WOODWARD™

Component Maintenance Manual
Bronze Level

Product Name: VariStroke-II (VS-II)

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General Precautions

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.

Revisions

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, on the *publications page* of the Woodward website:

www.woodward.com/publications

The latest version of most publications is available on the *publications page*. If your publication is not there, please contact your customer service representative to get the latest copy.

Proper Use

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty, thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

1. GENERAL INFORMATION

INTRODUCTION

This Component Maintenance Manual is intended to be used by customers and Woodward authorized service centers for repair or service of the VariStroke-II.

Bronze level service is preventative and routine maintenance that requires little to no specialized tooling, testing, or calibration procedures to maintain product between normal overhaul intervals. This manual is written with the assumption that the reader has access to the product manual and other Woodward documents referenced within this document.

1.1 Regulatory Compliance

The VS-II is subject to safety regulatory certifications. See product manual 26740 for additional details. The service center performing the work on the VS-II must not alter the construction such that the certifications are invalidated.

⚠WARNING

FLAMEPATH

Disassembly of product will require handling of critical components used in a Zone 1 Flameproof and/or Division 1 Explosion proof design. Special care must be taken as to not damage these parts as it could compromise the method of protection for the product. Flamepaths are identified in drawing 9989-7005.

Threaded Flamepaths: Care must be taken during handling and assembly to not damage threads. Inspect for damage to threads, which includes but is not limited to galling, cross threading, and excessive wear. Damage to threads and/or thread fit can compromise the effectiveness of the method of protection. If any damage is discovered, contact Woodward prior to reinstallation or assembly into system.

Radial and Flat Joint Flamepaths: Care must be taken during handling and assembly to not damage the flat surface of the flamepath. Inspect primary surface and mating surface for damage including, but not limited to scratches, porosity, and marks due to impact. Damage to these surfaces can compromise the effectiveness of the method of protection. If any damage is discovered, contact Woodward prior to reinstallation or assembly into system.

Repair of Flamepaths: The flameproof joints are not intended to be repaired. Return to Woodward for repair and maintenance if joints are damaged.

WARNING

Explosion Hazard— Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

Substitution of components may impair suitability for Class I, Division 1 or 2, or Zone 2 applications.

1.2 Warnings and Notices

This is the safety alert symbol used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER** - Indicates a hazardous situation, which if not avoided, will result in death or serious injury.
- **WARNING** - Indicates a hazardous situation, which if not avoided, could result in death or serious injury.
- **CAUTION** - Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury.
- **NOTICE** - Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT** - Designates an operating tip or maintenance suggestion.

⚠WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

⚠WARNING

Disconnect Power Supply

Before performing maintenance, always disconnect power and any hazardous voltages that may be connected. Follow all appropriate lockout/lockdown procedures.

⚠WARNING

Hazards due to insufficiently qualified personnel!

If unqualified personnel perform work on or with the product, hazards may arise which can cause serious injury and substantial damage to property. Therefore, all work must be carried out by appropriately qualified personnel.

⚠WARNING

Remove pressure before servicing. Failure to do so may damage the VS-II and/or cause injury.

1.3 Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Follow these precautions when working with or near the control:

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible, as these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. After removing the old PCB from the control cabinet, immediately place it in the antistatic protective bag.

1.4 List of Woodward Literature

Required documents	
Product Manual **26740** -	VARISTROKE-II (VS-II) ELECTROHYDRAULIC ACTUATOR
Installation Drawing **9999-1758-1** -	KIT, VSII, LVDT
Installation Drawing **9999-1758-10** -	KIT, VSII, SERVO
Installation Drawing **9999-1758-2** -	KIT, VSII, DVP
Installation Drawing **9999-1758-9** -	KIT, VSII, BRIDGE MANIFOLD SEALS
Installation Drawing **9999-1758-7** -	KIT, VSII, CYLINDER SEALS
Drawing **9989-7005** -	FLAMEPATH, VARISTROKE 2
Reference documents	
Manual **26455** –	Customer Publication Cross Reference and Revision Status & Distribution Restrictions
Manual **82715** –	Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, & Modules

Woodward software-download section website (www.woodward.com/searchpublications).

If unable to access Woodward documentation, refer to contact list at the end of this manual.

1.5 List of Required Hardware or Materials

Special Tool(s)*	• 1013-5894 (**Male Rod Thread** 1013-5894-01-D4, 1013-5894-01-D9 or **Female Rod Thread** 1013-5894-01-D1, 1013-5894-01-D9) - LIFTING EYE FOR PISTON/ROD ASSEMBLY • 1013-5803 (**cylinder size 10"**: 1013-5803-10_d01, 1013-5803-10_d02, 1013-5803-10_d03 or **cylinder size 12"**: 1013-5803-12_d01, 1013-5803-12_d02, 1013-5803-12_d03) - ASSEMBLY TOOL - PISTON SEAL TOOL • 2X1013-5894-01-D9 Cylinder Lifting tools: 1013-7361, 1013-7429, 1013-7447
Torque wrench(es)	• Torque wrench(es) to cover 10 – 200 in-lb torque range • Torque wrench(es) to cover 30 – 700 ft-lb torque range • Deep sockets: 11/32", 19 mm. • Crows feet: 15/16", 1 7/16", 9/16", 7/16", 3/4", 1 5/16" 1 1/16", 7/8" • Allen socket drives: 5/32", 3/8", 1/4", 3/4"
Wrench(es)	• Flat wrench; Size from 1/8 to 1 ¼ inch • Flat wrench; Size from 6 to 36 mm • Allen hex key; Size from 1/8 to ½ inch • Allen hex key; Size from 4 to 12 mm • Socket tools: Phillips screw driver
Screwdriver(s)	• Type: Phillips; screwdriver sets • Type: Slotted; screwdriver sets
Others	• ISOPROPANOL cleaning fluid • GN paste (Molykote DX Paste or similar) • Petroleum jelly to O-ring lubrication • Loctite 242 (Loctite Threadlocker Blue 242) • PC computer with Woodward PC Service Tool installed • 2X 20" adjustable clamps • Wire/dyke side cutters • Seal pick set
Measuring Equipment	• N/A
*Tools depend on the cylinder size and rod thread.	
NOTICE **Please remember to order the special tools separately. The tools are not added to the replacement kit.**	

1.6 Woodward Required Software

9927-2325 – VS II (VARISTROKE II) SERVICE TOOL

Woodward website (www.woodward.com/software)

1.7 General Instructions

⚠WARNING **VS-II actuator lifting is allowed ONLY by using two provided lifting eyes on the hydraulic power cylinder. The VS-II servo valve lifting is allowed ONLY by using two provided lifting eyes on the servo valve. Support the VS-II in the vertical position during transportation.**

⚠WARNING **Make sure that the crane, cables, straps, and all other lifting equipment used for VS-II lifting are able to support the VS-II weight. See outline drawings for VS-II weights.**

- Review the CMM and installation drawing before starting the replacement to be sure that all necessary tools are available and instructions are clear.
- Check the replacement parts kit to verify all replacement parts listed in the installation drawing are present. For questions, contact Woodward.
- Sort all parts for easy assembly.
- If not all parts are used, the unit or units must be inspected for completeness.
- Contact Woodward if an error is found during the replacement process.
- Clean the exterior of the VS-II by hand prior to disassembly to prevent dirt and debris from contaminating the interior.
- O-rings:
    - Use the correct tool to install or remove O-rings. If using a protective cone on small O-rings, lubricate the O-ring and slide it onto the part being sure it does not twist.
    - If a cone is not used on large O-rings, use a pick under the O-ring to lift it onto the part until it is in the desired location.
- Retaining rings:
    - During installation, be careful not to over-extend or over-compress a retaining ring. All retaining rings should be installed with the sharp edge away from the pressure. Inspect all installed retaining rings to be sure they have been properly seated, fit snugly, and do not rotate freely on the parts they are installed on or in.
- Helicoils:
    - To prevent damage to mid-grip helicoils, install screws at a slow speed. DO NOT USE A HIGH-SPEED TOOL. Stainless steel screws MUST be lubricated with an anti-seize lubricant before turning them into mid-grip helicoils or aluminum parts.
- Disassembly:

  - Parts that have been disassembled and will be reused must be inspected closely for damage and replaced if necessary. Parts that have been disassembled should be kept in a clean container such that they can be readily identified against this procedure, reference drawings, or visual aids for proper reassembly.
- Screws:
  - All screws loosen with counterclockwise (CCW) direction. In other situations, the direction will be specified.

2. LVDT REPLACEMENT

2.1 Replacement Kit Description

The purpose of this procedure is to show the correct sequence and method of LVDT replacement:

LVDT Replacement:
- KIT P/N: 8935-1223-10 – VSII, LVDT, 4 IN STROKE
- KIT P/N: 8935-1223-15 – VSII, LVDT, 6 IN STROKE
- KIT P/N: 8935-1223-20 – VSII, LVDT, 8 IN STROKE
- KIT P/N: 8935-1223-25 – VSII, LVDT, 10 IN STROKE
- KIT P/N: 8935-1223-30 – VSII, LVDT, 12 IN STROKE
- KIT P/N: 8935-1223-35 – VSII, LVDT, 14 IN STROKE
- KIT P/N: 8935-1223-40 – VSII, LVDT, 16 IN STROKE
- KIT P/N: 8935-1223-45 – VSII, LVDT, 18 IN STROKE

NOTICE

Review the CMM and Installation Drawing before starting the replacement to be sure that all necessary tools are available and everything is clear. For any questions, contact Woodward.

⚠WARNING

Refer to Section 1.1 for specific instructions.

FLAMEPATHS

2.2 Disassembly Procedure

⚠WARNING

Disconnect power supply before performing any maintenance or replacement. Always disconnect power and any hazardous voltages that may be connected. Follow appropriate lockout/lockdown procedures.

⚠WARNING

Due to unintended cylinder movement, disconnect power and drain hydraulic pressure before servicing hydraulic system.

NOTICE

Before starting any disassembly, connect to VS-II Service Port by using straight through RS232 cable. Connect other end of cable to PC with VS-II Service Tool. Download all .wset files.

A. Loosen the four bolts on the outer cover (a few turns).
B. Remove outer cover.

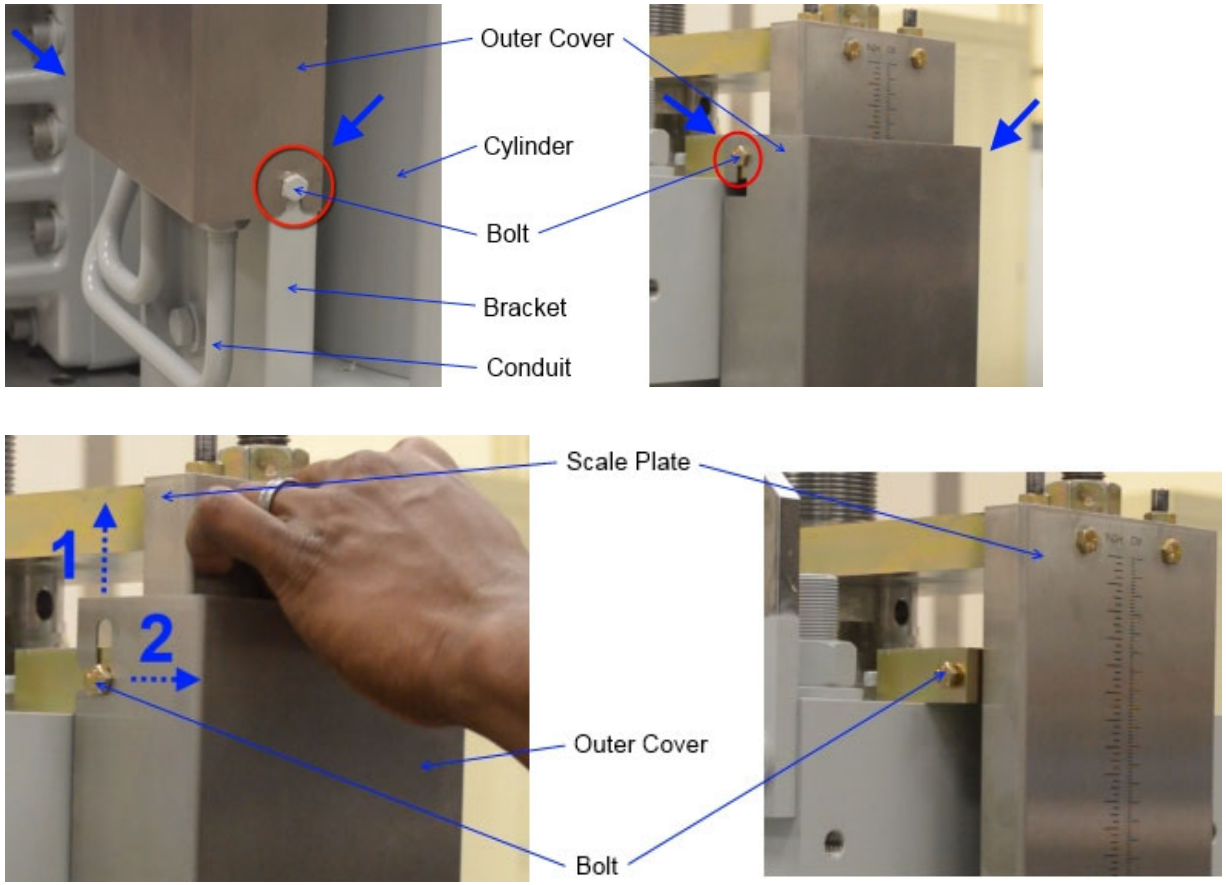


Figure 2-1. Remove Cover

C. Loosen one bolt located on the bottom of the scale plate (a few turns).
D. Remove two bolts with washers (located on the front of the plate) from the scale plate.

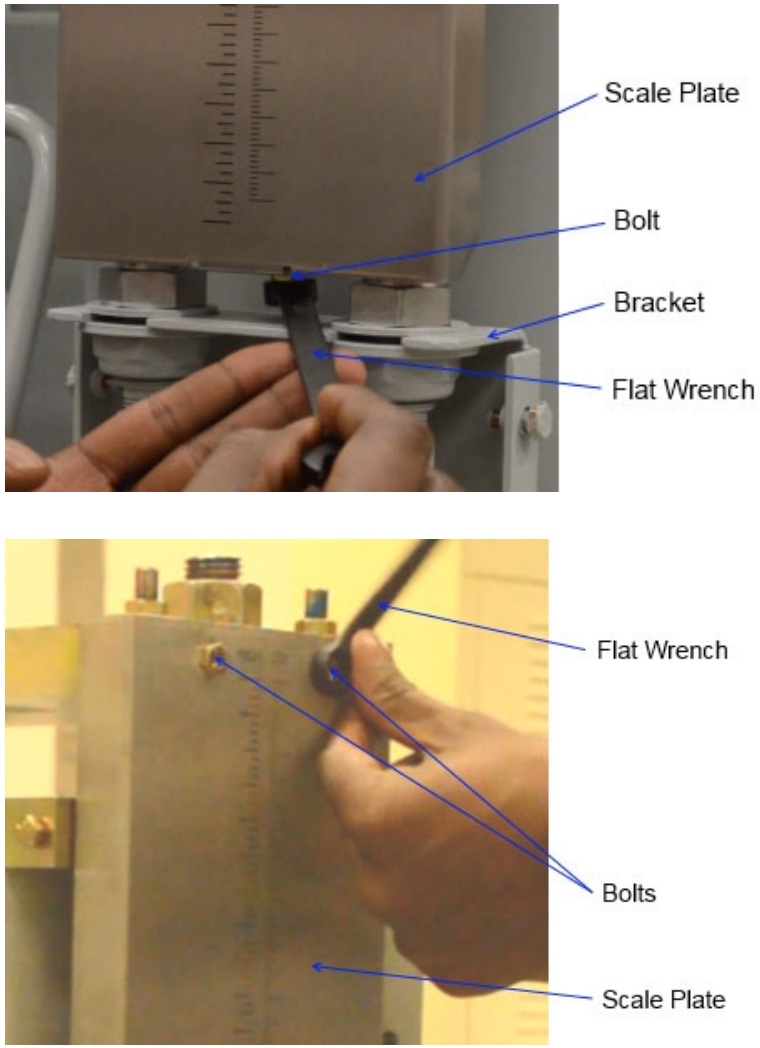
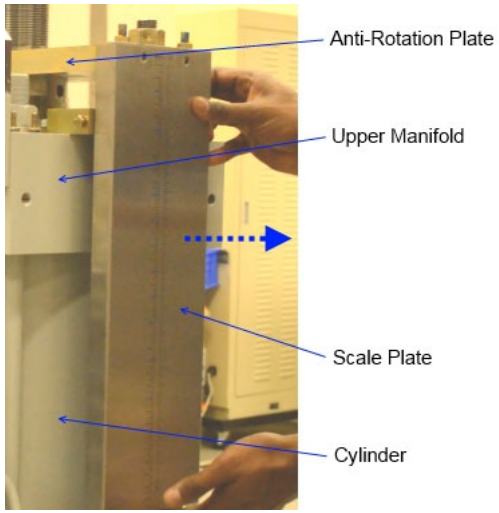


Figure 2-2. Loosen and Remove Screws

E. Remove the scale plate.
F. Remove twenty screws with washers from the electrical enclosure Cover. The cover is positioned by two guide pins.
G. Remove the electrical enclosure cover.



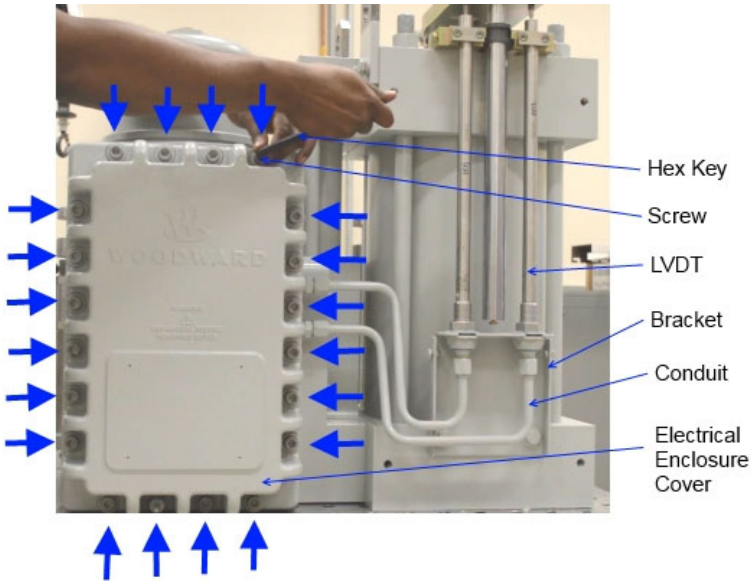


Figure 2-3. Remove Scale Plate and Electrical Enclosure Cover

H. Disconnect all wires of LVDT to be replaced – one or both (terminals 4-12 – LVDT 2 and/or 13-21 – LVDT 1). The picture at far right shows LVDT1 replacement.

I. Remove nut to disconnect LVDT ground wire as shown.

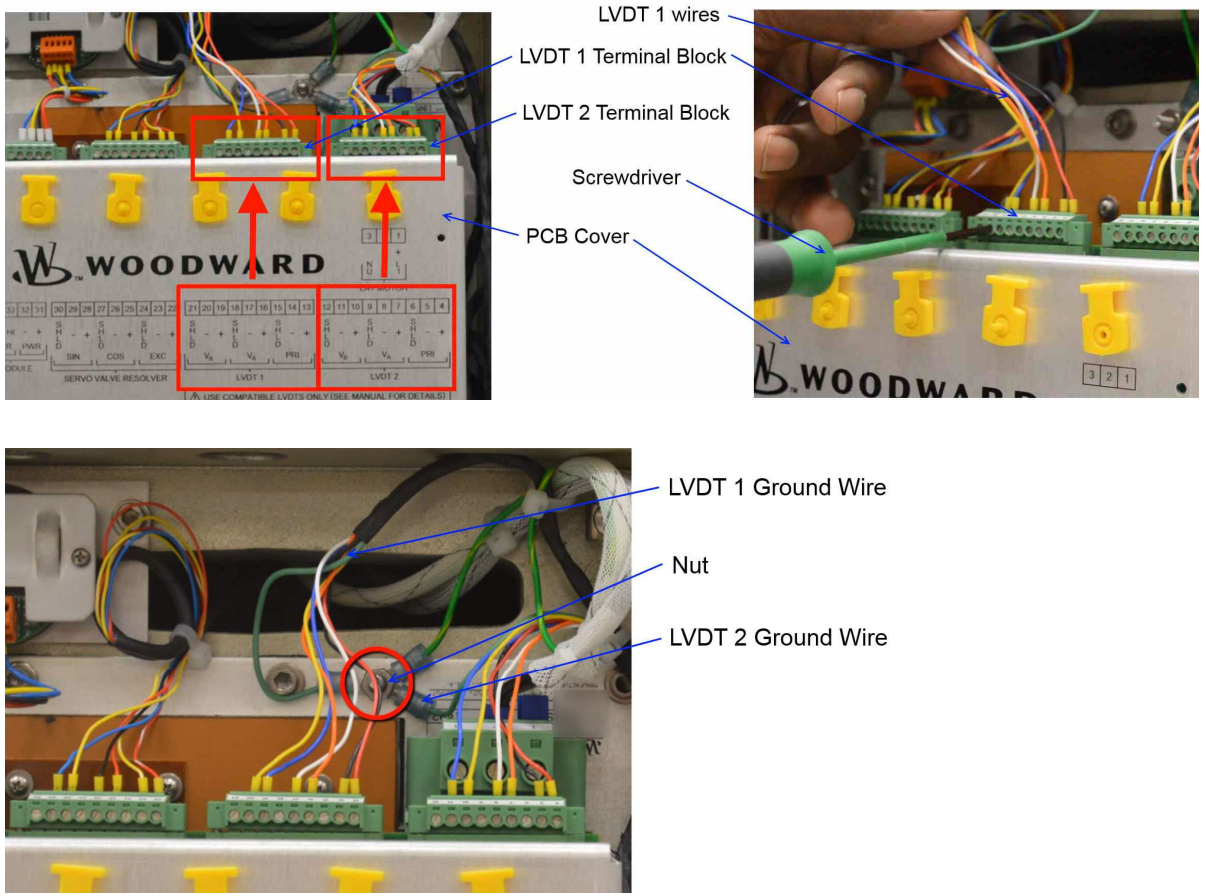


Figure 2-4. Disconnect LVDT Wires

J. Loosen LVDT core rod nut.
K. Remove LVDT core rod from the anti-rotation plate and LVDT housing.

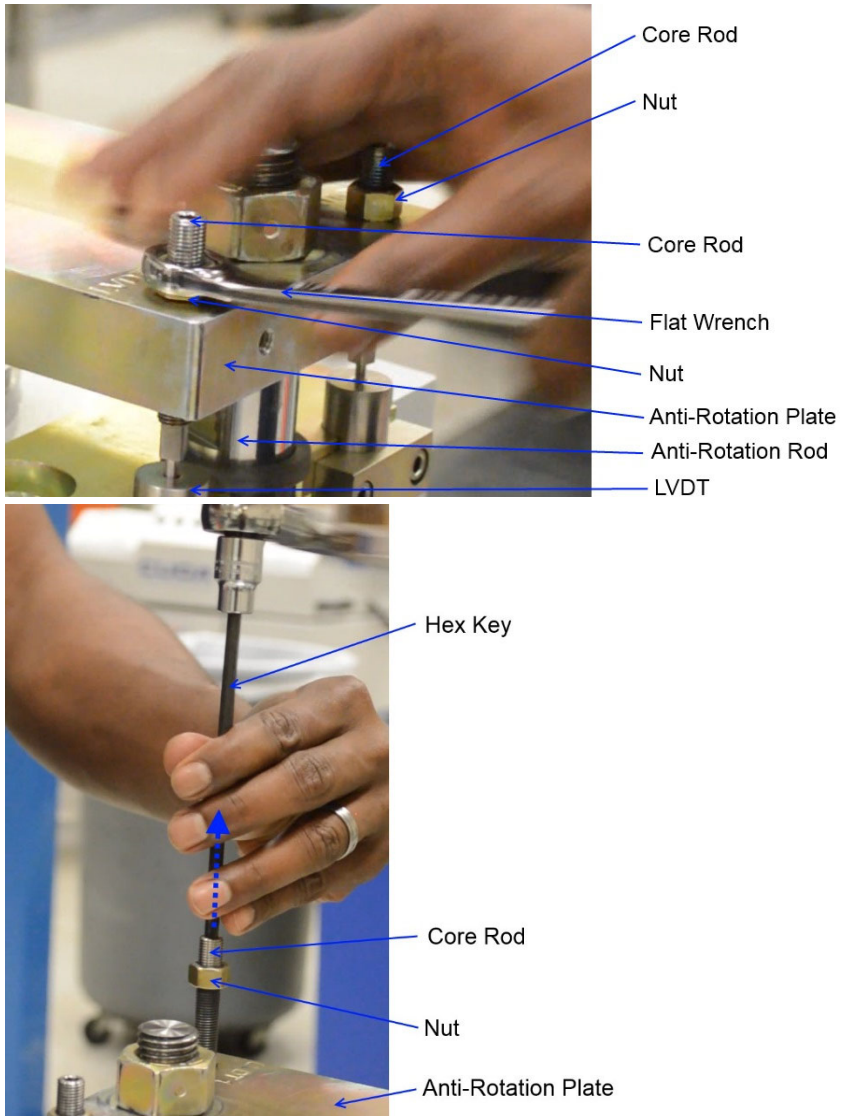


Figure 2-5. Remove LVDT Core Rod

L. Loosen conduit adapter nuts – from servo housing and bracket sides.
M. Gently remove conduit tube and LVDT wire from the conduit hub.
N. Using two wrenches (keep upper wrench in one position while turning lower wrench) loosen the locknut located on the bottom of the lower LVDT mounting bracket.

