HYTORC Tensioning

Description, Operation and Safety

HYTORC

January 4, 2018

Hydraulic Tensioner Technology

Tensioning is the direct axial stretching of the bolt to achieve preload (bolt load).

Basic Steps

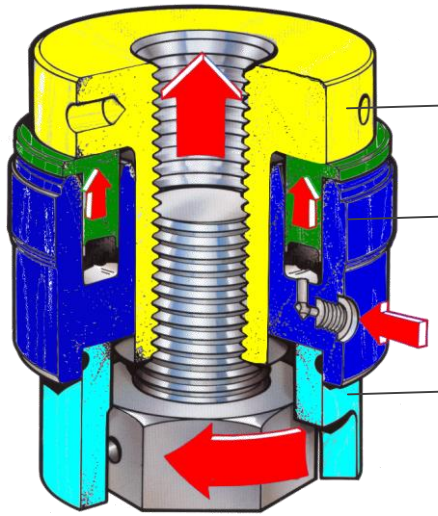
- Attach puller to stud
- Apply hydraulic pressure to tensioner stretching the stud
- Tighten/turn the nut against the flange to hold stretch
- Release pressure and remove tool

Advantages

- No need for reaction point
- No need for backup wrench
- Eliminates inaccuracies due to friction
- No side loading or lateral bending

Disadvantages

- Loads may vary from bolt to bolt
- Allowances for uneven interaction
- Use care so that bolts is not yielded
- Complex process
- Safety concerns

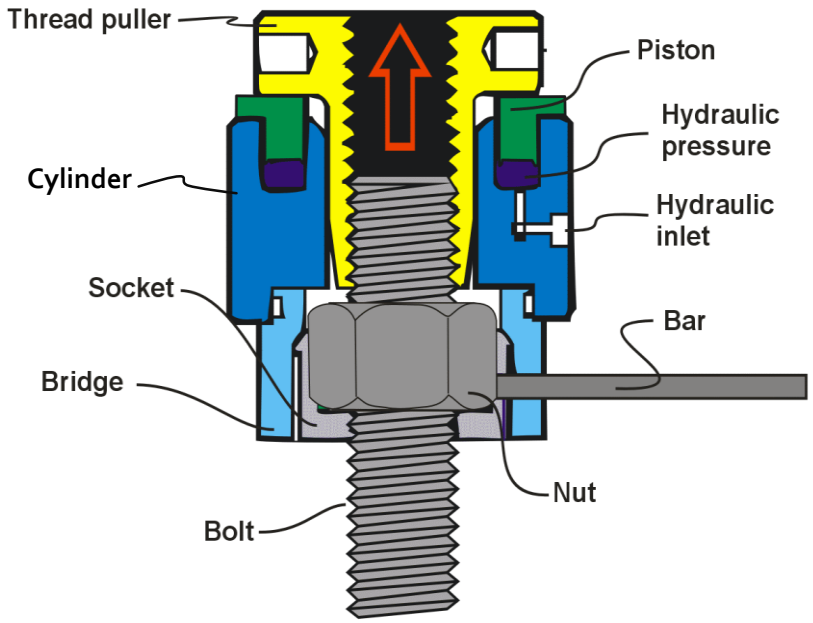


Primary Components

Thread Puller – special nut that engages the stud and stretches the stud

Hydraulic cylinder & piston – cylinder body & piston that lifts puller when hydraulic pressure is applied

Bridge & Socket – platform that allows access to tighten or loosen nut while cylinder is under pressure, retaining the bolt tension



Topside Tensioners

Topside Standard Tensioners

Topside standard tensioners provide a quality, cost-efficient solution designed to fit most standard flanges in a compact size that is easy to handle.

Topside Return Spring Tensioners

Topside spring return tensioners offers the same quality as the standard series, but incorporates a spring-return function and a more robust design to increase efficiency and enhance the tools load capabilities.

Strong, Dependable Tooling
Our standard topside tensioners are made from hardened AISI 4340 steel alloy for uncompromising strength and durability.

Wide Range of Sizing
HYTORC offers the standard series tensioner in standard sizes ranging from ¾” to 4” and metric sizes from M16 to M100.

Customizable to Any Specification
HYTORC's Tensioner Specialists can work with you to customize our spring return tensioners to fit your needs.

Designed for Long Life
Spring return tensioners are made with hardened steel bodies and metal treatments to withstand the toughest of operating environments..

Time and Energy Savings
Spring return feature provide automatic piston retraction when pressure is released saving time and effort required to reseat the piston after every stroke, giving you more energy to finish the job.

Customizable to Any Specification
HYTORC's Tensioner Specialists can work with you to customize our spring return tensioners to fit your needs.

Wind & Subsea Tensioners

Wind Single Stage

HYTORC's wind turbine tensioners are designed to provide single stage tensioners in bolting applications that have limited overhead clearance.

Compact Design
HYTORC's single stage tensioners are designed for areas where the tool must be small and powerful.

Manufacturer-specific Designs Available
HYTORC stocks tools for specific applications such as Siemens and Mitsubishi blade bearings and Clipper hub to mainshaft connections.

Wind Multi Stage

Wind turbine tensioners are designed to provide customers with uncompromising performance with the bolting applications that have limited radial clearance.

Slim Design
HYTORC's multi stage tensioners are designed for applications where regular loads are needed with little room for the tool. These tools are capable of high loads with minimal footprint.

Manufacturer-specific Designs Available
HYTORC stocks solutions for every major manufacturer such as Acciona, Clipper, Gamesa, Mitsubishi, Siemens, Vestas, and more.

Wind Foundation

Foundation tensioners provide foundation tensioning solutions for almost every type of foundation used on wind turbines. We stock tooling for foundation studs from 1" up to 3" rock anchor studs.

