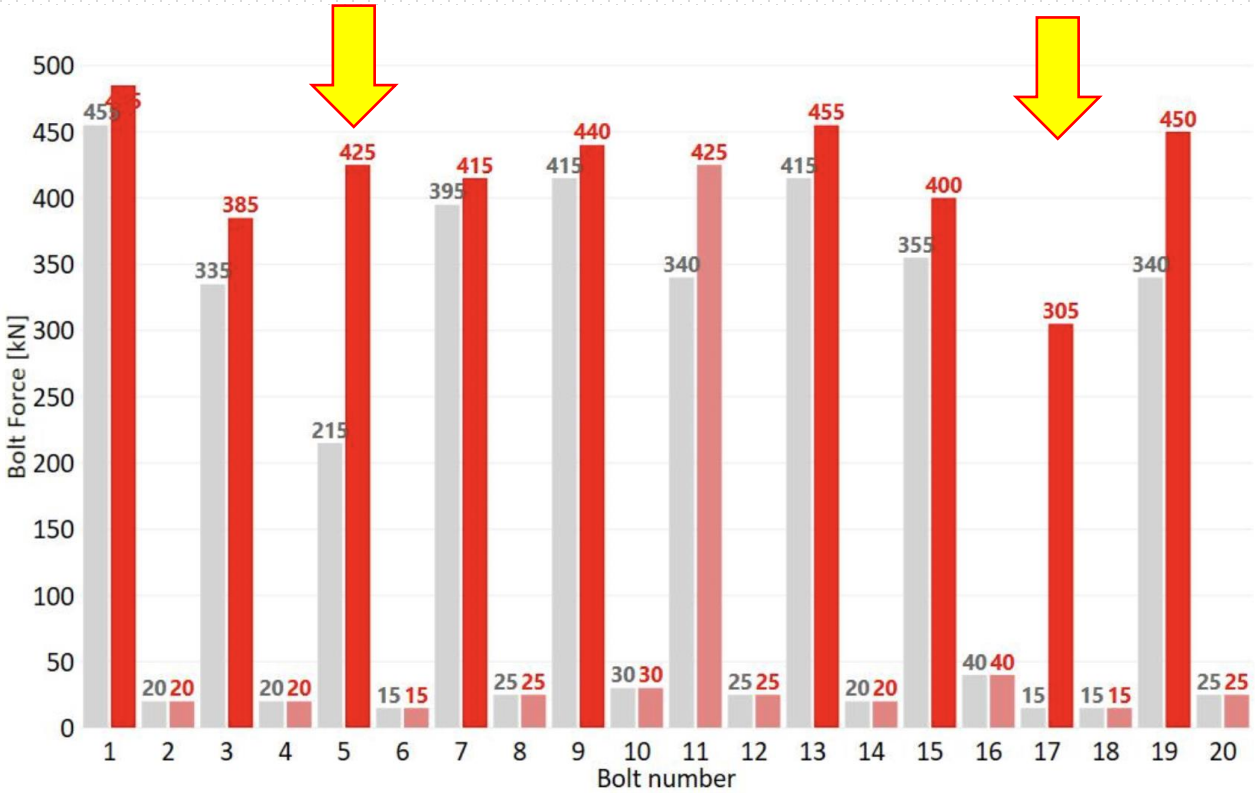
Step (1)

Grootste afwijking bij Hydraulic Tensioning 16" flange



Test id	F16-TE-T68
Torqueing / Tensioning	Tensioning
Tensioners	10
Equip. manufacturer	Hytorq
Equip. technology	Hydraulic
Equip. type	tentec no:3
Final boltforce	341 [kN]
Current boltforce	125% = 426 [kN]
Total steps	7
Current step	2
Current bolt(s)	19,17,15,13,9,7,5,3,1
Gasket type	SPW/Graphite
Bolt diamter	1-1/2
Bolt condition	New
Lubricant	None
Bolting Sequence	16"-tensioning

Boltforce [kN]	
1	485
2	20
3	385
4	20
5	425
6	15
7	415
8	25
9	440
10	30
11	425
12	25
13	455
14	20
15	400
16	40
17	305
18	15
19	450
20	25
Average [kN]	
221	
Scatter [kN]	
470	



Step (2)

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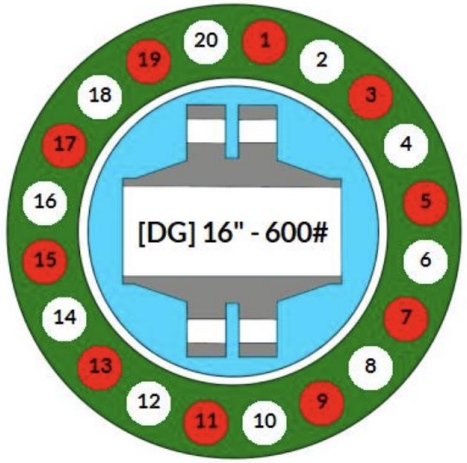
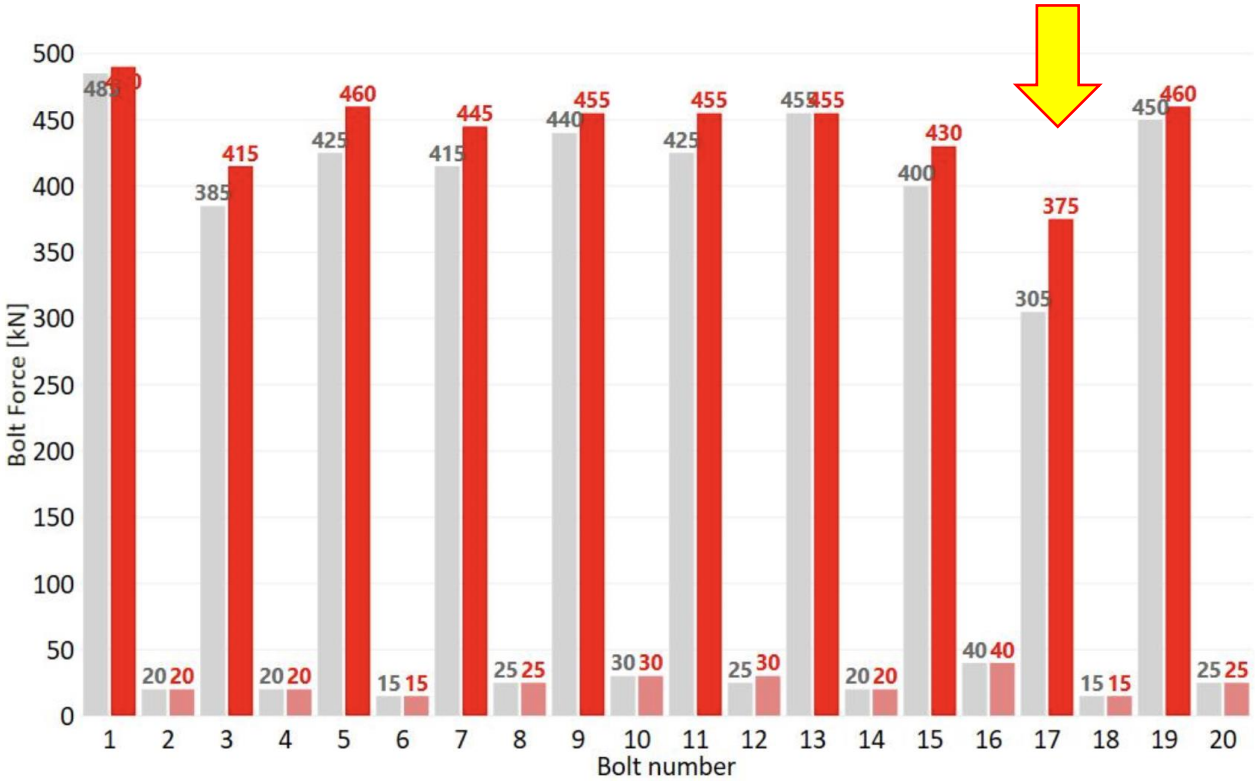
Grootste afwijking bij Hydraulic Tensioning 16" flange



