INTRODUCTION

The Hi-Force STU series bolt tensioners are designed for quick and accurate tensioning of pipe flanges etc. in a subsea environment. The tensioner has a minimum of parts to enable fast and simple attachment to studs where visibility is poor.

Use of STU tensioners requires that the hexagon nuts used be drilled to accept tommy bars for tightening of the nut. These are not supplied with the tensioner due to the large variety of sizes of nut drillings in use.

It is recommended that these instructions are read in conjunction with the pump instructions. Hi-Force recommends the use of an AHP275BTU pump unit for tensioning duties.

The use of Hi-Force Boltright software is a simple way to determine the pressures required for correct joint tightening.

SAFETY NOTES

WARNING!

All equipment used must be rated for the same operating pressure i.e. 1500 Bar (21,750 psi). DO NOT MIX high and low pressure components. If in doubt, contact your local Hi-Force Distributor.

Never attempt to use this High Pressure equipment if you are in any doubt regarding the correct assembly and operation.

Always wear eye protection and gloves.

Do not exceed the maximum working pressure as stated on the load cell.

Never exceed maximum piston stroke. When the red or yellow indicator band on the piston becomes visible, stop the pump see fig.

Never pressurise an un-coupled male coupling connector.

Only approach pressurised Bolt Tensioners
When you are certain pressure is holding.

Never attempt to solve leaks in the system while the system is pressurised.

Ensure there is sufficient thread protruding above the nut to allow full engagement of the quick release split nut.

Failure to follow these instructions will result in damage to the unit or may result in operator injury or death.

1. IDENTIFICATION OF COMPONENTS

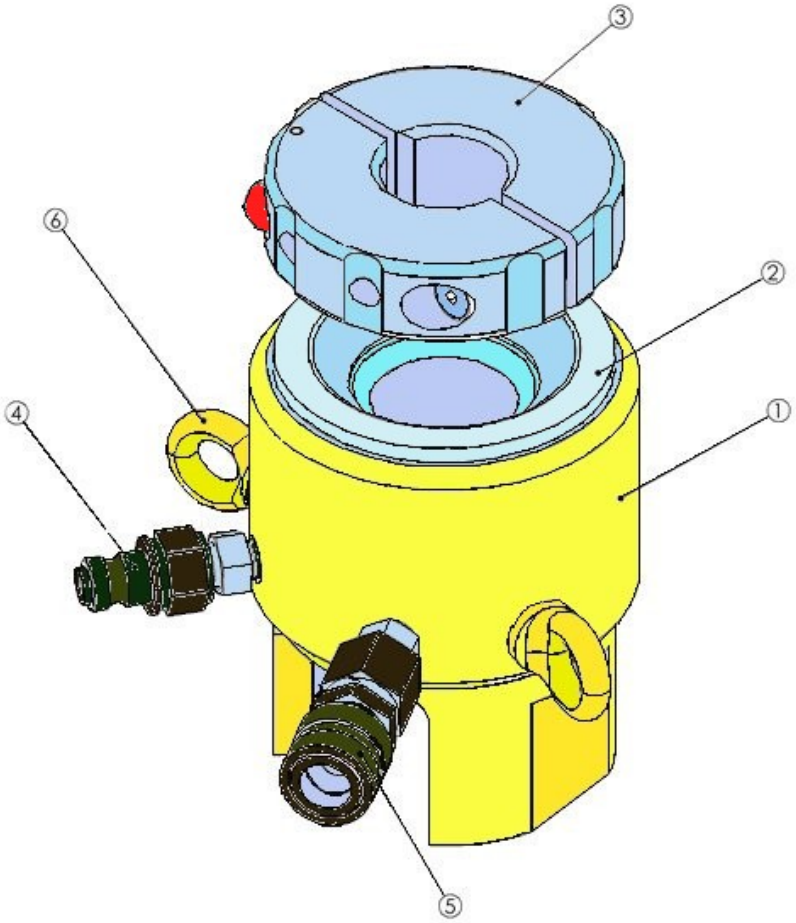


Fig 1 Tensioner components

1. Cylinder
2. Piston
3. Quick release split nut
4. Male coupler
5. Female coupler
6. Lifting eye

MODEL	Max thread size		capacity		Eff. Area cm²	Stroke mm
	Imperial	Metric	kN	Tonne		
STU1	1. 1/8”	M27	256.04	26.10	17.07	20
STU2	1. 3/8”	M36	430.36	43.87	28.69	30
STU3	1. 5/8”	M42	533.39	56.41	36.89	30
STU4	1. 7/8”	M48	756.30	77.09	50.42	30
STU5	2. ¼”	M56	1168.19	119.08	77.88	30
STU6	2. ¾”	M72	1649.12	168.11	109.94	30
STU7	3. 1/2”	M90	2483.44	253.15	165.56	30

