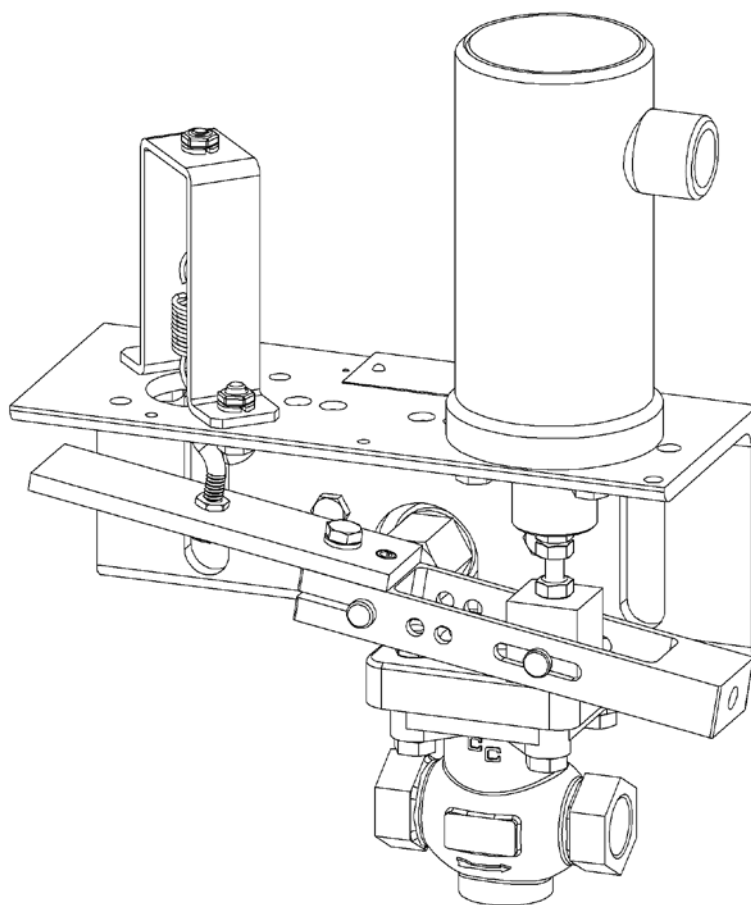




# ER Series Rotary Style Solenoid Valve



## Technical Manual

V2020.2

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Valve Type		<b>ER XX - XX X X X X X - X XX - X X XX A - ETL</b>																									
ER Rotary Style																											
<b>Operation</b> 15 2-Way, Solenoid Actuated, Direct Op Pilot Assisted 16 2-Way, Solenoid Actuated, Direct Operated 17 2-Way, Mechanically Latched, Direct Op Pilot Assisted (Trip When Energized, Manual Reset) 18 2-Way, Mechanically Latched, Direct Operated (Trip When Energized, Manual Reset) 19 2-Way, Heat Tripped, Direct Operated Pilot Assisted (Trip When Hot, Manual Reset) 20 2-Way, Heat Tripped, Direct Operated (Trip When Hot, Manual Reset) 21 3-Way, Solenoid Actuated, Direct Operated 22 3-Way, Mechanically Latched, Direct Operated (Trip When Energized, Manual Reset) 27 2-Way, Electromag. Latched, Direct Op Pilot Assisted (Trip When De-Energized, Manual Reset) 28 2-Way, Electromagnetically Latched, Direct Operated (Trip When De-Energized, Manual Reset) 32 3-Way, Electromagnetically Latched, Direct Operated (Trip When De-Energized, Manual Reset)																											
<b>Connection Size</b> 08 ½" 12 ¾" 16 1" 20 1¼" 24 1½" 32 2" 40 2½" 48 3" 64 4" 96 6"																											
<b>Connection Type</b> A NPT B Socket Weld C Butt Weld D 150# MIL Flange E 300# MIL Flange F MIL Union G 150# ANSI Flange H 300# ANSI Flange J 600# ANSI Flange K Comm. Union L 150# Flat Face Flange M 300# Flat Face Flange N SAE J1926/1 P Pipe Thread Z Other																											
		<b>Body Material</b> 1 Carbon Steel 2 316 SS 3 304 SS 4 Bronze 5 Monel 6 Alloy 20 7 Hastelloy 8 B61 Bronze 9 Aluminum				<b>Seat Material</b> X Integral 1 316 SS 2 Monel 3 Alloy 20 4 440C 5 Hastelloy 6 304 SS				<b>Disc Material</b> X Piston Metal 1 Teflon 2 Viton 3 Buna-N 4 15% GF Teflon 5 Silicone 6 EPDM 7 Stellite																	
		<b>Piston Material</b> 1 316 SS 2 303 SS 3 Monel 4 Alloy 20 5 Hastelloy 6 420 SS																									
		<b>Accessories</b> S Single Switch X Single Switch Explosion Proof M Dual Switch Y Dual Switch Explosion Proof L Locking Manual Override T Terminal Box H High Temperature (> 350°F) V Vertical Pipe																									
		<b>Solenoid Enclosure Rating</b> 4 NEMA 4 Watertight 6 NEMA 6 Submersible 7 NEMA 7 Explosion Proof																									
		<b>Solenoid Voltage</b> A1 24V AC A2 120V AC A3 240V AC D2 24V DC D4 48V DC D6 125V DC D7 250V DC																									
		<b>Solenoid Size</b> A 400 Series B 800 Series																									
		<b>ETL</b> CI I, Div 1, Grps B-D Hazardous Locations																									
		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2">ER</th> <th colspan="3">Action (3-Way)</th> </tr> <tr> <th>W</th> <th>S</th> <th>U</th> </tr> </thead> <tbody> <tr> <td>21-22, 32</td> <td>Diverting</td> <td>Selecting</td> <td>Universal</td> </tr> </tbody> </table>												ER	Action (3-Way)			W	S	U	21-22, 32	Diverting	Selecting	Universal			
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27-28	Energize to Open, Trip Closed	Energize to Close, Trip Open																									

