NORD-LOCK GROUP

Subsea Bolt Tensioners

HEALTH & SAFETY, OPERATING AND MAINTENANCE INSTRUCTION MANUAL

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BOLTIGHT™

FOREWORD

Thank you for choosing Boltight equipment.

Before using the equipment you are advised to study this manual carefully.

Boltight Limited is an ISO 9001:2015 company and our bolt tensioning equipment has been designed to comply with the European Pressure Equipment Directive and the UK Pressure Equipment Regulations and is CE marked and UKCA marked respectively. The pressures and forces involved with the use of this equipment are high and it is therefore imperative that users of the equipment read and understand the operating manual, paying particular attention to the safety information in Section 1.

CONTENTS

SECTION 1 – HEALTH & SAFETY INSTRUCTIONS

1.1 IMPORTANT NOTICE

Thank you for purchasing or renting your hydraulic bolt tensioning equipment from Boltight. Bolt tensioning tools are very powerful and capable of inducing very high stresses. This equipment has been designed to give many years of safe tightening of bolted connections when used in accordance with these instructions.

Persons using hydraulic bolt tensioning tools must be properly trained in the correct use of the equipment and must take adequate steps to ensure their own safety, and the health and safety of others working in the area where bolt tensioning operations are being performed. Boltight will be pleased to quote for the provision of training courses either at its UK base or onsite anywhere in the world.

Operators must read the instruction and maintenance manual before attempting to use the equipment. Do not use the equipment if you are not already an experienced user of hydraulic bolt tensioning tools or if you have not already received proper training. Your attention is particularly drawn to the notes in **RED**.

When using bolt tensioners, loads of hundreds or thousands of tons can be induced. If the bolt material is incorrect or faulty, or the tool is incorrectly installed, the broken bolt could be launched at high speed along the axis of the bolt. This is a very rare occurrence. If there is a failure, anyone standing near to the bolt tensioning tool or in line with the axis of the bolt during the tensioning operation will suffer a critical, possibly fatal, injury. It is therefore essential that anyone operating this equipment is properly trained in its safe use and take every precaution to ensure that nobody is allowed to stand, work or stray near to or in line with the axis of any bolt tensioning tool during the bolt tensioning operation.

Bolt tensioning tools are powerful and use high-pressure hydraulics. It is essential that you are trained in the correct use of the equipment and adhere fully with the Health & Safety Instructions.

1.2 EUROPEAN PRESSURE EQUIPMENT DIRECTIVE

The 1500 bar range of Boltight hydraulic bolt tensioning tools have been designed to operate at pressures up to 1500 bar with Group 2 liquid (hydraulic oil ISO 10) and volume less than 10 liters. This equipment falls into category 1 of the specified pressure volume thresholds.

Under these regulations, the equipment must therefore:

a) Be safe;

b) Meet the essential safety requirements covering design, manufacture and testing;

c) Satisfy the appropriate conformity assessment procedure;

d) Be accompanied by adequate instructions for use;

e) Be marked to identify the manufacturer and CE marked.

The pressure equipment directive calls for the pressure equipment to be pressure tested at 1.43 times the maximum pressure. However, the directive recognizes that in some cases this may be harmful or impractical. Because of the very high bolt stress developed, it is impractical to pressure test the equipment above 1650 bar. It would also be harmful to the oil seals if a pressure test of 2145 bar were applied.

The 1500 bar max pressure hydraulic cylinders have been pressure tested at 1650 bar and a test certificate has been issued. The CE mark has been applied.

1.3 USING QUICK CONNECTORS

DO NOT pressurize the connectors when they are disconnected.	Check that there is no pressure in the system before attempting to connect or disconnect the couplings.

To connect the quick-connect coupling and nipple, first check there is no pressure in the system. Pull back the shroud by hand and push the coupling onto the nipple. When together, release the shroud, which will spring back to connect the coupling and nipple together. The coupling should now be locked using the safety locking sleeve (SLS). To disconnect, again check there is no pressure in the system. Pull back the shroud by hand, and pull the coupling and nipple apart. Once apart, release the shroud.

Good

Bad

1.4 HOSES

The flexible hydraulic hoses supplied by Boltight have a small plastic core tube surrounded by multiple high-tensile, steel spiral windings. The outside of the hose is molded with a colored plastic coating. Most hoses are also given a clear plastic cover to provide additional protection against damage when in use. Each hose is identified with a serial number. All hoses are pressure tested when manufactured and test certificates can be issued.

Boltight supplies two types of high-pressure flexible hydraulic hoses, and they are easily identified by the color of the molded plastic coating beneath the clear plastic cover. The maximum working pressure for the hose is sometimes marked on the outside of the colored plastic coating; however, this is the working pressure of the hose ONLY and not the hose assembly. The maximum working pressure of a hose assembly is often limited by the pressure rating of the quick-connect couplings and/or the fittings on the end of the hose. Although the hose may be capable of operating at higher pressures, the limit you must observe is shown below, along with the minimum bend radius.

COLOR	MAX WORKING PRESSURE	MIN BEND RADIUS
BLUE	1500 bar	130 mm
RED	2500 bar	200 mm

Each type of hose is fitted with self-sealing, quick-connect couplings at one or both ends.

YOU MUST OBSERVE THE FOLLOWING HEALTH & SAFETY INSTRUCTIONS WHEN USING HYDRAULIC HOSES:

- Discard and do not use any hose that does not have an identifying serial number.
- Discard and do not use any hose that shows any sign of damage:
  - to the colored molded plastic coating;
  - where the spiral windings are exposed;
  - where the spiral windings are damaged or broken;
  - where there is damage to the swaged metal ends
- Do not allow any hose to be kinked or knotted. Hoses that have been kinked or knotted will have suffered damage and must be discarded.
- Do not allow heavy objects to fall on, rest on or roll over the hoses.
- Do not allow hoses to be subjected to temperatures higher than 60°C.
- Discard and do not use any hose that has been subjected to heat or fire.
- Do not bend the hose tighter than the minimum bend radius of the hose or it will be kinked.
- Do not exceed the maximum working pressure of 1500 bar for BLUE color hose, and 2500 bar for RED color hose.
- Only use the hoses for their intended purpose for use with Boltight hydraulic equipment.
- After use, check the hoses for damage, wipe to remove dirt and oil, refit dust caps and prepare for storage.
- When not in use, store the hoses in a safe place where they cannot easily be damaged.
- Do not mix the BLUE and RED color-coded hoses. The end fittings and quick-disconnect couplings on these hoses have different pressure ratings.
- Never move hose end connectors or quick disconnects from one color hose to another.
- Check that the bolt tensioning tools you use are compatible with the hoses you use. All Boltight tools are marked with the maximum operating pressure.
- Never pressurize a quick-disconnect coupling or nipple when disconnected.
- Do not take apart any ring main harness component or hose assembly. These are filled with oil and pressure tested after assembly. When taken apart, the integrity of the assembly is lost and the pressure test invalidated. Return any parts that need attention to Boltight where the correct specification parts will be used to effect repairs, followed by pressure testing and certification before return.
- Never use the hoses as a handle to carry or pick up the bolt tensioning tools.

If in doubt, contact your representative for further information.

1.5 BOLT TENSIONING TOOLS

Maximum pressure

The maximum pressure for the hydraulic bolt tensioners can be found in **Section 4**.

The bolt being tensioned may have a maximum load less than that generated by the tensioner at maximum working pressure. The operator needs to confirm and check what the maximum pressure is for the particular application being tensioned.

DO NOT exceed the maximum working pressure.

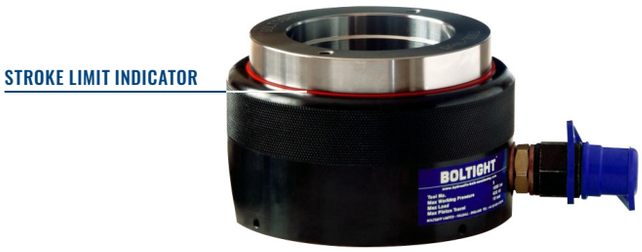
The tool has a positive piston stop to prevent accidental overstroke only.

Never pressurize the tool against the piston stop.

Maximum stroke

DO NOT exceed the maximum piston stroke.

A highly visible red line indicates when the piston has reached its maximum stroke. Stop the pump as soon as the red indicator can be seen. The maximum stroke for the tooling can be found in **Section 4**.



1.6 BOLT TENSIONING TOOLS – SAFETY NOTES

Bolt tensioning tools **MUST** always be used with a hydraulic pump which has a pressure limiting device. Always check that the pump stall pressure is set at or below the maximum working pressure for the tool being used.

Clear all personnel from the area where the bolt tensioning operation is to be performed. Position the pump a safe distance away from the bolt tensioning tools. Set up barriers and warning signs, or make other adequate arrangements to prevent unauthorized personnel from accidentally straying into the bolt tensioning area.

Never leave a pressurized bolt tensioning tool unattended. Keep the bolt tensioning tools under pressure for the minimum time necessary to complete the bolt tightening job.

The tools should only be used as a bolt tensioning tool. DO NOT use the tools as hydraulic jacks or for any other purpose.

Take care when handling the tools. Large tools may be heavy and require the use of lifting equipment.

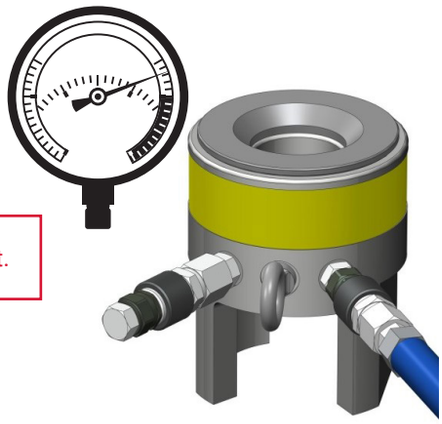
Do not try to tighten a leaking hydraulic connection when it is under pressure. First release the pressure then repair the leak. Do not try to tighten a leaking hydraulic connection when it is under pressure. First release the pressure, then repair the leak.

Make certain that nobody is allowed to stand near to a bolt tensioning tool during the pressurization process. At no time should anyone allow any part of his or her body to be positioned over the puller of a bolt tensioning tool while the pressure is rising or when it is pressurized. Do not allow anyone to stand anywhere near a direct line with the long axis of a bolt during the tensioning operation. In the case of stud bolts with nuts at each end, it is important that nobody stands in line with the long axis of the bolt at either end during the tensioning operation.

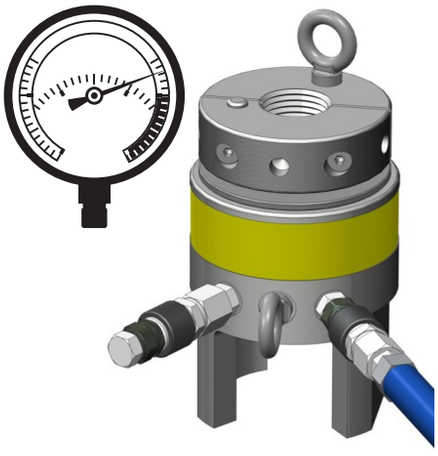
Do not approach a bolt tensioning tool while it is being pressurized. Remember that a damaged bolt or tool is most likely to fail at this critical time. When the operating pressure has been reached, approach a pressurized bolt tensioning tool only for as long as it takes to turn the permanent nut, always keeping away from the axis of the bolt and the puller.

