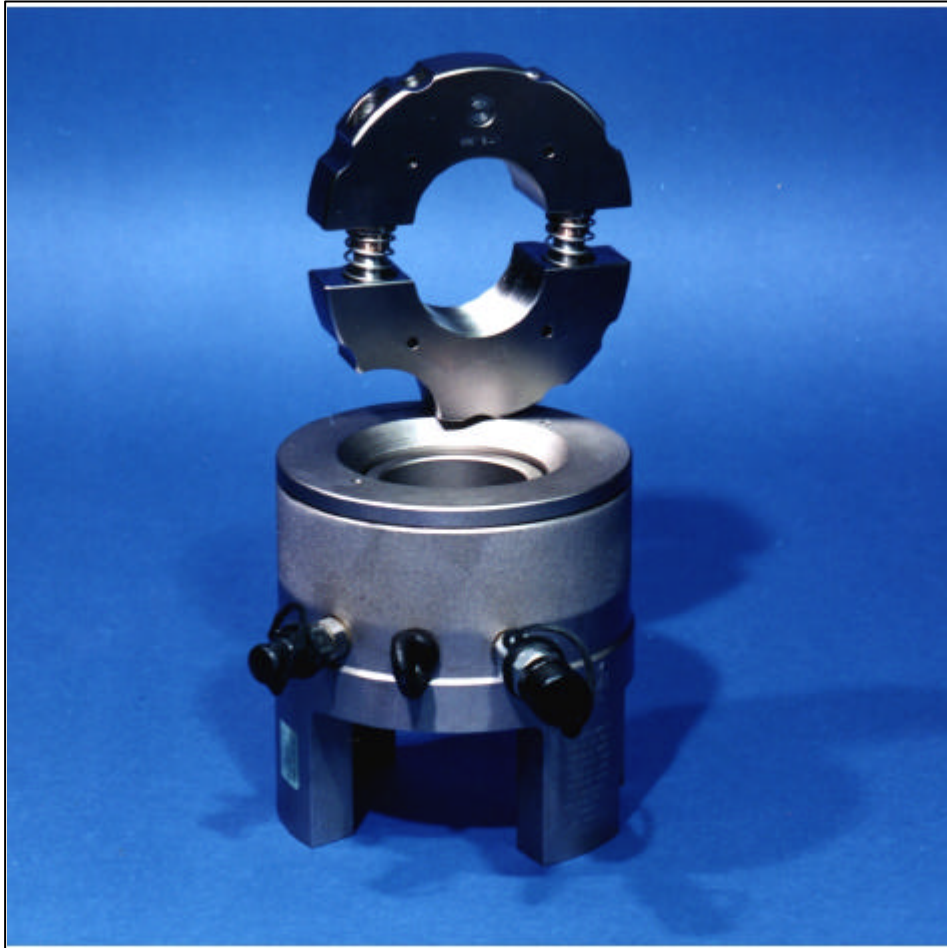


Operating Procedure



TITON SUBSEA BOLT TENSIONER



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Ref: BAH/OPS/ST/002

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Introduction

The TITON subsea bolt tensioning system has been developed for use on subsea bolted joints where speed reliability and simple operation are essential. They are hydraulically operated tools being connected to a hydraulic pump via a hydraulic harness and downline assembly.

The tensioning tool comprises of a hydraulic load cell and a reaction nut. The application requires extended bolt over which the tensioning tool is located so that the bolt protrudes through the tool. The reaction nut then screws onto the portion of the stud protruding above the hydraulic load cell.

Solid or 'Quick Reaction Nuts' can be provided. The Quick Reaction Nut (QRN) is a split nut assembly that can be opened (by pressing a release button) and closed. When in the closed position a positive, captive lock mechanism ensures absolute security.

Tensioning tools are used in multiples, one tool and reaction nut usually being applied to each bolt. This provides uniform tightening of the joint. The tools are connected in series to a pump unit via a harness assembly and downline. A pump pressure is determined for the bolt load required and the system pressurised to this pressure. As the hydraulic load cells become pressurised, the piston extends and reacts against the reaction nut thus inducing a load in the bolt. The load applied to bolts result in bolt extension and joint compression. When the required pressure is reached, the drilled nut under the tensioner is turned securely down against the joint face using a tommy bar. When the tool pressure is released the bolt load is transferred from the reaction nut to the nut on the joint (just tightened with the tommy bar). The Downline, Harness Assembly, Reaction Nuts, and Load Cells can then be removed and the joint is tensioned.

