CMM-03013

REV.-
09-22

Component Maintenance Manual
Bronze Level

Product Name: VariStroke-DX (VS-DX)

FOR GENERAL DISTRIBUTION

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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

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 of 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-DX (VS-DX). Bronze level service is preventative and routine maintenance requiring 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 literature referenced within this document.

1.1 Regulatory Compliance

The VS-DX is subject to safety regulatory certifications. See product manual **35132** for additional details. The service center performing the work on the VS-DX 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 to not damage these parts as it could compromise the protection method for the product. Flamepaths are identified in drawing 9989-7006.

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

Safety Symbols

	Direct current
	Alternating current
	Both alternating and direct current
	Caution, risk of electrical shock
	Caution, refer to accompanying documents
	Protective earth terminal
	Frame or chassis terminal

The following flamepaths have a maximum constructional gap (ic) less than that required by Tables 1 and 2 of EN 60079-1:

Flame Path	Max Gap, ic (mm)	Min. Width of Joint L (mm)
Spool to Spacer	0.079	13.46
Sleeve to Spacer	0.079	12.85
Sleeve to Sleeve	0.048	14.76
Sleeve to Housing	0.076	15.85
Sensor to Plate	0.08	36.25
Plate to Housing	0.10	22.91
Plate to Housing	0.10	20.22
Plate to Plate	0.10	22.91

⚠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.

⚠WARNING

Do not to damage the cover seal, cover surface, threads, or the VS-I surface while removing or replacing the cover. Damage to sealing surfaces may result in moisture ingress, fire, or explosion. Clean the surface with Isopropanol if necessary. Inspect the cover joint surfaces to ensure that they are not damaged or contaminated.

⚠WARNING

For Division 1/Zone 1 products: Proper torque on all joints is critical to ensure that the unit is sealed properly.

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.

1. **DANGER** - Indicates a hazardous situation, which if not avoided, will result in death or serious injury.
2. **WARNING -** Indicates a hazardous situation, which if not avoided, could result in death or serious injury.
3. **CAUTION** - Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury.
4. **NOTICE** - Indicates a hazard that could result in property damage only (including damage to the control).
5. **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-tagout 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-DX 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 since these materials do not store static electric charges as much as synthetics.
2. If you must open the VariStroke housing cover, follow these precautions:
   - Do not touch any part of the PCB.
   - Do not touch the electrical conductors, connectors, or components with conductive devices or with your hands.

1.4 Definitions and Used Abbreviations

CCW	– *Counter Clockwise*
CMM	– *Component Maintenance Manual*
Control System	– *Digital system that controls and monitors the VariStroke(s) turbine governor or Distributed Control System (DCS)*
CW	– *Clockwise*
In Control	– *The unit controlling the position of the servo system*
Master / Slave	– *The unit designated as the Master yields control to the other unit (Slave) through a link between the two VS's. The unit designated as the Master will take control during VS-DX startup.*
Not In Control	– *The unit acting as the backup to the In Control unit*
VS	– *VariStroke-I Servo*
VS-DX	– *VariStroke Duplex Hydraulic Servo Skid*
VS-GI	– *VariStroke-I GI Single Acting Servo*

1.5 List of Woodward Literature

Manual 26455 –	Customer Publication Cross Reference and Revision Status & Distribution Restrictions
Product Manual 35119 –	VariStroke-GI (VS-GI) Electro-hydraulic Actuator
Product Manual 35132 –	VariStroke-DX Duplex Hydraulic Servo Skid
Manual 35148 -	Customer Service Tool for VariStroke-I (VS-I, VS-GI, and VS-DX) Electro-hydraulic Actuator and Servo
Manual 82715 –	Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, & Modules

Download Woodward Material: (www.woodward.com).

Required Drawings		Reference Kit Number
Installation Drawing **9999-1852**	VariStroke-DX Duplex Hydraulic Servo Skid	N/A
Installation Drawing **9989-7006**	FLAMEPATH, VARISTROKE I	N/A
Installation Drawing **9999-1897-2**	Kit, VS-GI REPLACEMENT, J-BOX, FAIL EXTEND, FOR VS-DX SKID	8935-1341
	Kit, VS-GI REPLACEMENT, J-BOX, FAIL RETRACT, FOR VS-DX SKID	8935-1343
Installation Drawing **9999-1897-3**	Kit, REPLACEMENT ISOLATION VALVE, RIGHT HAND, FOR VS-DX SKID	8935-1338
	Kit, REPLACEMENT ISOLATION VALVE, LEFT HAND, FOR VS-DX SKID	8935-1339
Installation Drawing **9999-1897-4**	Kit, PRESSURE GAUGE, FOR VS-DX SKID	8935-1344
Installation Drawing **9999-1897-5**	Kit, SHUTTLE VALVE, FOR VS-DX SKID	8935-1336

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

1.6 List of Woodward Required Software

9927-2177	VS-I Customer Service Tool

Locate the installation program within Woodward's software download page by searching for "9927-2177" on www.woodward.com/software. The installation manual is provided within manual 35148 *Customer Service Tool for VariStroke-I.*

IMPORTANT **If the appearance or operation of the Customer Service Tool software differs from the description and screenshots in this document, please refer to the latest Customer Service Tool manual 35148.**

1.7 List of Required Hardware or Materials

Torque wrench(es) (required torque range during installation)	Required torque ranges, wrench end type, and sizes for installation
	• 90.0 – 110.0 LBFT (122 – 149 Nm), Type: open end; Size: 2 1/4 in • 56.0 – 68.0 LBFT (76 – 92 Nm) Hex bit socket, Type: open end; Size: 1 13/16 in • 100.0 – 128.0 LBFT (136 – 174 Nm), Type: open end; Size: 1 1/2 in • 40.0 – 60.0 LBFT (61 – 75 Nm), Type: socket head; Size: 3/4 in
Wrench(es)	• Type: Allen wrench ; Size: 1.5 mm • Type: socket head; Size: 2 1/4 in • Type: open end; Size: 1 13/16 in • Type: open end; Size: 1 1/2 in • Type: open end; Size: 3/4 in • Type: open end; Size: 13/16 in • Type: open end; Size: 1 3/8 in
Torque Screwdriver(s)	Installation required torques range, screwdriver end type, and size
	• 5.3 -7.0 LBIN (0.6-0.8 Nm), Type: slotted; Tip Size: 3.5 X 0.6 mm • 11.0 – 13.0 LBIN (1.2 – 1.5 Nm), Type: Philips; Tip Size: PH2 • 45 LBIN (5.1 Nm), Type: Philips; Tip Size: PH2

Screwdriver(s)	• Type: slotted; Tip Size 5.5 X 0.8 mm • Type: slotted; Tip Size 3.5 X 0.6 mm • Type: Philips; Tip Size: PH2 • Type: Philips; Tip Size: PH0 • Type: slotted; 2.5 mm x .4 mm
Others	• RS-232 straight-through serial cable (male connector- both ends) • Multimeter • Cable sleeving 3/4" (e.g., PTN0.75BK75) / foil and insulation tape • Cable ties approx. 8 inch (200 mm) long • Oil absorbent pads / mats • Lifting strap (minimum weight capacity 100 lbs / 50 kg) • Cable tie removal tool • PC computer with Woodward VS-I Customer Service Tool installed • Isopropyl alcohol • Petroleum jelly • Loctite 592 thread sealant • Parker Super O-Lube or similar • Lifting eye (minimum weight capability 100 lbs / 50 kg), thread size .500-13 • Parameterization .wset file as backup for the VS unit to be replaced - can be skipped if unit to be replaced is operable and can communicate via Customer Service Tool

NOTICE

Tools are not contained within the replacement kit. Please order separately.

1.8 General Instructions

- Lifting:
  - For proper and safe lifting instructions and diagrams, see product manual **35132**.
- Review this CMM and the installation drawing before starting the replacement procedure 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. Sort all parts for easy assembly. For questions, contact Woodward.
- If not all the 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-DX prior to disassembly to prevent dirt and debris from contaminating the unit 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 on to 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.
- Helical inserts:
  - To prevent damage to mid-grip helical inserts, 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 helical inserts 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 using this procedure, reference drawings, or visual aids for proper reassembly.
- Bolts and Screws:
  - All screws and bolts loosen with counterclockwise (CCW) direction. In other situations, the direction will be specified.

2. ON-LINE SERVO VALVE REPLACEMENT, VS-DX SKID J-BOX VERSION

⚠WARNING

For safety reasons, this procedure requires at least two operators due to risk of turbine overspeed, injury from heavy lifting, and leaking oil.

NOTICE

It is recommended that one person observes turbine operation while the servo replacement is in progress. This person would be able to react quickly if there is interference with turbine operation during replacement.

2.1 Replacement Kit Description

The purpose of this procedure is to show the correct sequence and method of servo replacement (VS-DX with J-Box version):

Servo Valve Replacement:

KIT P/N	Installation Drawing
8935-1341 – Kit, VS-GI REPLACEMENT, J-BOX, FAIL EXTEND, FOR VS-DX SKID	**9999-1897-2**
8935-1343 – Kit, VS-GI REPLACEMENT, J-BOX, FAIL RETRACT, FOR VS-DX SKID	

NOTICE

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

WARNING

On-Line Modification, Reconfiguration or Start-Up

The settings on the VS-GI servos must be precisely matched prior to engaging in concurrent "live" (on-line) operation or "live" transition between servos on an end application. Failure to precisely match and tune the configuration of servos to the proper control range prior to engaging in a "live" (on-line) replacement could result in turbine overspeed, loss of control, plant shutdown, property damage, and severe bodily injury, including death.

Proper servo configuration and dynamic settings are unique to specific end applications. It is the responsibility of the end user to determine the specific configuration and dynamic settings necessary for each specific servo application. This VS-GI unit replacement procedure is a guideline that is dependent upon user-supplied configuration and dynamic setting data. Because of the variability of end applications, Woodward makes no warranty, expressed or implied, as to the suitability of this procedure for any given "live" installation.

End users must develop site procedures suitable for specific end applications and ensure that personnel are fully trained on such procedures prior to attempting to replace a servo on a "live" running turbine. All safety protective systems (overspeed, over temperature, overpressure, etc.) must be in proper operational condition prior to the start of an on-line replacement procedure. Personnel should be equipped with appropriate personal protective equipment to minimize the potential for injury due to release of hot hydraulic fluids, exposure to hot surfaces, and/or moving parts located near the VS-GI.

WARNING

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be completely independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

NOTICE

Before starting to disassemble, make sure that VS-GI settings file back-up is created on a fully functional unit that has been previously tuned using the Customer Service Tool software. Download and save a .wset file in a safe storage in a place where you can find it for later use.

WARNING

FLAMEPATHS - Refer to Section 1.1 for specific instructions.

IMPORTANT

Before proceeding with the replacement procedure, print Appendix 1. Disassembly Checklist and Appendix 2. Installation Checklist.
Notate the disassembly and installation results at each checkpoint.

IMPORTANT

The procedure below provides instructions exclusively for replacing either Servo A or Servo B.
The instructions are differentiated by color.
To replace Servo A, use directions in Red only.
To replace Servo B, use directions in Blue only.

2.2 VariStroke Servo Disassembly Procedure from VS-DX Skid

1. Confirm that the servo to be withdrawn is designated as the Slave.
   a) Control system commands to the withdrawn servo to be designated Slave [notate result in Checklist: ID #1].
   b) Feedback in control system indicates the withdrawn Servo is NotInControl [notate result in Checklist: ID #2].
   c) Pressure reading on the withdrawn servo's gauge is 0 bar (Figure 2-1) [notate result in Checklist: ID #3].

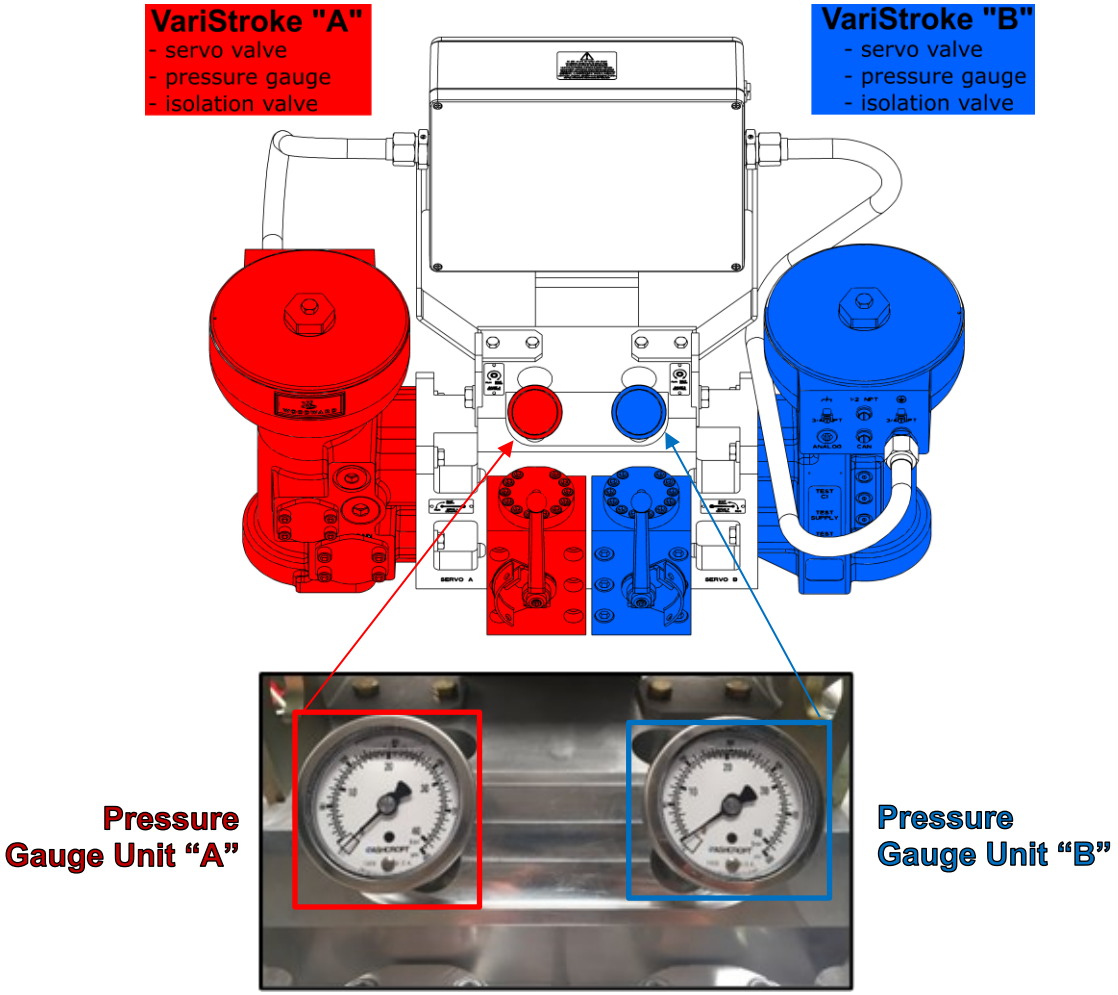

Figure 2-1. VS-DX Pressure Gauges

2. Confirm that the other servo is designated as the Master.
   a) Control system commands the other servo to be designated as the Master [notate result in Checklist: ID #4].
   b) Feedback in the control system indicates the other servo is InControl [notate result in paper Checklist: ID #5].
   c) Feedback in control system indicates the other servo is not in Shutdown state [notate result in Checklist: ID #6].
   d) Pressure reading on the other servo's gauge is greater than 0 bar (Figure 2-1) [notate result in Checklist: ID #7].

      The reading may be zero if the cylinder position is at the Failsafe stop position.

3. Ensure that any automatic control switchover logic is disabled to prevent the Master/Slave designation from swapping during the replacement procedure.

4. Remove the padlock from the isolation valve located on the withdrawn VariStroke's VS-DX unit (isolation valve nearest the withdrawn VariStroke).

5. Shutoff the isolation valve on the common skid (central block) by vertically turning the valve corresponding to the withdrawn servo (located near the withdrawn servo VariStroke) (Figure 2-2) [notate the result in Checklist: ID #8].

6. If present, lock the padlock on the withdrawn VariStroke's isolation valve.

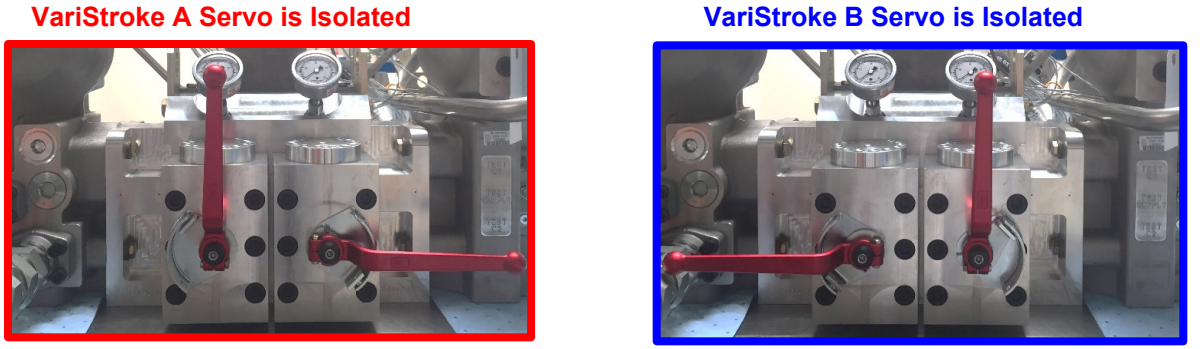

Figure 2-2. VS-DX Isolation Valves Position

7. If the RunEnable command is used, set the command to False in the control system for the VariStroke to be disassembled [notate result in Checklist: ID #9].
   a) The feedback signal in the control system will indicate that the VariStroke to be disassembled is in a Shutdown state.

8. Open the junction box by unscrewing all four bolts from its front cover (use slotted screwdriver; **5.5 X 0.8 mm** tip size) (Figure 2-3).

9. Open knife terminals **[ANALOG DMD CH1, ANALOG DMD CH2]** **(VariStroke A terminals #17 through 22, 6 terminals)** or **(VariStroke B terminals #48 through 53, 6 terminals)** inside the VS-DX J-Box (Figures 2-4 and 2-5).

⚠WARNING

Do not disconnect the Analog Demand signal to both servos simultaneously – it will cause immediate system shutdown.

⚠WARNING

Disconnect the Analog Demand dedicated to the withdrawn VariStroke servo only.

⚠WARNING

Analog Demand loops are still working. Disconnecting will break the 4-20mA current.

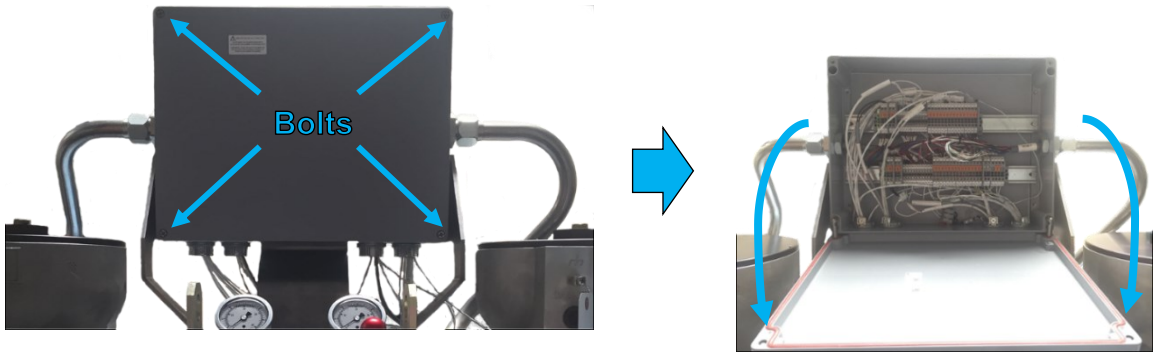

Figure 2-3. VS-DX J-Box Opening

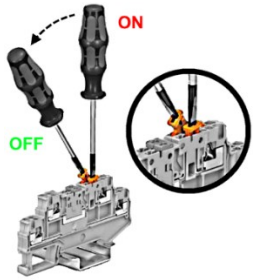

Figure 2-4. Knife Disconnect Terminal Usage

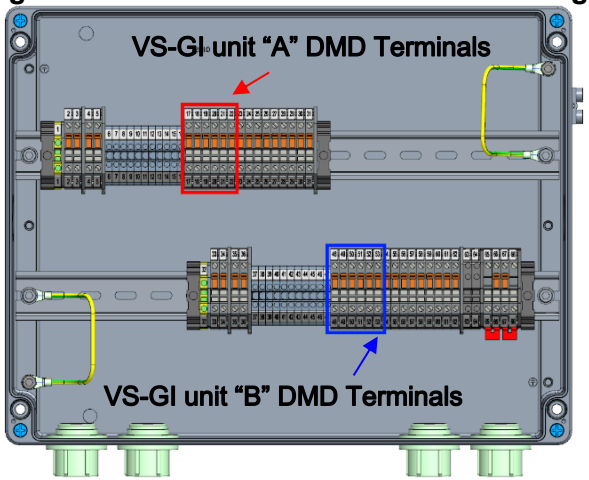

Figure 2-5. Analog Demand Terminals

10. Verify the withdrawn VariStroke communicates the alarm in the control system [notate result in Checklist: ID #10].

11. Verify the withdrawn VariStroke communicates shutdown in the control system [notate result in Checklist: ID #11].

12. Loosen the set screw from the withdrawn VariStroke cover (use **1.5mm** socket head wrench); (Figure 2-6).

13. Open the withdrawn VariStroke's cover (use **2 1/4 in** open end wrench); (Figure 2-7).

14. Connect the communication cable to the withdrawn VariStroke (Figure 2-8).
    **The following steps for communicating with the servo are to be performed only if the VariStroke is accessible via the RS-232 port, the electronics are not broken, and the settings parameters are not corrupted. Otherwise, you must use the backup setting.*

15. Launch the VariStroke Customer Service Tool application.

16. Establish connection to the withdrawn VariStroke by pressing the connect button in the Customer Service Tool software.

17. Verify alarms and shutdowns are active on the VariStroke Customer Service Tool screen.

18. In the first column of the Internal Status page in the Customer Service Tool, verify there are no active or logged events of memory or parameter fault [notate result in Checklist: ID #12].

19. Download and save parameters from the withdrawn VariStroke. Refer to Customer Service Tool manual 35148.
    **Perform this step only if the VariStroke is accessible via the RS-232 port, electronics are not broken, and the settings parameters are not corrupted. [notate result Checklist: ID #13 or #14].*

Figure 2-6. Set Screw in VariStroke Cover

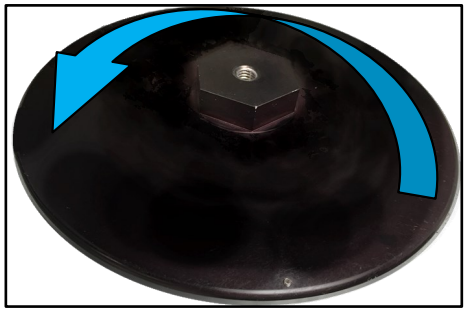

Figure 2-7. VariStroke Cover Opening

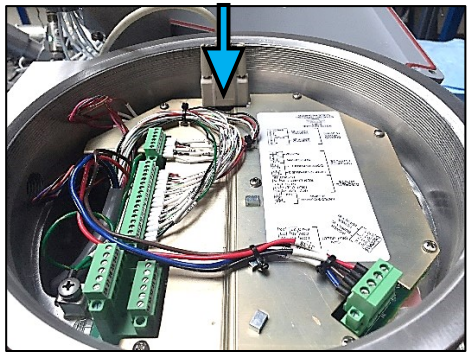

Figure 2-8. Connecting to RS-232 VariStroke Communication Port

IMPORTANT

Best practice is to save files settings from each VariStroke in the plant. Files should be saved and stored after each successful/finalized configuration change or calibration performed. This will allow settings to be backed up if the unit is replaced, or if there are further configuration modifications that cause improper behavior.

The downloaded file's name must clearly identify when and what location/device it was taken from, e.g., "Date_serial number_functional location.wset"

20. Terminate the connection to the withdrawn VariStroke by pressing the disconnect button in the Customer Service Tool software.
21. Disconnect the communication cable from the withdrawn VariStroke (Figure 2-9).

⚠WARNING

Knife disconnect terminals can be opened only when not energized.

22. Cut-off electrical power to the withdrawn VariStroke:
    a) Open the supply circuit breaker from the customer side.
    b) For the VariStroke being withdrawn only, open the knife terminals **[POWER]** in the junction box **(VariStroke A terminals # 2 through 5, 4 terminals)** or **(VariStroke B terminals #33 through 36, 4 terminals)**; (Figure 2-10) [notate result in Checklist: ID #15].
23. Alarm will appear in the control system of the other controlling VariStroke.