DO NOT pressurize the tool with the reaction nut removed.

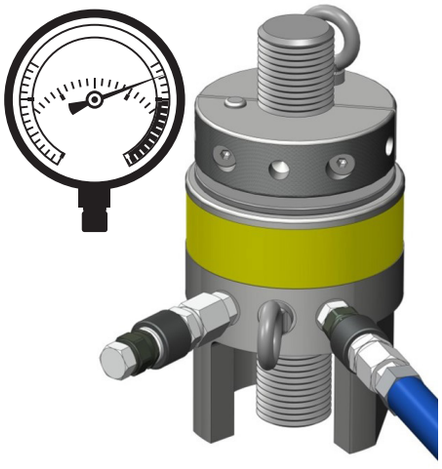
DO NOT pressurize the tool unless it is attached to a bolt or test bolt.



✖ Wrong and dangerous



✖ Wrong and dangerous



✔ Correct and safe

1.7 PERSONAL PROTECTIVE EQUIPMENT (PPE)

When using bolt tensioning tools, the operator should ensure that they are wearing the correct Personal Protective Equipment (PPE).

This equipment includes (but is not limited to):

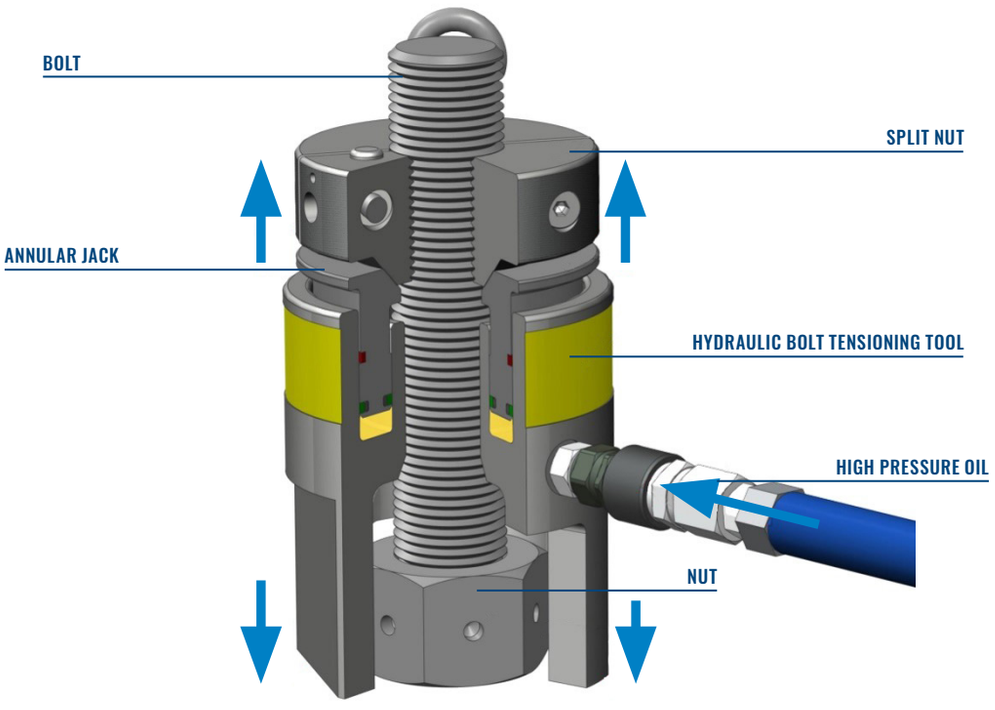
- Eye protection
- Gloves
- Overalls
- Hard hat
- Steel toe-capped boots or shoes
- Any other site-specific PPE required

SECTION 2 – OPERATING INSTRUCTIONS

Introduction

A subsea hydraulic bolt tensioning tool provides a quick and easy method for tightening subsea bolts to high and accurate pre-loads. Unlike conventional methods it does not use torque and does not require any forceful turning of the nut or bolt, like impact wrenches, flogging spanners or hydraulic torque wrenches. All of these methods have one common enemy: friction. Overcoming thread friction and friction between the nut and the washer uses up over 80% of the torque energy applied to the nut or bolt, leaving less than 20% of the energy to produce useful tension in the shank of the bolt. Variations in this friction loss from bolt to bolt causes non uniform tension in bolts that have been tightened to the same torque or impact wrench setting.

2.1 MAIN COMPONENT PARTS



A hydraulic bolt tensioner is an annular jack which fits over the bolt and nut to be tightened. The jack pushes against the bolted joint and pulls on the end of the bolt, which needs to be of adequate length to accommodate the bolt tensioning tool. Because the force produced by the jack is applied directly to the end of the bolt, a tension equal to the load generated by the jack is developed in the shank of the bolt. With the jack applying the tension, it is possible to turn the nut with zero torque until it is tight. The load applied by the jack is then relaxed and a high percentage, depending on the length of the bolt and its diameter, is retained in the shank of the bolt.

Bolt tensioning tools can be ganged together to enable multiple bolts to be tightened simultaneously, to the same high and accurate pre-load. This is particularly useful when compressing gaskets in pipeline or pressure vessel flanged connections. The high load developed by the multiple bolt tensioning tools, is evenly distributed around the joint causing the gasket to flow into the surface irregularities of the flange giving a much better seal.

Flexible hoses with self-sealing, quick-disconnect couplings are used to gang the bolt tensioning tools together to form a hydraulic ring main. The ring main and tensioning tools are usually pressurized using an air driven pump working from a compressed air supply, although hand pumps are available.

Important Notice

Boltight subsea tools have been designed specifically for use with metric and imperial thread forms as specified on their respective GA drawings that can be found in Section 4 of this manual.

The bolt tensioning tool comprises a reaction nut, a tensioner body and piston (fitted with hydraulic seals and overstroke indicator). A self-sealing quick-connect hydraulic nipple is provided in the tensioner body for the connection of the high-pressure hydraulic supply. A window is provided in the wall of the bridge through which a tommy bar can be inserted to rotate the nut.

The permanent hex nuts must feature tommy bar holes to rotate them during tensioning and detensioning.

Each tool has a maximum piston stroke of 30 mm. This should be more than adequate to tighten subsea bolts in one stroke, so the tools should never have to be reset by the diver while underwater.

Since each tool is designed to fit a range of bolt sizes, it is easily possible to overload any smaller bolt compatible with a particular tool. Care must be taken not to over-pressurize a bolt beyond its given yield stress value. Oil pressure versus bolt stress graphs can be found in Section 4 of this manual. If in any doubt, contact Boltight Ltd for further information.

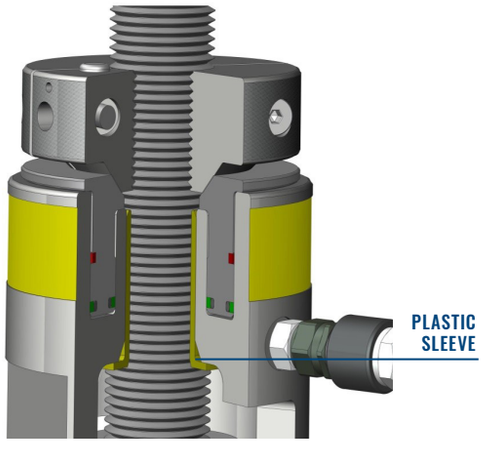
Stroke Indication

Despite featuring an extra-long stroke capacity of 30mm, in the interests of safety the tools still feature an overstroke indicator. Maximum stroke is indicated when the overstroke indicator can be seen protruding from the top of the tool (see diagrams overleaf). As the piston rises, the top of it will be seen traversing upwards. When the operator sees the overstroke indicator, they should stop the pump immediately.

Plastic Sleeves

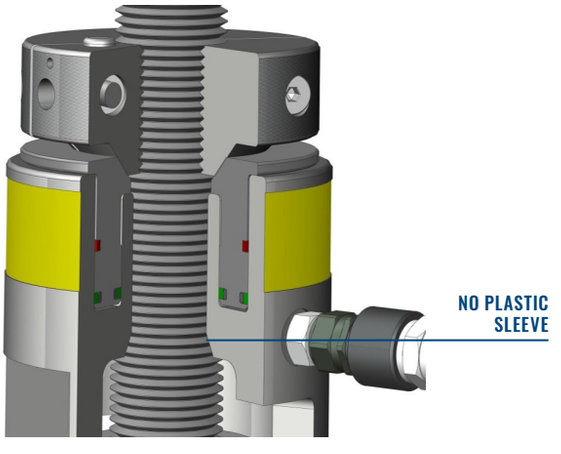
A plastic sleeve MUST be fitted when a tool is to be used on a bolt which is smaller in diameter than the largest bolt for which the tool is designed. If a plastic sleeve is not fitted, the tool will not centralize around the smaller diameter bolt. If used without a sleeve, the bolt may be bent and or the split reaction nut may be damaged or fail. It is an essential safety requirement that the tools are only used with the correct sleeves fitted.

The plastic sleeves are split and are easily fitted by hand. The sleeve is manually pushed up into the bore of the tool from the bottom, NOT down from the top.



✔ Correct and safe

Note the correct orientation of the sleeve.



✖ Wrong and dangerous

Table of Plastic Sleeves

The below table shows where plastic sleeves are required:

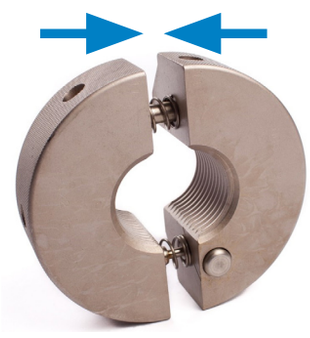
Tool No	Bolt Dia (in)	Sleeve	Sleeve Part No	Nominal Dia.	Sleeve	Sleeve Part No
G1	7/8"	Yes	G1-0875M22-SLE	M22	Yes	G1-0875M22-SLE
G1	1"	Yes	G1-1000M24-SLE	M24	Yes	G1-1000M24-SLE
G1	1-1/8"	Yes	G1-1125M30-SLE	M27	Yes	G1-0000M27-SLE
G1	1-1/4"	No	N/A	M30	Yes	G1-1125M30-SLE
G1	N/A	N/A	N/A	M33	No	N/A
G2	1-3/8"	Yes	G2-1375M36-SLE	M36	Yes	G2-1375M36-SLE
G2	1-1/2"	Yes	G2-1500M39-SLE	M39	Yes	G2-1500M39-SLE
G2	1-5/8"	No	N/A	M42	No	N/A
G3	1-3/4"	Yes	G3-1750M45-SLE	M45	Yes	G3-1750M45-SLE
G3	1-7/8"	Yes	G3-1875M48-SLE	M48	Yes	G3-1875M48-SLE
G3	2"	No	N/A	M52	No	N/A
G4	2-1/4"	Yes	G4-2250M56-SLE	M56	Yes	G4-2250M56-SLE
G4	2-1/2"	Yes	G4-2500M64-SLE	M64	Yes	G4-2500M64-SLE
G4	2-3/4"	No	N/A	M72	No	N/A
G5	3"	Yes	G5-3000M76-SLE	M76	Yes	G5-3000M76-SLE
G5	3-1/4"	Yes	G5-3250M00-SLE	M80	Yes	G5-0000M80-SLE
G5	3-1/2"	No	N/A	M85	Yes	G5-0000M85-SLE
G5	N/A	N/A	N/A	M90	No	N/A

Split Reaction Nuts

Split reaction nuts are a quicker and more convenient alternative to using solid reaction nuts. The split reaction nut transfers load from the tensioner to the bolt in exactly the same fashion as the solid reaction nut. However, it incorporates a spring-loaded, quick-release mechanism to aid installation. Significant operator time and effort is spared by using split reaction nuts as opposed to solid nuts, as they only have to be screwed downwards for the final few threads.