Safety Notes

The TITON bolt tensioning system must only be used for the purpose for which it is intended. That is the tightening and loosening of bolted joints. The tools should not be used for any other purpose or modified or adapted to other applications without prior consultation with B & A Hydraulics. The following safety notes are not an exhaustive list but serve to provide a framework for considerations to be observed whilst using the equipment.

1. Read the operating instruction manual
2. Always wear personal protective equipment - eye protection is essential
3. Keep personnel clear of the equipment when pressurisation takes place. Only approach the equipment once the pressure has stabilised. Never position yourself in-line with a bolt being tensioned.
4. Never exceed the equipment's stated maximum working pressure
5. Do not pressurise UN-COUPLED male 'Quick Disconnect Couplings'.
6. Only use TITON Quick Reaction Nuts with TITON Bolt Tensioners.
7. Do not load a Quick Reaction Nut that has not freely clicked into its closed position and / or does not have full thread engagement with at least 1 thread protruding above the Quick Reaction Nut.
8. Never attempt to tighten or loosen any part of the hydraulic system while it is still under pressure.
9. If in doubt - ASK.

Ref: BAH/OPS/ST/002

Preliminary System Checks

Prior to using any B & A Hydraulics Bolt Tensioning Equipment ensure the following requirements have been met:

Subsea Bolt Tensioner - See Appendix 1

The correct size of Tensioner has been selected for the application.

The correct size of Reaction Nut has been selected for the Stud Bolt and the Tensioner.

The correct amount of Bolt Tensioners and Reaction Nuts have been selected for the method of tensioning to be used i.e. 50% or 100% tensioning. Note: 100% is standard.

All Tensioner pistons are at zero stroke i.e. level with the top of the body.

The Tensioners and Reaction Nuts are in good condition and have not incurred any damage, look for damage to the couplings on the Tensioners and the threads of the Reaction Nuts.

The Correct length of Stud protrusion is available to fit the Bolt Tensioner and Reaction Nut.

A number of the correct size of Tommy bars to suit the Reaction Nuts and the drilled nuts are available.

Hose Whips - See Appendix 2

Sufficient amounts of Interconnecting Hoses are available to suit the amount of Tensioners being used.

The Hoses are in good condition and have not incurred any damage. Look for any crushing, cuts or kinks in the hose.

Hosereel - See Appendix 3

The Hosereel has sufficient hose length for your application.

The Hosereel is in good condition and has not incurred any damage.

Air Driven Pump - See Appendix 4

The pump unit reservoir is filled with hydraulic oil.

There is an air supply capable of delivering 100 - 120 PSI @ 56 C.F.M available.

The pump unit is in good condition and has not incurred any damage.

Ref: BAH/OPS/ST/002

Flange Checks

Prior to Bolt Tensioning ensure the following Flange Checks have been made.

Flanges

The Flanges to be tensioned are the correct mating flanges

Both Flanges are free from damage

Both Flange faces are clean and free from debris

Gaskets

The correct Gasket has been selected

The Gasket is free from damage

Stud Bolts

The correct number and size of Stud Bolts for the flange have been selected

Each Stud Bolt has one drilled and one plain nut.

Both the Stud Bolts and nuts are free from damage.

On completion of the above checks the flanges are ready for assembly.

Ref: BAH/OPS/ST/002

Flange Assembly

Pull the flanges together using B & A Hydraulics Hydraulic Flange Pullers until there is a gap of approximately 2 1/2 - 3 inches.

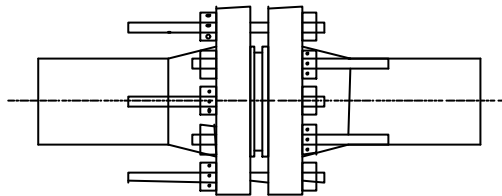
Insert the Gasket

Continue to pull up the flanges using the Flange Pullers until the flanges are firmly together and the gasket seated.

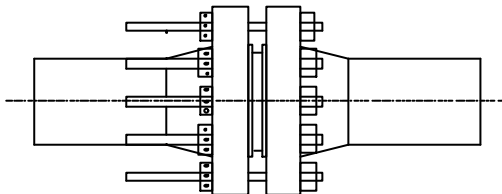
Insert the stud bolts in 4 opposite facing bolt holes i.e. at 12, 3, 6 & 9 o'clock, and hand tighten the nuts.

Remove the Flange Pulling Equipment.