Made for Wind Turbines
HYTORC's elliptical foundation tensioners are designed to meet the requirements of all popular foundation designs and studs. Specifically, Williams and Dyson foundation studs.

Light but Strong
HYTORC's foundation tensioners are optimized for size and weight as well as strength and durability. Our foundation tensioners are light enough to easily handle, but strong enough to stand up to the toughest jobs.

Subsea

Subsea tensioners are manufactured from high quality materials, fit a variety of sizes and budgets, easy to use and designed for continuous use in demanding environments.

Easy Handling
One-piece body design that allows the operator to handle the tool with confidence.

Long, 30mm Stroke
30mm of piston stroke and a highly visible maximum stroke indicator give the diver maximum tool strokes without over-stroking the tool and leaking oil.

Solid and Split Nuts Available
Split nuts allow for faster assembly times, especially when damaged threads are an issue. Lower cost solid nuts are also available to meet your budgetary needs.

Tensioner Pumps

HBT Pneumatic
HYTORC's HBT pneumatic pumps are available in standard flow rate and high flow rate to meet your specific tooling needs. Each pump comes equipped with an in-line filter, regulator, and lubricator assembly. These pumps are simple to use, simple to maintain, and will last for years to come.

Hand Pumps
HYTORC's hand pumps for tensioning tools are lightweight and mobile by design. With different pressures and capacities available, HYTORC can provide you with the flexibility you need. Our hand pumps have built in gauges with a unique steel handle that protects the gauge from impact.

Tensioner Pumps

Subsea

In order to stand up to the tough offshore environments, HYTORC has taken our tried and true high flow pneumatic pump and reconstructed it with stainless steel components. Additionally, we have doubled the size of the reservoir to suit the demands of subsea tensioning.

PES

The PES pump is HYTORC's workhorse tensioning pump. It has the ability to run multiple tools without sacrificing performance. It is reliable and gives our customers consistent results day in and day out. The PES pump is recommended for all applications including construction and is available in a variety of configurations

HY Series

The HY Series of tension pumps are our latest design for the tensioning market. This pump was designed with maintenance technicians in mind. With a smaller footprint, HYTORC's HY Series tension pumps are nearly 30 pounds lighter than most tension pumps on the market today.

1507-E

HYTORC's 1507-E pump was designed for the heaviest of jobs. With a 3-phase, 690V motor, the 1507-E provides HYTORC customers with heavy duty performance and reliability. The 1507-E will support multiple tools with little to no effort. With a full protective cage that is lift-rated, the 1507-E is ready for all applications including construction.

Tensioner Accessories

Hydraulic Nuts
Hydraulic nuts are designed to tighten large diameter bolts without causing the damage that occurs when hammer wrenches are employed. With HYTORC's hydraulic nut solutions, customers can tighten large bolts with little to no effort and do so without causing any damage.

Direct Fit Tensioners
Direct fit tensioners are very useful in applications where you have limited clearance in all directions. Additionally, technicians prefer them for overhead work because of the one-piece design. Direct fit tensioners can be customized to fit a wide range of applications

Interconnecting Hose Tee Fitting One End

Link Hose

Manifolds
HYTORC has manifolds for every application and any pressure.

Flexible Hose Assemblies
A wide variety of high pressure hoses are available, come prefilled with oil, multiple configurations.

Tommy Bars
Tommy Bars are short metal rods used to tighten the puller and the captive nut – sizes include 10mm and 8mm.

T - Hydraulic Tensioner Procedures

- ❑ T1 Inspect Tools
- ❑ T2 Determine Coverage
- ❑ T3 Account for Load Loss
- ❑ T4 Determine Tool Pressure – 100% Coverage
- ❑ T5 Determine Tool Pressure(s) – 50% Coverage
- ❑ T6 Setup Pump
- ❑ T7 Prepare Bolts
- ❑ T8 Install Tensioners
- ❑ T9 Connect Hoses
- ❑ T10 Tighten Bolt(s)
- ❑ T11 Repeat Tensioning Cycle
- ❑ T12 Loosen Bolt(s)

Inspect Tools

T1 Inspect Tools

- ❑ Inspect all Tensioner Equipment; Tools, Pumps and hoses for any sign of damage

- ❑ Appropriate number of tensioners to provide minimum coverage – usually enough tensioners to cover 50% or 100% of the bolts to be simultaneously tightened.

  If there is any damage or leaking discovered before the operation or during the operation the issue must be corrected before proceeding..

