WREN SUBSEA BOLT TENSIONER

OPERATION MANUAL

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1. INTRODUCTION

1.1 GENERAL INFORMATION

The WREN Subsea Tensioning tools (WST) have 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 unit via hydraulic hoses.

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

A 'Quick Reaction Nut' is provided. This 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 single down line hose. A pump pressure is determined for the bolt load required and the tensioning tools pressurized to this pressure. As the hydraulic load cells become pressurized, the piston extends and reacts against the reaction nut thus inducing a load in the bolt. The load applied to the bolt results in bolt extension and joint compression. When the required pressure is reached, the nut on the joint face is turned securely down 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 (previously tightened with a tommy bar). The reaction nuts and hydraulic load cells can then be removed.

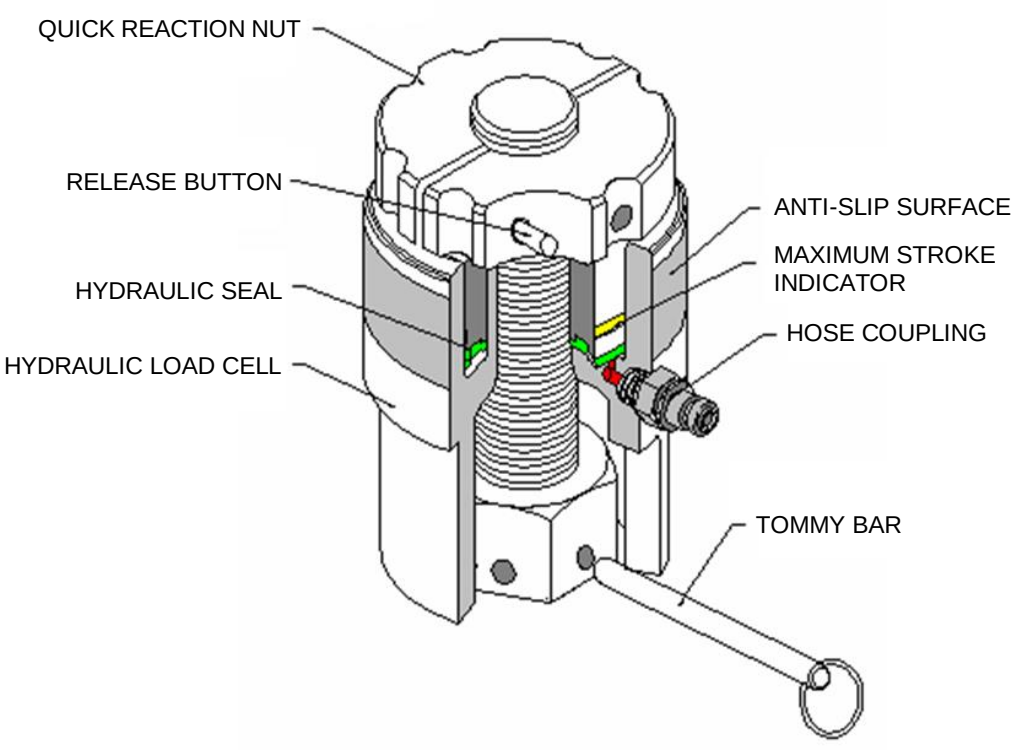

Figure 1 - Arrangement of Hydraulic Load Cell and Quick Reaction Nut

1.2 TECHNICAL SPECIFICATIONS

The following data is applicable to all WST Tensioners:

TENSIONER DESIGN : Single acting cylinder, manual piston retract

MAXIMUM PRESSURE : 1500 Bar (21750psi)

MAXIMUM PISTON STROKE : SST1 - 20mm
SST2 to SST8 - 30mm

OPERATING TEMPERATURE : -20°C to +50°C

HYDRAULIC OIL TYPE : Houghtosafe 620 or equivalent

BOLT TENSIONER RANGE

Tool Ref.	Bolt Dia.		Tool Load		Tool Hydraulic Area		Minimum Bolt Protrusion (above nut)		Weight **
	Imperial	Metric	Tonf.	kN	ins^2	mm^2	Imp bolts	Met bolts	Kg
WST 1	3/4" 7/8"	M20 M22	14.05	140	1.45	934	104 101	107 105	1.50
WST 2	1" 1-1/8"	M24 M27 M30	24.09	240	2.48	1600	133 130	139 136 134	2.80
WST 3	1-1/4" 1-3/8"	M33 M36	38.14	380	3.93	2534	136 133	142 139	4.00
WST 4	1-1/2" 1-5/8"	M39 M42	55.20	550	5.69	3668	140 136	147 144	6.00
WST 5	1-3/4" 1-7/8" 2"	M45 M48 M52	88.32	880	9.10	5868	151 148 145	160 158 154	9.00
WST 6	2-1/4" 2-1/2" 2-3/4"	M56 M60 M64 M68 M72	156.56	1560	16.14	10411	166 160 154	178 175 172 169 165	14.70
WST 7	3" 3-1/4" 3-1/2"	M76 M80 M85 M90	258.43	2575	26.63	17176	181 175 169	195 192 188 184	25.00
WST 8	3-3/4" 4"	M95 M100	346.1	3449	35.65	22997	205 199	224 220	39.00

** Weight indicated is for Load Cell only.

1.3 MAXIMUM ALLOWABLE WORKING PRESSURES

TOOL REF	BOLT DIAM (See Note 1)	MAX. REC. PUMP PRESS. psi (bar) (See Note 2)
WST1	3/4" – UNC 7/8" – UNC	19100 (1315) 21750 (1500)
WST2	1" – 8UN 1-1/8" – 8UN	20300 (1400) 21750 (1500)
WST3	1-1/4" – 8UN 1-3/8" – 8UN	21750 (1500) 21750 (1500)
WST4	1-1/2" – 8UN 1-5/8" – 8UN	21750 (1500) 21750 (1500)
WST5	1-3/4" – 8UN 1-7/8" –8UN 2"- 8UN	19700 (1360) 21750 (1500) 21750 (1500)
WST6	2-1/4" – 8UN 2-1/2" – 8UN 2-3/4" – 8UN	19300 (1330) 21750 (1500) 21750 (1500)
WST7	3" – 8UN 3-1/4" – 8UN 3-1/2" – 8UN	19400 (1340) 21750 (1500) 21750 (1500)
WST8	3-3/4" – 8UN 4" – 8UN	21750 (1500) 21750 (1500)