Split reaction nuts are installed in their open (release) position, and simply lowered over the protruding bolt until they abut gently with the top of the piston. The nut is easily closed by simply pushing the segments together, and the mechanism locks the two segments together. The nut MUST then be wound down the final few threads until it fully abuts against the piston. A tool fitted with a split nut MUST NOT be pressurized until the split nut has been fully locked down onto the top of the piston using a tommy bar. Failure to observe this important instruction may cause the nut to fail.

When tensioning is complete, the split nut must be first released using a tommy bar. The split nut mechanism is then released by simply pushing the button on the split nut's upper face. This also aids uninstallation as the nut can be simply lifted off rather than having to be completely unscrewed.



Push segments together to close

Push button to release

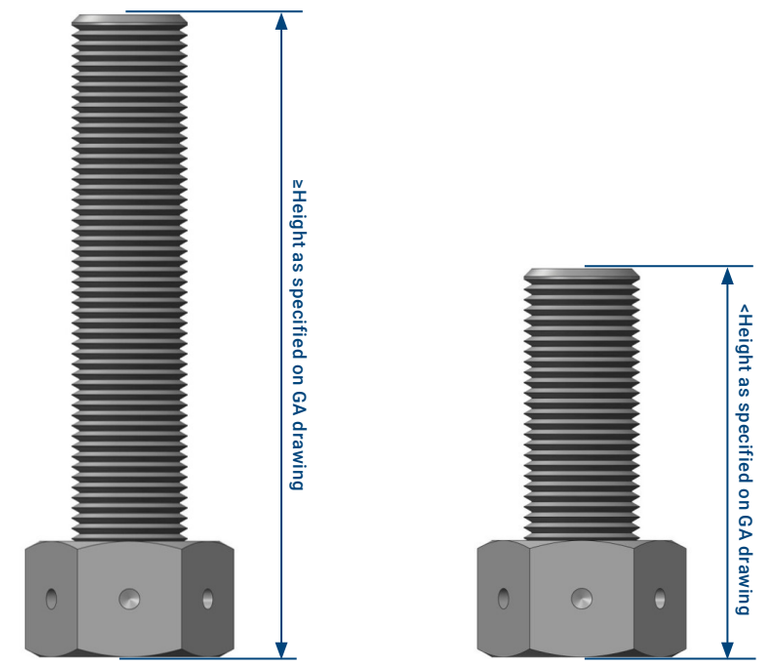
Prior to commencement of the bolt tensioning operation, the permanent hexagon nuts must be suitably drilled such that a tommy bar can be used to rotate the nuts during tensioning.

2.2 TIGHTENING A BOLT

Step 1

Before commencing the bolt tensioning the operator should have read and understood the Health & Safety Instructions as detailed in Section 1 of this Operating Manual.

Set the bolt into the nut so that the amount of protruding bolt is greater than or equal to the height specified on the General Assembly drawing for the tool as shown in Section 4 of this Operating Manual.



Correct and safe

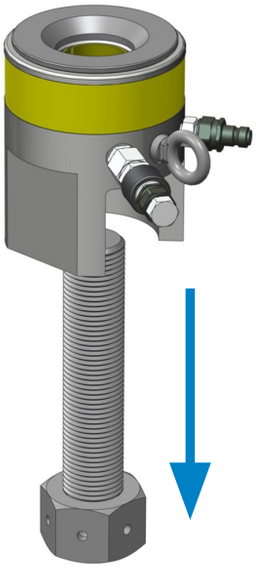
Wrong and dangerous

HEALTH & SAFETY WARNING

If only a few threads protrude, and an attempt is made to apply tension, the bolt threads will strip, and components of the tensioner could be launched with the possibility of serious injury.

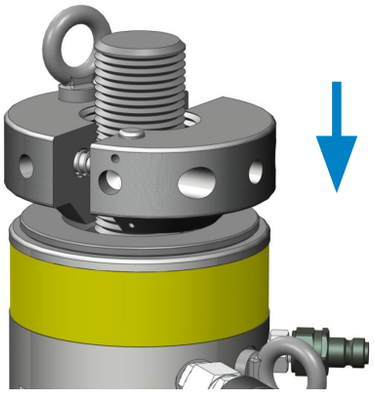
Step 2

Check that the correct plastic sleeve has been fitted then lower the tensioner over the bolt. Use the eye bolt provided to assist hoisting and assembly.



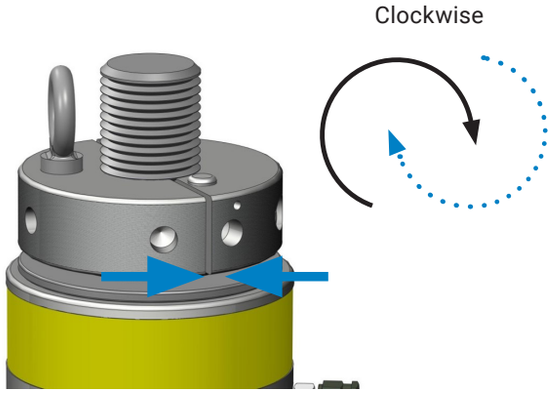
Step 3

Lower the split nut over the bolt in its open position.



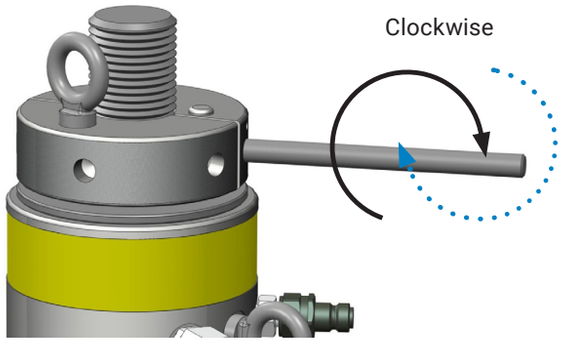
Step 4

Push the segments together to close the mechanism and wind downward by hand.



Step 5

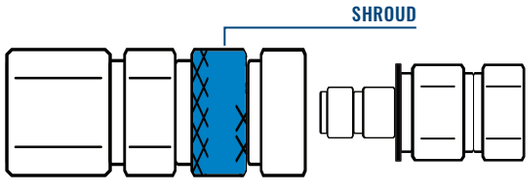
Be sure to lock down the split nut onto the piston by using a tommy bar. Make the sure reaction nut threads are fully closed onto the bolt threads



Using Quick Connectors

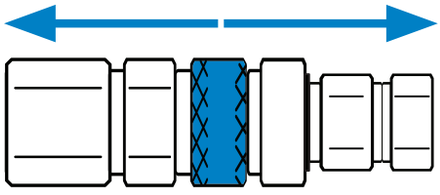
Before using quick-connectors, the operator should ensure that her or she has read and understood the quick-connectors' Health & Safety Instructions in **Section 1**. To connect the quick-connect coupling and nipple, first check there is no pressure in the system. Then pull back the shroud, which will spring back to lock the coupling and nipple together. To disconnect, first check there is no pressure in the system. Pull back the shroud, by hand, and pull the coupling and nipple apart. Release the shroud when apart.

1



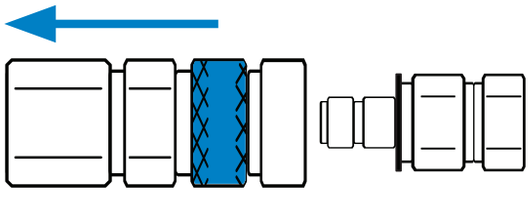
Pull back the shroud to retract.

3



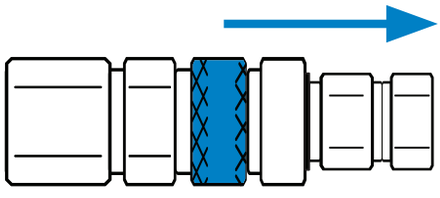
Coupling and nipple pushed together with the shroud retracted.

2



Coupling and nipple with the shroud retracted.

4

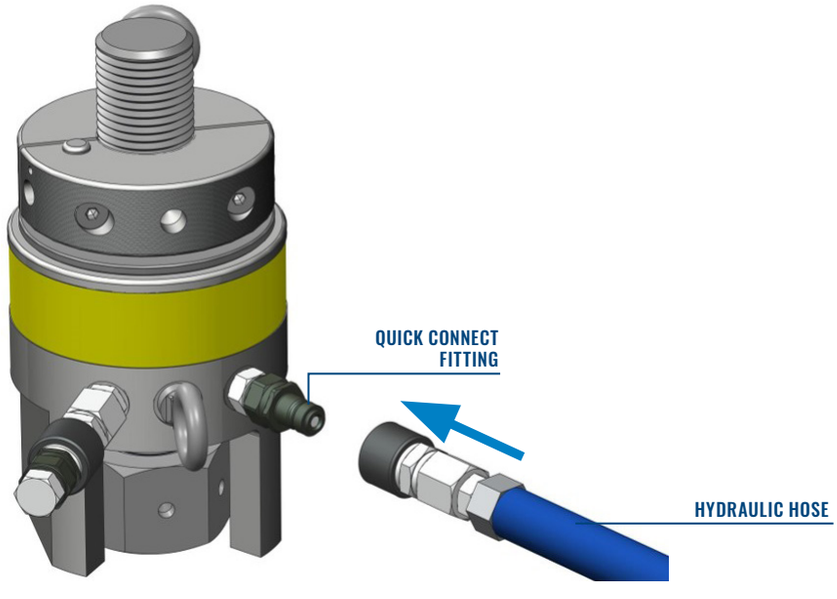


Shroud released; coupling and nipple are now locked together and safe to use.

Step 6

Connect the high pressure flexible hydraulic hose supplied with the tool.

Make sure the quick-connect fittings are fully engaged.



TIGHTENING A BOLT – HEALTH & SAFETY

The bolt tensioning tool is now ready to be pressurized. Before proceeding, read the Health & Safety Instructions given in this manual then proceed as follows:

- Clear all personnel from the area where the bolt tensioning operation is to be performed. Position the pump a safe distance away from the bolt tensioning tools. Set up barriers and warning signs, or make other adequate arrangements to prevent unauthorized personnel from accidentally straying into the bolt tensioning area.
- Make certain that nobody is allowed to stand near to a bolt tensioning tool during the pressurization process. At no time should anyone allow any part of his or her body to be positioned over the puller of a bolt tensioning tool while the pressure is rising or when it is pressurized. Do not allow anyone to stand anywhere near a direct line with the long axis of a bolt during the tensioning operation. In the case of stud bolts with nuts at each end, it is important that nobody stands in line with the long axis of the bolt at either end during the tensioning operation.
- Do not approach a bolt tensioning tool while it is being pressurized. Remember that bolt or tool failure is most likely to happen at this critical time. When the operating pressure has been reached, approach a pressurized bolt tensioning tool only for as long as it takes to turn the permanent nut, always keeping away from the axis of the bolt and the puller.
- Wear eye protection, gloves, overalls and a hard hat.
- Never leave a pressurized bolt tensioning tool unattended.
- Release the oil pressure immediately if any unauthorized person moves into the bolt tensioning area, and especially if anyone stands in front of the puller of a bolt tensioning tool under pressure or stands in line with the long axis of a bolt being tensioned.
- Determine the correct working pressure for the bolts to be tightened. Proceed with the following operations, keeping the bolt tensioning tools under pressure for the minimum time necessary to complete the bolt tightening job.

