



# WORK INSTRUCTIONS

**TITLE: Tapered Pin Adjustment**

**Instruction Number: WI0003**

**Revision: B**

**Description:** Adjustment of 2012-design tapered pins in snap-ring-retained spherical bearings for stabilizer hull unit hydraulic cylinders

**Applicable Product(s):** Various

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## Warnings and Precautions

### Warnings

#### **Fin Movement**

The fin will be rotated in this procedure. Fin collision with a person may result in fatal injuries. Fin collision with an object will most likely result in damage to the fin or object. While performing this procedure, maintain awareness of fin position and any obstacles to its movement located outside of the vessel.

Only perform this procedure while the vessel is in the water. Fin movement may cause the vessel to roll; notify the crew before rotating the fins.

#### **Moving Equipment**

This procedure requires working around moving equipment, capable of causing serious physical injury.

- While performing this procedure, carefully follow all instructions. Controller and valve setting adjustments listed in the instructions are included for safety. Failure to perform those steps may result in personal injury or equipment damage.
- Be aware of the placement of body parts and loose items such as loose fitting clothing.

#### **Hot Equipment**

This procedure requires working on hydraulic equipment, which may be hot. Elevated equipment temperatures can be enough to cause skin burns. Be aware of the placement of body parts and loose items such as loose fitting clothing.

#### **Torque Value**

Heed indicated torque values and DO NOT OVERTIGHTEN. Exceeding specified torque values for fasteners can drastically reduce bearing adjustability and service life.

### Vessel Status

This task requires the stabilizer controller and system to be on standby and operating during certain periods of the procedure. It is strongly recommended to perform this maintenance while the **vessel is dockside or in a very gentle sea state at anchor. For safety reasons, do not perform procedure while underway.**

### Background

#### Purpose of Adjustment

Loads from the hull unit cylinders are transferred to the hull unit shaft via a pin and bearing. The bearing consists of an inner and outer race separated by a liner. The liner is designed to wear over time in order to keep the inner and outer race properly lubricated. As a result of the liner wear, the clearance between the inner and outer race increases over time. Although the bearing is still fully functional, the increased clearance can result in a “knocking” sound which can be disruptive to those onboard the vessel. To reduce the clearance and associated sound without the work of replacing the bearings, Quantum employs tapered pins. These pins are used to expand the inner race into the outer race to compensate for increased clearances due to liner wear.

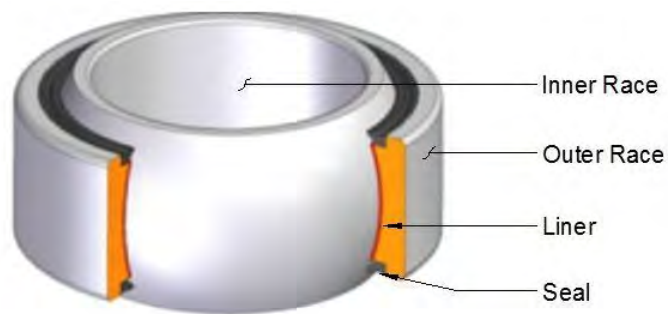


Figure 1: Illustration of spherical bearing with portion of outer race removed

Based on internal testing, cooperation with bearing manufacturers, and experience, Quantum recommends adjustment of the pins according to the intervals provided in the Quantum Maintenance Schedule. Adjusting less frequently than stated in the schedule should not affect the functionality or life of the bearing, but may result in unappreciated sounds. Adjusting more frequently than stated in the schedule may result in unnecessary wear and decreased life of the bearing.

The wear and corresponding play of the tiller-side bearings is likely to be greater than that in the housing-side bearings. This divergence is due to the large difference in swivel angles both sets of bearings endure during typical hull unit operation.

### Tapered Pin Adjustment Methodology

In essence, the objective of this procedure is simply to press the tapered pin further into the tapered bearing bushing. The resulting pressure against the inner race of the spherical bearing causes it to expand and reduce play.