Table 1 Tensioner capacities

Hi-Force STU tensioners in common with most other similar equipment have no physical built in device to prevent the piston being pumped right out of the cylinder. This allows the tool to be kept compact for use in confined spaces. In many cases when used with heavy series hexagon nuts the stroke will be limited by the top of the nut coming into contact with the inside of the tensioner body. For this reason the nuts should not be screwed down during the pressurisation process as this will eliminate this safeguard. Do not rely on the nuts to limit the stroke but observe the movement of the pistons. Hi-Force STU tensioners have a maximum stroke indicator in the form of a red band on the piston. When this band becomes visible the piston is at maximum stroke and the pump should be stopped immediately.

In the event of over stroking the tensioner is designed so that escaping oil will be directed inwards to the centre of the tool rather than towards the operator. Seal damage is very likely if pistons are over stroked in this manner.

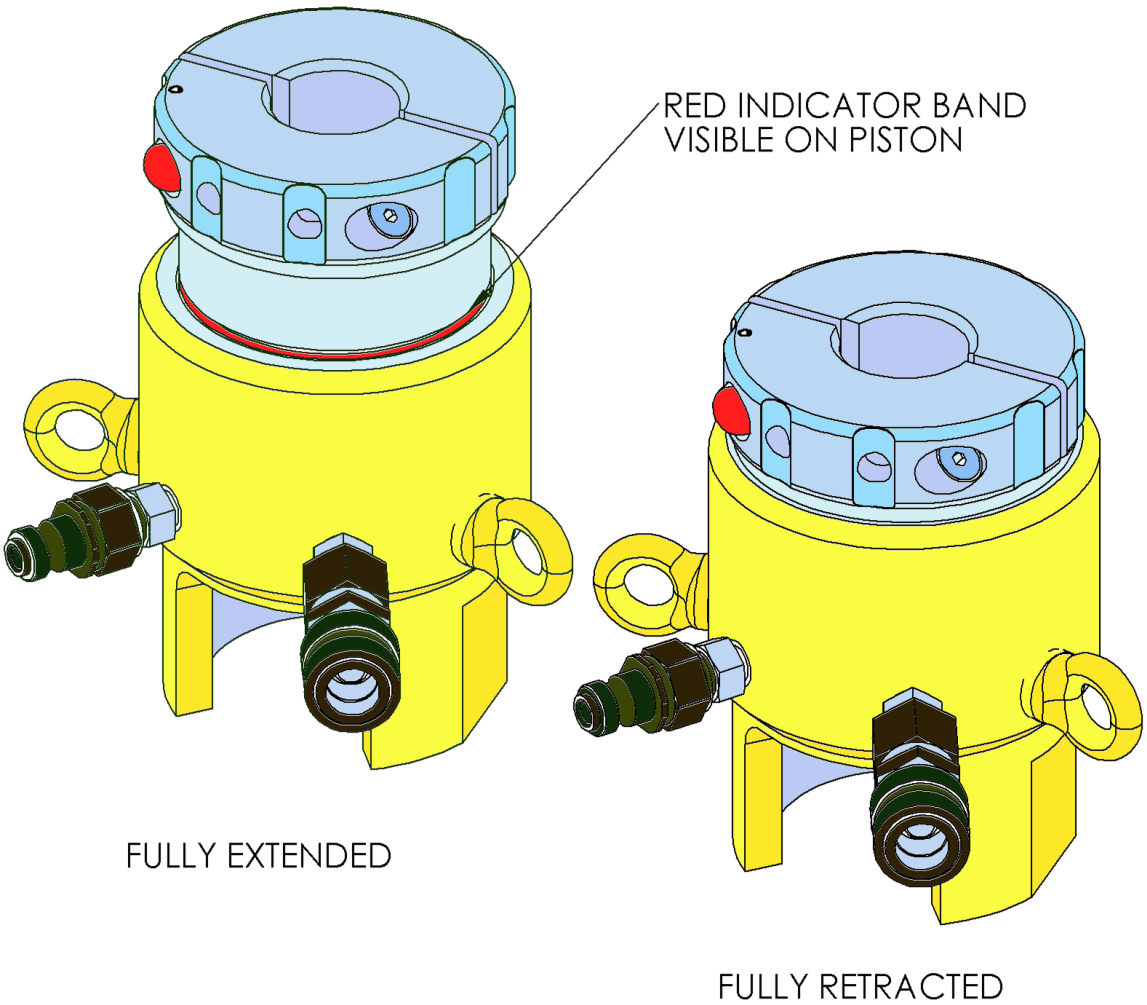
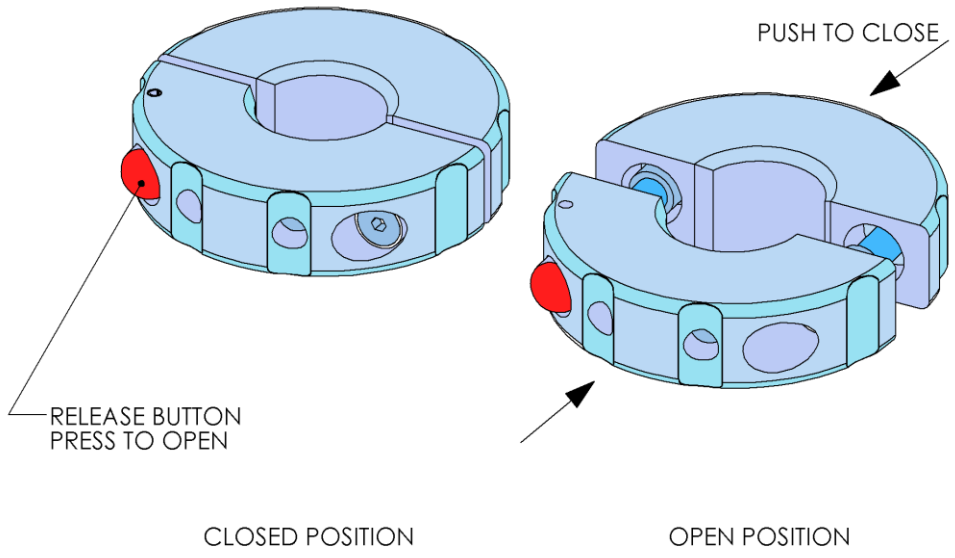