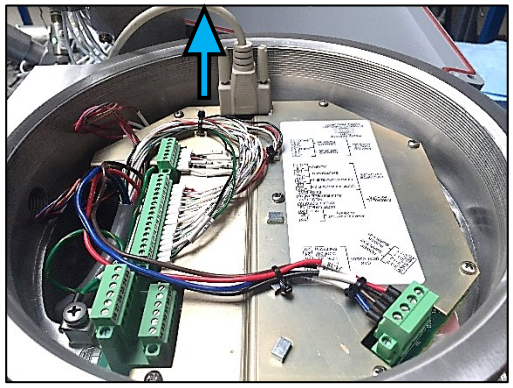

Figure 2-9. Disconnecting RS-232 Link

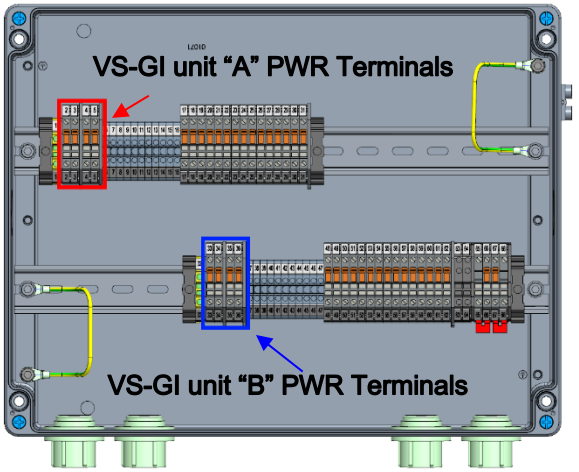

Figure 2-10. Power Terminals Inside VS-DX J-Box

24. Cut-off the hydraulic supply to the withdrawn VariStroke (valve is located on system process piping – not provided with VS-DX) [notate result in Checklist: ID #16].

25. Wait for two minutes.

26. Cut-off the hydraulic drain to the withdrawn VariStroke (valve is located on the system process piping – not provided with VS-DX) [notate result in Checklist: ID #17].

27. Ensure the withdrawn VariStroke's electrical circuit is disconnected from electrical power supply
(VariStroke A terminals # 2 through 5, 4 terminals) or
(VariStroke B terminals # 33 through 36, 4 terminals).

28. Open knife terminals **[HEALTH LINK]** **(terminals # 66 and 67, 2 terminals), valid for either VariStroke A or VariStroke B disassembly** (Figure 2-11) [notate result in Checklist: ID #18].

⚠WARNING

The Health Link is an active discrete loop when disconnected. Disconnecting breaks the 12VDC voltage.

29. Open knife disconnect terminals for the withdrawn VariStroke **[Discrete Outputs, Analog Outputs]**
(VariStroke A terminals #23 through 31, 9 terminals) or **(VariStroke B terminals #54 through 62, 9 terminals)** (Figure 2-12).

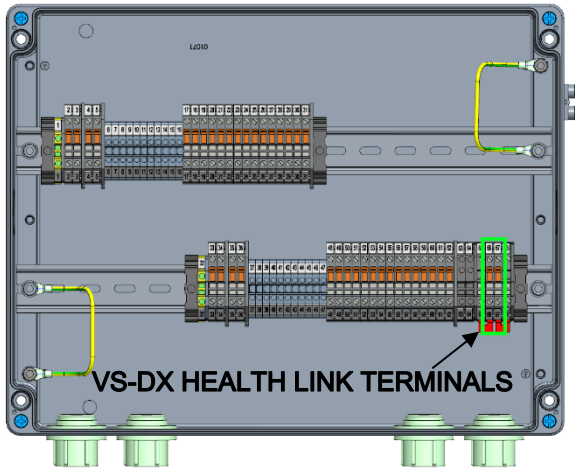

Figure 2-11. Health Link Terminals Inside VS-DX J-Box

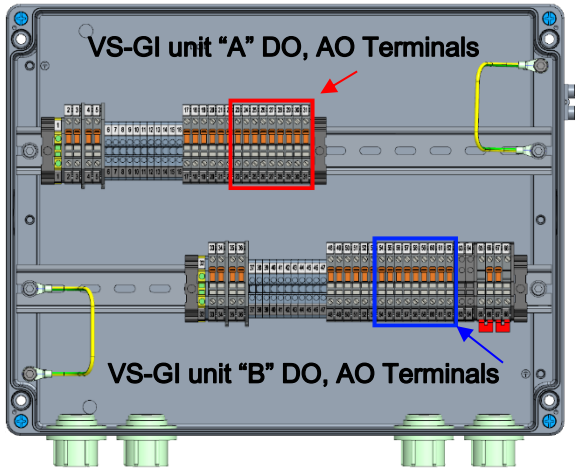

Figure 2-12. Discrete Outputs, Analog Outputs Terminals Inside VS-DX J-Box

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*.

30. Close the front cover of the junction box.

31. Verify all wire ends and terminals are properly marked in the VariStroke connection compartment. If not, mark according to the wiring diagram (see manual 35132).

32. Carefully cut-off cable ties in the VariStroke connection compartment (use Cable Tie Removal Tool) (Figure 2-13).

33. Unscrew cables from VariStroke power terminals #**35 to 38** (use slotted screwdriver; **3.5 X 0.6 mm** tip size) (Figure 2-14).

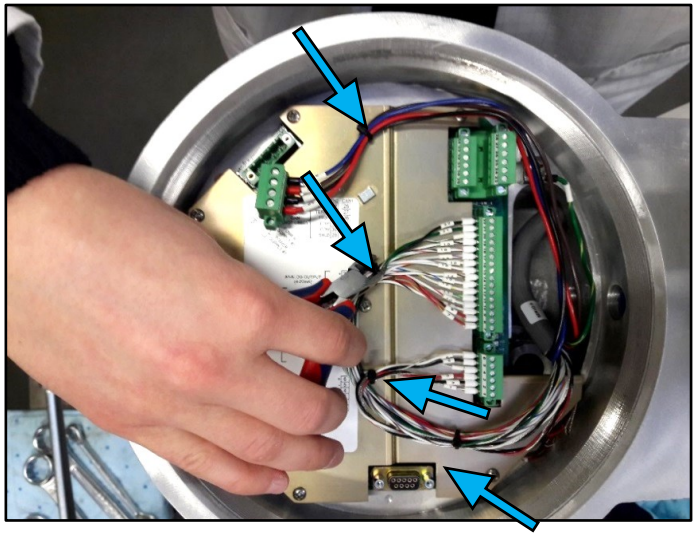

Figure 2-13. Cable Ties Removal Inside VariStroke

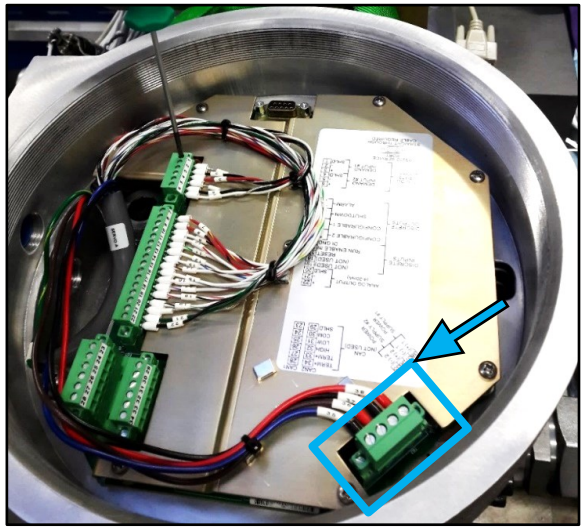

Figure 2-14. Power Connector Placement Inside VariStroke

34. Unscrew cables from VariStroke terminals **#1 to 22** (use slotted screwdriver; **2.5 X 0.4 mm** tip size) (Figure 2-15).

35. Unscrew grounding (use Phillips screwdriver; **PH2** tip size) (Figure 2-16).

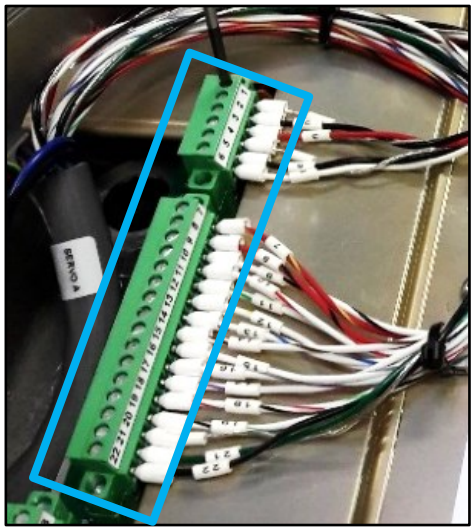

Figure 2-15. Signals Connector Placement Inside VariStroke

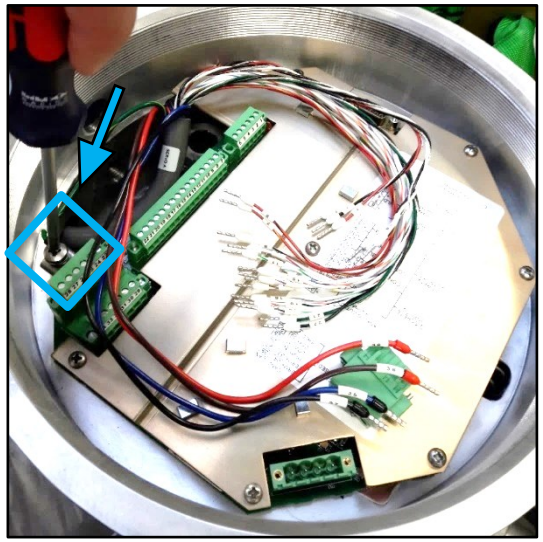

Figure 2-16. Ground Screw Placement Inside VariStroke

36. Unscrew 7 screws from the VariStroke PCB cover (use Phillips screwdriver; **PH2** tip size) (Figure 2-18).

37. Pick up the VariStroke PCB cover carefully as to not damage cables or PCB.

38. Verify all wire ends and terminals are properly marked on sensor wires. If not, mark according to the wiring diagram (Figure 2-19).

39. Unscrew cables from orange terminal [SENS 1 + PWR; SENS 1 +SIG; SENS 1 -SIG; SENS 1 -PWR; SENS 2 +PWR; SENS 2 +SIG; SENS 2 -SIG; SENS 2-PWR] (use Phillips screwdriver; **PH0** tip size) (Figure 2-19).

40. To protect wires while removing them from the VS housing, secure cable ends with vinyl electrical tape as shown below. To make the process easier, create two harness bundles (Figure 2-17)
    - Power cables from terminals #**35 to 38** in first protection jacket (one bundle)
    - Signals cables from terminals # **1 to 22** in second protection jacket (second bundle)

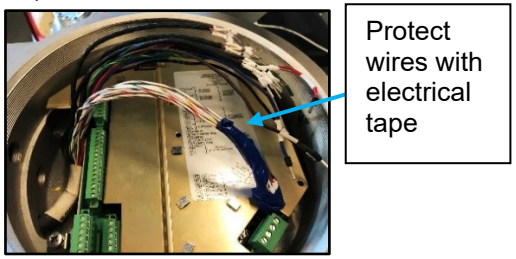

Figure 2-17. VariStroke Wires Protected with Vinyl Electrical Tape

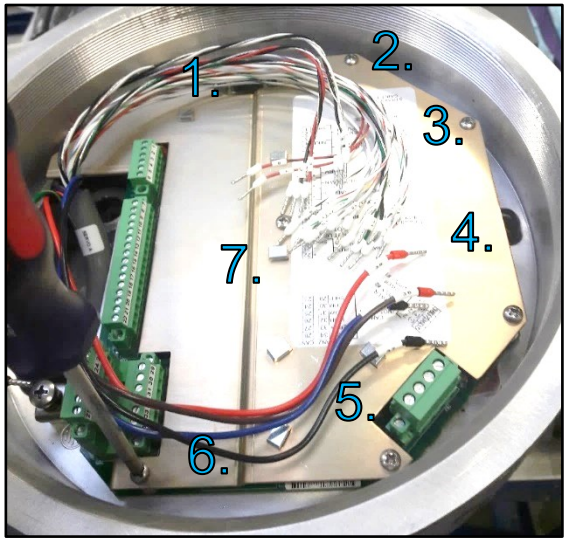

Figure 2-18. PCB Cover Holding Screws Placement Inside VariStroke

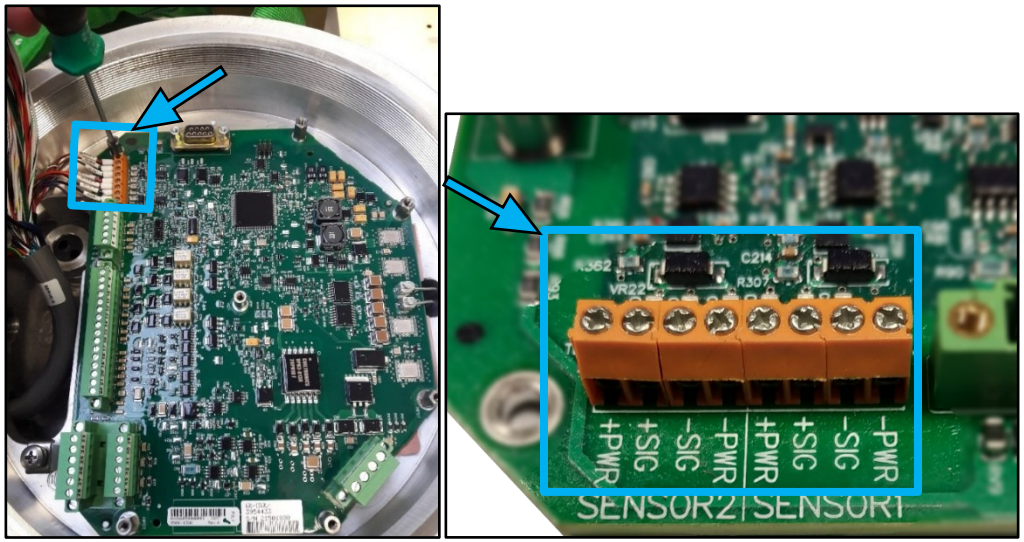

Figure 2-19. Actuator Position Sensors Terminals Placement Inside VariStroke

41. Loosen the conduit nut on the junction box side (use **1 1/2 in** open end wrench). Counter the junction box fitting (**use 1 13/16 in** open end wrench) (Figure 2-20).

42. Unscrew the conduit nut on the servo side (use **1 1/2 in** open end wrench) (Figure 2-21).

43. Unscrew the conduit adapter on the servo side (use **1 3/8 in** open end wrench (Figure 2-22).

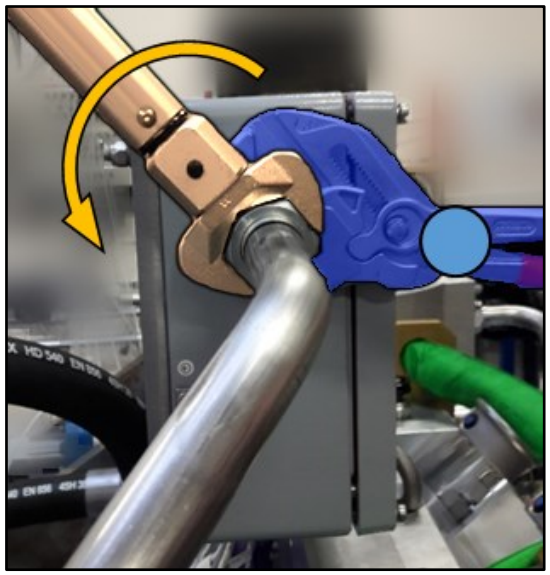

Figure 2-20. VariStroke J-Box Conduit Nut Loosening

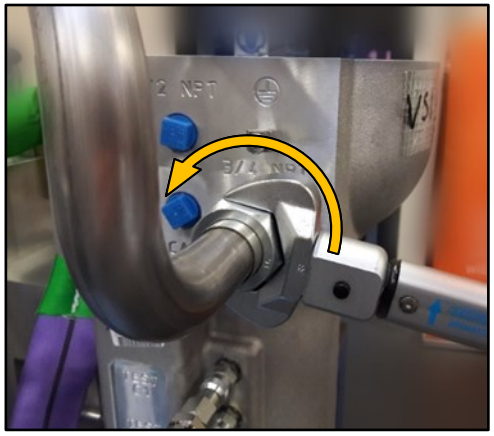

Figure 2-21. VariStroke Conduit Nut Loosening

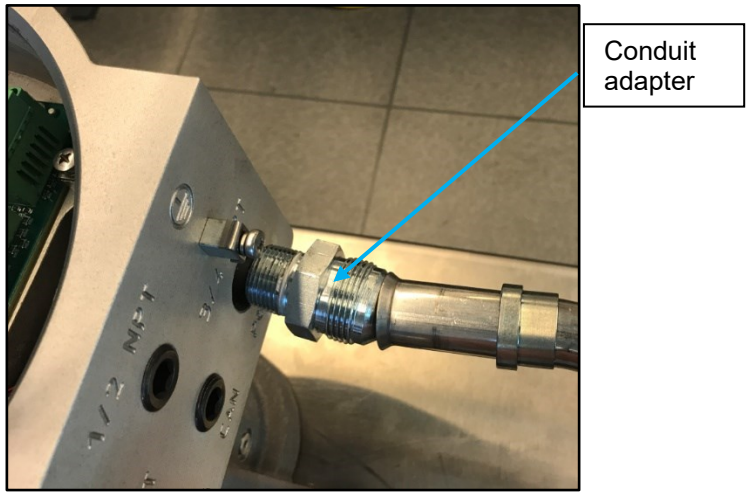

Figure 2-22. VariStroke Conduit Fitting Loosening

44. Feed the cable through the conduit toward the junction box, allowing the conduit to be rotated (Figure 2-23).

45. Carefully pull each bundle of wires individually by the VariStroke port to prevent wire damage (Figure 2-24).

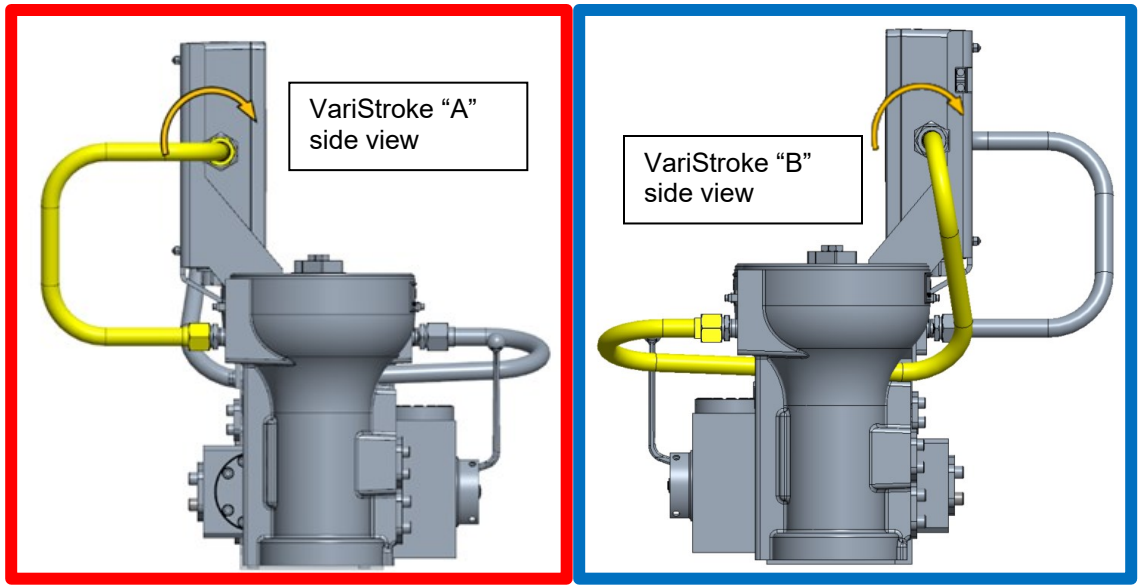

Figure 2-23. VariStroke Conduit Rotation

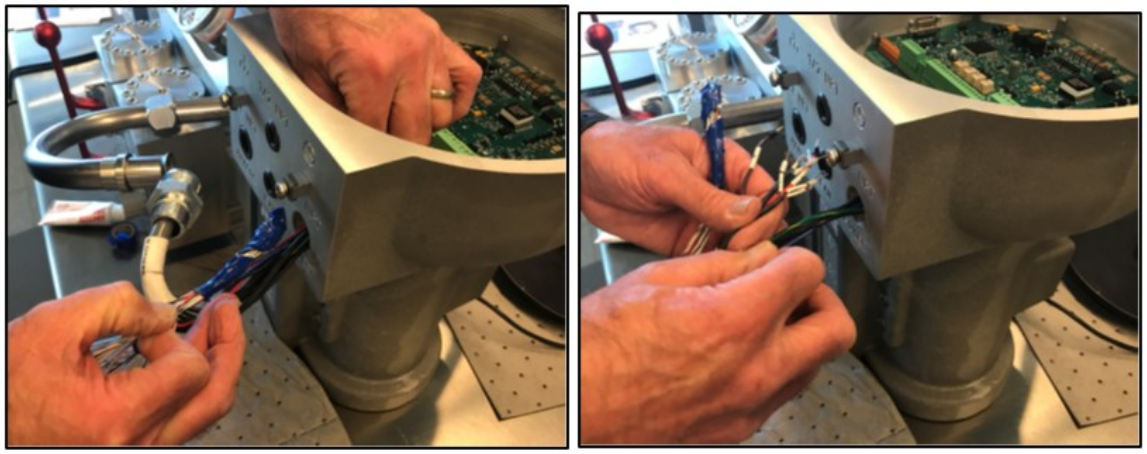

Figure 2-24. Wire Pulling from VariStroke

46. Install the VariStroke PCB cover with 7 screws (use Phillips screwdriver; **PH2** tip size).
    Note: There are two different lengths of screw (L=long, S=short); (Figure 2-25).

47. Install the VariStroke cover and torque to **100 ±10 LBFT (135 ±13.5 Nm)** using a **2 1/4 in** open end wrench (Figure 2-26).

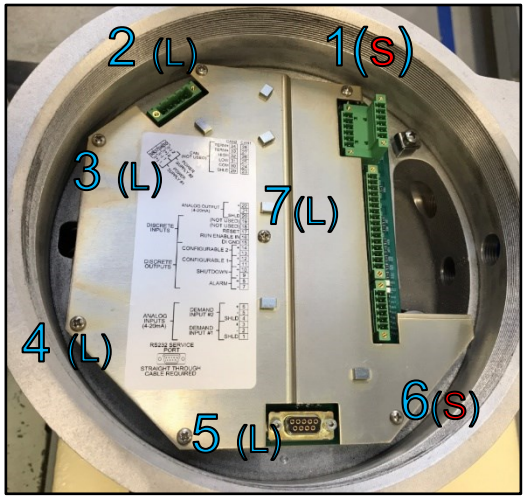

Figure 2-25. PCB Holding Screws Placement Inside VariStroke

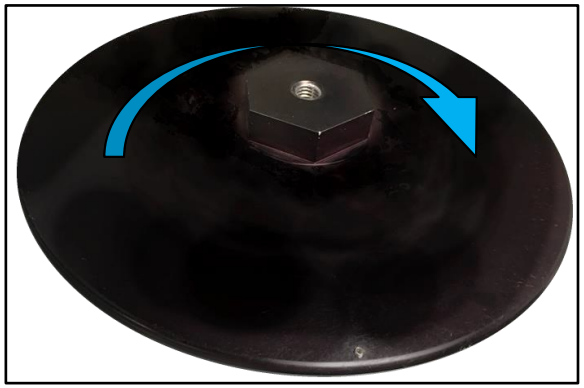

Figure 2-26. VariStroke Cover Installation

⚠WARNING

Failure to install the set screw could compromise the method of protection.

48. Screw in set screw in the withdrawn VariStroke cover (use **1.5 mm** socket head wrench). Thread the set screw into the cover until the end of the screw is flush with the top surface of the cover (Figure 2-27).

49. Screw the **.500-13 thread** eyebolt to the withdrawn VariStroke cover. Required thread engagement is 0.75 inch minimum (approx. 10 turns). Torque the eyebolt counter nut to **45 ±5 LBFT (61 ±7 Nm)** counter cover (use 2 **1/4 in** open end wrench) (Figure 2-28).

HINT: Use eyebolt installed on the new servo.