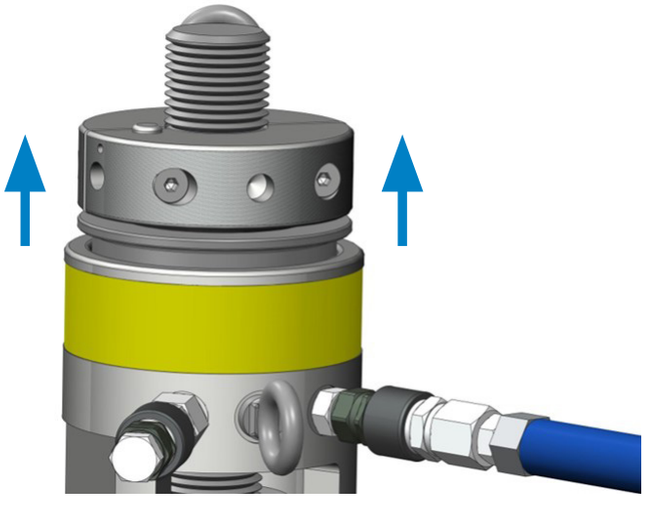
Step 7

Apply the correct hydraulic pressure. The piston will push the reaction nut up and out of the tool as the bolt is stretched and the bolted joint is compressed.

DO NOT exceed the maximum piston stroke. This is indicated by a red line around the piston.

DO NOT exceed the maximum pressure for the tool.

DO NOT use an oil pressure which will result in an initial bolt stress in excess of 90% of the minimum yield strength of the bolt material.

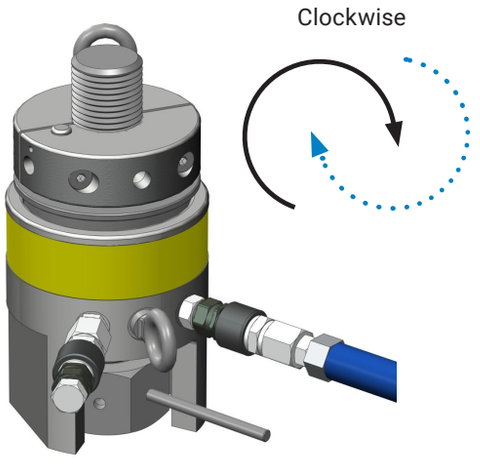


Step 8

Insert the tommy bar through the window in the bridge.

Engage the holes in the hexagon nut.

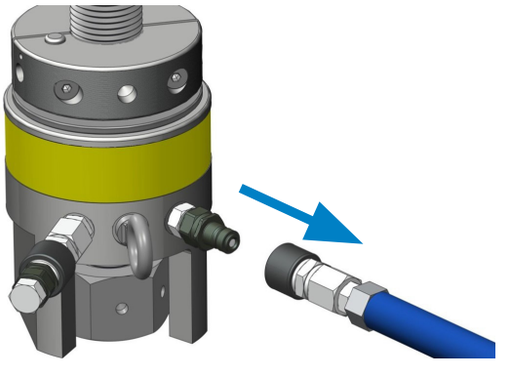
Turn the nut until it is tight.



Step 9

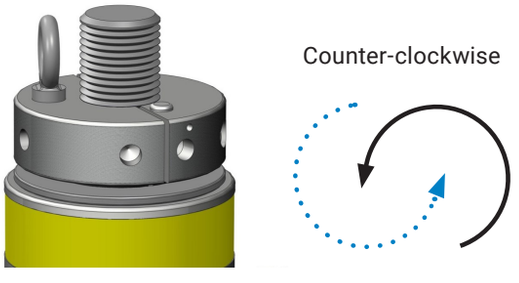
Slowly release the hydraulic pressure.

Remove the hydraulic hose.



Step 10

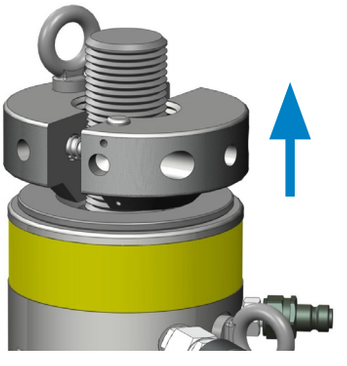
Unscrew the reaction nut until it is clear of the piston.



Step 11

Push the button the split nut to release it.

Lift the split nut off the bolt.



Step 12

Finally, lift the body off the bolt, using the eyebolt to assist hoisting and disassembly. Check that the plastic sleeve is not lost but remains in the tool during this operation.

The bolt is now tight.

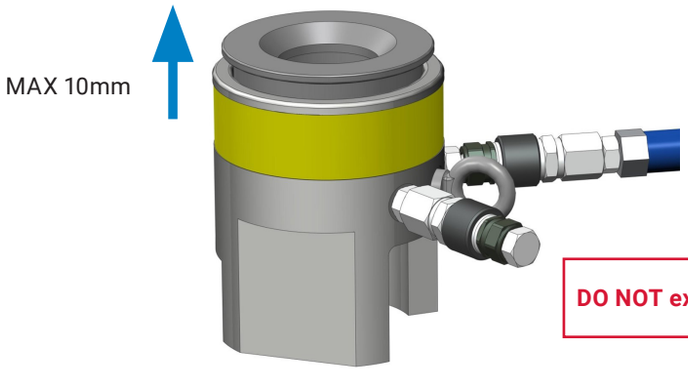
2.3 LOOSENING A BOLT

Step 1

Before commencing the bolt loosening the operator should have read and understood the Health & Safety Instructions as detailed in Section 1 of this Operating Manual.

WHEN DETENSIONING ONLY, the tools must be stroked slightly (10mm) topside before being used subsea.

To do this, attach a hydraulic hose between the pump and each tool as instructed in Step 8 of this section, and stroke the tool 10mm by running the pump at zero pressure. Note that you do NOT have to use a bolt or reaction nut to do this.



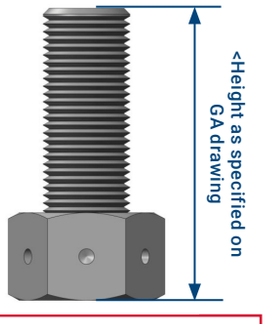
DO NOT exceed 10mm stroke.

This ensures that the tensioner does not become locked onto the flange during loosening operation.

Step 2

Check that the amount of protruding bolt is greater than or equal to the height specified on the General Assembly drawing for the tool as shown in Section 4 of this Operating Manual.

Correct and safe



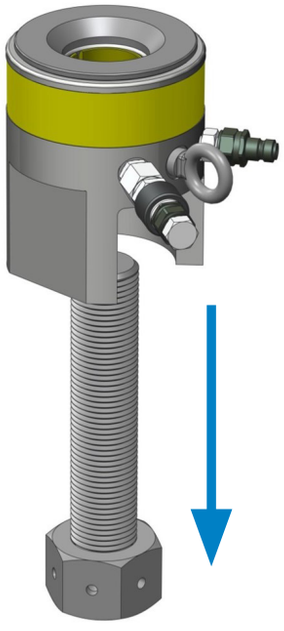
Wrong and dangerous

HEALTH & SAFETY WARNING

If only a few threads protrude, and an attempt is made to apply tension, the bolt threads will strip, and components of the tensioner could be launched with the possibility of serious injury.

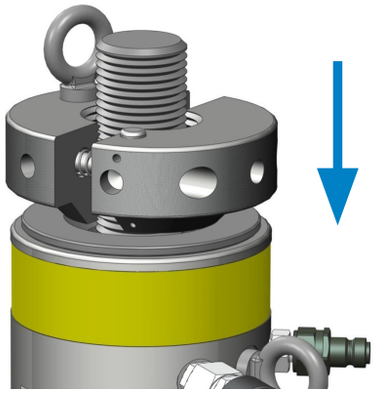
Step 3

Check that the correct plastic sleeve has been fitted then lower the tensioner over the bolt. Use the eye bolt provided to assist hoisting and assembly.



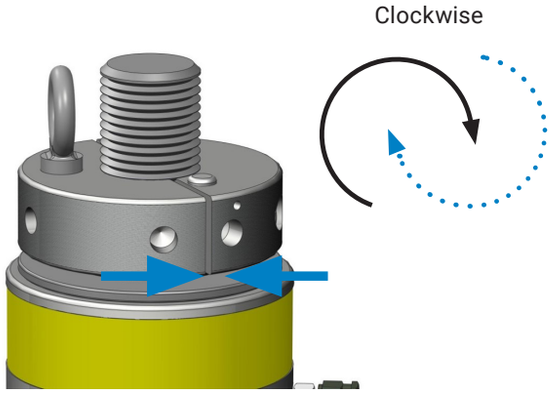
Step 4

Lower the split nut over the bolt in its open position.



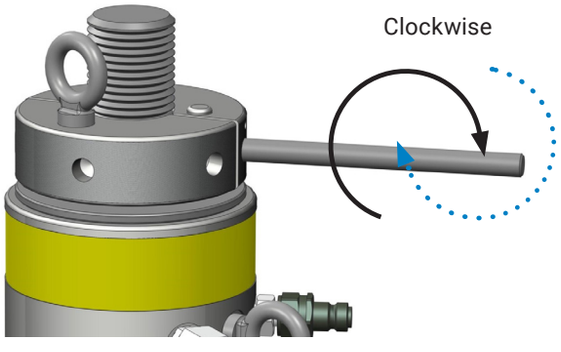
Step 5

Lower the split nut over the bolt in its open position.



Step 6

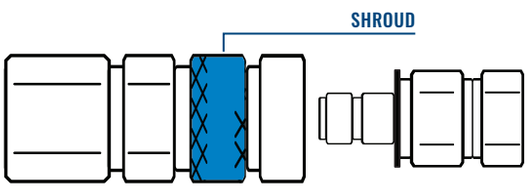
Be sure to lock down the split nut onto the piston by using a tommy bar. Make the sure reaction nut threads are fully closed onto the bolt threads.



Using Quick Connectors

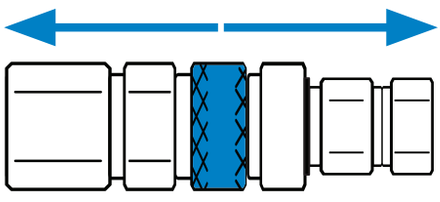
Before using quick-connectors, the operator should ensure that her or she has read and understood the quick-connectors' Health & Safety Instructions in **Section 1**. To connect the quick-connect coupling and nipple, first check there is no pressure in the system. Then pull back the shroud, which will spring back to lock the coupling and nipple together. To disconnect, first check there is no pressure in the system. Pull back the shroud, by hand, and pull the coupling and nipple apart. Release the shroud when apart.