Insert the remaining bolts as per diagrams below.



Ensure the stud bolts have extra length protruding to allow for the Bolt Tensioners. These should be inserted as above for 100% Tensioning and as below for 50% Tensioning



Check the Flange gap is even by taking measurements at 12, 3, 6 & 9 o'clock positions.

Record results on the Flange Tensioning Results Sheet

Ref: BAH/OPS/ST/002

System Set-Up

Set Up - Topside

Hydraulic Pump Unit - Setting the Stall Pressure:

Connect an air supply line to the air line connection.

Connect the Hose Whip Male Coupling to Female Coupling on pump outlet ensure the hose whip terminates in either a Female High Pressure Coupling or Blanking Plug fitted.

Ensure the Air On /Off valve is in the closed position and that the Hydraulic Pressure Release valve is fully open (turn anti-clockwise).

Lift the knob on the air pressure regulator and reduce air pressure to zero (turn adjusting knob anti-clockwise.)

Open the Air On / Off valve and slowly turn the air pressure regulator knob clockwise the air pressure is indicated on the air pressure gauge.

Open the Air On /Off valve and allow the pump to cycle.

Close the Pressure Release Valve and pressure will build up. This will be indicated on the Pressure Gauge, continue to increase the air pressure until the required hydraulic pressure is shown on the Pressure Gauge.

Close the Air On /Off valve. Pressure will at this point be held constant at the 'Stall Pressure'.

Release the pressure from the pump by slowly opening the pressure release valve, this will allow the hydraulic oil to return to tank.

The pump unit is now ready for use.

To operate the pump, close the Hydraulic Release valve, and open the Air On / Off valve the pressure will begin to rise.

When the required pressure is reached shut the Air On / Off valve and the pressure will be held.

Release the pressure by opening the Hydraulic Release valve.

Deploy the Downline

Connect the hose from the pump unit to the Downline (Remove any Blanking plugs first)

Ref: BAH/OPS/ST/002

System Set-Up Cont'd

Set up Subsea

Place tools on all the studs with additional stud protrusion for a 100% procedure. Or on every other stud for a 50% procedure. - See section Flange Assembly for 100% & 50% options.

Run Reaction Nuts down the studs until they are approximately 23 mm from the top of the tool.

Connect the Downline to a Tensioner.

Connect the tools via the Harness Assembly. Best practice is :

Connect a whip to the available female coupling on the tool connected to the Downline. Connect the other end of the hose to the male coupling on the tool situated on the next adjacent stud. Continue until all tools on one side of the flange are connected, take a whip and cross-over to the other side of the flange and continue. Once the tools are connected there should be one tool left with a female coupling unconnected, insert a bleed nipple.

Operate the pump unit.

Oil should be noted escaping from the bleed nipple. This confirms the tools have been connected correctly and simultaneously purges the system of any trapped air.

Stop the Pump, remove the bleed nipple and leave open the female coupling.

The Tensioning Operation can begin.

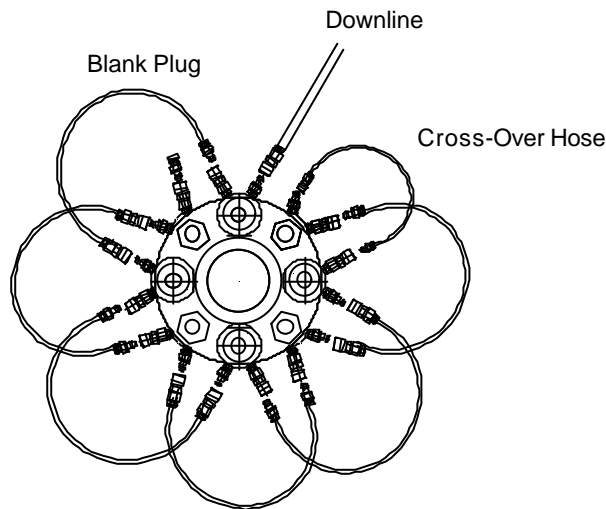


Diagram shows Hose Assembly for a 100% Tensioning Procedure

System Operation

100% Tensioning

Ensure the pump unit Stall Pressure is set at required pressure.

Complete all the Topside Set up procedures.

Complete all the Subsea Set up Procedures.

Pressure up to 1,000 Psi and check for leaks.

If there are no leaks continue to increase the pressure evenly to full pressure for 100% tensioning.