Fig 2 Quick release split nut



2. STUD BOLT AND FLANGE PREPARATION

Preparation of stud bolts where possible before installation in the flange will simplify the use of the tensioners.

In order to use the STU tensioner it is important that sufficient thread is protruding beyond the drilled hexagonal nut. See figure 3 and table 2 for the required lengths of stud for the tensioner in use.

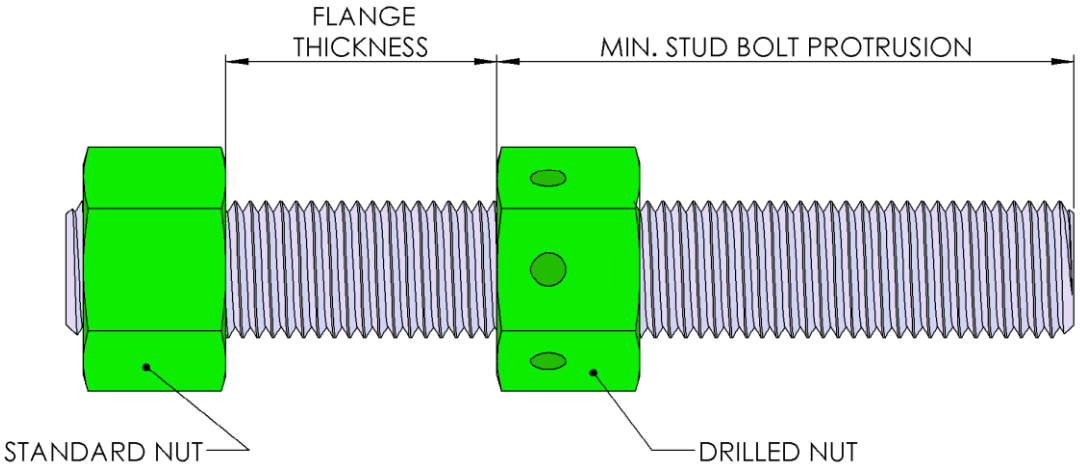


Fig 3 Stud Bolt preparation

TENSIONER MODEL	MIN. STUD BOLT PROTRUSION (mm)
STU1	150
STU2	164
STU3	169
STU4	181
STU5	202
STU6	231
STU7	260

Table 2 Stud bolt protrusion

Ensure that the drilled hexagon nut is free running over the entire protrusion length plus an additional 30mm to allow for joint compression. Note that the protrusion lengths given in table 2 are for the uncompressed joint and gasket assembly.

Check that the Quick release split nut can be closed onto on to the stud bolt by hand and that once closed it is free running.

Assembly of the stud bolts into the flange must be carried out in certain ways depending on the bolt spacing and whether it is intended to use 100% tensioning (one tensioner per bolt) or 50% tensioning (one tensioner for every two bolts).