1



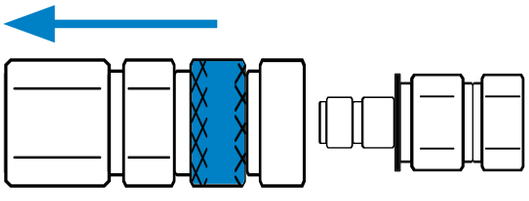
Pull back the shroud to retract.

3



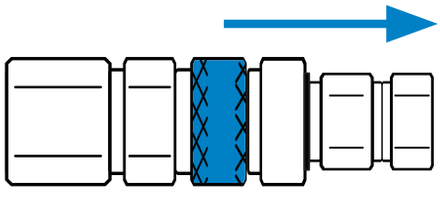
Coupling and nipple pushed together with the shroud retracted.

2



Coupling and nipple with the shroud retracted.

4

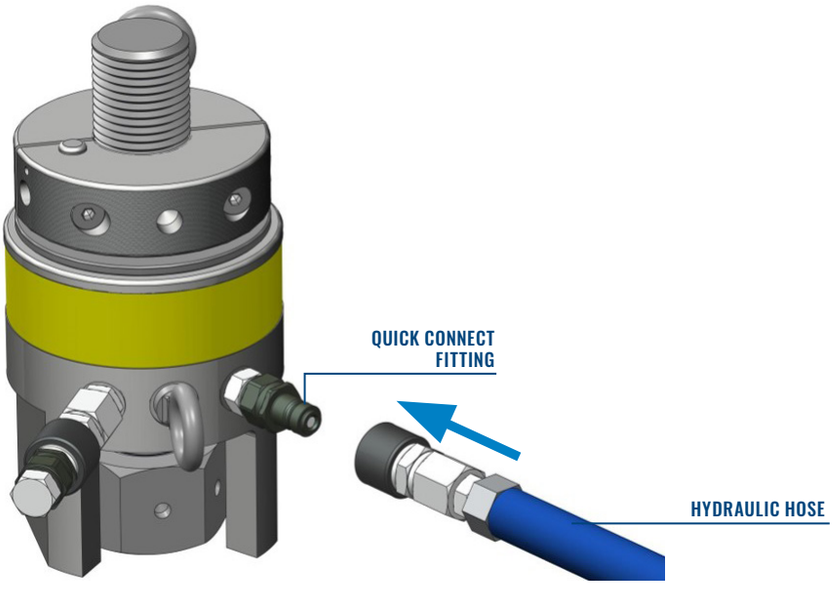


Shroud released; coupling and nipple are now locked together and safe to use.

Step 7

Connect the high pressure flexible hydraulic hose supplied with the tool.

Make sure the quick-connect fittings are fully engaged.



LOOSENING A BOLT – HEALTH & SAFETY

The bolt tensioning tool is now ready to be pressurized. Before proceeding, read the Health & Safety Instructions given in this manual then proceed as follows:

- Clear all personnel from the area where the bolt tensioning operation is to be performed. Position the pump a safe distance away from the bolt tensioning tools. Set up barriers and warning signs or make other adequate arrangements to prevent unauthorized personnel from accidentally straying into the bolt tensioning area.
- Make certain that nobody is allowed to stand near to a bolt tensioning tool during the pressurization process. At no time should anyone allow any part of his or her body to be positioned over the piston of a bolt tensioning tool while the pressure is rising or when it is pressurized. Do not allow anyone to stand anywhere near a direct line with the long axis of a bolt during the tensioning operation. In the case of stud bolts with nuts at each end, it is important that nobody stands in line with the long axis of the bolt at either end during the tensioning operation.
- Do not approach a bolt tensioning tool while it is being pressurized. Remember that bolt or tool failure is most likely to happen at this critical time. When the operating pressure has been reached, approach a pressurized bolt tensioning tool only for as long as it takes to turn the permanent nut, always keeping away from the axis of the bolt and the puller.
- Wear eye protection, gloves, overalls and a hard hat.
- Never leave a pressurized bolt tensioning tool unattended.
- Release the oil pressure immediately if any unauthorized person moves into the bolt tensioning area, especially if anyone stands in front of the piston of a bolt tensioning tool under pressure or stands in line with the long axis of a bolt being tensioned.
- Determine the correct working pressure for the bolts to be tightened. Proceed with the following operations, keeping the bolt tensioning tools under pressure for the minimum time necessary to complete the bolt tightening job.

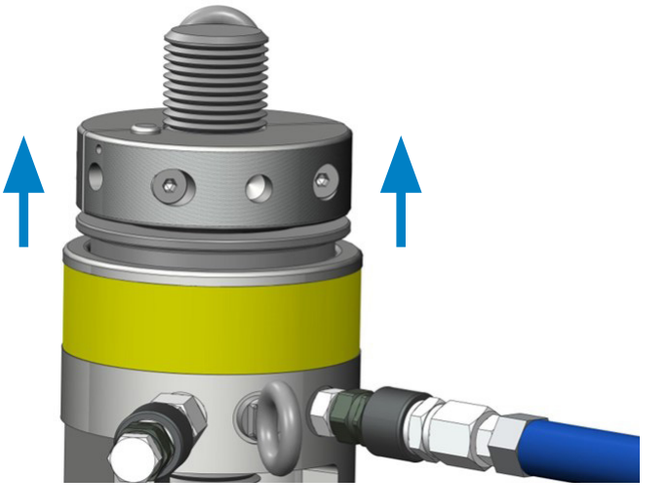
Step 8

Apply the correct hydraulic pressure. The piston will push the reaction nut up and out of the tool as the bolt is stretched and the bolted joint is compressed.

DO NOT exceed the maximum piston stroke. This is indicated by a red line around the piston.

DO NOT exceed the maximum pressure for the tool.

DO NOT use an oil pressure which will result in an initial bolt stress in excess of 90% of the minimum yield strength of the bolt material.



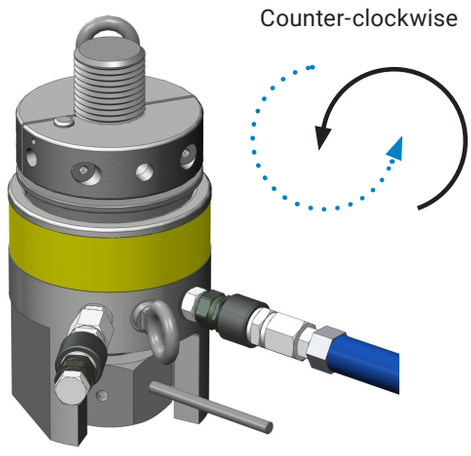
Step 9

Insert the tommy bar through the window in the bridge.

Engage the holes in the hexagon nut.

Turn the nut until it is loose (two full turns).

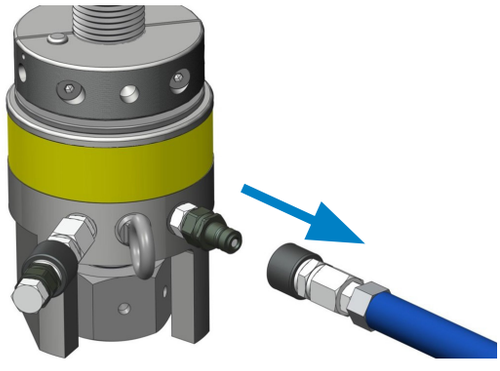
DO NOT turn the nut so far that it comes into contact with the tool.



Step 10

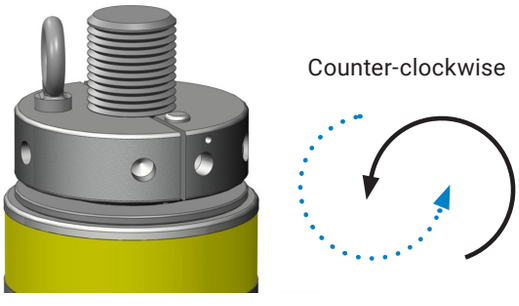
Slowly release the hydraulic pressure.

Remove the hydraulic hose.



Step 11

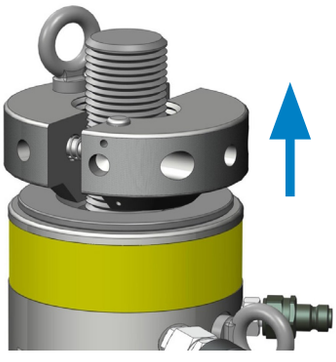
Unscrew the reaction nut until it is clear of the piston



Step 12

Push the button the split nut to release it.

Lift the split nut off the bolt.



Step 13

Finally, lift the body off the bolt, using the eyebolt to assist hoisting and disassembly. Check that the plastic sleeve is not lost but remains in the tool during this operation.

The bolt is now loose.

2.4 RESETTING THE TOOL (TOPSIDE ONLY)

Boltight subsea tensioners deliver 30mm of useable stroke which should be more than adequate to tighten subsea bolts in one pass. Therefore, the tool should never have to be reset by the diver underwater.

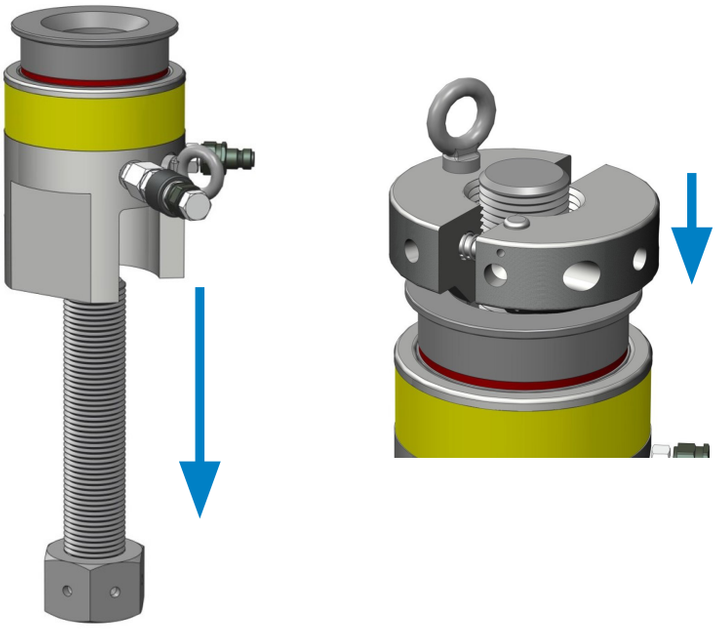
However, after the tools have been used subsea and returned to the surface, they will need to be reset prior to being used again.

The safest way to reset the tool is to assemble onto a test bolt and use the reaction nut to drive the piston downwards back into the hydraulic cylinder. A hydraulic hose must be connected (between the tool and pump) to allow the oil to vent from the tool.

The following instructions explain how to do this.

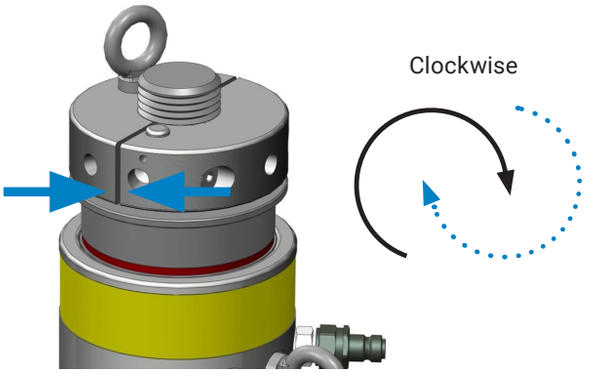
Step 1

Ensure the test bolt is adequately seated and engaged such that it will not fall over. Lower the stroked tool and reaction nut onto the test bolt.