Test id	F16-TE-T68
Torqueing / Tensioning	Tensioning
Tensioners	10
Equip. manufacturer	Hytorq
Equip. technology	Hydraulic
Equip. type	tentec no:3
Final boltforce	341 [kN]
Current boltforce	125% = 426 [kN]
Total steps	7
Current step	3
Current bolt(s)	19,17,15,13,11,9,7,5
Gasket type	SPW/Graphite
Bolt diamter	1-1/2
Bolt condition	New
Lubricant	None
Bolting Sequence	16"-tensioning

Boltforce [kN]	
1	490
2	20
3	415
4	20
5	460
6	15
7	445
8	25
9	455
10	30
11	455
12	30
13	455
14	20
15	430
16	40
17	375
18	15
19	460
20	25
Average [kN]	
234	
Scatter [kN]	
475	



Step (3)

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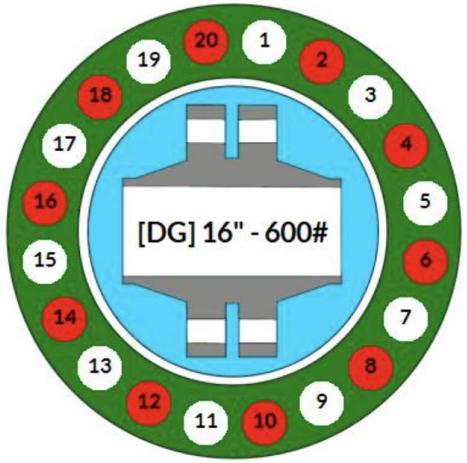
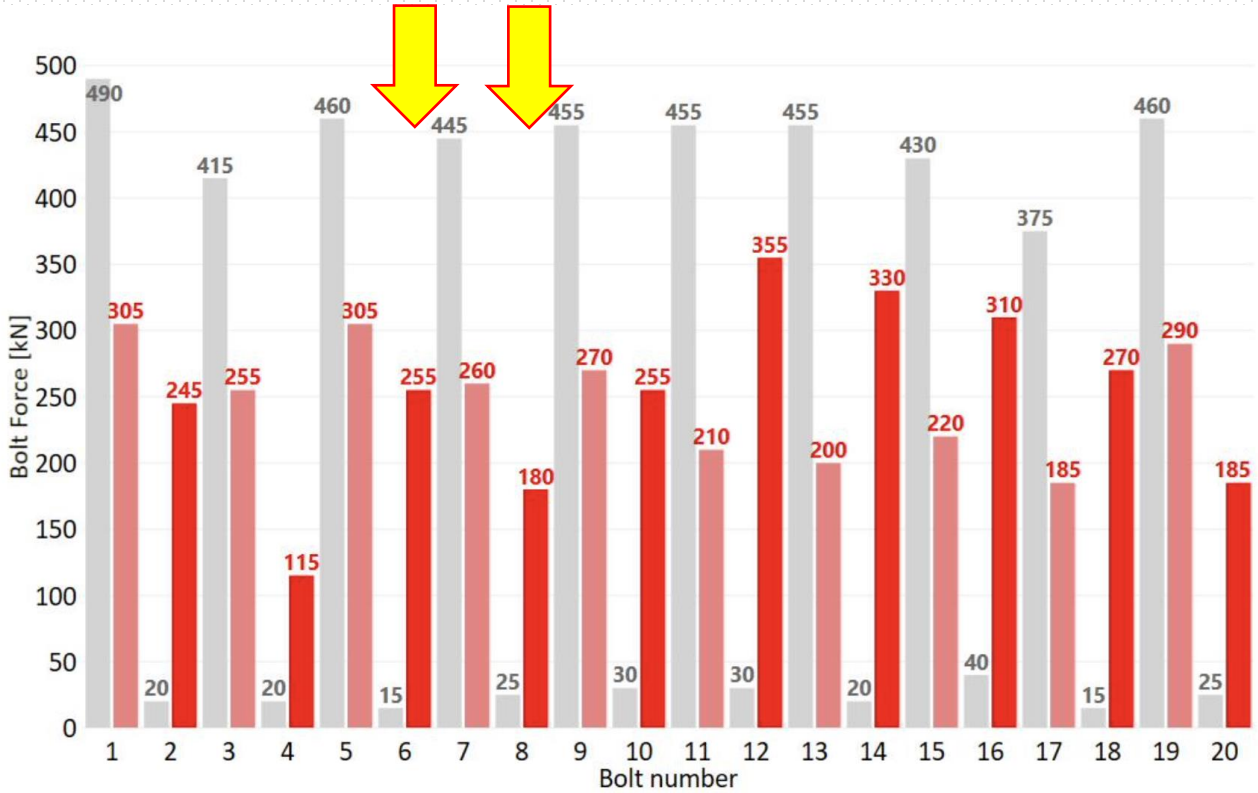
BEPERKING LEKVERLIEZEN FLENSVERBINDINGEN

Grootste afwijking bij Hydraulic Tensioning 16" flange



Test id	F16-TE-T68
Torqueing / Tensioning	Tensioning
Tensioners	10
Equip. manufacturer	Hytorq
Equip. technology	Hydraulic
Equip. type	tentec no:3
Final boltforce	341 [kN]
Current boltforce	100% = 341 [kN]
Total steps	7
Current step	4
Current bolt(s)	20,18,16,14,12,10,8,
Gasket type	SPW/Graphite
Bolt diamter	1-1/2
Bolt condition	New
Lubricant	None
Bolting Sequence	16"-tensioning

Boltforce [kN]	
1	305
2	245
3	255
4	115
5	305
6	255
7	260
8	180
9	270
10	255
11	210
12	355
13	200
14	330
15	220
16	310
17	185
18	270
19	290
20	185
Average [kN]	
250	
Scatter [kN]	
240	



Finish | Cancel | Previous Step | Save Step

Step (4)