The simplest and least time consuming method is to use 100% tensioning. This way all bolts are brought to the desired tension in a single operation. To carry out 100% tensioning it is usual to assemble the flange so that the stud bolts are arranged in alternate directions and tensioners are fitted to both sides of the flange. See Fig 4. An exception to this may be in situations where there is sufficient space to fit a tensioner to every adjacent bolt on the same side of the flange.

In situations where access is restricted on one side of the flange or where insufficient tensioners are available for 100% tensioning the bolts should be assembled as in Fig. 5.

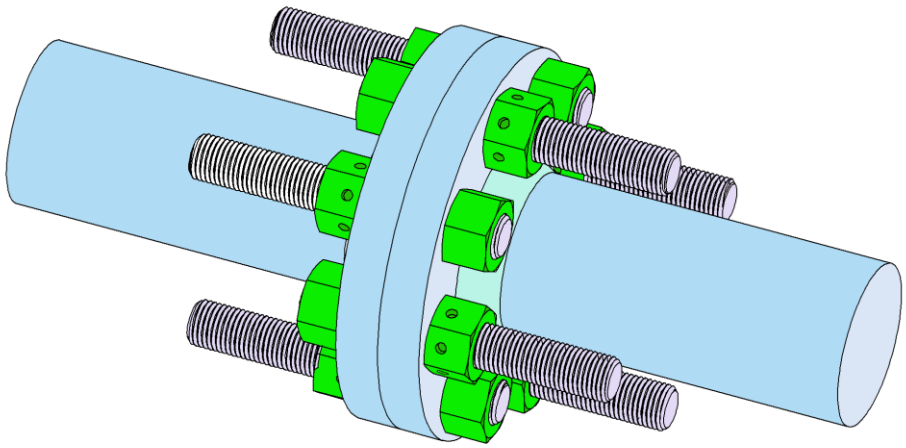


Fig 4 Flange assembly for 100% tensioning

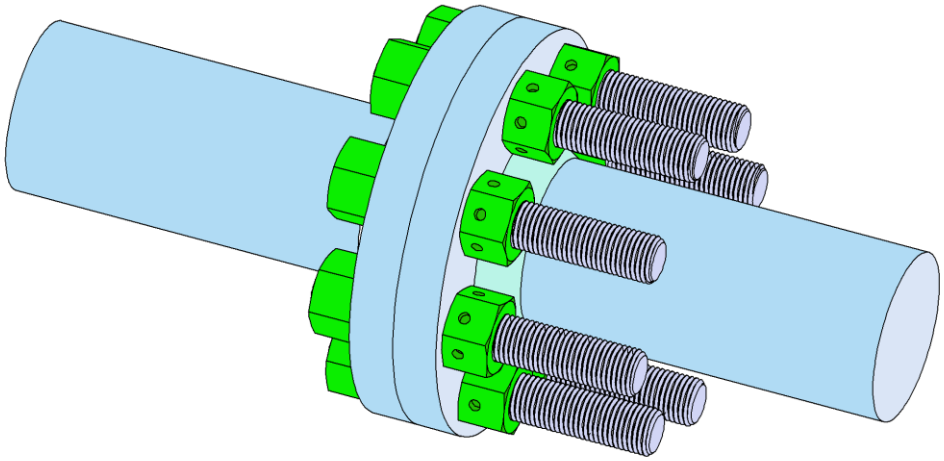


Fig 5 Flange assembly for 50% tensioning

The 50% tensioning method is a two stage process whereby half of the bolts are tensioned followed by the other half. This is more time consuming and can lead to less accurate bolt tensioning.