If at any time there is a leak immediately release the pressure by opening the Hydraulic Valve and closing the Air On / Off Valve on the pump unit. Replace the leaking component.

Once full pressure is reached, using a Tommy bar, run all the drilled nuts down tight against the flange. Record the amount of flats turned.

Release the pressure.

Measure the flange gap

Repeat the above steps a further 3 times, or, if movement of the drilled nuts can still be noted, continue until no movement can be noted.

On completion of the above the tensioning procedure is complete

Stroke back the Tensioner pistons by winding the Reaction Nuts down to the top of the tensioner using the Tommy bars

Remove all Hose Whips, Reaction Nuts & Tensioners from the flange and recover to surface.

NOTE:

Do not exceed maximum piston stroke of the tool (see relevant data sheet for details).

If max. stroke is reached prior to finishing the tensioning procedure:

Stop the pump and wind the drilled nuts down against the flange face.

Release the pump pressure

Wind the Reaction Nut down the stud, this will retract the pistons.

On completion of stroking back the piston resume the tensioning procedure as before.

Ref: BAH/OPS/ST/002

System Operation - Cont'd

50% Procedure

Ensure the pump unit Stall Pressure is set at required pressure.

Complete all the Topside Set up procedures.

Complete all the Subsea Set up Procedures ensuring the tools are set up for 50% procedure.

Pressure up to 1,000 Psi and check for leaks.

If there are no leaks continue to increase the pressure evenly to 1st pass pressure for 50% Tensioning.

If at any time there is a leak immediately release the pressure by opening the Hydraulic Valve and closing the Air On / Off Valve on the pump unit. Replace the leaking component.

Once 1st Pass pressure is reached, using a Tommy bar, run all the drilled nuts down tight against the flange. Record the amount of flats turned.

Release the pressure.

Measure the flange gap

Repeat the above a further two times, or if movement of the drilled nuts can still be noted continue until no movement can be noted

Remove the Tensioners and set them up on the remaining 50% of studs (Second Set)

Pressure up to 1,000 Psi and check for leaks.

If there are no leaks continue to increase the pressure evenly to 2nd Pass pressure for 50% Tensioning.

If at any time there is a leak immediately release the pressure by opening the Hydraulic Valve and closing the Air On / Off Valve on the pump unit. Replace the leaking component.

Once 2nd Pass pressure is reached, using a Tommy bar, run all the drilled nuts down tight against the flange. Record the amount of flats turned.

Release the pressure.

Measure the Flange Gap.

Repeat the above on the second set a further two times, or, if movement of the drilled nuts can still be noted, continue until no movement can be noted.

Remove the Tensioners and set them up on the first set (50% of studs)

Pressure up to 1,000 Psi and check for leaks.

If there are no leaks continue to increase the pressure evenly to 2nd Pass pressure for 50% Tensioning.

If at any time there is a leak immediately release the pressure by opening the Hydraulic Valve and closing the Air On / Off Valve on the pump unit. Replace the leaking component.

Ref: BAH/OPS/ST/002

System Operation - Cont'd

Once 2nd Pass pressure is reached, using a Tommy bar, run all the drilled nuts down tight against the flange. There should be no movement of the nuts if this is the case the tensioning procedure is complete. If movement is noted then apply the 2nd Pass pressure a further two times.

Release the pressure.

Measure the Flange Gap.

Remove the Tensioners and set them up on the second set.

Pressure up to 1,000 Psi and check for leaks.

If there are no leaks continue to increase the pressure evenly to 2nd Pass pressure for 50% Tensioning.

If at any time there is a leak immediately release the pressure by opening the Hydraulic Valve and closing the Air On / Off Valve on the pump unit. Replace the leaking component.

Once 2nd Pass pressure is reached, using a Tommy bar, run all the drilled nuts down tight against the flange. There should be no movement.

Release the pressure, the Tensioning Operation is now complete

Stroke back the Tensioner pistons by winding the Reaction Nuts down to the top of the tensioner using the Tommy bars

Remove all Hose Whips, Reaction Nuts & Tensioners from the flange and recover to surface.

System Operation - Cont'd

De-Tensioning

100% De-Tensioning

Ensure the pump unit Stall Pressure is set at the required De-Tensioning pressure.

Complete all the Topside Set up procedures.

Complete all the Subsea Set up Procedures ensuring the tools are set up for 100% procedure and a gap of approx. 10 mm is left between the Reaction Nut and the top of the tool..

Pressure up to 1,000 Psi and check for leaks.

