`Hydraulic Tensioner Procedure for 50% tensioning:
Document: PWL-HTS-101

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Joint Preparation prior to Tensioning:
General:

- Clean Flanges and check for scars on the flange surface area
- Check studs and nuts for: size, material, specifications and cleanliness (Clean rust, paint, etc. with a wire brush)
- Remove burrs from all threads of studs and nuts
- If one stud is replaced all studs must be replaced (if the studs are being re-used)
- Gaskets to be checked for size and PROPER SPECS. No substitutions.
- Metal gaskets must be free of grease, etc. Install without tape/gook, etc.
- Check flange where nut makes contact. Area must be clean and smooth.
- Flanges must be parallel and gaskets inserted according to approved procedure.
- Flanges will be mated using the approved procedure as follows:
  Two bolts shall be installed diametrically opposite each other, and one bolt halfway between the previously installed (for flanged joints in horizontal line, one on the underside) for retaining the gasket.
- The nuts shall be engaged.
- The gasket shall be inserted, and centered between the flanges.
- Nuts shall be hand tightened to hold the gasket in place.
- The remaining bolts and nuts shall be installed with the flange faces parallel.
- Care shall be taken to ensure proper centering, seating and sealing of the gasket within the allowable tolerances.
- Make sure flange is relatively stiff
- Use ¼" thick hardened steel washers on both ends of studs when installing new bolts.
- Check flange alignment:
  Tolerance limited to 3/32" up to 24" flange diameter and 1/16" on flanges greater than 24".
- Lubricate if specified on the washer (side touching bolt), bolt threads and inside nut threads.

Procedure for Tensioning using 50% Pullers
· (i.e.: One puller on every other stud,
· and performing two steps to ensure proper tensioning).

(1.0)
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Prerequisites for assembly of tools:

(1.1)
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Ensure that all the bolts have been assembled into the joint as per the above-mentioned procedure and the nuts fitted hand-tight.

(1.2)
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Ensure that the Tensioner Pump, the Complete Tensioner (including the Ram, Adaptor Kits,

Spare Seals, Sockets, Tommy Bars, Pullers, and Bridges) are available for the particular sized flanges and studs.

(1.3)
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Ensure that the tightening sequences and all procedures and application documents have been approved.
Note: It is advisable to tighten the nuts down as much as possible by hand so as to avoid slackness in the joint assembly, as it will take longer to tension the bolts using the tools.

(2.0)
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General information for Tensioning:

2.1.
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This procedure is for the use of:
(a) All flanged joints with a stud diameter of 2" and above.
(b) All flanged joints wit a bolt diameter of 1-1/2" and above in a critical service as defined by the owner or purchaser.
(c) Shell and Heat exchanger flange assemblies with a bolt diameter of 1" and above.
(d) Any flanged Joint with a bolt diameter of 1-1/2" and above, which can not be hydro-tested because of a construction or hydro-test boundary defined by the owner or purchaser.
(e) Any other applicable equipment flanges defined by the owner or purchaser.

2.2
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Approval of the Tensioning procedure as per Portable Works Limited's "Tensioning procedure MUST be given in writing by the Plant Owner and/or Contractor.

2.3
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Using the PWL Bolt Tensioning Application Sheet (known as BTAS) that details the
(1) Line number,
(2) Flange details,
(3) Bolt Load Calculations, and Pump Pressures in accordance with Aztec Bolting specifications
(4) Equipment Make/Model/Type, Readout/Range/Accuracy,
(5) Calibration Certificates,
(6) Training Certificates for the operators,
(7) Bolt Stretch Measurement Technique, and
(8) Quality assurance plan
And thereafter, proceed with the sequence of steps as detailed below.

2.4
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When using Tensioning tools to achieve the correct final tension, each bolt must be as often as required "tensioned" until the application of the calculated oil pressure results in no further bolt extension (i.e.: until the nuts can not be turned any further whilst the tools are at the calculated working pressure).

2.5
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If, During the application of pressure the tools attain their maximum permissible piston stroke BEFORE the calculated working pressure is reached, then the nuts must be tightened down at this point and the tools reapplied.