3. FITTING OF TENSIONERS AND HOSES TO STUD BOLTS

Once the flange halves have been brought together and the gasket and stud bolts fitted, the STU tensioners can be assembled onto the flange.

Ensure that each tensioner is fully retracted. See figure #. (An exception to this is when de-tensioning a joint – refer to detensioning section) If the tensioner is not fully retracted see Maintenance section.

Slide a tensioner over each stud bolt (for 50% tensioning every alternate bolt). Centralise the tensioner by hand and fit a quick release split nut onto the stud bolt, with the conical end towards the tensioner. Squeeze the two halves of the split nut together until it locks onto the thread. If the split nut does not close, the threads have not engaged. Simply move it slightly and try again. Screw the split nut fully down onto the tensioner by hand so that the conical faces are fully engaged. This will also serve to centralise the tensioner on the thread. Ensure that the window in the tensioner and the couplers are pointing radially outwards from the joint.

Now that the tensioners are in place, the hoses can be connected. To connect hoses, slide the collar on the female half of the coupler away from the end of the coupler, push in the male half of the coupler and release the collar. A gentle tug on the assembled connection will check that they are correctly engaged. It is vital that all connections are correctly made otherwise oil cannot flow in the system.

Connect the male end of the main line hose to the pump. Connect the female end of the main line hose to a convenient male connection on one of the tensioners. Then, using short link hoses work in a logical sequence around the joint connecting all the tensioners together generally as in Fig 6. At the end of this sequence one tensioner will be left with an un-connected female coupler half. N.B. If there is an unconnected male connection, an error has occurred in the connection sequence. **An unconnected male coupler must never be pressurised.**

If couplers are difficult to connect this can be caused by a damaged coupler, or pressure already locked in the system. The most likely cause of pressure in a tensioner is due to the split nut being screwed down too tightly. Simply unscrew the split nut slightly and try again. Pressure can be locked in a hose that has previously been used at a greater depth. In this case return the hose to the surface and follow instructions in Maintenance section for hose bleeding.