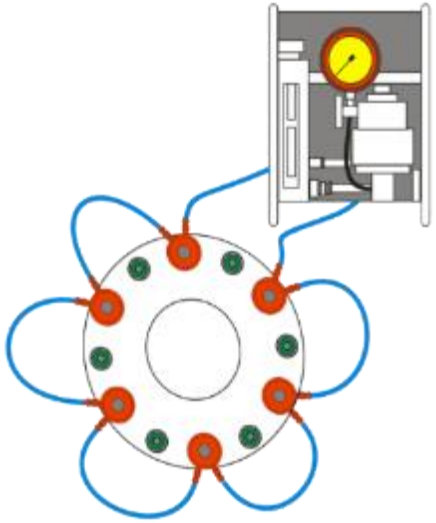
Determine Coverage

T2 Determine Coverage

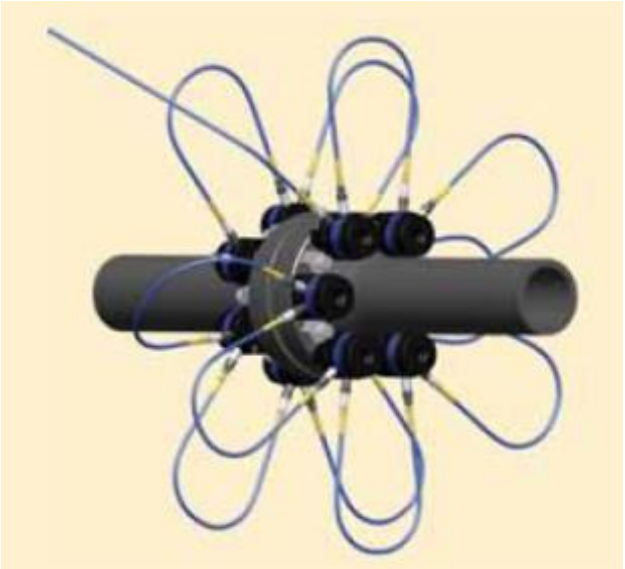
- ❑ Based on number of tensioners available and number of bolts determine how much coverage will be used

  Tensioning permits the simultaneous tightening of multiple bolts; the tools are connected in sequence via a high-pressure hose assembly to a single pump unit. This ensures each tool develops the exact same load and provides a uniform clamping force across the joint. This is especially important for pressure containing vessels requiring even gasket compression to affect a seal.

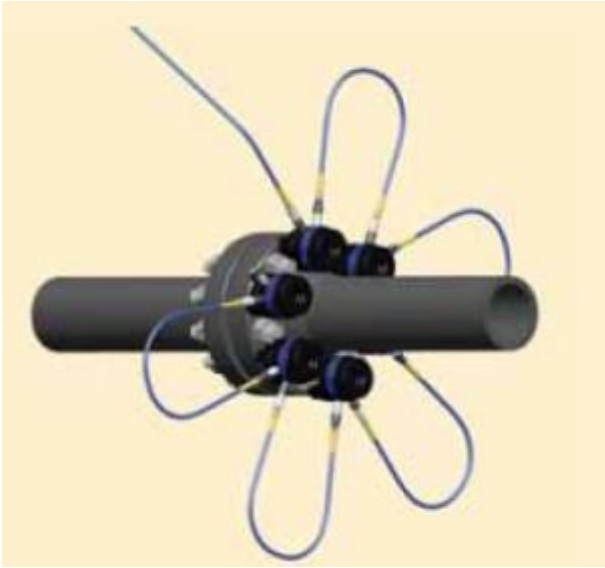
- Tensioners usually used in sets.
- 100% coverage would be best.
- 50% is common because of space or cost constraints.
- Less than 50% is possible but not covered in this procedure.



100% Coverage
All bolts are tensioned simultaneously – tensioners are positioned on alternating sides of the flange.



50% Coverage
Half the bolts are tensioned simultaneously, the tools are relocated on the remaining bolts and they are subsequently tensioned.



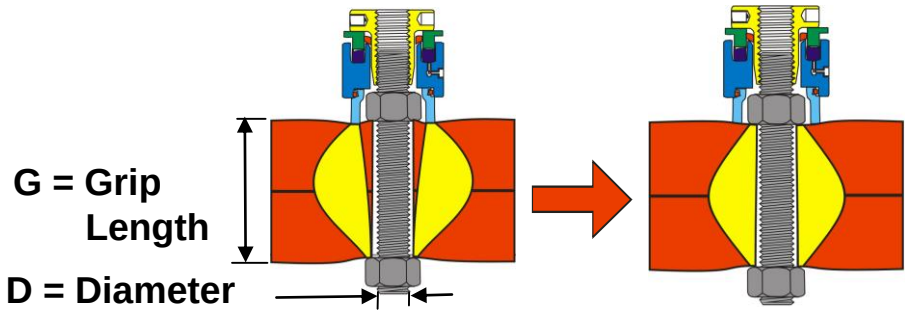
Account for Load Loss

T3 - The tensioning procedure must account for load lost between the tensioner and the bolt and where less than 100% coverage is used the load lost between adjacent bolts on the flange.

❑ Load Loss Factor (LLF)

Accounts for Transfer Loss between Tensioner and Bolt

During the tensioner process there is a loss of bolt elongation that occurs during load transfer between the tensioner and the bolt due to thread deflections, radial expansion of the nut, and embedding of the nut into the joint. Load loss is accounted for by way of a correction factor called the Load Loss Factor (LLF) that increases the pressure (Pressure B) applied to the bolt so that the residual load on the bolt after applying pressure and accounting for loss meets the target bolt load. LLF is based on configuration of bolt diameter and grip length.



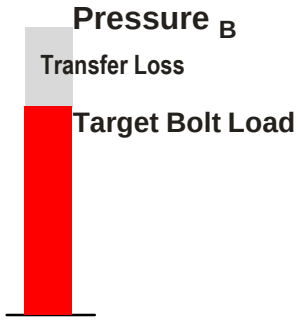
LLF = 1.01 + D/G

(mfg. min. recommended LLF = 1.1)