TOOL REF	BOLT DIAM (See Note 1)	MAX. REC. PUMP PRESS. psi (bar) (See Note 2)
WST1	M20 x 2.5 M22 x 2.5	21500 (1480) 21750 (1500)
WST2	M24 x 3 M27 x 3 M30 x 3.5	18000 (1245) 21750 (1500) 21750 (1500)
WST3	M33 x 3.5 M36 x 4	21750 (1500) 21750 (1500)
WST4	M39 x 4 M42 x 4.5	21750 (1500) 21750 (1500)
WST5	M45 x 4.5 M48 x 5 M52 x 5	18600 (1285) 21000 (1440) 21750 (1500)
WST6	M56 x 5.5 M60 x 5.5 M64 x 6 M68 x 6 M72 x 6	16500 (1135) 19250 (1325) 19900 (1375) 21750 (1500) 21750 (1500)
WST7	M76 x 6 M80 x 6 M85 x 6 M90 x 6	17450 (1200) 19500 (1345) 21750 (1500) 21750 (1500)
WST8	M95 x 6 M100 x 6	21180 (1460) 21750 (1500)

Notes :

1. For other bolt diameters contact WREN Bolting Systems.
2. The maximum working pressure that can be applied on an application depends primarily upon the bolt size and bolt material.

   The maximum recommended pump pressures shown in table 2 are safe for the following bolt material grades:

   ASTM- A193-B7
   ASTM- A193-B16
   ASTM- A320-L7
   ASTM- A320-L43

For maximum recommended working pressure for other bolt materials contact WREN Bolting Systems.

2. SAFETY

The WREN Subsea 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 must not be used for any other purpose nor must they be modified or adapted to any applications with out the approval of the equipment supplier. The following safety precautions must be observed. Exhibit common sense and most importantly of all, READ AND UNDERSTAND THE OPERATING MANUAL AND PROCEDURES.

1) The maximum allowable working pressure is 21750 psi. (1500 bar) and must not be exceeded.
2) Ensure that the minimum studbolt protrusion (above nut) exists as specified.
3) The maximum allowable working pressure of the bolt tensioning tool may exceed the safe allowable working pressure of the bolted joint application. A nominated responsible engineer must specify the maximum safe working pressure for the application and the pump output pressure should be set so that this pressure is not exceeded. Refer section 5.
4) Tools and hoses are fitted with C116 Quick Disconnect Couplings. Their maximum working pressure is as follows: -

Coupled		Un-coupled	
Male	21750 psi (1500 bar)	**Male**	**1000 psi (68.9 bar)**
Female	21750 psi (1500 bar	Female	21750 psi (1500 bar

Do not pressurise UN-COUPLED male 'Quick Disconnect Couplings'. Always fit a blanked female 'Quick Disconnect Coupling' as shown in fig 7.

5) Always ensure that all fittings used to connect the tooling to the pump unit are rated at a working pressure of 21,750 psi (1500 bar).
6) Ensure that the tensioning tools can operate without obstruction, i.e. during pressurisation, the piston / QRN moves away from the load cell, make sure it can move without obstruction.
7) Do not exceed the maximum piston stroke. When the yellow piston stroke indicator is visible the piston is at maximum stroke and further pressurization of the tools must be stopped.
8) Do not attempt to tighten, loosen or disconnect any part of the hydraulic system when under hydraulic pressure.
9) Keep personnel clear of the equipment while pressurization takes place. Only approach the equipment once the pressure has stabilised. Never position yourself in line with a bolt being tensioned.
10) Equipment must be handled with care. Quick Disconnect Couplings are particularly susceptible to knocks and damage. Damaged couplings may be difficult to connect and must be renewed.
11) Always wear eye protection, and personal protective equipment where appropriate
12) Only use WREN Quick Reaction nuts with WREN Subsea Tensioning Tools. Always ensure that the Quick Reaction Nut is placed with its tapered portion engaging the mating tapered portion of the hydraulic load cell.
13) Do not pressurise a hydraulic load cell against 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.
14) Hydraulic hose has a minimum bend radius of 150mm (6") which must not be exceeded or damage to the hose could result which will compromise the safety of the operator. Applications should be reviewed for difficult access and a range of coupling adapters made available to allow for hose connection from axially as well as radial directions.
15) Operators must be made familiar with the equipment, its operation, safety requirements and application procedures prior to working on the application.
16) Misuse and/or abuse of the equipment will invalidate the equipment warranty.
17) If not in use, and when practical, disconnect the pump from the power supply to prevent accidental starting. Also ensure tensioning tools are depressurised.

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3. FLANGED JOINT PREPARATION

3.1 STUDBOLT PREPARATION

To assist problem free application of the WREN Subsea Tensioning Tool and Quick Reaction Nut the following preparation and checks should be carried out prior to installation subsea.

