[redacted]

Southern States

The Quality Name in High Voltage Switching

# Type CSH & CSH-B
# CSH2 & CSH2-B

# Circuit Switcher

Horizontal Circuit Switcher

38kV to 245kV
1200, 1600, 2000 Amps

INSTALLATION &

INSTRUCTION

MANUAL

Southern States



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# Safety Information

## ⚠ WARNING

IMPROPER HANDLING, INSTALLATION, OPERATION OR MAINTENANCE OF THIS EQUIPMENT MAY CAUSE IMMEDIATE HAZARDS WHICH WILL LIKELY RESULT IN SERIOUS PERSONNEL INJURY OR DEATH.

## ⚠ WARNING

The equipment covered by this publication must be handled, installed, operated and maintained by qualified persons who have direct knowledge and experience dealing with the hazards involved and are thoroughly trained in the handling, installation, operation and maintenance of high voltage transmission and distribution equipment. These instructions are meant for only such **Qualified Persons**. They are not intended to be a substitute for adequate training and experience in safety procedures for this type of equipment. **Please ensure that you are using the latest installation and maintenance instructions.**

A **Qualified Person** is one who is trained in and has skills necessary:

- to read and comprehend this instruction book – understanding that these instructions are general in nature
- to accept personal responsibility to prepare and maintain an intrinsically safe work environment and maintain control of the work site to safeguard all persons present
- to develop and implement a proper rigging, lifting, and installation plan along with all safety precautions required to insure safe and proper lifting and installation of the equipment.
- to distinguish between energized and non-energized parts
- to determine proper approach distances to energized parts
- to properly work with and around energized or de-energized equipment that may be pressurized with gas
- for proper use of personal protective equipment, insulating and shielding materials, insulated tools for working near energized and /or pressurized electrical equipment
- to recognize and take necessary precautions for the unique and dynamic conditions of site and specialized equipment to maintain a safe work environment during handling, installation, operation, and maintenance of high voltage switching equipment

The instructions in this manual are general guidelines for this type of equipment and not specific to the equipment supplied. Portions of it may not be applicable or may not have complete instructions for your specific equipment.

If you do not understand any part of these instructions or need assistance, contact Southern States Service Division at 770-946-4562 during normal business hours (EST) or 770-946-4565 after normal business hours.

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# Southern States, LLC

## Equipment Receipt, Installation, Use, Operation and Maintenance Terms

## *("Terms of Use")*

The purchaser ("Purchaser") of certain Equipment (the "Equipment") identified in the Instruction Manual accompanying these Terms of Use sold by Southern States, LLC ("Southern States"), by Purchaser's acceptance or Use of Equipment in any way, agrees to the Terms of Use set forth below (the word "Use" herein means receipt, testing, inspection, installation, operation, maintenance and otherwise handling the Equipment):

- Purchaser represents and warrants that it is fully qualified to Use the Equipment, and that it is a sophisticated user of the Equipment with a high level of expertise in the Use of the Equipment and Purchaser knows that Southern States is relying on Purchaser's sophistication and expertise with respect to the Equipment.

- The Purchaser will, within seven (7) days after receipt of the Equipment, inspect the Equipment and identify and notify Southern States in writing of any missing parts, damage or defects observed in the Equipment.

- The Purchaser will Use the Equipment, only in conformity with all manuals, data sheets and instructions provided by Southern States, and in keeping with sound engineering, utility and safety practice. Purchaser will at its own expense, provide all necessary labor, supplies, and facilities required to Use the Equipment.

    - The Purchaser may use its own personnel or engage a third party to Use the Equipment. The Purchaser shall insure that it only utilizes personnel who are fully qualified or certified by a reputable certification agency to Use the Equipment. In the event that Purchaser cannot find such qualified personnel, the Purchaser will notify Southern States and seek its advice to determine a mutually agreeable solution.

    - By separate agreement, Southern States may provide such services and the personnel to conduct such services in connection with the installation of the Equipment. In the event Southern States agrees to provide personnel to install, maintain, and operate the Equipment, such personnel will function only in an advisory capacity and shall have no responsibility for the supervision, or the quality or workmanship of such installation, maintenance, or operation of the Equipment.