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# Installation

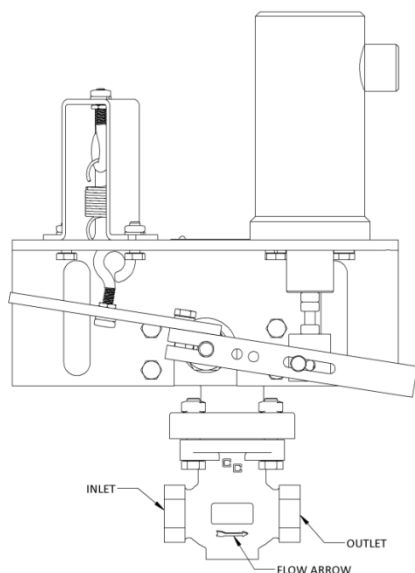
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## Valve orientation

Clark Cooper ER Series rotary style solenoid valves are intended to operate on a horizontal pipeline and are to be installed upright with the solenoid on top. The valve will not function properly unless it is upright as it uses gravity to assist with closing due to the mass of the internal components.

For 2-way valves, the flow arrow on the valve body indicates the direction of flow from inlet to outlet as seen in Figure 1 below. See Figure 4 on page 8 for 3-way valve ports.

Pipelines on either side of the valve are to be properly supported to prevent strains on the valve body.



*Figure 1. Flow directions of a 2-way ER Series valves.*

## Filters

Piping upstream of the ER Series valve should be clean and free of particulate. It is recommended to install filters to prevent large particles from damaging the internals of the valve. Particles can get stuck inside the valve and prevent proper operation. They can also damage metal components such as the pilot or the seat and prevent the valve from sealing properly.

## End connections

Always use mating end connections and seals/gaskets compatible and rated for the fluid pressure and type.

Female NPT end connections are to be installed with PTFE tape or other appropriate thread sealant. Follow the sealant manufacturer installation instructions. Some general guidelines are:

- Use only 3 to 4 wraps of PTFE tape around the external thread.
- Looking at the external thread, wrap the PTFE tape clockwise. When the threads are turned together, this will prevent unraveling of the tape.

- Start the tape at least one thread away from the end to eliminate any chance of tape getting in the flow path.
- Do not combine thread sealant and PTFE tape.
- Do not back off a connection simply to adjust orientation. This may break the thread seal.

Be sure that no PTFE tape ends up in the system. No torque is recommended due to the varying nature of NPT pipe connections. Always use the hexagonal portion of the valve body when applying torque.

For welded end connections, it is recommended that the valve internals are removed from the valve body. This is done by removing the bonnet bolts and lifting the bonnet along with the piston assembly. See full steps in the maintenance section of this technical manual. Damage to the internal seals may occur if they are not removed. Ensure that no slag or debris enters the valve upon welding.

For flanges, unions, or other end connections, make sure that the mating end connections are appropriately rated and compatible with the valve. Flange bolt torque is dependent upon bolt and gasket material. Consult with the gasket manufacturer on required compression and corresponding bolt torque. Be sure that these torque values are adjusted if anti-seize compound is used.

## Electrical Connections

Wiring, conduit, and conduit connections must comply with National and Local Electrical Codes, as appropriate.

The coil can be rotated in 90° increments. To turn the coil, remove the four ¼-20 bolts holding it in place using a 7/16" wrench. Rotate the coil as desired and re-secure with the four bolts. See the Coil Replacement procedure in the Maintenance section for further details.

Coils have a ½" NPT female conduit connection and 3 lead wires. Lead wires are 36" long and a minimum of 18 AWG (see Table 2) depending on the required current. Lead wires are to be connected as follows:

*Table 1. 400 & 800 Series coil wiring colors.*

Power	Lead Wire Color	Usage
AC	Black	Hot/Neutral
	Black	
	Green	Chassis Ground
DC	Black	(+) Positive/
	Black	(-) Negative
	Green	Chassis Ground

Coils provided on valves with "ETL" at the end of the part number are explosion proof certified for use in hazardous locations. A conduit seal must be installed within 1 inch of the conduit connection of the coil.

**For Use In:** Class I, Division 1, Groups B – D Hazardous Locations

**Operating Temperature Code:** T2D

**Ambient Temperature Range:** -20°C to +85°C

Coils on these valves will have this information marked on the coil itself.

## Power requirements

Power requirements are listed in the table below. AC voltages are 50/60 Hz. Solenoids are designed to operate at  $\pm 10\%$  of nominal voltage. Check the nameplate on the bracket of the valve for the operating voltage.