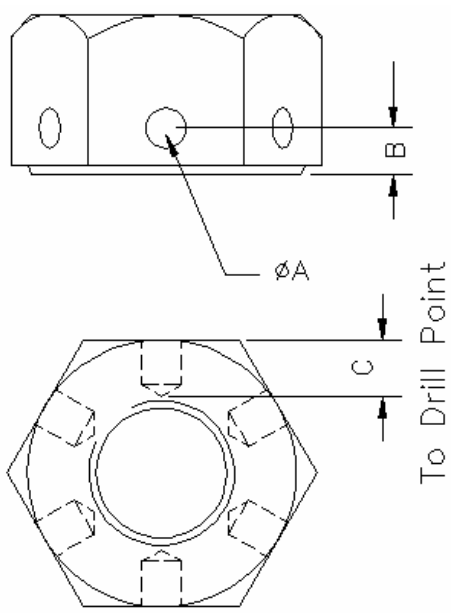
1. One nut should be drilled to accept a tommy bar. Table 2 shows the recommended drilling details.

2. Stud bolts must be assembled with the nuts positioned as shown in Fig 2. Ensure that the drilled and un-drilled nuts are correctly positioned and check that the correct nut faces will be in contact with the joint. The drilled nut must be free running for at least length 'B' and should be positioned at length 'A'.

3. The Quick Reaction nut (or solid reaction nut) should be tried over the end of the bolt (end opposite the un-drilled nut) and should be free fitting. During this stage check the operation of the Quick Reaction Nut ensuring that it opens and closes satisfactorily.

4 Use adhesive tape, a plastic sleeve or other means to protect the thread length A and to prevent rotation of the drilled nut. During installation of the bolts on the joint, remove the un-drilled nut and insert the bolt through the bolt hole and then replace the un-drilled nut.

BOLT DIA (in)	NUT A/F (in)	A +/- 0.1mm	B +/- 0.1mm	C +/- 0.1mm
3/4"	1-1/4"	6.2	9.0	5.5
7/8"	1-7/16"	6.2	9.0	6.0
1"	1-5/8"	6.2	9.0	6.5
1-1/8"	1-13/16"	6.2	9.0	7.0
1-1/4"	2"	8.2	12.0	8.0
1-3/8"	2-3/16"	8.2	12.0	8.5
1-1/2"	2-3/8"	10.2	15.0	9.0
1-5/8"	2-9/16"	10.2	15.0	9.5
1-3/4"	2-3/4"	10.2	15.0	10.5
1-7/8"	2-15/16"	10.2	15.0	11.0
2"	3-1/8"	12.4	18.0	12.0
2-1/4"	3-1/2"	12.4	18.0	13.0
2-1/2"	3-7/8"	14.4	21.0	15.0
2-3/4"	4-1/4"	14.4	21.0	16.0
3"	4-5/8"	16.4	24.0	17.0
3-1/4"	5"	16.4	24.0	18.0
3-1/2"	5-3/8"	16.4	24.0	19.0
3-3/4"	5-3/4"	16.4	24.0	21.0
4"	6-1/8"	16.4	24.0	23.0



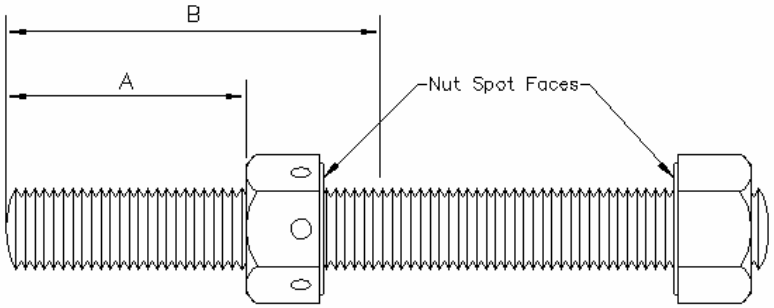


Figure. 2

Note:

1. Imperial bolts consider heavy series nuts.
2. Metric bolts consider normal series nuts. For heavy series metric nuts refer to equivalent imperial size.

TOOL REF	BOLT DIA	A (mm)	B (mm)
WST1	3/4” 7/8”	104 101	140
WST2	1” 1-1/8”	133 130	170
WST3	1-1/4” 1-3/8”	136 133	190
WST4	1-1/2” 1-5/8”	140 136	205
WST5	1-3/4” 1-7/8” 2”	151 148 145	225
WST6	2-1/4” 2-1/2” 2-3/4”	166 160 154	290
WST7	3” 3-1/4” 3-1/2”	181 175 169	330
WST8	3-3/4” 4”	205 199	400

TOOL REF	BOLT DIA	A (mm)	B (mm)
WST1	M20 M22	107 105	140
WST2	M24 M27 M30	139 136 134	170
WST3	M33 M36	142 139	180
WST4	M39 M42	147 144	200
WST5	M45 M48 M52	160 158 154	215
WST6	M56 M60 M64 M68 M72	178 175 172 169 165	275
WST7	M76 M80 M85 M90	195 192 188 184	310
WST8	M95 M100	224 220	400

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3.2 FLANGED JOINT ASSEMBLY

Joints should be aligned square and brought into close contact using draw-bolts, flange pulling equipment or other means.

The stud bolts must be installed in a specific manner depending upon the number of tools being used. It is recommended that whenever possible a tensioning tool is applied to every bolt simultaneously (100% cover refer Fig 3), this generally requires access to both sides of the joint.

When access to only one side of the joint is available then generally (due to fouling of adjacent tooling) tensioning tools can only be applied to every other bolt (50% cover refer Fig. 4).

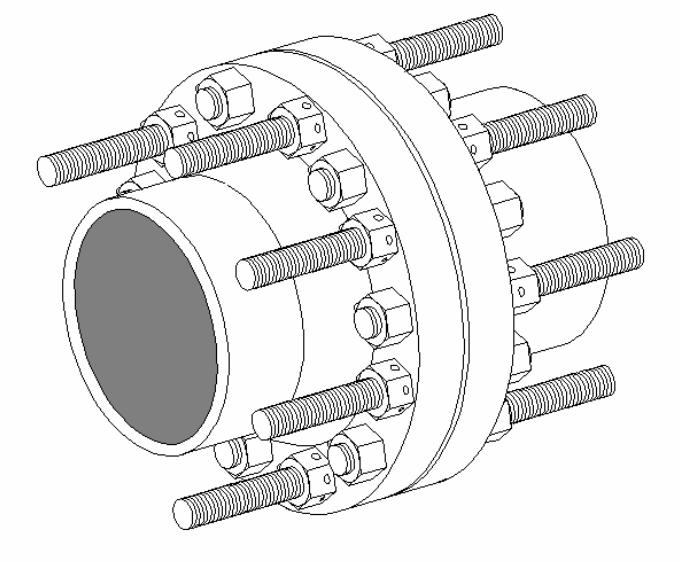

Figure 3. - Stud bolt installation for 100% Tool Coverage

Tensioning tool applied to every bolt working from both sides of the flanged joint.