- The Purchaser shall not install and operate the Equipment in a way such that a single point of Equipment failure leads to a cascading event or consequential damage to any person or property. Purchaser shall ensure redundancy in its system at all times. Purchaser acknowledges and agrees that electric service is by nature subject to interruptions due to Equipment failures and shall not agree to provide service free from the effects of Equipment failures.

- The Equipment will be maintained and inspected as provided by this instruction manual and in compliance with best industry practices, but in no event will the Equipment be inspected and tested less frequently than once in every 6 months.

- The Purchaser shall not repair, dismantle, or alter any of the Equipment without Southern States' written consent.

- Any failure of Equipment either in service, testing or inspection will be promptly reported in writing to Southern States within 24 hours of the failure so that adequate evidence can be collected, appropriate diagnostic tests can be conducted, and analysis of the failure can be determined.

- Southern States will have no liability for any direct, indirect, consequential or remote damage or injury, whether or not foreseen or foreseeable, to the Purchaser or any third party or person for any damages or injury to person or property caused by Purchaser's or any third party's actions, whether or not negligent, in the Use of the Equipment. Purchaser shall indemnify and hold Southern States and its employees, officers and directors against any damage or injury caused in whole or part by Purchaser's or any third party's action whether or not negligent, resulting from the Use of the Equipment. Southern States expressly rejects any liability to third parties. The Purchaser expressly waives any claim against Southern States, its employees, officers, directors and affiliates, for injury or damage to person or property resulting from Use of the Equipment not directly and solely caused by Southern States' negligence. For the purposes of clarity, Southern States shall not be liable, and be fully indemnified by the Purchaser, for the following related to the Equipment: normal wear and tear, excessive use and loading, improper interference or maintenance on the part of the Purchaser or third parties, incomplete or false information given by the Purchaser, inappropriate or improper Use, faulty operation, installation or start-up, faulty or careless handling, improper maintenance, use of unsuitable operating materials/substitute materials, defective construction work, hazardous ambient conditions unknown to the Purchaser, chemical, electro-chemical or electrical influences, changes to the subject of delivery made without Southern States consent.

- In the event that Southern States is found by a court of competent jurisdiction or a properly empaneled arbitral body to be liable to the Purchaser for any reason, Southern States shall be entitled to a reduction in the liability by taking into account the exceptions provided by statute, law, and any counterclaims Southern States may have against Purchaser.

- The failure of Purchaser to comply with these Terms of Use herein shall void any and all warranties related to the Equipment. These Terms of Use shall be deemed to be part of the binding contractual agreements between Purchaser and Southern States related to the Equipment and shall govern over any inconsistent term or provision in such other contractual agreements.

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# LIMITED WARRANTY

Southern States, LLC ("SSLLC") warrants only to the Warranty Holder (hereinafter defined as the "End User" or the "Immediate Purchaser", as applicable, pursuant to the terms and conditions of this Limited Warranty as set forth below), that the Product identified below will, upon shipment, be free of defects in workmanship and material for the applicable Warranty Period. The "Warranty Period" is that period of time during which this Limited Warranty is effective, and such period begins on the invoice date issued by SSLLC for the Product, and continues until the earlier to occur of (1) the expiration of the Warranty Duration period, or (2) the Number of Operations, both as specified in the table below. If the Product is both purchased and installed within the United States or Canada, this Limited Warranty is granted to each end user of the Product who acquired the Product for its own use during the Warranty Period ("End User"). In all other situations, this Limited Warranty is granted only to the first purchaser of the Product ("Immediate Purchaser") from SSLLC. No primary or remote purchaser or owner of the Product who is not a Warranty Holder may claim any benefit under this Limited Warranty, or any remedial promise included in this Limited Warranty. SSLLC shall, upon prompt written notice from the Warranty Holder, correct a nonconforming Product by repair or replacement at the sole discretion of SSLLC of the nonconforming Product or any part or component of a nonconforming Product necessary in SSLLC's discretion to make such Product conforming. Any transportation charges, labor for removing, reinstalling the Product or part, and/or costs related to providing access to the Product shall be the responsibility of the Warranty Holder. Correction in this manner will constitute the Warranty Holder's exclusive remedy and fulfillment of all SSLLC's liabilities and responsibilities hereunder. SSLLC's duty to perform under this limited warranty may be delayed, at SSLLC's sole option, until SSLLC has been paid in full for all products purchased by the Warranty Holder. No such delay will extend the Warranty Period. If SSLLC does not make such repair or replacement, SSLLC's liability for damages on account of any claimed nonconformity will in no event exceed the purchase price of the Product in question. This Limited Warranty does not apply to any Product that has been disassembled, repaired, or altered by anyone other than SSLLC. This Limited Warranty will not apply to any Product that has been subjected to improper or abnormal use of the Product. SSLLC has no responsibility to repair or replace any Product or component thereof manufactured by another party, but SSLLC will assign, to the extent assignable, to the Warranty Holder any manufacturers' warranty that applies to products and components not manufactured by SSLLC.