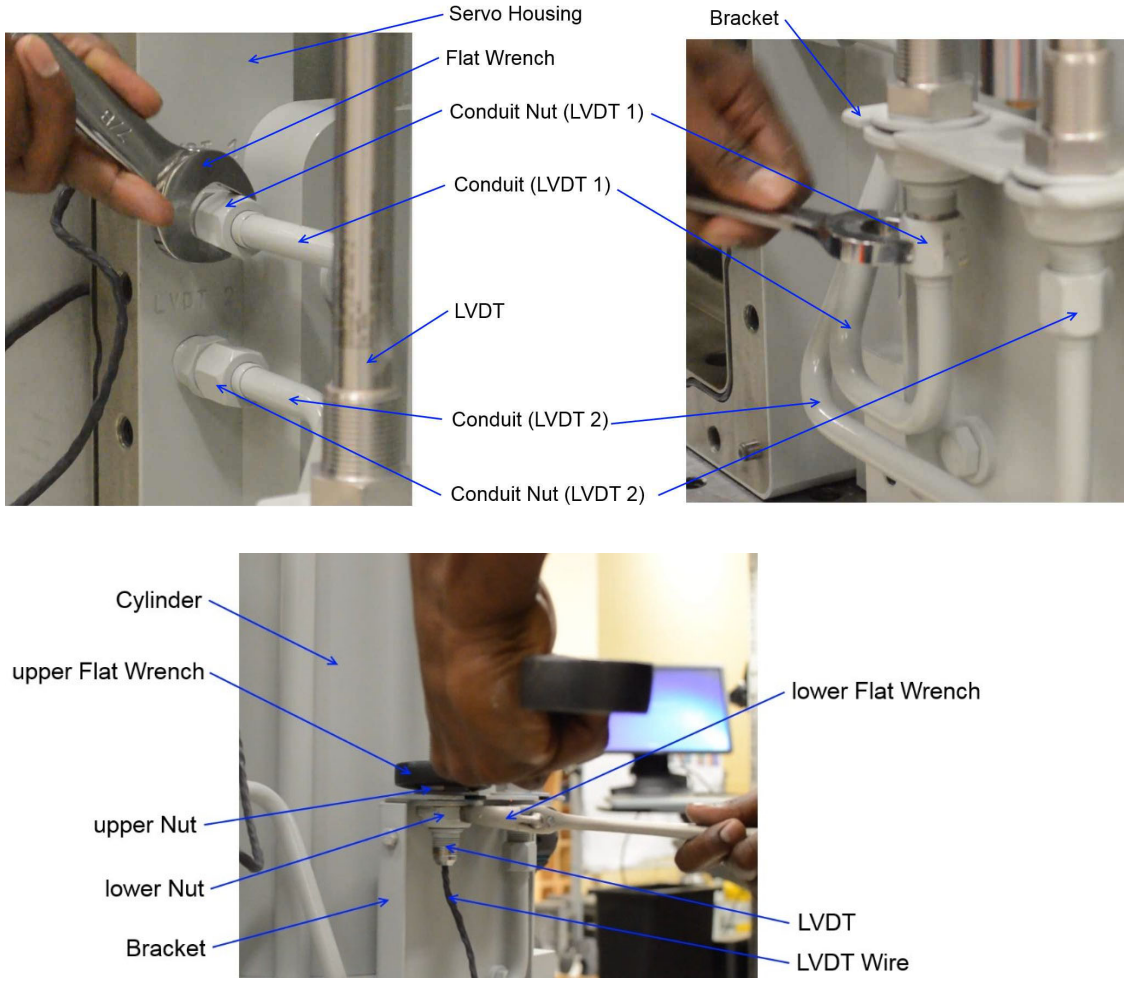


Figure 2-6. Remove Conduits

O. Remove two bolts from the LVDT clamp.
P. Remove LVDT.
Q. Using ISOPROPANOL cleaning fluid, clean all surfaces and visually inspect the mounting surfaces.

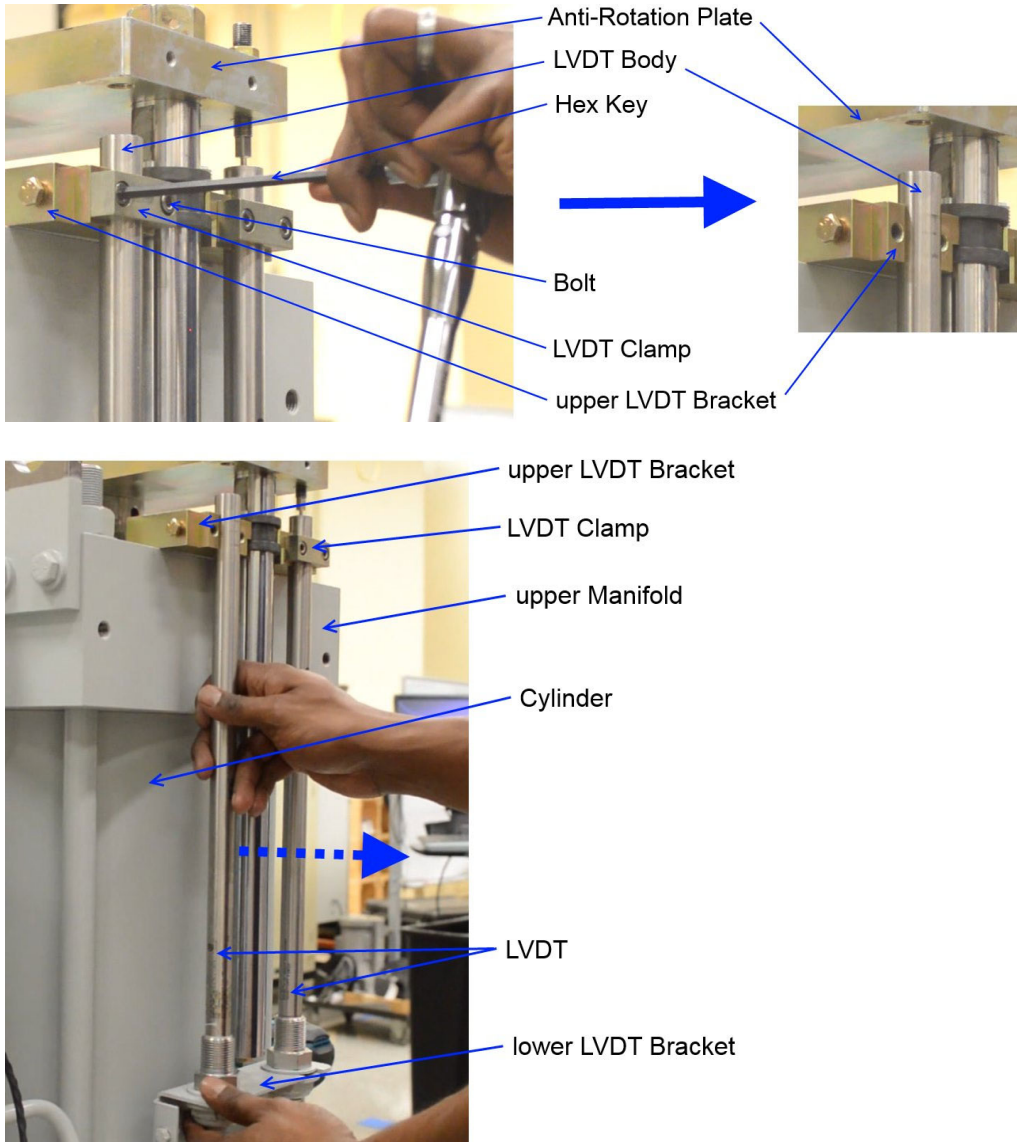


Figure 2-7. Remove LVDT

2.3 Assembly Procedure

⚠WARNING

FLAMEPATHS

Refer to Section 1.1 for specific instructions.

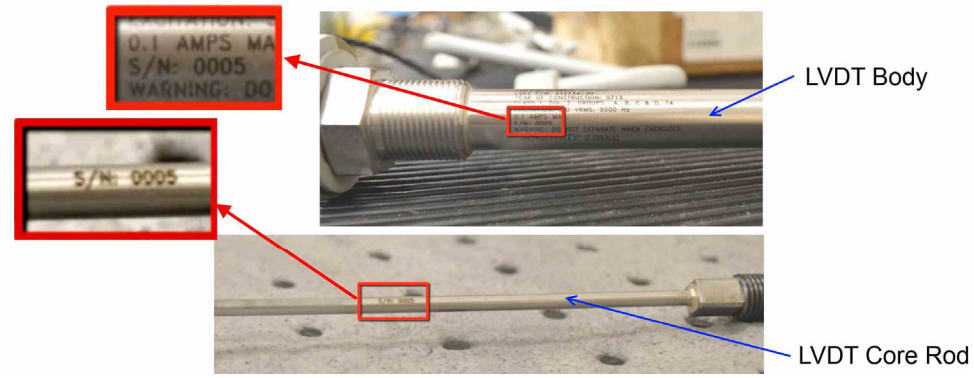
A. Inventory all parts in the parts kit and ensure they are present compared to the installation drawing.

B. Unpack LVDT and verify rod and body serial numbers match.

C. Remove core rod from LVDT body.

D. Install large and small washers and LVDT lock nut as shown. Install LVDT body by inserting body into the slot of the lower bracket while positioning the larger washer on the top surface. Upper part of the LVDT body should move into the proper place in upper bracket.

Note: LVDT bodies and rods need to match when installed for LVDT function and accuracy.



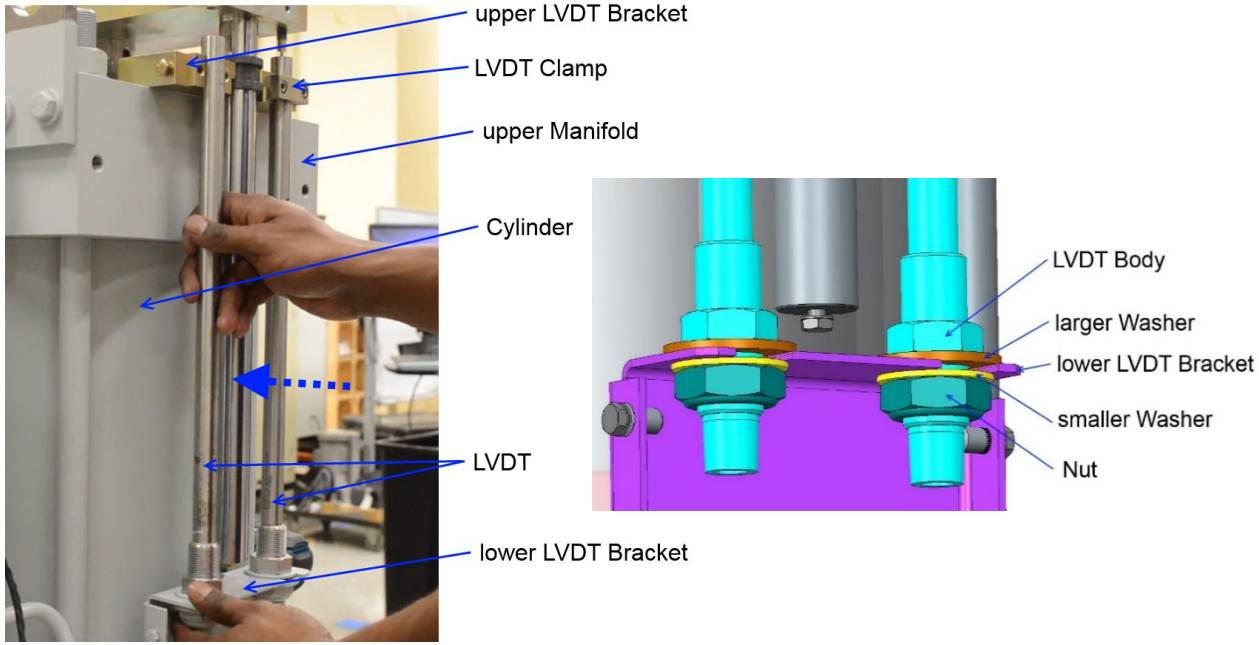


Figure 2-8. Install LVDT

E. Locate the vendor-etched sensitivity values by rotating the LVDT housing and positioning so that the values are visible.

F. Install LVDT clamp onto the upper bracket with two screws. Torque screws to 15 ± 1 lb-inch.

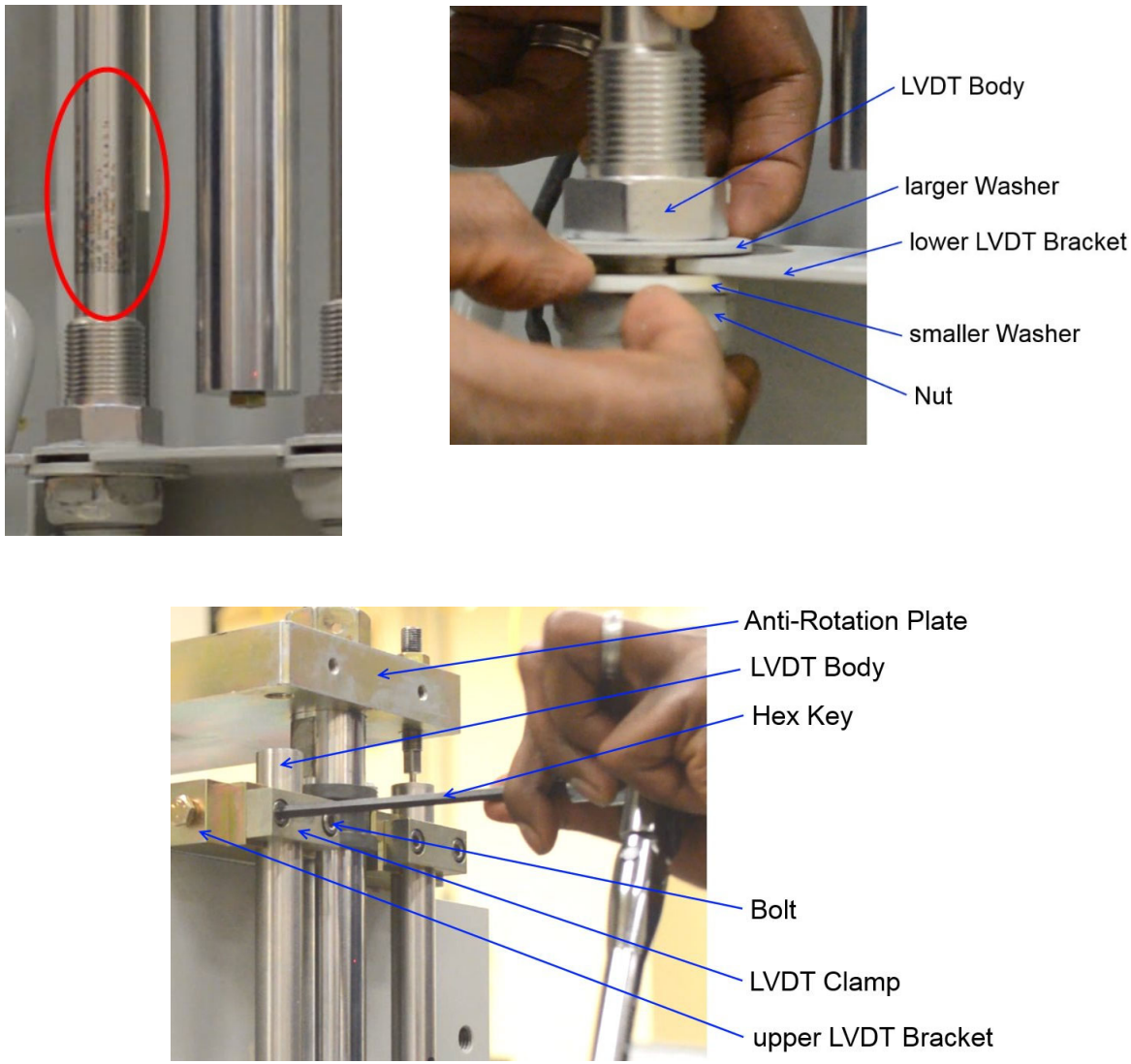


Figure 2-9. Install LVDT Clamp and Torque Screws

G. Secure LVDT to the lower mounting bracket by tightening the LVDT Locknut. Ensure the LVDT does not rotate while tightening the locknut— keep upper wrench in place and rotate just the lower wrench. Also, ensure that some force is applied in the cylinder direction so the LVDT does not slide out of the mounting bracket opening. Torque the locknut to 40 ± 5 lb.- ft.

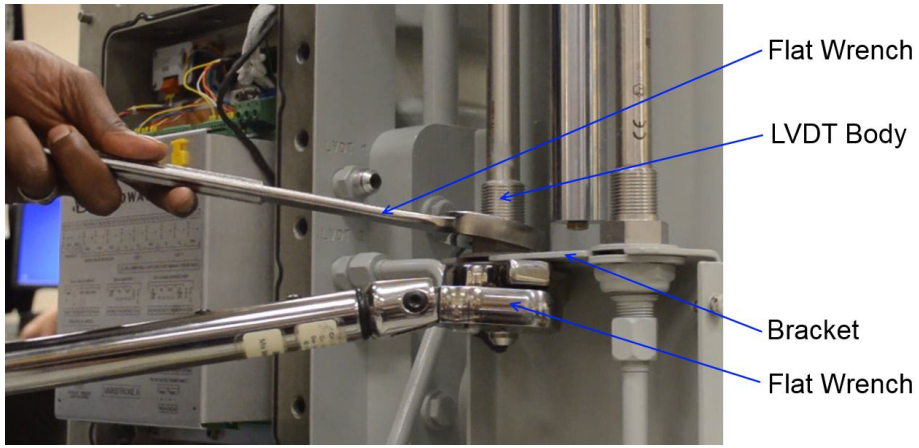


Figure 2-10. Secure LVDT and Torque Locknut

H. Pull LVDT wires through the conduit and into the servo valve housing.

I. Install the conduit and torque both nuts to 50 ft lb ± 5 lb.- ft.

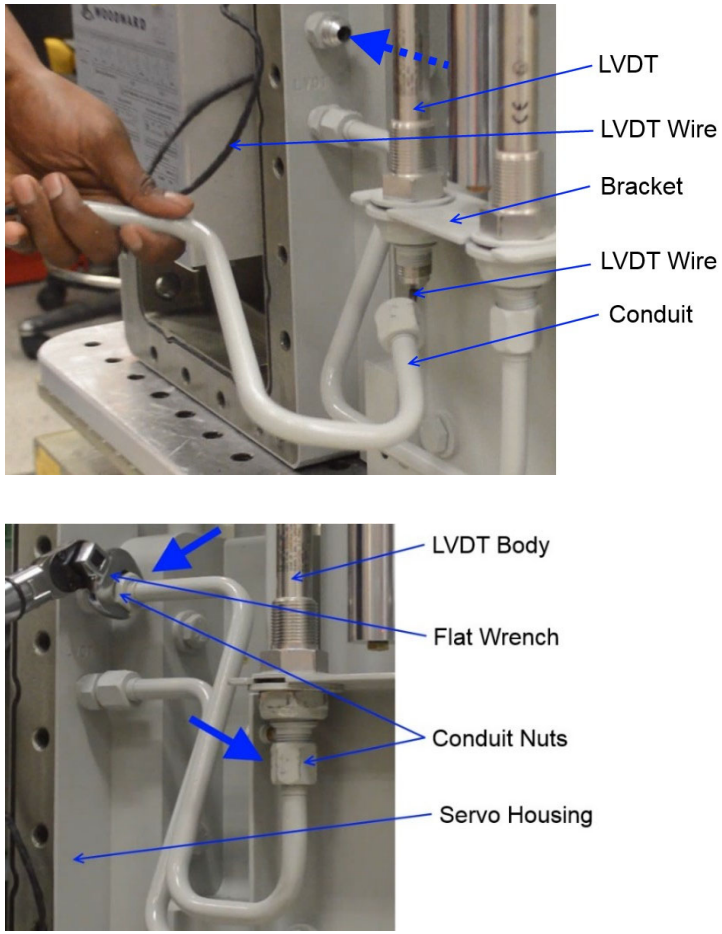


Figure 2-11. Install Conduits

J. Make sure LVDT rod SN matches LVDT body. Apply GN paste to core rod threads and install the core rod into the LVDT body.

K. Rig the LVDT by ensuring the distance between the core rod thread and the top of the LVDT body is 1.5 centimeters.

L. Torque the jam nut to 45 ± 5 lb- inches.

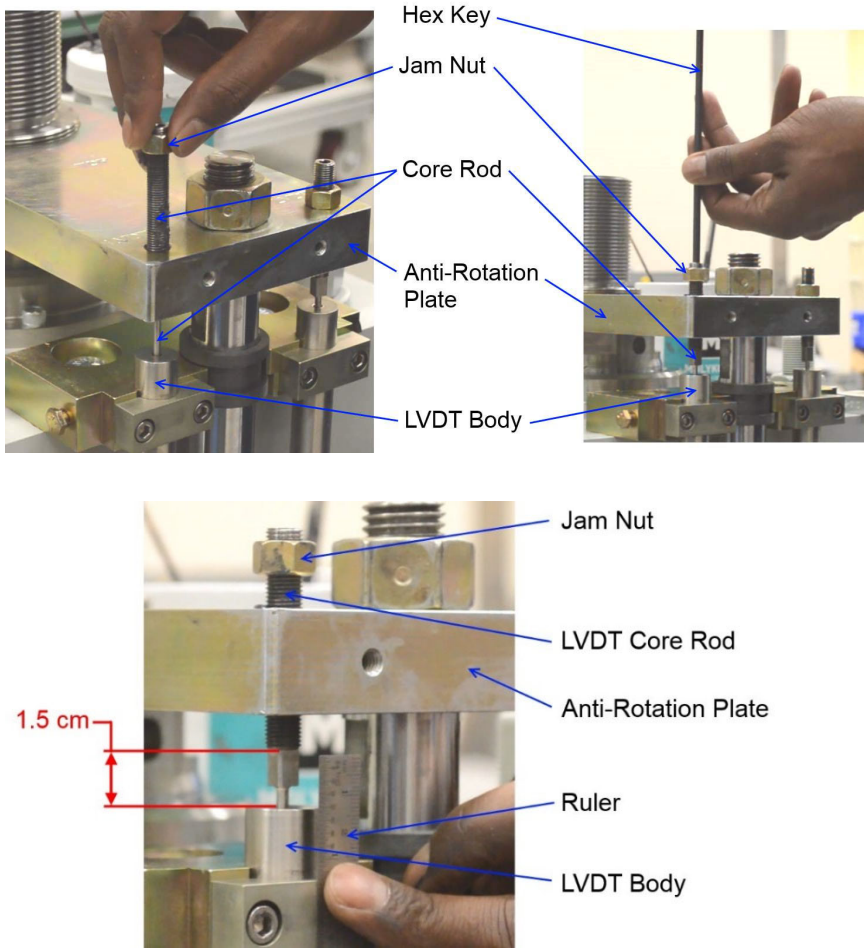
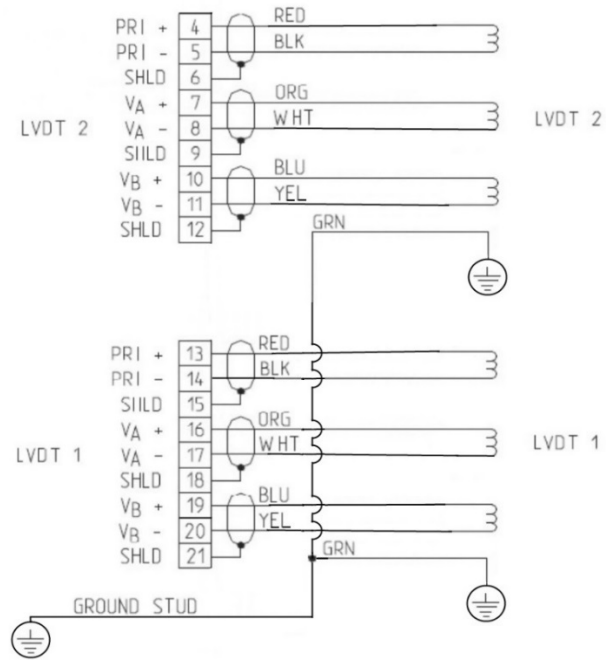


Figure 2-12. Core Rod Installation

M. Rewire the new LVDT according to the following diagram.



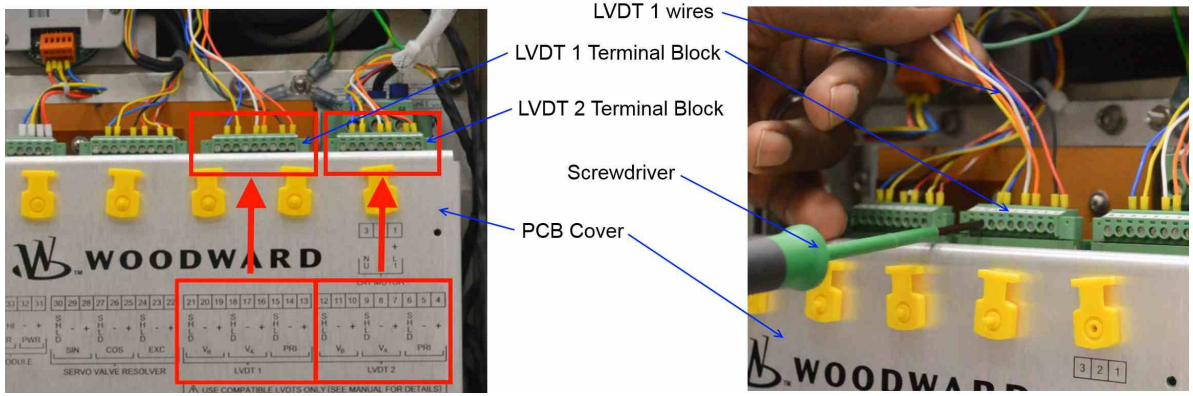
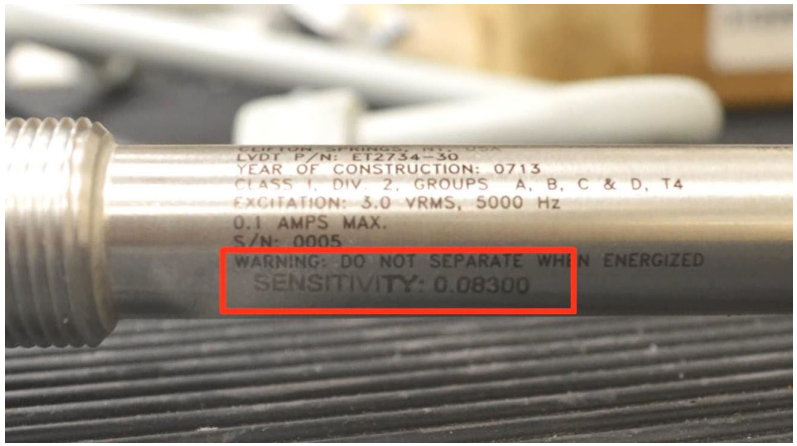
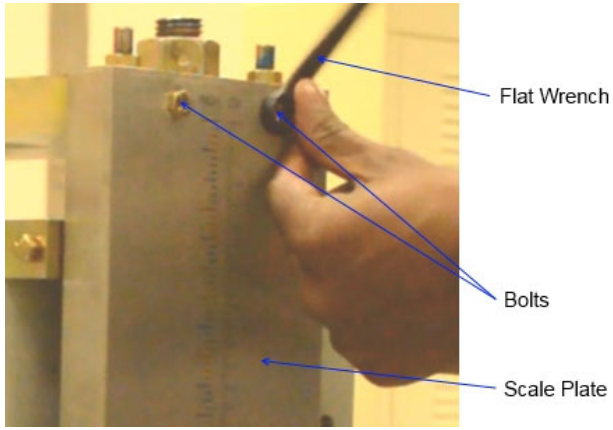


Figure 2-13. LVDT Wiring Installation

N. Record the sensitivity values (printed on the LVDT body). This value is needed for the Service Tool.

O. Install scale plate and tighten three bolts (located in front and on the bottom of the Plate). Torque bolts to 16 ± 2 lb-inches.