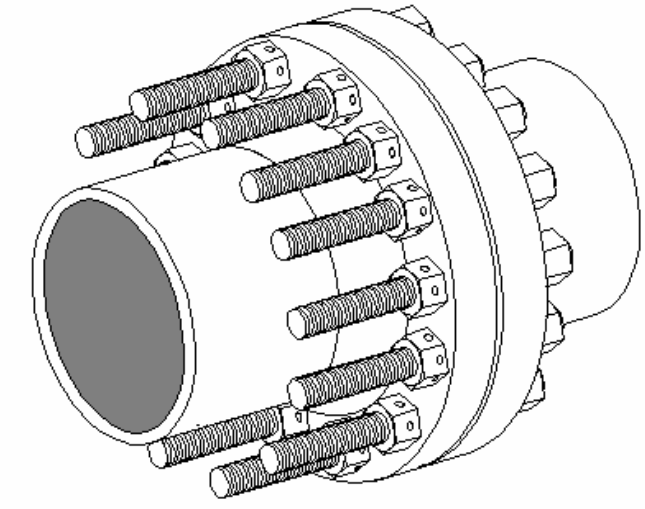

Figure. 4 - Stud bolt installation for 50% Tool coverage.

Tensioning tool applied to every other bolt working from one side of the flanged joint.

4. TENSIONING TOOL ASSEMBLY

4.1 ASSEMBLING THE TOOLS ONTO THE FLANGE

1. Before assembly with the stud bolts the WREN Subsea Tensioning Tool pistons should be correctly positioned depending upon tightening or de-tensioning as follows:

   Bolt Tensioning – Pistons should be fully retracted.

   Bolt De-tensioning – Pistons should be extended so that they protrude approximately 10mm.

2. Slide the WREN Subsea Tensioning Tool cell over the stud bolt

   protrusion. **Solid Reaction Nut**

   Screw on the reaction nut (tapered side facing the tool) until it is securely in contact with the mating tapered portion of the cylinder piston.

   Quick Reaction Nut

   a) Ensure the Quick Reaction Nut is in its open position by pressing the release button. Slide the nut over the stud bolt protrusion (tapered side facing the tool) placing the nut as close to the tensioning tool as possible.

   b) Close the nut halves onto the bolt, juggling the nut slightly so that the nut threads engage with the bolt threads. The nut should 'click' closed.

      (If the nut halves will not click closed then remedial action is required. Check the bolt threads for damage or heavy ingress of dirt etc. Restore or clean bolt threads)

   c) Screw down the Quick Reaction Nut a few turns until it is securely in contact with the mating tapered portion of the cylinder piston. Use a tommy bar in the holes provided if necessary, only applying a light force. (The gap between the top surface of the tensioning tool and the under side of the nut should be approximately 3 – 6mm)

The tensioning tool is now assembled with the bolt to be tightened.

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4.2 CONNECTING THE HYDRAULIC HARNESS / HOSES

Hose connection is very simple. Figure 5 below shows a typical hydraulic harness arrangement for a flange application using 100% tool cover