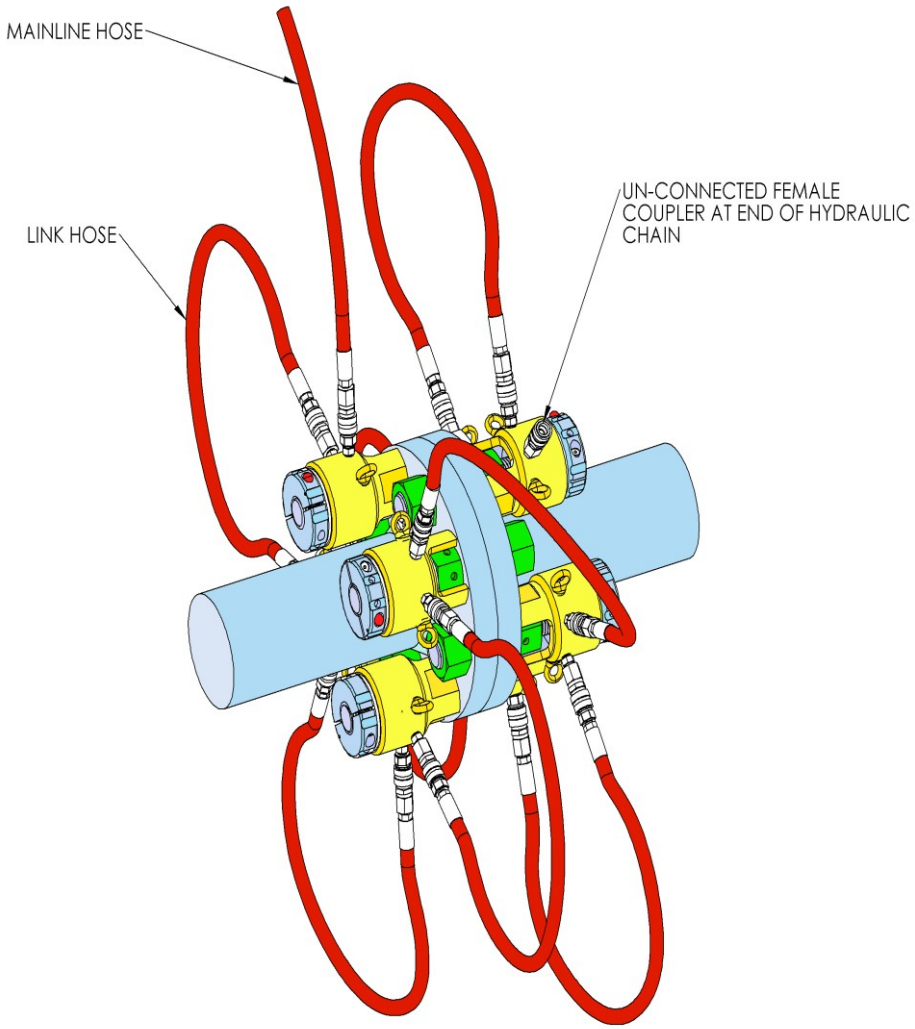


Fig 6 Typical flange assembly for 100% tensioning

4. SETTING OF PUMP PRESSURE

It is strongly recommended that a Hi-Force AHP275BTU pump unit is used to pressurise the STU tensioners. Refer to the pump literature for detailed instructions. However in general terms, the pump must be pre-set to the calculated tensioning pressure for the flange/bolt combination in question. To do this proceed as follows:-

- Ensure that no hose is connected to the pump
- Open the hydraulic release valve fully
- Turn the air pressure regulator knob fully anticlockwise to reduce air pressure to zero
- Connect pump to the air supply
- Open the air shut off valve adjacent to the regulator. The pump should not operate.
- Increase the air pressure by slowly turning the pressure regulator knob clockwise until the pump starts operating.
- Close the hydraulic release valve without using undue force.
- Monitor the oil pressure gauge and increase the air pressure until the pump stalls at the desired oil pressure
- Slowly open the hydraulic release valve to release pressure, and then close again to check the pressure setting. Adjust if required.
- Close the air shut off valve first, then, open the hydraulic release valve.
- Even though the pump has been set to stall at the desired pressure, it is good practice to monitor the oil pressure during the tensioning procedure.

5. PROCEDURE FOR 100% TENSIONING

It is strongly recommended that Hi-Force Boltright software is used to calculate the correct tensioner pressure to ensure that the desired residual bolt load is achieved after the tensioning operation is complete. Boltright software will generate a pump pressure setting designated as pressure B.

1. Assemble the flange by manual methods, ensuring the flange faces are parallel. Fit the tensioners and hoses as in section 3 and set the pump pressure as in section 4. Obtain a signal from the diver that the joint is ready for pressurisation.
2. Apply a low hydraulic pressure of approx 50-60Bar and obtain confirmation that all tensioners are centralised on the nuts and that quick release split nuts are fully engaged. Correct any problems before proceeding.
3. Apply pressure “B” as determined by Boltright software or calculation. Check that all tensioners have extended. If a tensioner has not extended the most likely cause is a faulty connection.
4. Screw down all drilled hexagon nuts using a tommy bar through the window on the bridge body.
5. Release the pressure and then re-apply twice more. At each pressure application attempt to screw down the hexagon nuts further.
6. Check that the gap around the flange is still uniform, and as a final test re-apply hydraulic pressure once more. If the nuts can still be tightened repeat steps 5 and 6. If after this the nuts can still be turned this suggests a problem with the stud bolt or nut. Check that the correct grade is being used and that the load being applied is not too high.

6. PROCEDURE FOR 50% TENSIONING

It is strongly recommended that Hi-Force Boltright software is used to calculate the correct tensioner pressure to ensure that the desired residual bolt load is achieved after the tensioning operation is complete. This software will generate two pressure settings, A and B (sometimes referred to as first pass and second pass pressures) Pressure A is the higher value and is designed to compensate for cross talk between bolts.

1. Assemble the flange by manual methods, ensuring the flange faces are parallel. Fit the tensioners and hoses as in section 3 and set the pump pressure as in section 4. Obtain a signal from the diver that the joint is ready for pressurisation.