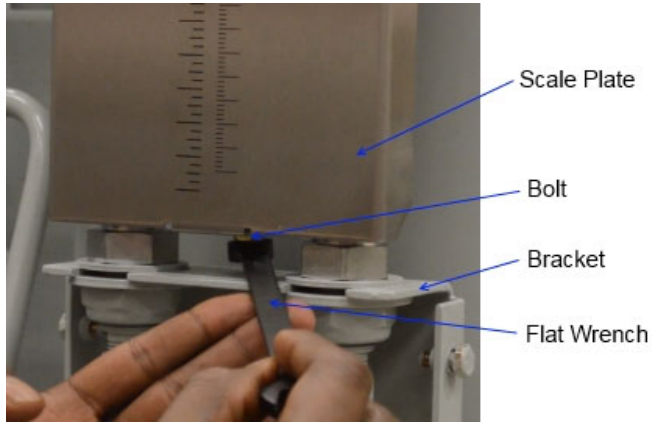


Figure 2-14. Install Scale Plate

P. Install outer cover and tighten four bolts. Torque bolts to 16 ± 2 lb-inches.

Q. Secure LVDT wires to the servo valve housing using cable ties.

R. Before replacing the electronic cover, go to section 2.4 “Verification & Calibration”.

S. Install the electronic cover and install twenty screws with washers. Torque screws to 55 ± 5 lb. - ft.

⚠WARNING

Ensure electronic cover O-ring is in groove and is not pinched by the cover. Incorrect installation will result in loss of ingress protection for Zone 2 installations. A spare O-ring is provided in parts kit.

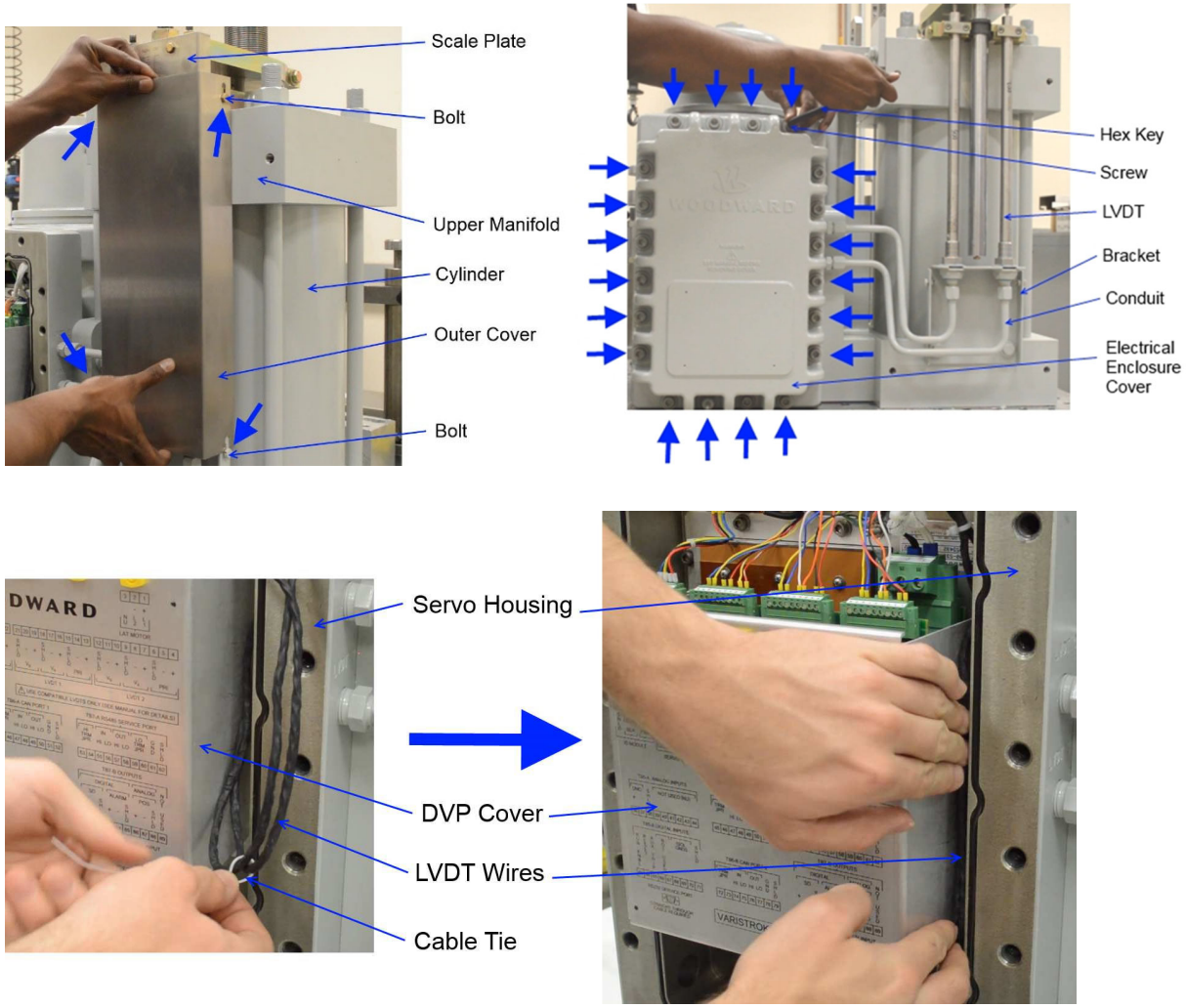


Figure 2-15. Scale Plate Installation

2.4 Verification & Calibration

A. Verify that hydraulic and electrical connections are correct. See product manual for more information.
B. Confirm that the hydraulic and electrical power to the VS-II is turned off.
C. Apply electrical power to VS-II.
D. Connect a PC Service Tool to VS-II. See product manual for more information.
E. Start the hydraulic supply system.
F. Go to Configuration & Calibration screen (see example on right).
G. Enter the new sensitivity value for LVDT.

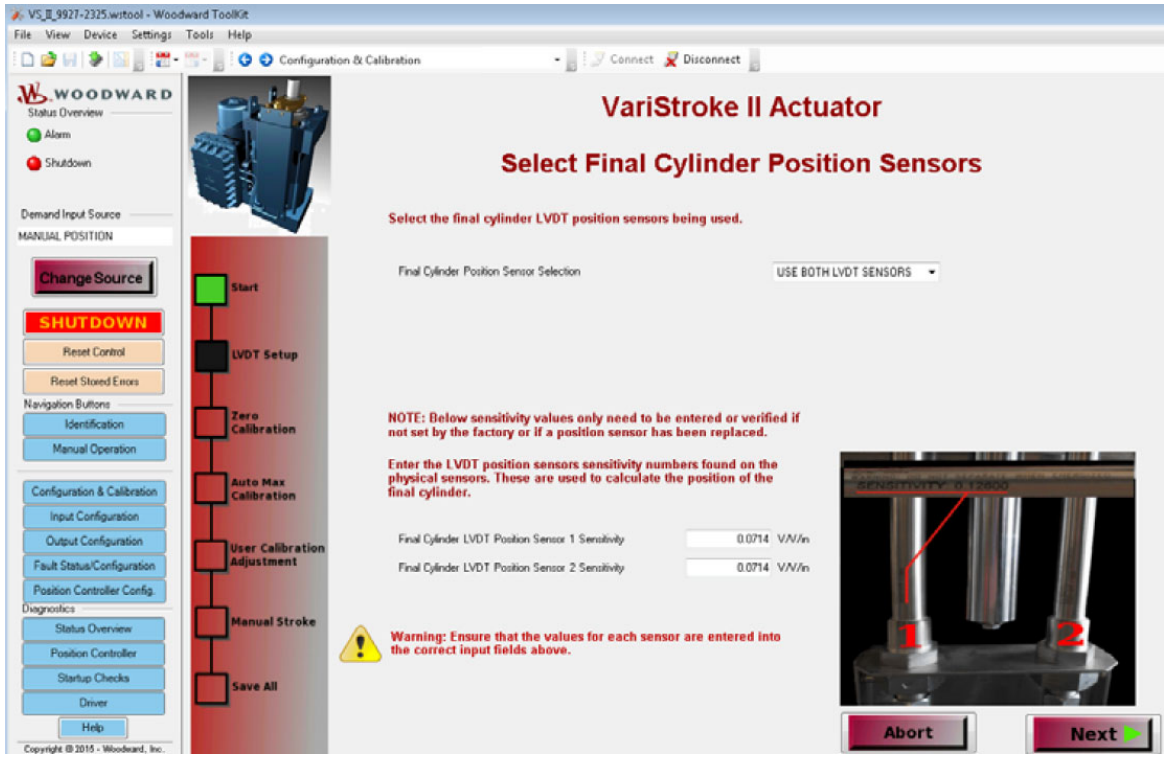


Figure 2-16. Configuration & Calibration Screen

3. DVP REPLACEMENT

3.1 Replacement Kit Description

The purpose of this procedure is to show the correct sequence and method of DVP replacement:

DVP Replacement:
- KIT P/N: 8935-1224 – VSII, V90

NOTICE

Before starting any disassembly, connect to the VS-II using the PC Service Tool. Download and save a .wset file from the service unit. Store the settings file on the PC in a place where you can find it for later use.

⚠WARNING

Refer to Section 1.1 for specific instructions.

FLAMEPATHS

3.2 Disassembly Procedure

NOTICE

Before starting any disassembly, connect to the VS-II using the PC Service Tool. Download and save a .wset file from the service unit. Store the settings file on the PC in a place where you can find it for later use.

⚠WARNING

Disconnect power supply before performing any maintenance or replacement. Always disconnect power and any hazardous voltages that may be connected. Follow appropriate lockout/lockdown procedures.

⚠WARNING

Because of unintended cylinder movement, disconnect power and drain hydraulic pressure before servicing hydraulic system.

A. Remove twenty screws with washers from the electrical enclosure cover. The cover is positioned by two guide pins.
B. Remove the electrical enclosure cover.

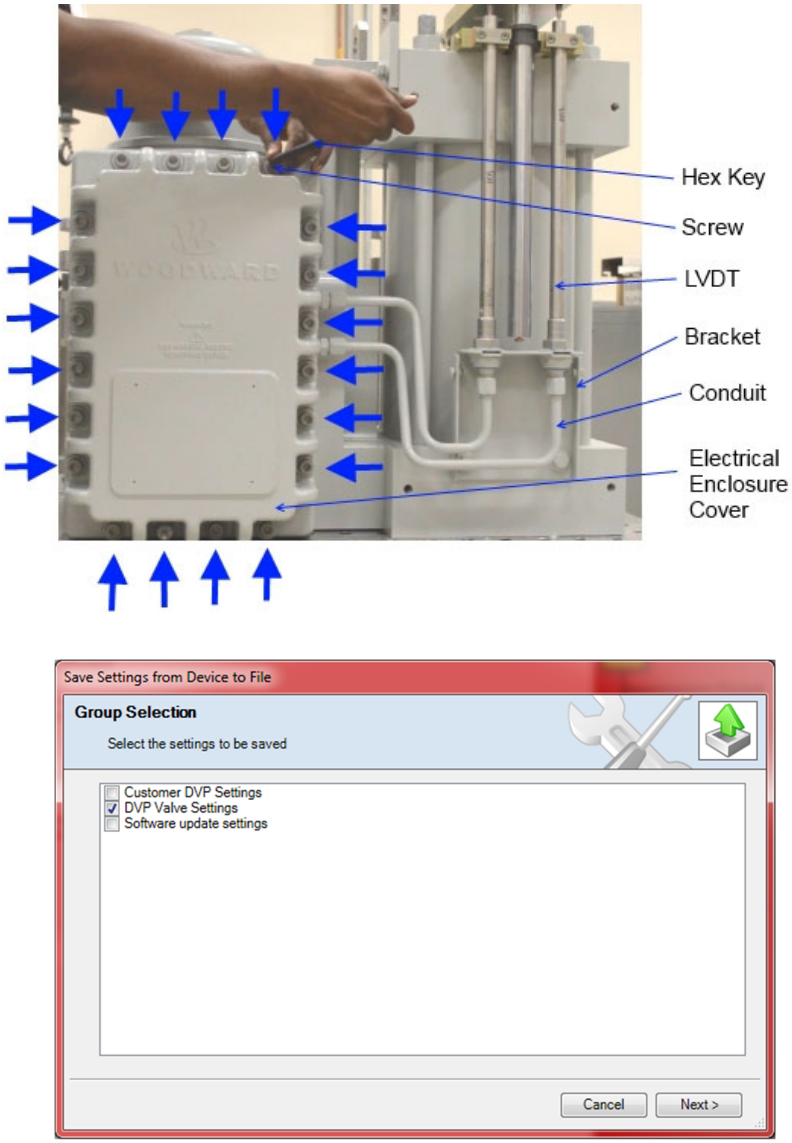


Figure 3-1. Remove Electrical Enclosure Cover

C. Woodward recommends the technician connect the VariStroke II driver using the PC Service Tool and the service port (located in the bottom of the DVP) to save all settings to the PC. These settings can be loaded to new servo valve to make configuration easier.
D. Remove ground wires.

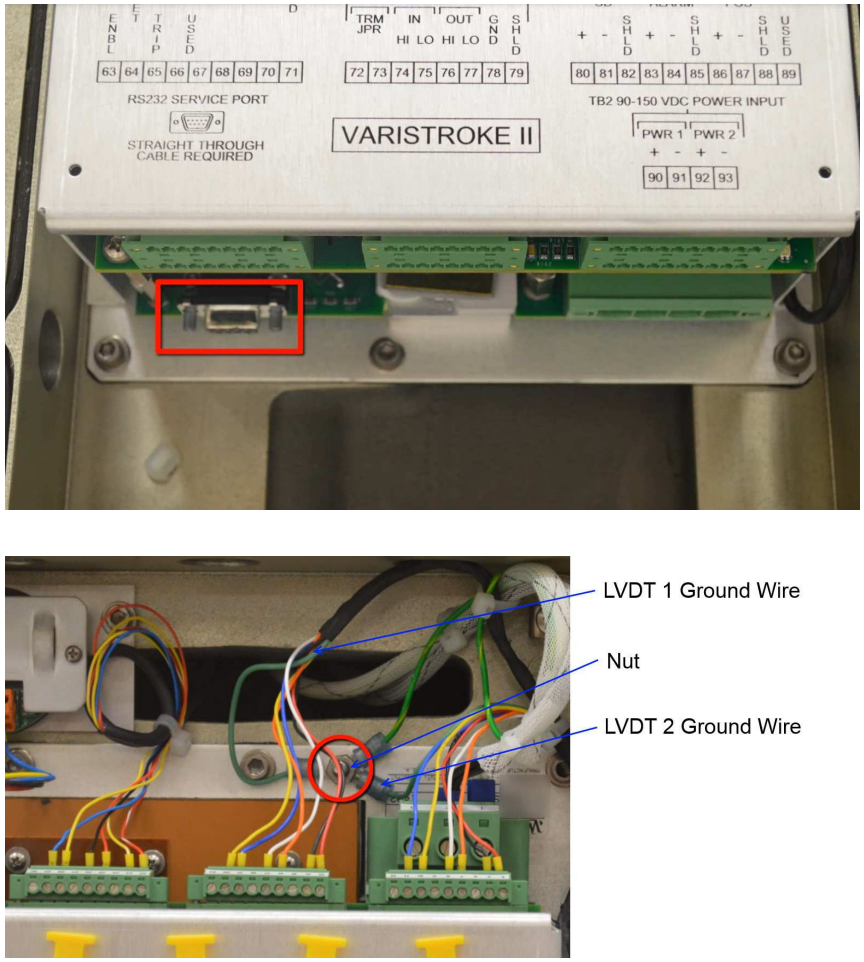


Figure 3-2. Service Port and LVDT Ground Wires

E. Remove four terminal blocks located on the top side of the driver by loosening four screws (two for each terminal block).

F. Repeat the process above for terminal blocks located on the bottom of the driver.

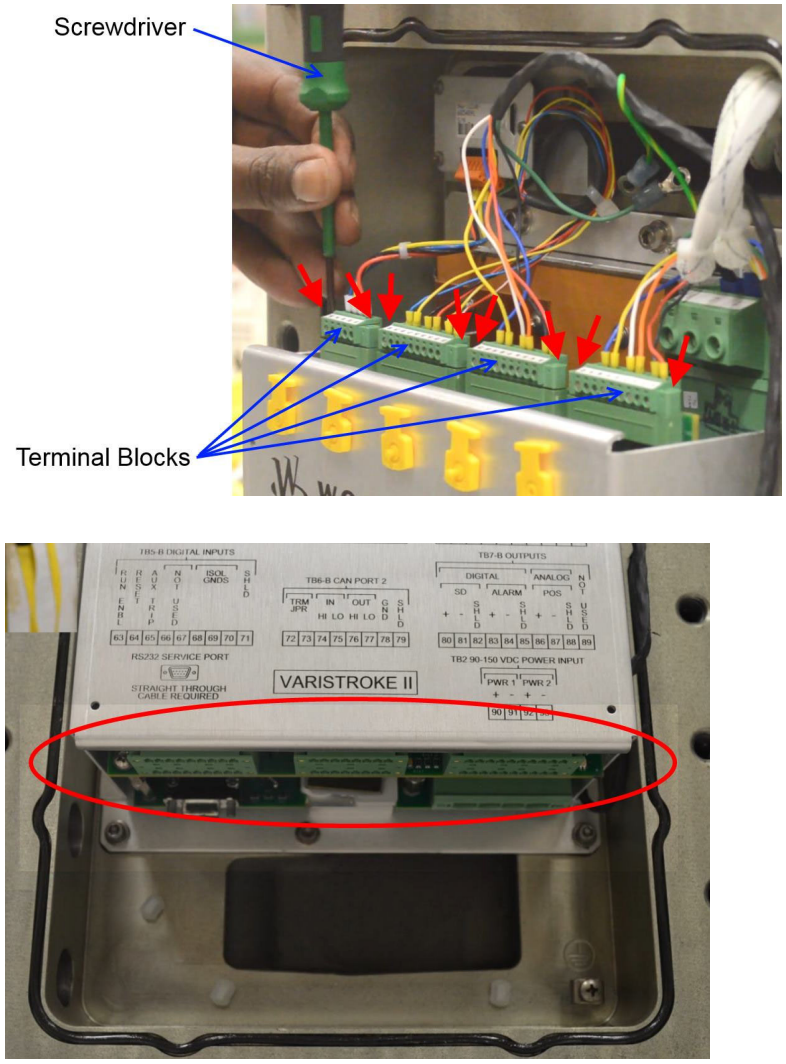


Figure 3-3. Remove Terminal Blocks

G. Remove four screws from the driver protective shield.
H. Remove the cover.

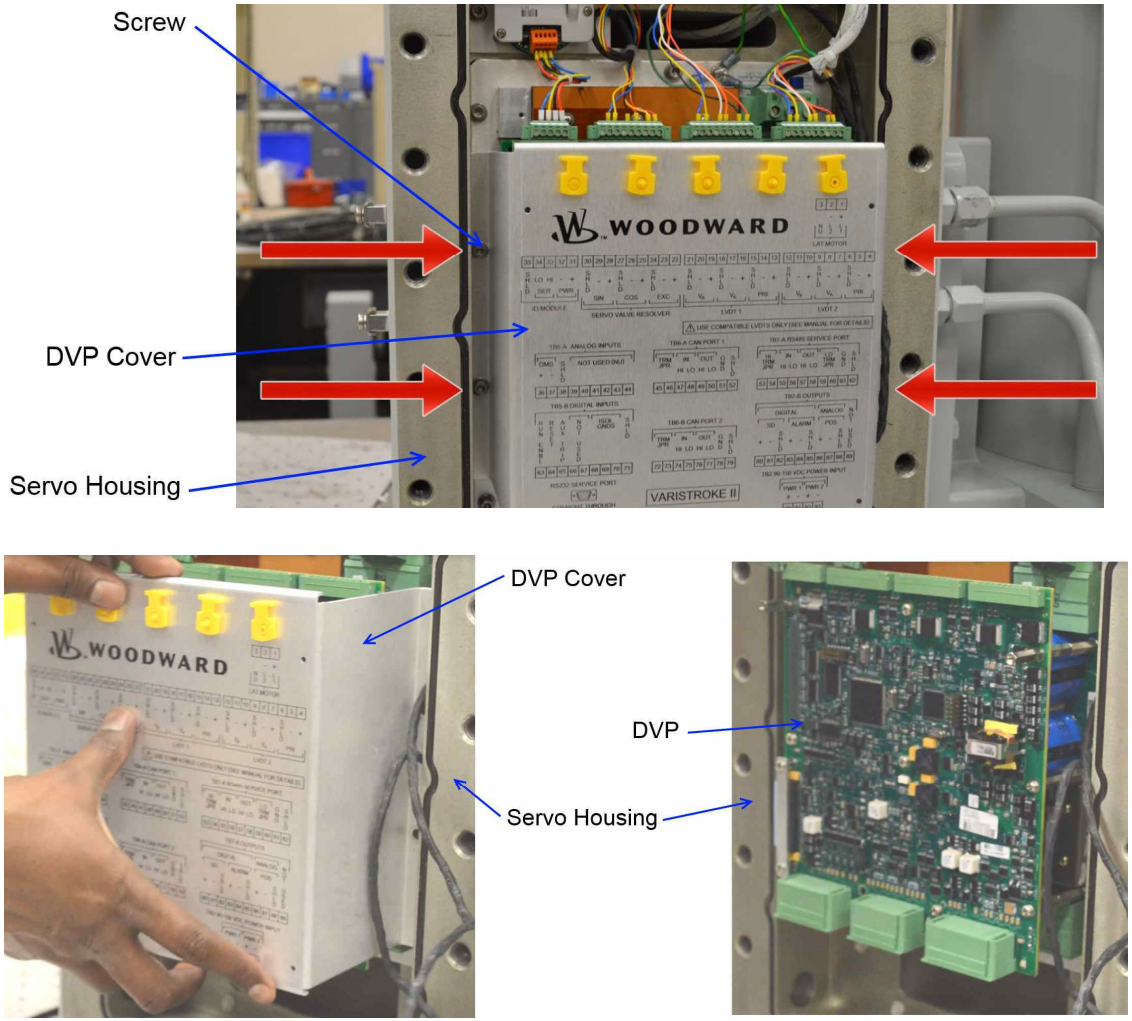
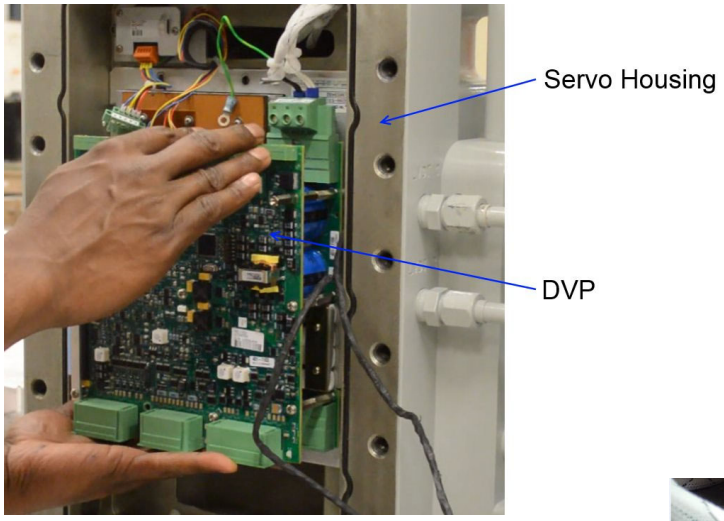


Figure 3-4. Remove DVP Cover

I. Remove LAT motor wires from terminal block. White wire (L1) is in terminal block 1. Black wire (L2) is in terminal block 2.
J. Remove three screws located on the bottom and four screws located on the top. Support the driver when removing the last screws so that no components on the circuit board are damaged.
K. Gently remove the DVP from the enclosure.
L. Remove 3-tier terminal block from the removed DVP.



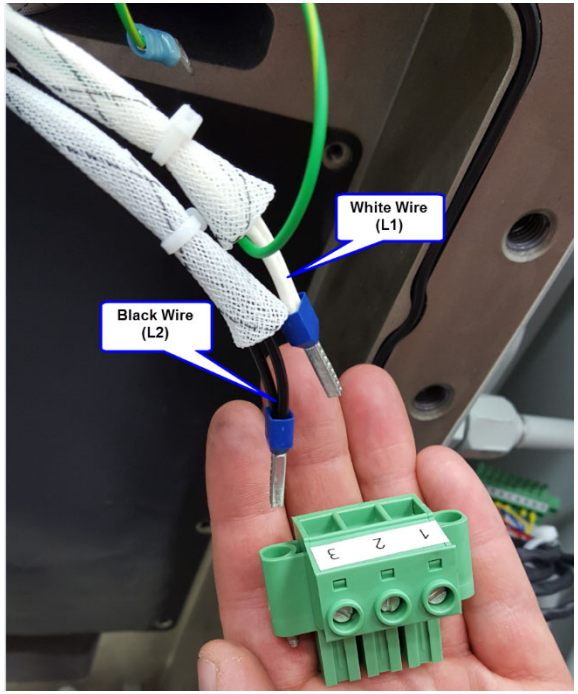


Figure 3-5. Remove DVP

M. Remove the black pad (black heat sink material) located between the driver and the servo valve housing.
N. Clean all surfaces with ISOPROPANOL cleaning fluid and visually inspect the surfaces.
O. Replace with new heat sink material provided in the driver replacement kit.

Note: When replacing the black pad, the 3-pad slot side is oriented to the left.

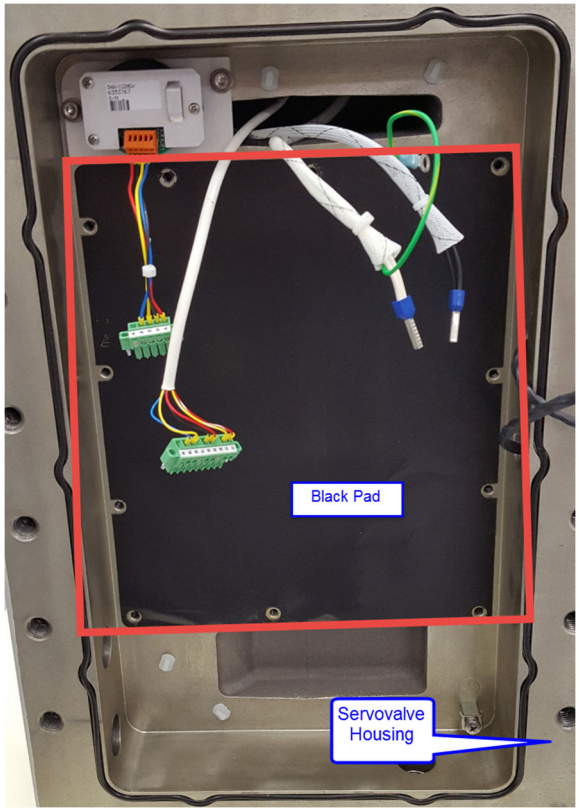


Figure 3-6. Inspect the Black Pad (Heatsink)

3.3 Assembly Procedure

⚠WARNING

FLAMEPATHS

Refer to Section 1.1 for specific instructions.