If there are no leaks continue to increase the pressure evenly to full pressure for De-Tensioning.

If at any time there is a leak immediately release the pressure by opening the Hydraulic Valve and closing the Air On / Off Valve on the pump unit. Replace the leaking component.

Once full pressure is reached, using a Tommy bar, loosen all the drilled nuts off by approx. 10 mm from the flange.

Release the pressure.

On completion of the above the De-Tensioning procedure is complete

Stroke back the Tensioner pistons by winding the Reaction Nuts down to the top of the tensioner using the Tommy bars

Remove all Hose Whips, Reaction Nuts & Tensioners from the flange and recover to surface.

Ref: BAH/OPS/ST/002

System Operation - Cont'd

50% De-Tensioning Procedure

Ensure the pump unit Stall Pressure is set at required pressure.

Complete all the Topside Set up procedures.

Complete all the Subsea Set up Procedures ensuring the tools are set up for 50% procedure and a gap of approx. 10 mm is left between the Reaction Nut and the top of the tool.

Pressure up to 1,000 Psi and check for leaks.

If there are no leaks continue to increase the pressure evenly to 1st Pass pressure for De-Tensioning.

If at any time there is a leak immediately release the pressure by opening the Hydraulic Valve and closing the Air On / Off Valve on the pump unit. Replace the leaking component.

Once full pressure is reached, using a Tommy bar, loosen all the drilled nuts off by approx. 10 mm from the flange

Release the pressure.

Remove the Tensioners and set them up on the remaining 50% of studs (Second Set)

Pressure up to 1,000 Psi and check for leaks.

If there are no leaks continue to increase the pressure evenly to 2nd Pass pressure for De-Tensioning.

If at any time there is a leak immediately release the pressure by opening the Hydraulic Valve and closing the Air On / Off Valve on the pump unit. Replace the leaking component.

Once full pressure is reached, using a Tommy bar, loosen all the drilled nuts off by approx. 10 mm from the flange.

Release the pressure.

The De-Tensioning Operation is now complete.

Stroke back the Tensioner pistons by winding the Reaction Nuts down to the top of the tensioner using the Tommy bars

Remove all Hose Whips, Reaction Nuts & Tensioners from the flange and recover to surface.

Ref: BAH/OPS/ST/002

Maintenance

After each operation of the system it is recommended that the following post-use maintenance procedures be carried out.

In general clean all equipment parts with WD40 or similar to remove any dirt or grease. If corrosion is evident clean the effected areas using a wire brush or wire wool and WD40 or similar.

Subsea Bolt Tensioner

Each Tensioners piston is fully retracted

Spray the Quick Disconnect couplers with a water repellent such as WD40 or similar. Particular attention should be given to the ball bearings in the female coupler. If corrosion is evident spray with WD40 or similar and wire brush the effected areas.

Spray the pins and threaded portions of the QRN with WD40 or similar. If corrosion is evident spray with WD40 or similar and wire brush the effected areas.

Do not use grease on any of the moving parts - this will attract grit & debris and could cause the mechanism to jam.

Hose Whips

Spray the Quick Disconnect couplers with a water repellent such as WD40 or similar. Particular attention should be given to the ball bearings in the female coupler. If corrosion is evident spray with WD40 or similar and wire brush the effected areas

Hosereel

Spray the Quick Disconnect couplers with a water repellent such as WD40 or similar. Particular attention should be given to the ball bearings in the female coupler. If corrosion is evident spray with WD40 or similar and wire brush the effected areas

Apply grease to the reel spindles where they rest on the stand.

Air Driven Pump

Spray the Quick Disconnect couplers with a water repellent such as WD40 or similar. Particular attention should be given to the ball bearings in the female coupler. If corrosion is evident spray with WD40 or similar and wire brush the effected areas

Refill the pump unit reservoir if necessary.

