On-Site Procedure

Rev Number	Date	Description	Prepared	Approved HSEQ	Approved TECH

DOCUMENT TITLE:

FLANGE BOLT TENSIONING METHOD STATEMENT

DOCUMENT REFERENCE:

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1.0 SCOPE

This procedure covers the Hydratight preferred system for flange tightening by the means of hydraulic bolt tensioning and should be used as the best practice internal procedure to follow. It is the objective of the procedure to provide a sealed flange first time in a safe manner whenever applied.

2.0 APPLICATION

This procedure applies to any flange, which has been assembled to be bolt tensioned.

3.0 DEFINITIONS

Applied Bolt Load	The Load applied to the bolt by means of a Hydraulic Torque Wrench or Bolt Tensioner.
Residual Bolt Load	The load remaining in the bolt after bolt tensioning.
JIMS & JDMS	Software used for planning, managing and implementing 'Joint Integrity Assurance'.
Boltup & Informate	Bolt load calculation software that recommends tightening methods, tooling selection, torque and tension values.
Tool Operating Pressures	The Hydraulic oil pressure to be applied to the Hydraulic Tensioner.
Joint Completion Certificate	A Report completed giving details of the tightened joint.
Tag	A Tag, which is affixed to the joint before & after tightening to detail joint status for quick verification and traceability.
'HL' Hydraulic Bolt Tensioner	'High Lift' Hydraulic actuated tools, which operate by stretching the bolt to a pre-defined strain and are normally powered by an air operated pump unit up to a maximum operating pressure of 15,500 psi.
'PS' Hydraulic Bolt Tensioner	'Puller Sleeve' Hydraulic actuated tools, which operate by stretching the bolt to a pre-defined strain and are normally powered by an air operated pump unit up to a maximum operating pressure of 21,750 psi.

4.0 RELATED DOCUMENTS/REFERENCES

ECITB NSDS PF018 "Assembly and Tightening Bolted Connections".

5.0 APPROVED OPERATORS

Bolt Tensioning is a specialist skill.

This procedure applies to all personnel who hold Hydratight TE1 competency status; personnel who have TE2 approval can only work under supervision of personnel holding TE1 status

Only technicians trained and competent in the use of bolt tightening equipment, who have completed a recognised competence assessment program, can carry out the controlled breakout/assembly and tightening of bolted joints.

6.0 SAFETY FIRST

Hydraulic power tools enable the user to more easily accomplish bolting tasks with increased force, accuracy and efficiency.

Due to the powered nature of the tools, with large forces generated from high-pressure fluid/air and electricity strict safety issues are followed through the tools proper design and documentation However, the user must accept the primary responsibility of safety when using hydraulic tools by carrying out site related risk assessments, reading, understanding, and complying with all operating instructions prior to and during operation.

In a commitment to facilitate user understanding of all operating instructions, Hydratight supplies operation manuals and upon request on site training courses.

This procedure and additional safety related sections contained towards the end of this document are designed to assist in the proper instruction for use and care of hydraulic tools and play a major role in preventing accidents and increasing safety.

7.0 PRE-JOB CHECKS

- Scope of Work has been identified
- On-site Technical Procedure has been read and understood
- Pipeline or vessel is free of pressure - if not STOP until a Risk assessment is carried out and Safe method approved.
- Site specific Permit to Work is in place
- Generic Risk Assessment has been read and understood
- Job specific Risk Assessment has been carried out
- All members of the work party have read, understood and signed:
    - Permit to Work
    - Job Specific Risk Assessment
- PPE is suitable and sufficient for the task
- Equipment is suitable for the task, tested and in serviceable condition
- Access and egress to the work site is adequate and scaffold fit for purpose, tagged and inspected within the last seven days.
- Work area is safely cordoned off.