A. Check replacement parts kit to verify all replacement parts listed in the Installation Drawing are present.
B. Carefully remove the replacement driver from protective packaging and do not touch or damage any of the components on the circuit boards.
C. Install the 3-pin terminal block into DVP.
D. Torque two screws (23±3 lb-inches) of the terminal block. Do not touch any of the components on the circuit boards.
E. Support the driver by ONLY holding the metal on the base plate and the terminal blocks. Do not touch any of the components on the circuit boards.
F. Install seven screws to keep the driver in the servo valve housing. Torque the screws to 27 ± 3 lb.- inches.
G. Install wires into the three-pin terminal block. White wire (L1) into terminal block 1. Black wire (L2) into terminal block 2.

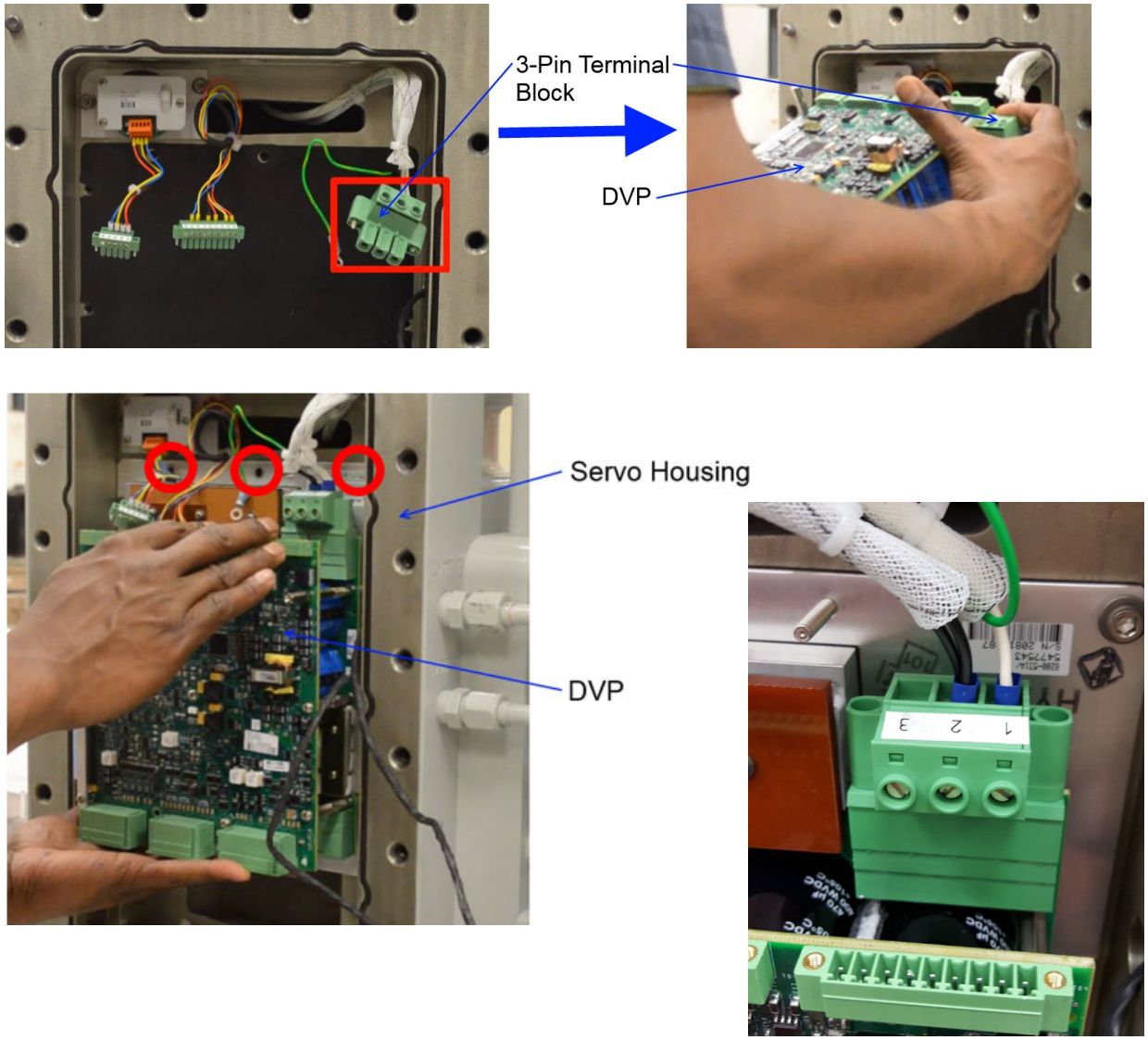


Figure 3-7. Install DVP into Housing

H. Install and tighten all terminal blocks into the driver. Use DVP cover schematic or wiring diagram to re-install terminal blocks. Ensure LVDTs are plugged into the appropriate LVDT terminals.

I. Install and tighten all terminal blocks into the driver.

J. Re-install all grounding wires onto ground lug. Tighten nut down on grounding wire terminal rings.

K. Install cable ties to secure all wiring and cut the excess part of the ties. Pack the cables to gaps to make sure they will not be damaged during cover mounting process.

L. Re-install DVP wiring cover. Torque four screws to 27 +/- 3 lb-inches.

M. Before installing electronic cover, go to the Verification & Calibration section 3.4.

N. Install the electronic cover and install twenty screws with washers. Torque screws to 55 ± 5 lb.- ft.

⚠WARNING

Ensure electronic cover O-ring is in groove and is not pinched by the cover. Incorrect installation will result in loss of ingress protection for Zone 2 installations.

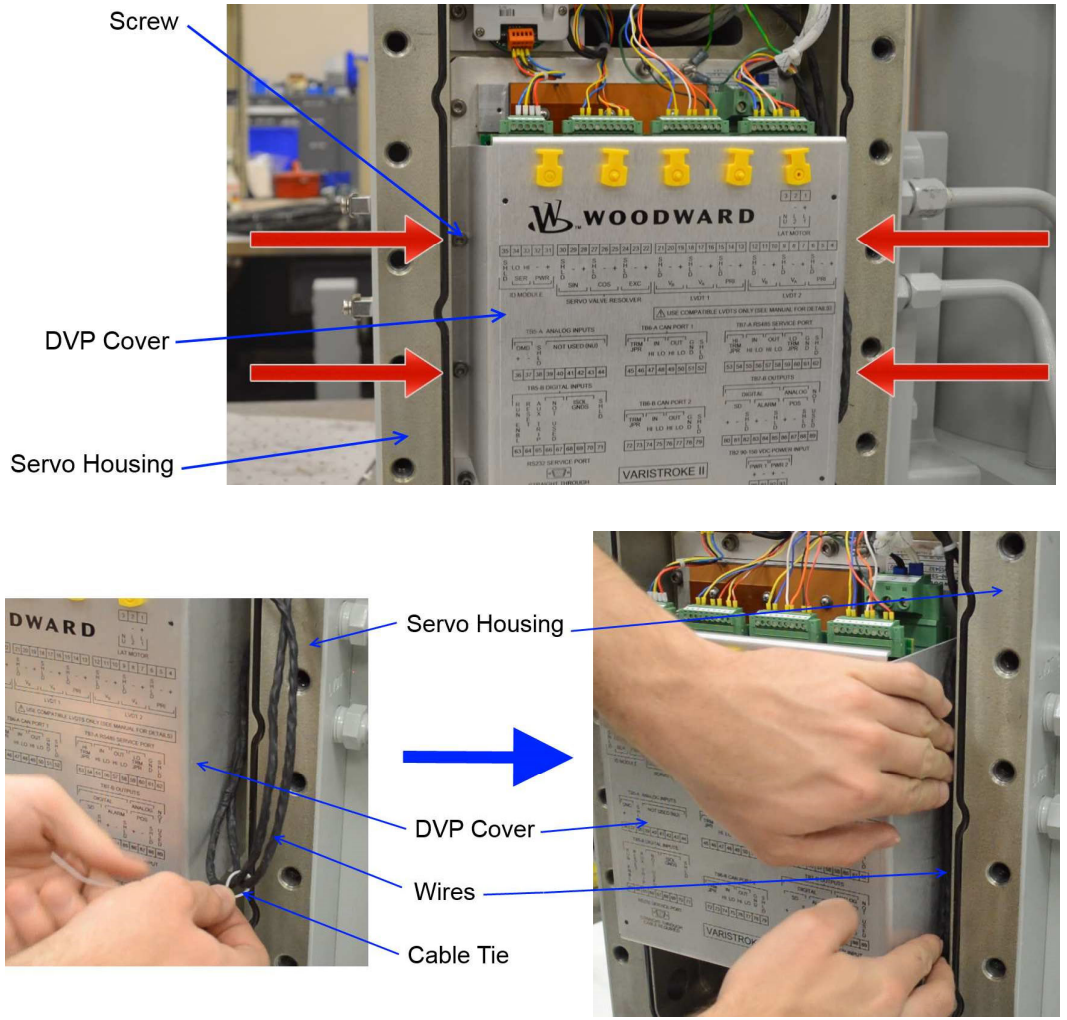


Figure 3-8. Install Terminal Blocks

3.4 Verification & Calibration

A. Verify that the hydraulic and electrical connections are correct. See product manual for more information.
B. Confirm that the hydraulic and electrical power to the VS-II is turned off.
C. Apply electrical power to VS-II.
D. Connect a PC Service Tool to VS-II. See product manual for more information.
E. Start the hydraulic supply system.
F. Go to **Configuration & Calibration** screen (see example and right).
G. Reload the DVP valve settings files saved from the old servo. Load DVP valve settings, then load customer DVP settings to VS-II. If no settings files are available, you may also perform general configuration and calibration. See product manual for more information.
H. Input the LVDT sensitivity values into the Service Tool. The LVDT sensitivity values can be found printed on the side of each LVDT. You may need to remove the LVDT protective covers to see these numbers. For the procedure on how to remove the covers refer to Chapter 2 LVDT Replacement. See product manual for where to input LVDT sensitivity values.
I. Perform actuator calibration. During calibration enter the sensitivity values for LVDT. See product manual for procedure.

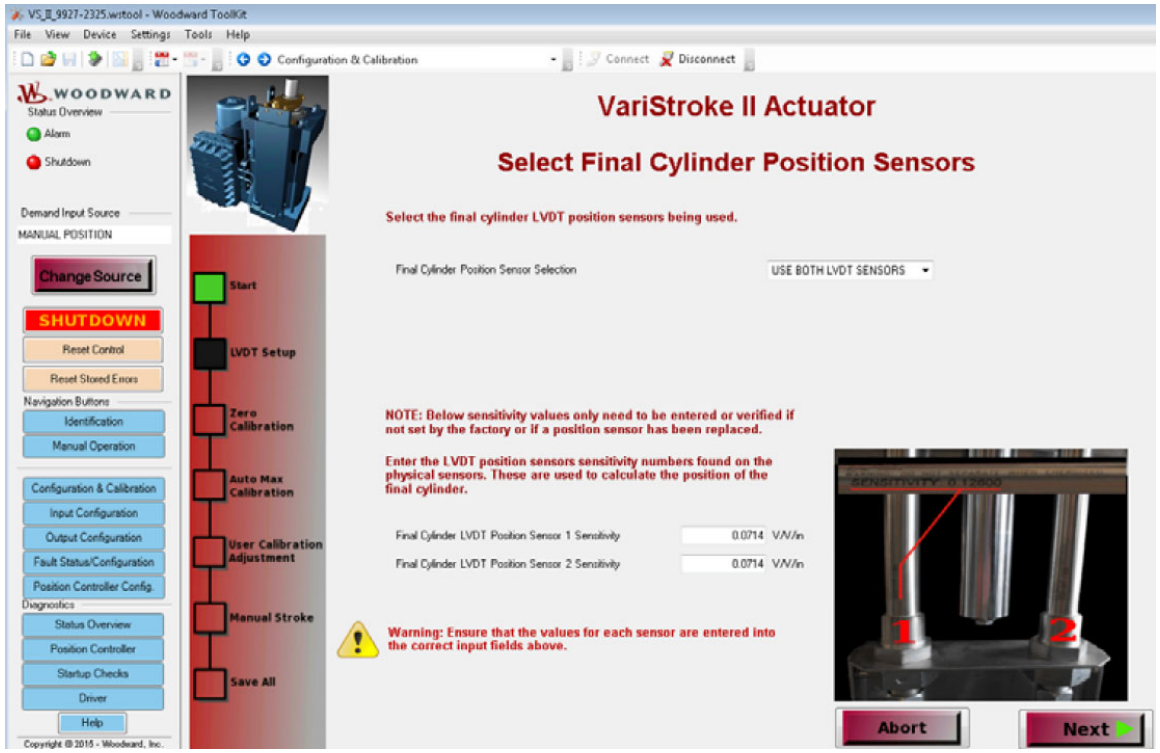


Figure 3-9. Enter LVDTs Sensitivity Value

4. SERVO AND BRIDGE MANIFOLD SEALS REPLACEMENT

4.1 Replacement Kit Description

The purpose of this procedure is to show the correct sequence and method of servo and bridge manifold seals replacement:

Servo and bridge manifold seals Replacement Kits:
- KIT P/N: 8935-1230 – VSII, BRIDGE MANIFOLD SEALS
- 9907-1287 – VSII, SERVO, FAIL EXTEND
- 9907-1288– VSII, SERVO, FAIL RETRACT

NOTICE

Before starting any disassembly, connect to the VS-I using the PC Service Tool. Download and save a .wset file from the service unit. Store the settings file on the PC in a place where you can find it for later use.

⚠WARNING

Refer to Section 1.1 for specific instructions.

FLAMEPATHS

4.2 Disassembly Procedure

NOTICE

Before starting any disassembly, connect to VS-II Service Port by using straight through RS232 cable. Connect other end of cable to PC with VS-II Service tool. Download all .wset files.

⚠WARNING

Disconnect power supply before performing any maintenance or replacement. Always disconnect power and any hazardous voltages that may be connected. Follow appropriate lockout/lockdown procedures.

⚠WARNING

Because of unintended cylinder movement, disconnect power and drain hydraulic pressure before servicing hydraulic system.

A. Remove twenty screws with washers from the electrical enclosure cover. The cover is positioned by two guide pins.
B. Remove the electrical enclosure cover.

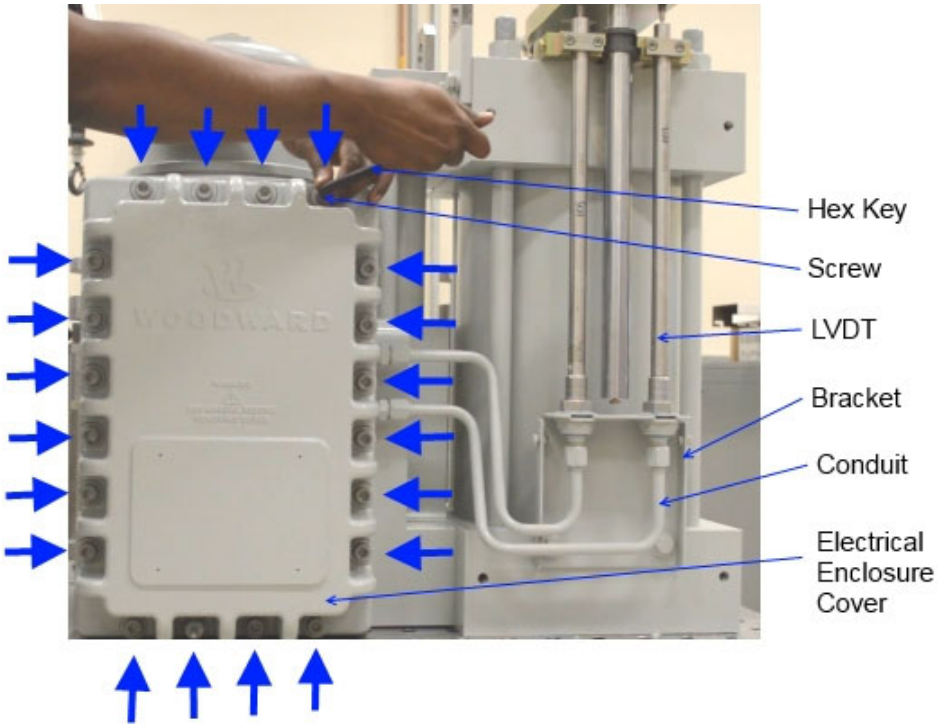


Figure 4-1. Remove Electrical Enclosure Cover

C. Woodward recommends the technician connect the VariStroke II driver using the PC Service Tool and save all settings to the PC. These settings can be loaded to the new servo valve to make configuration easier. The service port is located in the bottom of the DVP.
D. Disconnect external interface – hydraulic lines and electrical cables.

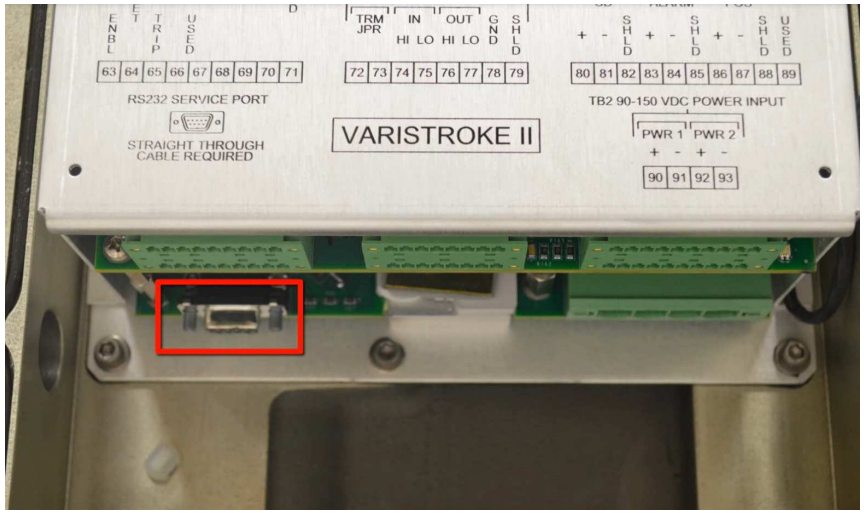


Figure 4-2. DVP Service Port

R. Remove all LVDT wires from the driver.
S. Carefully cut all wire ties that secure any LVDT wires to the servo housing. Do not to damage any of the LVDT wires.
T. Remove nut to remove LVDT wire from ground.

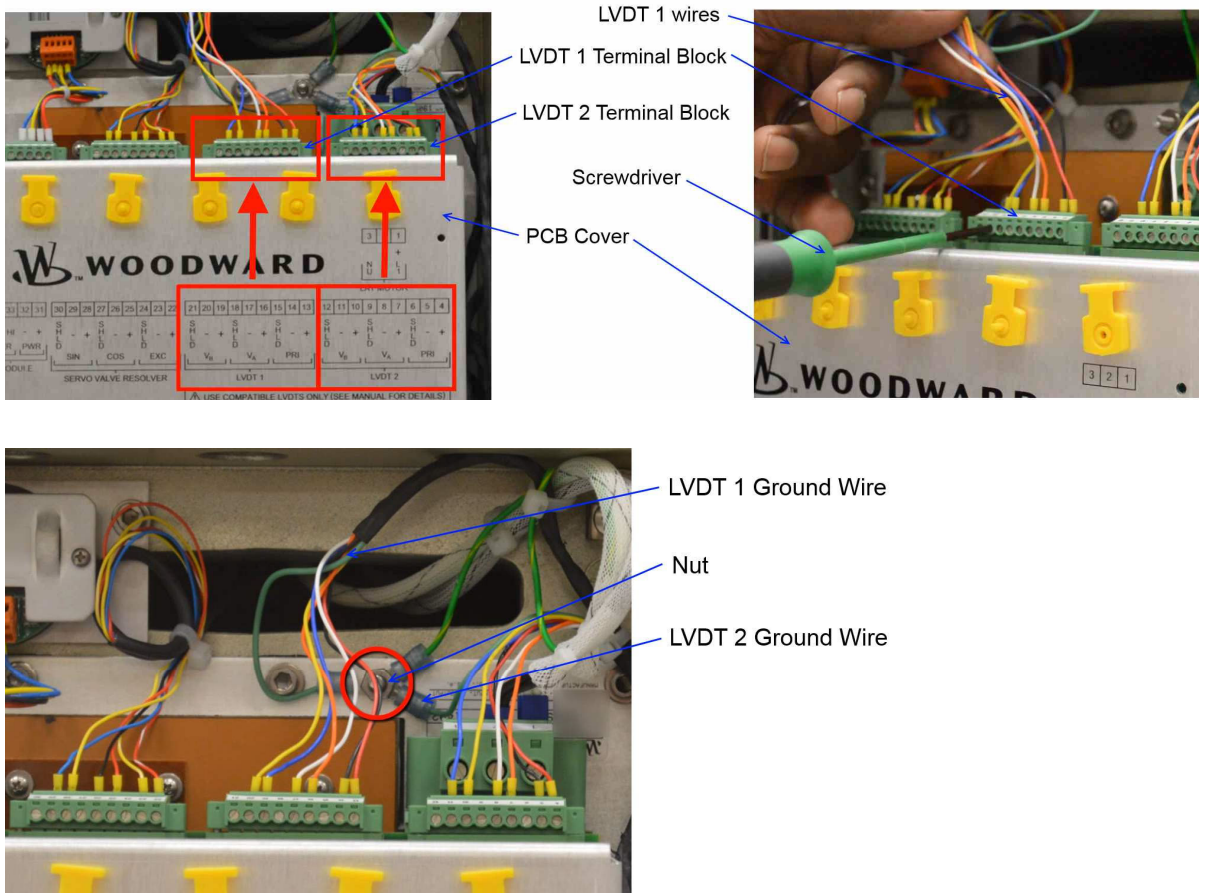


Figure 4-3. Disconnect LVDT Wires

U. Loosen conduit adapter nuts from servo housing and bracket sides.
V. Gently remove conduit and LVDT wire from the servo housing conduit hub. Secure LVDT wires and conduit to the side of the cylinder to keep from being damaged during next steps.
W. Remove existing 1/2"-13 hex head bolts above electronics cavity.
X. Thread two 1/2 -13 UNF inch lifting eyes (added to the replacement kit).
Y. Reinstall outer cover and bolts (8) (snug, but not torqued).This will protect electronics during lifting operations.
Z. Use appropriately rated lifting straps/hooks and put tension on lifting eyes. Do not lift servo portion of valve (120 Kg).

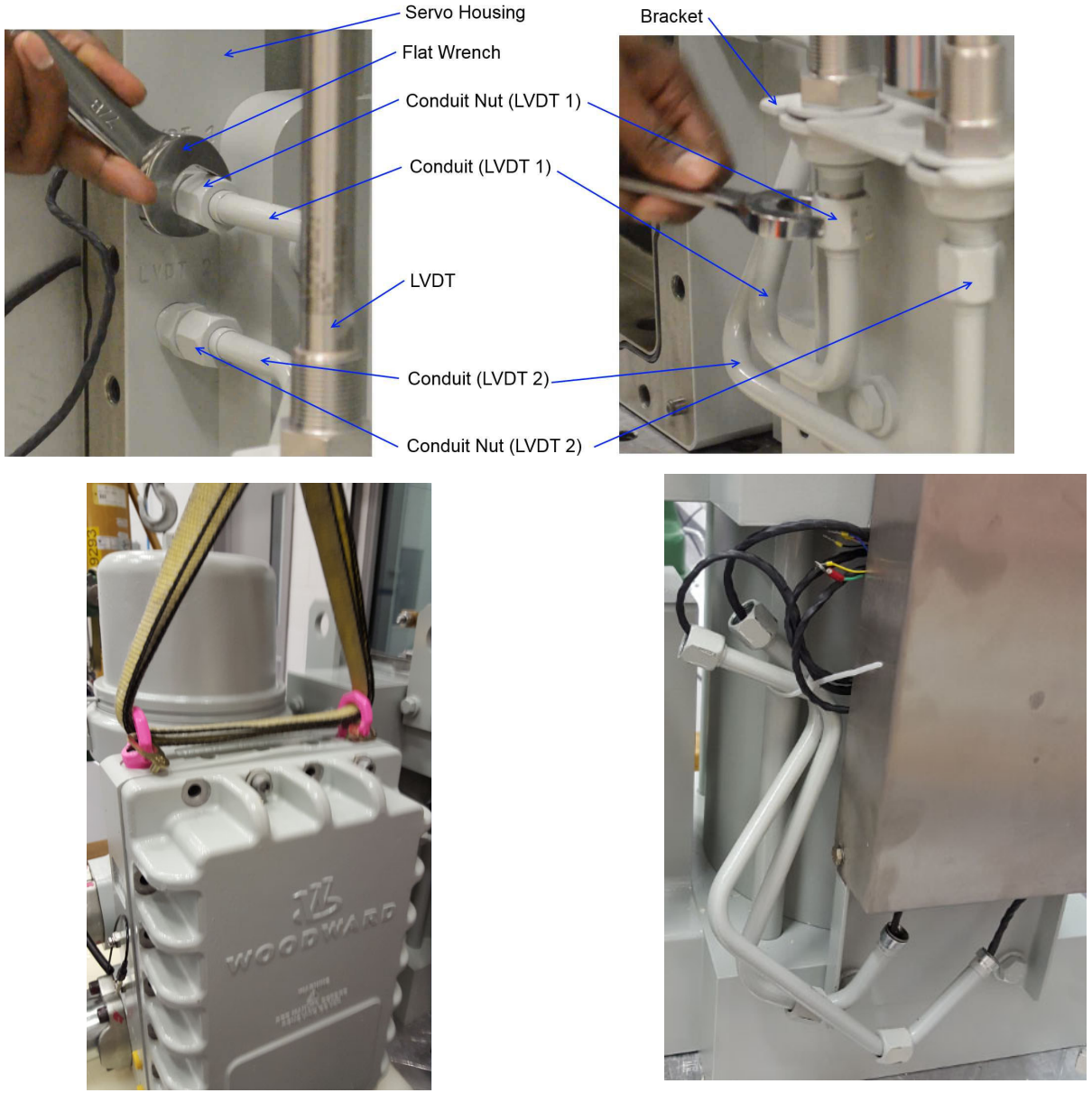


Figure 4-4. Remove Conduits

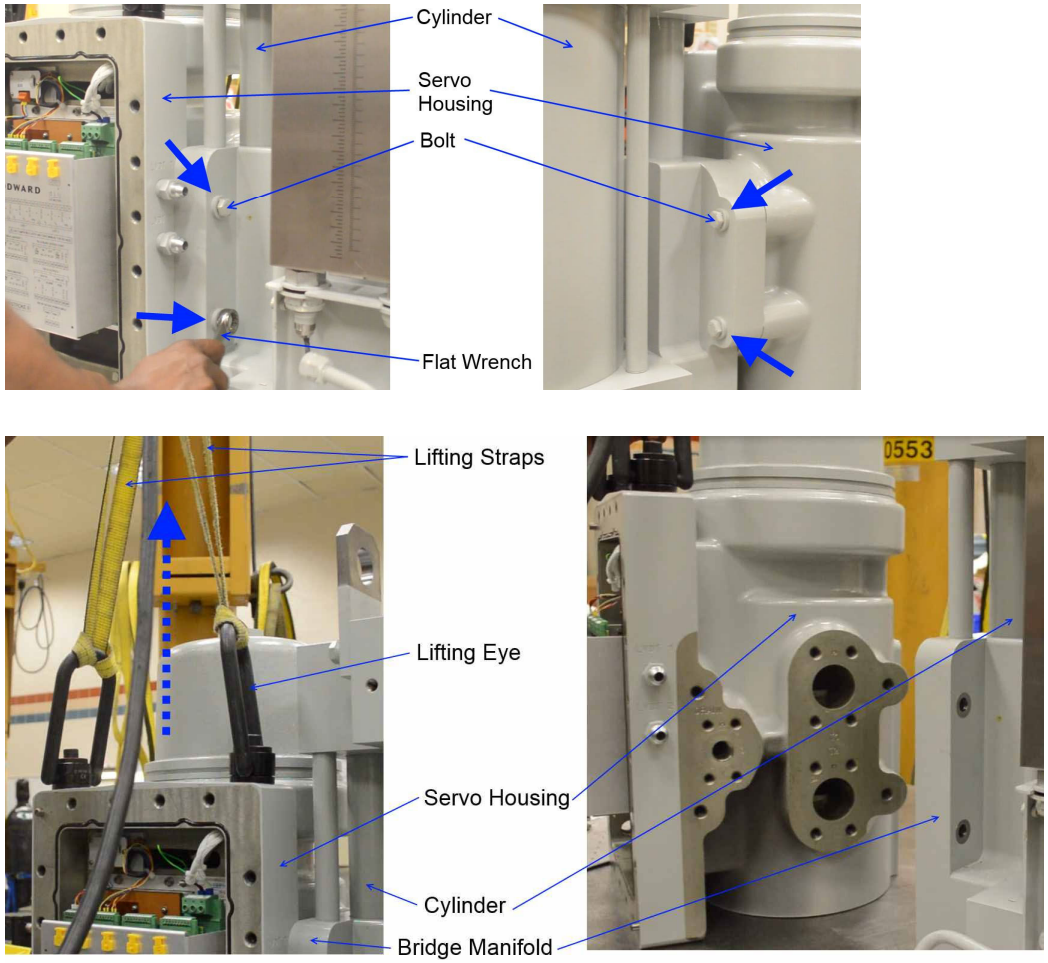
AA. Secure straps to the lifting eyes (this will support the servo valve weight during disassembly) and attach the straps to the lifting crane or hoist (120 kg).
BB. Raise the crane only enough to put slight tension into the lifting straps. This will support the servo during removal.
CC. Remove four screws which attach the servo valve to the bridge manifold.
DD. Separate the servo valve from the bridge manifold. Lift the servo if needed.