THIS LIMITED WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES. THERE ARE NO OTHER EXPRESS, IMPLIED, OR STATUTORY WARRANTIES. ALL IMPLIED WARRANTIES WHICH MAY ARISE BY IMPLICATION OF LAW, OR APPLICATION OF COURSE OF DEALING OR USAGE OF TRADE, INCLUDING, BUT NOT LIMITED TO, IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, NONINFRINGEMENT OR OTHERWISE ARE EXPRESSLY EXCLUDED. SSLLC SHALL NOT BE LIABLE OR RESPONSIBLE FOR ANY CONSEQUENTIAL, INCIDENTAL, INDIRECT, EXEMPLARY, SPECIAL, OR PUNITIVE DAMAGES, EVEN IF SSLLC HAS BEEN ADVISED OF THE POSSIBILITY OF SAME. THE WARRANTY HOLDER IS SOLELY RESPONSIBLE FOR THE SUITABILITY OF THE PRODUCT FOR ANY PARTICULAR APPLICATION.

| Product Purchased Region | Product Installed Region | Warranty Holder | Warranty Duration | Number of Operations |
|---|---|---|---|---|
| U.S and Canada | U.S and Canada | End User | 5 Years | 1000 |
| All Other Conditions | | Immediate Purchaser | Earlier of 1 year from installation or 18 months from shipment | N/A |