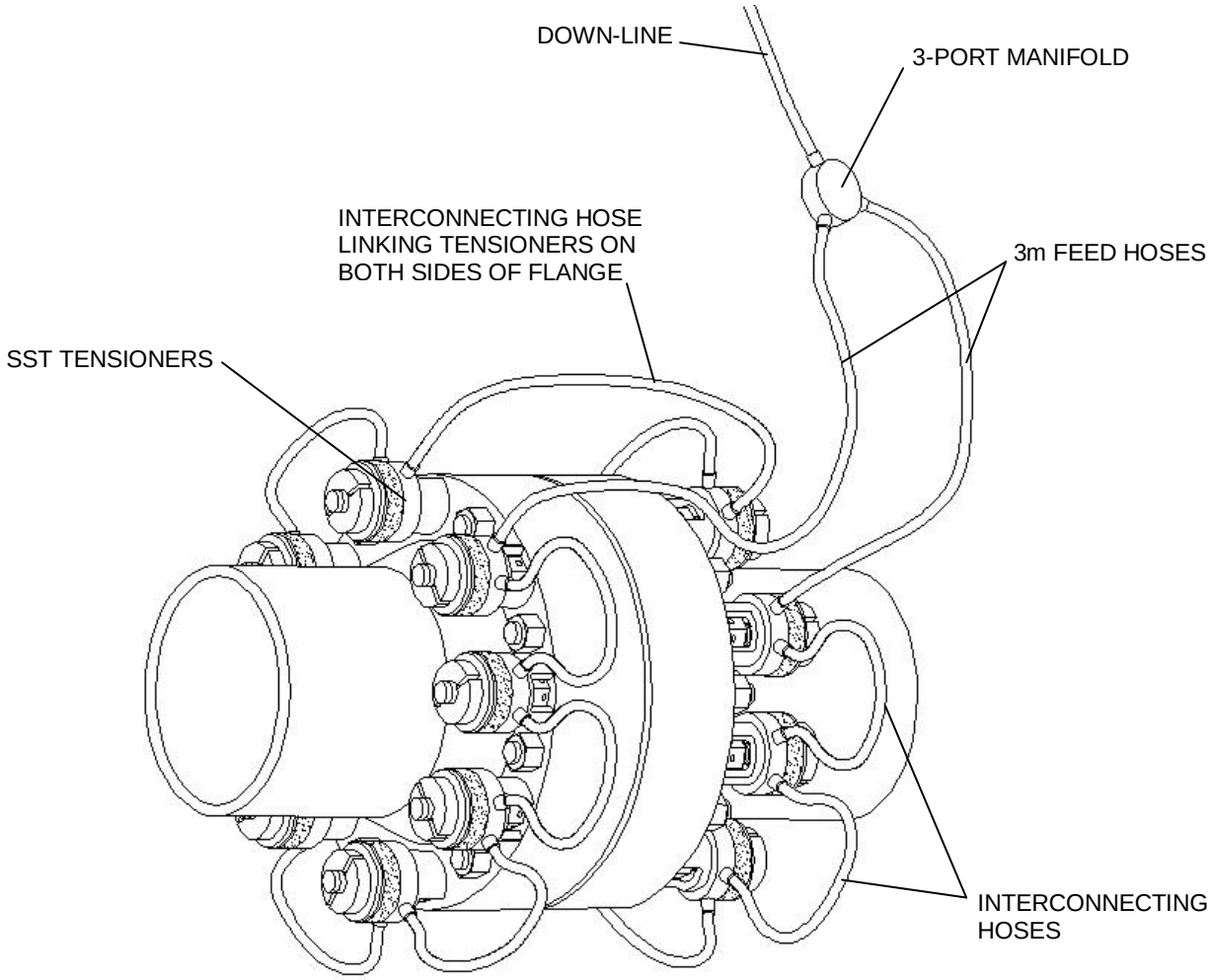

Figure 5 - Typical hydraulic harness arrangement (100% tool cover)

When assembling the harness, the following simple rules should be observed: -

a) Ensure that the pump unit 'Hydraulic Oil Release Valve' is fully open.

b) Always use 2 feed hoses (3m length), connected to 2 separate hydraulic load cells, via a 3-way manifold.

c) Connect interconnecting hoses (1m length) in a clockwise or anti-clockwise direction to minimise errors.

d) When using 100% tool coverage (with tensioning tools on each side of a joint) ensure that an interconnecting hose links two hydraulic load cells, one either side of the joint.

e) When the hose connection is complete, no unconnected hydraulic load cell couplings should exist. Each end of an interconnecting hose should be connected to different hydraulic load cells.

Cont…

f) Male and Female ‘Quick Disconnect Couplings’ have a self sealing mechanism to prevent them losing hydraulic fluid when disconnected. If not properly connected hydraulic fluid will not flow, therefore it is extremely important to check the couplings for complete connection prior to pressurization.

g) Should any ‘Quick Disconnect Couplings’ prove difficult to assemble, this could be due to:

   i) Internal pressure in the hydraulic load cell caused by over-tightening of the reaction nut. Loosen the reaction nut slightly to allow the coupling to be fitted. When both ends of the hose are connected re-tighten the reaction nut.

   ii) Internal pressure in the hose itself. Ensure hoses are properly vented prior to sending subsea. Hoses can be vented in accordance with Section 8 Post use maintenance.

5. AIR & ELECTRIC DRIVEN PUMP UNIT

5.1 PUMP REQUIREMENTS

AIR DRIVEN PUMP:

AIR SUPPLY	:	1/2" Nominal bore supply line
AIR PRESSURE (REGULATED)	:	4.8 Bar (70 psi)
TYPICAL AIR CONSUMPTION	:	28CFM

Prior to pump operation, the following fluid level checks should be carried out.

- Hydraulic fluid reservoir - Ensure that the tank is 3/4 full. Top up with Ovosafe 620 or equivalent hydraulic oil if necessary.
- Air Lubricator - Ensure bowl is filled to within 6mm of the top. Use pneumatic tool oil such as Silkolene Icefree or similar.
- Air Filter / Regulator - Drain any water from the filter bowl (use drain plug on bottom of bowl). In operation, drain away water from the bowl before it reaches the level of the lower baffle.

ELECTRIC DRIVEN PUMP:

POWER SUPPLY	:	200V~240V / 50Hz

5.2 PUMP OPERATING PROCEDURE

The pump unit should be regulated on-site to either stall at a predetermined hydraulic pressure (associated with the particular bolt size to be tightened) or to the maximum pressure of the tensioning tools, i.e. 1500Bar (21750psi). This is achieved by carrying out the following procedure:

a) Either loop a 3m feed hose across the pump hydraulic oil outlets or alternatively attach blank female couplings.

   WARNING: Unattached couplings, male or female, must not be pressurised under any circumstances

b) Open the pump hydraulic oil pressure release valve.

c) Ensure that the pump start / stop valve is closed.

d) Connect the pump to the air supply

e) Turn the air pressure regulator adjustment knob anti clockwise until the air pressure gauge reads zero pressure.

f) Open the pump start / stop valve. As the regulator has been set to read zero pressure the pump should not start. If the pump does operate, it should be very slow.

g) Close the hydraulic oil pressure release valve.

h) Rotate the air pressure regulator adjusting knob slowly clockwise until the required hydraulic oil pressure reads on the pump pressure gauge

   NOTE : DO NOT ADJUST THE AIR PRESSURE REGULATOR TO ANY HIGHER THAN 70 PSI

i) Close the pump start / stop valve.

j) Slowly open the hydraulic oil pressure release valve to relieve the system pressure.

The pump is now ready for operation and will automatically stall at the pre-set pressure. When using the pump unit the following safety rules must be adhered to.

- Always wear eye protection during pump operation and during tensioning.
- Although the pump may be have been pre-set to stall at a certain pressure, always monitor the pressure gauge during pressure build up.
- Should power failure occur during pressurisation, close the pump start / stop valve, and depressurise the system by opening the hydraulic oil pressure release valve. Disconnect the power supply until the power has been restored.
- Always depressurise before leaving the system unattended.