2. Apply a low hydraulic pressure of approx 50-60bar and obtain confirmation that all tensioners are centralised on the nuts and that quick release split nuts are fully engaged. Correct any problems before proceeding.

3. Apply pressure “A” as determined by Boltright software or calculation. Check that all tensioners have extended. If a tensioner has not extended the most likely cause is a faulty connection.

4. Screw down all drilled hexagon nuts using a tommy bar through the window on the bridge body.

5. Release the pressure and then re-apply twice more. At each pressure application attempt to screw down the hexagon nuts further. Check at this stage how much of the available stroke of the tensioners has been used. If more than approximately 75% of the stroke is used, the tensioners must be retracted before proceeding to the next stage. To retract the tensioners release the pressure and ensure that the hydraulic release valve on the pump remains open. Using a tommy bar screw down each quick release split nut in turn until the pistons are pushed fully back into the cylinders.

6. Transfer the tensioners to the remaining bolts and set up as previously.

7. Apply pressure B to the bolts and screw down the hexagon nuts us in a tommy bar.

8. Reapply pressure B twice more, tightening the hexagon nuts at each stage.

9. Transfer the tensioners to the original group of bolts and apply pressure B. If the nuts cannot be tightened, the tensioning is complete. If it is possible to tighten the nuts further than re apply the pressure twice more, tightening the nuts at each stage.

10. Transfer the tensioners to the other 50% of the bolts and repeat stages 9 and 10. If subsequent repetition is needed then this points to a problem with the stud bolts or nuts.

7. PROCEDURE FOR DE-TENSIONING A JOINT

1. It is not generally possible to determine the pressure required to de-tension a joint. It is usually but not always slightly more than the tensioning pressure. However to be sure that adequate pressure is available, set the pump pressure to the maximum tool pressure (1500 bar).

2. Before subsea detensioning operations advance the STU tensioners by approximately 5mm to prevent the quick release split nut becoming locked onto the piston when pressure is released.
3. Assemble the tensioners and hoses as in section 3.

4. Apply a low hydraulic pressure of approx 50-60bar and obtain confirmation that all tensioners are centralised on the nuts and that quick release split nuts are fully engaged. Correct any problems before proceeding.

5. Increase pressure until the drilled hexagon nuts can be rotated by means of the tommy bar. Stop the pump.

6. Un-screw all of the nuts by at least 2 turns.

7. De pressurise the system and remove the tensioners.

8. ROUTINE MAINTENANCE

TENSIONERS

Immediately after use the tensioners must be rinsed with freshwater (not seawater) or immersed in light oil pending cleaning in the near future. After rinsing the tensioners should be coated with moisture displacing spray such as WD40. Retract tensioners ready for the next use as follows. Fit an open coupler or hose to one of the couplers on the tensioner. Position a suitable container under the open coupler to catch the oil. Then use either a weight or a small press to push the piston back. The oil collected will be contaminated with sea water and should not be returned to the pump reservoir. It should be disposed of in a responsible manner.

QUICK RELEASE SPLIT NUTS

Thoroughly rinse with fresh water immediately after use. Operate the mechanism repeatedly to clear debris and salt water residue. Spray with moisture displacing spray (WD40 or similar) or coat in light oil.

HOSES

Vent pressure from hoses by fitting an open coupling and collecting oil in a suitable container. Do not return this oil to the pump reservoir as it will be contaminated by sea water. Do not drain hoses completely unless they are to be immediately refilled with clean oil. A hose full of air can be dangerous when re-pressurised.

APPENDIX 1 LOAD TABLES

The following tables give figures for guidance to assist with tool selection. For accurate bolt tension loads, Boltright software should be used.