Explained briefly and without detail, the process is to disengage the cylinder pin from the tiller or housing by lifting the upper bushing loose. Then, push the cylinder pin down into the bearing bushing to reduce the clearance between the inner and outer race of spherical bearing. When adjustment is completed, the fasteners are installed to lock the adjustment and keep the taper fit snug between components.

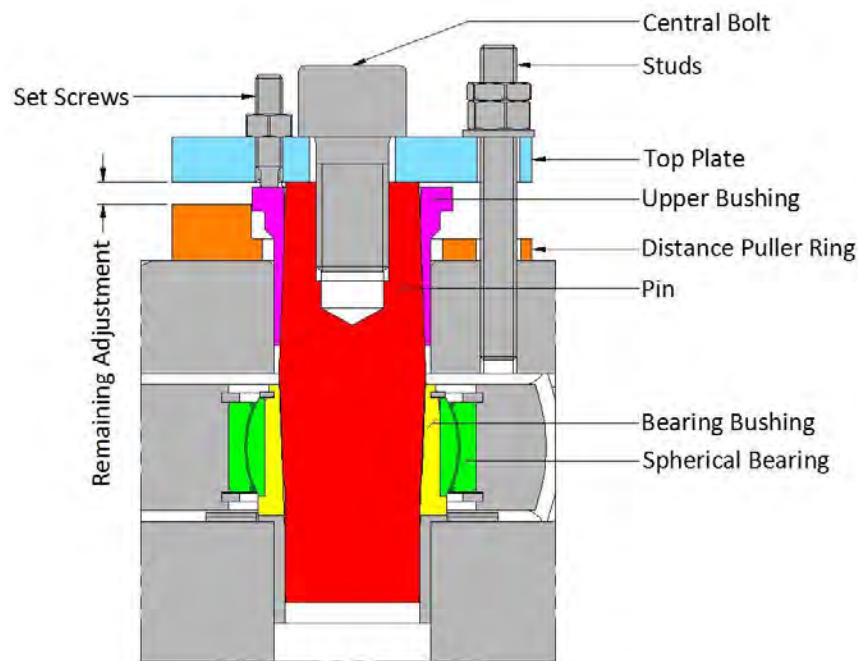


Figure 2: Cross-section of tapered pin

The amount of adjustment remaining is visible as a gap between the top plate and distance puller ring as shown in the figure above. When this clearance diminishes to 0mm [0 in], the useable adjustment range has been depleted; the bearings must be replaced at the next adjustment period.

The steps in the following pages explain details of how to perform the adjustment. Please be sure to follow each step carefully. This procedure involves handling heavy equipment that is capable of moving quickly. Injury or damage is possible if safety precautions are not taken.

## Getting Started

### Equipment

Before beginning work, ensure that the following equipment is on site and available:

Item	Type	Quantity	Source
Lifting Plates, Marked "A" and "B"	Special tool	2 pair	Quantum
Fin Oscillation Simulator	Special tool	1	Quantum
Lifting Bolt: ISO 12.9 Grade, DIN912, 40mm length*	Hardware	4	Customer
Torque Wrench: 0-40 Nm [0-30 ft-lbs, 0-4.0 kg-m]	Tool	1	Customer
Hose: Test port connection	Tool	1	Customer
Test gauge	Tool	1	Customer
Molykote P-37	Consumable	30g [1.0 oz]	Customer
Safety glasses	Personal protective equipment (PPE)	1	Customer

**Table 1: Equipment needed for tapered pin adjustment**

\*For the lifting bolt size, consult the Hardware and Tools table below.

### Hardware and Tools

Tapered pin adjustment requires manipulation of hardware, which varies with the nominal pin size. Nominal pin size is measured as the bore diameter in the tiller or housing. Consult the "Cylinderpin Assembly" drawing(s) provided in the manual for the installed nominal pin size(s). Below is a list of the hardware to be manipulated, their sizes for reference, and the tool type and size required.