8.0 JOB SPECIFIC CHECKS

- The puller sleeve although a simple device is highly critical during tensioning. Check the puller sleeve is of the correct thread size and form for the bolt and is a good close fit on the threads of the bolt. The puller will become a missile should the threads strip.
- Check that the tensioning pressures to be applied have been recommended by the manufacturer, client or Hydratight bolt load calculation software and are applicable to the tools being used and for the flange and bolt material being tightened.
- Make sure that the full thread engagement of the puller has been achieved and rams/pistons will not be over stroked when using hydraulic bolt tensioners.
- Check the bolts aren't damaged or corroded and that all components, flange, gasket, botls and nuts are of the correct specification.
- Ensure that you are fully conversant with the safe use of the tools and their operating procedures.
- If any check falls out of limit then the Technical Authority is to be informed for rectification. If rectification is not carried out, details are to be included on the Joint Completion Certificate or recorded in JIMS/JDMS.
- Check that the working pressures or loads required are applicable to the tools being used and for the bolts being loosened.
    - **'HL'** Tensioners Maximum Working Pressure 15,000psi

- **'PS'** Tensioners Maximum Working Pressure 21,750psi

9.0 EQUIPMENT

Bolt Tensioners operate by hydraulically "stretching" the Stud bolt to a pre-defined strain after which the operator is then able to hand tighten the nuts onto the flange face. The hydraulic load is then transferred from the Tensioner to the nut by depressurising the Tensioner resulting in an accurate load transfer into the Stud bolt. The advantage of tensioning against torquing is that the process is not dependent on the type of lubrication used and eliminates the effect of friction under the nut face and between the threads. Flanges are also pulled together square and more accurate bolt loads are obtained.

50% Tensioning is the preferred method and shall only be deviated from on direct instruction by the customer/operator.

50% Bolt Tensioning requires sufficient equipment available to be able to fit a Bolt Tensioner to every alternate bolt around the flange so as to ensure simultaneous Tensioning of that 50% of the bolts.

The remaining 50% of the bolts are subsequently simultaneously tensioned by moving the equipment to these bolts.

10.0 TOOL SELECTION AND HYDRAULIC PRESSURES.

Hydratight bolt load calculation software will recommend the bolt-tensioning tool required, as well as the specified hydraulic pressures to be used to achieve the manufacturers recommended bolt stress. This information can be recorded and printed on a Joint Completion Certificate.

For 50% cover procedures a pass A (1st Pass) and Pass B (2nd Pass) pressure will be given.

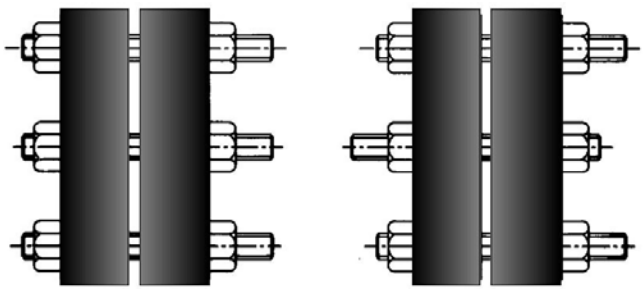
11.0 CALIBRATION

The Pump must have a Calibration Certificate valid for the job. If Pump has no certificate, it should be re-calibrated or changed.

12.0 SETTING OF NUTS & BOLTS

1. Nuts and bolts should be arranged as shown below around the flange,
   - Fig 1 for 50% procedure and
   - Fig 2 for 100% procedure.

Fig 1 **Fig 2**



2. For imperial and metric threads, all bolts must protrude at least 1 x bolt diameter from the top of the nut on the 'conical tensioner washer' side, when the flange is assembled and the nuts are nipped up.

   Note: All nuts should be nipped up snug using a spanner prior to fitting of the tensioning tools

13.0 TOOL FITTING & OPERATION – 50% PROCEDURE

Note: 'HL' Maximum Working Pressure 15,500psi

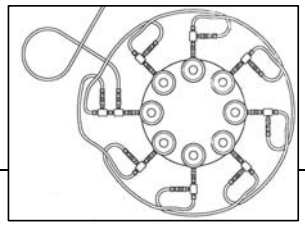
1. Place socket over the nut.