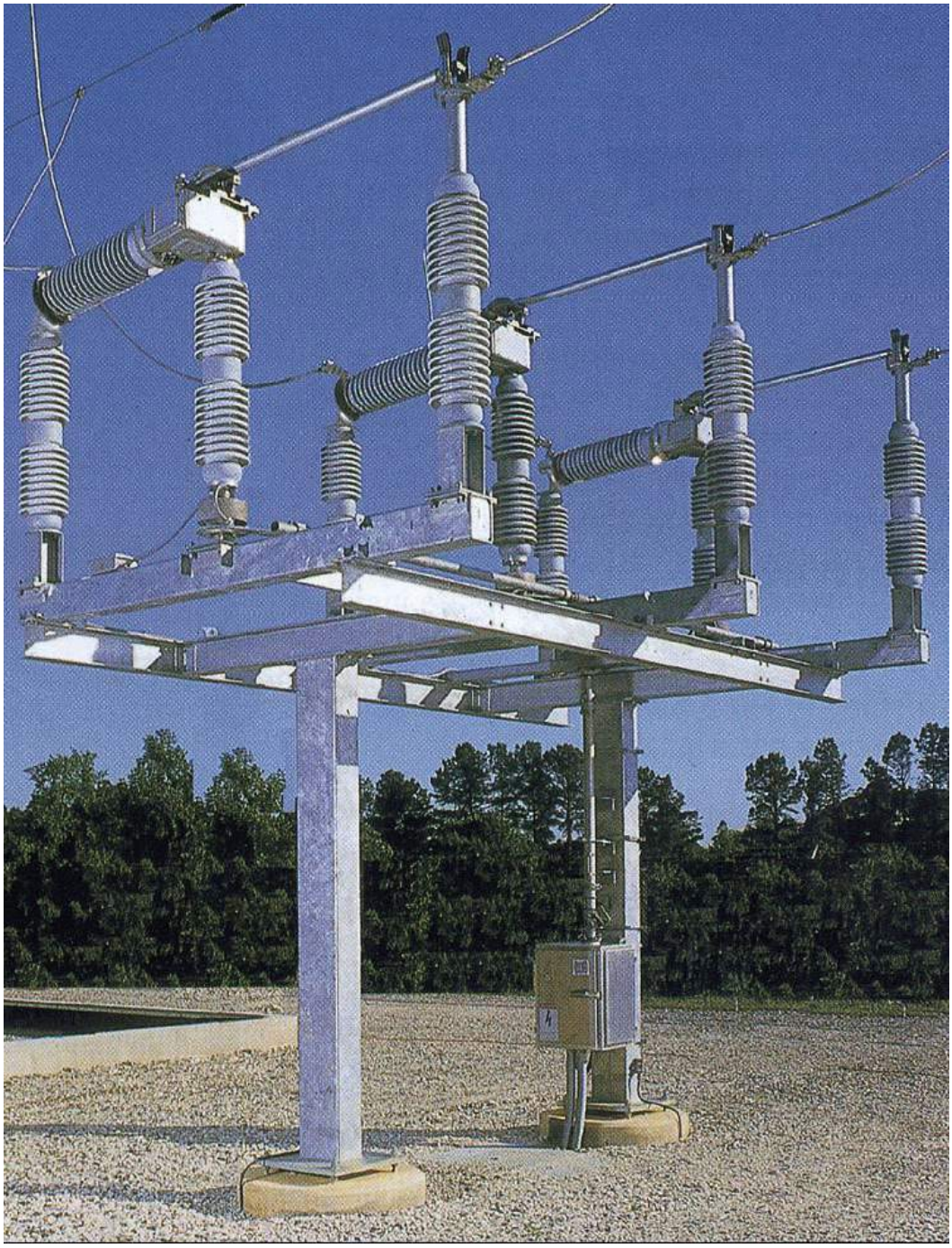
Southern States



The Quality Name in High Voltage Switching

# Type CSH & CSH-B

## 38 kV – 245 kV



# Table of Contents

# List of Tables and Figures

## Tables



## Figures

# Summary & Information

## Summary

These instructions do not purport to cover all details or variations in equipment, or provide for every possible contingency to be met in connection with installation, operation, or maintenance. Should information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local Southern States Representative.

The contents of this instruction manual should not become part of or modify any prior or existing agreement, commitment or relationship. The sales contract contains the entire obligation of Southern States. The Warranty contained in the contract between the parties is the sole warranty of Southern States. Any statements contained herein do not create new warranties or modify the existing warranty.

## Important

The information contained herein is general in nature and not intended for specific application purposes. It does not relieve the user of responsibility to use sound practices in application, installation, operation, and maintenance of the equipment purchased. Southern States reserves the right to make changes in the specifications shown herein or to make improvements at any time without notice or obligations. Should a conflict arise between the general information contained in this publication and the contents of drawings or supplementary material, or both, the latter shall take precedence.

## CSH/CSH-B/CSH2/CSH2-B

The CSH/CSH-B and the CSH2/CSH2-B are similar products with the only difference being the interrupting ratings of the device. This installation and instruction manual is written using the CSH-B as the focus. The guidelines provided should also be utilized when installing the CSH2-B. This manual can also be used as a guide for the CSH and CSH2 products which are similar but do not have the integral disconnect.

# Introduction

The Southern States CSH-B horizontal circuit switcher is an outdoor, high voltage interrupting device equipped with an in-series integral disconnect switch. Operation of the Southern States CSH-B is controlled by a motor operator or by a manual worm gear operator. The Southern States CSH-B is designed and certified to switch and protect transformers. The horizontal circuit switcher is also available without the integral disconnect (CSH). For more information on this and other applications and ratings, contact the nearest Southern States Representative.

A standard package consists of:

- 3 phase SF6 gas CSH-B and support frame
- Support columns designed to customer specifications
- Accessory Box with SF6 gas fill kit

Additional information about the application and ratings of the CSH/CSH-B can be found in the latest updates of Product Bulletins PB-803-40 and PB-803-20. For specific ratings for your device, refer to the product nameplate and job specific drawings.

The instructions contained within this manual are necessary for the safe installation, maintenance, and operation of the CSH-B. A qualified person, familiar with this type of equipment, should carefully read and follow the instructions.

These instructions are intended to provide a general guideline for the installation, adjustment, and Maintenance of the CSH-B. It is not possible to cover all details, equipment variations, and potential conditions. Contact Southern States, LLC in the event conditions associated with a specific application are not sufficiently addressed.