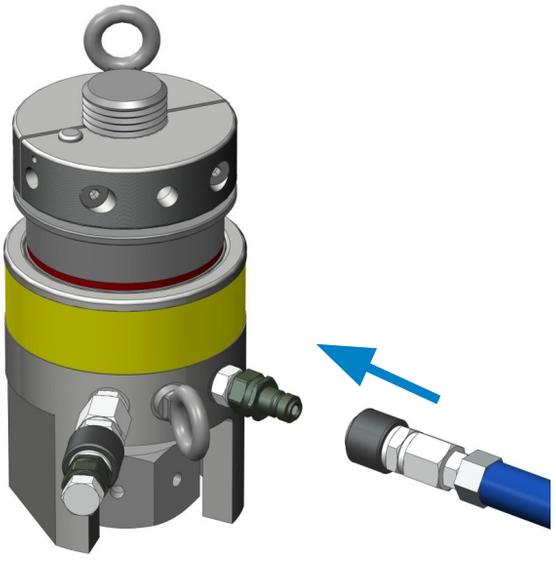
Step 2

Push the segments together to close the mechanism and wind downward by hand.



Step 3

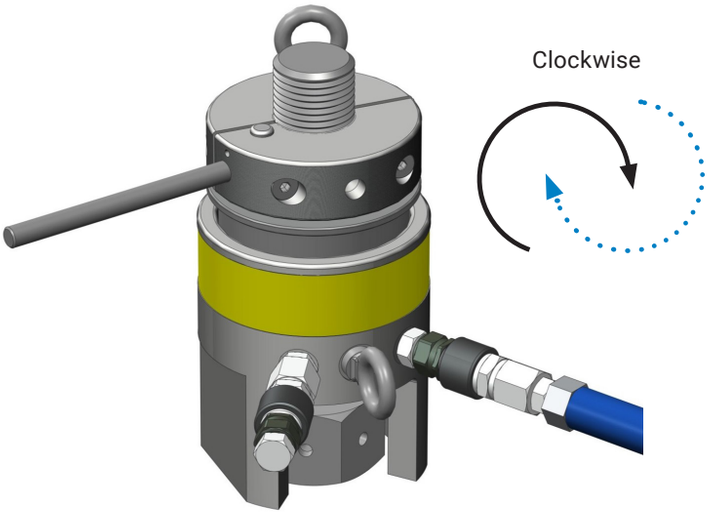
Connect the high pressure flexible hydraulic hose supplied with the tool. Make sure the quick-connect fittings are fully engaged. Ensure the other end of the hose is connected to the pump and that the return to tank valve is open.



Step 4

Using a tommy bar, retract the piston by winding the reaction nut downwards. This will vent hydraulic oil out of the tool and back to the pump.

Continue to turn the nut until the piston will turn no further, i.e. when the lip of the piston is flush with the top face of the body. The tool is now reset and can be disassembled from the test bolt.



2.5 SIMULTANEOUS BOLT TENSIONING

You should have read and understood tightening & loosening bolts before attempting to use multiple tools for simultaneous operation.

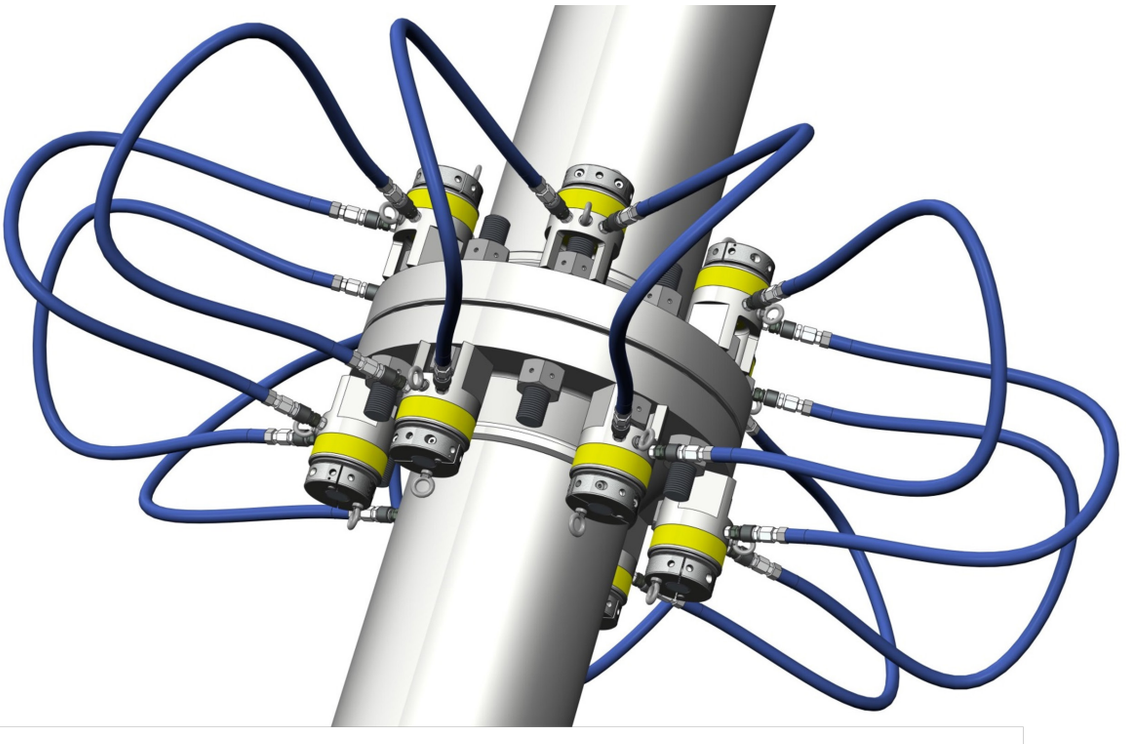
Simultaneous bolt tensioning may involve the use of any number of bolt tensioning tools from two to more than twenty, depending on the number of the bolts in the joint and the percentage of bolts to be tightened simultaneously. In flanged applications, BOLTIGHT strongly recommends simultaneous tensioning of 100% of the bolts.

The method for simultaneous tensioning is similar to tightening one bolt, but requires a number of additional operations. These simply involve the ganging of the tools together with flexible hydraulic hoses and T-blocks to construct a hydraulic main which will supply oil under pressure to all of the tools simultaneously.

The diagrams in this section show one way of connecting the tools for simultaneous operation.

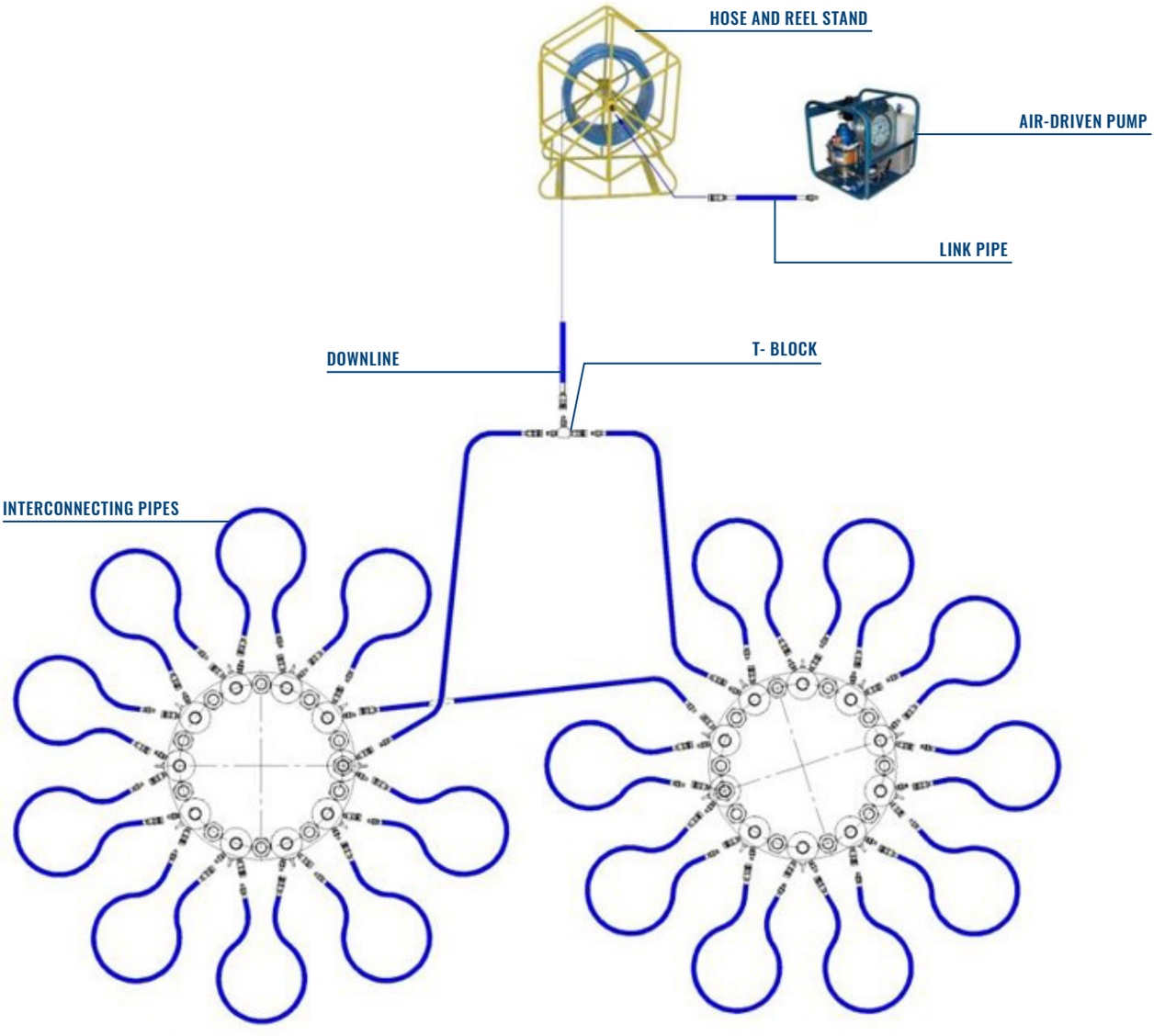
The user may construct a hydraulic main to suit their circumstances. The hoses and T-blocks may be connected together in any combination as long as the end result is a hydraulic main which will supply oil to all of the bolt tensioning tools simultaneously.

The following pages show examples of simultaneous tensioning configurations.