2. Place the bridge/head assembly over the socket.

3. Insert the puller into the head and screw down onto the bolt and ram/head assembly.

4. Connect an assembled interconnecting pipe to the head assembly via the nipple and coupling but do not disconnect the spare end from the 3-way tee block assembly.

5. Repeat steps 1 – 4 for:
   - 50% procedure - every alternate bolt around the flange
   - 100% procedure - every bolt around the flange
6. Once each tool has an interconnecting pipe fitted, disconnect each spare end and reconnect to the 3-way tee block assembly on the next adjacent tool on the flange ensuring the pipes are all connected in the same direction around the flange.
7. At an easily accessible point, disconnect a coupling from the nipple on a 3-way tee block assembly and insert and additional 3-way tee block assembly.
8. There will now be a spare nipple on the tee block where the link pipe from the pump can be connected.
9. Connect the coupling end of the link pipe to the tee block to complete circuit as shown below:



10. Connect the nipple end of the link pipe to the pump.
11. Connect the pump to an air supply with whip checks and pins at all connections.
12. Ensure that the Power Console is full of Hydraulic Oil and, if an Air Power Console is being used, that the Air Lubricator has sufficient oil in it.
13. Open the return to tank valve and then tighten each puller down onto the head assembly ensuring that the ram is fully retracted.

    Note: The ram must be fully retracted inside the head assembly and extra care must be taken to ensure sufficient thread engagement when tensioning bolt diameters 1.1/8" and below.
14. The required tightening tool pressures and procedure should be obtained from either the Hydratight engineer, customer, equipment manufacturer by using Hydratight bolt load calculation software, which will also recommend the bolt-tensioning tool required, as well as the specified hydraulic pressures to be used to achieve the recommended bolt stress
15. Ensure that the all tools are in full view of the pump operator, if not a second man will be needed to operate the tool while communicating verbally to the pump operator.
16. Adjust air regulator to (zero) 0 psi
17. Close the return to tank valve.
18. Open the pump air valve fully.
19. Slowly increase the air pressure by lifting the air regulator knob and turning clockwise until 1,000psi is achieved on the pump pressure gauge.

    Note: At this point the ram will extend and the pump pressure will begin to build up and the pump will stall when the required pressure is achieved.

    Note: Do not stand directly in line with the tool when energising the system!
20. Close the air valve and check the system for leaks. Using a tommy bar, turn all sockets clockwise until the nuts are seated on the flange face then open the return to tank valve slowly.

    Note: Always ensure that the ram does not exceed maximum stroke at any time.
21. If it any time the ram approaches maximum stroke:
    - Close the pump air valve
    - Tighten the socket
    - Open the return to tank valve slowly
    - Retract ram by tightening the puller down on to the head assembly
22. To proceed, close the return to tank valve.
23. Open the pump air valve fully.
24. Slowly increase the air pressure by lifting the air regulator knob and turning clockwise until the Tool Operating Pressure 'A' is achieved on the pump pressure gauge.
25. Once the 'A' pressure has been reached:
    - Close the pump air valve
    - Tighten down all sockets clockwise using a tommy bar Lightly tap the end of the bar with a hammer to seat the nuts.
    - Open the return to tank valve slowly
    - Retract ram by tightening the puller down on to the head assembly if required

26. Repeat steps 18 – 25 another two times at the tool operating 'A' pressure

    Note on Ring Type Joints it is advisable to repeat the first pass pressure until no further movement occurs. It is also advisable to allow 2-3 minutes between passes to allow settlement of the joint.

27. Once the 'A' pressure has been completed, all nuts on the 'B' set of bolts should be nipped up snug using a spanner prior to fitting of the tensioning tools.
28. Move all tools from the 'A' set to the 'B' set of bolts and repeat steps 1–26 using Tool Operating Pressure 'B'.
29. Summary:
    - Tool operating 'A' pressure – 3 times
    - Tool operating 'B' pressure – 3 times
30. After completing the above procedure the 'Post Tensioning Inspection/test procedure should be followed in section 15.0.