Pressure B is the pressure applied

Pressure C is the pressure read from the tool chart

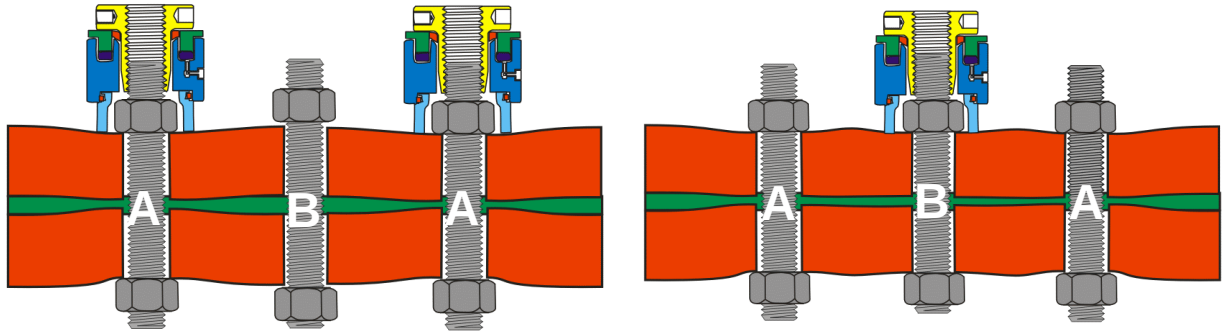
Pressure $_B$ = Pressure $_C$ X LLF



❑ Cross-Load Factor (CLF)

Accounts for Elastic Loss between Bolts on the Flange

When Using Less than 100% Coverage (e.g. 50% of bolts tightened followed by the other 50%) the load on the first set of bolts is diminished due to cross elastic interaction through the flange (and gasket) as the second set of bolts are tightened. To account for this loss additional pressure (Pressure A) must be applied to the first set of bolts for the residual load meets the target. A correction factor called the Cross-Load Factor is used to adjust to Pressure A.



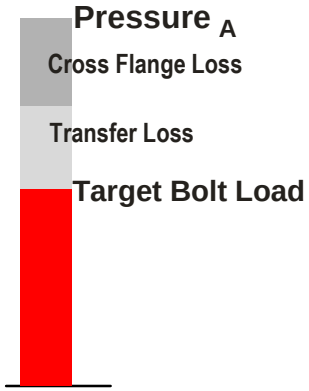
CLF = 1.2

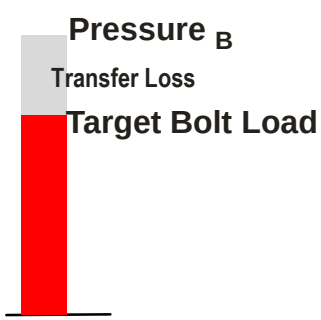
(mfg. range from 1.15 to 1.25)

Pressure A applied first 50% tensioners

Pressure B applied the next 50%

Pressure $_A$ = Pressure $_B$ X CLF





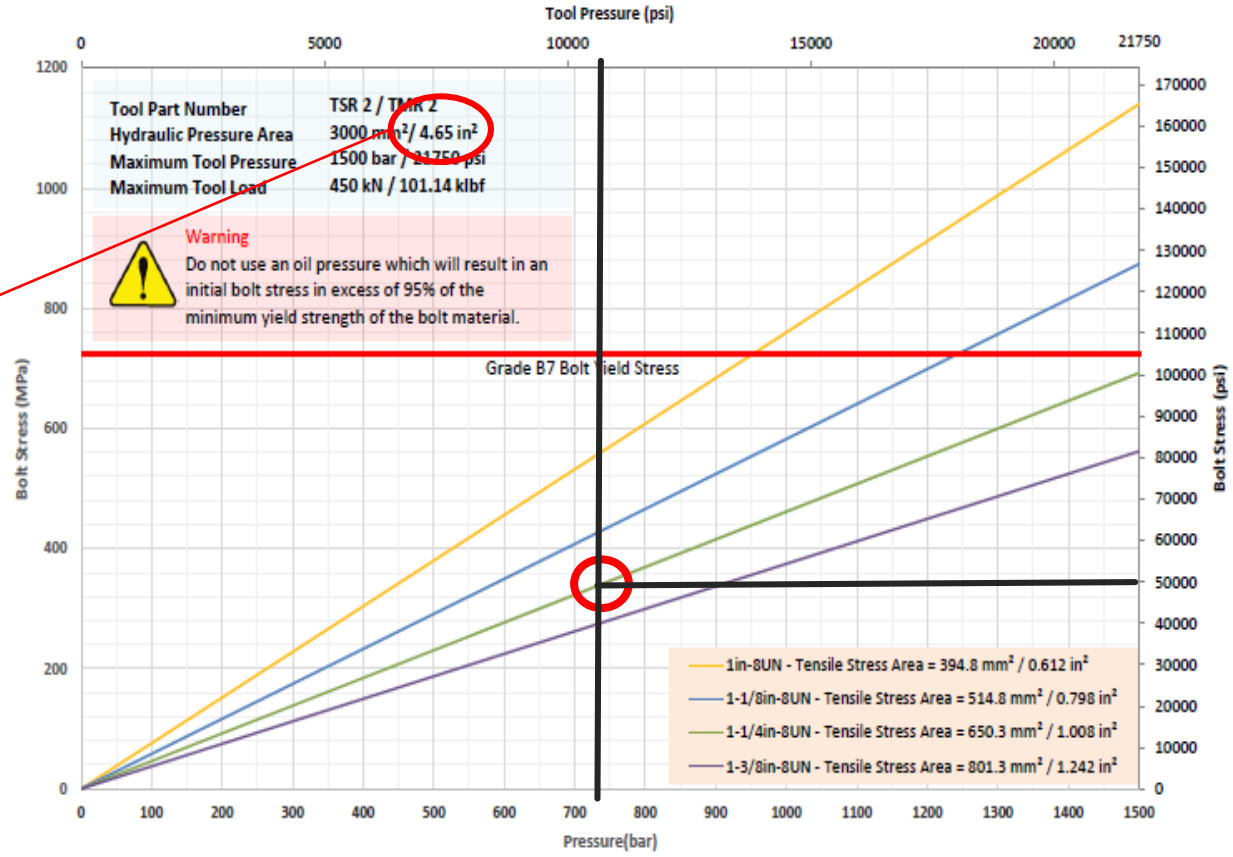
Determine Tool Pressure – 100% Coverage

!All calculations should be verified by a qualified engineer trained in hydraulic tensioning.