*Table 2. ER Series valve coil specifications.*

ER Series	Coil Series	Voltage	Amps, Inrush	Amps, Holding	AWG
ER15 ER16 ER17 ER18 ER21 ER22	400  (0.5 Second Inrush)	24V AC	16.9	1.00	14
		120V AC	4.6	0.29	18
		220V AC	3.8	0.10	18
		24V DC	18.5	1.00	14
		125V DC	5.2	0.29	18
		250V DC	2.9	0.10	18
	800  (1 Second Inrush)	24V AC	26.7	1.00	18
		120V AC	13.8	0.50	18
		220V AC	7.3	0.20	18
		24V DC	26.7	1.00	18
		125V DC	15.6	0.50	18
		250V DC	8.3	0.20	18
ER27 ER28 ER32	400  (No Inrush)	24V AC	—	0.18	18
		120V AC		0.07	18
		24V DC		0.18	18
		125V DC		0.07	18

## Circuit Protection

Fuses or circuit breakers are recommended and should be sized according to the inrush and holding amperage requirements of the solenoids specified above.

## Optional Position Switch Wiring

For position switch wiring and setup, refer to the separate Position Switch Information document provided at the end of this technical manual.

## Optional Terminal Box Wiring

The terminal box option provides a small enclosure with a terminal block attached directly to the coil instead of having 36" lead wires. The terminal block contains three terminals corresponding to Table 1 above. Connections are to be made with the appropriate wire gauge and with terminals appropriate for a #5 screw size. Hole for wiring is to be created upon installation of valve by the end user.

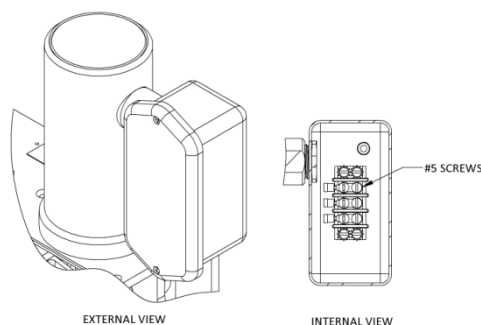


Figure 2. Terminal box option installed.

## Product Description

### Rotary Style Solenoid Valve Description

Rotary style solenoid valves use external solenoid to control internal piston movement. The plunger and other solenoid components are isolated from the working fluid, providing the advantage that all of the valve internals can be corrosive resistant materials. Another advantage is that the valve can handle hotter fluids without overheating the coil as it is mounted on top of the bracket away from the bonnet.

Depending on the operation (described below in the Types of ER Series Valves section), the solenoid controls the lever movement in various ways. This is done either directly via a plunger in the solenoid used to control the lever movement or indirectly by having the plunger control a mechanical latch that controls the lever movement. The lever is pinned directly to the rotary shaft.

The rotary shaft penetrates the pressure boundary and is the only component connecting the external assemblies to the internal assemblies. It utilizes a spring loaded packing seal and o-ring seals to prevent external leakage. Assembly can be seen on the Internal Exploded View on page 12.

The rotary shaft turns the clevis, which lifts or lowers the stem of the piston assembly for opening or closing depending on the direction of rotation of the lever. Pistons and piston assemblies will differ depending on whether the valve is *direct operated* or *direct operated pilot assisted*.

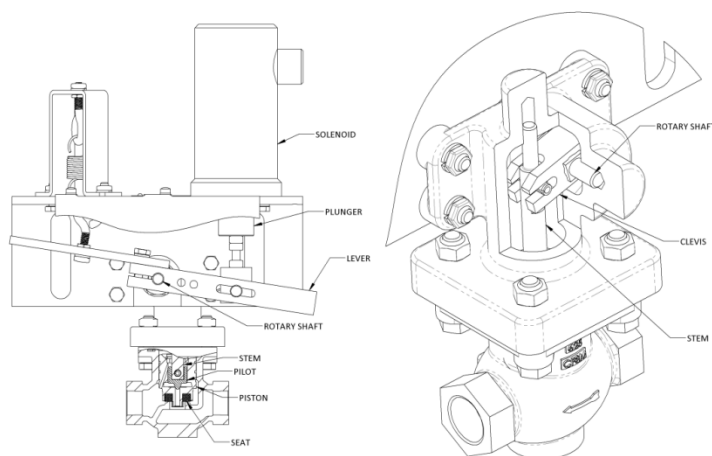


Figure 3. View of the mechanical operation of an ER Series valve.

## General ER Series Valve Operation

The ER series valves operate in many different ways, indicated by the “Operation” and “Action” on the model number breakdown page.

All ER series valves are *direct operated* (also known as direct acting). This means that the piston on the orifice is directly connected to the opening/closing armature. This is in contrast to *pilot operated* valves in which the fluid assists in the opening and closing of the piston. Some of the ER series valves are *direct operated pilot assisted*. This means that the pilot opens first to help reduce the pressure differential across the piston seat. This helps the opening/closing armature pull the piston off of valve seat as there is less force from the fluid pressure. These *pilot assisted direct operated* valves are still *direct operated*.

ER series valves are either 2-way unidirectional valves or 3-way valves. The 2-way unidirectional valves can only allow fluid to flow from inlet to outlet according to the flow arrow embossed on the valve body. The 3-way ER series valves can be operated as a diverting, selecting, or universal valve. Flow directions are indicated in Figure 4 below.