6. BOLT TENSIONING PROCEDURES

6.1 SUBSEA BOLT TENSIONING PROCEDURE – 100% COVER

It is important that the correct bolt load for each specific joint is achieved in a controlled manner. The following procedure details the general method of achieving the correct bolt load in each bolt for standard API and ANSI flanged joints. This procedure is given as guidance only and experienced operators may wish to adopt their own preferred methods for a particular application. A responsible engineer should specify the required bolt load and tensioning tool pressures required to achieve this.

SAFETY: Prior to commencement of bolt tensioning ensure that:

- All necessary safety precautions have been carried out
- Personnel involved in bolt tensioning are competent and fully trained in the use of bolt tensioners and tightening techniques.
- The procedure and data to be used is authorised by a responsible Engineer.
- The joints / pipework to be worked on are not 'live'. Joints must be at zero pressure and free from hazardous substances.
- Bolt tensioning pressures, specific to the flanged joint to be tightened, are available.

STAGE 1 Check that the assembled joint faces are parallel and pulled up in contact with the gasket.

STAGE 2 Prior to connection of the hoses set the pump unit maximum output pressure to the specified tool pressure for the application (as provided by the nominated responsible engineer).

Assemble the hydraulic load cells, reaction nuts and hoses in accordance with the equipment Operating Manual. Make a final check to ensure that:

a) The reaction nuts are securely fastened and have been turned down to make contact with the hydraulic load cell.
b) The hydraulic load cell is in line with the bolt and firmly and squarely in contact with the flange.
c) The hydraulic hoses are securely and correctly assembled.

STAGE 3 Apply an initial tool pressure of approximately 1000 psi. Before proceeding make the following checks.

a) The joint faces have remained parallel and bolts are squarely aligned.
b) Each hydraulic load cell is under hydraulic pressure. (It should not be possible to move the reaction nuts).

STAGE 4 Apply the *'Pressure 2'* as indicated in the bolt tensioning data. Using a tommy bar turn down the drilled hexagonal nuts (accessible through the hydraulic load cell window) firmly onto the joint surface then release the tool pressure.

(At the discretion of the nominated responsible engineer, the specified tool pressure may be achieved in a number of intermediate stages).

STAGE 5 Re-apply and release the specified tool pressure (*Pressure 2*) twice further, checking each time that the drilled hexagonal nuts are firmly seated on the joint surface.

STAGE 6 Once all the bolts have been tightened at least 3 times, as a final check, re-apply the tool pressure and check that the drilled hexagonal nut cannot be further tightened. If the nuts can be turned, repeat stage 5.

Release the tool pressure.

STAGE 7 The bolt tensioning operation is now complete and the hose assembly and tensioning tool may now be disassembled.

6.2 SUBSEA BOLT TENSIONING PROCEDURE – 50% COVER

It is important that the correct bolt load for each specific joint is achieved in a controlled manner. The following procedure details the general method of achieving the correct bolt load in each bolt for standard API and ANSI flanged joints. This procedure is given as guidance only and experienced operators may wish to adopt their own preferred methods for a particular application. A responsible engineer should specify the required bolt load and tensioning tool pressures required to achieve this. It is usual when using 50% tool coverage to specify two tool pressures and the following procedure assumes that this is the case.

SAFETY: Prior to commencement of bolt tensioning ensure that:

- All necessary safety precautions have been carried out
- Personnel involved in bolt tensioning are competent and fully trained in the use of bolt tensioners and tightening techniques.
- The procedure and data to be used is authorised by a responsible Engineer.
- The joints / pipework to be worked on are not 'live'. Joints must be at zero pressure and free from hazardous substances.
- Bolt tensioning pressures, specific to the flanged joint to be tightened, are available.

STAGE 1 Check that the assembled joint faces are parallel and pulled up in contact with the gasket.

STAGE 2 Prior to connection of the hoses set the pump unit maximum output pressure to specified *'Pressure 1'* tool pressure for the application (as provided by a nominated responsible engineer).

Assemble the bolt tensioning tools, reaction nuts and hoses in accordance with the equipment Operating Manual. Make a final check to ensure that:

a) The reaction nuts are securely fastened and have been turned down to make contact with the hydraulic load cell.
b) The hydraulic load cell is in line with the bolt and firmly and squarely in contact with the flange.
c) The hydraulic hoses are securely and correctly assembled.

STAGE 3 Apply an initial tool pressure of approximately 1000 psi. Before proceeding make the following checks.

a) The joint faces have remained parallel and bolts are squarely aligned.
b) Each hydraulic load cell is under hydraulic pressure. (It should not be possible to move the reaction nuts).

STAGE 4 Apply the full specified (higher) *'Pressure 1'* tool pressure. Using a tommy bar turn down the drilled hexagonal nuts (accessible through the hydraulic load cell window) firmly onto the joint surface then release the tool pressure.

(At the discretion of the nominated responsible engineer, the specified tool pressure may be achieved in a number of intermediate stages).

STAGE 5 Re-apply the specified *'Pressure 1'* twice further, checking each time that the drilled hexagonal nuts are firmly seated on the joint surface.

STAGE 6 Once all the bolts have been tightened at least 3 times, as a final check, re-apply the tool pressure and check that the drilled hexagonal nut cannot be further tightened. If the nuts can be turned repeat Stage 5.

Release the tool pressure.

Cont.....

STAGE 7 The hoses and bolt tensioning tools can now be disassembled and re- assembled on the remaining bolts to be tightened.
Prior to connection of the hoses set the pump unit maximum output pressure to the specified *'Pressure 2'* tool pressure for the application (as provided by a nominated responsible engineer)
Carry out all the assembly checks specified in stages 2 and 3 (applying an initial pressure of 1000 psi) before proceeding.