100% PROCEDURE

For 100% tensioning procedures using 'HL' tensioning tools:

- Steps 1-26 should be followed using a tool on every bolt in the flange.
- Apply tool operating 'B' pressure only.

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14.0 TOOL FITTING & OPERATION – 50% PROCEDURE

Using 'PS' hydraulic bolt tensioners:

Note: 'PS' Maximum Working Pressure 21,750psi

1. Place assembled tool (load cell, bridge and nut rotating disc) over the nut and bolt.
2. Insert the puller sleeve into the load cell and screw down onto the bolt and load cell/piston.
3. Repeat steps 1 – 3 for:
   - 50% procedure - every alternate bolt around the flange
   - 100% procedure - every bolt around the flange
4. Connect interconnecting hoses to each tool in series around the flange as shown below:

5. Connect feed hoses to the two remaining male couplings on the first and last tensioning tools then to the pump.

   Note: Ensure all hose connection-locking rings are tightened
6. Connect the pump to an air supply with whip checks and pins at all connections.
7. Ensure that the Power Console is full of Hydraulic Oil and, if an Air Power Console is being used, that the Air Lubricator has sufficient oil in it.
8. Open the pressure set/release valve and then tighten all puller sleeves down onto the load cells ensuring that the pistons are fully retracted.

Note: The piston must be fully retracted inside the load cell and extra care must be taken to ensure sufficient thread engagement when tensioning bolt diameters 1.1/8" and below

9. The required tightening tool pressures and procedure should be obtained from either the Hydratight engineer, customer, equipment manufacturer by using Hydratight bolt load calculation software, which will also recommend the bolt-tensioning tool required, as well as the specified hydraulic pressures to be used to achieve the recommended bolt stress.
10. Ensure that the all tools are in full view of the pump operator, if not a second man will be needed to operate the tool while communicating verbally to the pump operator.
11. Adjust air regulator to (zero) 0 psi
12. Close the pressure set/release valve.
13. Open the pump air valve fully.
14. Slowly increase the air pressure by lifting the air regulator knob and turning clockwise until 1,000psi is achieved on the pump pressure gauge.

    Note: At this point the piston will extend and the pump pressure will begin to build up and the pump will stall when the required pressure is achieved.

    Note: Do not stand directly in line with the tool when energising the system!
15. Close the air valve and check the system for leaks. Using a toggle bar, turn all nut rotation discs clockwise until the nuts are seated on the flange face then open the pressure set/release valve slowly.

    Note: Always ensure that the piston does not exceed maximum stroke at any time.
16. If it any time the piston approaches maximum stroke:
    - Close the pump air valve
    - Tighten the nut rotation disc
    - Open the pressure set/release valve slowly
    - Retract piston by tightening the puller sleeve down on to the load cell
17. To proceed, close the pressure set/release valve.
18. Open the pump air valve fully.
19. Slowly increase the air pressure by lifting the air regulator knob and turning clockwise until the 'First Pass' (Pressure A) pressure is achieved on the pump pressure gauge.
20. Once the 'First Pass' (Pressure A) pressure has been reached:
    - Close the pressure set/release valve
    - Tighten down all nut rotation discs clockwise using a toggle bar. Lightly tap the end of the bar with a hammer to seat the nuts.
    - Open the pressure set/release valve slowly
    - Retract piston by tightening the puller sleeve down on to the load cell if required
21. Repeat steps 18 – 21 another two times at the 'First Pass' (Pressure A) pressure.

    Note on Ring Type Joints it is advisable to repeat the first pass pressure until no further movement occurs. It is also advisable to allow 2-3 minutes between passes to allow settlement of the joint.
22. Once the 'First Pass' (Pressure A) pressure has been completed, all nuts on the 'Second Pass' set of bolts should be nipped up snug using a spanner prior to fitting of the tensioning tools.
23. Move all tools from the 'First Pass' set to the 'Second Pass' set of bolts and repeat steps 1 – 21 using the 'Second Pass' (Pressure B) pressure.