100% Tensioning

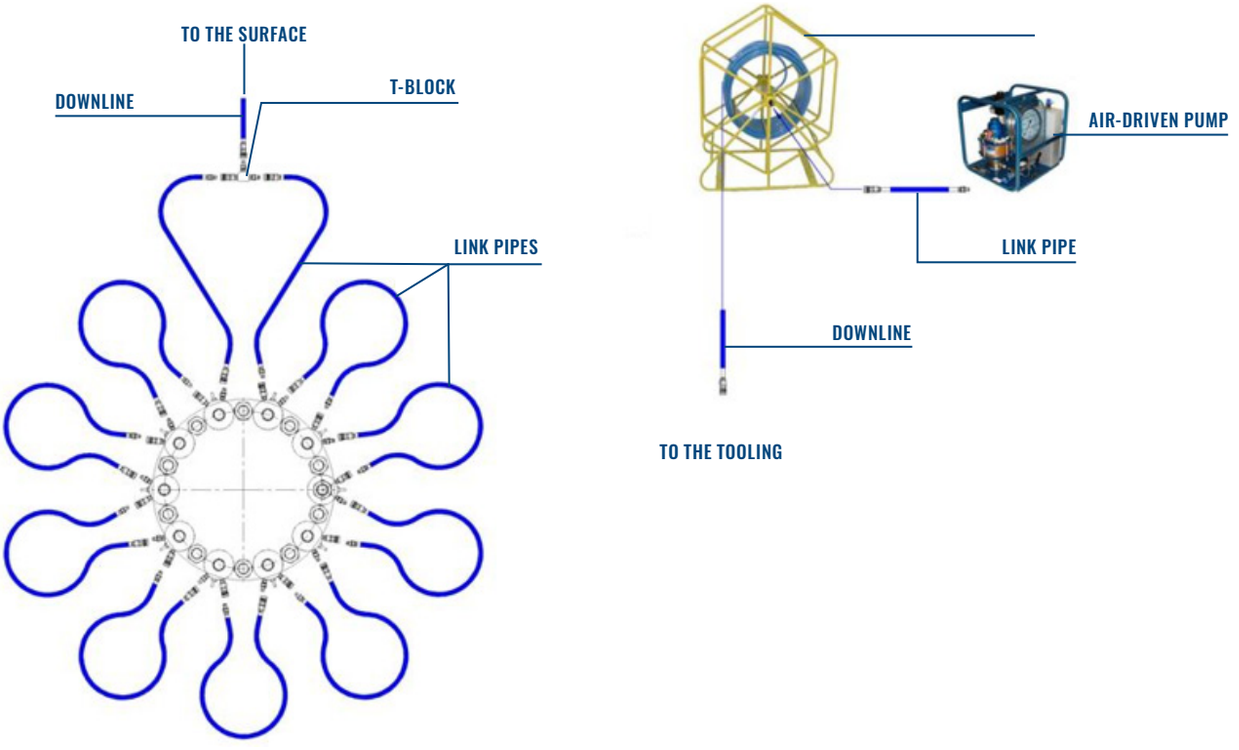
Double port tool configuration:



Front side of flange **Rear side of flange**

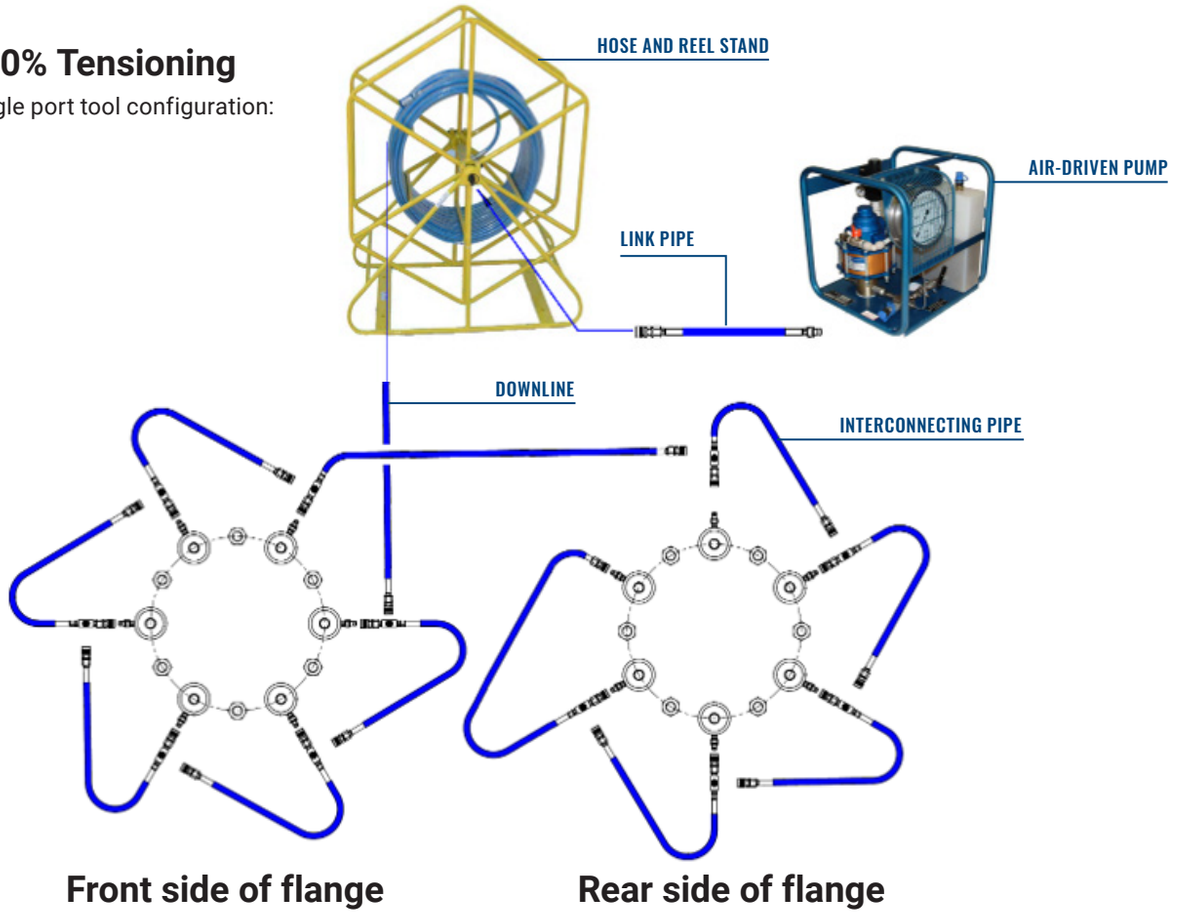
50% Tensioning

Double port tool configuration:



100% Tensioning

Single port tool configuration:



SECTION 3 – MAINTENANCE & STORAGE

3.1 GENERAL INFORMATION

A hydraulic bolt tensioning tool will provide many years of trouble-free service if used, maintained and stored correctly.

3.2 STORAGE

Each tool is electroless nickel plated before leaving the factory. This provides a good degree of corrosion protection when the tools are in operation, however additional protection should be applied when the tools are to be stored for any period of time. It is recommended that, before storage, the tools should be checked for damage and if OK, lightly oiled.

The reassembled tool must have the piston returned to the zero-stroke position and the hydraulic connection must have its plastic protective cap fitted. The hydraulic bolt tensioner should be stored upright in a clean, dry environment. The tensioners were delivered in wooden cases, and these can be used to store the tools.

3.3 MAINTENANCE

Very little maintenance is required for a bolt tensioning tool. The only items which may require changing will be the seals and the quick-connect fittings. However, the seals have a very long life and are not expected to require attention during the life of the bolt tensioning tool. If the seals fail to hold pressure it will be necessary to change the seals as described on the following pages.

Seals

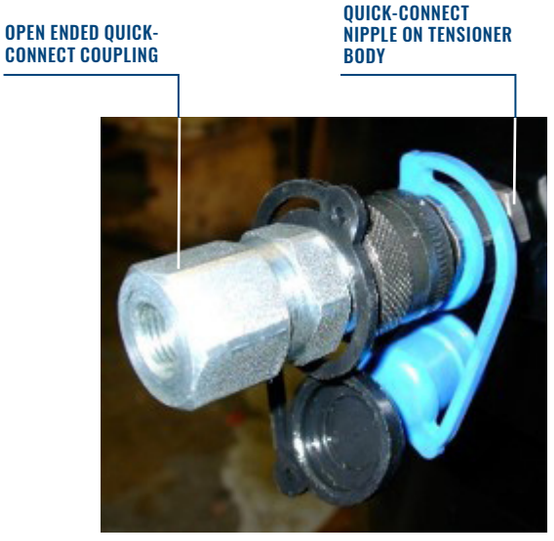
The composite seals used in this bolt tensioning tool are self-energizing and self-lubricating. Under normal operating conditions the seals will have a life in excess of 20,000 operations. When first assembled new seals must be energized before they work properly. When working properly the seals hold pressure during the pressure increase cycle. A small amount of oil is allowed to pass the seal during the pressure decrease cycle. This acts as a lubricant for the cylinder wall. If a small amount of oil is seen around the piston this is not an indication the seals have failed. As long as the seals maintain pressure during the pumping process they are working properly.

Removing the Piston

Due to the interference fit of the hydraulic seals, the piston and body will be very tightly assembled and will not disassemble by hand. It is recommended that the hydraulic cylinder is hydraulically stroked at very low pressure to remove the piston from the body.

To finally remove the piston, first attach an open ended quick-connect coupling to the quick-connect nipple on the side of the bolt tensioner body. This will allow air to enter as the piston is removed. Provision should be made to capture any oil that bleeds from the open coupling.

When the piston has been removed, carefully take it to a clean workbench. Wipe away all oil and examine the piston for any signs of damage, such as score marks. In the unlikely event of the piston being damaged the cylinder bore may also be damaged and the tool will need to be returned to the manufacturer for repair.



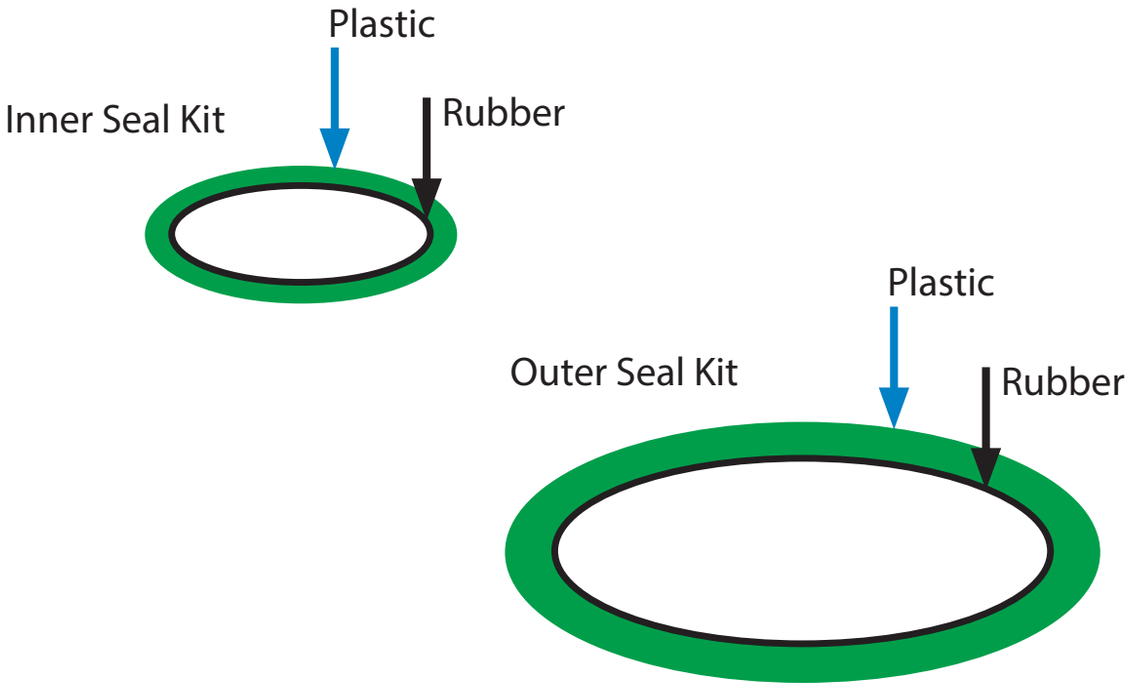
Changing Seals

Each bolt tensioning tool has an inner and an outer seal set. Each seal set consists of a rubber “O” ring and an elastomeric seal. If the seals are damaged or badly worn, the complete set (“O” ring and seal) must be changed. It is recommended that both inner and outer sets are changed at the same time.