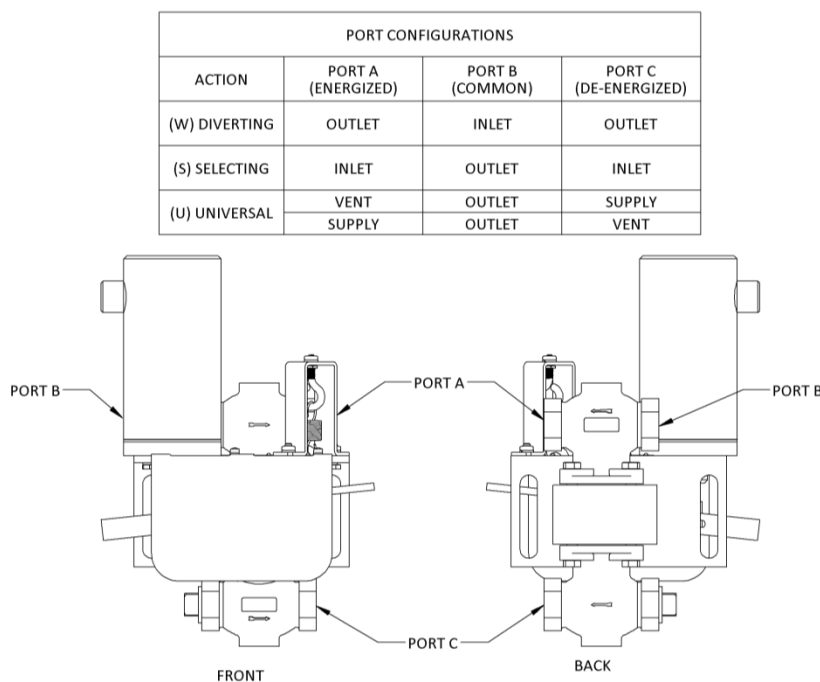


Figure 4. Ports and flow direction options for 3-way ER Series valves.

## Types of ER Series Valves

The opening and closing mechanisms of the ER series valves depend on the ‘Operation’ and ‘Action’ selected as shown on the M sheet.

### ER15, ER16, ER21

These valves are solenoid operated. The solenoid is energized and de-energized to switch the valve between its open and closed states. A spring is used to return the valve to its “fail” state.

### ER17, ER18, ER22

These valves are operated using a mechanical latch to hold the lever in place. When the solenoid is energized, the latch releases the lever and a spring turns the lever. The solenoid only needs to be



energized for a small pulse to trip the latch. To reset, the solenoid must be de-energized and the lever must be manually lifted.

#### ER27, ER28, ER32

These valves are operated using the solenoid as an electromagnetic latch. When the solenoid is energized, it will hold the lever up. When de-energized, the spring will turn the lever. To reset, the solenoid must be energized and the lever must be manually lifted. The solenoid must remain energized to continue to hold the lever.

### **Solenoid Operation**

All coils are equipped with a thermal fuse. If they get too hot, the fuse will break and the coil will have to be replaced. Due to the large inrush currents of these solenoids, they are limited on how frequently they can be powered on.

- 400 series coils are to be cycled a maximum of 4 times per minute in 120°F ambient air.
- 800 series coils are to be cycled a maximum of 2 times per minute in 120°F ambient air.

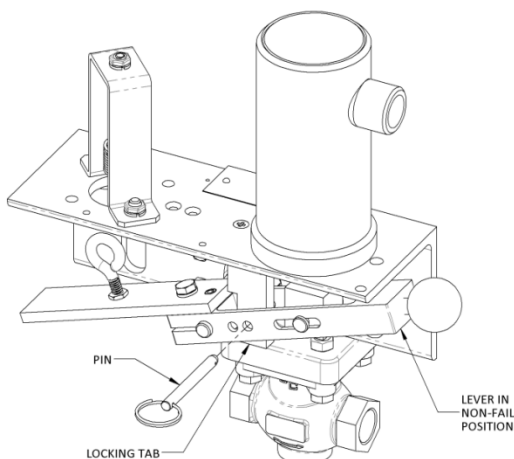
All solenoids can be held energized indefinitely due to the low holding current. For higher cycle frequencies and higher ambient temperatures, contact Clark Cooper for more information.

When the solenoid is energized for long periods of time, it is normal for the coil to have high surface temperatures approaching 200°F.

400 series coils on the ER27, ER28, and ER32 have no limitations on the cycling frequency as there is no inrush current.

### **Optional Locking Manual Override**

Valves equipped with the locking manual override allow the valve to be physically locked in its non-fail (energized) state without requiring power. This is done by inserting the provided pin through the lever into the designated locking tab.



*Figure 5. Locking manual override option.*

The lever can be raised manually or by using the solenoid depending on the type of valve. Energizing or de-energizing the solenoid will have no effect on opening and closing when the pin is in place.

## Service Information

### Pressure Ratings

The maximum allowable differential pressure rating depends on the size, type, operation, solenoid, and end connections of the ER series valve. The operating pressure will be located on the nameplate on the bracket of the valve.