Hardware and Tools	Quantity**	Nominal Pin Size					
		30mm	35mm	40mm	45mm	50mm	60mm
<b>Central Bolt:</b>	-	<b>M12</b>	<b>M16</b>	<b>M16</b>	<b>M16</b>	<b>M20</b>	<b>M20</b>
Allen Key	1	10mm	14mm	14mm	14mm	17mm	17mm
<b>Stud Nuts:</b>	-	<b>M8</b>	<b>M8</b>	<b>M10</b>	<b>M8</b>	<b>M10</b>	<b>M10</b>
Wrench	2	13mm	13mm	17mm	13mm	17mm	17mm
Deep Socket	1	13mm	13mm	17mm	13mm	17mm	17mm
<b>Set Screws and Nuts:</b>	-	<b>M6</b>	<b>M6</b>	<b>M6</b>	<b>M6</b>	<b>M8</b>	<b>M8</b>
Allen Key	1	3mm	3mm	3mm	3mm	4mm	4mm
Wrench	1	10mm	10mm	10mm	10mm	13mm	13mm
<b>Lifting Bolts:</b>	<b>4*</b>	<b>M10</b>	<b>M10</b>	<b>M12</b>	<b>M10</b>	<b>M12</b>	<b>M12</b>
Allen Key	1	8mm	8mm	10mm	8mm	10mm	10mm

**Table 2: Hardware and associated tools required, by nominal pin size**

\* The 30mm and 35mm nominal pin sizes only require quantity 3 lifting bolts.

\*\* Indicates quantity to be sourced by customer. Items indicated with "-" are supplied in the pin assembly.

Hardware manipulated in the tapered pin adjustment is to be torqued per the instructions to a maximum torque, which is indicated below.

Hardware	Torque Units	Nominal Pin Size					
		30mm	35mm	40mm	45mm	50mm	60mm
Central Bolt	Nm	30	30	30	30	30	30
	Ft*lbs	22	22	22	22	22	22
	Kg*m	3.0	3.0	3.0	3.0	3.0	3.0
Stud Nuts (Maximum)	Nm	35	35	30	35	30	30
	Ft*lbs	26	26	22	26	22	22
	Kg*m	3.6	3.6	3.0	3.6	3.0	3.0
Set Screws	Nm	6.0	6.0	6.0	6.0	8.0	8.0
	Ft*lbs	4.4	4.4	4.4	4.4	5.9	5.9
	Kg*m	0.6	0.6	0.6	0.6	0.8	0.8

Table 3: Hardware torque specifications

### Lifting Plates

When lifting the upper bushing, use the Quantum-supplied special tools referred to as lifting plates. These lifting plates fit within the recesses of the distance puller ring and beneath the collar of the upper bushing. The plates act as a spacer, allowing the upper bushing to be lifted as illustrated below.

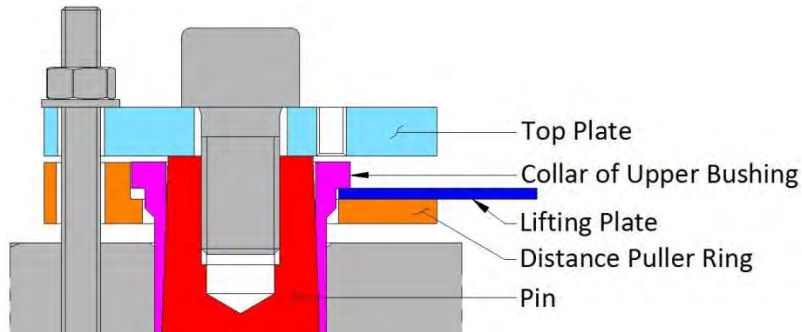


Figure 3: Pin cross-section with lifting plate engaged.



Figure 4: Example lifting plate.

These plates utilize small magnets where possible to hold the lifting plate in place while the adjustment procedure is performed.

When engaging the lifting plates, the stamped side of the plate is to be positioned upwards. Stamped on the end of the plate is a number and a letter, designating the applicable pin size and lifting plate thickness respectively. The lifting plates are provided in two thicknesses. The thin plate is stamped with an "A", and the thicker plate with a "B". In the early stages of pin adjustment, the thick plate ("B") alone will be sufficient for adjustment. However, as the bearing wears, it will become necessary to use the thin plate ("A") in order to lift the bushing sufficiently to then fit the thick plate ("B") in position.