Distinctive signal words are used to indicate the degree of hazard that may be encountered by the user. Identification of the signal words and their definition follow:

| | |
|---|---|
| ⚠ DANGER | Indicates an imminently hazardous situation, which, if not avoided, will result in death or serious injury. |
| ⚠ WARNING | Indicates a potentially hazardous situation, which, if not avoided, could result in death or serious injury. |
| ⚠ CAUTION | Indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices. |
| *NOTICE* | Indicates a possible material damage or can be used to highlight specific instructions or notes. |

# Product Description

## Overview

The Type CSH is similar to the Type CSH-B. The CSH units do not have an integral disconnect blade. Line termination is on the driver end. Two, rather than three insulator columns are used to support and operate the interrupter. When referring to the Type CSH, omit sections of this manual relating to operation and adjustment of the disconnect blade and hinge.

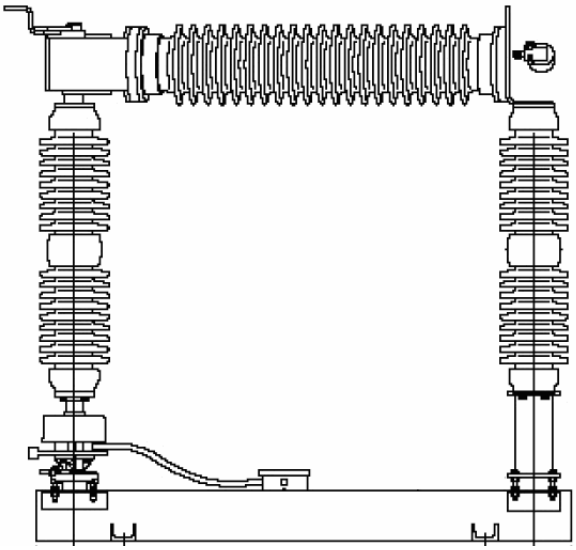


**Figure 1: CSH**

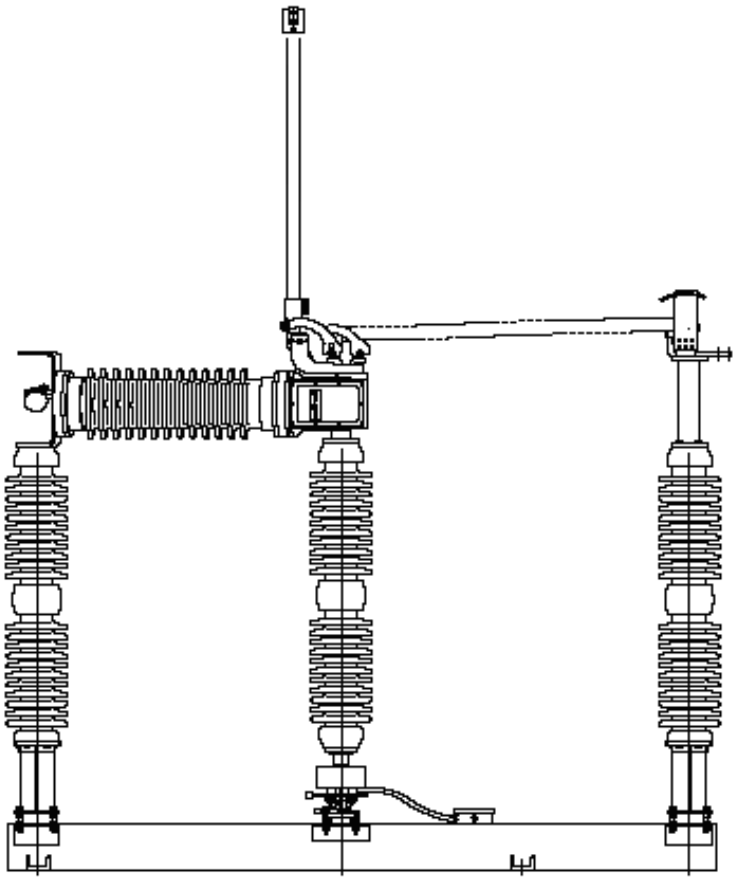


**Figure 2: CSH-B**

Note: Please refer to customer drawings for specific construction details.