*Table 3. Maximum Operating Pressure Differential (PSI) of ER Series valves.*

Size	Solenoid Series	ER15, ER17, ER27		ER16, ER18, ER28		ER21, ER22, ER32		
		D	R	D	R	W	S	U
½"	400	2,160		500	400	200		
	800	—		2,160	2,000	720		
¾"	400	1,200		125	100	50		
	800	—		800	720	350		
1"	400	1,200		50		25		
	800	—		375	300	150		
1½"	400	500	450	10		—		
	800	1,200		75				
2"	400	200		5		—		
	800	720		25				
3"	800	275		—		—		
4"	800	150		—		—		
6"	800	75	60	—		—		

### Temperature Ratings

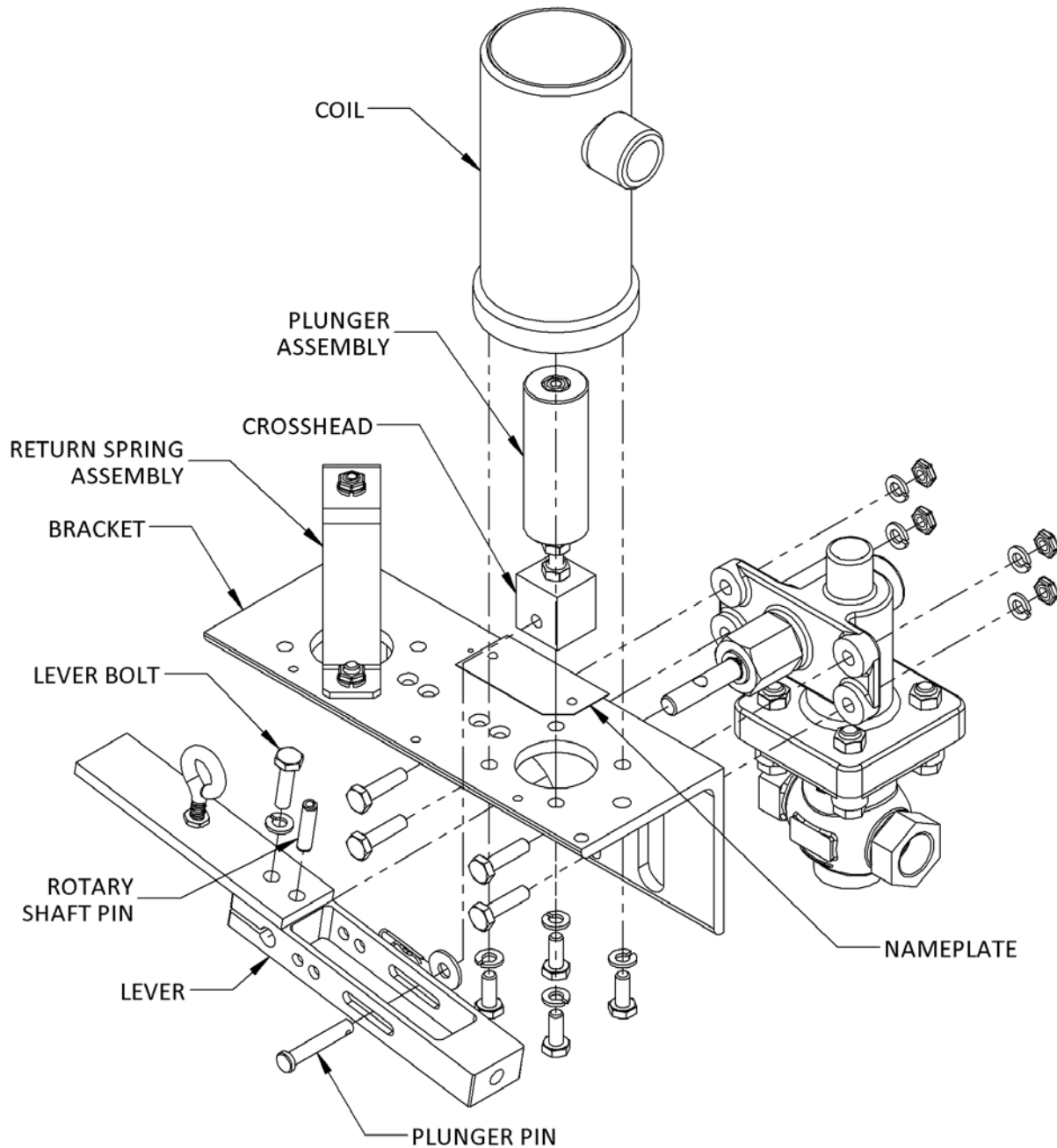
Allowable fluid temperature range: -50°F to +350°F

With high temperature option 'H': +550°F.