T4 Determine Tool Pressure – B

An Applied Bolt Stress/Tool Pressure Graph is provided for each tensioner type. The chart provides lines for different size tensioners at different bolt stress levels.

This Chart provided by the manufacturer represents to the relationship between tool pressure (Pressure C Chart pressure) and the residual target bolt load.



- Select the target pressure from the chart for the desired bolt pressure and for the specific tensioner used:

  Example:

  Bolt size 1-1/4" (green line)
  Required bolt load 50,000 psi
  Pressure C = 10,700 psi (Read from chart)

  OR Calculate the target pressure
  Pressure C = Bolt Load / Tensioner Area
  Example:
  Pressure C = 50,000psi/4.65 in^2
  Pressure C = 10,753 psi (Calculated)

- Calculate "Pressure B" that Accounts for Load Loss.
  Pressure B = Pressure C x (1.01 + D/G)
  where D = nominal diameter 1.25in and G = Grip length 5in
  Example:
  Pressure B = Pressure C x LLF
  Pressure B = 10,753 psi x (1.01+ 1.25/5)
  Pressure B = 10,753 x 1.26
  Pressure B = 13,550 psi (Calculated)

Determine Tool Pressures – 50% Coverage

!All calculations should be verified by a qualified engineer trained in hydraulic tensioning.

T5 Determine Tool Pressures – A & B

An Applied Bolt Stress/Tool Pressure Graph is provided for each tensioner type. The chart provides lines for different size tensioners at different bolt stress levels.

- Select the recommended chart pressure from the chart provided for the specific tensioner used:

  Example:

  Bolt size 1-1/4" (green line)
  Required bolt load 50,000 psi
  Pressure C = 10,700 psi (Read from chart)

  OR Calculate the recommended chart pressure
  Pressure C = Bolt Load / Tensioner Area

  Example:

  Pressure C = 50,000psi/4.65 in^2
  Pressure C = 10,753 psi (Calculated)

- Calculate "Pressure B" that Accounts for Load Loss.
  Where D = nominal diameter and G = Grip length

  Example:

  Pressure B = Pressure C x LLF
  Pressure B = 10,753 psi x (1.01+ 1.25/5)
  Pressure B = 10,753 x 1.26
  Pressure B = 13,550 psi (Calculated)

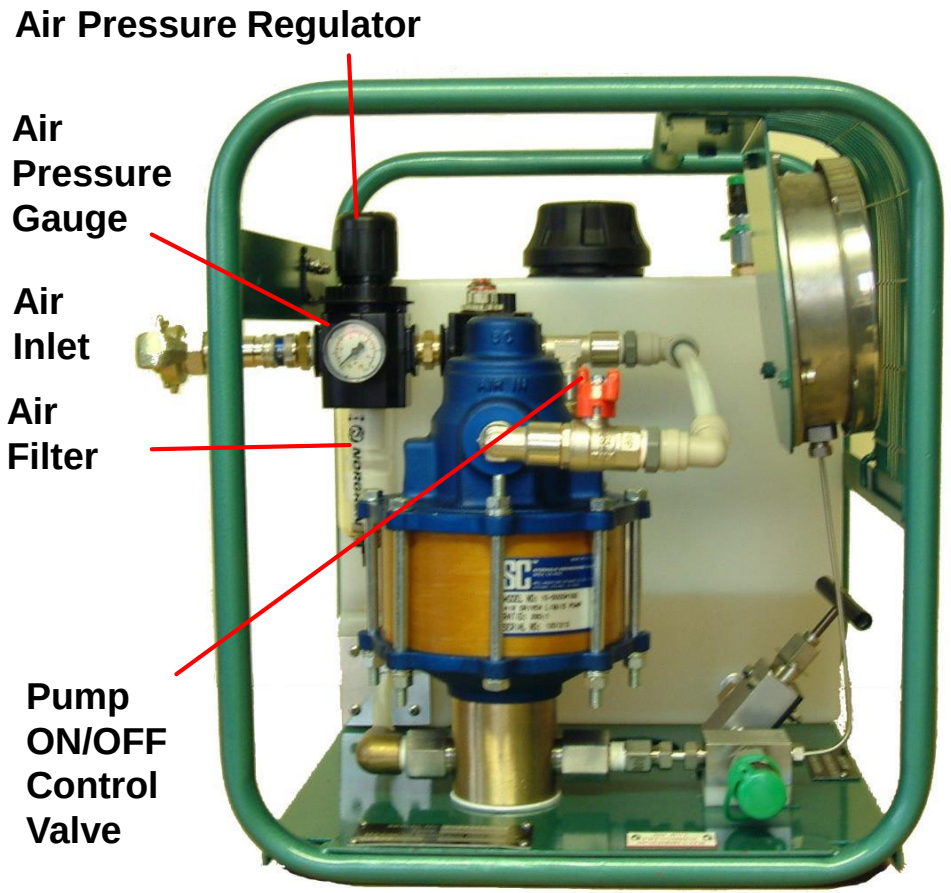
This Chart provided by the manufacturer represents to the relationship between tool pressure (Pressure C chart pressure) and the residual target bolt load.