## Tapered Pin Adjustment, Rev B WORK INSTRUCTIONS

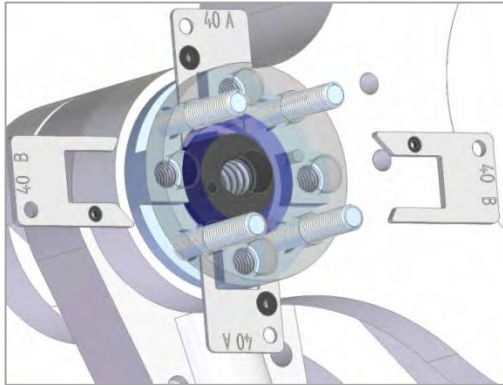


Figure 5: Pin assembly with the "A" plates engaged.

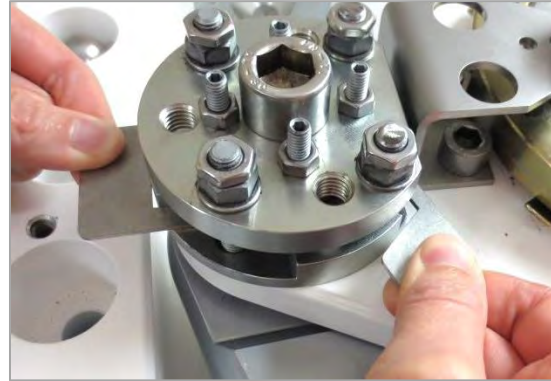


Figure 6: Lifting plates in place on the 35mm pin size.

Two lifting plates are needed to be installed either side of the tapered pin assembly while completing this task. Most pin assemblies are symmetrical; the lifting plates can be installed at 0° and 180°, or 90° and 270° orientation, as illustrated above.

However, the 30mm and 35mm tapered pin is not symmetrical, in order to accommodate equipment in close vicinity to the pins. The non-symmetrical aspect is visible by a flat edge on one side of the pin top plate and distance puller ring. For these pins, a key-shaped lifting plate is provided for use on the flat-edge side of the pin assembly; a fork-shaped lifting plate is provided for use 180° from the flat edge.

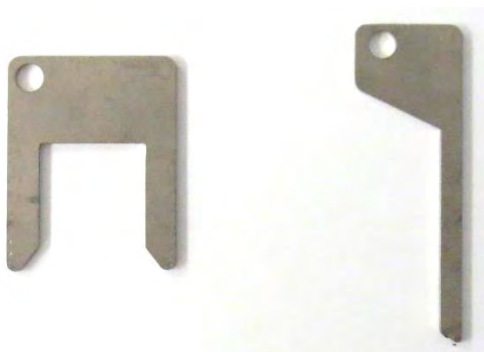


Figure 7: Lifting plates for 30mm and 35mm pin sizes

Nominal Pin Size	Kit Number
30mm	QCPIN90025-0A
35mm	QCPIN90025-0A
40mm	QCPIN90026-0A
45mm	QCPIN90027-0A
50mm	QCPIN90028-0A
60mm	QCPIN90029-0A

Table 4: Lifting plate kit part numbers

The lifting plates must be removed and safely stored elsewhere after the adjustment procedure is completed. Part numbers for kits containing the necessary plates are provided in Table 4.

### Reference Material

Prior to beginning work, consult the Quantum manual for stabilizer controller operation guide and cylinder hydraulic pressure relief instructions. Also, consult fin oscillation simulator operation instructions.

### Time to Complete

With full accessibility to all components, it should take approximately 30 minutes to adjust each tapered pin.