⚠WARNING

Remember to support the servo during disassembly. Make sure that the crane, cables, straps, and all other lifting equipment, and the lifting lug you are using for servo valve transportation, are able to support the servo valve weight.

NOTICE

Be aware that the servo valve and hydraulic power cylinder contain a large amount of hydraulic fluid that may be spilled during disconnection of hydraulic fittings. For safety reasons, spilled hydraulic oil should be dried by absorbing mats or other environmentally friendly methods.



IMPORTANT **Do not mix up bridge manifold bolts. Four bolts are metric bolts. Eight are standard bolts. All are different lengths.**

Figure 4-5. Separate the Servo Valve from the Bridge Manifold

EE. Remove four screws (with washers) connecting the upper manifold with cylinder.

FF. Remove four screws (with washers) connecting the lower bridge manifold with cylinder.

GG. Remove O-rings from lower bridge manifold.

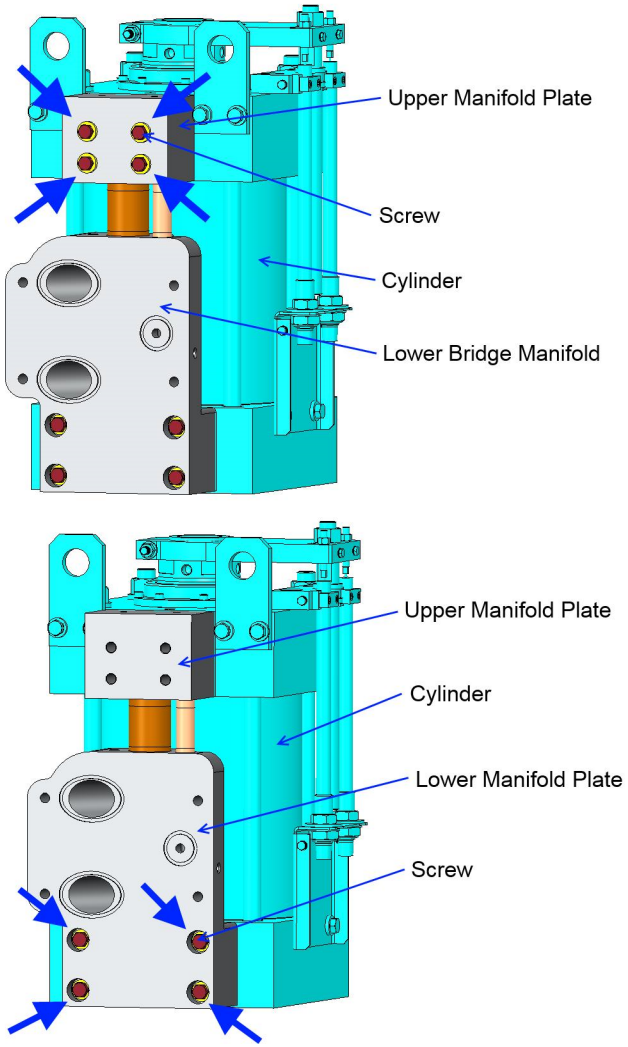


Figure 4-6. Remove Screws from Lower and Upper Manifold

HH. Remove one O-ring from the upper bridge manifold and one O-ring from the lower bridge manifold.

II. Remove O-ring from the upper manifold plate of cylinder assembly.

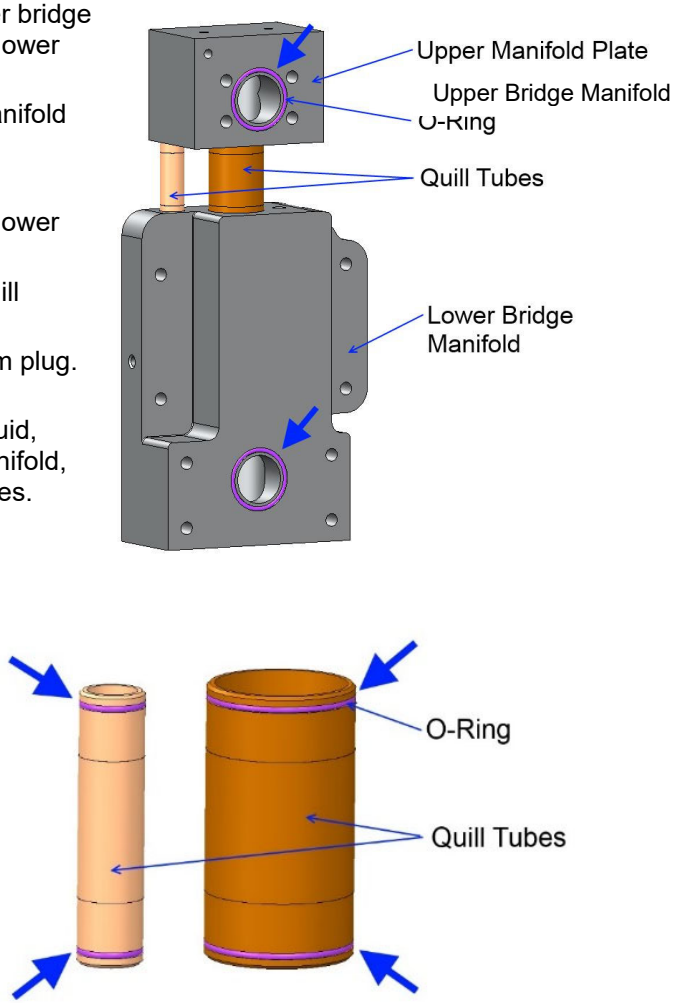
JJ. Remove upper bridge manifold.

KK. Remove both quill tubes from the lower bridge manifold.

LL. Remove four O-rings from both quill tubes.

MM. Remove lower manifold bottom plug. Remove O-ring from plug.

NN. Using ISOPROPANOL cleaning fluid, clean surfaces of lower bridge manifold, upper manifold plate, and quill tubes. Visually inspect all surfaces.



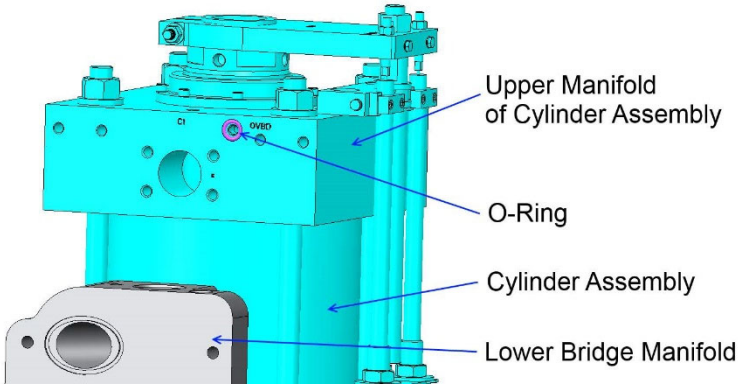


Figure 4-7. Remove O-rings and Both Quill Tubes

4.3 Assembly Procedure

WARNING

FLAMEPATHS

Refer to Section 1.1 for specific instructions.

A. Inventory replacement parts kit to verify all replacement parts listed in the Installation Drawing are present.

B. Lube the SAE plug O-ring and install it on the SAE plug.

C. Install plug into bottom of lower manifold plate.

D. Torque plug to 100-150 ft-lbs.

E. Lubricate O-ring with petroleum jelly and install into the face groove of the cylinder portside hole of the lower bridge manifold plate.

F. Install one washer onto each of four screws (standard 4.5" long screws). Apply GN paste to the threads of four screws. Align the four screw holes of the lower bridge manifold with the threaded holes of the lower plate of the cylinder assembly. Install the screws through the four screw holes of the lower bridge manifold plate into the lower plate of the cylinder assembly. Tighten and torque the four screws, torquing to 45-55 ft-lbs.

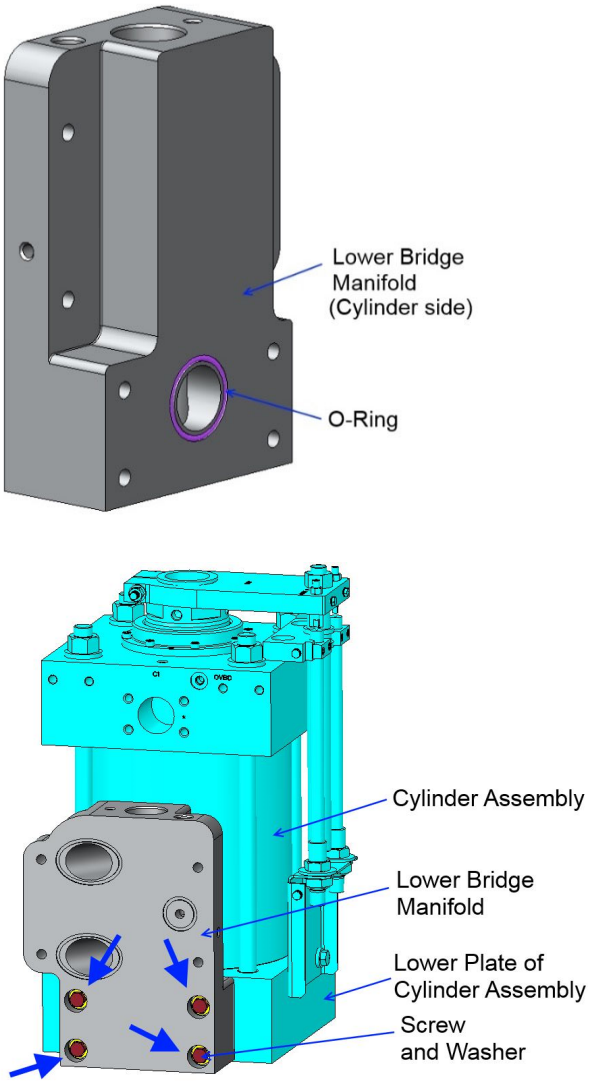


Figure 4-8. Install Lower Bridge Manifold

G. Lubricate O-ring with petroleum jelly and install O-ring into the face groove of the upper bridge manifold.

H. Lubricate O-ring with petroleum jelly and install O-ring into the face groove of the upper plate of the cylinder assembly. The face groove is the port stamped OVBD.

I. Lubricate O-rings with petroleum jelly and install on the two quill tubes.

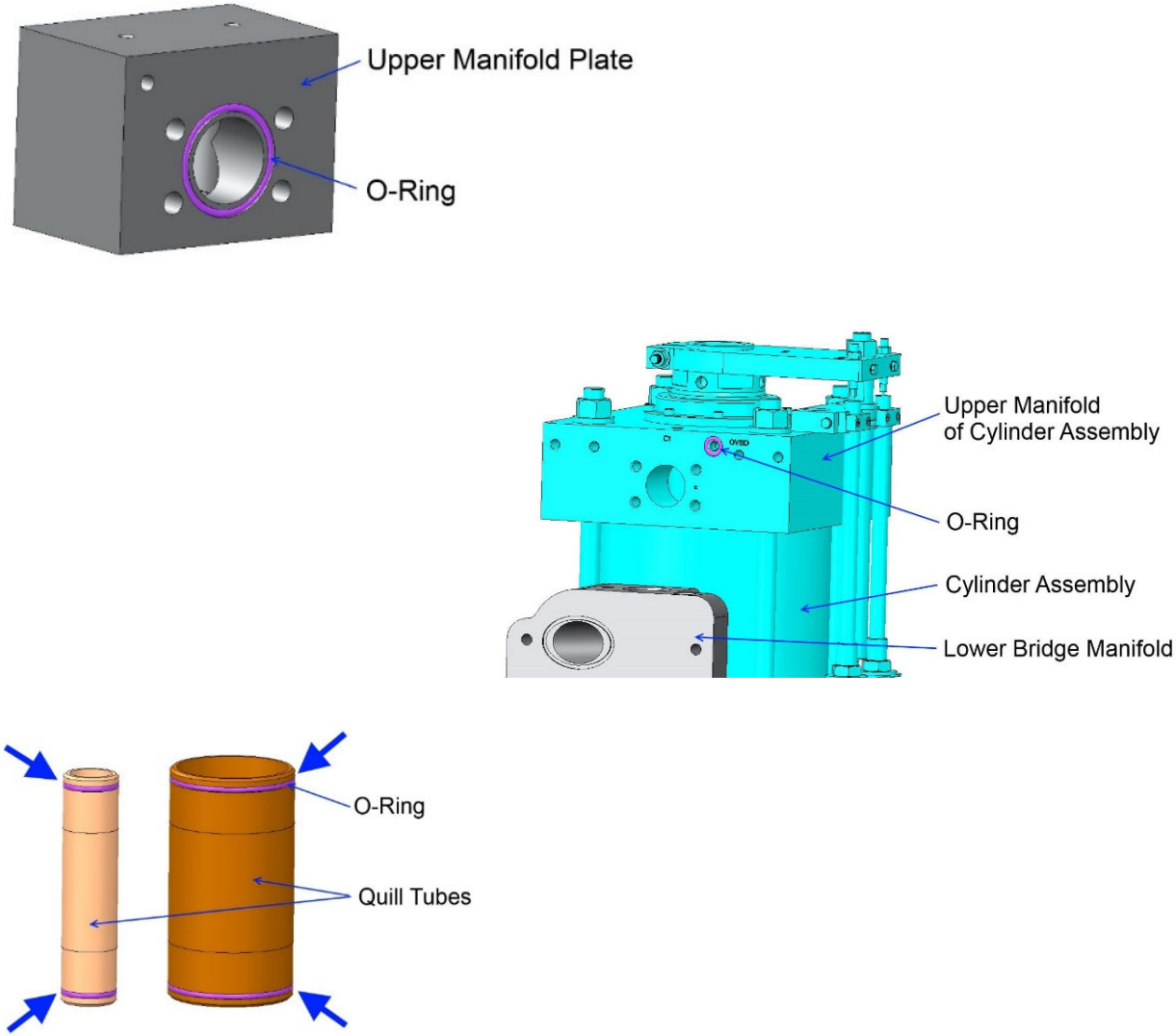


Figure 4-9. Install O-rings

J. Install quill tubes into holes. Carefully install the upper bridge manifold onto the two quill tubes so as not to dislodge the face groove O-rings on the mating surfaces of the bridge plate and the cylinder.

K. Install washers onto each of four screws (60mm long). Align the four screw holes of the upper bridge plate with the threaded holes of the upper plate of the cylinder. Apply GN paste to the threads of four screws and install through the upper bridge manifold into the upper plate of the cylinder. Torque screws to 50 ft-lb ± 5 ft-lb.

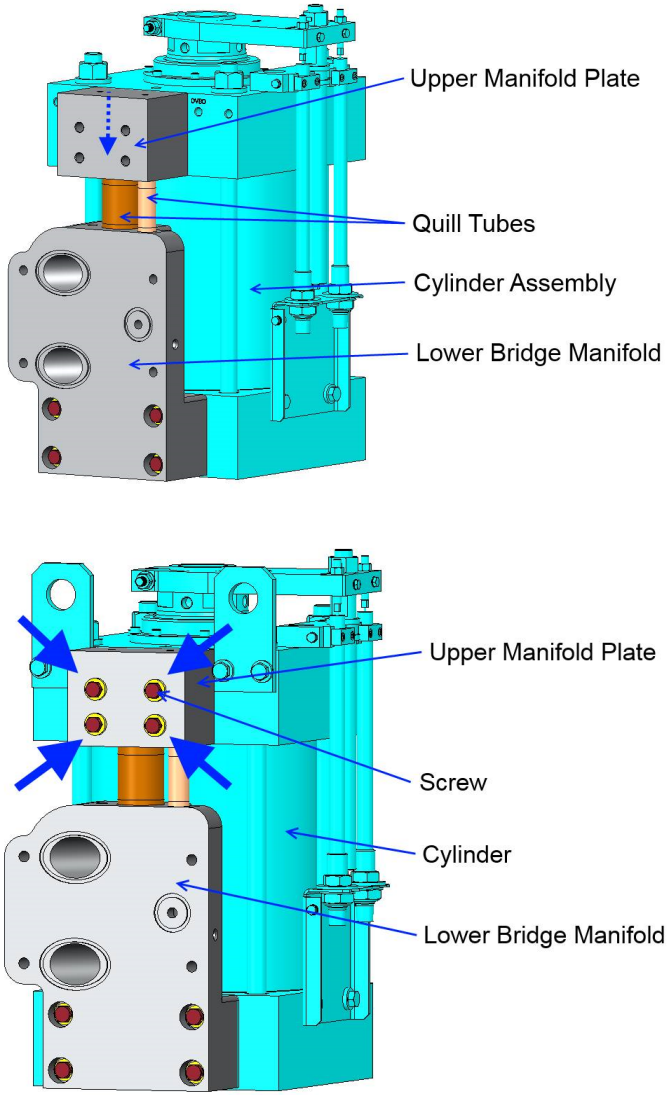


Figure 4-10. Install Upper Bridge Plate

L. Lubricate three O-rings with petroleum jelly and install into grooves of bridge manifold.

M. Check overboard port on servo assembly. If plug is present, remove before mating.

N. Attach new servo valve to bridge manifold.

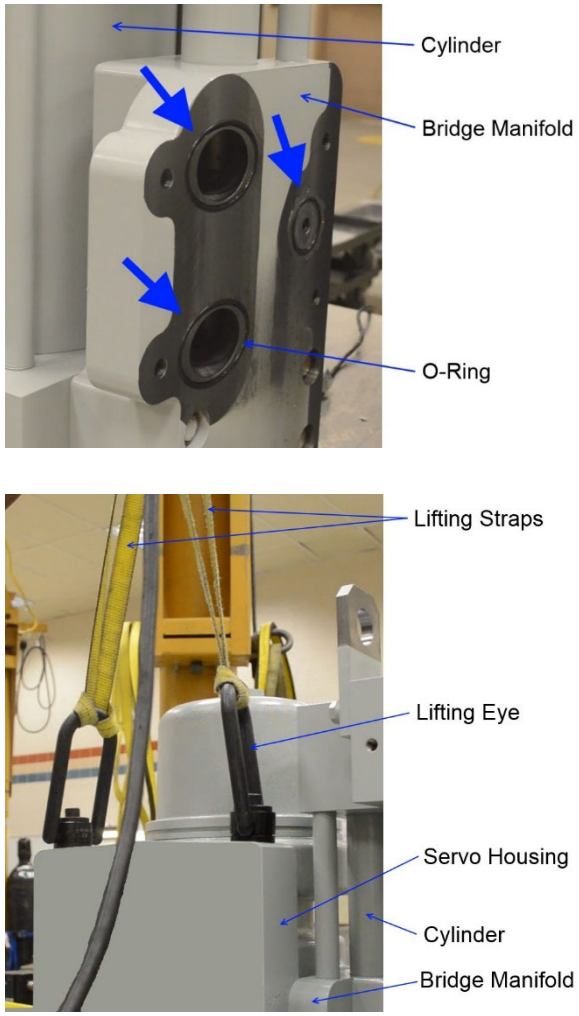


Figure 4-11. Install New Servo to the Cylinder

O. With the assistance of the lifting device, install four screws (standard 3.5" screw) attaching the servo valve to the bridge manifold. Torque screws to 50 ft-lb ± 5 ft-lb.

P. Remove the electronics cover by loosening eight (8) screws.

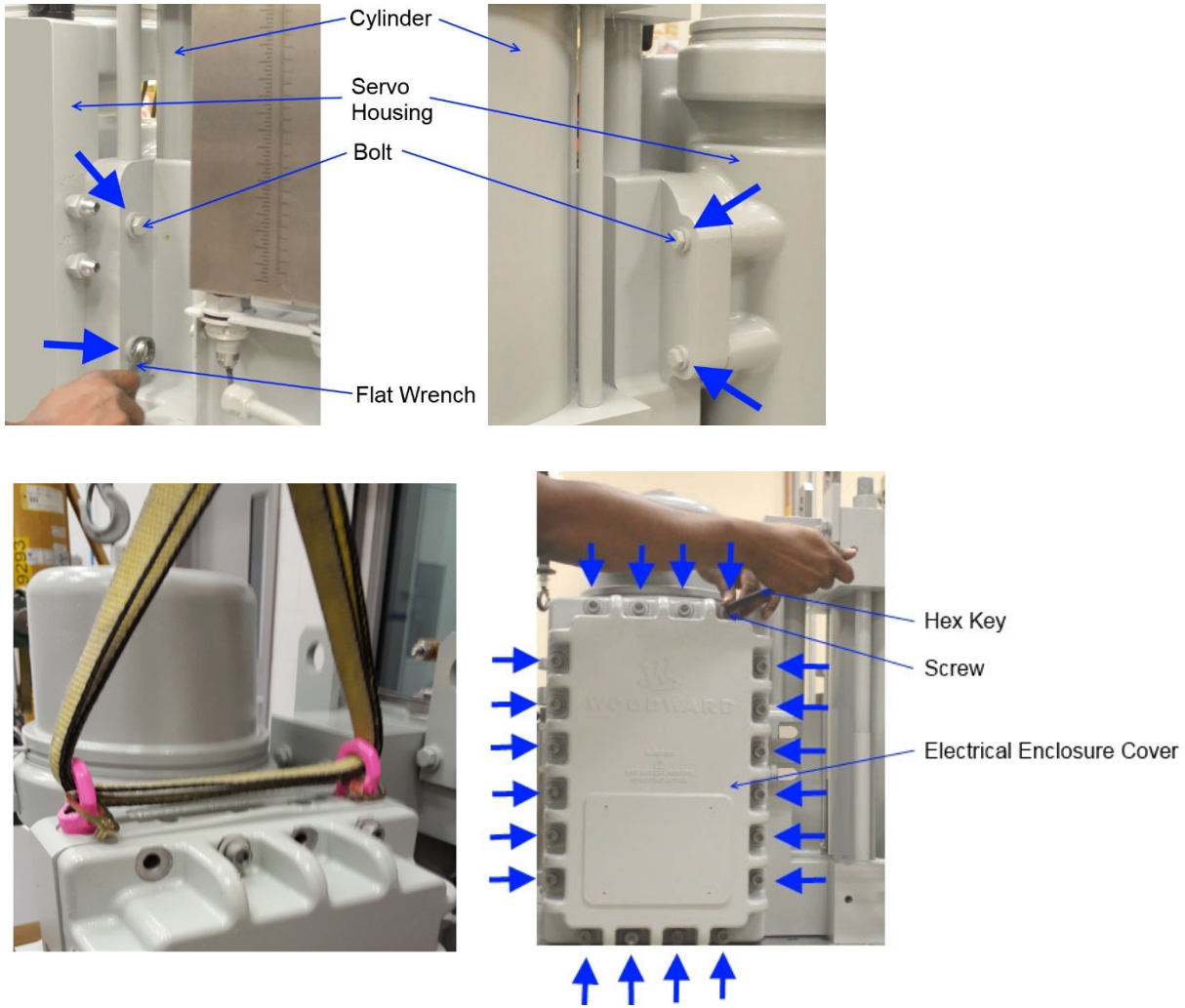


Figure 4-12. Torque Manifold Screws and Remove Electronic Cover

Q. Feed the LVDT wires into the servo valve housing.

Note: The wire entries are labeled LVDT 1 and 2. LVDT 1 is located closest to the servo valve.