STAGE 8 Apply the full specified (lower) *'Pressure 2'* tool pressure. Using a tommy bar turn down the drilled hexagonal nuts (accessible through the hydraulic load cell window) firmly onto the joint surface then release the tool pressure.

(At the discretion of the nominated responsible engineer, the specified tool pressure may be achieved in a number of intermediate stages).

STAGE 9 Re-apply the specified *'Pressure 2'* twice further, checking each time that the drilled hexagonal nuts are firmly seated on the joint surface.

STAGE 10 Once that all of the bolts have been tightened at least 3 times, as a final check, re-apply the tool pressure (*Pressure 2*) and check that the drilled hexagonal nut cannot be further tightened. If the nuts can be turned, then repeat stage 9.

Release the tool pressure.

STAGE 11 The bolt tensioning procedure is now complete. However, the operator may wish to check the first 50% (1st pass) bolts for tightness. To do so carry out the following procedure:-

a) Disassemble and re-assemble the hoses and bolt tensioning tools back onto the first 50% of bolts tightened. Carry out assembly checks as specified in stages 2 and 3.
b) Apply the *'Pressure 2'* tool pressure and using a tommy bar check that the drilled hexagonal nuts are firmly seated on the joint surface.
c) Depressurize the hydraulic load cells.

STAGE 12 The bolt tensioning procedure is now complete. Disassemble the hoses and bolt tensioning tools.

6.3 SUBSEA BOLT DE-TENSIONING PROCEDURE

When de-tensioning, specific tool pressures are not normally available as it is not always possible to calculate the pressure at which the flange nut will break free. As a guide, if the original flange bolt tightening pressures are available, the de-tensioning pressure is usually marginally higher than the original tensioning pressure (but not always)

SAFETY: Prior to commencement of bolt de-tensioning ensure that:

- All necessary safety precautions have been carried out
- Personnel involved in bolt tensioning are competent and fully trained in the use of bolt tensioners and tightening techniques.
- The procedure and data to be used is authorised by a responsible Engineer.
- The joints / pipework to be worked on are not 'live'. Joints must be at zero pressure and free from hazardous substances.
- The maximum pressure that can be applied has been calculated to ensure that either 85% of bolt material yield is not exceeded or the maximum tool pressure is not exceeded, whichever is the lower. Pump must be pre-set to achieve this.

STAGE 1 Set the pump unit output pressure to 10 to 15% above the original joint make-up tool pressure.
When the original tool pressure is not known then the pump unit should be set to a pressure that is safe for the bolt material and joint make up. A nominated responsible engineer must specify this pressure.

STAGE 2 The pistons of the hydraulic load cells must be partially stroked 10mm (3/8"). **This is necessary to prevent the bolt tensioning tools becoming locked onto the bolt being loosened.**

STAGE 3 Assemble the bolt tensioning tools, reaction nuts and hoses. Make final checks to ensure that: -

a) The reaction nuts are securely fastened and have been turned down to make contact with the hydraulic load cell.
b) The hydraulic load cell is in line with the bolt and firmly and squarely in contact with the flange.
c) The hydraulic hoses are securely and correctly assembled

STAGE 4 Apply an initial tool pressure of approximately 1000 psi. Before proceeding make the following checks.

a) Each hydraulic load cell is under hydraulic pressure. (It should not be possible to move the reaction nuts with minimal force).

STAGE 5 Apply hydraulic pressure in stages until the predrilled nuts (accessible through the hydraulic load cell window) can be released. Turn the nuts at least 2 full turns (i.e. 12 flats of the nut).

STAGE 6 De-pressurise and disassemble the hoses and bolt tensioning tools.

7. PISTON OVERSTROKE PREVENTION AND RETRACTION

7.1 PISTON OVERSTROKE PREVENTION

Should the maximum stroke of the hydraulic load cell piston be exceeded, damage to the piston seals may result. This will necessitate removal of the tool and replacement of the piston seal.

To assist the operator the piston is provided with a 'maximum stroke indicator' in the form of a yellow band marked around the circumference of the piston. During the bolt tensioning operation the following should be observed: -

a) As the hydraulic load cells become pressurized and their pistons begin to extend the operator must keep a visual check on the amount of piston extension.

b) As the piston reaches maximum stroke the 'maximum piston stroke indicator' will become visible. (i.e. A yellow band will appear refer Fig.1) .

c) When the maximum piston stroke is reached the pump unit must be stopped and the tool pressure retained. The pre-drilled hex nuts must be turned down firmly onto the joint surface using a tommy bar.

d) The hydraulic load cells can now be de-pressurized and pistons retracted. Once the pistons have been fully retracted the bolt tensioning operation can proceed.

7.2 PISTON RETRACTION WHILST SUBSEA

The maximum piston stroke provided should be sufficient for most applications enabling piston retraction to be carried out topsides between operations or during post use maintenance.

However, should piston retraction be necessary subsea, this can be achieved by turning down the 'Quick Reaction Nuts' or 'Solid Reaction Nuts' using a tommy bar in the pre drilled holes provided.

Piston retraction should only be attempted having carried out the '**Piston over-stroke prevention'** procedure detailed above. Ensure the pump unit pressure release valve is fully open during piston retraction.

7.3 PISTON RETRACTION TOPSIDES

Refer to section 13 'Post use tool maintenance'

8. POST USE TOOL MAINTENANCE

The WREN Subsea Tensioning Tools require little on-site maintenance. In order to ensure the tooling and equipment is kept in good working condition the following post use maintenance should be carried out.

Hydraulic load cell

a) Thoroughly clean and rinse each hydraulic load cell in fresh water (not sea water).

b) Stand the hydraulic load cell on a firm surface or floor and fit an open ended female quick release coupling to one of the male couplings. Place a container under the open ended coupling to collect the hydraulic fluid that will be exhausted when the piston is retracted.

c) Apply your weight to the piston, the piston will slowly retract. Ensure the piston is fully retracted. The top of the piston should be flush with the cylinder.

d) Remove the open-ended coupling and discard any hydraulic fluid.

e) Dry with a cloth and liberally coat each hydraulic load cell with a water repellent spray such as WD40 or similar product.