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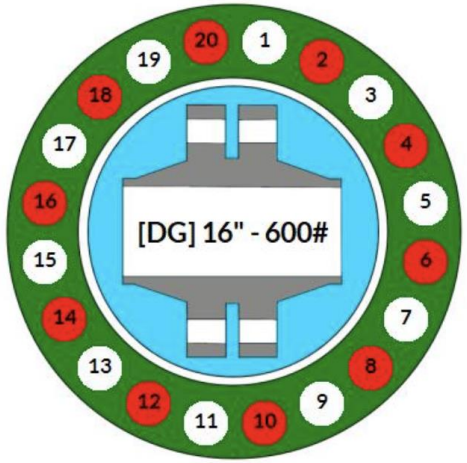
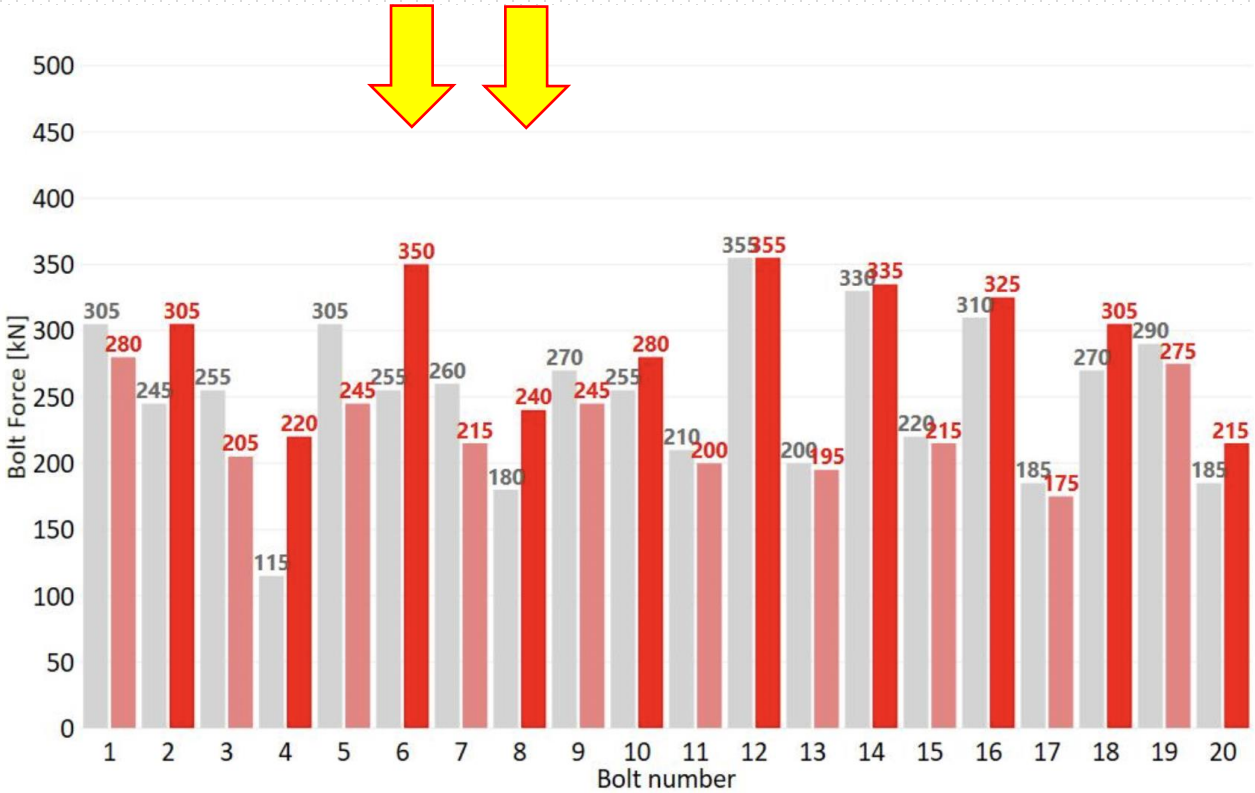
Grootste afwijking bij Hydraulic Tensioning 16" flange



Test id	F16-TE-T68
Torqueing / Tensioning	Tensioning
Tensioners	10
Equip. manufacturer	Hytorq
Equip. technology	Hydraulic
Equip. type	tentec no:3
Final boltforce	341 [kN]
Current boltforce	100% = 341 [kN]
Total steps	7
Current step	5
Current bolt(s)	20,18,16,14,12,10,8,
Gasket type	SPW/Graphite
Bolt diamter	1-1/2
Bolt condition	New
Lubricant	None
Bolting Sequence	16"-tensioning

Boltforce [kN]	
1	280
2	305
3	205
4	220
5	245
6	350
7	215
8	240
9	245
10	280
11	200
12	355
13	195
14	335
15	215
16	325
17	175
18	305
19	275
20	215
Average [kN]	
259	
Scatter [kN]	
180	



Step (5)

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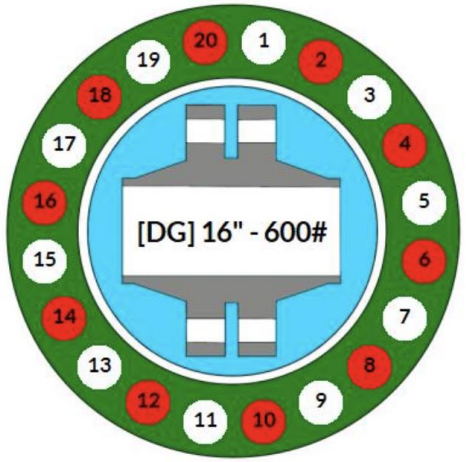
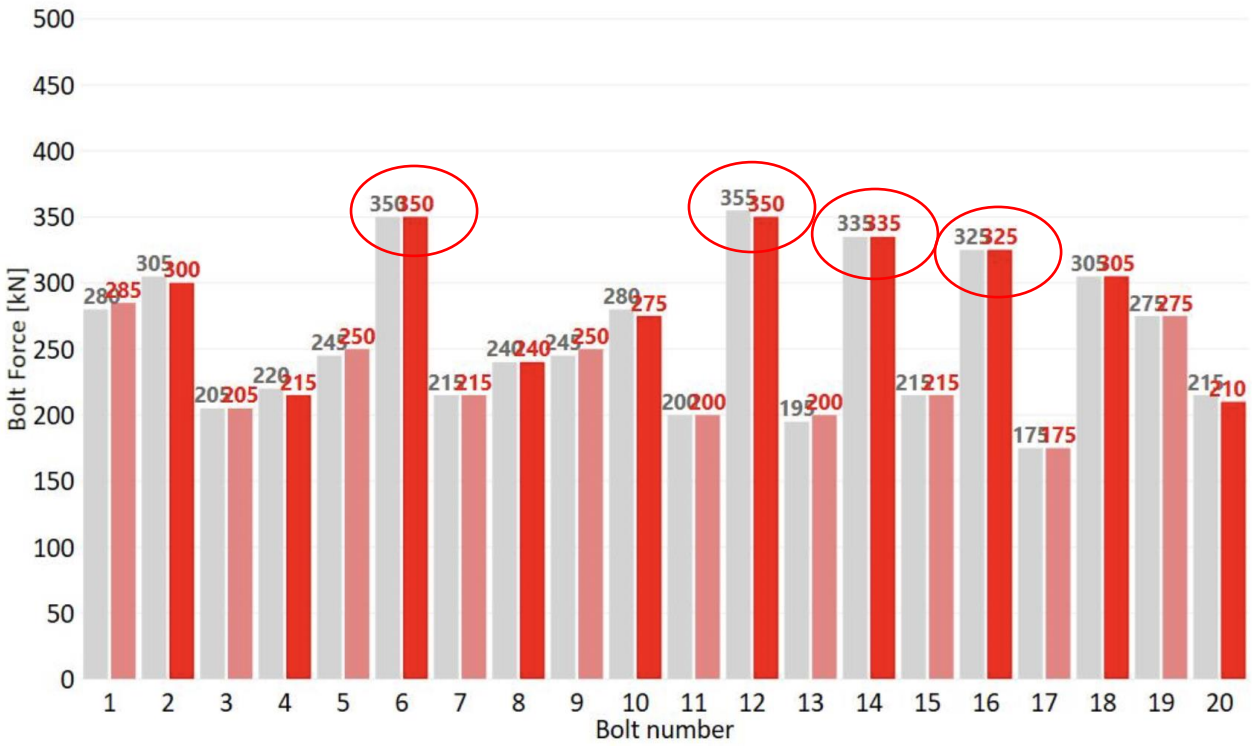
Grootste afwijking bij Hydraulic Tensioning 16" flange