### Instructions

#### Secure the Stabilizer System

1. Ensure that the stabilizer system is shut down and the power unit local controls are in AUTO mode.
2. Engage centering cylinder or centering bolts. If the centering cylinders are automatically deployed, ensure that the centering cylinders will remain engaged upon system start-up by one of the means below:
  - a. For systems fitted with separate centering cylinder extension manifold, engage the manual over-ride on the P-blocking valve.
  - b. For remaining systems, engage over-ride on centering circuit pilot valve.
3. Connect the Fin Oscillation Simulator to the local control module (FCM or ECM).
4. Activate the stabilizer controller and place the system in "CENTER" mode.
5. Hydraulically isolate the hull unit by closing the ball valve on the stabilizer manifold "P" port or pressure filter. Close accumulator ball valve, if fitted.
6. Relieve hydraulic pressure in A and B cylinder lines. Confirm that the pressure is zero by connecting a gauge to the A and B gauge ports on the stabilizer manifold.

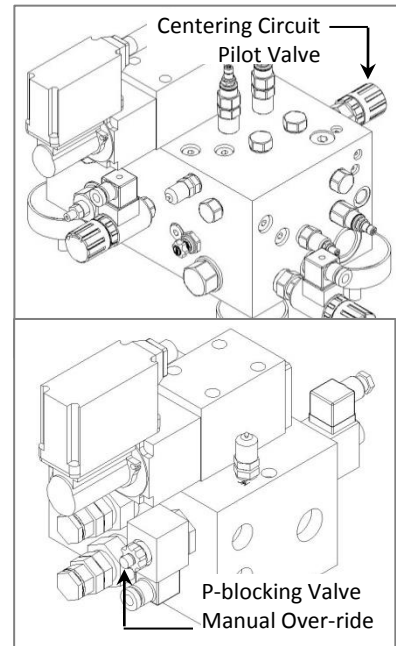


Figure 8: Sample stabilizer manifolds with centering circuit pilot (above) and P-blocking (below) valves indicated.

#### Remove Hardware

7. Put on safety glasses and take safety precautions as appropriate.
8. Remove the safety cover from the hull unit.
9. Remove the set screws with nuts (quantity 4).
10. Check torque of the central bolt. Ensure that the bolt is torqued per Table 3.
11. Remove the stud locknuts (quantity 4). Use two wrenches, being sure not to disturb the position of the lower stud nut.

**NOTE: This hardware will be reused. Please store safely to prevent loss or damage.**

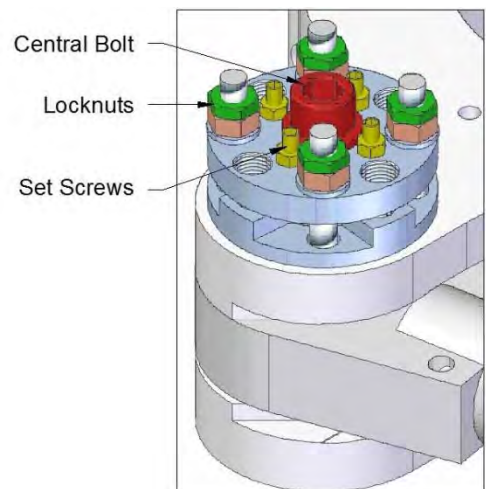


Figure 9: Hardware adjusted in Steps 9-11.



### Disengage the Pin

12. Engage two of the lifting plates, opposite to each other.
  - Slide the plates into position underneath the collar of the upper bushing.
  - Use the thick lifting plates, marked “B”. After advanced bearing wear, the thick plates might not fit. In this case, use the thin plates, marked “A”. Perform steps 13 and 14. Then, repeat steps 13 and 14 with the thicker plates, marked “B”, engaged.
13. Apply Molykote P-37 to threads of the lifting bolts. Thread the bolts into the threaded holes of the distance puller ring. Tighten the lifting bolts by hand until the lifting plates contact the collar of the upper bushing.
14. Carefully tighten the lifting bolts in a sequential crosswise pattern. Increase torque in steps for each torqueing sequence until the upper bushing is loose from the cylinder pin. The top of the upper bushing and the top of the distance puller ring will touch the bottom of the top plate. This can be seen through the sides of the distance puller ring.