Quick Reaction Nuts

a) Thoroughly clean and rinse each ‘Quick Reaction Nut’ in fresh water (not sea water). During this process open and close the nut several times ensuring that the locking mechanism is working correctly. This will clear any lodged debris.

b) Dry with a cloth and liberally coat each ‘Quick Reaction Nut’ with a water repellent spray such as WD40 or similar product.

Hydraulic hoses and connectors

a) Thoroughly clean and rinse each hydraulic quick release coupling in fresh water (not sea water). During this process operate the couplings several times to ensure correct operation.

b) During use sub-sea some internal pressure may have become locked in the hoses. The use of an open-ended mating coupling should release this pressure. Some force may be needed to bring the couplings together. Discard any hydraulic fluid exhausted from the hose.

c) Dry with a cloth and liberally coat each hydraulic coupling with a water repellent spray such as WD40 or similar product.

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9. FAULT FINDING

Fault	Possible Cause	Remedy	Refer section
Quick Reaction Nut will not engage	Damaged threads Different thread forms Oversize threads	Rectify thread Change QRN for correct thread form Check bolt size	6
Hoses difficult to assemble	Coupling locking collars not fully screwed back Damaged coupling Internal pressure in hose	Fully screw back collar Check and replace coupling Fully vent hose	7
Pump does not operate	Air supply not connected Air start stop valve closed Air regulator closed	Connect air supply Gradually open valve Adjust air regulator to provide the correct application pressure.	8
Application pressure cannot be achieved with pump running continuously.	Leaking Hydraulic oil release valve Leaking coupling and/or seals Leaking hydraulic load cell seals	Ensure valve is tightly closed. Replace coupling and/or seals Replace seals	8 Maintenance and Servicing manual
Pump stalls before reaching application pressure	Insufficient air supply Incorrectly set air regulator	Increase air supply Set air regulator to correct application pressure	8
Hydraulic load cell pistons do not stroke but system shows pressure build up.	Hose coupling not assembled Incorrect hydraulic hose harness assembly	Check connection of couplings Check harness assembly	7
Hydraulic load cell pistons do not stroke with no system pressure build up	Defective pump unit Open hydraulic oil release valve Burst Hose Leaking coupling and/or seals Leaking hydraulic load cell seal	Check pump for oil delivery Ensure valve is tightly closed Check and replace hose Check and replace coupling/seal Replace seal	8 Maintenance and Servicing manual

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10. EMERGENCY MEASURES

Improvised Reaction Nuts.

The WREN Bolt Tensioning System can be supplied with Solid Reaction Nuts or Quick Reaction Nuts.

Standard Hexagonal nuts CANNOT be used as a substitute for the standard Quick Reaction Nut or Solid Nut. Irreparable damage will occur to the hydraulic load cell piston and possibly cylinder. The safety of the operator could be compromised.

In an emergency a standard hexagonal nut can be used provided.

a) A thick washer at least equal in diameter to the piston outside diameter is used between piston and the standard nut. The washer thickness should be at least ¼ of the bolt diameter.

b) Full thread engagement of the standard nut (being used as a reaction nut) exists.

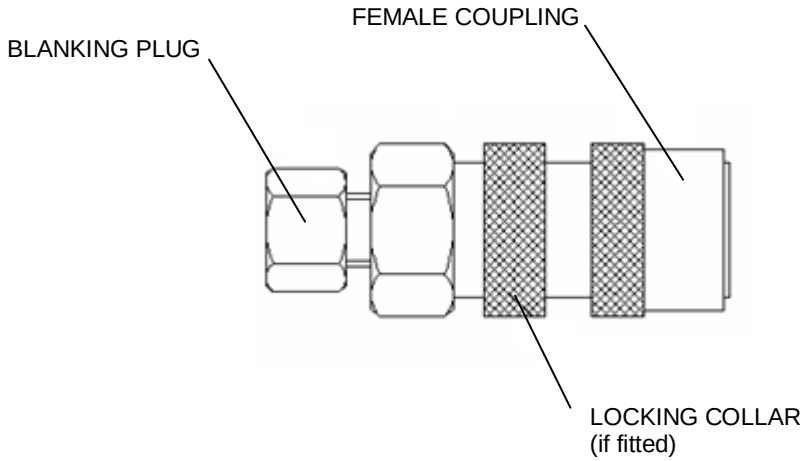

Figure 7 - Blanked Female Coupling

11. MAINTENANCE, SERVICING AND WARRANTY

In addition to post use maintenance it is recommended that routine maintenance and servicing be carried out by WREN Bolting Systems.

Maintenance and servicing should be carried out in accordance with the manufacturers 'Equipment Maintenance and Servicing Manual'.

WARRANTY

All WREN Subsea Bolt Tensioners and Quick Reaction nuts are supplied under the Manufacturers' standard terms and conditions.

All components shall be guaranteed for a period of twelve months from the date of purchase against material defects and workmanship. All components shall be guaranteed for a period of twelve months from the date of purchase against defects arising from normal use with the following exclusions;

- Hydraulic seals and back-up rings
- O-ring seals
- Quick-disconnect couplings
- Labels and decals
- Tommy bars
- Paints and coatings
- Plastic screws
- Springs

End of Life and Disposal

In accordance with our End of Life Policy, should the product be no longer required for use, it should be returned to WREN Bolting Systems where it shall be disposed of in a safe and environmentally friendly manner.

WREN HYDRAULIC TOOL

All WREN products are guaranteed against defects in workmanship andmaterials for as long as you own them.Under this guarantee,free repair or replacement will be made to your satisfation.

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