R. Install the conduit and torque the nuts to 50 ft lb ± 5 lb.- ft

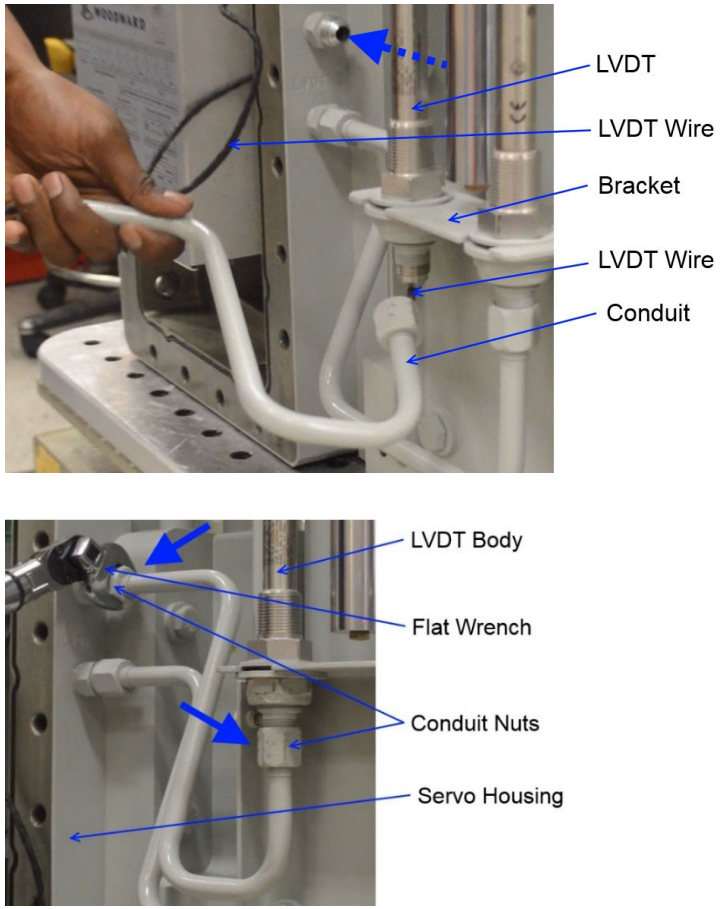


Figure 4-13. Install Conduits

S. Rewire the LVDTs according to Figure 4-18.

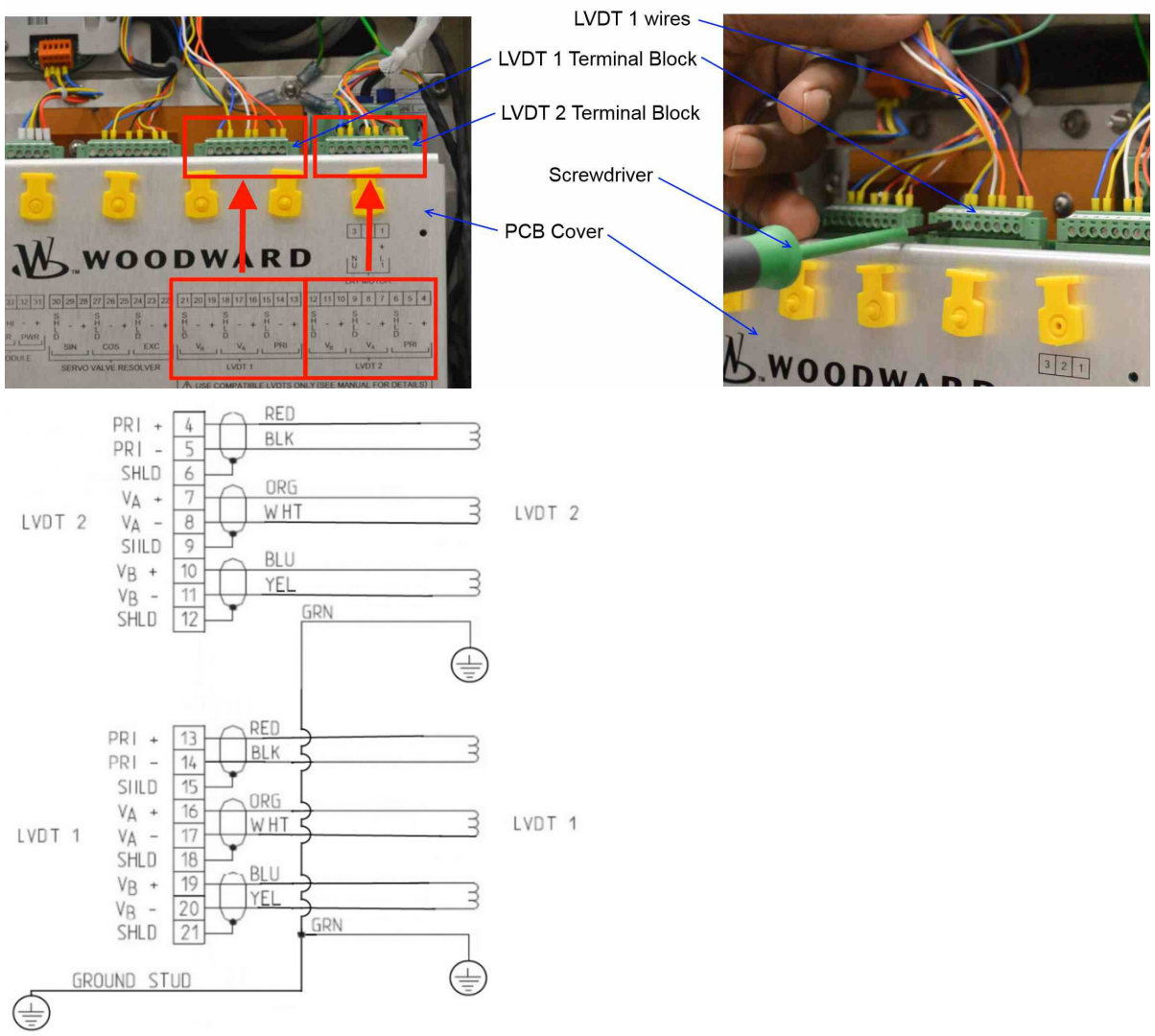


Figure 4-14. LVDT Wiring Diagram

T. Secure LVDT wires to the servo valve housing using cable ties.

U. Go to the Verification & Calibration section 4.4.

V. Install the electronic cover with twenty screws and washers. Torque screws to 55 ± 5 ft lb.

⚠WARNING

Ensure electronic cover O-ring is in groove and is not pinched by the cover. Incorrect installation will result in loss of ingress protection for Zone 2 installations.

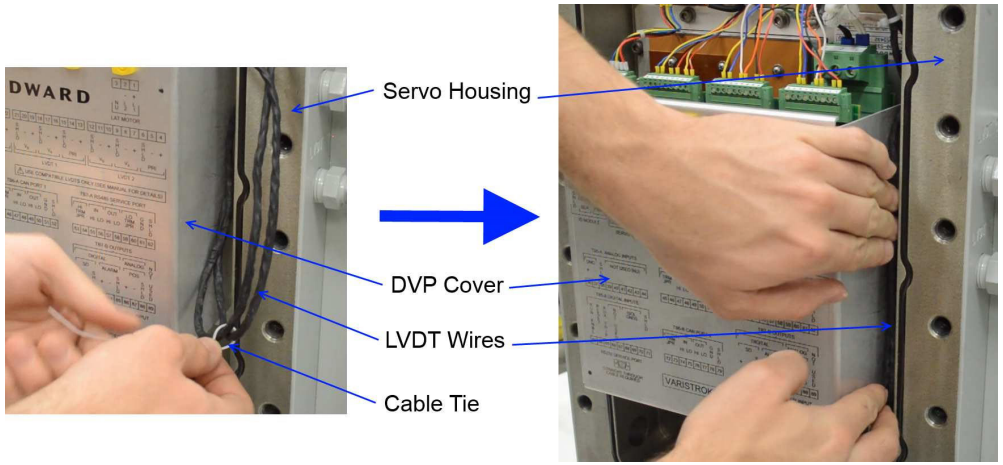


Figure 4-15. Install Outer and Electronic Covers

4.4 Verification & Calibration

A. Verify that the hydraulic and electrical connections are correct. See product manual for more information.
B. Confirm that the hydraulic and electrical power to the VS-II is turned off.
C. Connect a PC Service Tool to VS-II. See product manual for more information.
D. Apply electrical power to VS-II.
E. Start the hydraulic supply system.
F. Go to **Configuration & Calibration** screen.
G. Reload the service files saved from the old servo. If no settings files are available, you may also perform general configuration and calibration.
H. Regardless if the settings files were loaded, you will need to input the LVDT sensitivity values (see Figure 4-19) into the Service Tool. The LVDT sensitivity values can be found printed on the side of each LVDT. You may need to remove the LVDT protective covers to see these numbers. For removing the covers, refer to the LVDT replacement.
I. Purge all air from the system. Adjusting the position setpoint up and down several times will aid purging air. Allow for warm-up time.
J. Examine the unit for external leakage.

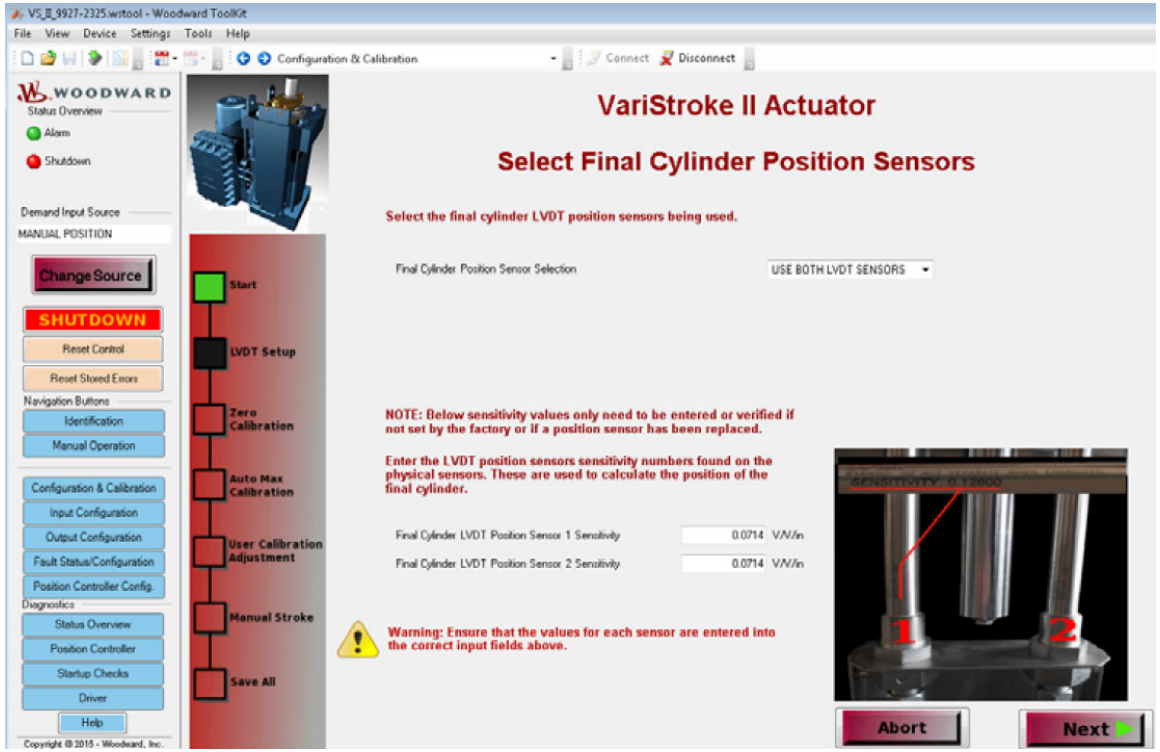


Figure 4-16. Service Tool Configuration & Calibration Screen

5. CYLINDER SEALS REPLACEMENT

5.1 Replacement Kit Description

The purpose of this procedure is to show the correct sequence and method of cylinder seals replacement:

Servo and bridge manifold seals replacement:
- 8935-1225-10 – VSII, CYLINDER SEAL, 10 BORE
- 8935-1225-15 – VSII, CYLINDER SEAL, 12 BORE

NOTICE

Before starting any disassembly, connect to the VS-II using the PC Service Tool. Download and save a .wset file from the service unit. Store the settings file on the PC in a place where you can find it for later use.

⚠WARNING

Refer to Section 1.1 for specific instructions.

FLAMEPATHS

5.2 Disassembly Procedure

NOTICE

Before starting any disassembly, connect to VS-II service port by using the straight through RS232 cable. Connect other end of cable to PC with VS-II Service tool. Download all .wset files.

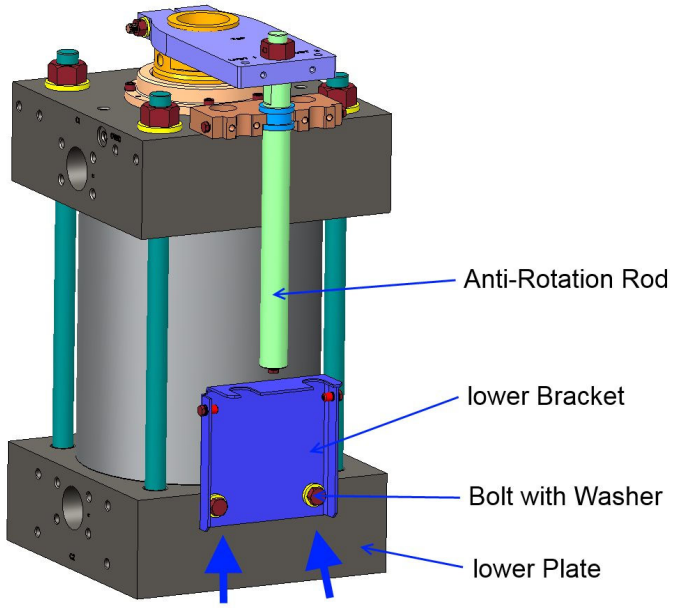
⚠WARNING

Disconnect power supply before performing any maintenance or replacement. Always disconnect power and any hazardous voltages that may be connected. Follow appropriate lockout/lockdown procedures.

⚠WARNING

Due to unintended cylinder movement, disconnect power and drain hydraulic pressure before servicing hydraulic system.

A. Disconnect external interface hydraulic lines and electrical cables.
B. Remove servo and manifold bridge according to Chapter 4.
C. Remove LVDT core rods by loosening jam nuts and threading core rods up out of anti-rotation plate. Set aside, do not damage.



⚠WARNING

Remember to support the servo during disassembly. Make sure that the crane, cables, straps, and all other lifting equipment, and the lifting lug you are using for servo valve transportation are able to support the servo valve weight.

NOTICE

Be aware that the servo valve and hydraulic power cylinder contain a large amount of hydraulic fluid that may be spilled during disconnection of hydraulic fittings. For safety reasons, spilled hydraulic oil should be dried by absorbing mats or other environmentally friendly methods.

Figure 5-1. Remove Servo and LVDTs

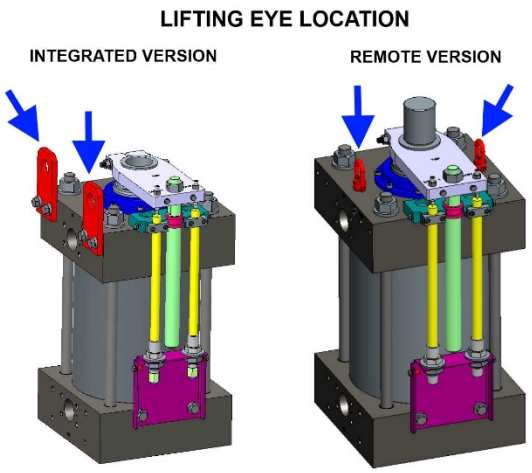
D. Install lift tool on the threaded piston end.

E. Lift piston rod with lifting tool and crane. Lift so anti-rotation plate is above cylinder lifting dog ears.

F. Remove anti-rotation rod lock nut. Remove anti-rotation rod and bushing from assembly. Loosen anti-rotation plate clamp screw. Do not remove.

G. Rotate anti-rotation plate off of piston rod. Orient plate so when the piston rod is lowered down, it will not come in contact with the dog ears.

H. Lower piston rod back into cylinder. Remove lifting tool from piston rod. Remove anti- rotation plate.



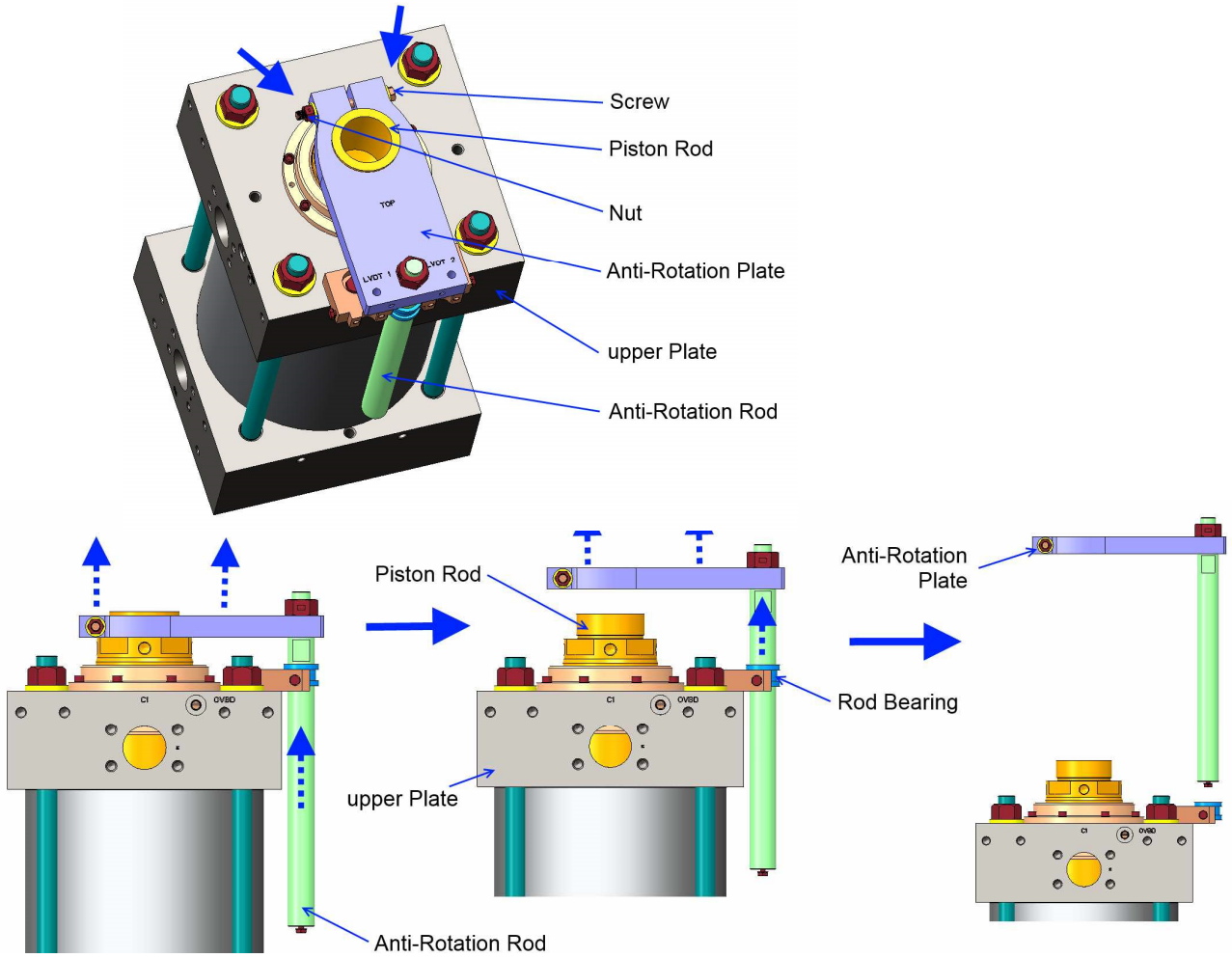


Figure 5-2. Remove Anti-Rotation Plate

I. Remove upper LVDT bracket screws (2).
J. Remove lower LVDT bracket screws (2).
K. Remove LVDT's upper bracket, LVDT bodies, and lower LVDT bracket as one assembly.

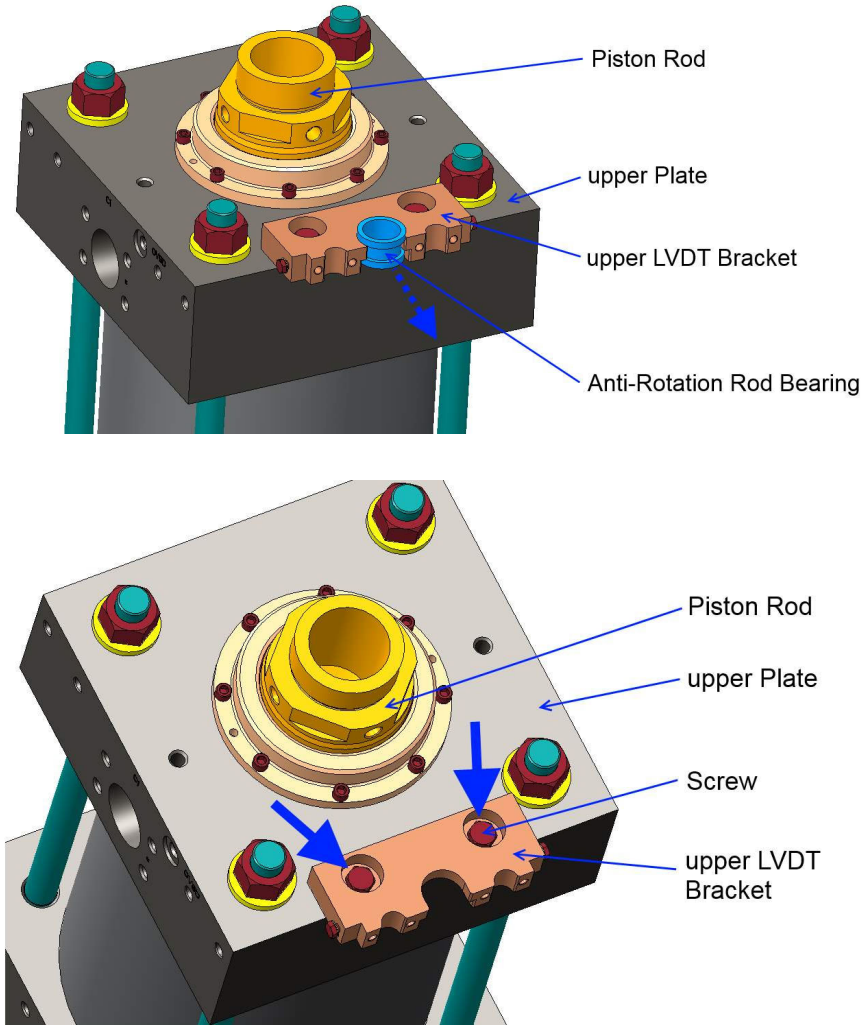
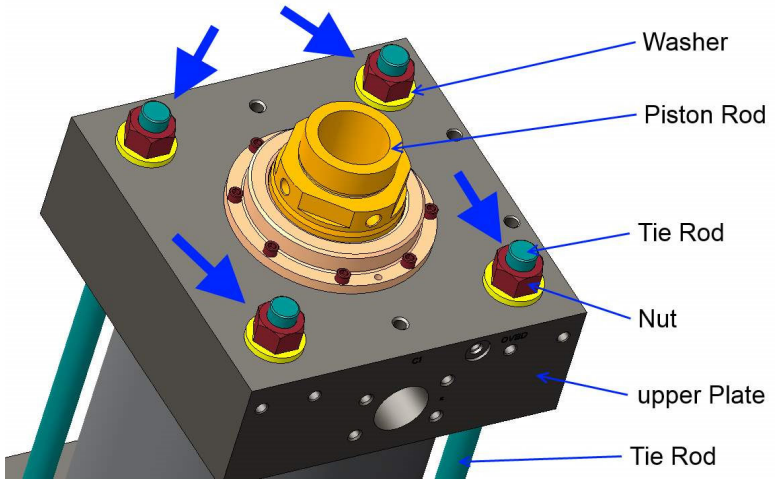


Figure 5-3. Remove Upper LVDT Bracket

L. Pick up the cylinder by dog ears on cylinder assembly and lay on its side. Do not lay cylinder on the C1 and C2 ports.
M. Clamp cylinder assembly down (not on sealing surface) and break all four tie rod nuts loose. Do not remove at this time.
N. Pick up cylinder by dog ears and set right side up.
O. Remove the four nuts, washers, and tie rods. (Nuts and rods may come out together).
P. Install Tool 1013-5894-01-D9 into the two upper plate threaded holes. With lifting device, lift plate and rod bushing off of the cylinder assembly (heavy, use crane or equivalent).
Q. Install lifting eyes to the upper plate and using a lifting device, gently remove upper plate with bushing.
R. With plate in the air, remove bottom O-ring from upper manifold plate as shown.
S. If tie rods did not come out, remove tie rods by double nutting them with the unit tie rod nuts.



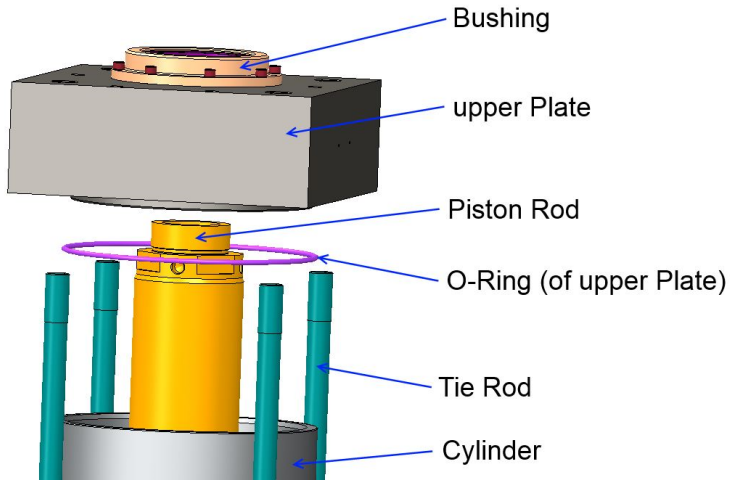


Figure 5-4. Remove Upper Plate

T. Remove eight bushing screws from bushing
U. Using two of the eight removed screws, remove bushing from upper plate. Screw the two screws in the two threaded holes located on the bushing flange as shown. Tighten the two screws about half turn at a time in alternating sequence.