Table A1: Metric bolt loads

PUMP PRESSURE		BOLT LOAD (kN)						
(BAR)	(PSI)	STU1	STU2	STU3	STU4	STU5	STU6	STU7
50	725	8.535	14.345	18.445	25.21	38.94	54.97	82.78
100	1450	17.07	28.69	36.89	50.42	77.88	109.94	165.56
150	2176	25.605	43.035	55.335	75.63	116.82	164.91	248.34
200	2901	34.14	57.38	73.78	100.84	155.76	219.88	331.12
250	3626	42.675	71.725	92.225	126.05	194.7	274.85	413.9
300	4351	51.21	86.07	110.67	151.26	233.64	329.82	496.68
350	5076	59.745	100.415	129.115	176.47	272.58	384.79	579.46
400	5802	68.28	114.76	147.56	201.68	311.52	439.76	662.24
450	6527	76.815	129.105	166.005	226.89	350.46	494.73	745.02
500	7252	85.35	143.45	184.45	252.1	389.4	549.7	827.8
550	7977	93.885	157.795	202.895	277.31	428.34	604.67	910.58
600	8702	102.42	172.14	221.34	302.52	467.28	659.64	993.36
650	9428	110.955	186.485	239.785	327.73	506.22	714.61	1076.14
700	10153	119.49	200.83	258.23	352.94	545.16	769.58	1158.92
750	10878	128.025	215.175	276.675	378.15	584.1	824.55	1241.7
800	11603	136.56	229.52	295.12	403.36	623.04	879.52	1324.48
850	12328	145.095	243.865	313.565	428.57	661.98	934.49	1407.26
900	13054	153.63	258.21	332.01	453.78	700.92	989.46	1490.04
950	13779	162.165	272.555	350.455	478.99	739.86	1044.43	1572.82
1000	14504	170.7	286.9	368.9	504.2	778.8	1099.4	1655.6
1050	15229	179.235	301.245	387.345	529.41	817.74	1154.37	1738.38
1100	15954	187.77	315.59	405.79	554.62	856.68	1209.34	1821.16
1150	16680	196.305	329.935	424.235	579.83	895.62	1264.31	1903.94
1200	17405	204.84	344.28	442.68	605.04	934.56	1319.28	1986.72
1250	18130	213.375	358.625	461.125	630.25	973.5	1374.25	2069.5
1300	18855	221.91	372.97	479.57	655.46	1012.44	1429.22	2152.28
1350	19580	230.445	387.315	498.015	680.67	1051.38	1484.19	2235.06
1400	20306	238.98	401.66	516.46	705.88	1090.32	1539.16	2317.84
1450	21031	247.515	416.005	534.905	731.09	1129.26	1594.13	2400.62
1500	21756	256.05	430.35	553.35	756.3	1168.2	1649.1	2483.4

Table A2: Imperial bolt loads

PUMP PRESSURE		BOLT LOAD (Lbf)						
(BAR)	(PSI)	STU1	STU2	STU3	STU4	STU5	STU6	STU7
50	725	1919	3225	4146	5667	8754	12357	18609
100	1450	3837	6450	8293	11334	17507	24715	37218
150	2176	5756	9674	12439	17002	26261	37072	55827
200	2901	7675	12899	16586	22669	35015	49429	74436
250	3626	9593	16124	20732	28336	43769	61786	93045
300	4351	11512	19349	24879	34003	52522	74144	111654
350	5076	13431	22573	29025	39670	61276	86501	130263
400	5802	15349	25798	33171	45338	70030	98858	148872
450	6527	17268	29023	37318	51005	78783	111215	167480
500	7252	19187	32248	41464	56672	87537	123573	186089
550	7977	21105	35472	45611	62339	96291	135930	204698
600	8702	23024	38697	49757	68006	105045	148287	223307
650	9428	24943	41922	53904	73674	113798	160644	241916
700	10153	26861	45147	58050	79341	122552	173002	260525
750	10878	28780	48371	62197	85008	131306	185359	279134
800	11603	30699	51596	66343	90675	140059	197716	297743
850	12328	32617	54821	70489	96343	148813	210073	316352
900	13054	34536	58046	74636	102010	157567	222431	334961
950	13779	36455	61270	78782	107677	166321	234788	353570
1000	14504	38373	64495	82929	113344	175074	247145	372179
1050	15229	40292	67720	87075	119011	183828	259502	390788
1100	15954	42211	70945	91222	124679	192582	271860	409397
1150	16680	44129	74169	95368	130346	201335	284217	428006
1200	17405	46048	77394	99514	136013	210089	296574	446615
1250	18130	47967	80619	103661	141680	218843	308931	465224
1300	18855	49885	83844	107807	147347	227597	321289	483833
1350	19580	51804	87068	111954	153015	236350	333646	502441
1400	20306	53723	90293	116100	158682	245104	346003	521050
1450	21031	55641	93518	120247	164349	253858	358360	539659
1500	21756	57560	96743	124393	170016	262611	370718	558268

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