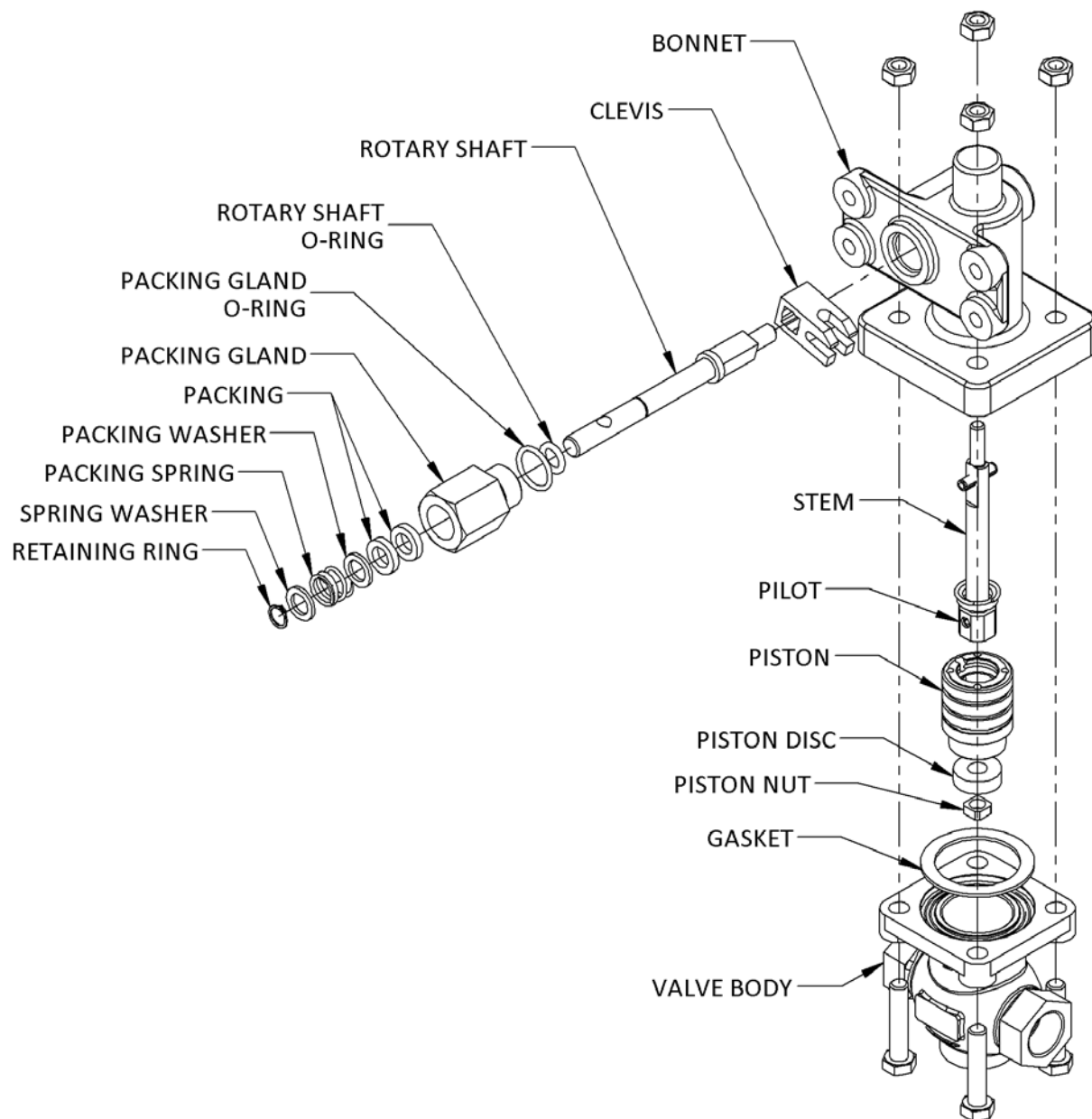
Allowable ambient temperature range: See Solenoid Operation section

# Maintenance

## External Exploded View



## Internal Exploded View



## Torque Tables

*Table 4. Body/bonnet flange bolt/stud torques.*

Valve Size	Wrench Size	Torque	Fastener	Fastener Qty
½" - ¾"	1/2"	265 in-lbs	5/16-18 Bolts	4
1"	9/16"	204 in-lbs	3/8-16 Studs	4
1½"	3/4"	540 in-lbs	1/2-13 Studs	4
2"	3/4"	384 in-lbs	7/16-14 Studs	6
3"	3/4"	540 in-lbs	1/2-13 Studs	8
4"	1-1/16"	95 ft-lbs	5/8-11 Bolts	8
6"	1-1/16"	95 ft-lbs	5/8-11 Studs	10

When tightening the bonnet to the valve body, be sure to tighten the fasteners in a star pattern to ensure even compression of the gasket.

*Table 5. Packing gland torques.*

Valve Size	Wrench Size	Torque
½" - 1½"	1"	75 ft-lbs
2" - 3"	1-1/4"	105 ft-lbs
4"	1-3/8"	150 ft-lbs
6"	2"	

## Maintenance Notes



Never disassemble a valve that is under pressure. Evacuate pressure on all lines connected to the valve to ensure safe disassembly.

The various repair instructions below are meant to be used as a guide. The ER Series valves are highly configurable and may not perfectly match the instructions or exploded views provided. Clark Cooper strongly suggests that valves that are no longer functioning properly to be returned via the RMA (Return Material Authorization) process for a complete evaluation.

## Coil Replacement

1. Disconnect the coil from the power supply.
2. Using a 7/16" socket wrench, remove the (4) ¼-20 bolts on the underside of the bracket that hold the coil in place.
3. Lift the coil straight up off of the top of the bracket.
4. Replace with the new coil in the desired orientation and secure with the (4) bolts.
5. Reconnect the power supply to the coil.

## Removing Internals for End Connection Welding

1. Secure the valve body so that the valve is upright.
2. Remove the body/bonnet fasteners.

3. Rotate the lever fully counter-clockwise and keep it in this position to hold the piston assembly inside the bonnet.
4. Lift the entire bracket/bonnet assembly straight off of the valve body.
5. Remove the gasket sitting in the top of the valve body.
6. Reverse the previous steps after welding. Be sure to properly torque the body/bonnet fasteners.