Test id	F16-TE-T68
Torqueing / Tensioning	Tensioning
Tensioners	10
Equip. manufacturer	Hytorq
Equip. technology	Hydraulic
Equip. type	tentec no:3
Final boltforce	341 [kN]
Current boltforce	100% = 341 [kN]
Total steps	7
Current step	6
Current bolt(s)	20,18,16,14,12,10,8,
Gasket type	SPW/Graphite
Bolt diamter	1-1/2
Bolt condition	New
Lubricant	None
Bolting Sequence	16"-tensioning

Boltforce [kN]	
1	285
2	300
3	205
4	215
5	250
6	350
7	215
8	240
9	250
10	275
11	200
12	350
13	200
14	335
15	215
16	325
17	175
18	305
19	275
20	210
Average [kN]	
259	
Scatter [kN]	
175	



Finish | Cancel | Previous Step | Save Step

Step (6)

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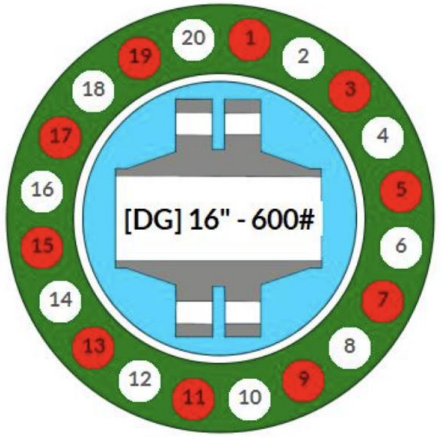
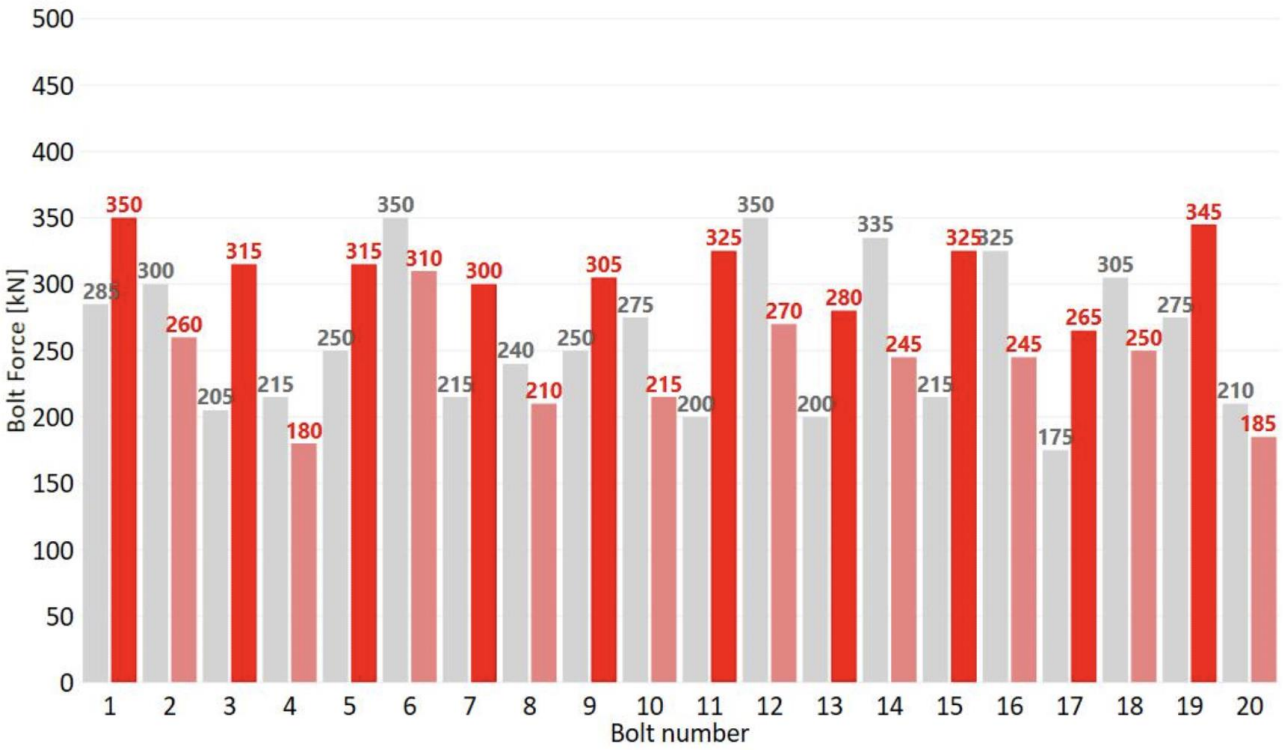
Grootste afwijking bij Hydraulic Tensioning 16" flange



Test id	F16-TE-T68
Torqueing / Tensioning	Tensioning
Tensioners	10
Equip. manufacturer	Hytorq
Equip. technology	Hydraulic
Equip. type	tentec no:3
Final boltforce	341 [kN]
Current boltforce	100% = 341 [kN]
Total steps	7
Current step	7
Current bolt(s)	19,17,15,13,11,9,
Gasket type	SPW/Graphite
Bolt diamter	1-1/2
Bolt condition	New
Lubricant	None
Bolting Sequence	16"-tensioning

Boltforce [kN]	
1	350
2	260
3	315
4	180
5	315
6	310
7	300
8	210
9	305
10	215
11	325
12	270
13	280
14	245
15	325
16	245
17	265
18	250
19	345
20	185
Average [kN]	
275	
Scatter [kN]	
170	



Finish | Cancel | Previous Step | Save Step

Step (7)