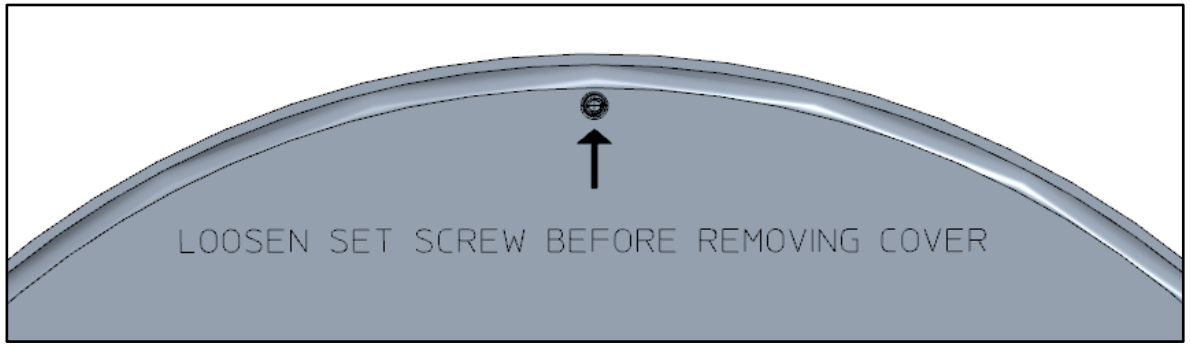

Figure 2-27. VariStroke Cover Set Screw Installation

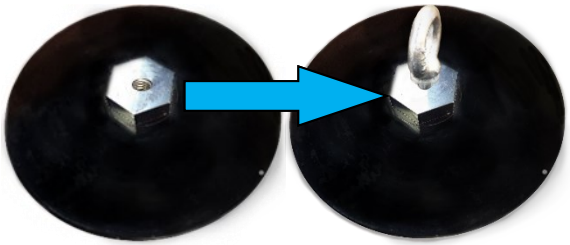

Figure 2-28. Eyebolt Installation

50. Place the oil collection container/oil absorbent mats under the piping being disconnected.

⚠WARNING

Potential for residual hot oil spillage exists.

It is recommended to place oil absorbent pads or a container underneath the servo assembly (5 liter capacity minimum) to collect residual oil leakage.

⚠WARNING

Take care when loosening the hydraulic piping. Released assembly stress can result in additional forces and unexpected piping displacement.

51. Unscrew the hydraulic supply pipe attached to the withdrawn servo.

52. Unscrew the hydraulic drain pipe attached to the withdrawn servo.

⚠WARNING

Remember to support the servo while disassembling. Ensure the crane, cables, straps, and all other lifting equipment, as well as the lifting lug being used for servo-valve transportation, can support the servo-valve weight.

53. Pull the lifting strap through the VariStroke eyebolt and secure the VariStroke prior to unscrewing it from the VS-DX skid manifold (gently tense the lifting strap) (Figure 2-29).

54. Place the oil absorbent mat under the VariStroke servo.

⚠WARNING

Potential for residual hot oil spillage exists.

It is recommended to place oil absorbent pads or a container underneath the servo assembly (5 liter capacity minimum) to collect residual oil leakage.

55. Unscrew the four screws connecting the VariStroke to the VS-DX skid manifold (use **3/4 in** open end wrench) (Figure 2-30).

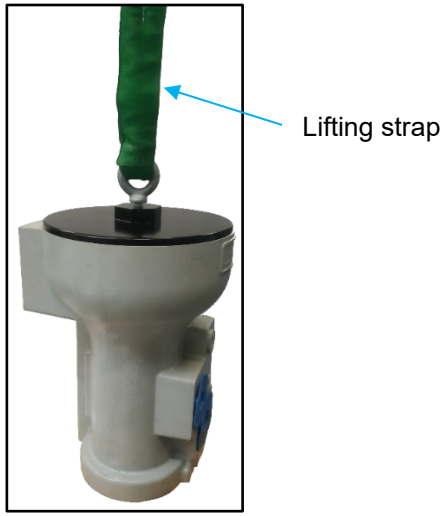

Figure 2-29. VariStroke with Lifting Strap Installed

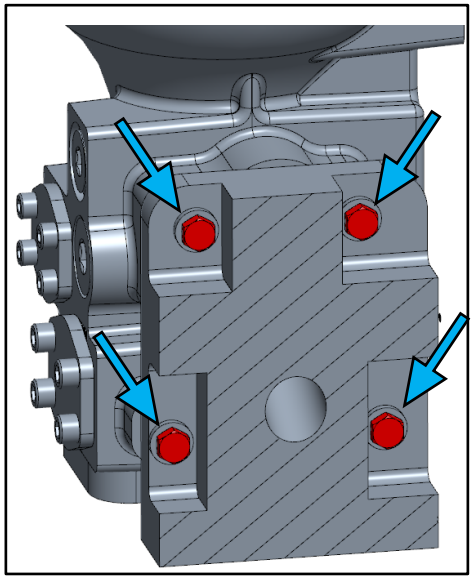

Figure 2-30. VariStroke Four Mounting Screws (VS-DX section view)

56. After unscrewing all four bolts, use lifting equipment to gently support the disjointed servo by pushing/pulling it in the directions shown in Figure 2-31.

57. Transport the withdrawn VariStroke away from the VS-DX skid manifold.

58. Ensure that withdrawn VariStroke's ports are secured with plugs to avoid internal cavity contamination (Figure 2-32 and Figure 2-33).

59. VariStroke Servo disassembly process completed.

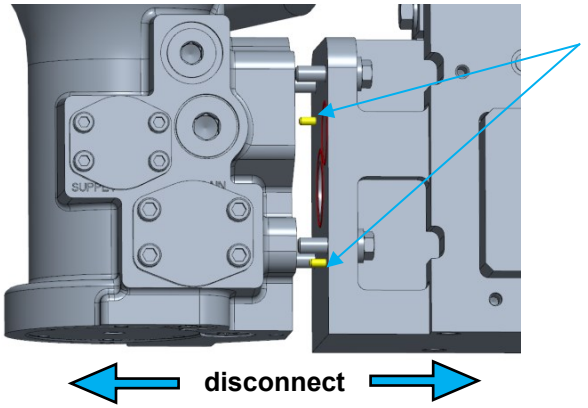

Figure 2-31. VariStroke Disconnection

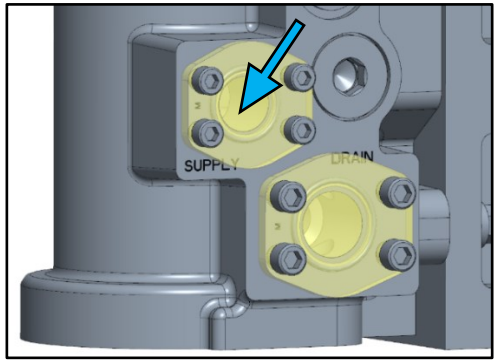

Figure 2-32. VariStroke with Supply Piping Disconnected and Plugged Port

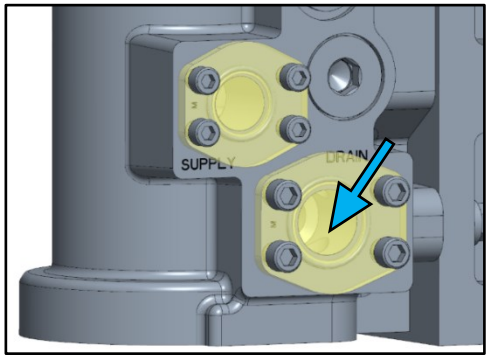

Figure 2-33. VariStroke with Drain Piping Disconnected and Plugged Port

2.3 VariStroke Servo Installation Procedure on VS-DX Skid

1. Remove the shipping plate by unscrewing all four bolts (use **3/4 in** open end wrench) (Figure 2-34).

2. Clean connection interface surfaces using Isopropanol alcohol (Figure 2-35).

3. Replace soft sealing in VariStroke DX skid manifold (use new seals provided with servo kit replacement; see replacement kit installation drawing P/N 9999-1897-1 and 9999-1897-2 for details).
   Lubricate O-rings (two pieces) with Parker Super O-Lube or petroleum jelly and install onto grooves (Figure 2-35).

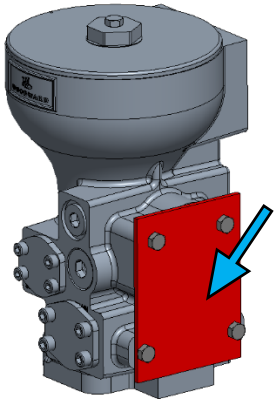

Figure 2-34. VariStroke Shipping Plate Removal

Note:
Lower port seal not required

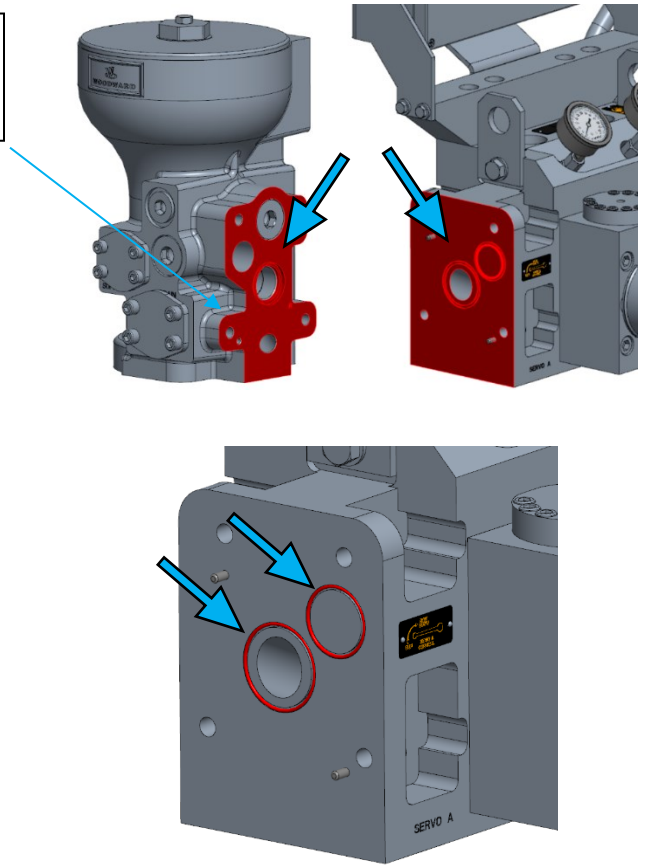

Figure 2-35. Connection Interface Cleaning and O-rings Installation

4. Unscrew the bolt from the new VariStroke cover (use **3/4 in** open end wrench) and counter cover (use **2 1/4 in** open end wrench) (Figure 2-36).

5. Screw the **.500-13 thread** eyebolt to the VariStroke cover (if it had been removed and used earlier while removing the servo from the skid). Required thread engagement is 0.75 inch minimum. Torque the eyebolt counter nut to **40-50 LBFT (54-81 Nm)** while countering the cover (use **2 1/4 in** open end wrench) (Figure 2-36).

⚠WARNING

Remember to support the servo while assembling. Ensure that the crane, cables, straps, and all other lifting equipment, as well as the lifting lug being used for servo-valve transportation, can support the servo-valve weight.

6. Pull the lifting strap through the VariStroke eyebolt prior to installing it onto the VS-DX skid manifold (Figure 2-37).

IMPORTANT

Remove plugs from the supply and drain ports if the supply and drain piping arrangement would not allow the plugs to be removed while installing the servo on the skid manifold.

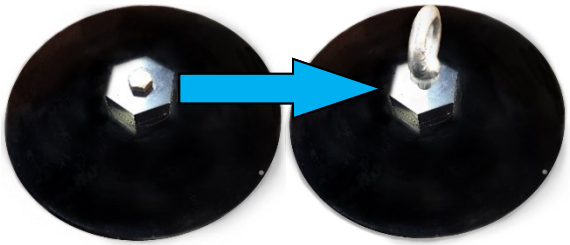

Figure 2-36. Eyebolt Installation

Figure 2-37. VariStroke with Lifting Strap Installed

7. Align the new VariStroke servo with the VS-DX manifold using two dowel pins (Figure 2-38).

⚠WARNING

Ensure sealing O-rings are correctly placed in their grooves during servo connection process.

8. Connect the servo with the VS-DX manifold. (Figure 2-39).

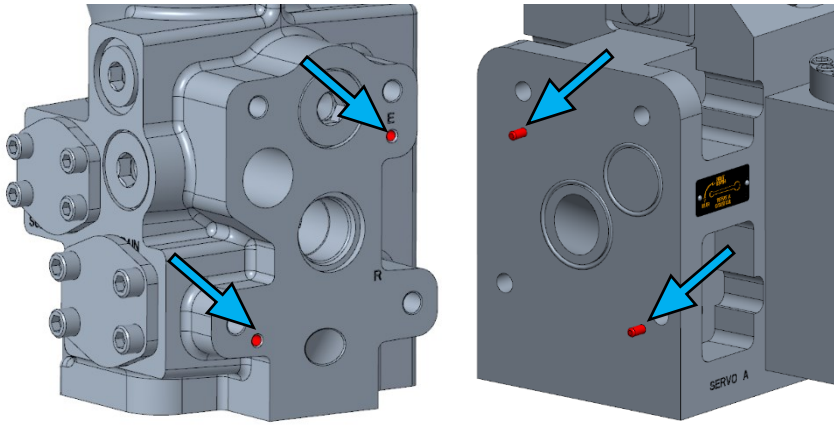

Figure 2-38. VariStroke Alignment with VS-DX Manifold

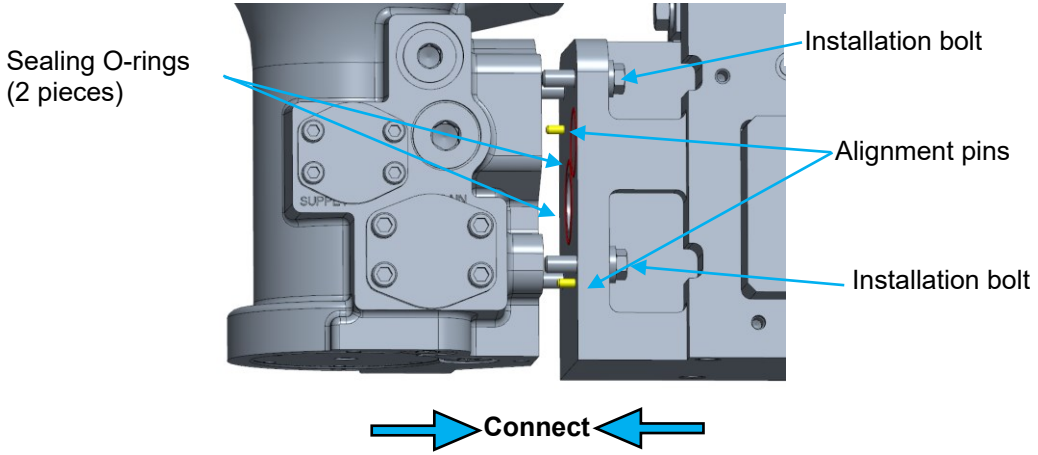

Figure 2-39. VariStroke Attaching to VS-DX Skid Manifold

9. Finalize the servo connection by tightening the four bolts (use **3/4 in** open end wrench, tighten to **50 ± 5 LBFT (68±7 Nm)** (Figure 2-40).

10. Release and remove the lifting strap used to secure the VariStroke servo during assembly.

11. Remove the port plug attached to the new servo and connect the hydraulic drain pipe flange bolts. Torque the bolts according to ISO 6162-1 (Figure 2-41).

12. Remove the port plug attached to the new servo and connect the hydraulic supply pipe flange bolts. Torque the bolts according to ISO 6162-1 (Figure 2-42).

13. Loosen the set screw from the new VariStroke cover (use **1.5 mm** socket head wrench (Figure 2-43).

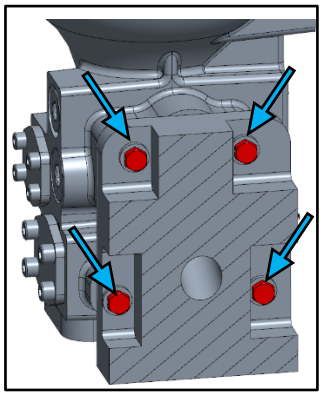

Figure 2-40. VariStroke Four Mounting Screws (VS-DX section view)

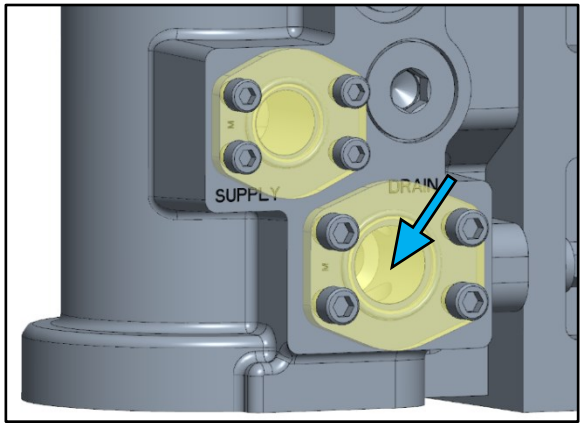

Figure 2-41. VariStroke Drain Port Location

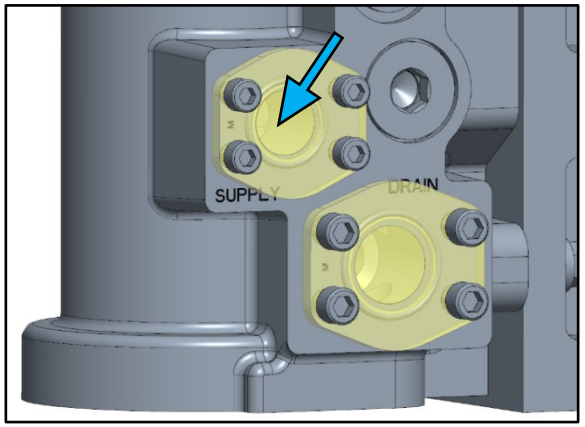

Figure 2-42. VariStroke Supply Port Location

Figure 2-43. VariStroke Cover Set Screw Location

14. Open the new VariStroke cover (use **2 1/4 in** open end wrench) (Figure 2-44).

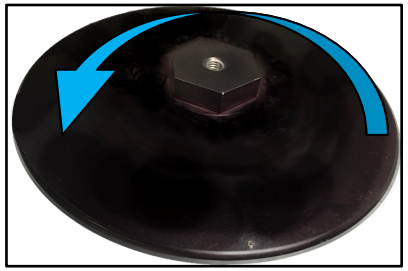

Figure 2-44. VariStroke Cover Opening

15. Clean the conduit adapter threads (Figure 2-45).

16. To protect wires while routing them through the VS housing, wrap wires with vinyl electrical tape. To make the cable installation process easier, create two harness bundles (Figure 2-46).
    - Gather power cables from terminals **#35 to 38** in the first protection jacket (one bundle)
    - Gather signals cables from terminals **#1 to 22** in the second protection jacket (second bundle)

    Verify all wires are routed through the conduit adapter (Figure 2-46).

17. Carefully route each individual bundle of cable wires through the servo power port to prevent wire damage (Figure 2-46).

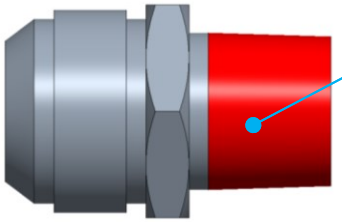

Figure 2-45. Cleaning Conduit Adapter Thread

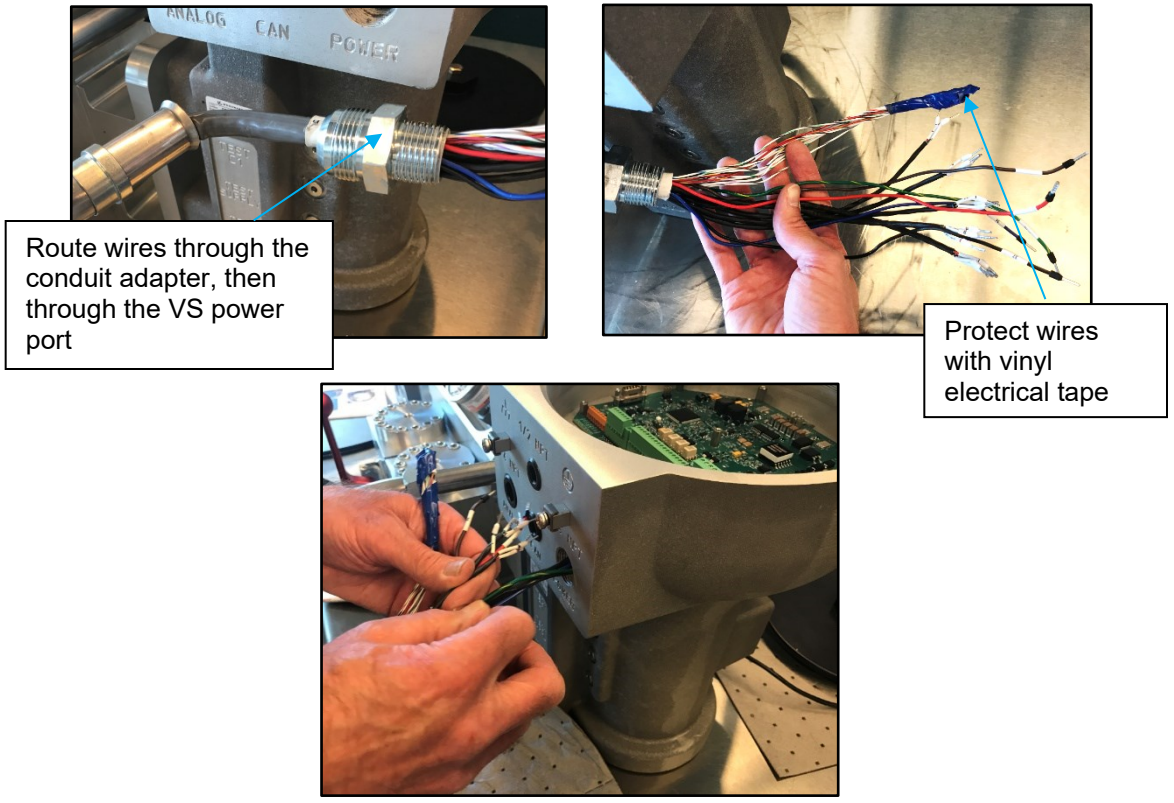

Figure 2-46. Wiring Routing for Connection

18. Apply Loctite 592 to the previously cleaned tapered threads prior to assembly. Install the adapter into the servo's "power" port hole. Tighten installed fitting on the servo side to **62 ±6 LBFT (76 – 92 Nm)** (use **1 3/8 in** open end wrench (Figure 2-47).

    With a clean shop towel, clean the excess Loctite 592 from the connector.

⚠WARNING

Failure to apply thread sealant could compromise the method of protection.

19. Place conduit nuts on the conduit fittings on both the junction box and the servo valve.

20. While holding the servo conduit fitting, tighten the conduit nut on the servo side to **114 ±14 LBFT** (**154 ±18 Nm**) (use 1 1/2 in open end wrench) (Figure 2-47).

21. While holding the junction box conduit fitting, tighten the conduit nut on the junction box side to **114 ±14 LBFT** (**154 ±18 Nm**) (use **1 1/2 in** open end wrench).

    Counter the junction box fitting (use **1 13/16 in** open end wrench (Figure 2-48).

Figure 2-47. VariStroke Conduit Adapter Installation

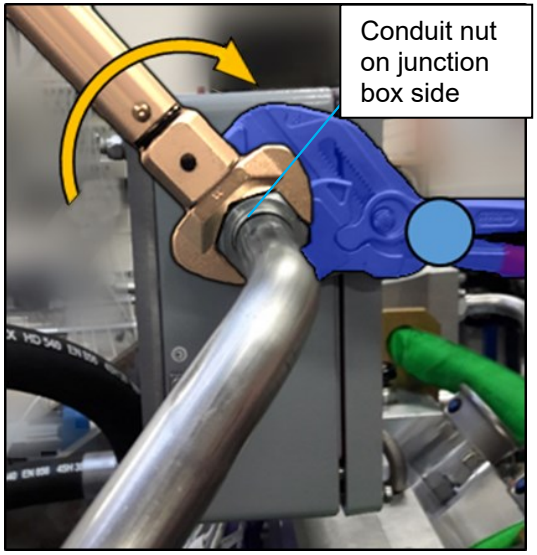

Figure 2-48. VariStroke J-Box Conduit Nut Tightening

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*.

22. Remove the protective electrical tape after placing the cable inside the VariStroke PCB compartment (Figure 2-49).

23. Unscrew seven screws from the VariStroke PCB cover (use Phillips screwdriver; **PH2** tip size) and remove the cover.

    Note: There are two different lengths of screw (L=long, S=short) (Figure 2-50).