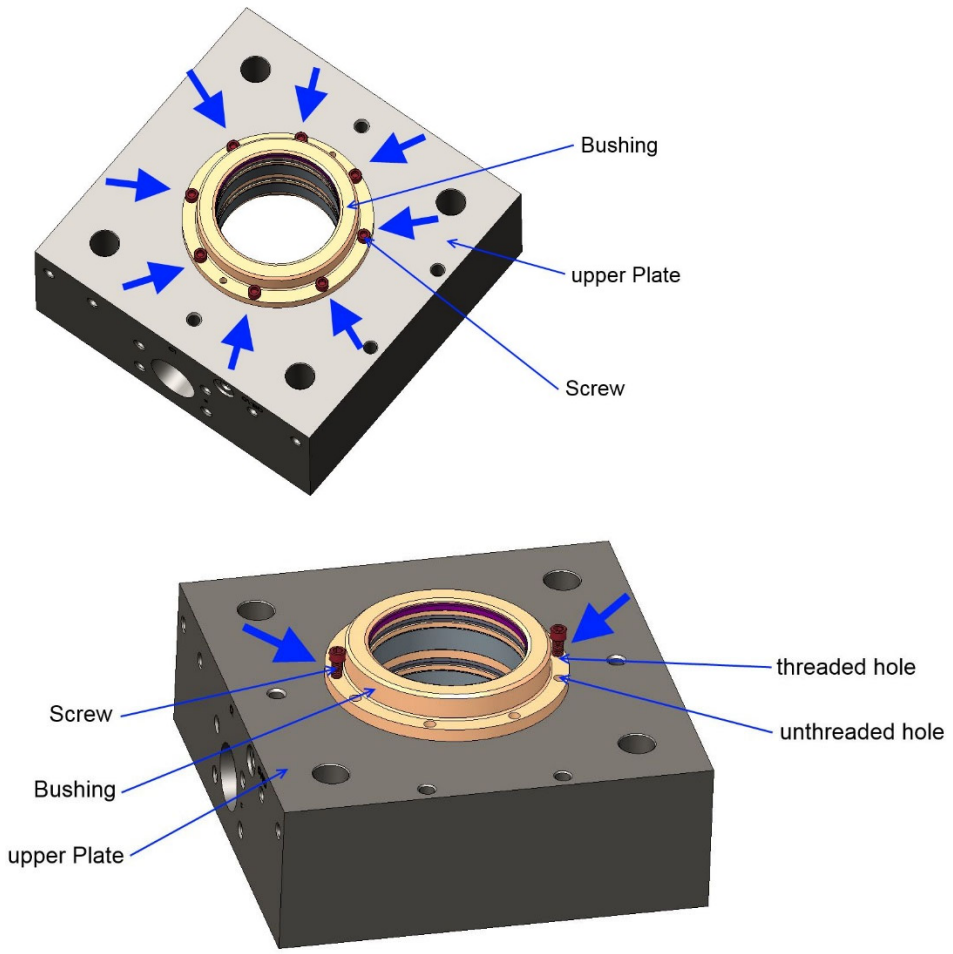
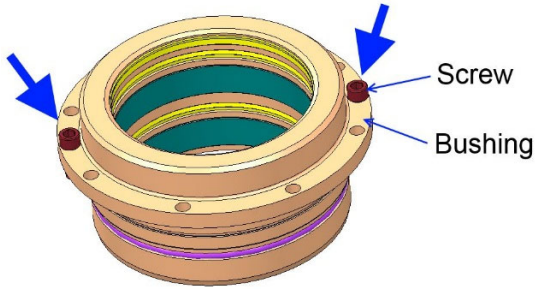


Figure 5-5. Remove Bushing

V. Remove two screws from bushing flange.
W. Remove all inside and outside seals from the bushing.

NOTICE

Do not damage the bushing when removing seals.



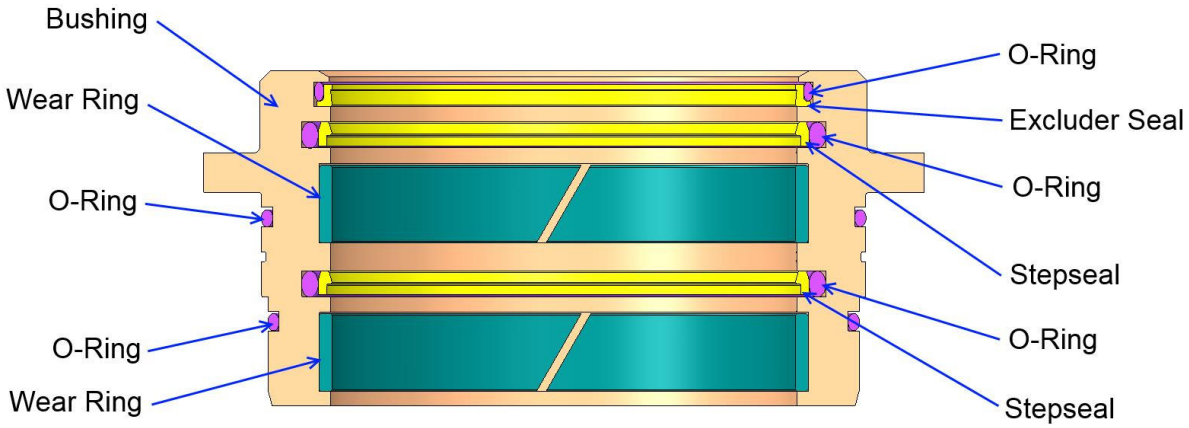


Figure 5-6. Remove All Seals and Rings

X. Remove piston rod assembly from cylinder. Use Tool 1013-5894 and a crane to lift the piston rod assembly. Hold cylinder tube down as you pull piston and piston rod out. Do not damage cylinder-sealing surface.
Y. Set piston rod and piston down on soft surface.
Z. Remove the lifting eye Tool 1013-5894 from the piston rod.
AA. Remove glyd ring, O-ring, and wear ring from the piston.

NOTICE

Do not scratch outside of piston during seal removal.

Lifting tool			
Cylinder Bore Size inch	Rod Thread: M=Male F=Female	Tool P/N	Hoist Ring P/N
10	M-M64x3	1013-5894-01-D4	1013-5894-01-D9
	F- M64x3	1013-5894-01-D1	
12	M-M64x3	1013-5894-01-D4	
	F- M64x3	1013-5894-01-D1	

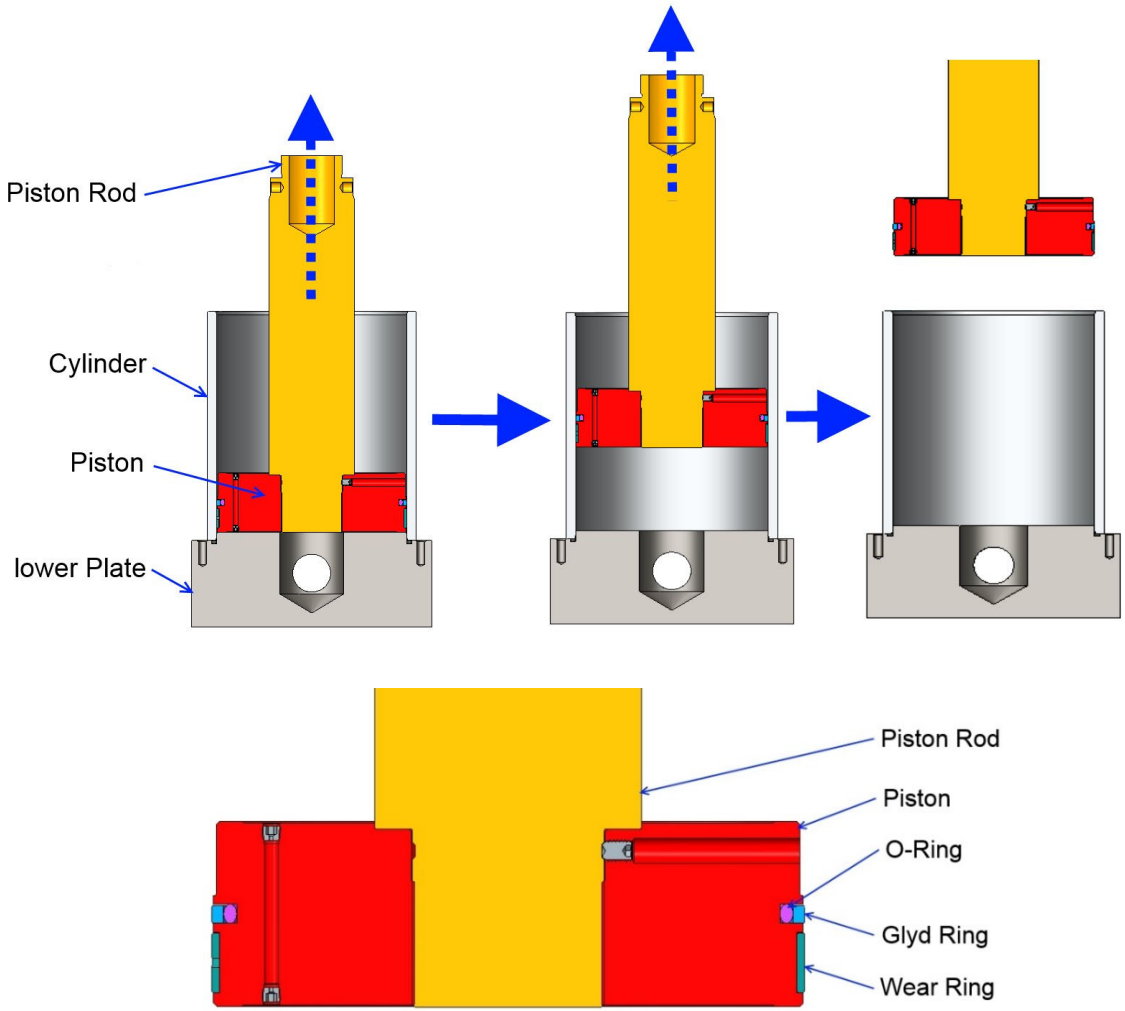


Figure 5-7. Remove Piston Rod Assembly

BB. Using cylinder lift tools as provided, remove cylinder and O-ring.

CC. Clean all surfaces using ISOPROPANOL cleaning fluid and visually inspect all surfaces.

NOTICE

Cylinder ends are sealing surfaces. Do not scratch

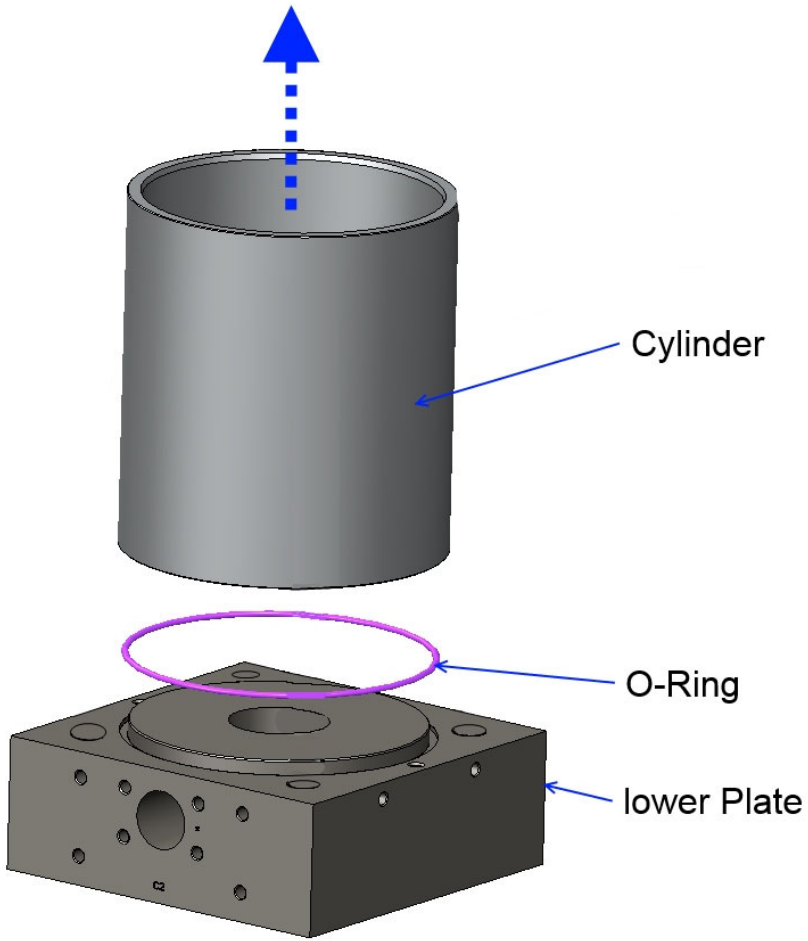


Figure 5-8. Remove Cylinder

5.3 Assembly Procedure

⚠WARNING

FLAMEPATHS

Refer to Section 1.1 for specific instructions.

A. Inventory replacement parts kit to verify all replacement parts listed in the Installation Drawing are present.

B. Lubricate O-ring with petroleum jelly and install into the groove of the lower plate.

C. Install cylinder onto the lower plate.

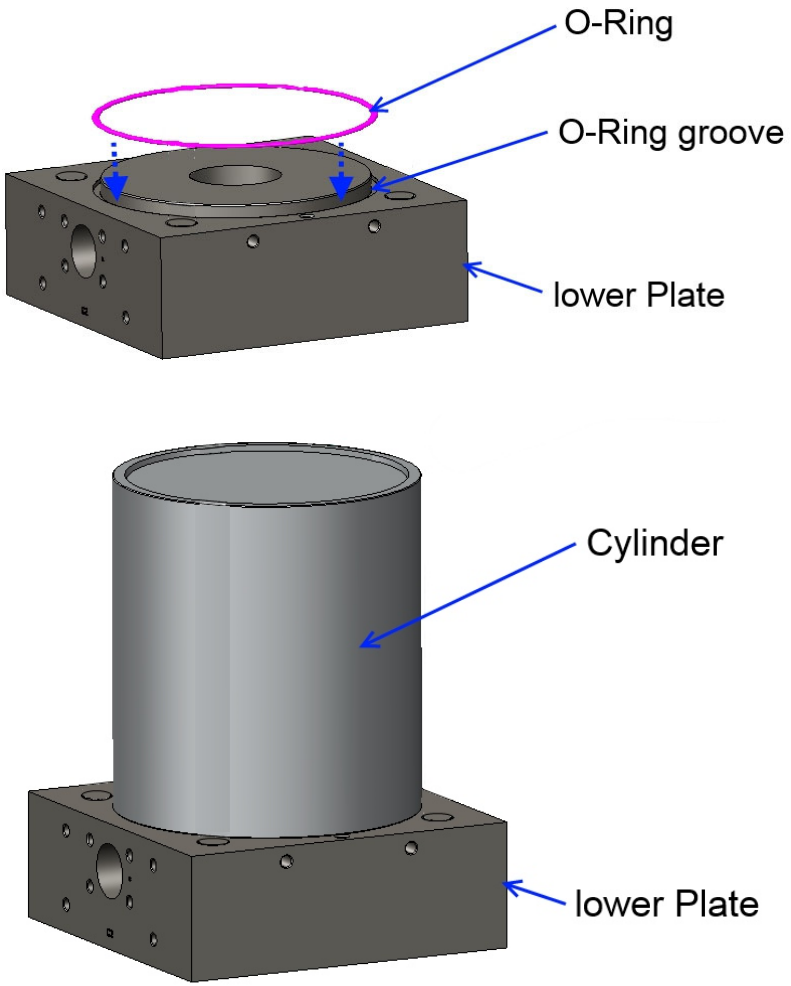


Figure 5-9. Install O-ring and Cylinder

D. Lubricate O-ring with petroleum jelly and install into the center OD groove of the piston.
E. Place glyde seal on metal portion of Tool 1013-5803. Place metal portion and glyde seal tool into white pusher tool. Orient pusher tool as illustrated.
F. Install piston lifting tool onto piston rod. Lift piston rod and piston and carefully lower into slideway tool. Using the weight of the piston, slowly lower the piston into the pusher tool. This will push the glyde ring over the piston and into the groove on top of the O-ring. Glyde ring is stretched and may not fit fully into the piston groove. The next steps will correct this.
G. Lift piston and piston rod out of pusher tool.
H. With piston still in the air, apply petroleum jelly onto wear ring and install onto piston in groove.
I. Set piston into seal compressor tool. This will resize the glyde ring to sit in the piston groove.

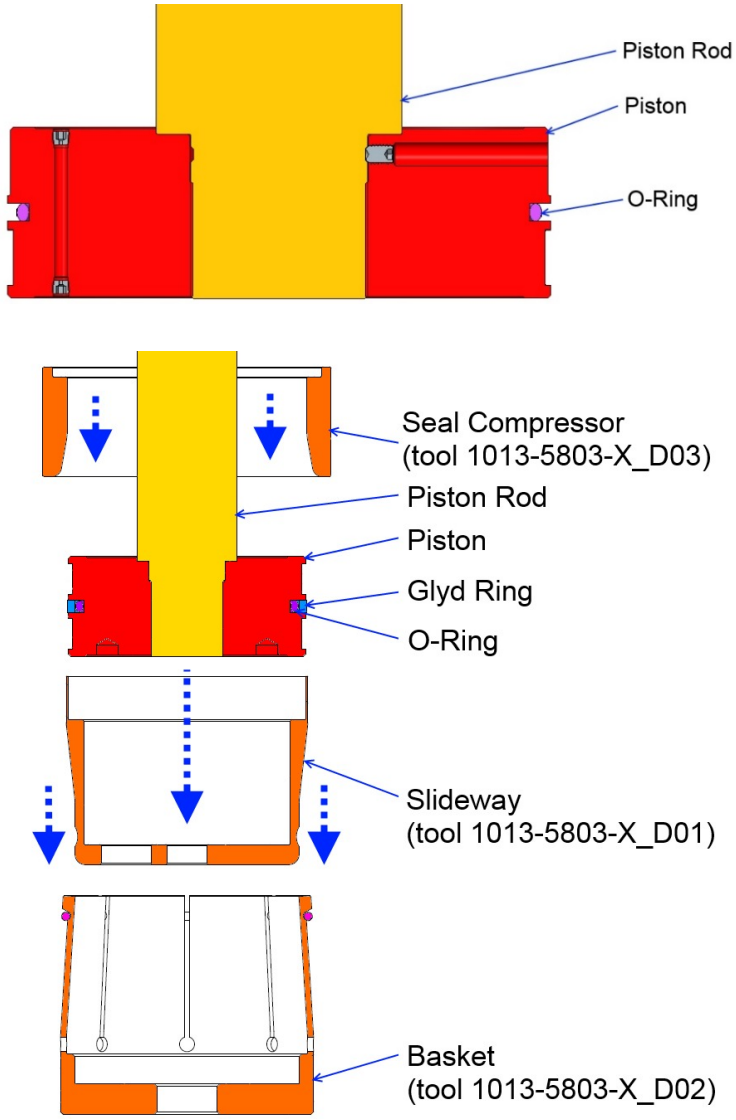


Figure 5-10. Install O-ring and Glyd Ring

J. With lifting tool, lift piston and resizing tool over the cylinder. Use the resizing tool as a guide to press piston into cylinder. Lower piston into cylinder.

K. Remove the lifting eye tool number 1013-5894 from the piston rod. Remove Tool 1013-5803 from the cylinder.

Note: Use glyd seal sizing tool 1013-5803 to help with piston installation.

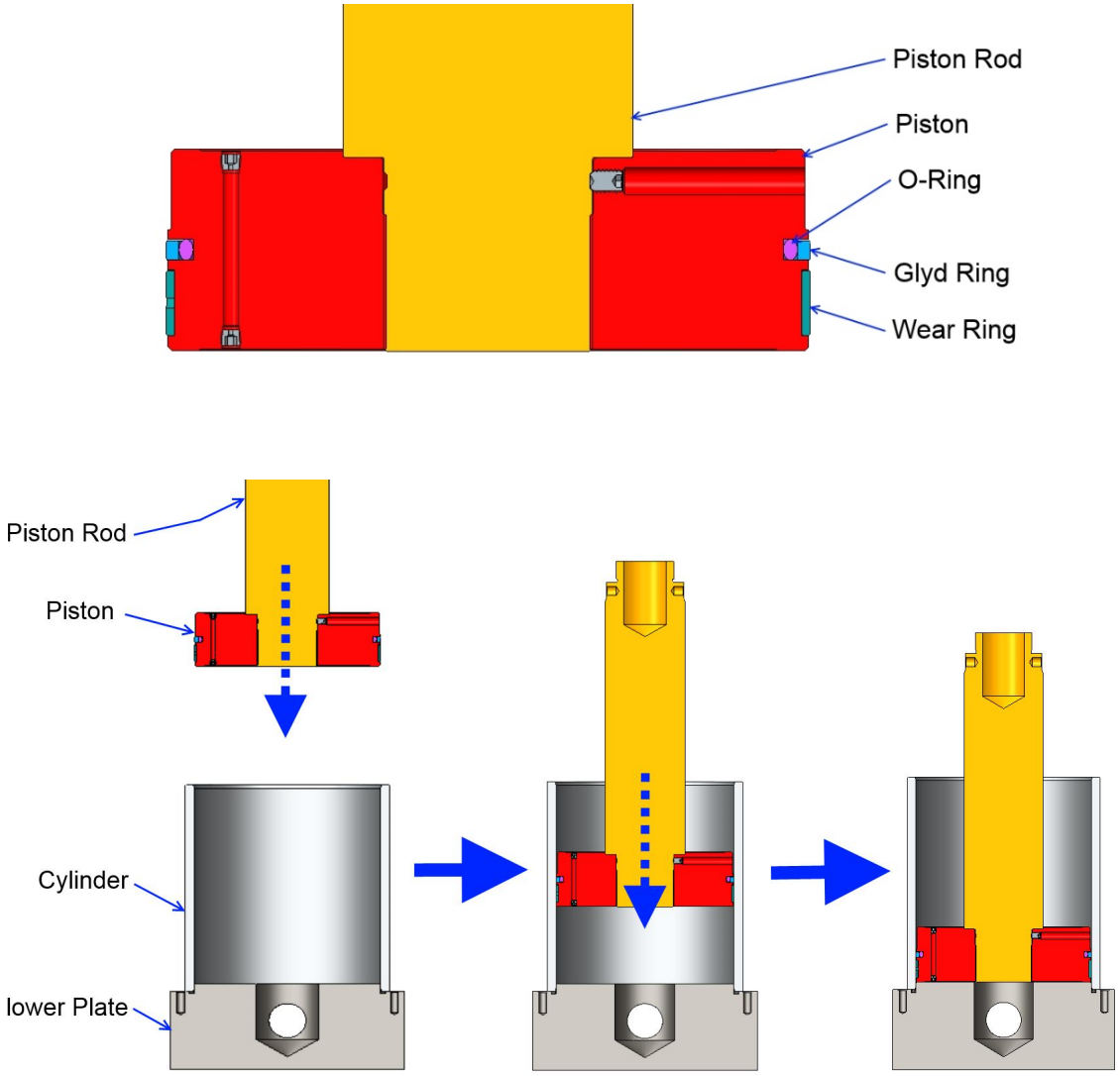


Figure 5-11. Install the Piston in the Cylinder

L. Lubricate two wear rings with petroleum jelly and install one wear ring into each of the two wide ID grooves of the bushing as shown below.

Note: Orient the scarf cuts of the wear rings 180 degrees apart from each other in the grooves.

M. Lubricate two O-rings with petroleum jelly and install one O-ring into each of the two ID grooves of the bushing as shown below.

N. Lubricate two stepseals with petroleum jelly. Orient the stepseals with the smaller ID of the seal positioned up and install one seal into each of the two ID grooves of the bushing over the previously installed O-rings.

O. Lubricate excluder seal with petroleum jelly. Orient the excluder ring with the cup of the OD of the ring positioned upwards. Install the excluder seal into the upper ID groove of the bushing over the previously installed O-ring.

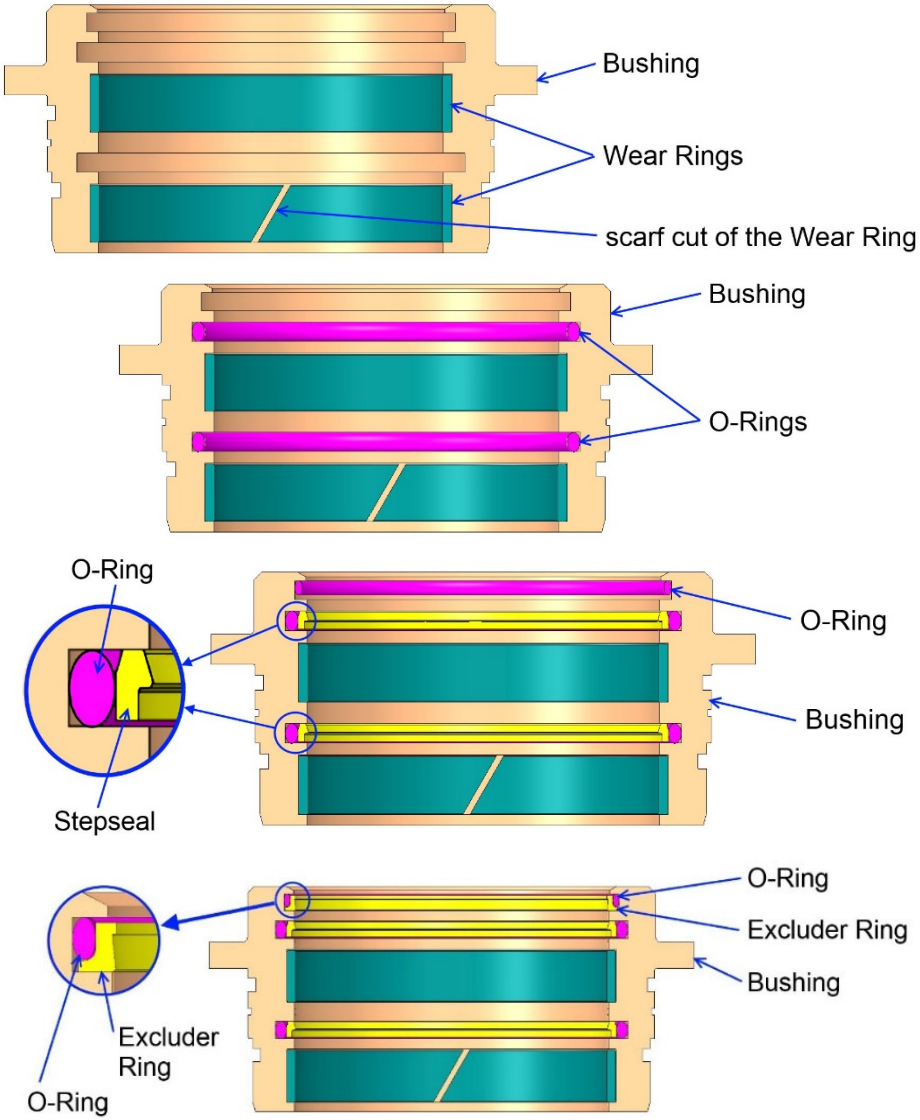


Figure 5-12. Install Seals

P. Lubricate O-ring with petroleum jelly and install into the face groove of the upper plate around the piloting OD of the plate.
Q. Apply a film of petroleum jelly to the OD surface of the bushing and to the center bore of the upper plate.
R. Align the screw holes of the flange of the bushing with the threaded holes of the upper plate and install the bushing into the upper plate. Use care to not roll or tear the O-rings in the bushing when installing.
S. Apply Loctite 242 to the threads of eight screws prior to final installation. Install the bushing into the bore of the upper plate far enough to be able to start the eight bushing screws.