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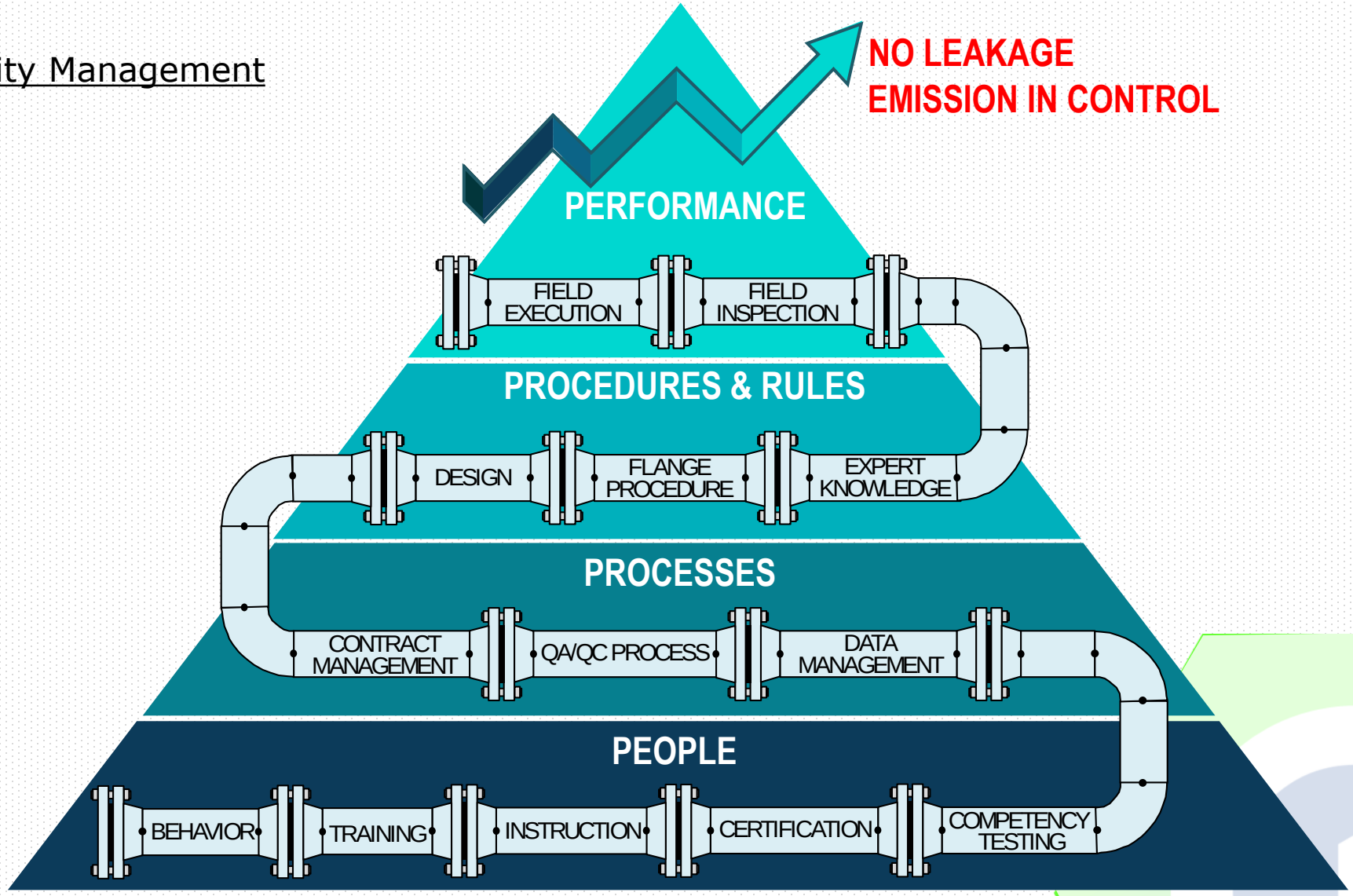
BEPERKING LEKVERLIEZEN FLENSVERBINDINGEN

FIM Model

FIM = Flange Integrity Management



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BEPERKING LEKVERLIEZEN FLENSVERBINDINGEN

Is er 'winst' te behalen met multi-tooling hydraulic torquing?

Praktijk demo 'multi-tooling' 10" flens met 4 cassettes

- Stap 1 en 2 : 'cross-wise' bouten (1-5-9-13) en (3-7-11-15) op 120%
- Stap 3 en 4 : 'cross-wise' bouten (2-6-10-14) en (4-8-12-16) op 120%
- Stap 5 en 6 : 'cross-wise' bouten (1-5-9-13) en (3-7-11-15) op 100%
- Stap 7 en 8 : 'cross-wise' bouten (2-6-10-14) en (4-8-12-16) op 100%
- Stap 9 en 10 : 'cross-wise' bouten (1-5-9-13) en (3-7-11-15) op 100%
- Stap 11 en 12 : 'cross-wise' bouten (2-6-10-14) en (4-8-12-16) op 100%

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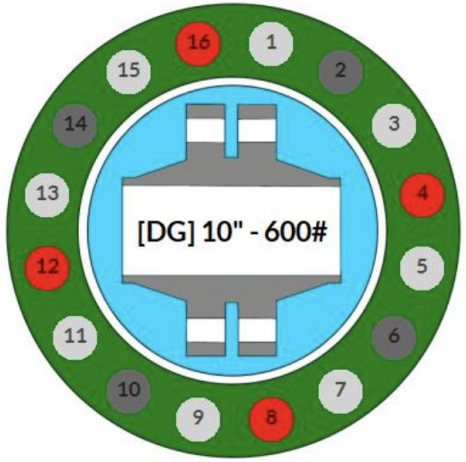
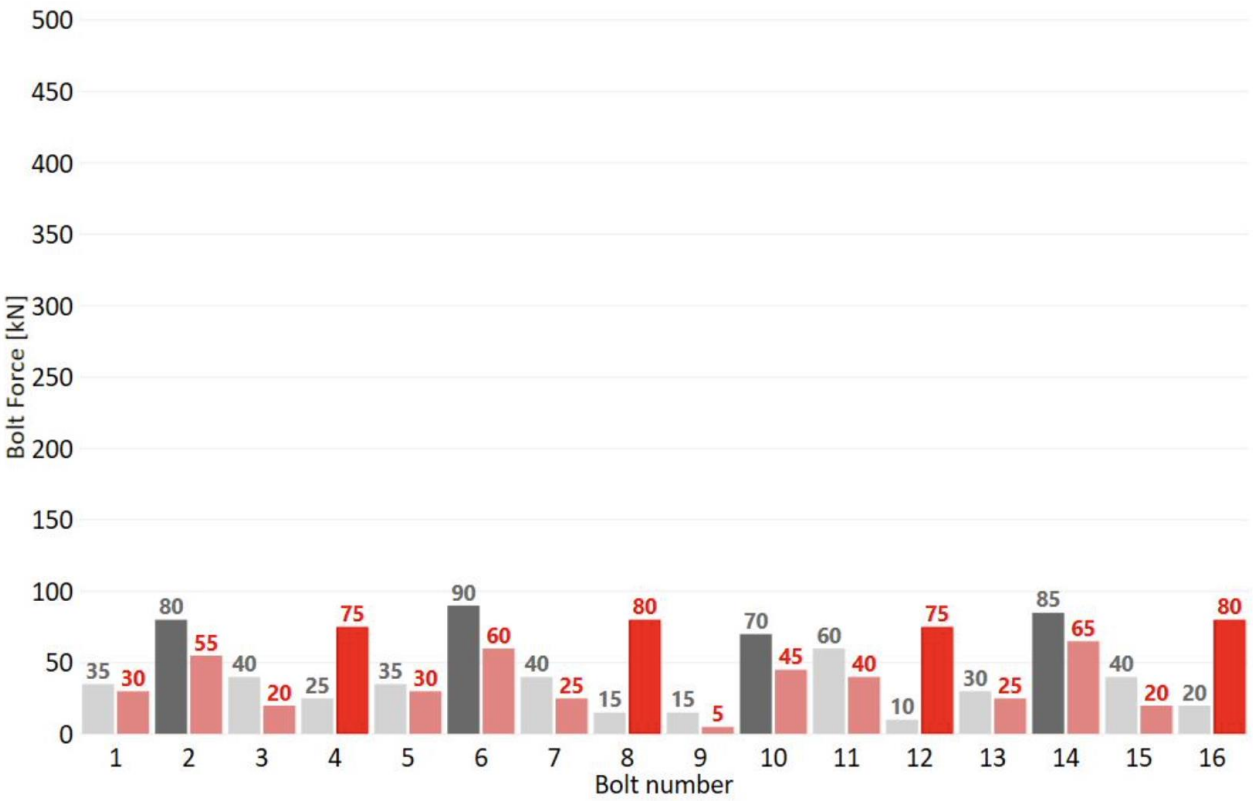
Screenshots test 10" flange – Gasket SPW – Greased P37