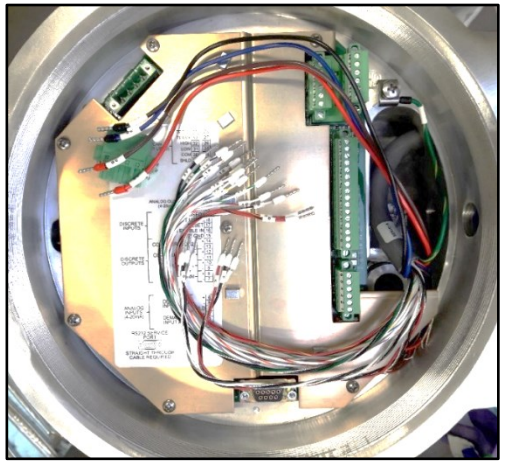

Figure 2-49. Vinyl Electrical Tape Protection Removed From Wires

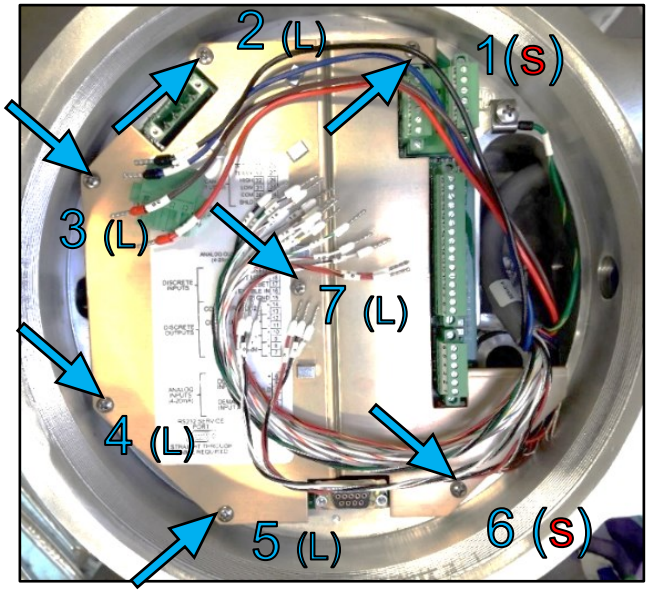

Figure 2-50. VariStroke PCB Cover Screws Location

24. Connect position sensor(s) cables to the orange terminal

[SENS 1 -PWR; SENS 1 -SIG; SENS 1 +SIG; SENS 1 +PWR; SENS 2 -PWR; SENS 2 -SIG; SENS 2 +SIG; SENS 2 +PWR].

Torque to **6.2 ±0.9 LBIN** (**0.7 ±0.1 Nm**) (use Philips screwdriver; **PH0** tip size) (Figure 2-51).

25. Install the PCB cover using all seven screws and torque to **12 ±1 LBIN** (**16 ± 1 Nm**) (use Philips screwdriver; **PH2** tip size)

Note: There are two different lengths of screw (L=long, S=short) (Figure 2-50).

26. Screw the grounding screw and torque to **12 ±1 LBIN** (**16 ± 1 Nm**) (use Philips screwdriver; **PH2** tip size) (Figure 2-52).

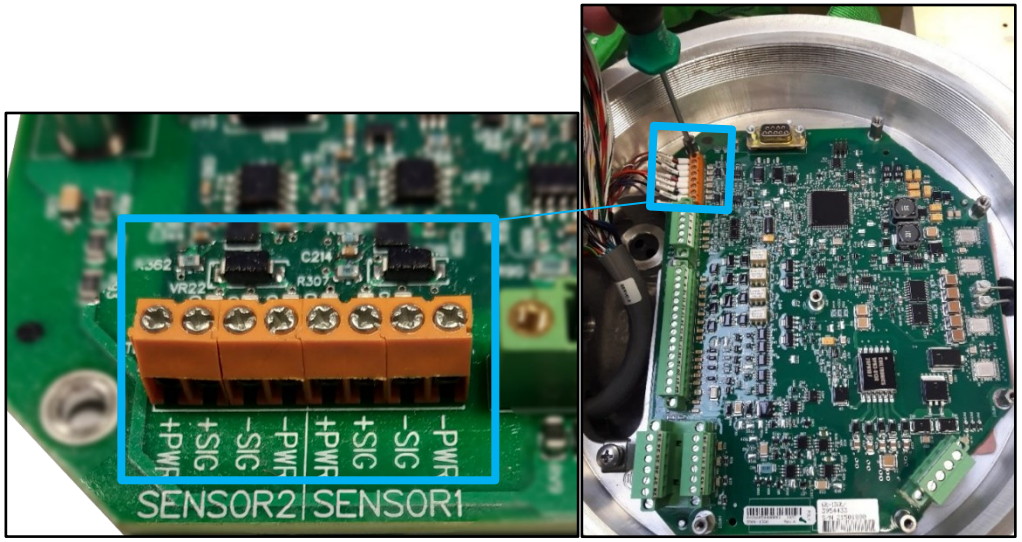

Figure 2-51. Actuator Position Sensors Terminals Placement Inside VariStroke

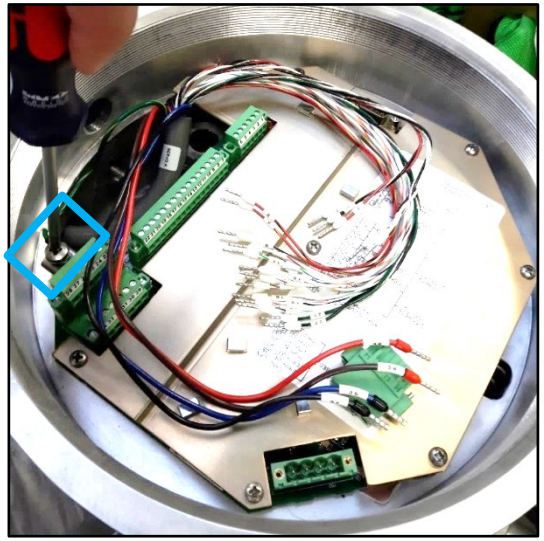

Figure 2-52. Ground Screw Placement Inside VariStroke

27. Install signal cables to VariStroke terminals #**1 to 22.** Torque to **6.2 ±0.9 LBIN** (**0.7 ±0.1 Nm**) (use slotted screwdriver; **3.5 X 0.6 mm** tip size) (Figure 2-54).

HINT: To avoid connection error between cable numbers #6 and #9, verify cable color:

Terminal #6: connected cable color: **WHITE**

Terminal #9: connected cable color: **WHITE/BLACK**

28. Install power cables to VariStroke power terminals #**35 to 38.** Torque to **6.2 ±0.9 LBIN** (**0.7 ±0.1 Nm**) (use slotted screwdriver; **3.5 X 0.6 mm** tip size) (Figure 2-55).

29. Secure the installed cable in VariStroke connection compartment using cable ties. (Figure 2-55).

30. Open the junction box by unscrewing the four bolts from the junction box front cover (use slotted screwdriver; **5.5 X 0.8 mm** tip size) (Figure 2-53).

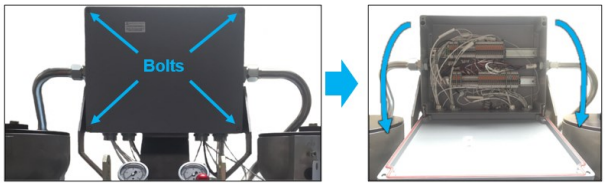

Figure 2-53. VS-DX J-Box Opening

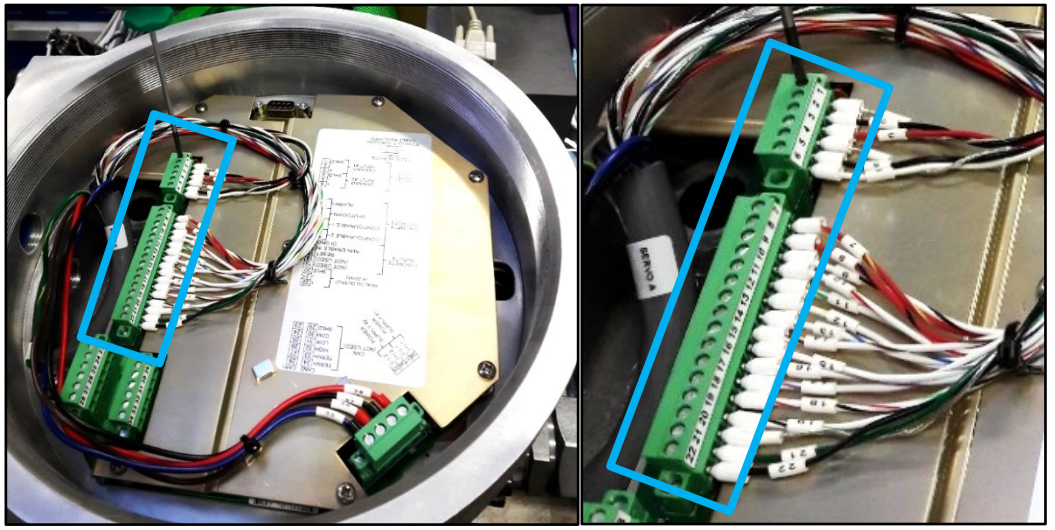

Figure 2-54. Signals Connector Placement Inside VariStroke

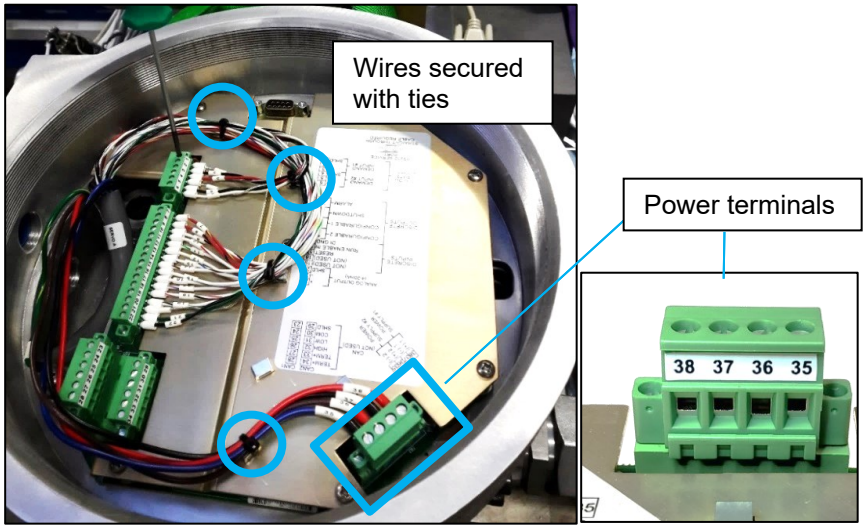

Figure 2-55. Power Connector Placement Inside VariStroke

31. Close the knife disconnect terminals for the newly installed VariStroke **[Discrete Outputs]** **(VariStroke A terminals #23 through 26, 4 terminals)** or **(VariStroke B terminals #54 through 57, 4 terminals)** (Figure 2-56 and Figure 2-57).

32. Close the knife disconnect terminals for the newly installed VariStroke **[Analog Output]** **(VariStroke A terminals #29 through 31, 3 terminals)** or **(VariStroke B terminals #60 through 62, 3 terminals)** (Figure 2-56 and Figure 2-57).

33. Knife disconnect terminals **(VariStroke A terminals #27 and 28, 2 terminals)** or **(VariStroke B terminals #58 and 59 , 2 terminals)** shall remain open (position OFF) (Figure 2-57 and Figure 2-58).

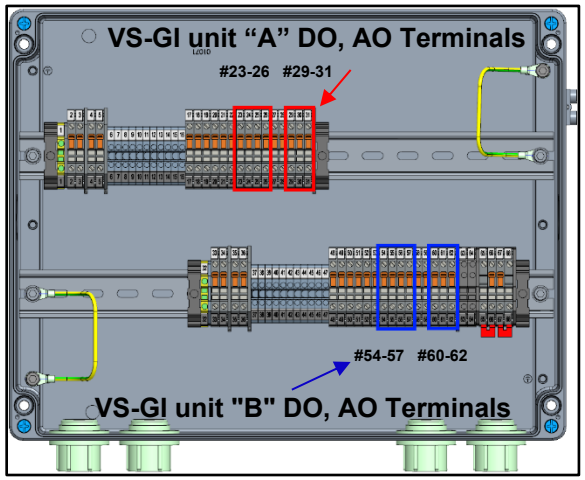

Figure 2-56. Discrete Outputs and Analog Outputs, Terminals Inside VS-DX J-Box

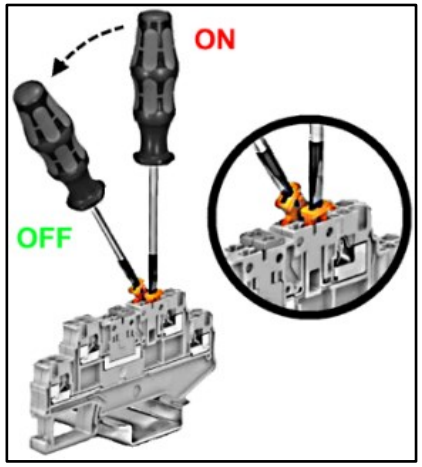

Figure 2-57. Knife Disconnect Terminal Usage

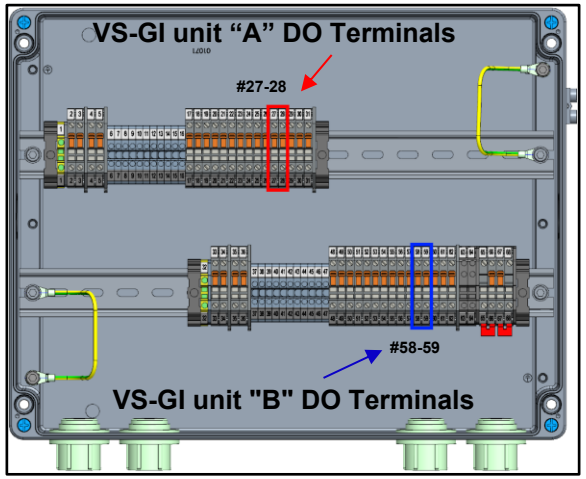

Figure 2-58. Discrete Outputs, Terminals Remaining Open Inside VS-DX J-Box

34. Reinstate the electrical power to the new VariStroke:
    a) Close knife terminals **[POWER]** in the junction box **:**

       VariStroke A terminals #2 through 5, 4 terminals) or

       (VariStroke B terminals #33 through 36, 4 terminals) (Figure 2-59)
    b) Power on the supply circuit at the customer side.

⚠WARNING

Power knife disconnect terminals can be opened only when not energized.

NOTICE

For a detailed description on how to connect and use the Customer Service Tool software, please refer to manual 35148

35. Connect the communication cable to the new VariStroke using the RS-232 communication cable (Figure 2-60).

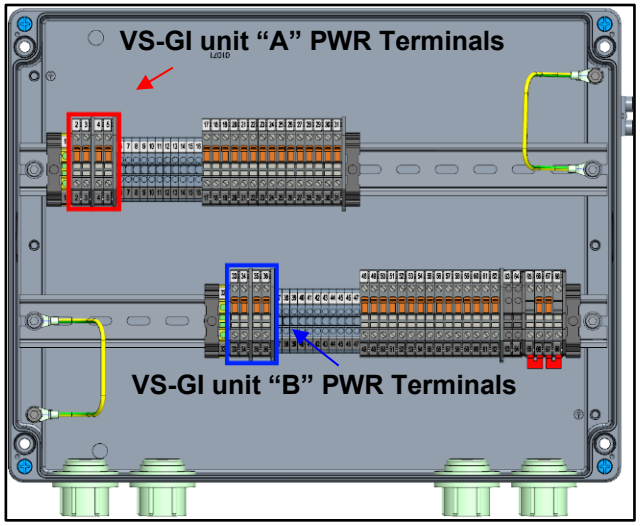

Figure 2-59. Power Terminals Inside VS-DX J-Box

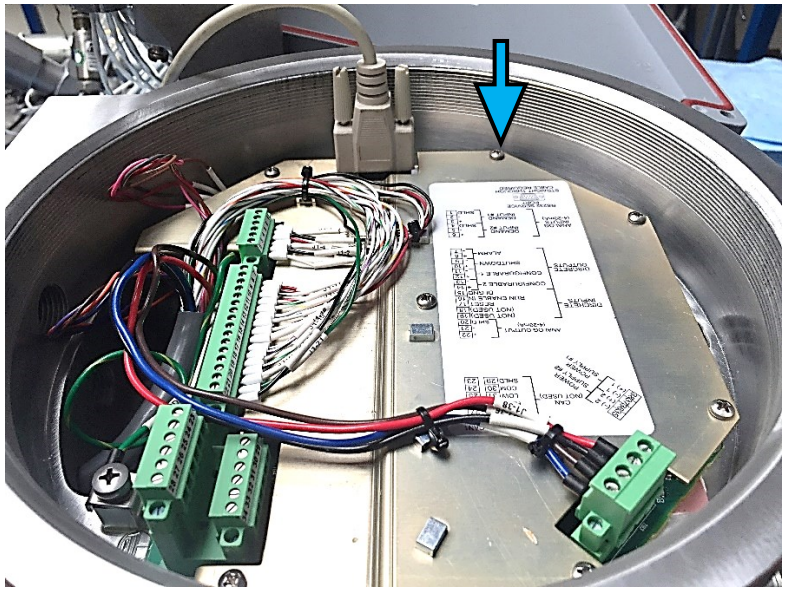

Figure 2-60. Connecting RS-232 Link

36. Launch the VariStroke Customer Service Tool application.

37. Establish a connection to the newly installed VariStroke by pressing the connect button in the Customer Service Tool software. (Figure 2-61).

38. Load the VariStroke settings file from a PC to the new VS-GI (Figure 2-62). Click on Settings in the ribbon at the top left of the page and select “Load to Device”.

WARNING

Any change of parameters must be saved by using the “Save Values” button (microchip icon). This ensures parameters are stored in a non-volatile memory and will be recovered at the next power up. Unsaved changes will disappear at the next power up and may lead to significant configuration change and affect safe system operation.

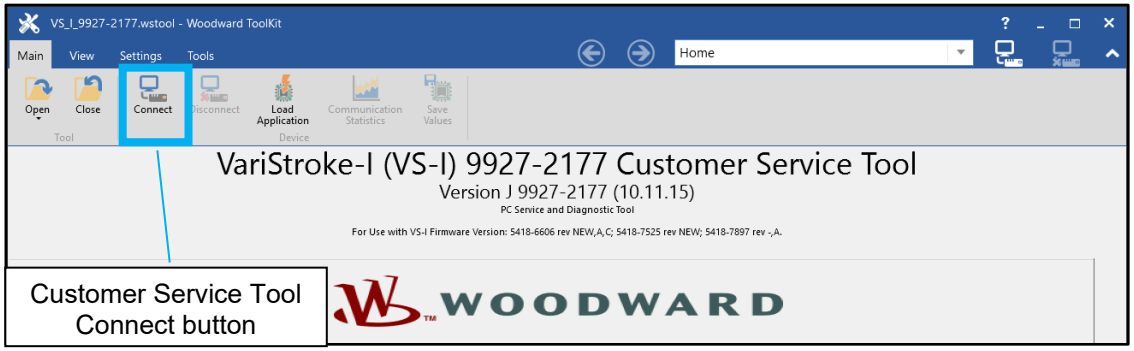

Figure 2-61. VS-I Customer Service Tool Home Screen

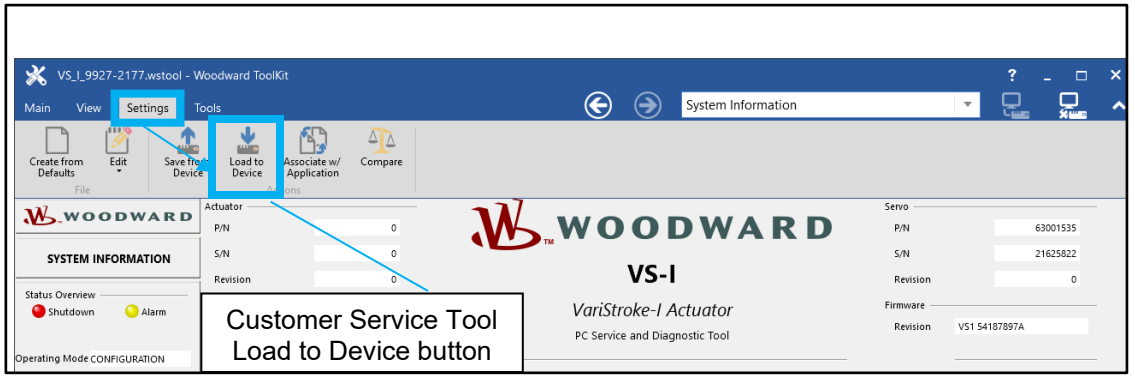

Figure 2-62. Settings File Loading to VariStroke

39. Save configuration values (Figure 2-64)

40. On the Configure Alarms/Shutdowns screen, verify that **Cylinder Tracking Alarm** has configuration "**E A N**" (Enable/Alarm/Non-Latched) and **Cylinder Tracking Fault** has configuration "**E A L**" (Enable/Alarm/Latched) (Figure 2-65). If not, modify them so they are set to Alarm. These settings are required for the next steps of the installation procedure only, and final customer values will recover later. The desired configuration is shown in Figure 2-63.