- Calculate "Pressure A" that Accounts for Cross Load Factor

  Example:

  Pressure A = Pressure B x CLF
  Pressure A = 13,550 psi x 1.2
  Pressure A = 16,260 psi (Calculated)

Setup Pump



OFF
Closed

ON
Open

Setup Pump

T6 Setup Pump

- ❑ With MAIN AIR SUPPLY OFF, fit the correct type air pressure inlet connector and connect the air supply to the pump (70 to- 100 psi).
- ❑ Remove the oil filler cap and fill the reservoir with hydraulic fluid until it is about ¾ full.
- ❑ Check the air lubricator to see if it is filled with lubricating oil – if not fill the lubricator to the maximum level marked on the bowl.
- ❑ Fully open the oil pressure release valve – turn CCW to open the valve.
- ❑ Close the pump Air (on/off) Control Valve by turning the handle quarter control CW.
- ❑ TURN ON MAIN AIR SUPPLY
- ❑ Adjust air pressure gauge to zero by lifting the cap of the air pressure regulator to unlock and turn CCW until the air pressure is zero.
- ❑ Open the pump ON/OFF Control Valve by turning CCW.
- ❑ Slowly turn the air pressure regulator CW until the pump runs at speed between 30 and 60 strokes per minute – allow to run for at least 2 min.
- ❑ Observe the air lubricator is applying oil at the rate of 1 drop for every fifty strokes, adjust the red plastic knob as required.
- ❑ Close the ON/OFF Control Valve, the pump is ready for use.

Air Inlet Connector

Connect Air Supply

Oil Filler Cap

Air Lubricator

Oil Pressure Release Valve

Close ON/OFF Valve

Air Pressure Regulator

Air Pressure Gauge

Open ON/OFF Valve

Close ON/OFF Valve

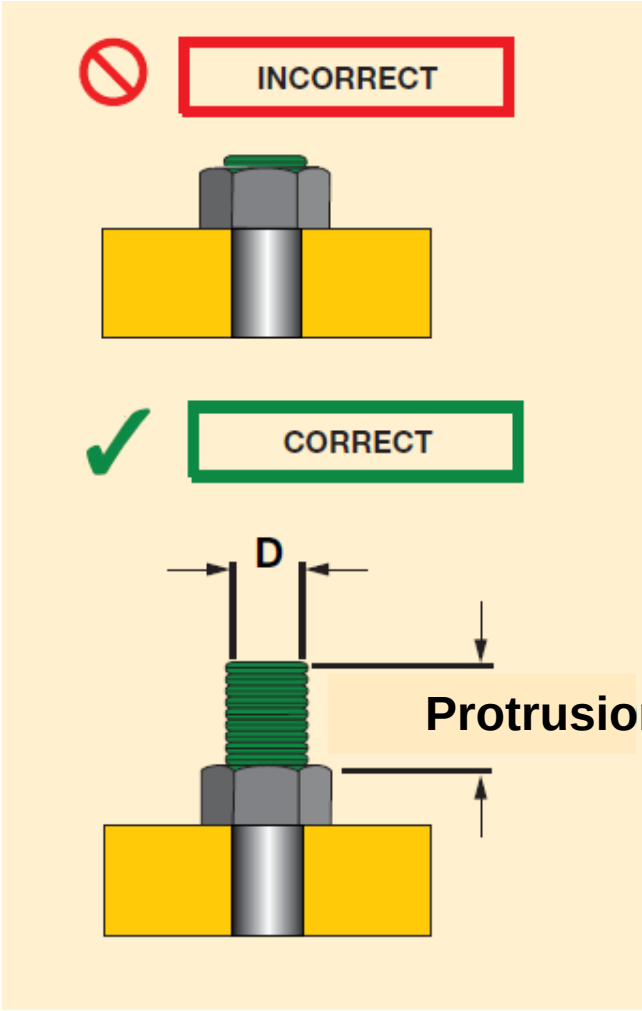
Prepare Bolts

T7 Prepare Bolts

- Assemble nuts to bolts such that bolt thread protrudes at least 1 times the nominal bolt diameter beyond the nut in order to provide adequate engagement with the thread puller.

  Recommendation: Target a protrusion length of 1 x D to ensure adequate and safe thread engagement

- No Washers are Used
- No Lubrication is Used



Install Tensioners

T8 Install Tensioners

- ❑ Place the Hydraulic Bridge and socket over the bolt and nut to be tightened.
- ❑ Insert the puller through the Hydraulic Bridge opening and thread onto the bolt.

  Important Technique – Keep thumb inside the puller when threading and unthreading to avoid accidentally dropping puller.
- ❑ Thread puller CW all the way over the bolt until the puller is flush with the Hydraulic Bridge.
- ❑ Make sure the window for access to the socket and pressure input couplers are accessible on the outside of the flange.
- ❑ Use the Tommy Bar to apply additional CW pressure to the Thread Pullers to hold them firmly in place.
- ❑ Repeat for all tensioners and bolts to be tightened simultaneously.