2.6
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This means that even if every bolt in a joint is tensioned simultaneously, the bolts MAY NEED to go through more than one tensioning cycle.

2.7
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In the case when only a few of the bolts in a joint are simultaneously tensioned regardless of whether maximum extension is achieved prior to working pressure, it is fairly certain that more than one pressurization cycle will be required.

3.0
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Recommended Procedure for Testing the "Tensioners" prior to
executing the Tensioner PROCESS:

(3.1)
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The Nuts will have been hand tightened, with lubrication and have one stud diameter of thread extending above the nut or two stud diameters of additional threads extending above the flange face to accommodate the tensioning equipment.

(3.2)
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Using Chalk or Metal marker, starting with the Stud/bolt located at right-most to the Stud/bolt at 12 O'clock, mark this as BOLT#1, Then the stud located to the right of the Stud/Bolt #1, will be Marked as BOLT#2. The bolt pattern is continued as Bolt#1,Bolt#2 and 1,2…. Around the flange. The number of tools is half the number of bolts.

(3.3)
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The studs are Numbered nuts for identification and control as per the steps listed below.
Tension pattern is noted as one tensioner (Set #1) is to be applied on every-other-stud (50%).

(3.4)
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Before installing the tensioner check to see that there are enough threads above the nut to properly engage the puller and that the nut runs freely on the stud past its point of travel.

(3.5)
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Remove the puller from the tensioner assembly.
Remove the socket from the tensioner assembly.
The bridge and ram (load cell) remains complete.

(3.6)
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Thereafter, install hex socket, then the RAM (Load cell assembly) with the bridge over one of the studs starting at 12 O'clock (Set #1). The Hydraulic fittings must point away from the center of the flanged joint. The Ram has a "window" which should be facing away from the flange and be free of interferences. The socket should be clearly seen.
Place the Puller (threaded insert) into the bore of each load cell. Mate the threads and screw the thread insert onto the bolt until it tightens down onto the load cell sufficiently to hold the tool in place.

(3.7)
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Connect the link hoses to the tensioners installed on the flange

(3.8)
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When the interconnecting link hoses are attached to each tensioner unit, it is necessary further screw the puller down until there exists no gap between the top of the tensioner and the puller. THEREAFTER, back off the puller 1/8 of a turn so as to give the ram some space to breathe when the oil is pumped into the Tensioner so that the tensioner will move on its own before getting resistance from the puller.

(3.9)
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Fit the Tee Block on the tensioner nearest the pump

(3.9.1)
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Close the oil pressure release valve (G) on the pump unit (By Rotating clockwise).

(3.9.2)
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Very SLOWLY, open the pump unit air "On/OFF" valve (F), by rotating anti-clockwise. As this is done, the pump will begin to operate. After, a short time the pressure gage (B) will begin to register pressure. CONSTANTLY monitor the oil pressure. IF EITHER the operating oil pressure or Maximum piston extension is reached then stop the pump immediately, by closing the "On/OFF" valve (F) by rotating clockwise.
Take the Pump PRESSURE UP TO 5,000 PSI.
This is the "Test Pressure" at which we test the hose lines at 5000 PSI (to see if the lines leak).

(3.9.3)
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Check ALL fittings and make sure they are all tightened. If no leaks then proceed to next step.

4.0
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Performing the Tensioning PROCESS:

(4.1)
Increase Pump Pressure-to-Pressure A (which has been given/known and verified by the Bolt Tensioning Application Sheet-BTAS). The stud will stretch to the desired elongation, and the Nut face will move from the flange face. The tensioner must pull the stud STRAIGHT. It cannot be cocked.

(4.2)
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Using the "Tommy Bars" insert into the Tensioner socket provided and Tighten the nut (clock-wise) to meet the flange face. This step must be performed on all the studs that are fitted with a tensioner until all the nuts are tightened.

(4.3)
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Then very slowly open the oil pressure release valve (G) on the pump unit. The oil pressure registered on the gage will fall to zero. For RING TYPE joints the tensioner pump pressure must be held longer to achieve proper GASKET COMPRESSION.