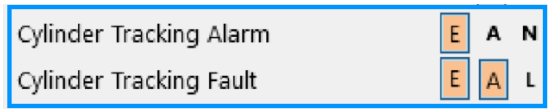

Figure 2-63. Cylinder Tracking Alarm/Shutdown Configuration

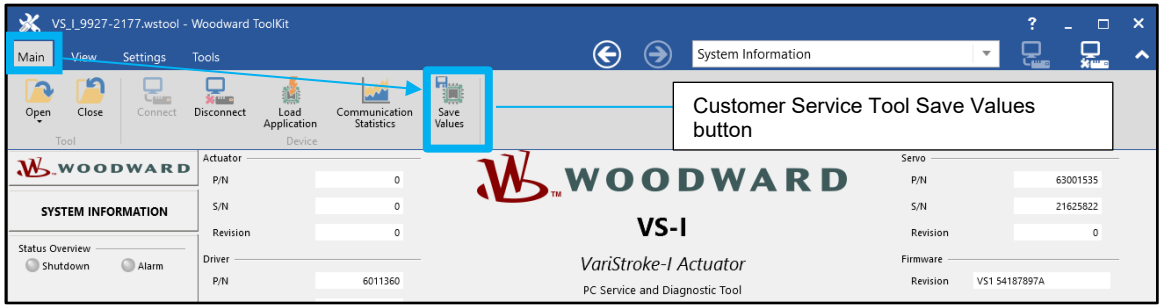

Figure 2-64. Save Values Button Location

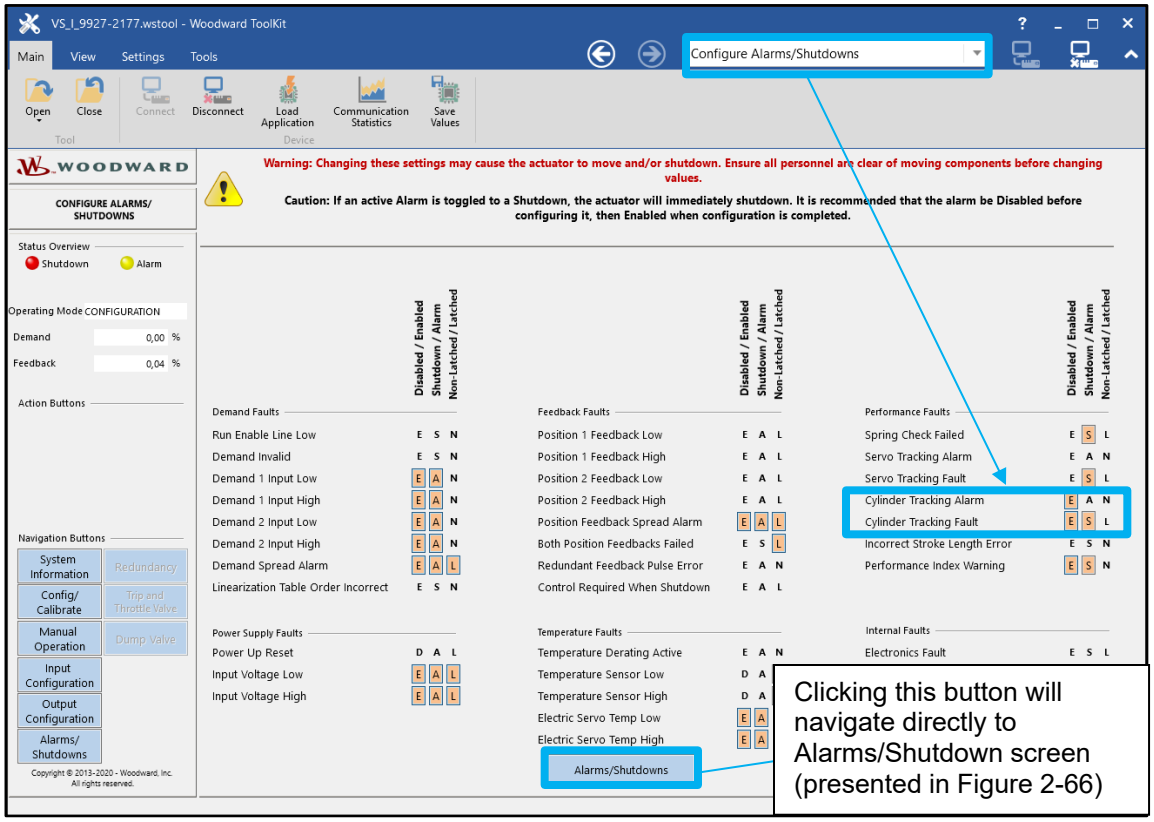

Figure 2-65. Alarms/Shutdowns Configuration Page

41. Reset alarms by using the Reset button on Alarms/Shutdowns screen (Figure 2-66).

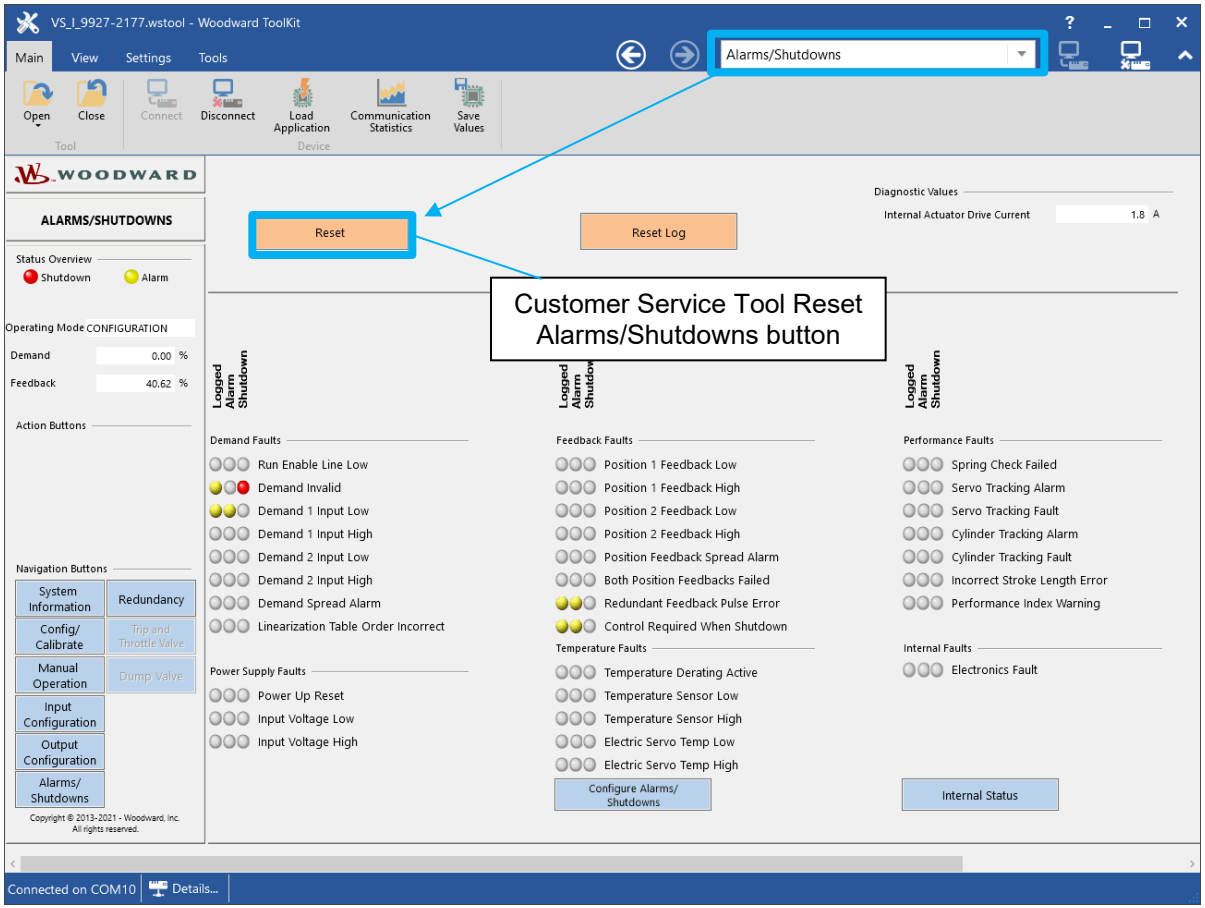

Figure 2-66. Alarms/Shutdowns Page

42. Open the hydraulic drain to the new VariStroke (valve located on system process piping – not provided with VS-DX) [notate result in Checklist: ID #1].

43. Open hydraulic supply to the newly installed VariStroke (valve located on system process piping – not provided with VS-DX) [notate result in Checklist: ID #2].

44. Wait for five minutes.

NOTICE

Waiting for five minutes is highly recommended to let the new servo fill with hydraulic oil.

⚠WARNING

Prior to air bleeding, the servo being serviced must be hydraulically isolated from the cylinder. Any possible leakage will interfere with the cylinder positioning, causing uncontrolled movement or oscillations. During air bleeding procedure, User must observe the cylinder position under the other servo's control. In case of abnormal cylinder behavior, air bleeding must be canceled immediately by pressing the Cancel button.

45. Using the Customer Service Tool software, navigate to the Redundancy screen and initiate "Servo Air Bleeding Procedure" on the newly installed VariStroke by pressing activation button "Start Servo Air Bleeding" (Figure 2-67 and 2-68) (refer to manual 35148).

NOTICE

Air Bleeding page is available only for redundant servo configuration VS-DX.

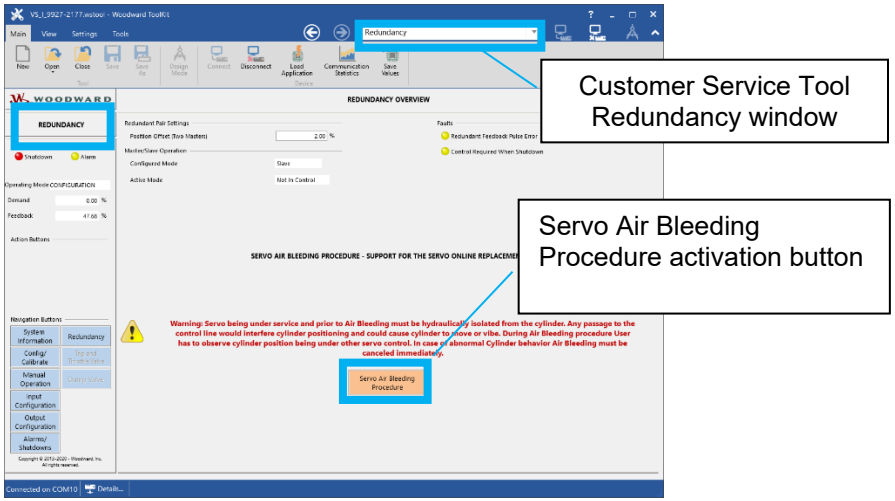

Figure 2-67. Redundancy Screen – Air Bleeding Control Screen

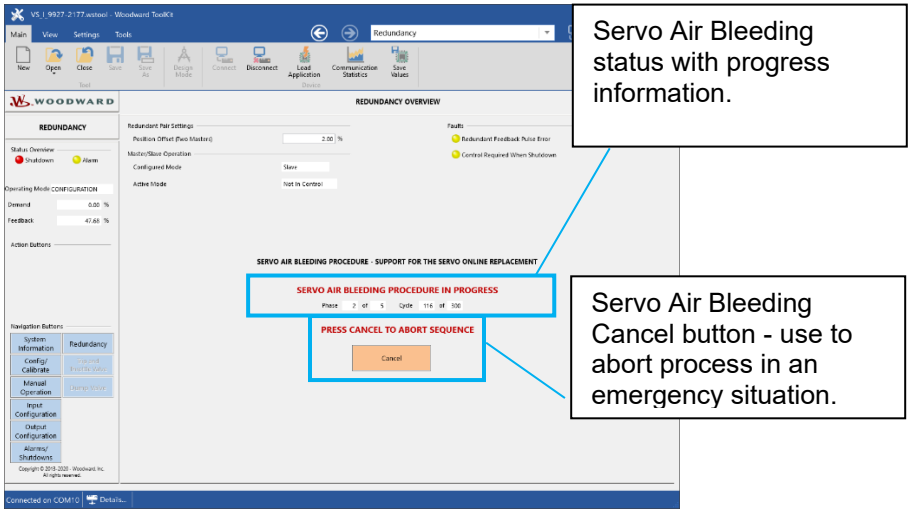

Figure 2-68. Air Bleeding Progress Screen

NOTICE

The servo air bleeding procedure takes about 20-30 minutes depending on the supply oil pressure. Please be patient. The Customer Service Tool will confirm when the procedure has ended.

46. Confirm the “Servo Air Bleeding Procedure is Completed” in the Customer Service Tool (Figure 2-69) [notate the result in Checklist: ID #5].

47. Load the VariStroke settings file from a PC to the new VS-GI once again– this is to retrieve all customer specific configurations (Figure 2-62):

    a) Click on Settings in the ribbon at the top left of the page and select “Load to Device”.
    b) Wait until the Customer Service Tool confirms successful operation displaying message: **“Device settings loaded successfully”.** [Notate the result in Checklist: ID #6].
    c) Save configuration values (Figure 2-64).

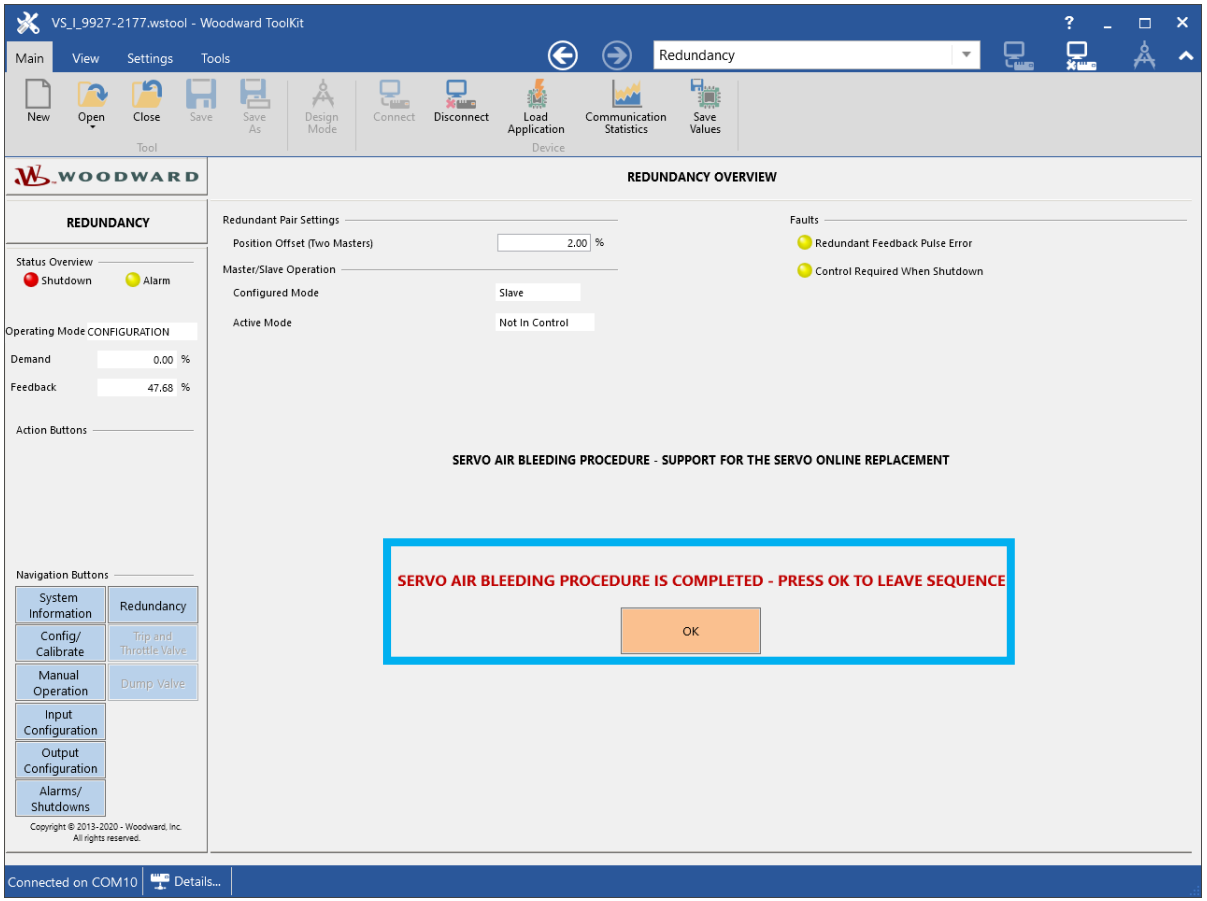

Figure 2-69. Servo Air Bleeding Completed

⚠WARNING

Review the Customer Service Tool software pages and verify that the parameterization/settings are aligned with plant needs (this is especially important when the settings file *.wset comes from the plant archives).

48. If RunEnable command is used in the system, execute the following steps (a-d) on the newly installed unit:
    a) Ensure control system command **RunEnable** is set to **False** on the newly installed unit
    b) In the Customer Service Tool, verify current **Run Enable** Status is **Circuit Open** on the Input Configuration page [notate result in Checklist: ID #14] (Figure 2-70)
    c) Set the **RunEnable** command in the control system to **True**
    d) In the Customer Service Tool, verify that the current **Run Enable** Status is **Circuit Closed** [notate result in Checklist: ID #13] (Figure 2-70).

49. Verify the **Reset** command loop with the following steps (a-d):
    a) From the control system, command **Reset True** to the newly installed unit.
    b) In the Customer Service Tool, verify current **Reset** Status is **Circuit Closed** on input configuration page (Figure 2-70) [notate result in Checklist: ID #15]
    c) From the control system, command the **Reset** value to **False**.
    d) In the Customer Service Tool, verify the current **Reset** status is **Circuit Open** (Figure 2-70) [notate result in Checklist: ID #16].

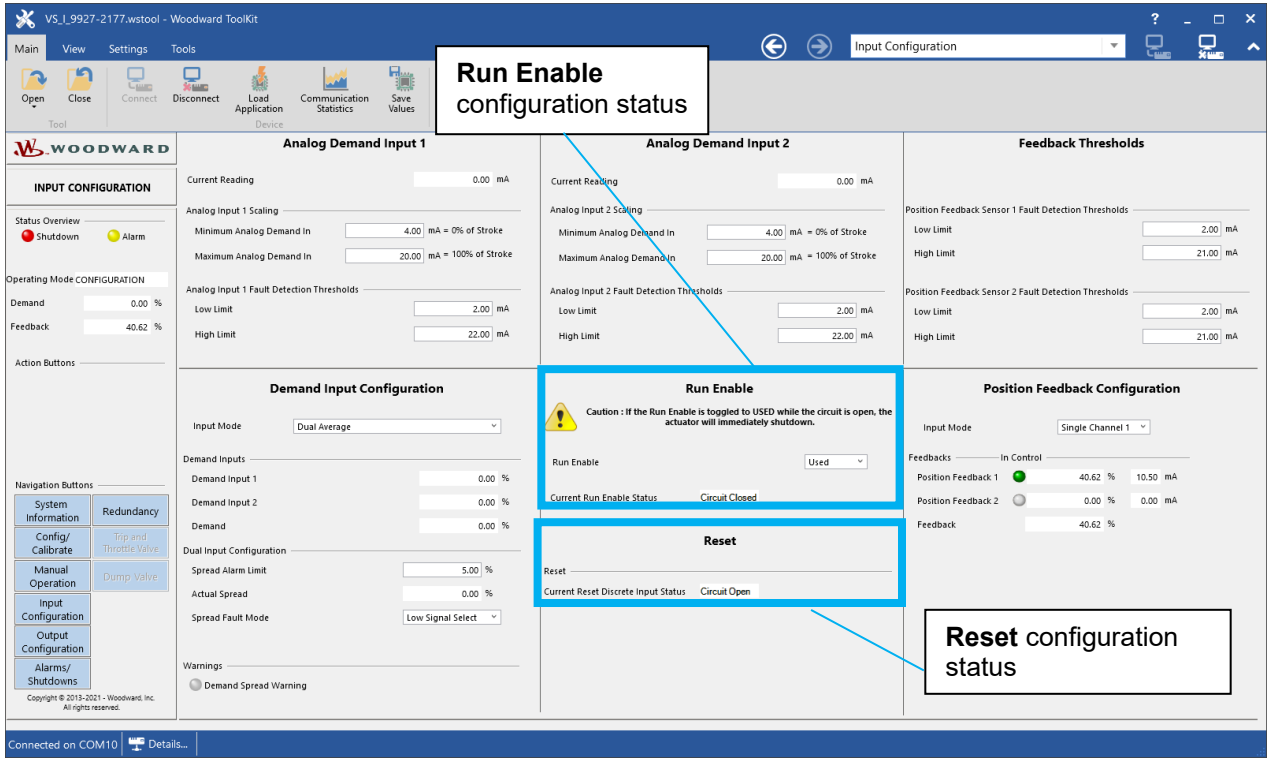

Figure 2-70. Run Enable and Reset Status on the Input Configuration Screen

50. In the control system, verify that the new VariStroke communicates **Shutdown active** [notate result in Checklist: ID #23].

51. Close knife terminals **[ANALOG DMD CH1, ANALOG DMD CH2]** for the new VariStroke (Figure 2-71)
(VariStroke A terminals # 17 through 22, 6 terminals) or
(VariStroke B terminals # 48 through 53, 6 terminals)

52. Perform verification and comparison of demands (Demand Input 1, Demand Input 2). Values recorded between the control system and the newly installed VariStroke **must be identical** per the Customer Service Tool Input Configuration screen (Figure 2-72), although very minor differences are expected. Register two readings to confirm the values are alive [notate result in Checklist: ID #9, #10, and #11, #12 if used].

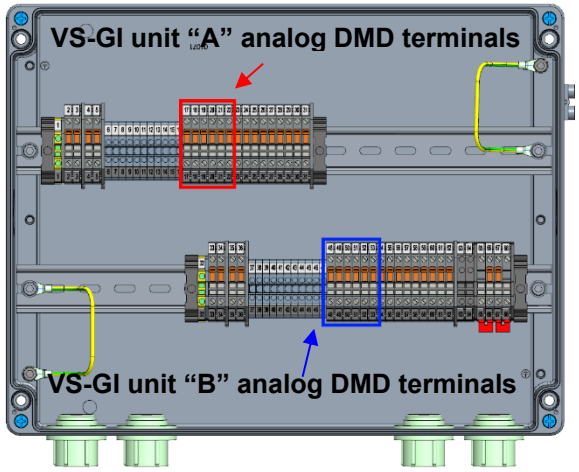

Figure 2-71. Analog Demand Terminals

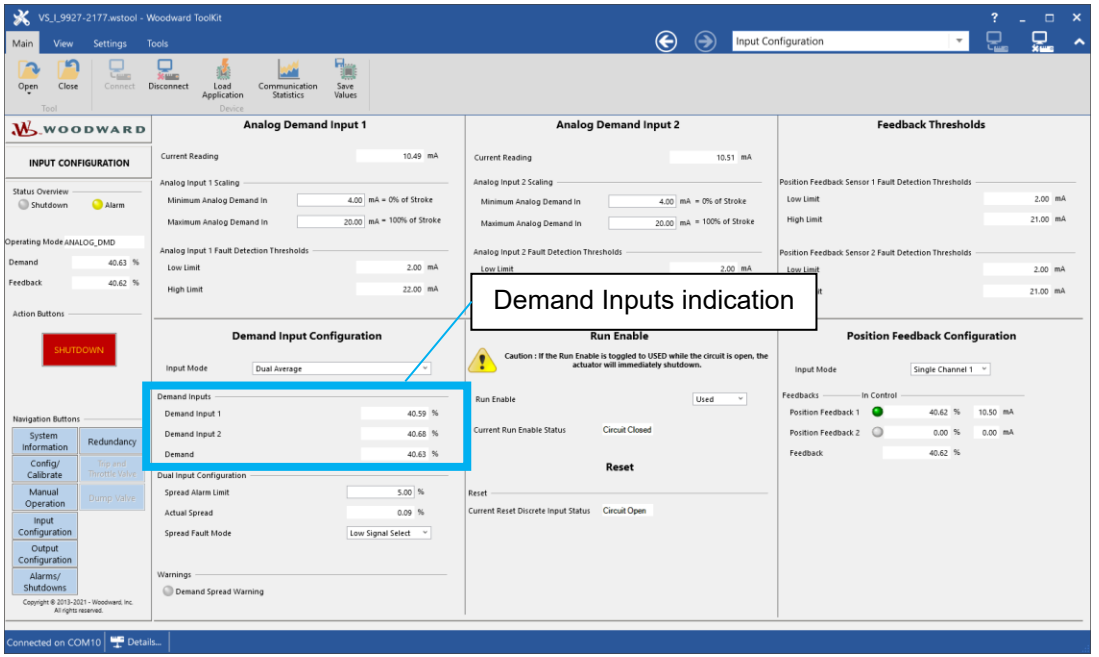

Figure 2-72. Input Configuration Screen

53. In the control system, verify that the new VariStroke **does not communicate Shutdown** [notate result in Checklist: ID #24].

54. In the control system, verify that the new VariStroke communicates **Alarm active** [notate result in Checklist: ID #21].

55. On the Alarm/Shutdown screen, verify that the **Redundant Feedback Pulse Error** is currently active [notate result in Checklist: ID #19] (Figure 2-73).

56. Close knife terminal **[HEALTH LINK]** from the other operating unit **(VariStroke A terminal # 66)** or **(VariStroke B terminal # 67)** (Figure 2-74).

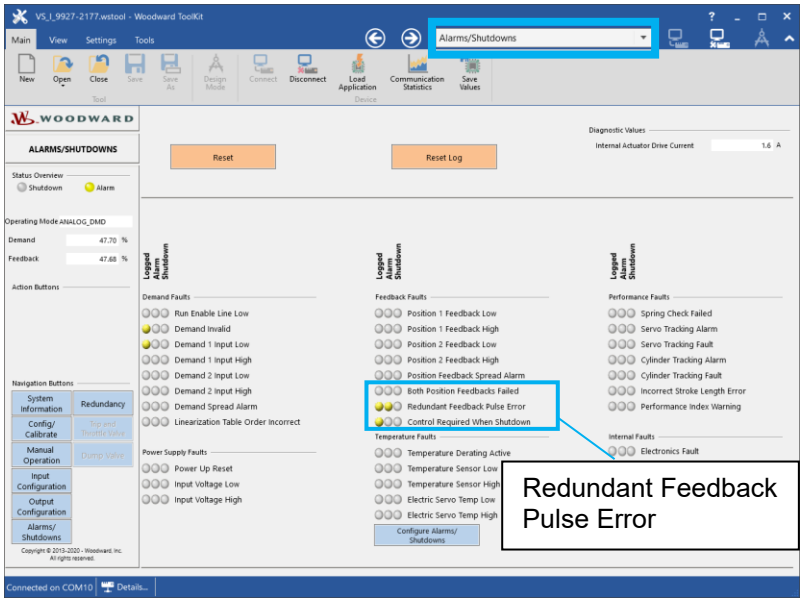

Figure 2-73. Redundant Feedback Pulse Error on the Alarms/Shutdowns Screen

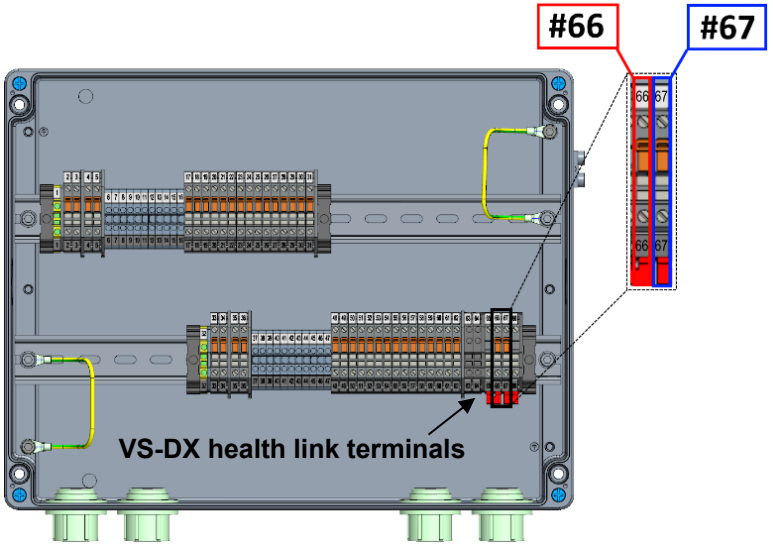

Figure 2-74. Health Link Terminals Inside VS-DX J-Box

57. On the Alarm/Shutdown screen, verify that Redundant Feedback Pulse Error is not currently active in the Alarm column [notate result in Checklist: ID #20] (Figure 2-73).