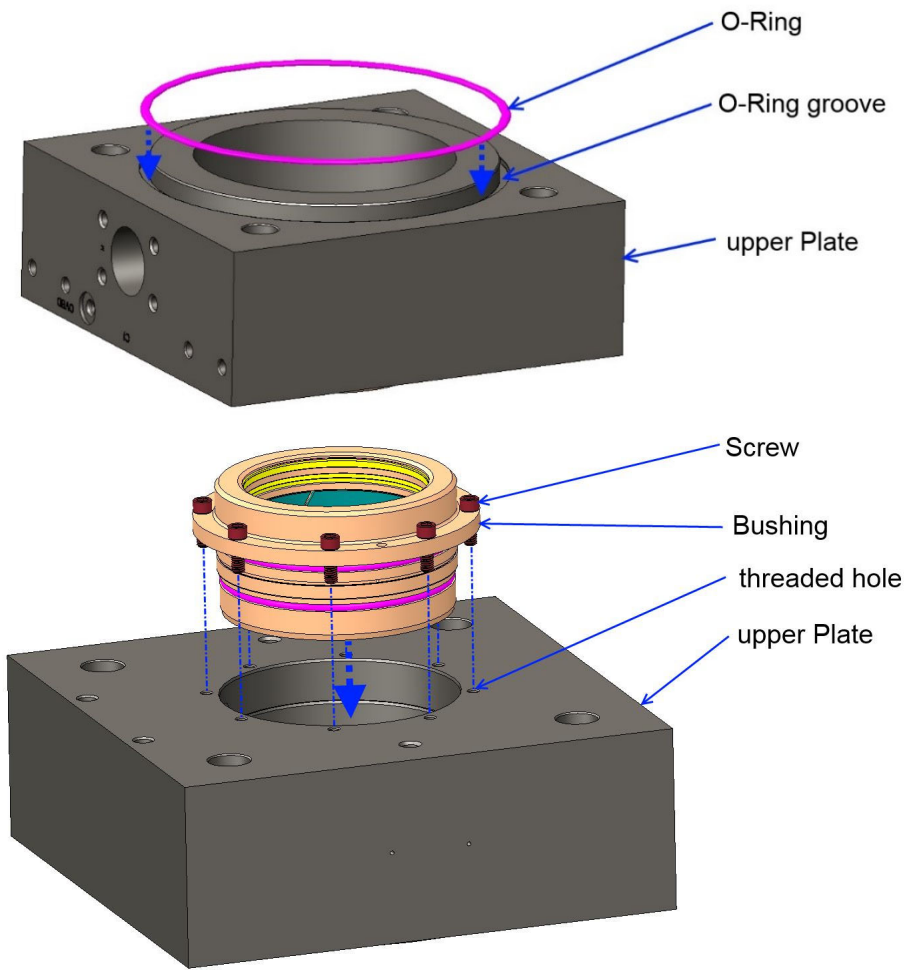


Figure 5-13. Install the Bushing into the Upper Plate

T. Thread the screws down evenly in a crosshatch pattern to lower the bushing squarely into the bore. When the flange of the bushing is squarely seated against the upper plate, torque the screws to 96-108 in-lbs.

U. Protect piston rod sharp edges (threads) with an adhesive tape to prevent damage to bushing sealing.

V. Apply Loctite 242 to all threads and re-install into bottom cylinder plate. Run tie rods all the way down until no threads are showing. Remove nuts if they are still present.

W. With lifting eyes and a hoist, raise the upper plate and position above the cylinder assembly. Orient the upper plate with the hydraulic port on the same side as the port in the lower plate and align the four screw holes with the four tie rods. Use care to not damage seals in the bushing when installing.

X. Lower the upper plate onto the piston rod and the tie rods until the tie rods protrude above the top of the upper plate. Do not damage O-ring between upper plate and cylinder when installing. If needed, use dead blow or rubber mallet to tap manifold down onto piston rod.

NOTICE

Make sure the hydraulic ports of the lower plate and top plate are in line.

NOTICE

Make sure the piston rod thread is protected (adhesive tape) to protect bushing sealing.

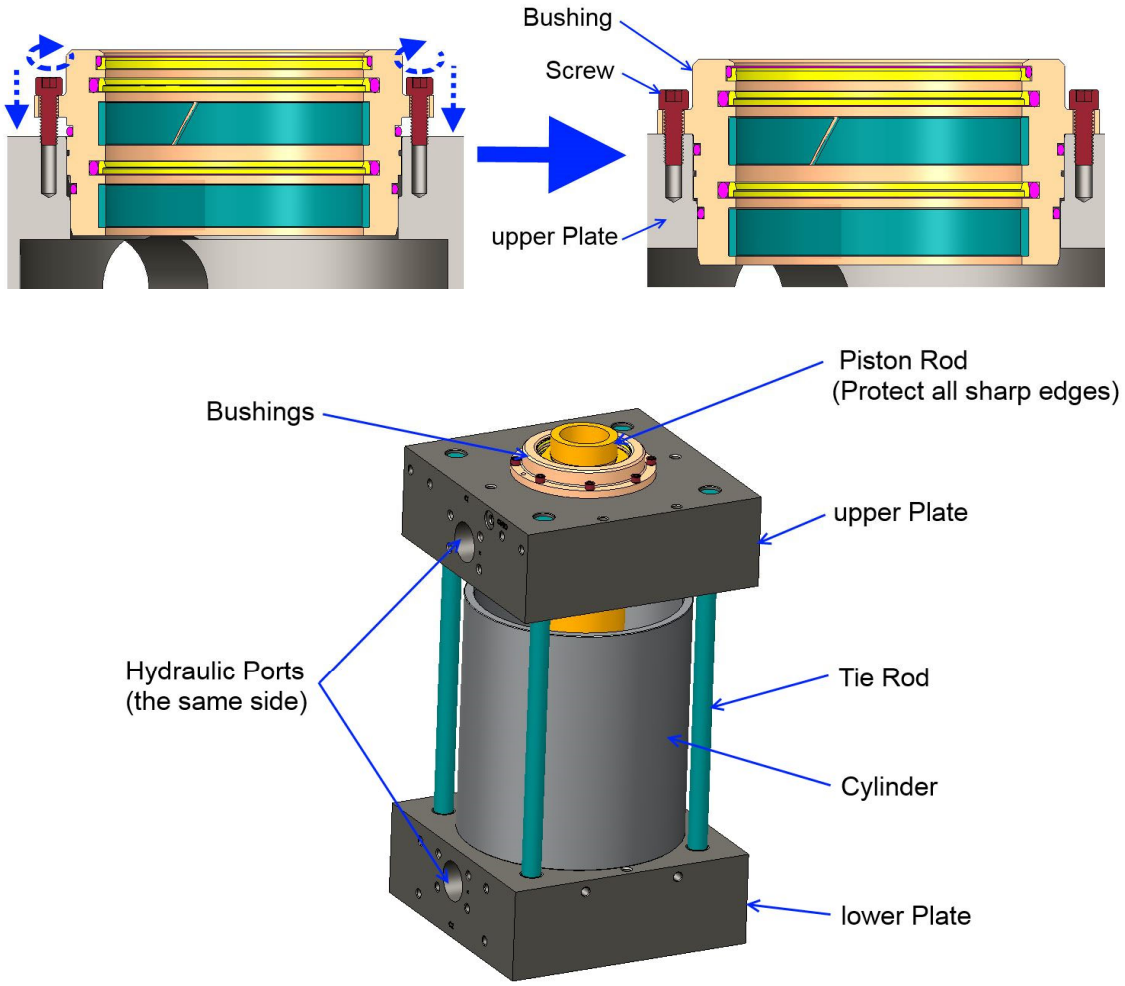


Figure 5-14. Install Upper Plate

Y. Apply Loctite 242 to the threads of the tie rods above the plate. Install the four washers and start the four nuts.

Z. Torque nuts in cross hatch pattern to 50 ft-lbs.

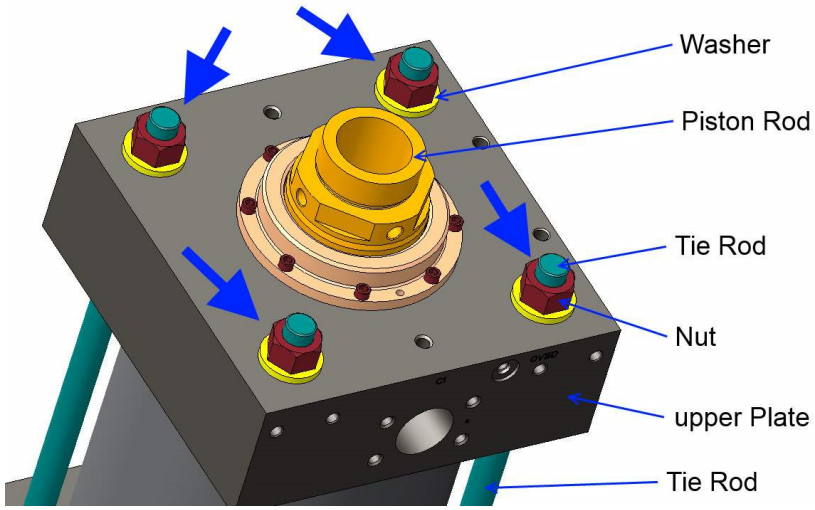


Figure 5-15. Install the Upper Plate

AA. Lift cylinder by dog ears and lay on its side. Do not lay cylinder on the C1 and C2 ports. Clamp cylinder down (not on sealing surface).

BB. Torque the four nuts in a crosshatch pattern to 100 lb.- feet increments, in a crosshatch pattern until within 100 lb.- feet of the final torque value. Set the torque tool to the final torque 570-690 ft-lbs and torque the nuts.

CC. Unclamp and pick up cylinder by its dogears and orient cylinder in upright position.

DD. Re-install LVDT, upper and lower brackets. Torque upper LVDT bracket to 45-55 ft-lbs.

EE. Torque lower bracket bolts to 25-35 ft-lbs.

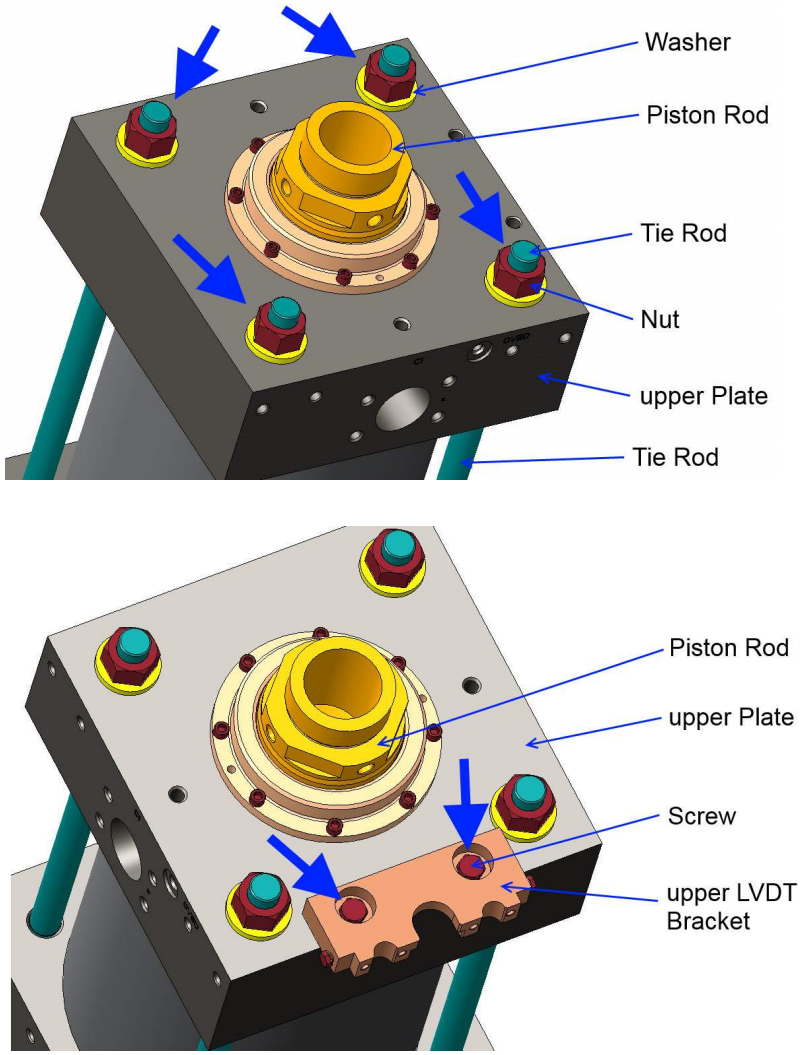


Figure 5-16. Torque the Tie Rods and Install Upper LVDT Bracket

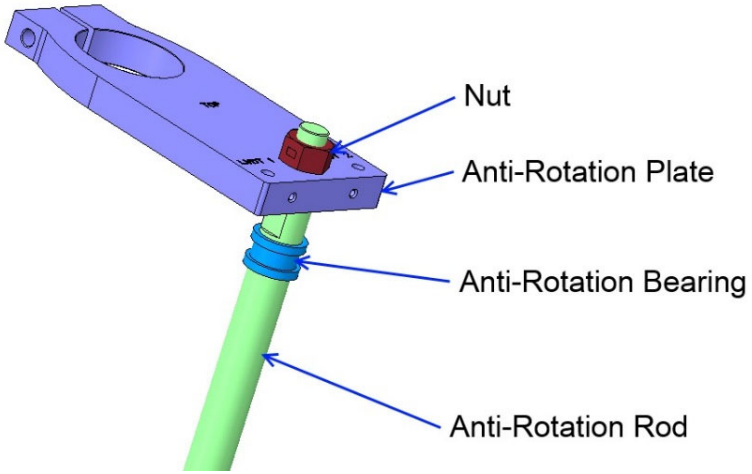
FF. Orient with "TOP" lettering up and place anti-rotation plate over piston rod threaded end. While holding plate in place, install piston rod lifting tool.

GG. With crane, pull on piston rod lifting tool to pull piston rod up. Pull until anti-rotation plate clears dog ears.

HH. Thread anti-rotation plate onto piston rod until plate bottoms out on piston rod. Then rotate CCW until anti-rotation rod hole is oriented above LVDT upper bracket.

II. Install anti-rotation bushing onto anti-rotation rod. Insert threaded end of anti-rotation rod into the anti-rotation plate. At the same time, push anti-rotation bushing into upper LVDT bracket bushing slot. Thread anti-rotation lock nut onto anti-rotation rod.

JJ. Using a wrench on anti-rotation rod flats, torque lock nut down to 90-110 ft-lbs.



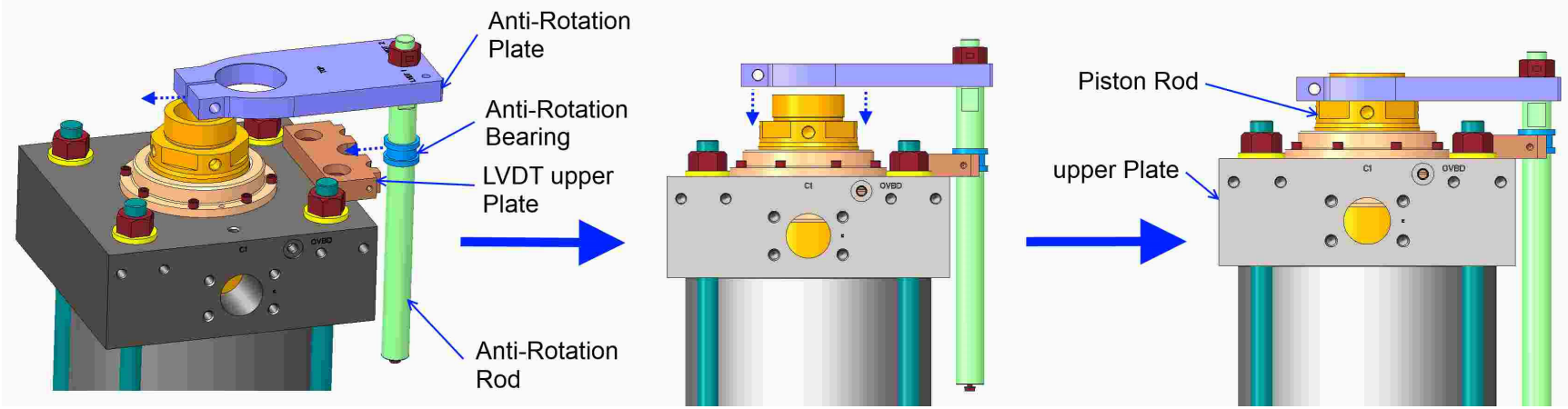


Figure 5-17. Install Anti-Rotation Plate

KK. Tighten and torque anti-rotation plate pinch bolt and nut to 45-55 ft-lbs.

LL. Lower piston rod back into cylinder. Remove cylinder rod lifting tool.

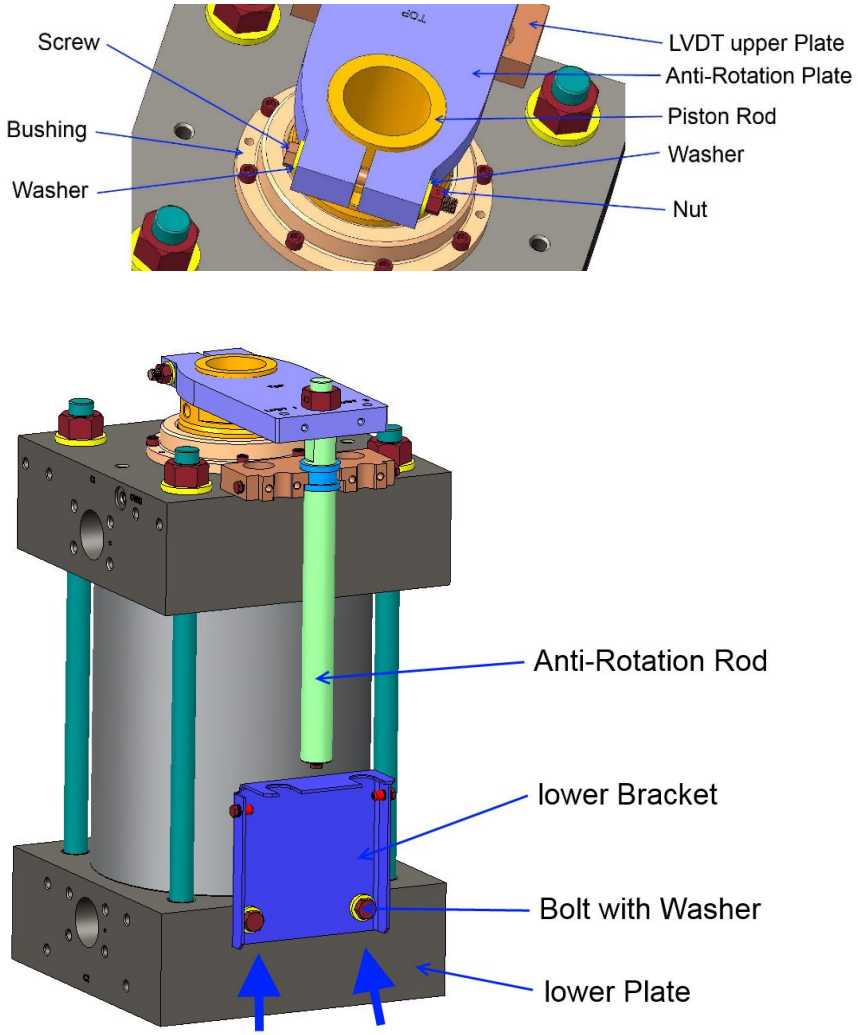


Figure 5-18. Install Lower LVDT Bracket

MM. Install servo and manifold bridge according to Chapter 4.

NN. Install both LVDT rods and LVDT Cover according to Chapter 2.

OO. Connect external interface hydraulic lines and electrical cables.

PP. Go to the Verification & Calibration section 5.4.

QQ. Install the electronic cover and install twenty screws and washers. Torque screws to 55 ft lb ± 5 lb.- ft.

⚠WARNING

Ensure electronic cover O-ring is in groove and is not pinched by the cover. Incorrect installation will result in loss of ingress protection for Zone 2 installations.

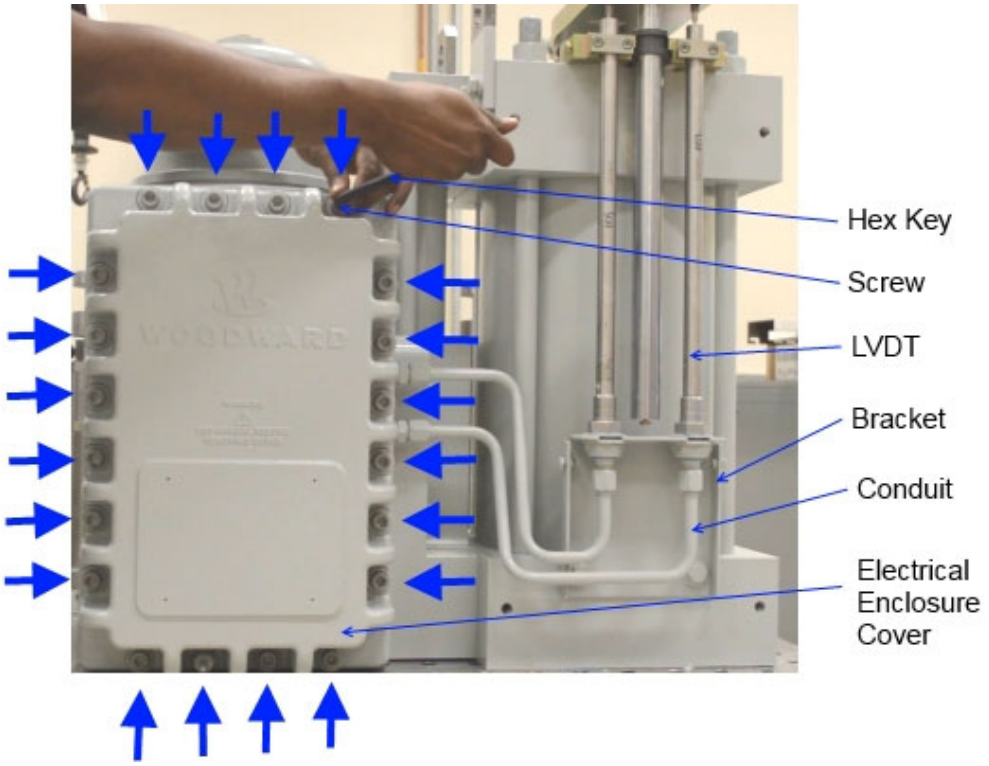


Figure 5-19. Install Electronic Cover

5.4 Verification & Calibration

A. Verify that the hydraulic and electrical connections are correct. See product manual for more information.
B. Confirm that the hydraulic and electrical power to the VS-II is turned off.
C. Connect a PC Service Tool to VS-II. See product manual for more information.
D. Apply electrical power to VS-II.
E. Start the hydraulic supply system.
F. Purge all air from the system. Adjusting the position setpoint up and down several times will aid purging air. Allow for warm-up time.
G. Examine the unit for external leakage.

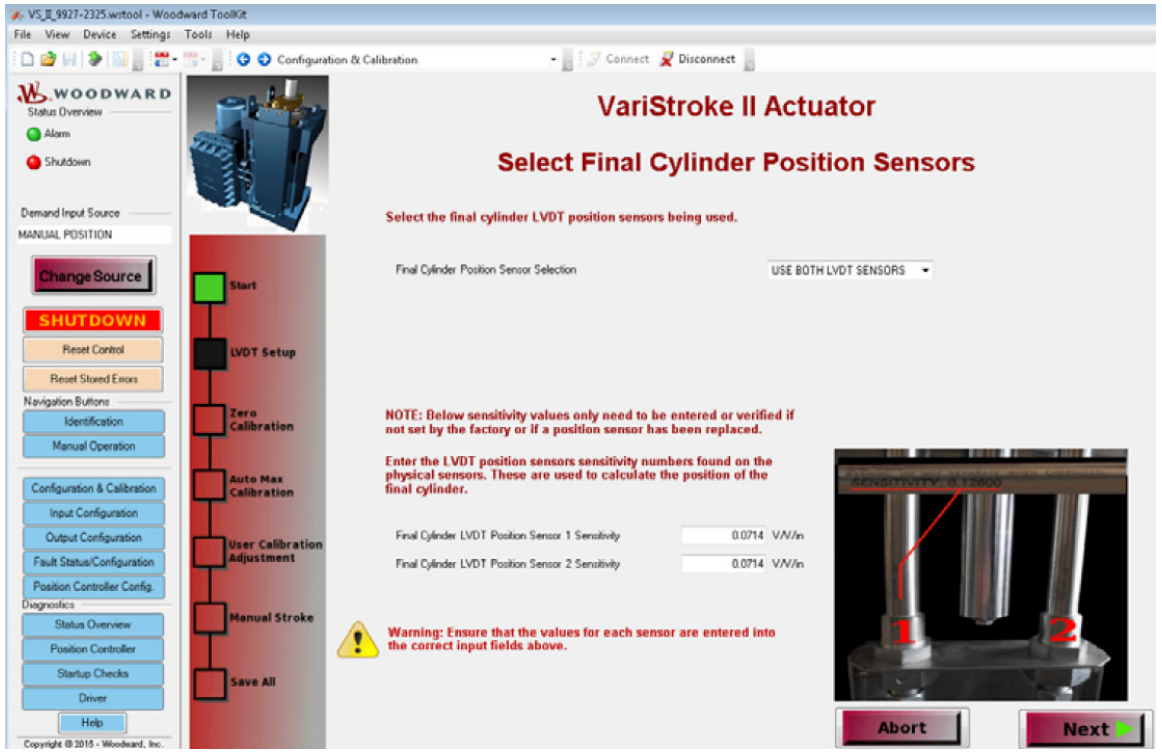


Figure 5-20. Service Tool Configuration & Calibration Screen

6. REVISION HISTORY

REVISION DATE	REVISION LETTER	DESCRIPTION OF CHANGE	PAGE #
10/17	A	Change Web Access to None – Remove from E-Biz	
01/22	B	Revised Introduction section	6
01/22	B	Added Repair of Flamepaths note and removed flamepaths table	6

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