Ensure the air lubricator oil reservoir has sufficient oil

Bolt Tensioning Record Sheet

| | |
|---------------------------|-------------------|
| Company | |
| Project | |
| Flange Connection | |
| No. of Bolts | |
| Bolt Size | |
| Final Pump | PSI |
| Residual Bolt Load | Tonf / Knf |

| Pressure | Remarks | Gap (mm) @ Clock Position | | | |
|----------|-------------------------------------|---------------------------|---|---|----|
| | | 3 | 6 | 9 | 12 |
| | Initial results prior to Tensioning | | | | |
| Psi | Check for Leaks | | | | |
| Psi | Mid Pressure | | | | |
| Psi | 1 st Pass | | | | |
| Psi | 2 nd Pass | | | | |
| Psi | 3 rd Pass | | | | |
| Psi | | | | | |
| Psi | | | | | |

| | No. of Flats Turned for Stud Number | | | | | | | | | | | |
|--------------------------------------|-------------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Pre Tensioning | | | | | | | | | | | | |
| 1st Pressurisation | | | | | | | | | | | | |
| 2nd Pressurisation | | | | | | | | | | | | |
| 3rd Pressurisation | | | | | | | | | | | | |
| | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| Pre Tensioning | | | | | | | | | | | | |
| 1st Pressurisation | | | | | | | | | | | | |
| 2nd Pressurisation | | | | | | | | | | | | |
| 3rd Pressurisation | | | | | | | | | | | | |
| | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 |
| Pre Tensioning | | | | | | | | | | | | |
| 1st Pressurisation | | | | | | | | | | | | |
| 2nd Pressurisation | | | | | | | | | | | | |
| 3rd Pressurisation | | | | | | | | | | | | |

Comments:

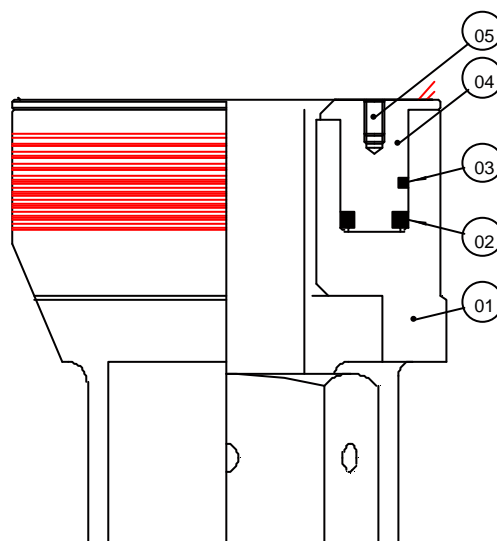
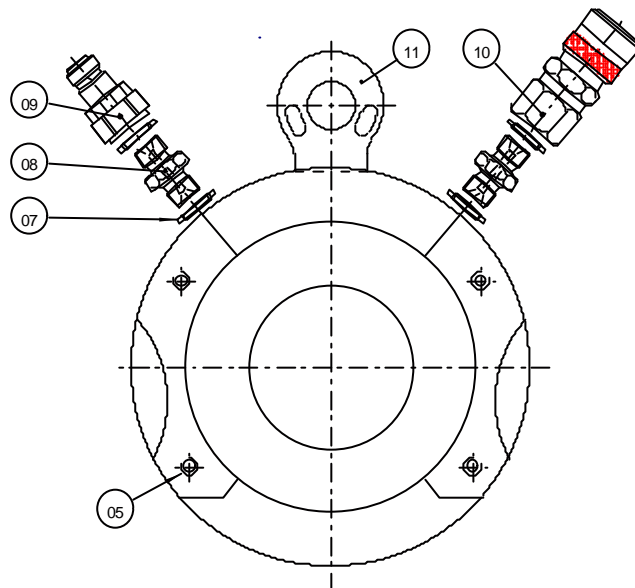
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Signed Date