(4.4)
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Perform steps (4.1) and (4.2) and (4.3) two more times to compensate for gasket compression

and therefore relaxation. When tightening the bolts be sure the nut is run up completely before you relieve the hydraulic pressure.

(4.5)
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Disconnect the link hoses attached to the tensioners. At this stage there will be a gap between the piston and the load cell body indicating that the piston extension is attained. THIS gap must be returned to zero by manually tightening down each insert with the "Tommy Bar".

(4.6)
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Unscrew and remove each puller (thread insert), and remove the Tensioners (puller, bridge, socket and ram) and begin assembly onto the other studs (Set Number 2)

(4.7)
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Perform 5000 PSI pump pressure test on all hose connections as per step (3.6) to (3.9.3) above.

(4.8)
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Increase Pump Pressure to Pressure B (which has been given/known and should be 2000-3000 PSI below Pressure A or 20% less than Pressure A) as per steps (4.1) to (4.3) above. Tighten the nut to meet the flange face and release the pump pressure as per step (4.1), (4.2) and (4.3) USING Pressure "B" instead of pressure "A".

(4.9)
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Perform steps (4.4) two more times to compensate for gasket compression and therefore relaxation

(5.0)
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Inspection and verification:

(5.1)
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Inspect the joint for uniform bolt loading.
a) The gap between the flange faces shall be measured at 0/90/180/270 degrees to check for alignment.
b) After Hydraulic Stud Tensioning the extra length of thread extending above the nut shall be protected using an extra nut, which shall be backed off from the "Engaged" nut.

(5.2)
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The Both sets of studs have to be verified to determine that the Pressures A and B produce the desired result.
Therefore:
- Move one of the Tensioners that is STILL on Set #2, to one of the studs of set #1.
- To make room for this tensioner on Stud#1, remove another tensioner (on Stud#2) on the other side of Stud#1.

(5.3)
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Check the hose connection at 5000-PSI
Then Gradually increase the pump pressure TO the point where the nut becomes SLACK.

(5.4)
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This BREAK-OUT pressure. It (Pump Pressure Break-Out or P(b-o))should be less than Pressure B and should not exceed Pressure A. If either of the above happens:
- Move the One tensioner Back to set 2 and input Pressure A to all this set three times in all.
- Then move all tensioners to Set 1 and test at 5000 PSI.
- Then input Pressure B three times.
- Check breakout pressure. It should now be between Pressure A and Pressure B.

IF BREAK OUT Pressures are not Between A and B as a result of Not enough elongation (in the instance of NEW studs) THEN Input The Tensioner Steps #1 and Steps #2, three times. That is; Use "A Pressure" sequence, then "B Pressure" sequence, then go back to "A" and then to "B" and finally to "A" and then to "B".

(5.5)
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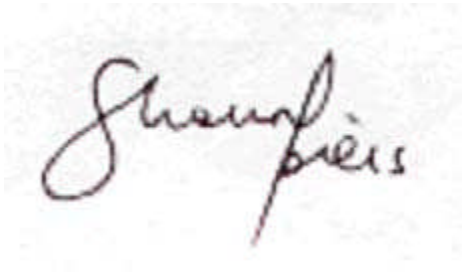
On Completion of Work:
1. The application data sheets shall be signed
2. Assessment of the initial condition of the joint shall be documented.
3. Measured Elongation of the reference bolts shall be documented
4. Flange Gap measurements shall be documented
5. Calibration certificates shall be documented.
6. The PWL Bolt Tensioning report form will be completed and signed.
7. 10% of all flanges will be tested to verify the preload stress values and post load stress values by method of Stud Elongation.

- Note: Tensioning is inaccurate for low load applications
  Tensioning requires that the threads be in good condition
  Tensioning is not suitable for high yield (where the Residual Bolt Load) nears the yield strength.

The above Procedure is given by Portable Works Limited and is endorsed by the "Engineering Construction Industry Training Board (UK Unit No.:PF015) as per the "Best Practices Method for the Assembly and Tightening of Bolted Flanged Connections", as well as the Standard Procedure adopted by "Aztec Bolting Services", world leaders in Bolting Solutions.

Reviewed and Approved
For an on behalf of Portable Works Limited



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