### **Piston Assembly Replacement**

1. Remove pressure from the valve. Both inlet and outlet are to be at 0 psig.
2. Disconnect the coil from the power supply.
3. Remove the body/bonnet fasteners.
4. Rotate the lever fully counter-clockwise and keep it in this position to hold the piston assembly inside the bonnet.
5. Lift the entire bracket/bonnet assembly straight off of the valve body.
6. Remove the gasket sitting in the top of the valve body.
7. Rotate the lever fully clockwise to allow the piston assembly to slide off of the clevis and fall out of the bonnet. On some sizes and configurations, the piston assembly will not fall out. If this happens, follow these steps:
  - a. Press the rotary shaft pin out of the rotary shaft. It is not recommended to hammer the pin out as this can damage the rotary shaft.
  - b. Loosen the lever bolt. The rotary shaft and lever should be able to spin freely from each other.
  - c. Pull the piston assembly out.
8. For piston disc Replacement:
  - a. Remove the piston nut. This is typically secured by either Loctite 242 or staking.
  - b. Remove the piston disc and replace with the new disc.
  - c. Replace nut with new Loctite 242. Nut should sit snugly onto disc. Do not over-tighten and deform disc.
9. With the lever fully clockwise, install the new piston assembly into the bonnet. The top of the stem should slide into the top of the bonnet and the stem pint should slide into the clevis. See Figure 3 on page 7. For valves that required the lever to be loosened, tighten the lever bolt and press the rotary shaft pin back in once the piston assembly is inserted correctly.
10. Hold the lever in its fully counter-clockwise position so that the piston assembly stays in the bonnet.
11. Replace the body/bonnet gasket into the groove in the valve body.
12. Line up the piston and place the bracket/bonnet assembly back on top of the valve body.
13. Release the lever and tighten the body/bonnet fasteners per Table 4 on page 13.
14. Reconnect the coil to the power supply.

### **Rotary Shaft and Seal Replacement**

1. Remove pressure from the valve. Both inlet and outlet are to be at 0 psig.
2. Disconnect the coil from the power supply.
3. Remove the safety shield from the front of the bracket if applicable.
4. If the rotary shaft is being replaced, mark the lever position:
  - a. For 2-way ER valves, rotate the lever fully clockwise so that the valve is in its closed position. For 3-way ER valves, rotate the lever fully counter-clockwise.

- b. Take a flat piece of bar stock and place it so that it is flush against the top of the lever and flush against the front face of the bracket. Mark a line on the bracket to accurately reproduce the lever angle upon re-assembly.
5. Unhook the return spring from the lever eye bolt on the lever.
6. Remove the crosshead pin from the lever.
7. Press the rotary shaft pin out of the rotary shaft. It is not recommended to hammer the pin out as this can damage the rotary shaft.
8. Loosen the lever bolt. The rotary shaft and lever should be able to spin freely from each other.
9. Pull the lever straight off of the rotary shaft.
10. If possible, place the valve on its back so that the rotary shaft is pointing upwards. Loosen the packing gland counter-clockwise until the whole rotary shaft assembly comes off.
11. For full disassembly of the rotary shaft assembly, follow these steps:
  - a. Remove the retaining clip from the rotary shaft with a pair of snap ring pliers.
  - b. Slide the rotary shaft out of the packing gland. If only replacing rotary shaft, slide in the new rotary shaft, replace the retaining clip, and go to step 12.
  - c. Separate the packing, washers, spring, and o-rings from the packing gland.
  - d. Clean off lubricant and debris from rotary shaft and packing gland.
  - e. Slide the small o-ring back on to the rotary shaft.
  - f. Lubricate the o-ring and rotary shaft with suitable valve lubricant.
  - g. Insert the large o-ring at the base of the threads of the packing gland.
  - h. Slide the packing gland onto the rotary shaft.
  - i. Press two pieces of packing between the rotary shaft and the packing gland. Open ends of packing should be opposite of each other.
  - j. Insert the packing washer, packing spring, and spring washer into the packing gland. Secure with replacement retaining clip.
  - k. Apply anti-seizing compound to the threads of the packing gland to avoid galling.
12. Check that the rotary shaft spins within the packing gland relatively easy. Disassemble and reassembly if it is difficult to turn.
13. Insert the rotary shaft into the bonnet so that the squares on each part line up.
14. Tighten the packing gland and torque according to Table 5 on page 13.
15. Slide the lever back on to the rotary shaft. Make sure the piston assemble inside valve is in its closed position like in step 4. Align the lever with the mark made in step 4 and tighten down the lever bolt so that the lever securely grips the rotary shaft. Turn the lever and make sure that the lever aligns with the more when the valve is closed. At this point, the rotary shaft pin hole can be drilled, but it is recommended to wait until the valve is properly tested.
16. Hook the return spring back onto the lever eye bolt and re-insert the crosshead pin to connect the plunger assembly to the lever.
17. Reconnect power to the coil.
18. Test for proper operation of the valve. If it functions correctly, disconnect power and drill a  $\varnothing 0.253$  hole through the rotary shaft using the lever to align the hole. Press the rotary shaft pin into the rotary shaft.
19. Re-install the safety shield.