Ref: BAH/OPS/ST/002

Appendix 1 - TITON Bolt Tensioner

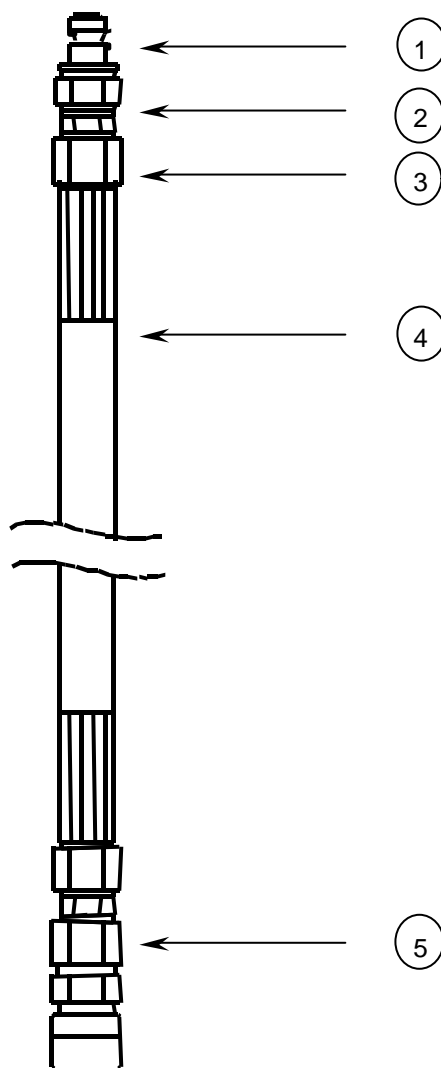
| Item No | Description | Qty |
|---------|--|-----|
| 01 | Tensioner Body | 1 |
| 02 | Piston Seal Assembly | 1 |
| 03 | Stroke Limit Indicator | 1 |
| 04 | Piston | 1 |
| 05 | Foot / Pistion Mounting Holes (M8 x 15Lng) | 4 |
| 07 | 1/4" Dowty Seal | 4 |
| 08 | 1/4" BSP Adaptor | 2 |
| 09 | Cejin 116 Series Hydraulic Nipple | 1 |
| 10 | Cejin 116 Series Hydraulic Coupling | 1 |
| 11 | M16 Eye Bolt | 1 |



Ref: BAH/OPS/ST/002

Appendix 2 - Hose Assembly

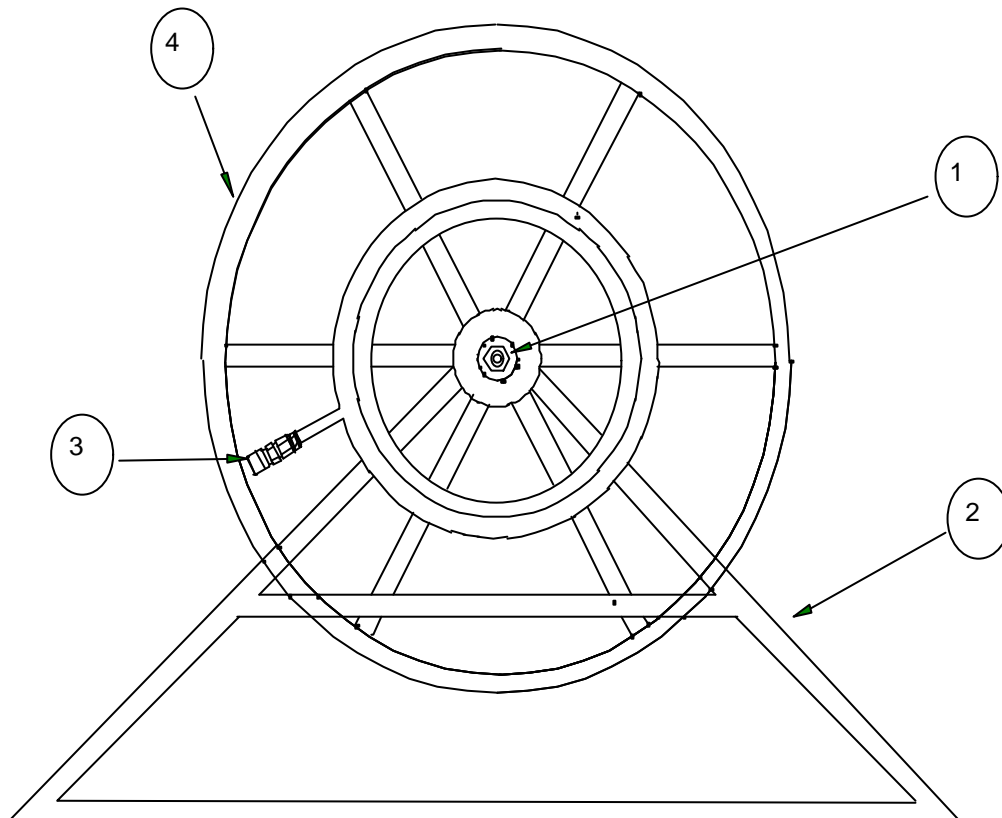
| Item No | Description | Qty |
|---------|--|-----|
| 1 | Cejin 116 Series Nipple | 1 |
| 2 | Adapter Assembly (1 off 1/4" x 1/4" Bsp m/m & 1 off 1/4" Dowty) | 2 |
| 3 | 1/4" Bsp Female Swivel Swaged Hose End | 2 |
| 4 | 1m or 3m Hose 21,750 Psi MWP Hose | 1 |
| 5 | Cejin 116 Series Coupling | 1 |