58. In the control system, verify that the new VariStroke does not communicate **Alarm**. [notate result in Checklist: ID #22].

59. Using the Customer Service Tool software, navigate to the Redundancy screen and verify if the configured mode on the newly installed VariStroke is **SLAVE** and Active Mode is **Not In Control** (Figure 2-75). If not, verify what the cause of the issue is with the unit (most likely incorrect wiring of Master/Slave designation or the control system has the wrong signal) [notate result in Checklist: ID #18].

60. In the control system, verify the new VariStroke communicates that it is **NotInControl**. However, if the status reads InControl, then there is a short circuit in the wires for this signal.

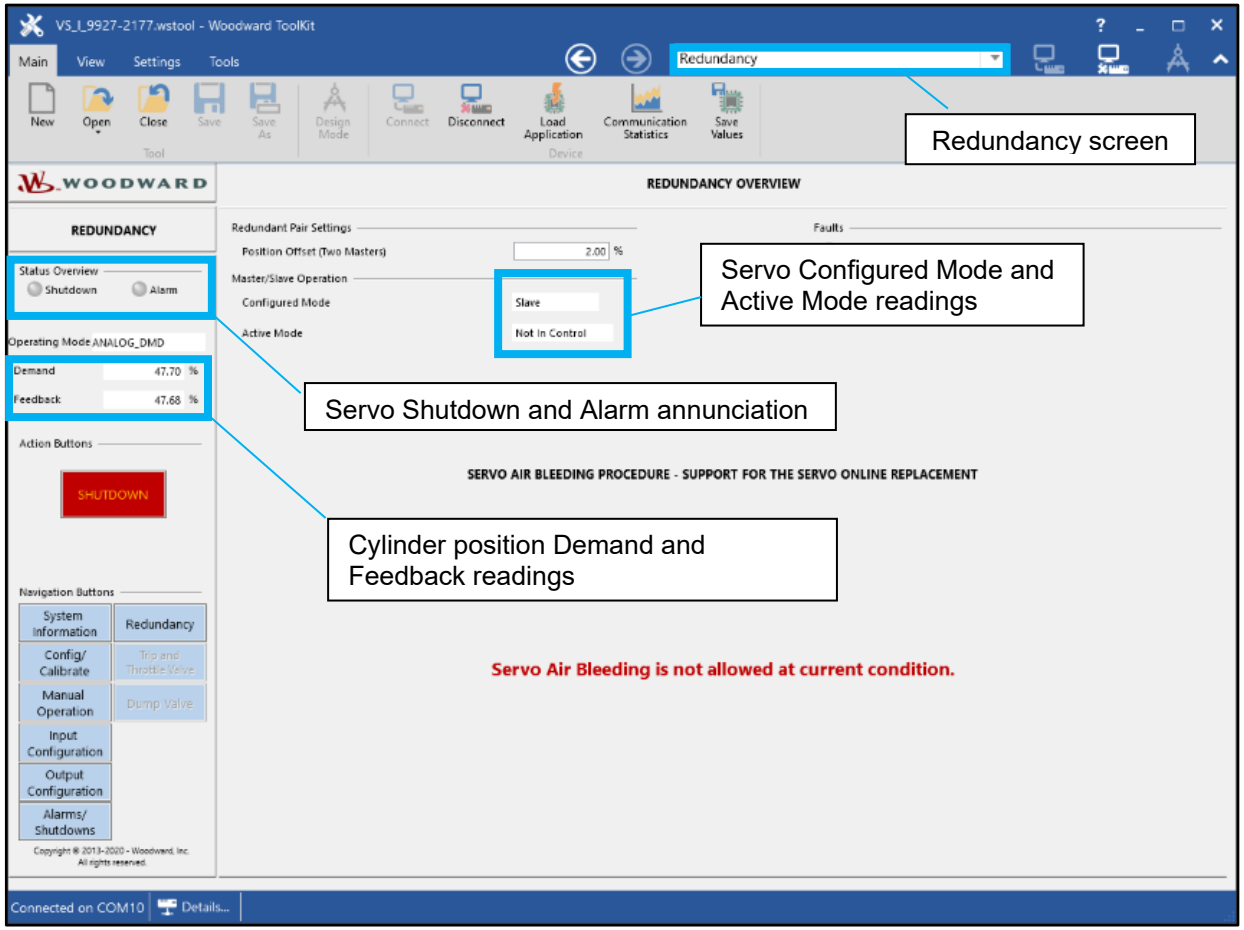

Figure 2-75. Redundancy Screen and Alarm/Shutdown Annunciation

61. Close knife disconnect terminals for the newly installed VariStroke **[Discrete Output]** **(VariStroke A terminals #27, 28**) or **(VariStroke B terminals #58, 59)** (Figure 2-76).

62. In the control system, verify that the new VariStroke still communicates as **NotInControl** [notate result in paper Checklist: ID #26].

63. In the control system, verify that the other VariStroke (the one InControl) communicates **Alarm active** [notate result in Checklist: ID #27].

64. Close knife terminal **[HEALTH LINK]** towards the other operating unit **(VariStroke A terminal # 67)** or **(VariStroke B terminal # 66)** (Figure 2-77).

65. The unit that is In Control (VariStroke currently controlling process) will stop announcing the alarm. In the control system, verify that the other **VariStroke does not communicate Alarm** [notate result in Checklist: ID #28]. The alarm may remain if there is another reason on the other, operating VariStroke causing its diagnostic to trigger an alarm.

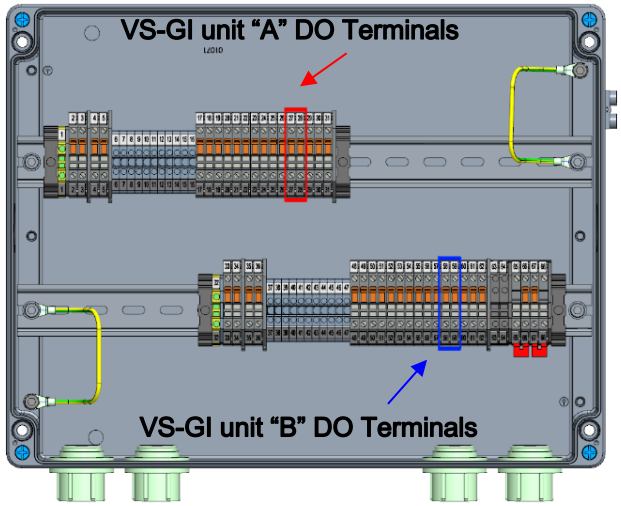

Figure 2-76. Discrete Outputs Terminals Inside VS-DX J-Box

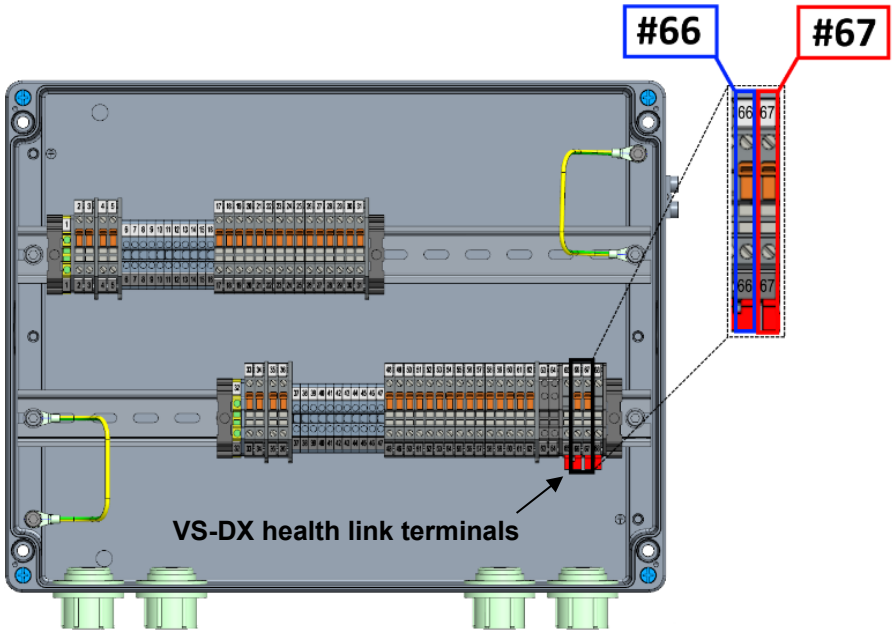

Figure 2-77. Health Link Terminals Inside VS-DX J-Box

66. Using the Customer Service Tool software, navigate to the Alarms/Shutdowns screen and click the **Reset** button to reset Shutdowns/Alarms on the newly installed VariStroke (Figure 2-78).

67. Reset the Alarms/Shutdowns logged events in the newly installed VariStroke by pressing the **Reset Log** button (Figure 2-78).

68. Verify there are **no alarms** and **no shutdowns** on the newly installed VariStroke (Slave Unit) (Figure 2-78). If not, verify what the cause of the issue is with the unit.

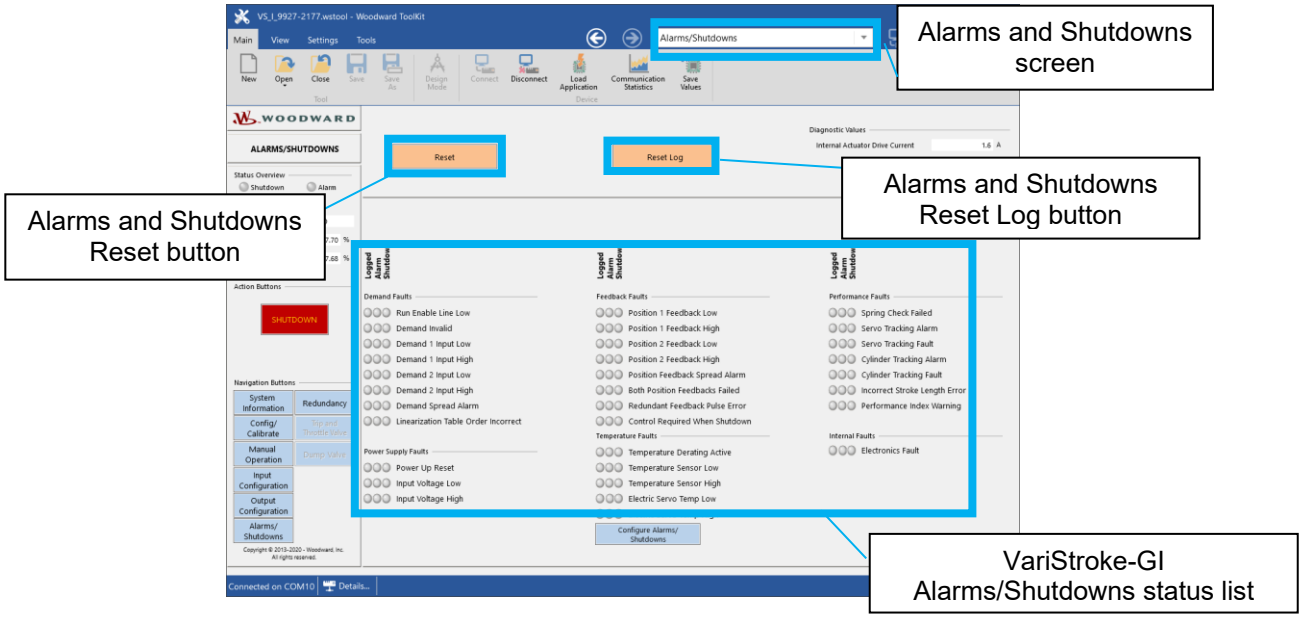

Figure 2-78. Alarms and Shutdowns Screen

69. Perform verification and comparison of **Position Feedback values** between the control system and the newly installed VariStroke (Figure 2-79). These values must be identical, but very minor differences are expected. Register two readings to confirm the values are alive [notate result in Checklist: ID #7 and #8].

70. Terminate the connection to the newly installed VariStroke by pressing the **Disconnect button** in the Customer Service Tool software (Figure 2-80).

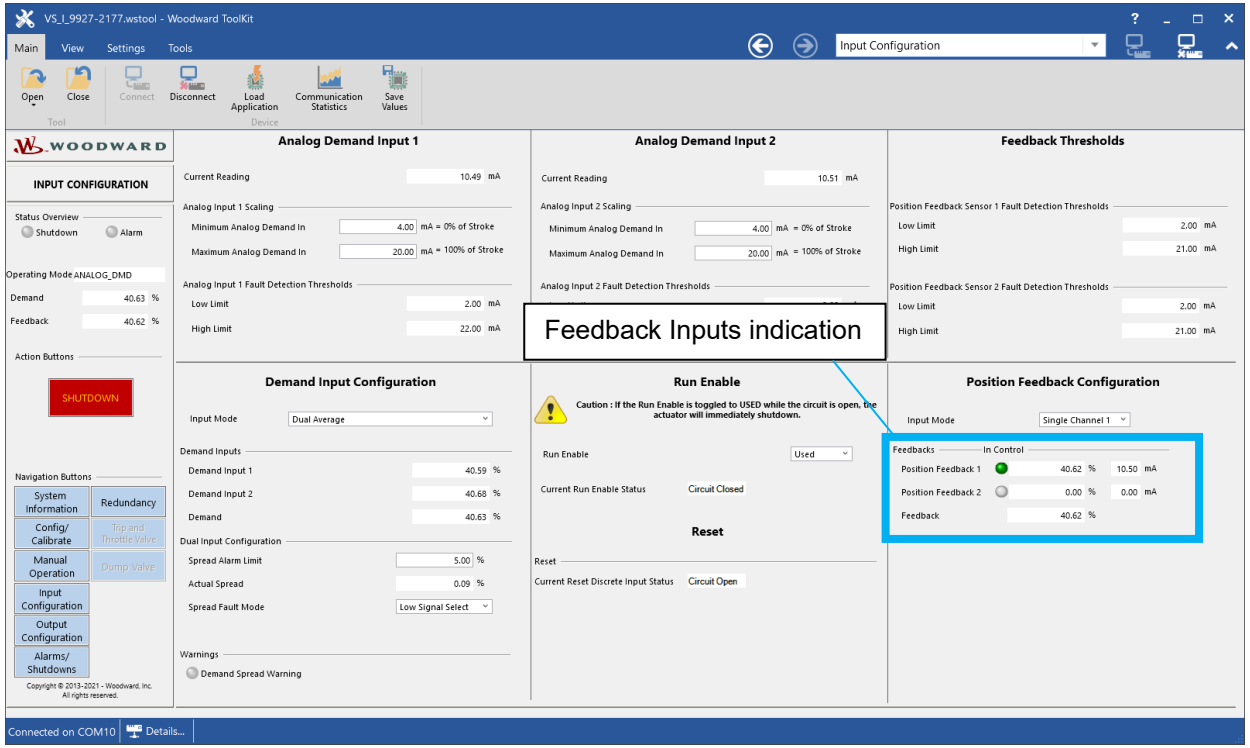

Figure 2-79. Feedback Readings on the Input Configuration Screen

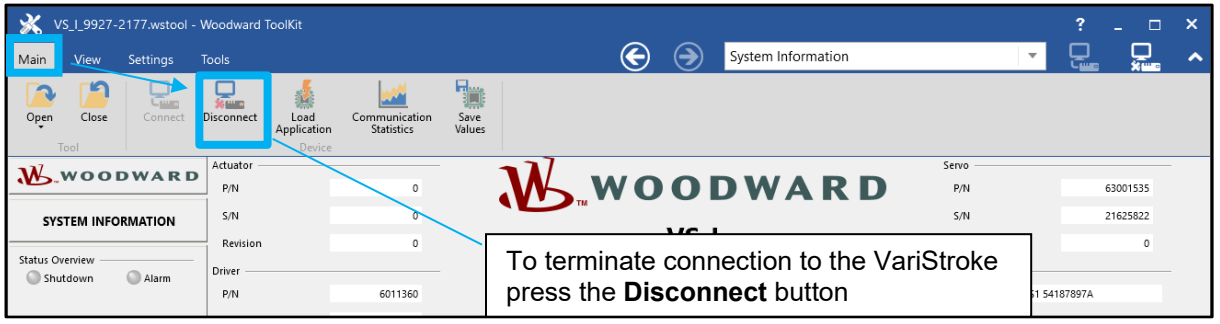

Figure 2-80. Terminating Connection to the VariStroke

71. Close the front cover of the junction box (use a slotted screwdriver: **22.0 – 27.0 LBIN (2.5 – 3.0 Nm); 5.5 X 0.8 mm** tip size) (Figure 2-81).

72. Disconnect the RS-232 communication cable from the newly installed VariStroke. (Figure 2-82).

73. Unscrew the eyebolt from the VariStroke counter cover (use **2 1/4 in** open end wrench) (Figure 2-83).

74. Screw the bolt into the newly installed VariStroke cover (use **3/4 in** open end wrench: **40-60 LBFT (54-81 Nm)** while using another wrench (use **2 1/4 in** open end wrench) to hold the cover in place and prevent rotation while the nut is tightened (Figure 2-83).

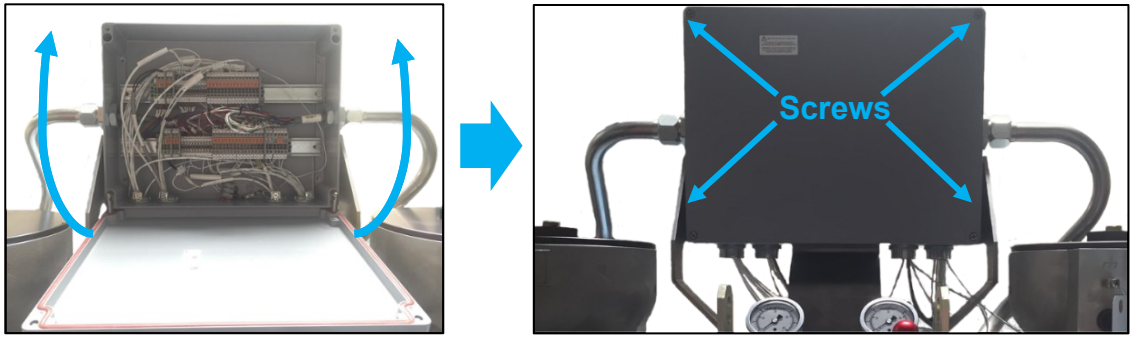

Figure 2-81. VS-DX J-Box Closing

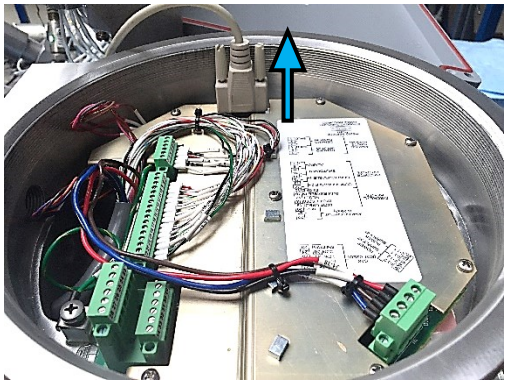

Figure 2-82. Disconnecting RS-232 Link

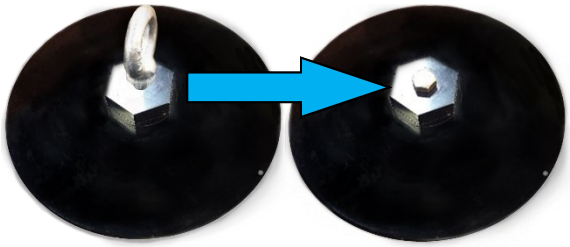

Figure 2-83. VariStroke Eyebolt Removal

75. Assemble the newly installed VariStroke cover (use **2 1/4 in** open end wrench: **90.0 – 110.0 LBFT (122 – 149 Nm)** (Figure 2-84).
76. Screw the set screw in the newly installed VariStroke cover (use **1.5 mm** socket head wrench). Thread the set screw into the cover until the end of the screw is flush with the top surface of the cover (Figure 2-85).
77. Remove the padlock from the VS-DX isolation valve (if installed).
78. Slowly open the isolation valve that corresponds to the newly installed VariStroke (isolation valve nearest new VariStroke) by turning the crank to the horizontal position. **During this step, carefully monitor that there is no external leakage from the VS-DX skid and its surroundings.** (Figure 2-86) [Notate action in Checklist: ID #3].

IMPORTANT

It is recommended to perform control switchover between the other operating unit and the new VS-GI unit to verify that the new servo can fluently take control and its control output is stable and does not cause severe system disturbances.

During this process, be prepared to switch control back to the "old servo" and isolate the new servo from the process control using the respective VS-DX isolation valve (for quick access, do not install padlock on respective isolation valve). If this switchover has been performed, notate results in Checklist: ID #4, #17, and #25.

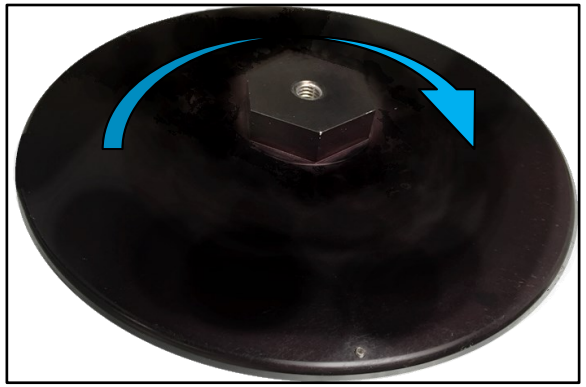

Figure 2-84. VariStroke Cover Installation

Figure 2-85. VariStroke Cover Set Screw Location

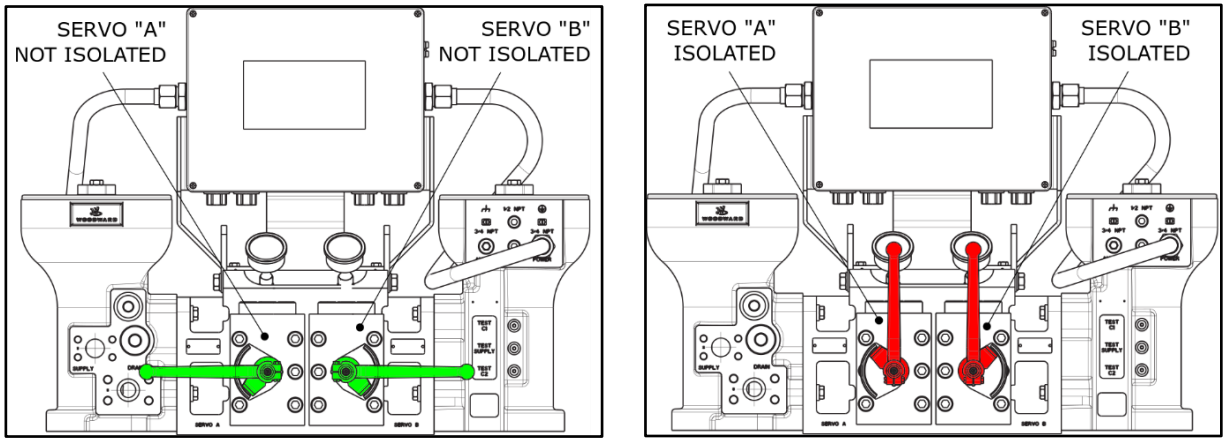

Figure 2-86. VS-DX Isolation Valves Position

IMPORTANT

Recalibrate cylinder at the next turbine overhaul.

IMPORTANT

At the next possibility, use the Customer Service Tool software to review the alarm logs on the VariStroke that was not replaced.