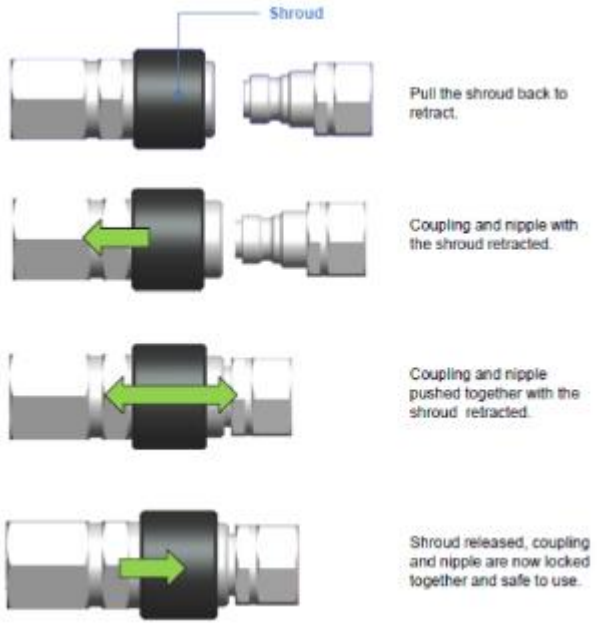
Keep thumb in puller

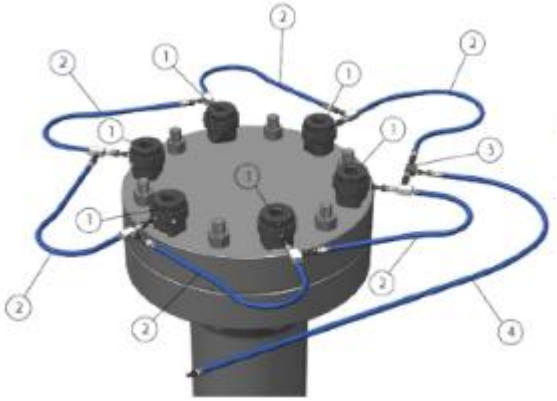
Make sure bridge window, socket and pressure input are accessible

Connect Hoses

T9 Connect Hoses

- ❑ Check that there is no pressure in the system.
- ❑ Pull back the shroud and push the coupling onto the nipple.
- ❑ Release shroud which will spring to lock the Coupling and Nipple together.
- ❑ Connect tensioners together in series.
- ❑ Connect the last hose to the pump.
- ❑ To disconnect, check there is no pressure in the system, pull back the shroud and pull the coupling apart.





Tighten Bolt(s)

T10 Tighten Tensioner

- ❑ Ensure the tensioning team are aware of the target Pressure for the cycle – A or B.
- ❑ Turn the Oil Pressure Release T-valve handle clockwise to close off the oil reservoir from the pump and hoses.
- ❑ Open the ON/OFF valve turning the valve CCW to apply air pressure to the pump.
- ❑ Build pressure in the system to a nominal pressure of 1000 psi (70bar) and check that the pressure is holding. If the pressure drops investigate any leaks.
- ❑ When using a compliant gasket build pressure to 50% of target, and hold for 90s to allow gasket to seat.
- ❑ Continue to apply more pressure to 100% of the target pressure (Pressure A or B), monitor the gauge as pressure builds to the target pressure and hold at least 60s.
- ❑ Watch the tensioner as it pulls, stop if the color coded maximum stroke indicator color ring becomes visible and stop if there are any leaks.
- ❑ Once pressure is stable, hand tighten tensioner socket with Tommy Bar through the window turning the socket CW to tighten the nuts until the nut is tight against the flange.
- ❑ Complete tightening for all nuts in this pass.
- ❑ Turn the Oil Pressure Release T-valve handle CCW to open the valve and drain oil back into the reservoir to return the pressure down to zero slowly.
- ❑ Pressure is taken off the tensioners and they return back into the tensioner to it's original position – may need to tap tensioners or turn pullers with the Tommy Bar to return all the way.
- ❑ Tensioning this cycle is complete and tensioners can be moved/removed.