Ref: BAH/OPS/ST/002

Appendix 3 - Hose Reel & Downline

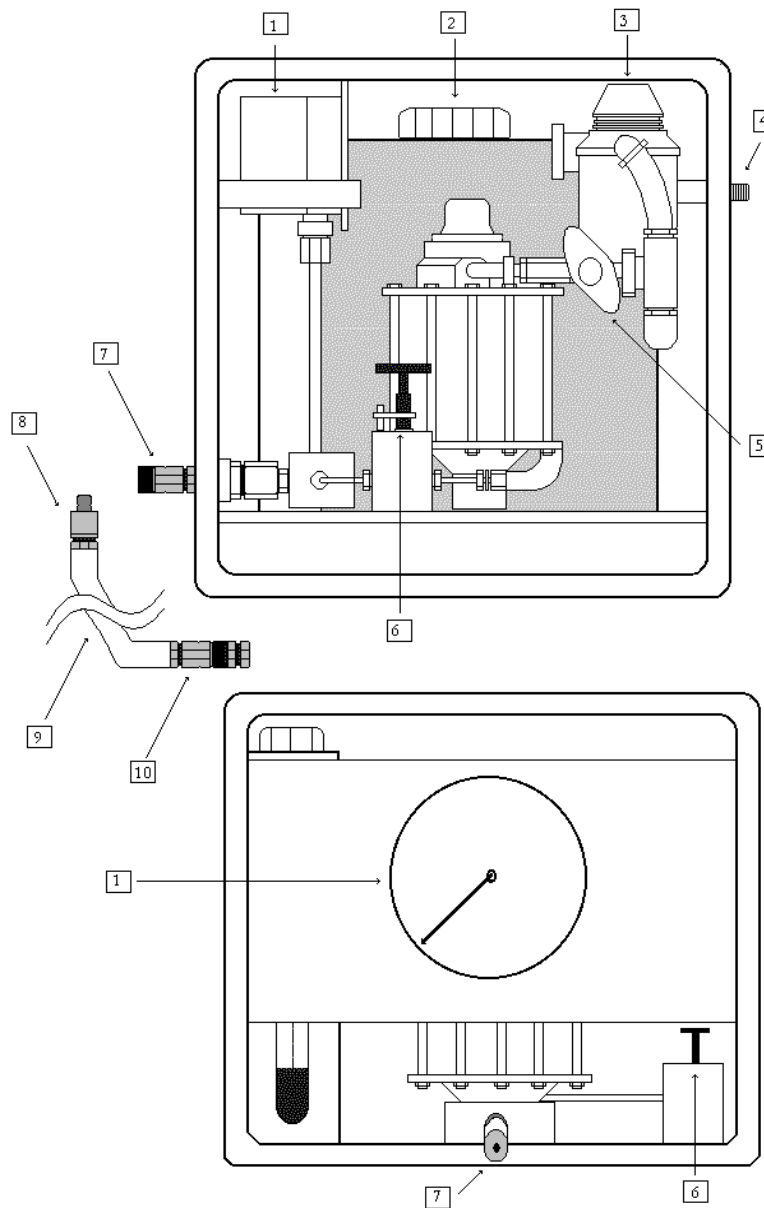
| Item No. | Description | Qty |
|----------|---|-----|
| 01 | Cejin 116 Series Nipple assembly c/w: 1 off 1/4" x 1/4" Bsp m/m & 1 off 1/4" Dowty | 1 |
| 02 | Reel Stand | 1 |
| 03 | Cejin 116 Series Coupler Assembly c/w 1 off 1/4" x 1/4" Bsp m/m & 1 off 1/4" Dowty | 1 |
| 04 | Reel c/w 210m D/Line (7 x30m as standard) | 1 |



Ref: BAH/OPS/ST/002

Appendix 4 - Air Driven Pump Unit

| Item No | Description | Qty |
|---------|------------------------------------|-----|
| 1 | Pressure Gauge | 1 |
| 2 | Pump Unit Reservoir | 1 |
| 3 | Air Pressure Regulator | 1 |
| 4 | Air Line Connection | 1 |
| 5 | Air On / Off Valve | 1 |
| 6 | Hydraulic Release Valve | 1 |
| 7 | Female High Pressure Coupling | 1 |
| 8 | Male Coupling | 1 |
| 9 | High Pressure Hose | 1 |
| 10 | Cejin 116 Series Coupling Assembly | 1 |



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Ref: BAH/OPS/ST/002