24. Summary:
    - 'First Pass' pressure – 3 times
    - 'Second Pass' pressure – 3 times
25. After completing the above procedure the 'Break Loose/Check Pass' test procedure should be followed in section 15.0.

100% PROCEDURE

For 100% tensioning procedures using 'PS' tensioning tools:

- Steps 1-21 should be followed using a tool on every bolt in the flange.
- Apply 'Second Pass' (Pressure B) pressure only.

15.0 BREAK LOOSE/CHECK PASS TEST

To ensure the first 50% of bolts have retained the required Residual Bolt Load a break loose or check pass test is required.

BREAK LOOSE TECHNIQUE

1. Move a single tool from the 'B or Second Pass' set of bolts to one bolt on the 'A or First Pass' set of bolts connected via the Link Pipe/Feed Hose direct to Pump.
2. Using a Tommy/Toggle Bar, apply pressure in an anti clockwise direction to the Socket/Nut Rotation Disc.
3. Pressurise the tool slowly whilst maintaining (2) until anti-clockwise rotation of the nut is achieved.
4. At the point of nut movement, immediately stop the pump & take a note of pump pressure.
5. If pressure is below Tool Operating Pressure 'B' or 'Second Pass' pressure, repeat tensioning process as detailed in section 13.0 or 14.0 dependent on tooling until correct load is achieved.

CHECK PASS TECHNIQUE

1. Move two tools from the 'B or Second Pass' set of bolts to two diametrically opposite bolts on the 'A or First Pass' set of bolts connected via the Link Pipe/Feed Hose direct to Pump.
2. Pressurise the tools slowly to the second pass (Pressure B) pressure.
3. Using the Tommy bar attempt to tighten the nuts as before.
4. If nuts can be moved then repeat tensioning process as detailed in section 13.0 or 14.0 dependent on tooling until correct load is achieved
6. Perform "TAP TEST" on every bolt.
7. A light careful tap with a hammer on the nut flat or the bolt end will produce a "ring".
8. A loose bolt will not produce a "ring".
9. Uniform bolt loads will produce a uniform "ring".
10. When all of the above steps have been completed the equipment can be removed from the flange.
11. Complete a Flange Tag and attach to the joint.
12. Ensure that the work area is left in a safe and tidy condition and that any Permit to Work has been signed off.
13. Record all tightening information on a Joint Completion Certificate.
14. Input all tightening data into JIMS or JDMS or the clients data management system if applicable.

16.0 SAFETY REQUIREMENTS

Risk Assessments will be undertaken according to Hydratight and Operator procedures. This may result in extra safety requirements. The following list gives minimum requirements.

- Eye protection must be worn BS 2092-2.
- Do not stand in line with bolt axis.
- Gloves must be worn.
- Monitor the ram movement proportional to its maximum stroke.
- Do not exceed maximum pressure for the tool used.
- Ensure Puller has 1 x bolt diameter thread engagement.
- Check Puller sleeves are correct and thread is a good fit onto each bolt.
- Wear Safety boots and overalls.
- Observe site-specific safety requirements
- Observe all equipment operating instructions.
- Observe COSHH instructions when using hydraulic oil.

17.0 BOLT TENSIONING DO'S & DON'T'S

Do's

- Ensure that you are fully conversant with the safe use of the tools and their operating procedures.
- Check that the pressures stated are applicable for the tools being used and for the flange and/or bolt material being tightened.
- Hand tighten the nuts first, ensuring that the correct face of the nut will seat squarely onto the flange surface.
- Make sure that the full thread engagement of the Puller on the bolt has been achieved.
- Always tighten in a direction away from the body.
- Ensure the holes in the socket are not worn.
- Wear suitable protective clothing.

Don't's

- Never pressurise unconnected hydraulic couplings.
- Never tension damaged or corroded bolts.
- Never use a worn tommy/toggle bar.
- Do not apply excessive force to tommy bar.
- Never stand in line with the bolt axis when tools are pressurised.
- Never exceed the maximum ram/piston stroke.