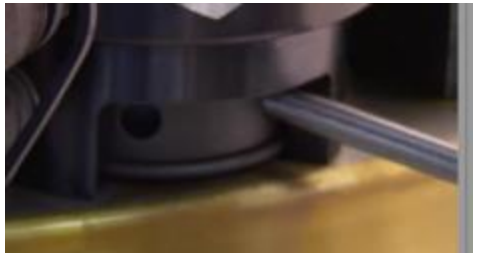
Close Oil Pressure Release

Turn ON Air Pressure

Watch Oil Pressure Gage Build to Target

Watch for Maximum Stroke Indicator Yellow Warning as Puller Moves

Tighten Socket and Nut with Tommy Bar – all Tensioners



Open Oil Pressure Valve to Release Pressure

Repeat Tensioning Cycle

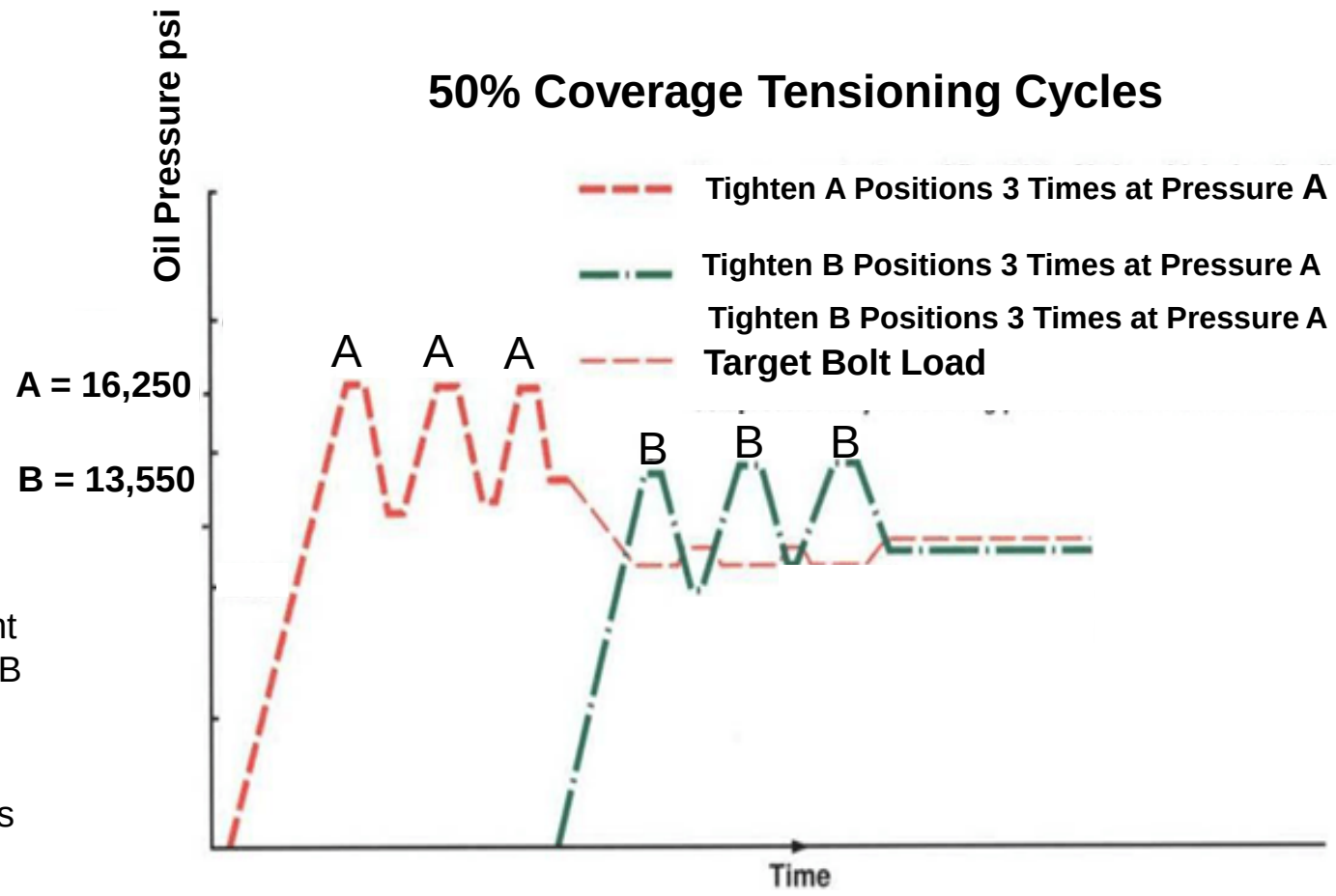
T11 Repeat Tensioning Cycle

100% Coverage

- ❑ The tensioning cycle is repeated two more times at Pressure A
- ❑ Tensioners may be removed

50% Coverage (see diagram)

- ❑ The tensioning cycle is repeated two more times at the Pressure A – checking that there is no further movement
- ❑ Tensioners are moved to the B positions.
- ❑ Tension Tighten Bolt procedure is repeated three times on the B nuts at Pressure B, each subsequent time bringing the pressure up to 100% of Pressure B to verify there is no further movement and then pressuring down to zero slowly.
- ❑ Tensioners are moved for check pass on A positions – tightened one more time at Pressure B to make sure no further movement
- ❑ Check to see if there is any movement in the nuts, if nuts tighten then Pa needs to be higher – try a 5% increase on the next flange.
- ❑ Tensioners may be removed



Loosen Bolt(s)

T12 Loosen Bolt (De-tensioning)

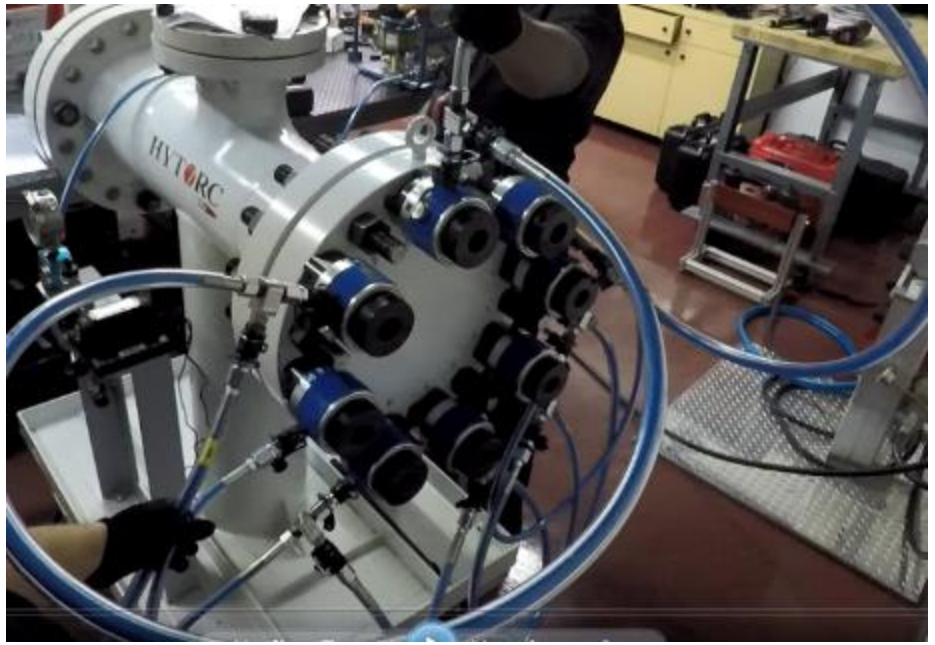
- ❑ Install tensioners on nuts
- ❑ Connect hoses
- ❑ Tighten thread puller so that it is flush against the tensioner body.

  IMPORTANT – then back off the thread pull one full revolution to give the nut space to loosen

- ❑ The tensioner is tightened gradually until the nut breaks loose - Starting at 300bar check to see if nut breaks loose, then to 400bar check, then to 500bar check, etc. continuing to increase pressure by 100bar increments until the nut breaks loose.
- ❑ Nuts are turned CCW with the Tommy Bar 3 windows

  IMPORTANT – turning more than 3 windows can cause the nut to tighten against the puller making further loosening difficult

- ❑ If other nuts are to be loosened, this is done gradually until all nuts are loosened



Let’s Bolt!

HYTORC®
Since 1968