79. Install the padlock on the VS-DX isolation valve (if required).

80. At this point, automatic control switchover logic in the control system can be activated back if applicable.

81. New VariStroke installation process is complete.

2.4 Appendix 1. Dissasembly Checklist

CMM-03013, ON-LINE SERVO VALVE REPLACEMENT, VS-DX SKID J-BOX VERSION - **DISASSEMBLY CHECKLIST**

Date:	
Plant Name:	
Unit Plant ID / Functional location:	
VariStroke Part Number:	
VariStroke Serial Number:	
Cylinder Bore diameter:	mm / in
Cylinder Rod diameter:	mm / in
Cylinder Stroke diameter:	mm / in
Cylinder Fail direction:	Fail Extended / Fail Retracted
Hydraulic Oil Supply Pressure:	barg / psig

⚠WARNING **Please do not proceed with actions in sequence of this checklist. Proper order of actions is provided by the CMM-03013 procedure. Wrong execution can lead to hazards for operator and also disturb turbine operation.**

ID	Verification Point	CMM procedure step	Result	Expected result	Comment
1	Control System designation command is Slave to Withdrawn Servo	2.2. 1.a	Control System:	Slave	
2	Wthdrawn Servo gives feedback that is Not In Control	2.2. 1.b	Control System:	Not in Control	
3	Pressure gauge shows no pressure at the side of withdrawn servo	2.2. 1.c	Pressure:	0 bar	
4	Control System designation command is Master to the other Servo (controlling)	2.2. 2.a	Control System:	Master	
5	Other Servo gives feedback that is In Control	2.2. 2.b	Control System:	In Control	
6	Other Servo gives feedback that is not in Shutdown	2.2. 2.c	Control System:	not in Shutdown	
7	Pressure gauge at the side of the other servo (controlling) shows positive control pressure	2.2. 2.d	Pressure:	> 0 bar	
8	Isolation valve position closed for the withdrawn servo	2.2. 5.	Valve:	Servo Isolated, valve closed	Valve is a part of VS-DX assembly
9	Control System commands RunEnable False towards withdrawn servo (if applies)	2.2. 7.	Control System:	RunEnable == False	Only if RunEnable discrete input is used
10	Alarm status active from withdrawn servo in Control system	2.2. 10.	Control System:	Alarm Active	
11	Shutdown status active from withdrawn servo in Control system	2.2. 11.	Control System:	Shutdown Active	
12	Memory / parameters failures on Internal Status page in Service Tool	2.2. 18.	Service Tool:	No internal faults related to memory nor parameters	Required if the parameters file is expected to be downloaded from existing VariStoke
13	Parameters file available from the storage (backup file)	2.2. 19.	File available (Y/N):	Yes for one of the parameters file source is required	One of the options must be fulfilled: either the parameters file from the back-up storage or the file recently downloaded from withdrawn servo
14	Parameters file available from the withdrawn servo		File available (Y/N):		
15	Supply voltage cut-off for the withdrawn servo	2.2. 22.b	Circuits:	Circuit breaker open	
16	Supply oil valve position closed	2.2. 24.	Valve:	Supply Isolated, valve closed	Valve not provided with VS-DX skid
17	Drain line valve position closed	2.2. 26.	Valve:	Drain Isolated, valve closed	Valve not provided with VS-DX skid
18	Health Link terminals position disconnected	2.2. 28.	Circuits:	Open, disconnected	

2.5 Appendix 2. Assembly Checklist

CMM-03013, ON-LINE SERVO VALVE REPLACEMENT, VS-DX SKID J-BOX VERSION - **INSTALLATION CHECKLIST**

Date:	
Plant Name:	
Unit Plant ID / Functional location:	
VariStroke Part Number:	
VariStroke Serial Number:	
Cylinder Bore diameter:	mm / in
Cylinder Rod diameter:	mm / in
Cylinder Stroke diameter:	mm / in
Cylinder Fail direction:	Fail Extended / Fail Retracted
Hydraulic Oil Supply Pressure:	barg / psig

⚠WARNING **Please do not proceed with actions in sequence of this checklist. Proper order of actions is provided by the CMM-03013 procedure. Wrong execution can lead to hazards for operator and also disturb turbine operation.**

ID	Verification Point	CMM procedure step	Result	Expected result	Comment
1	Drain Valve open	2.3. 42.	Position:	Position Open	Valve not provided with VS-DX skid
2	Supply Valve open	2.3. 43.	Position:	Position Open	Valve not provided with VS-DX skid
3	Isolation Valve open	2.3. 78.	Position:	Position Open	Valve is a part of VS-DX assembly
4	Gauge operating Presure reading when operating > 0	optional	Pressure:	Pressure > 0 Pressure < Supply pressure	Optional for the end of procedure - if possible to designate Master to the newly installed Varistroke; Verify that pressure dial is a live
5	AirBleeding procedure completed	2.3. 46.	Service tool:	Air Bleeding Completed	
6	Device settings loaded successfully	2.3. 47.b	Service tool:	Yes, Device settings loaded successfully	
7	Analog Output (Feedback) reading 1	2.3. 69.	Service tool: Control System:	Control System value similar to Service Tool value	
8	Analog Output (Feedback) reading 2	2.3. 69.	Service tool: Control System:	Control System value similar to Service Tool value	
9	Analog Input 1 (Demand) reading 1	2.3. 52.	Service tool: Control System:	Control System value similar to Service Tool value	
10	Analog Input 1 (Demand) reading 2	2.3. 52.	Service tool: Control System:	Control System value similar to Service Tool value	
11	Analog Input 2 (Demand) reading 1	2.3. 52.	Service tool: Control System:	Control System value similar to Service Tool value	Optional if Demand Analog Input Channel 2 is in use
12	Analog Input 2 (Demand) reading 2	2.3. 52.	Service tool: Control System:	Control System value similar to Service Tool value	Optional if Demand Analog Input Channel 2 is in use
13	Discrete Input RunEnable ON	2.3. 48.d	Service tool:	Run Enable Status: Circuit Closed	Only for the system where RunEnable command is used and wired up
14	Discrete Input RunEnable OFF	2.3. 48.b	Service tool:	RunEnable Status: Circuit Open	Only for the system where RunEnable command is used and wired up
15	Discrete Input Reset ON	2.3. 49.b	Service tool:	Reset Status: Circuit Closed	
16	Discrete Input Reset OFF	2.3. 49.d	Service tool:	Reset Status: Circuit Open	

Date:	
Plant Name:	
Unit Plant ID / Functional location:	
VariStroke Part Number:	
VariStroke Serial Number:	
Cylinder Bore diameter:	mm / in
Cylinder Rod diameter:	mm / in
Cylinder Stroke diameter:	mm / in
Cylinder Fail direction:	Fail Extended / Fail Retracted
Hydraulic Oil Supply Pressure:	barg / psig

⚠WARNING **Please do not proceed with actions in sequence of this checklist. Proper order of actions is provided by the CMM-03013 procedure. Wrong execution can lead to hazards for operator and also disturb turbine operation.**

ID	Verification Point	CMM procedure step	Result	Expected result	Comment
17	Discrete Input Master Designation open (Master)	optional	Control System:	InControl announced in Control System by the tested unit; Other unit announced NotInControl at the time	Optional for the end of procedure - if possible to designate Master to the newly installed VariStroke. Verify on the Service Tool Redundancy screen the Configured mode is Master or confirm the #25 below is passed while both VariStrokes do not annouciate Alarm nor Shutdown
18	Discrete Input Master Designation closed (Slave)	2.3. 59.	Service tool:	Configured Mode: Slave	
19	Discrete Input Healthy link (disconnected)	2.3. 55.	Service tool:	Redundant Feedback Pulse Error active	
20	Discrete Input Healthy link (properly connected)	2.3. 57.	Service tool:	Redundant Feedback Pulse Error inactive	
21	Discrete Output Alarm (Active)	2.3. 54.	Control System:	New Unit Alarm active	
22	Discrete Output Alarm (InActive)	2.3. 58.	Control System:	New Unit Alarm inactive	
23	Discrete Output ShutDown (Active)	2.3. 50.	Control System:	New Unit ShutDown active	
24	Discrete Output ShutDown (InActive)	2.3. 53.	Control System:	New Unit ShutDown inactive	
25	Discrete Output InOperationStatus (InControl)	optional	Control System:	New Unit InControl	Optional for the end of procedure - if possible to Designate Master to the newly installed Varistroke; Verification in Control System that new unit is In Control
26	Discrete Output InOperationStatus (NotInControl)	2.3. 62.	Control System:	New Unit NotInControl	Test do not confirm if the wire isn't broken open in test scenario until Control is given to the new Servo
27	Discrete Output Healthy link (disconnected)	2.3. 63.	Control System:	Other unit Alarm active	Presence of an alarm in Operating Servo (InContol) indicates the healthy link wire disconnected.
28	Discrete Output Healthy link (properly connected)	2.3. 65.	Control System:	Other unit Alarm inactive	Other unit Alarm may remains active if there ware other reasons in Operating Unit

3. ISOLATION VALVE REPLACEMENT

3.1 Replacement Kit Description

The purpose of this procedure is to show the correct sequence and method of isolation valve replacement:
VS-DX SKID - 8935-1338 - KIT- REPLACEMENT ISOLATION VALVE, RIGHT HAND
VS-DX SKID - 8935-1339 - KIT- REPLACEMENT ISOLATION VALVE, LEFT HAND,

Follow this procedure during replacement. Please contact Woodward with any questions.

3.2 List of Required Hardware or Materials

Torque wrench(es)	Installation required torques ranges, wrench end type, and size • 63 – 77 LBFT (61 – 75 Nm), Type: socket head; Size: 1/2 in • 89-99 LBIN (10-11 Nm) Type: socket head; Size: 3/16 in
Wrench(es)	• Type: hex bit socket; Size: 1/2 in • Type: hex bit socket; Size: 3/16 in
Others	• Oil absorbent pads / mats • Petroleum jelly for O-ring lubrication • Oil collection container 5 liters/2 gallons • Isopropyl alcohol • Parker Super O-Lube or similar

3.3 Isolation Valve Removal

1. Identify the control isolation valve to be replaced.

⚠WARNING

The entire VariStroke-DX skid must be offline during isolation valve replacement.

2. Place the oil absorbent mat under VS-DX isolation valve to be replaced.

3. Crank the withdrawn isolation valve to the horizontal position.

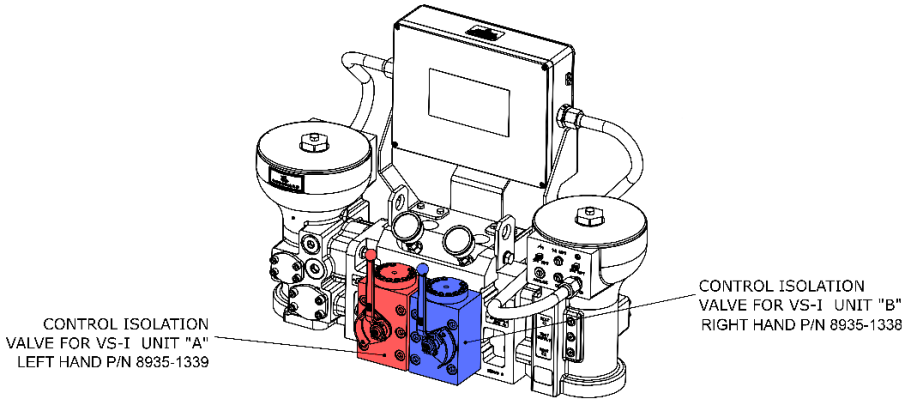

Figure 3-1. VariStroke Isolation Valves

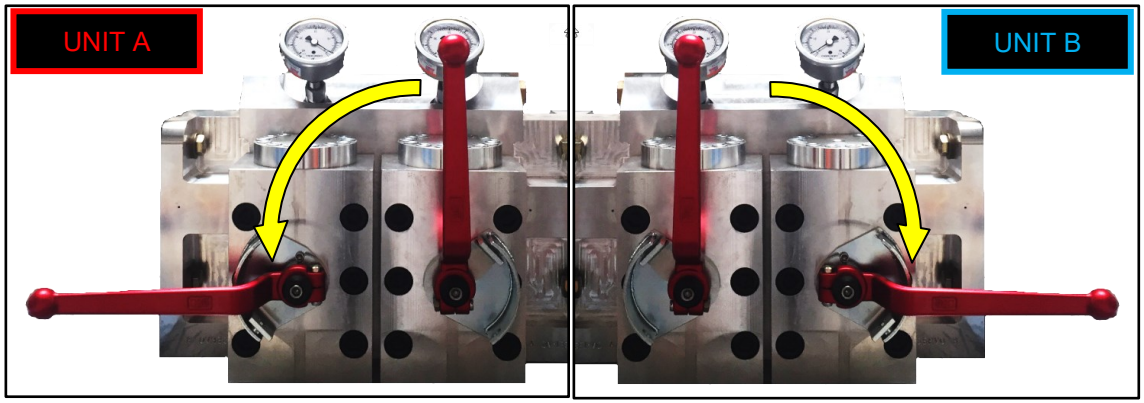

Figure 3-2. VariStroke Isolation Valves in Horizontal Position

4. Loosen and remove the retaining screw on the handle of the lock bracket using a **3/16 in** hex key wrench (Figure 3-3).

5. Adjust the handle locking bracket position to reach all six screws retaining the isolation valve (Figure 3-4). Move the bracket using a dead blow hammer, if required.

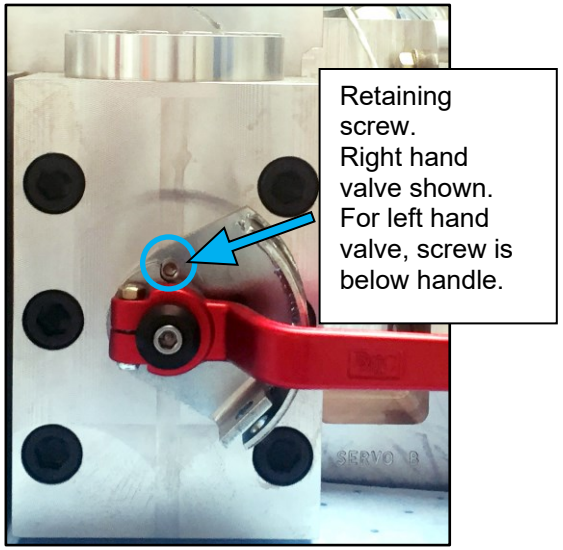

Figure 3-3. Isolation Valve Bracket Retaining Screw Location

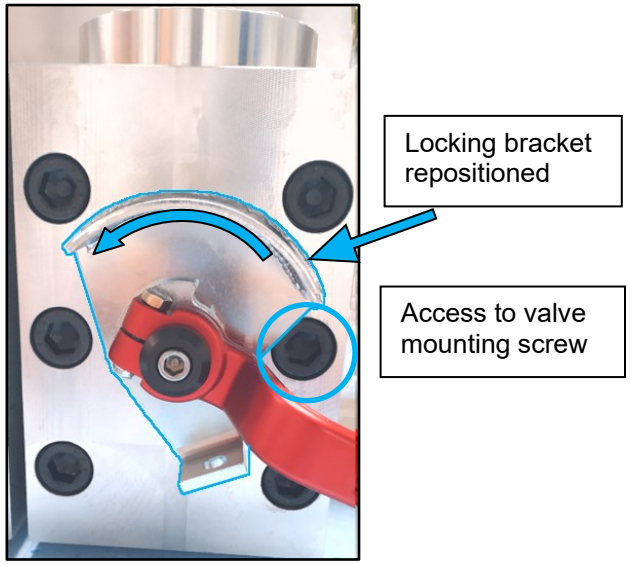

Figure 3-4. Isolation Valve Locking Bracket Repositioning

6. Loosen and remove all six screws using ½ **in** hex key wrench (Figure 3-5).

7. Remove isolation valve (Figure 3-5).

⚠WARNING

Potential for residual hot oil spillage exists.

It is recommended to place oil absorbent pads or a container underneath the servo assembly (5 liter capacity minimum) to collect the residual oil leakage.

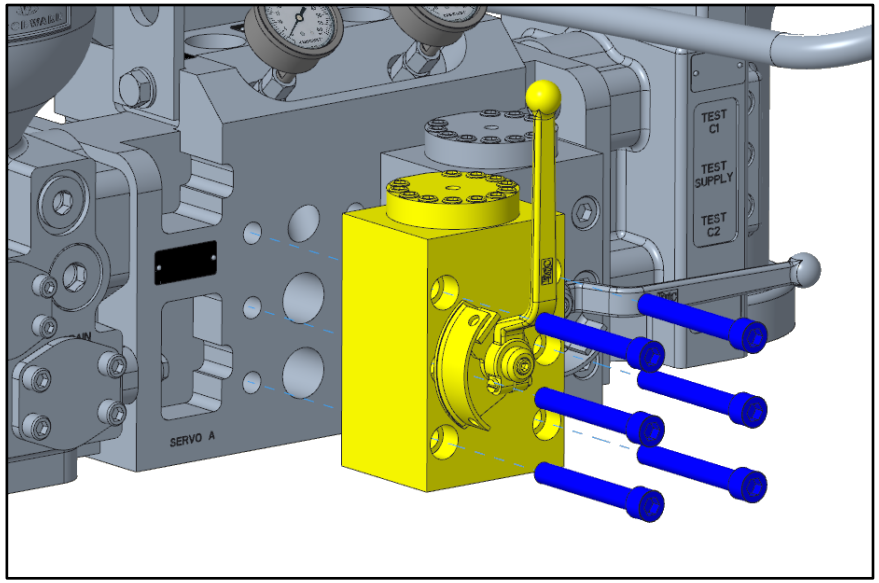

Figure 3-5. Isolation Valve Removal

3.4 Isolation Valve Installation

1. Obtain replacement isolation valve kit 8935-1338 (left hand) or 8935-1339 (right hand) containing isolation valve and soft sealing.

2. Loosen and remove the screw locking handle lock bracket using **3/16 in** hex key wrench (Figure 3-6).

3. Adjust the handle locking bracket position to reach all six screws retaining the isolation valve (Figure 3-7).

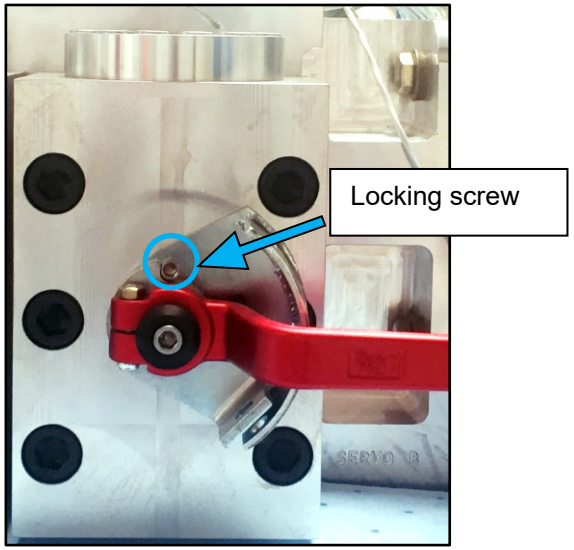

Figure 3-6. Isolation Valve Bracket Retaining Screw Location

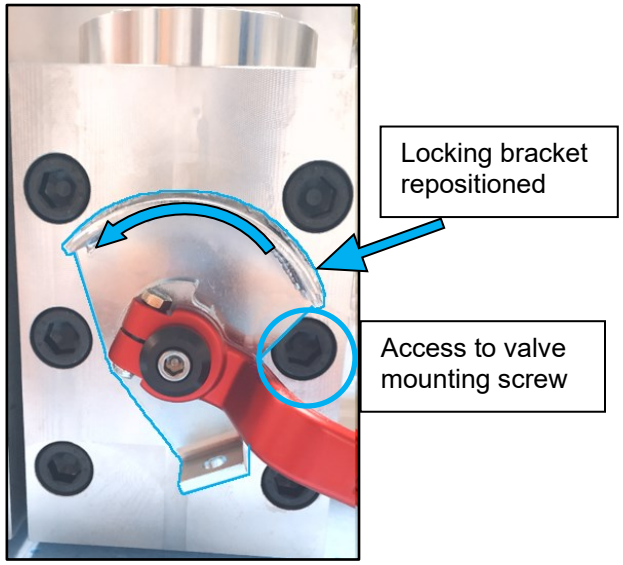

Figure 3-7. Isolation Valve Locking Bracket Repositioning

4. Clean connection interface surfaces using Isopropyl alcohol (Figure 3-8).

5. Lubricate O-rings (3 pieces) provided in the isolation valve kit with Parker Super O-Lube or petroleum jelly and install them in the valve seal grooves (Figure 3-9).

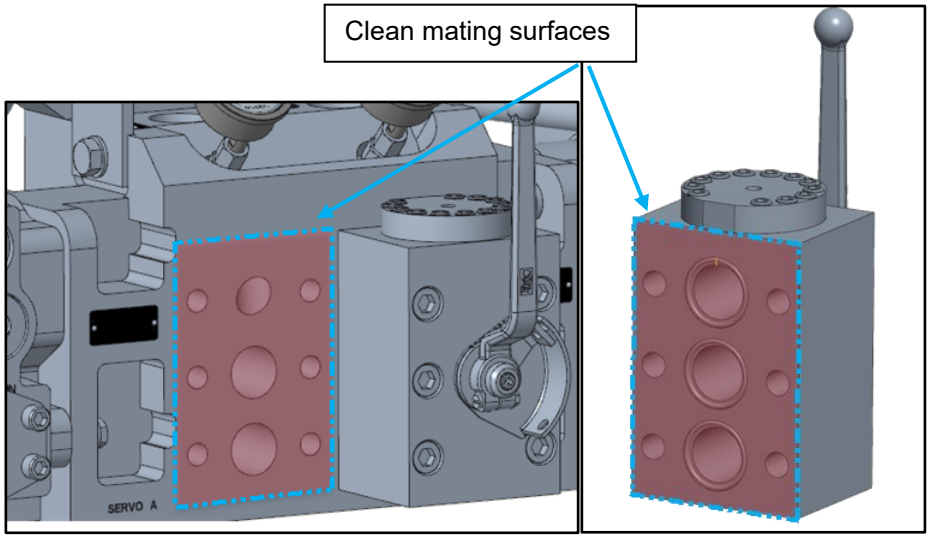

Figure 3-8. Isolation Valve Mating Surfaces Cleaning

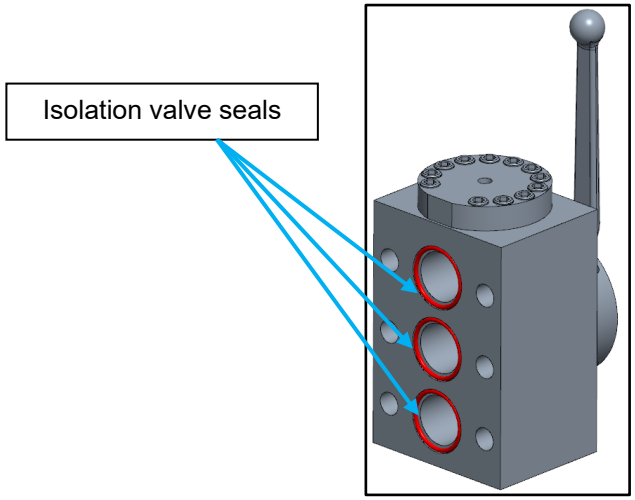

Figure 3-9. Isolation Valve Seals

6. Apply anti-seize to the six screws and install them inside the isolation valve manifold (Figure 3-10).

7. Align isolation valve screws with VS-DX manifold threaded holes. Hand-tighten screws using a cross screwing pattern (Figure 3-10).

⚠WARNING

Ensure sealing O-rings are correctly placed in their grooves during valve installation process.

8. Torque screws to 63-77 LBFT (85-104 Nm) using **½ in** hex key torque wrench. Follow the order of tightening shown in the picture (Figure 3-11).

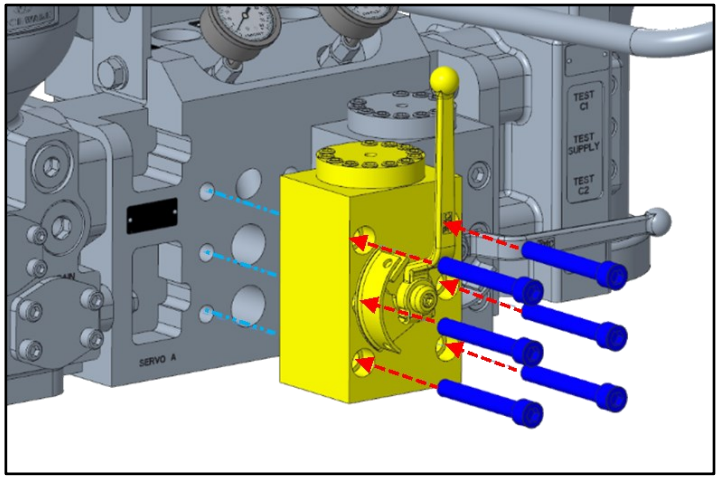

Figure 3-10. Isolation Valve Mating Surfaces Cleaning

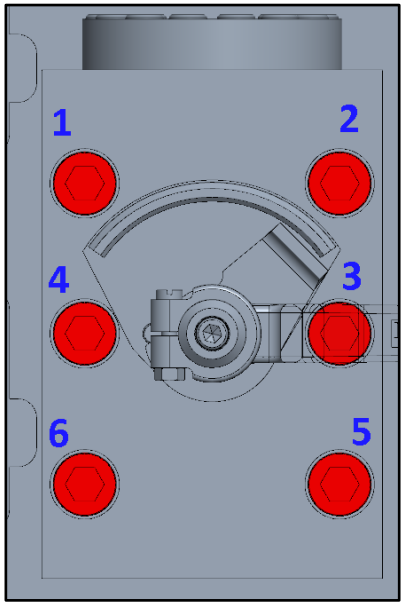

Figure 3-11. Isolation Valve Tightening Sequence

9. Adjust the valve locking bracket. Set valve crank in the horizontal position (Figure 3-12).

10. Apply Loctite 242 to the locking screw and tighten using **3/16** hex key wrench. Installation torque: 89-99 LBIN (10-11 Nm) (Figure 3-13).