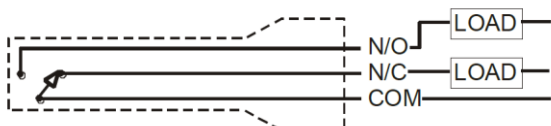
## ER Position Switches

### SPECIFICATIONS:

#### Contacts

Single Pole, Double Throw, Form C

#### Wiring Diagram



Red – Normally Closed (N/C)

Blue – Normally Open (N/O)

Black – Common (COM)

#### Wire and Connection Specifications

- PVC insulated lead wires
- 18 AWG
- 36" lead length
- ½" NPT conduit connection

#### Electrical Ratings

4A @ 120VAC/3A @ 24VDC

2A @ 240 VAC/1.25A @ 48VDC

#### Temperature Rating

-40 to 105°C

#### Sensing Range

Approximately 0.10" inches

#### Certifications

General Purpose

- UL General Purpose

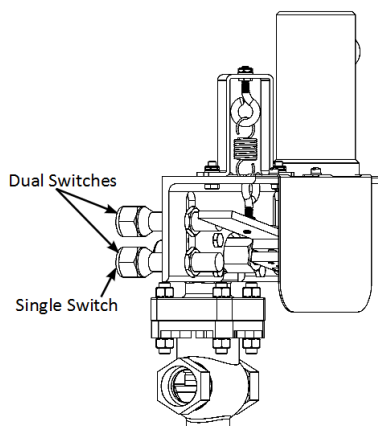
Explosion Proof

- UL Class 1, Divisions 1 & 2, Groups A-D
- UL Class II, Divisions 1 & 2, Groups E-G
- Lead seal fitting required within 18" of switch



**OPTIONS:**

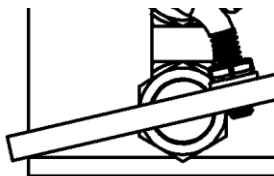
Option Code	Switch Qty	Indication	Certification
S	1	Energized Position	General Purpose
X	1	Energized Position	Explosion Proof
M	2	Open and Closed Positions	General Purpose
Y	2	Open and Closed Positions	Explosion Proof



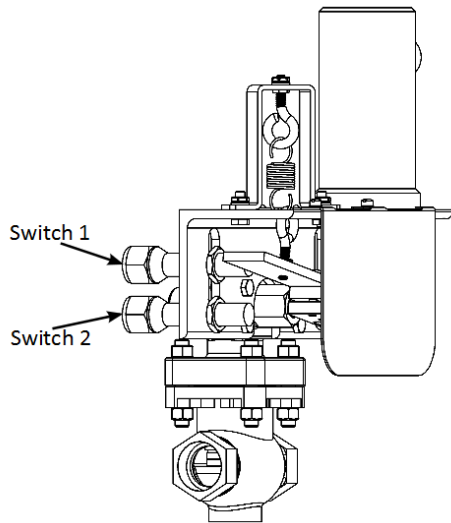
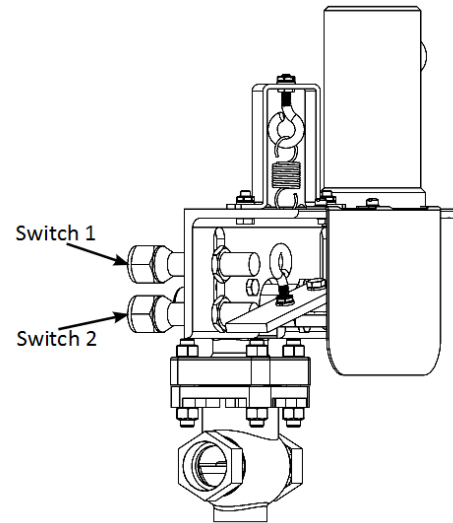
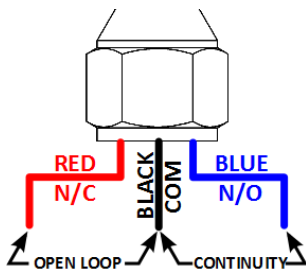
Single vs. Dual Switch Example: ER15, Energize to Open

The single switch options S and X use one switch to indicate whether the valve is in its energized state or not. In the example above, a single switch on a valve that opens when energized would indicate when the valve is open or not open. It would not indicate when the valve is closed.

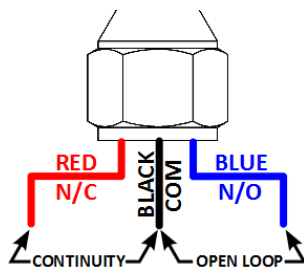
The dual switch options M and Y use two switches to indicate both open and closed positions for the valve. One switch will indicate whether the valve is open or not open and the other switch will indicate if the valve is closed or not closed.

**SWITCH INDICATION:**


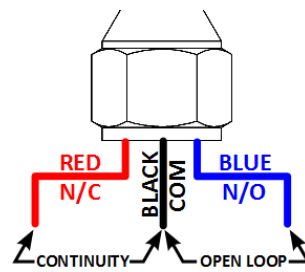
For a switch to indicate properly, the lever should be aligned with the center of the switch as shown above. The lever cannot be further away than the sensing range of approximately 0.10".

**EXAMPLE: ER15, ENERGIZE TO OPEN**
**De-Energized State (Valve Closed)**

**Energized State (Valve Open)**

**Switch 1**


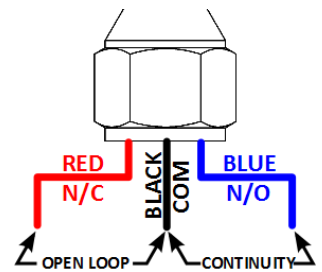
Indicates valve is closed.

**Switch 2**


Indicates valve is not open.

**Switch 1**


Indicates valve is not closed.

**Switch 2**


Indicates valve is open.