Bolt loads after 30% final torque cross-wise (step 12)



Test id	F10-HY-T55
Torqueing / Tensioning	Torqueing
Tool(s)	4
Equip. manufacturer	Hytorc
Equip. technology	Hydraulic
Equip. type	st2 slw50
Final torque	1200 [Nm]
Current torque	30% = 360 [Nm]
Total steps	92
Current step	4
Current bolt(s)	16,12,8,4
Gasket type	Kamprofiel
Bolt diamter	1-1/4
Bolt condition	New
Lubricant	P37

Boltforce [kN]	
1	30
2	55
3	20
4	75
5	30
6	60
7	25
8	80
9	5
10	45
11	40
12	75
13	25
14	65
15	20
16	80
Average [kN]	
46	
Scatter [kN]	
75	



Note: Gasket type in table wrongly mentioned as 'Kamprofiel'

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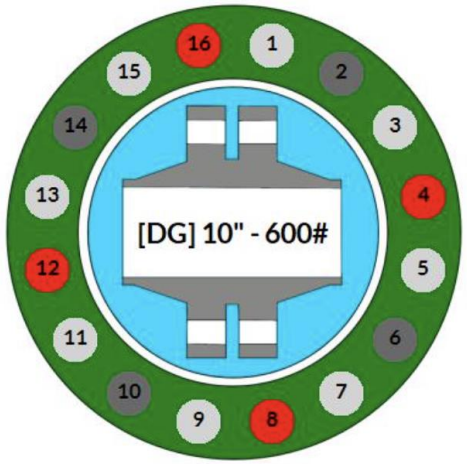
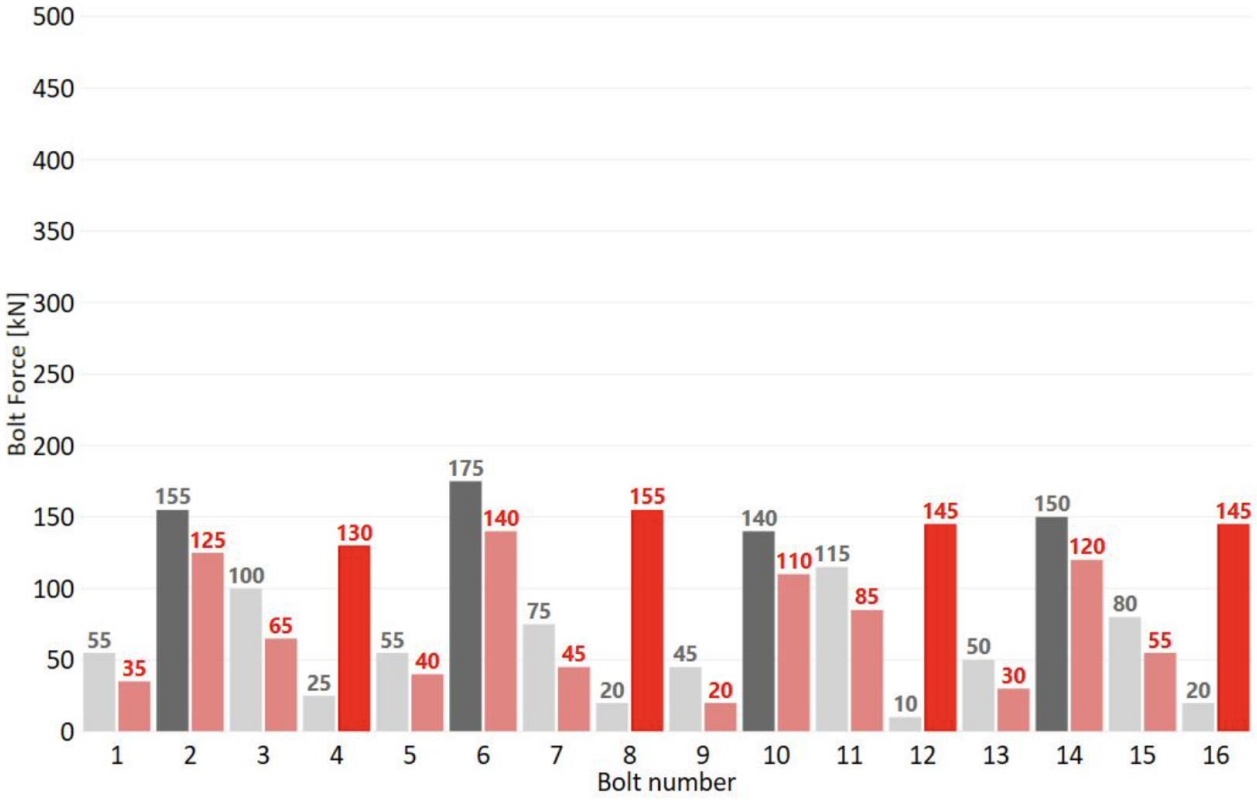
Screenshots test 10" flange – Gasket SPW – Greased P37

Bolt loads after 60% final torque cross-wise (step 8)



Test id	F10-HY-T55
Torqueing / Tensioning	Torqueing
Tool(s)	4
Equip. manufacturer	Hytorc
Equip. technology	Hydraulic
Equip. type	st2 slw50
Final torque	1200 [Nm]
Current torque	60% = 720 [Nm]
Total steps	92
Current step	8
Current bolt(s)	16,12,8,4
Gasket type	Kamprofiel
Bolt diamter	1-1/4
Bolt condition	New
Lubricant	P37

Boltforce [kN]	
1	35
2	125
3	65
4	130
5	40
6	140
7	45
8	155
9	20
10	110
11	85
12	145
13	30
14	120
15	55
16	145
Average [kN]	
90	
Scatter [kN]	
135	



Note: Gasket type in table wrongly mentioned as 'Kamprofiel'