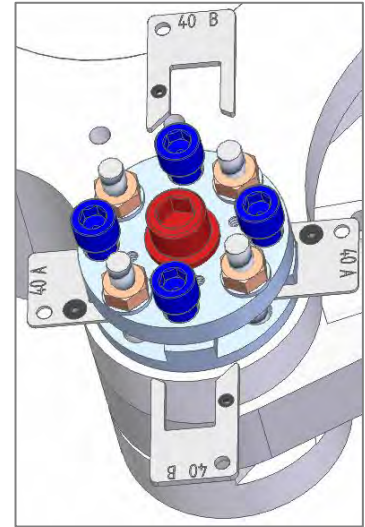


Figure 10: Tapered pin with “A” lifting plates and lifting bolts in position.

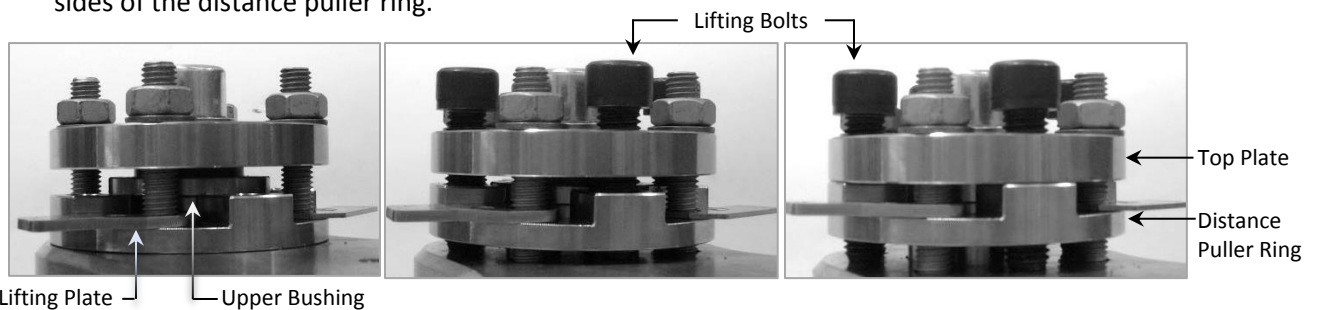


Figure 11: Side view of tapered pin as pin is disengaged. Step 12, lifting plates engaged (left). Step 13, lifting plates contact collar of upper bushing (middle). Step 14, upper bushing raised (right).

### Adjust the Pin

15. Remove the four lifting bolts and the two lifting plates.
16. Starting with a 10 Nm [7 ft-lbs, 1.0 kg-m] torque setting, tighten the stud nuts in a crosswise pattern.
 

**NOTE: Perform this task slowly by rotating each nut by 1/4 of a turn (90°) at a time so that the top plate doesn't get canted from the horizontal compared to the top of the pin. Do not apply full torque entirely on one nut before proceeding to torque the next nut.**
17. Repeat on all four (4) pins.

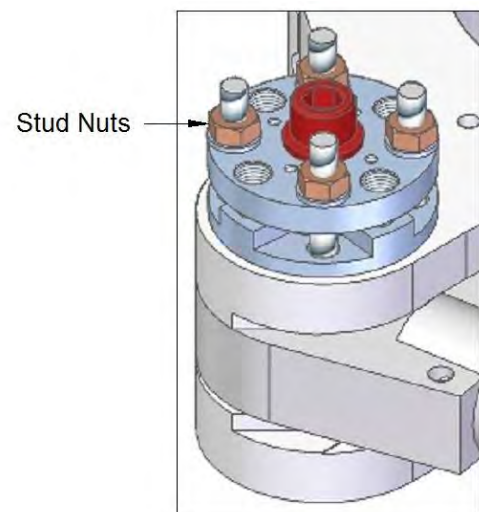


Figure 12: Nuts torqued in Step 16.