11. The isolation valve replacement procedure is complete.

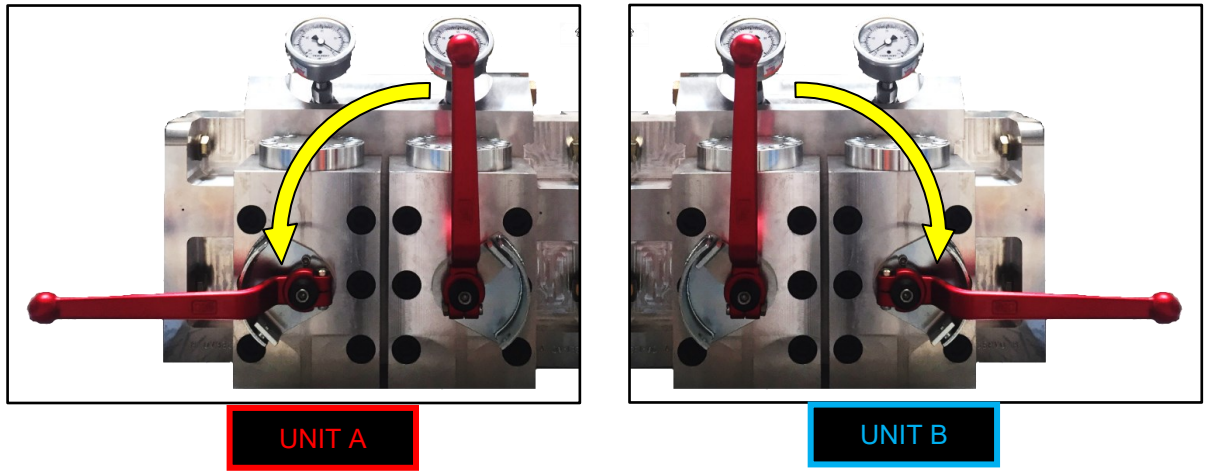

Figure 3-12. VariStroke Isolation Valves in Horizontal Position

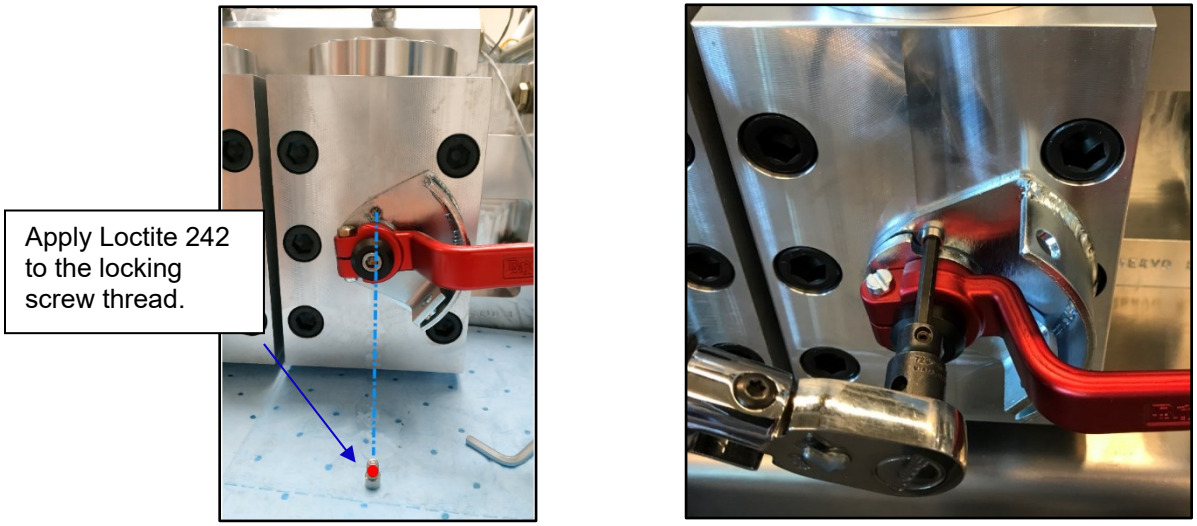

Figure 3-13. Locking Bracket Installation

4. SHUTTLE VALVE REPLACEMENT

⚠WARNING

The entire VariStroke-DX skid must be offline during shuttle valve replacement.

4.1 Replacement Kit Description

The purpose of this procedure is to show the correct sequence and method of shuttle valve replacement:
VS-DX SKID - 8935-1336- KIT- REPLACEMENT SHUTTLE VALVE
Follow this procedure during replacement. Please contact Woodward with any questions.

4.2 List Of Required Hardware or Materials

Torque wrench(es)	Installation required torques ranges, wrench end type, and size
	• 47.0 – 53.0 LBFT (63.7 – 71.8 Nm), Type: socket head; Size: 3/8 in
Wrench(es)	• Type: hex key; Size: 3/8 in
Others	• Oil absorbent pads/mats • Super-O-Lube for O-ring lubrication • Oil collection container 5 liters or 2 gallons • Isopropanol • O-ring picking tool (optional) • Parker Super O-Lube or similar

4.3 Shuttle Valve Removal

1. Shut-off both isolation valves by turning the cranks to the vertical position (Figure 4-1).

2. Place the oil collection container and absorbing mats under the piping being disconnected.

⚠WARNING

Potential for residual hot oil spillage exists.

It is recommended to place oil absorbent pads or a container underneath the servo assembly (5 liter capacity minimum) to collect the residual oil leakage.

3. Unscrew hydraulic pipe attached to shuttle valve control port (Figure 4-2).

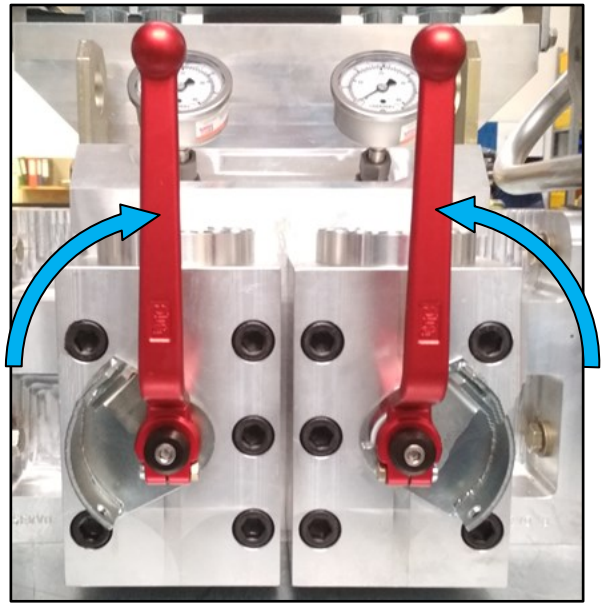

Figure 4-1. VariStroke Isolation Valves in Vertical Position (isolating)

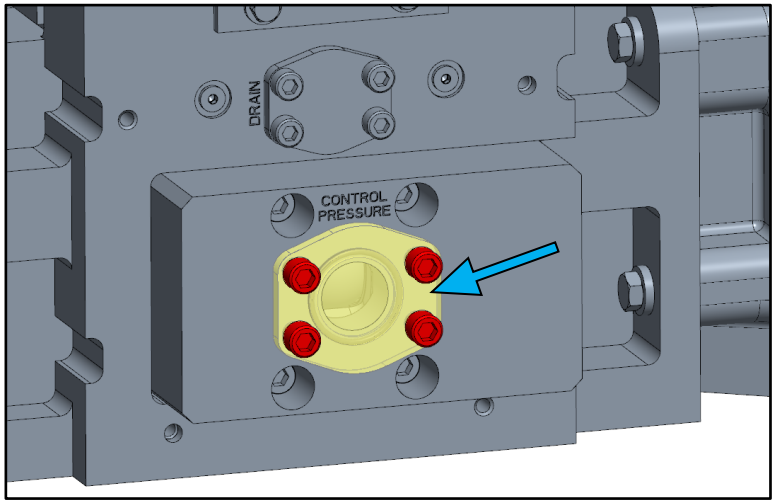

Figure 4-2. VariStroke Isolation Valves Control Port Location

4. Loosen and remove all four screws retaining the shuttle valve using **3/8 in** hex head wrench (Figure 4-3).

5. Carefully pull-out the shuttle valve (Figure 4-4).

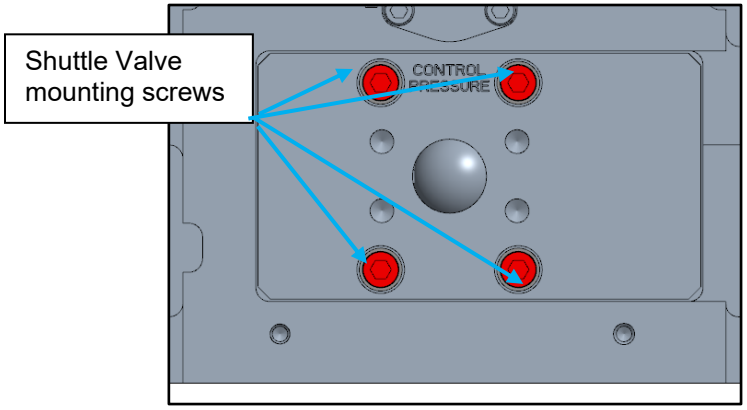

Figure 4-3. VariStroke Shuttle Valve Retaining Screws

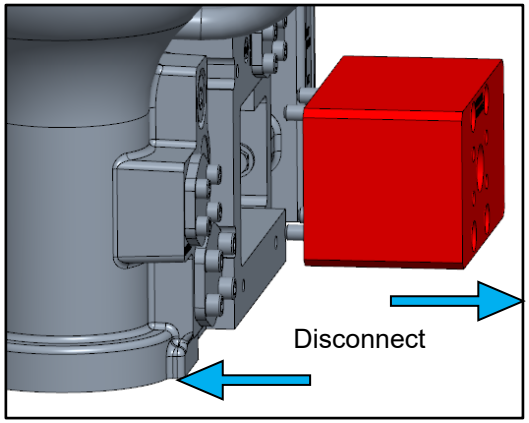

Figure 4-4. VariStroke Shuttle Valve Removal

6. Verify the locating pin is present in the shuttle valve (Figure 4-5). If not, remove it from the VS-DX manifold (Figure 4-6).

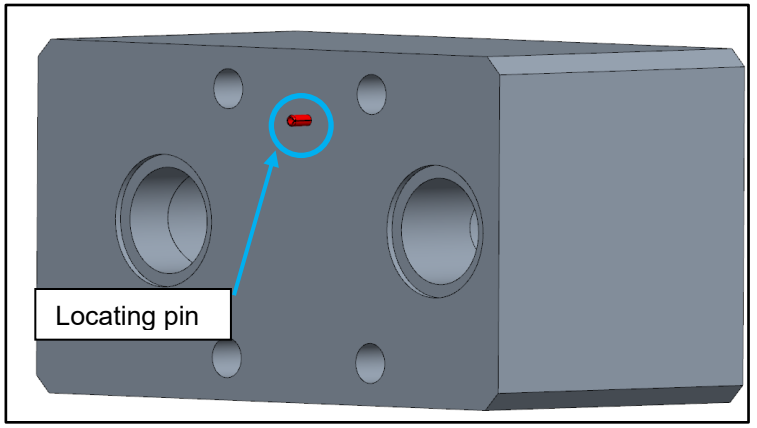

Figure 4-5. Shuttle Valve Locating Pin

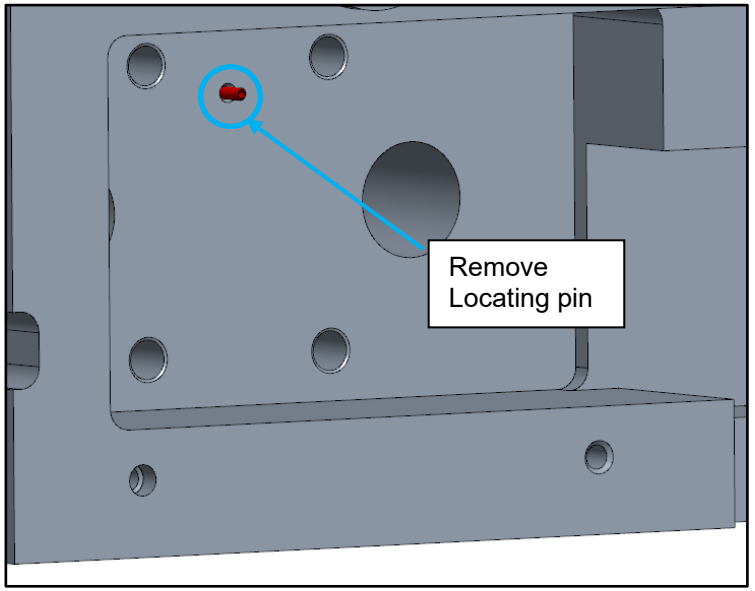

Figure 4-6. Shuttle Valve Locating Pin in VS-DX Manifold

4.4 Shuttle Valve Installation

1. Obtain a new shuttle valve kit 8935-1336 containing soft components and dowel pin installed.

2. Clean both mating surfaces of VS-DX manifold and shuttle valve manifold using Isopropyl alcohol (Figure 4-7).

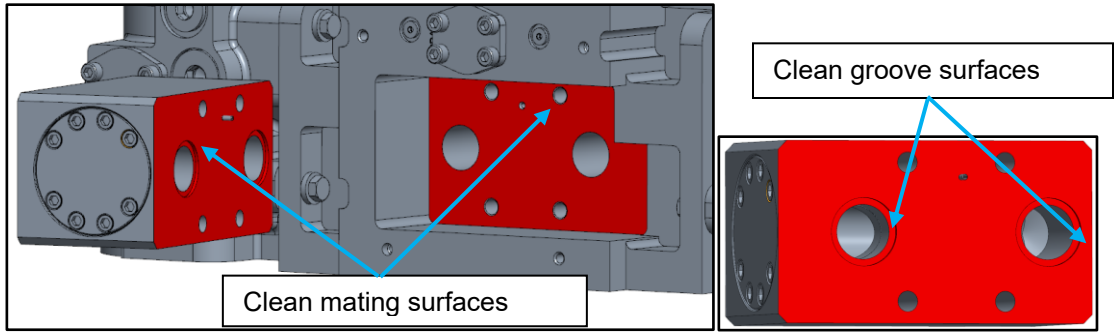

Figure 4-7. Shuttle Valve and VS-DX Mating Surfaces Cleaning

3. Lubricate O-rings with Parker Super O-Lube or petroleum jelly and install into the ID groove of the shuttle valve manifold (Figure 4-9).

4. Align the shuttle valve with the VS-DX manifold using a dowel pin and connect. (Figure 4-10).

⚠WARNING

Make sure sealing O-rings are placed correctly in their grooves during the valve installation process.

5. Apply anti-seize to four screws and install into the shuttle valve. Torque to 47-53 LBFT (5.3-6.0 Nm) using **3/8 in** hex head wrench (Figure 4-8).

6. The shuttle valve replacement procedure is complete.

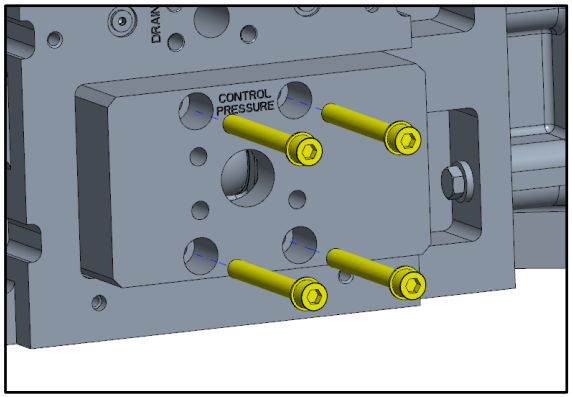

Figure 4-8. Shuttle Valve Installation Screws

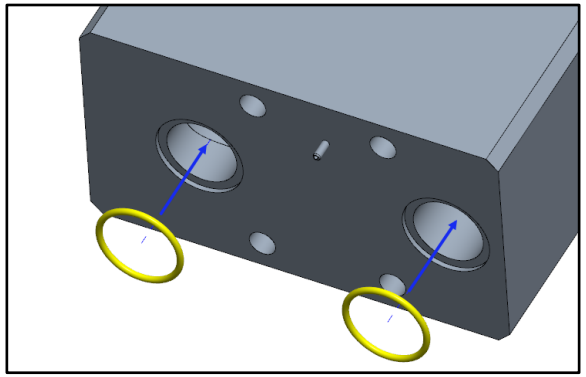

Figure 4-9. O-rings Installation into Shuttle Valve Manifold

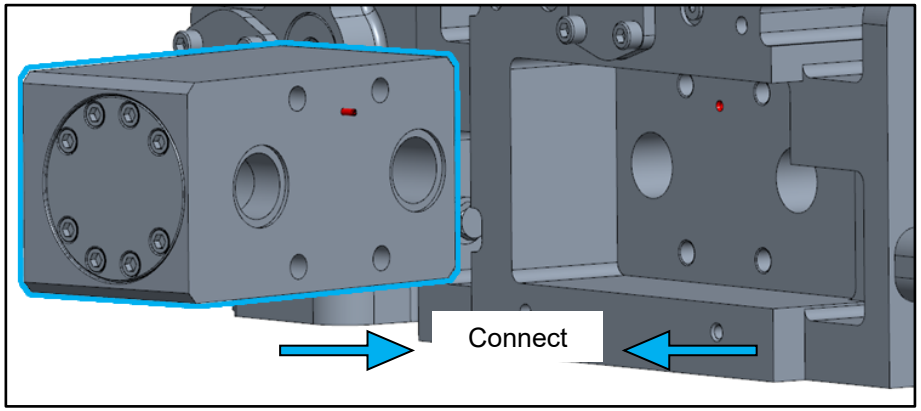

Figure 4-10. Shuttle Valve Installation

5. PRESSURE GAUGE REPLACEMENT

5.1 Replacement Kit Description

The purpose of this procedure is to show the correct sequence and method of shuttle valve replacement:
VS-DX SKID - 8935-1344- KIT- PRESSURE GAUGE

Follow this procedure during replacement. Please contact Woodward with any questions.

Wrench(es)	• Type: flat wrench; Size 19 mm • Type: hex key; Size: 3/16 in • Type: open end; Size: 22 mm • Type: open end; Size 13/16 in • Torque wrench
Others	• Oil absorbent pads / mats

5.2 Pressure Gauge Removal

1. Loosen the needle valve adjuster locking nut using **13/16 in** wrench. Using **3/16 in** hex key, close the needle valve located on top of housing, turning clockwise. (Figure 5-1).

2. Using a **22 mm** flat wrench and then using your hand, unscrew (in counterclockwise direction) the adapter with pressure gauge from the pressure test port. Use oil absorbent pads in case of an oil leak.

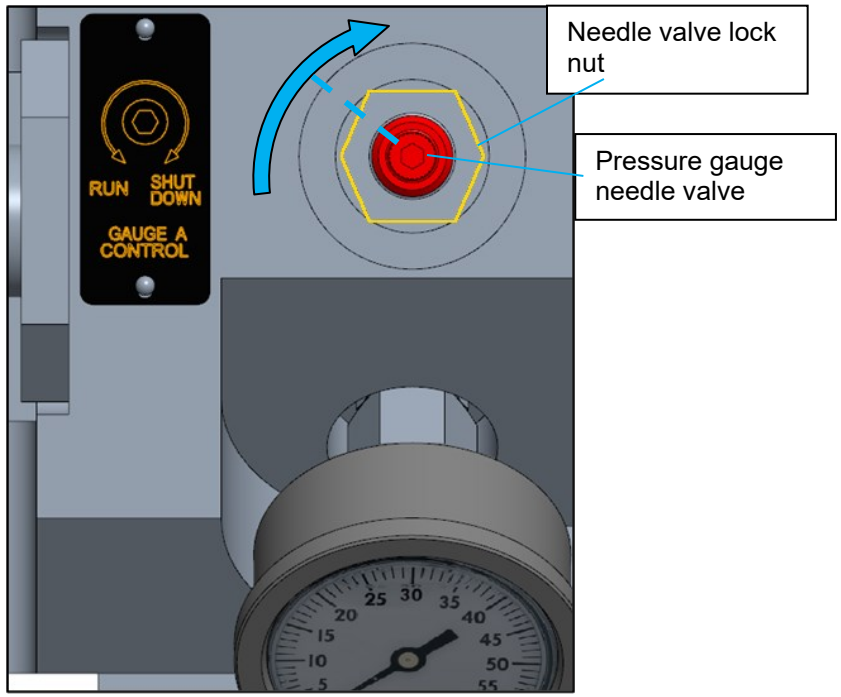

Figure 5-1. Needle Valve Closing

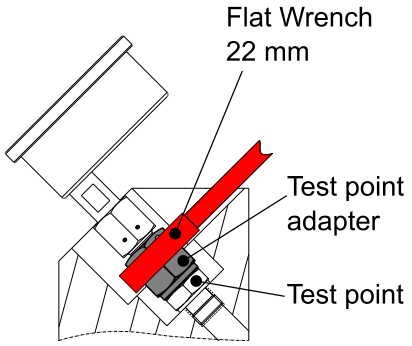

Figure 5-2. Pressure Gauge and Adapter Installation / Removal

5.3 Pressure Gauge Installation

1. Obtain a new pressure gauge Kit 8935-1344.

2. Examine all mating surfaces for debris and dirt. If present, clean it before proceeding.

⚠WARNING

Make sure sealing O-rings are correctly placed in their grooves during gauge installation process.

3. Hand-tighten the adapter to the test port. While maintaining the gauge orientation with a **19mm** wrench, assemble the gauge adapter to test port coupling using a **22 mm** open end socket to 23-27 LBFT (31-37 Nm) (Figure 5-3).

4. Using a **3/16 in** hex key wrench, open the needle valve located on top of the housing, turning counter-clockwise (Figure 5-4).

5. Using a **13/16 in** open end wrench tighten needle valve lock nut to 89-106 LBIN (10-12 Nm) (Figure 5-4).

6. The pressure gauge replacement procedure is complete.

Figure 5-3. Assembling Gauge Coupling

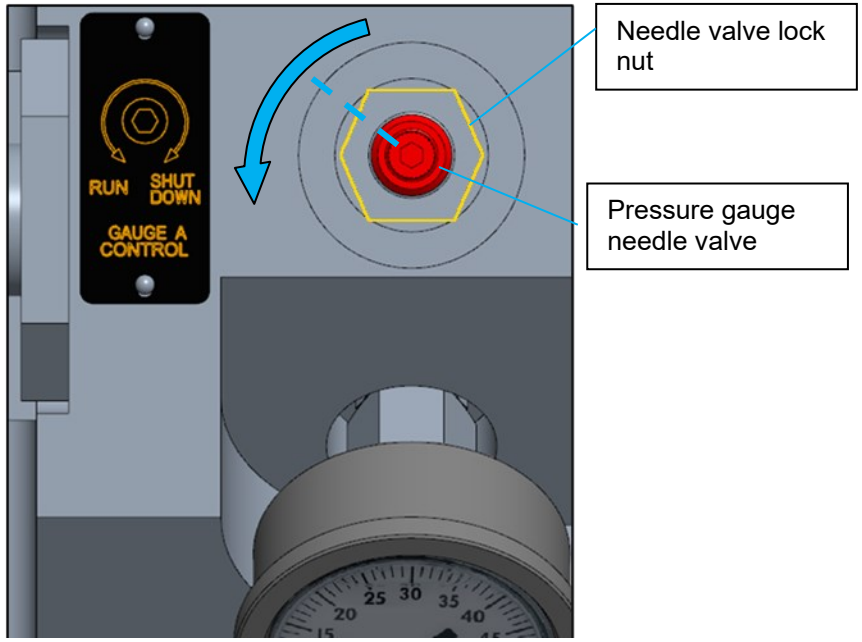

Figure 5-4. Needle Valve Opening

6. REVISION HISTORY

REVISION DATE	REVISION LETTER	DESCRIPTION OF CHANGE	PAGE #
SEP 2022	-	Initial revision	-

PO Box 1519, Fort Collins CO 80522-1519, USA
1041 Woodward Way, Fort Collins CO 80524, USA
Phone +1 (970) 482-5811
Email and Website—www.woodward.com

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