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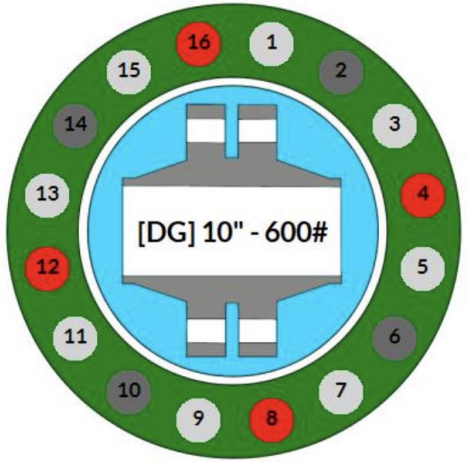
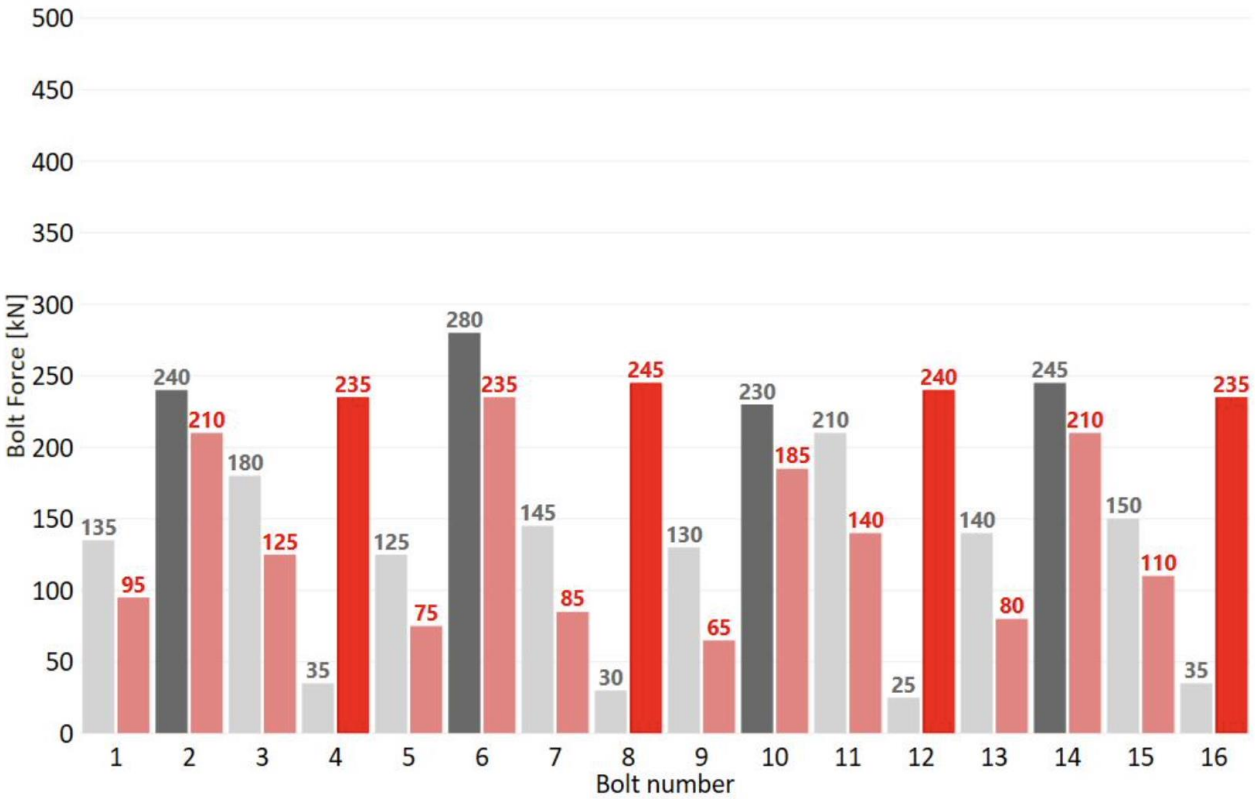
Screenshots test 10" flange – Gasket SPW – Greased P37

Bolt loads after 100% final torque cross-wise (step 12)



Test id	F10-HY-T55
Torqueing / Tensioning	Torqueing
Tool(s)	4
Equip. manufacturer	Hytorc
Equip. technology	Hydraulic
Equip. type	st2 slw50
Final torque	1200 [Nm]
Current torque	100% = 1200 [Nm]
Total steps	92
Current step	12
Current bolt(s)	16,12,8,4
Gasket type	Kamprofiel
Bolt diamter	1-1/4
Bolt condition	New
Lubricant	P37

Boltforce [kN]	
1	95
2	210
3	125
4	235
5	75
6	235
7	85
8	245
9	65
10	185
11	140
12	240
13	80
14	210
15	110
16	235
Average [kN]	
161	
Scatter [kN]	
180	



Note: Gasket type in table wrongly mentioned as 'Kamprofiel'

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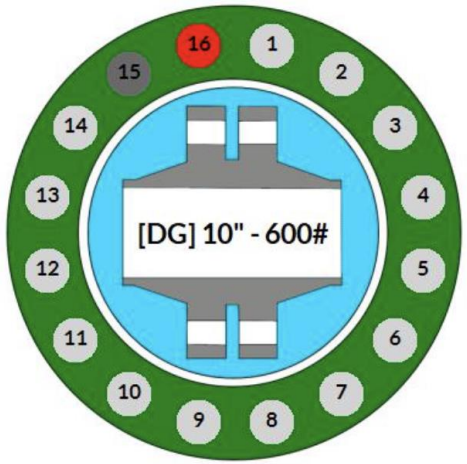
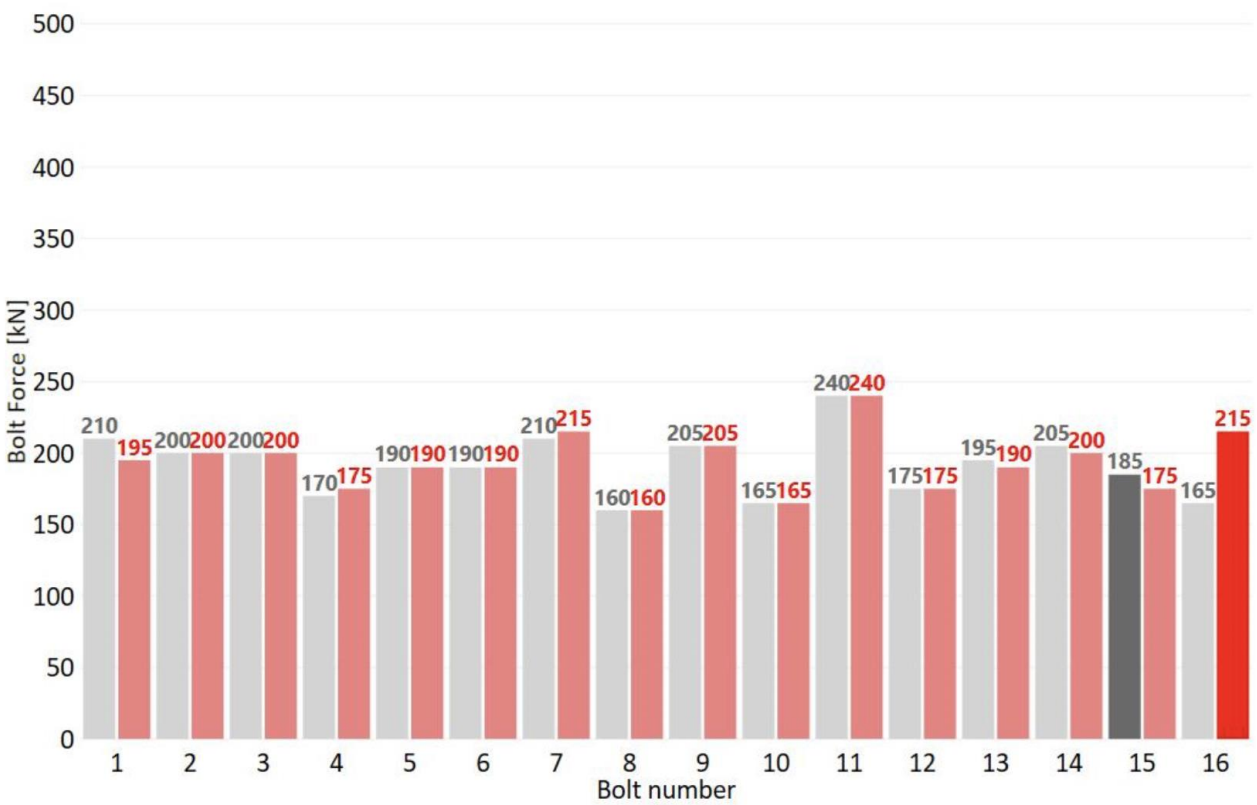
Screenshots test 10" flange – Gasket SPW – Greased P37