### Test

18. Open the "P" port or pressure filter ball valve.
19. Retract centering bolts or cylinders. If centering cylinders were automatically deployed in Step 2, allow them to retract by:
  - a. dis-engaging the centering circuit pilot valve over-ride,
  - or
  - b. dis-engaging the P blocking valve manual over-ride.
20. Use the fin oscillation simulator to oscillate the hull unit. Determine if adjustment is adequate by listening for unpleasant knocking sound at the bearings.
21. Re-engage the centering bolts or cylinders. If the centering cylinders were automatically deployed in Step 2:
  - a. engage the centering circuit pilot valve over-ride,
  - or
  - b. engage the P-blocking valve over-ride.
22. Close the "P" port or pressure filter ball valve.
  - a. If the sound observed in step 20 was excessive, proceed to step 23 for further adjustment.
  - b. If the sound observed was acceptable, proceed to step 24 to secure the pin adjustment.

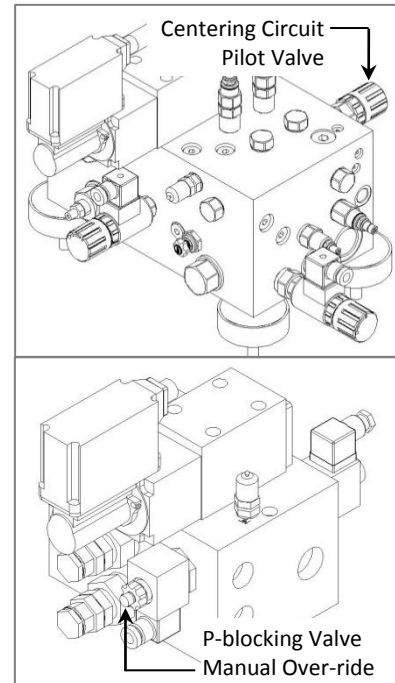


Figure 13: Sample stabilizer manifolds with centering circuit pilot (above) and P-blocking (below) valves indicated.

### Re-adjust

23. Make further play adjustment, only if required.
  - a. Increase torque setting in Step 16 by another 5 Nm [4 ft-lbs, 0.5 kg-m] and repeat steps 16 through 22.
  - b. Do not exceed an applied maximum torque listed in Table 3 or 180 degrees of nut rotation for every 1000 hours of hull unit operation.

### Re-secure the Pin

24. Apply Molykote P-37 to the studs and install the locknuts (quantity 4). Tighten them firmly.
25. Apply Molykote P-37 to threads and mount the set screws (quantity 4) with hex up. Tighten the set screws in a cross-pattern to the maximum torque listed in Table 3.
26. Install and tighten the set screw nuts (quantity 4) firmly to secure the set screws.

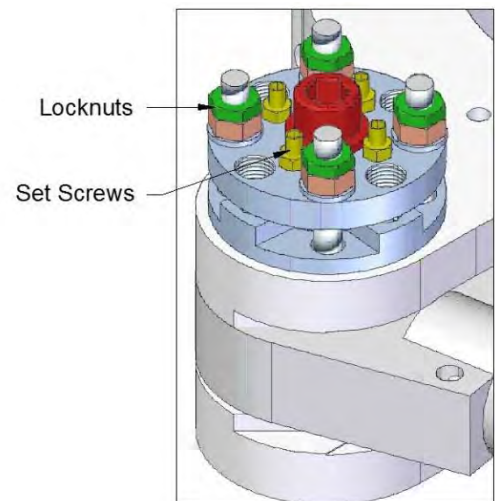


Figure 14: Hardware for steps 24-26.

#### Re-instate Original Conditions

27. Disconnect the fin oscillation simulator.
28. Dis-engage centering bolts or cylinders. If the centering cylinders were automatically deployed in Step 2:
  - a. For systems fitted with separate centering cylinder extension manifold, dis-engage the manual over-ride on the P-blocking valve.
  - b. For remaining systems, dis-engage over-ride on centering circuit pilot valve.
29. Open the “P” port or pressure filter ball valve and accumulator ball valves, if fitted.
30. Reinstall safety cover.
31. Turn off the stabilizer controller.