To change the seals, the piston must be withdrawn from the cylinder. If the seals are not badly damaged, this may be achieved by carefully blowing compressed air into the cylinder through the quick-connect nipple. All applicable Health & Safety precautions relating to the use of compressed air must be observed. In addition, suitable safe provision must be made to catch the piston and any escaping oil when it leaves the cylinder.

If the seal damage is too great to allow air to be used, the piston may be removed by making a simple piston extraction tool from a bar of steel. The bar must be drilled with two holes to align with the threaded holes found in the top of the piston. Two screws can be used to secure the bar to the piston. The piston can then be pulled from the body using the bar.

The seals used do not run dry. They are self-lubricating and will always exhibit a small amount of oil around the inner and outer edges of the piston. The presence of a small amount of a small volume of oil around the piston is NOT a signal the seals need to be changed. It is normal and to be expected. The oil lubricates the cylinder wall, reduces the force required to return the piston and helps to prevent corrosion. After extensive use, as much as 5 ml of oil may be present around the piston. Simply wipe away any oil when the tools have been used. The seals will need to be changed only if the tool will not pressurize or a very large volume of oil escapes while the oil pressure is being increased, or if the tools will not hold pressure.



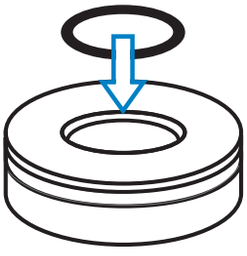
Changing the Inner Piston Seals

The old seal set must be removed by cutting through the seal with a knife.
The “O” ring can be removed by cutting or by levering it out. Both items should be discarded.

Lubricate the “O” ring with grease. Ensure the seal groove is clean.

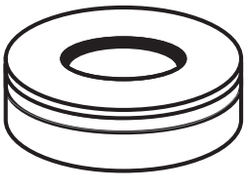
Step 1

Place the piston on a clean surface and insert the rubber “O” ring into the seal groove.



Step 2

Fit the “O” ring into the seal groove.

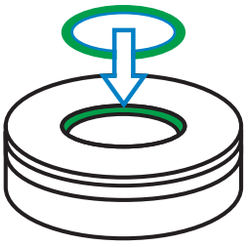


Step 3

Pack the “O” ring with grease.

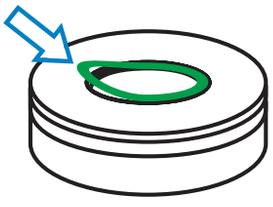
Step 4

Insert the green plastic seal into the seal groove.
Make sure the chamfer is at the top.



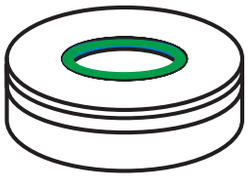
Step 5

Work the seal into the groove using hand force only.



Step 6

The seal will snap into the seal groove.



Step 7

Wipe away any excess grease.

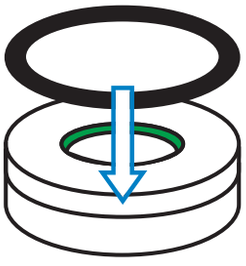
Changing the Outer Piston Seals

The old seal set must be removed by cutting through the seal with a knife.
The “O” ring can be removed by cutting or by levering it out. Both items should be discarded.

Lubricate the “O” ring with grease. Ensure the seal groove is clean.

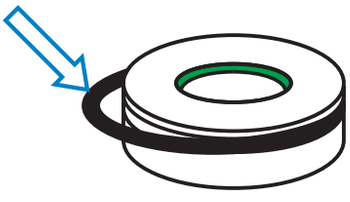
Step 1

Place the piston on a clean surface. Insert the rubber “O” ring into the seal groove.



Step 2

Stretch the “O” ring until it snaps into the seal groove.

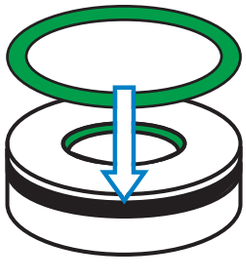


Step 3

Pack the “O” ring with grease.

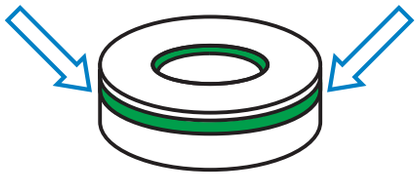
Step 4

Insert the green plastic seal into the seal groove. Make sure the chamfer is at the top.



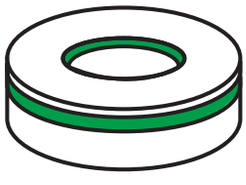
Step 5

Stretch the seal over the outer lip of the piston by working around both sides of the piston simultaneously.



Step 6

Work the seal into the groove using hand force only.



Step 7

Wipe away any excess grease.

Fitting the Piston

To fit the piston, proceed as follows:

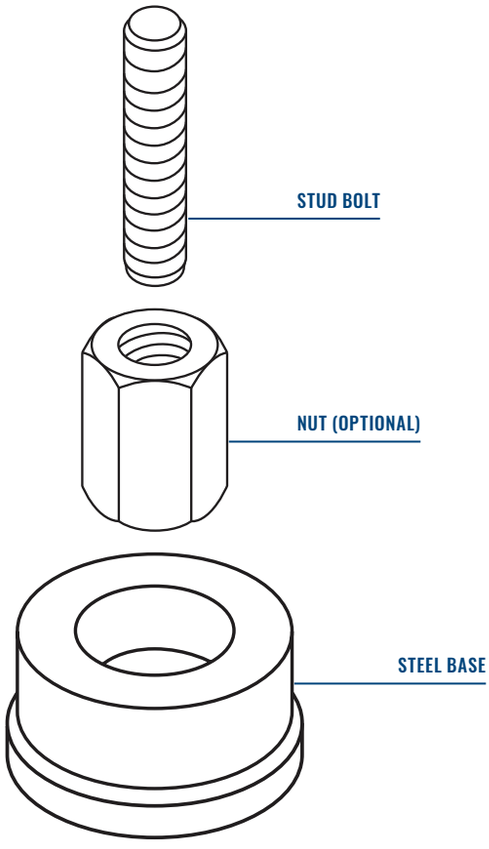
First fit an open quick-disconnect coupling to the hydraulic connection to enable air to be expelled from the cylinder as the piston is pushed in.

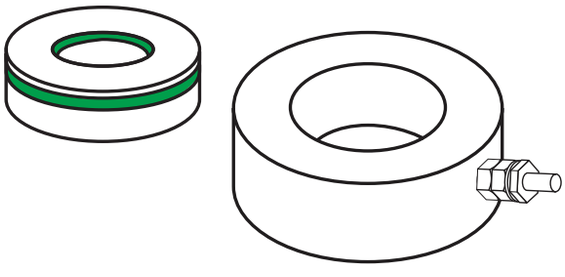
Now make sure the cylinder is clean and free from foreign objects and dirt. Lightly lubricate all the sealing surfaces and the seals with silicone grease.

Lower the piston into the body, ensuring the two components always remain square to one another.

Push the piston into the body. This may require a high load, which may be generated using a simple press, or by using a mallet to carefully drive press the two components together.

Use the mallet or simple press to fully insert the piston into the tensioner body. When the piston is fully home, remove the open quick-disconnect nipple from the hydraulic connection.





Energizing the Seals

After fitting new seals and before the bolt tensioning tool can be used, the new seals must be energized. Proceed as follows:

Using a test bolt, or an actual bolt to be tensioned, lower the bolt tensioning tool onto the bolt. Screw the reaction nut onto the bolt. Centralize the tool, if necessary, to allow the reaction nut to fit into the center of the tool. Turn the reaction nut by hand until it comes into contact with the top of the piston. Screw back the reaction nut 1/2 a turn anti-clockwise to create a gap between the reaction nut and the top of the piston of 3 mm.

Connect the tool to the pump. Run the pump as fast as possible to pump oil into the tool quickly. Air and oil may escape from the seals during this operation and the pressure gauge may indicate rising and falling pressure at each stroke of the pump. If the seals have been properly fitted the seals will quickly energize. Any leakage from the seals will stop and pressure will start to be generated in the tool.

Stop the pump when the pressure reaches 1000 bar. The pressure should be steady and not fall, to show the seals are working. When satisfied the seals are functioning, release the oil pressure.

Allow time for the spring retraction system to fully return the piston.

The seals are now energized and the tool is ready for use. If the seals will not energize, the tool must be taken apart again because the seals have not been correctly fitted. The seals may not energize if the pump is unable to deliver oil quickly enough.

Fitting a Quick Connector

Fitting either the quick connect nipple or coupling, can be achieved by following the simple steps shown below.

Step 1

Check the internal and external threads are clean and free from damage.

Step 2

Screw the adaptor into the hydraulic cylinder. The adaptor is identical at each end, so it does not matter which end is inserted into the cylinder

Step 3

Screw the nipple onto the adaptor.

Step 4

Using a spanner, firmly tighten the nipple onto the adaptor.

SECTION 4 – TECHNICAL INFORMATION

4.1 OIL PRESSURE CALCULATIONS

The formula widely used to calculate the oil pressure to be used with a bolt tensioning tool is given below along with definitions of the terms used:

Bolt load
Residual bolt load required when the tensioning operation is complete.

Tensioning force
The load that will be applied by the bolt tensioner during the tensioning operation.

Load transfer factor
The ratio of **tensioning force** to **bolt load**.

$$\text{Load transfer factor} = \frac{\text{Tensioning force}}{\text{Bolt load}} = 1.01 + \frac{\text{Bolt diameter (mm)}}{\text{Grip length (mm)}}$$

If the **load transfer factor** calculates to less than 1.10, then use 1.10
Tensioning force = bolt load x load transfer factor

Always check that the tensioning force will not exceed 95% of the yield strength of the bolt material. If it does, the grip length of the bolt must be increased. Please contact your representative for advice on this.

$$\text{Oil pressure (bar)} = \frac{10 \times \text{Tensioning force (Newtons)}}{\text{Tool pressure area (mm}^2\text{)}}$$

4.2 OIL PRESSURE GRAPHS

Oil pressure graphs are provided for each bolt size.

One graph shows the theoretical tensioning force developed by the tool against the oil pressure applied.

The graphs included with this manual show the initial bolt stress developed by the tool against the oil pressure applied for each bolt size. This graph is provided to assist with the check that the tensioning force does not exceed 95% of the yield strength of the bolt material.

Users who require highly accurate residual bolt stresses should perform a bolt extension measurement before and after tensioning. In this way, residual bolt stresses can be calculated from the actual bolt extensions measured.

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