Bolt loads after 100% final torque clock-wise 1st round (step 28)



Test id	F10-HY-T55
Torqueing / Tensioning	Torqueing
Tool(s)	4
Equip. manufacturer	Hytorc
Equip. technology	Hydraulic
Equip. type	st2 slw50
Final torque	1200 [Nm]
Current torque	100% = 1200 [Nm]
Total steps	92
Current step	28
Current bolt(s)	16
Gasket type	Kamprofiel
Bolt diamter	1-1/4
Bolt condition	New
Lubricant	P37

Boltforce [kN]	
1	195
2	200
3	200
4	175
5	190
6	190
7	215
8	160
9	205
10	165
11	240
12	175
13	190
14	200
15	175
16	215
Average [kN]	
193	
Scatter [kN]	
80	



Note: Gasket type in table wrongly mentioned as 'Kamprofiel'

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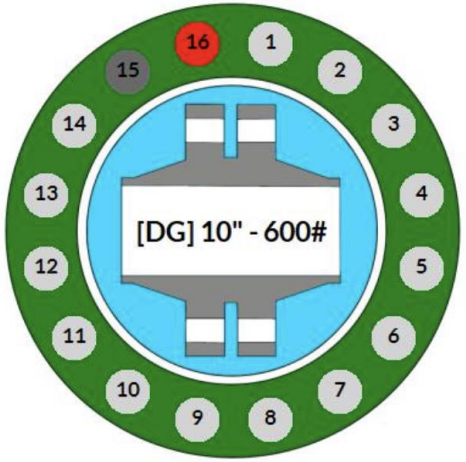
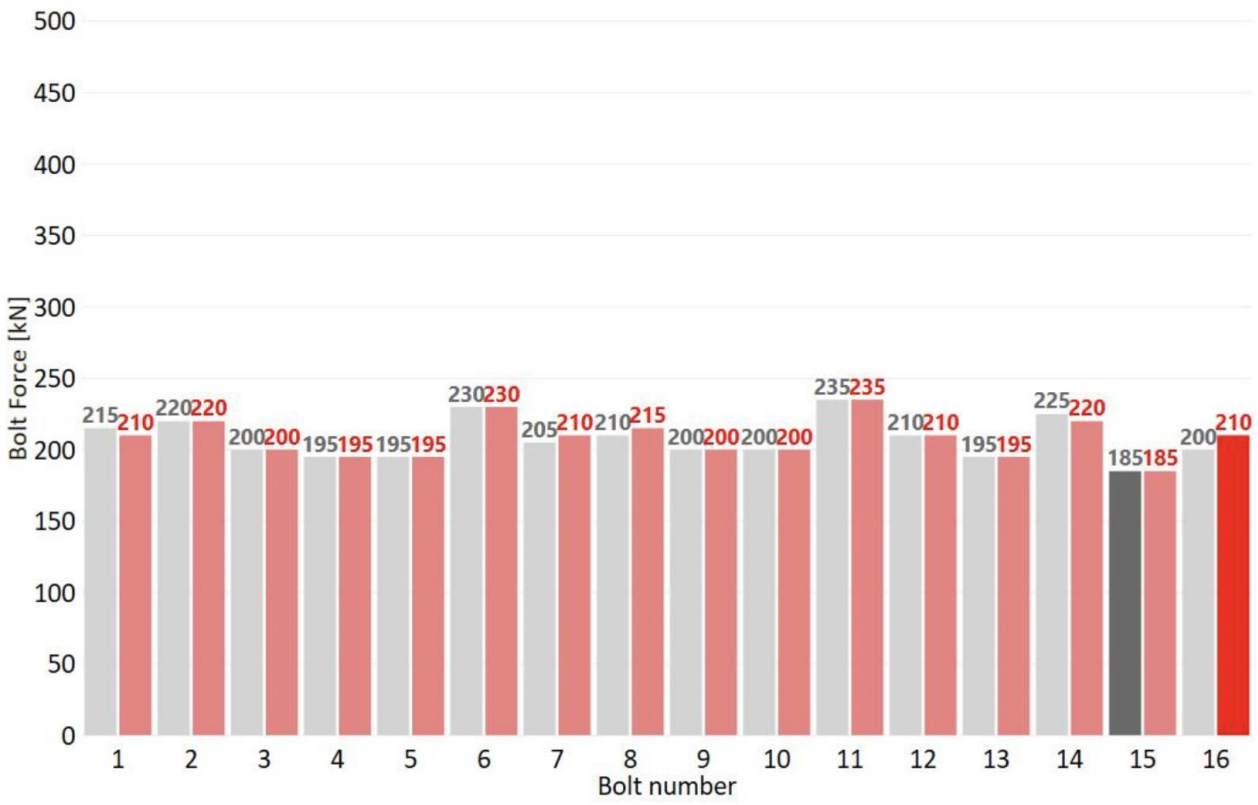
Screenshots test 10" flange – Gasket SPW – Greased P37

Bolt loads after 100% final torque clock-wise 2nd round (step 44)



Test id	F10-HY-T55
Torqueing / Tensioning	Torqueing
Tool(s)	4
Equip. manufacturer	Hytorc
Equip. technology	Hydraulic
Equip. type	st2 slw50
Final torque	1200 [Nm]
Current torque	100% = 1200 [Nm]
Total steps	92
Current step	44
Current bolt(s)	16
Gasket type	Kamprofiel
Bolt diamter	1-1/4
Bolt condition	New
Lubricant	P37

Boltforce [kN]	
1	210
2	220
3	200
4	195
5	195
6	230
7	210
8	215
9	200
10	200
11	235
12	210
13	195
14	220
15	185
16	210
Average [kN]	
208	
Scatter [kN]	
50	



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Project partijen

Interreg Vlaanderen-Nederland

Europees onderzoek subsidie

BEMAS

KIC MPi Kennis- en innovatiecentrum Maintenance Procesindustrie

Interreg project management

DIJKGRAAF SUPPORT

Project Lead
Financiering
Design
Analyse & Reporting

PROGRESSO GROUP - QUALITY - KNOWLEDGE - PERFORMANCE -

Project Supporter
Inbouw sensoren
Uitvoering testen

BoltSafe Load Measuring Systems

Project Supporter
Levering sensoren
Software meetsysteem

LASSEDRIJF MINDERHOUD

Constructie test-skid

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Praktijk test 10" flens: hydraulic torquing met 4 cassettes

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