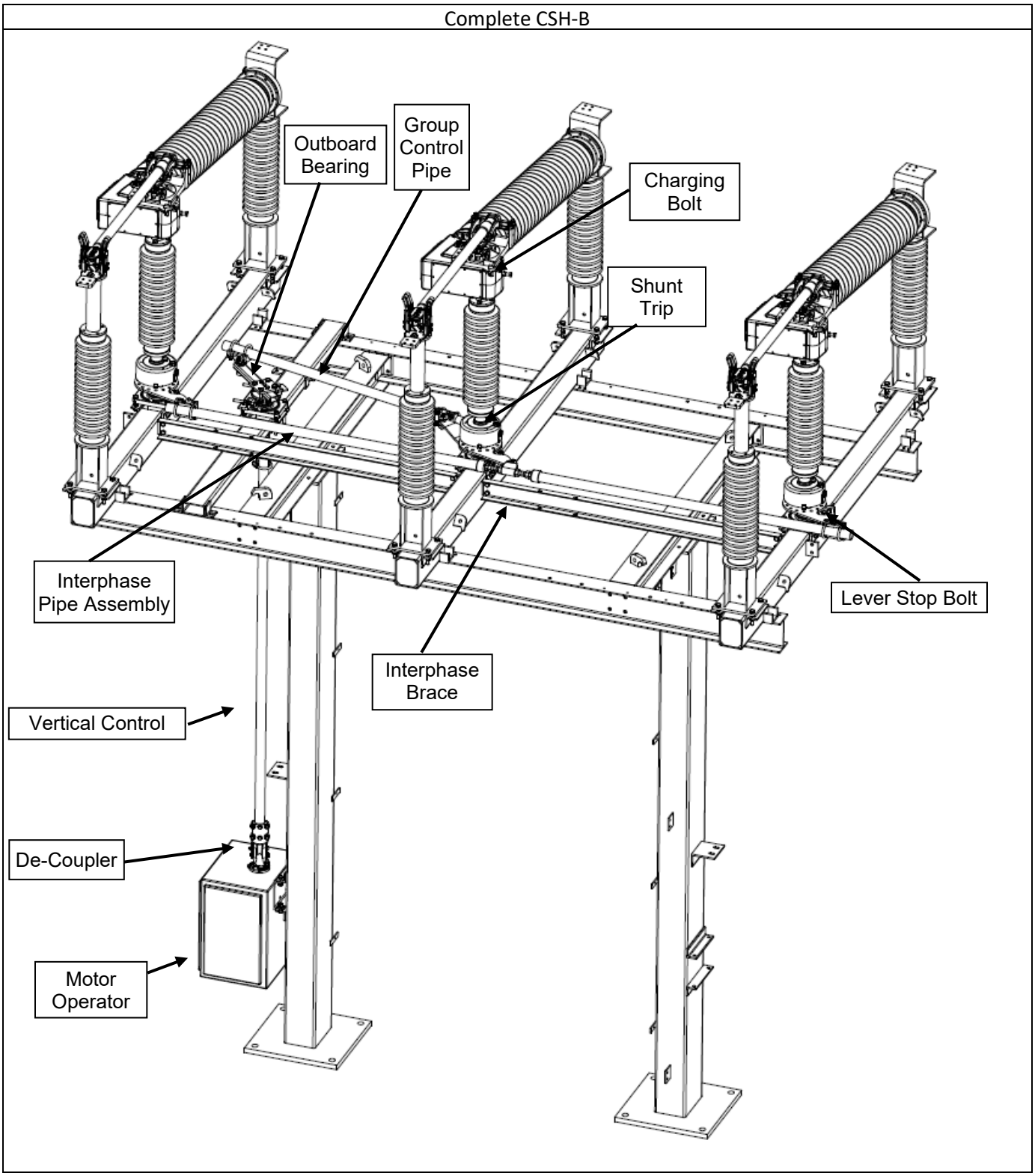



**Figure 3: CSH-B (Typical Construction)**

Note: Please refer to customer drawings for specific construction details.

# Interrupter

The interrupter is an $SF_6$ puffer design. The contact structure is robust and designed for many switching operations. The CSH-B also utilizes a rupture disk that is designed to vent the gas in the event of an overpressure condition inside the interrupter.

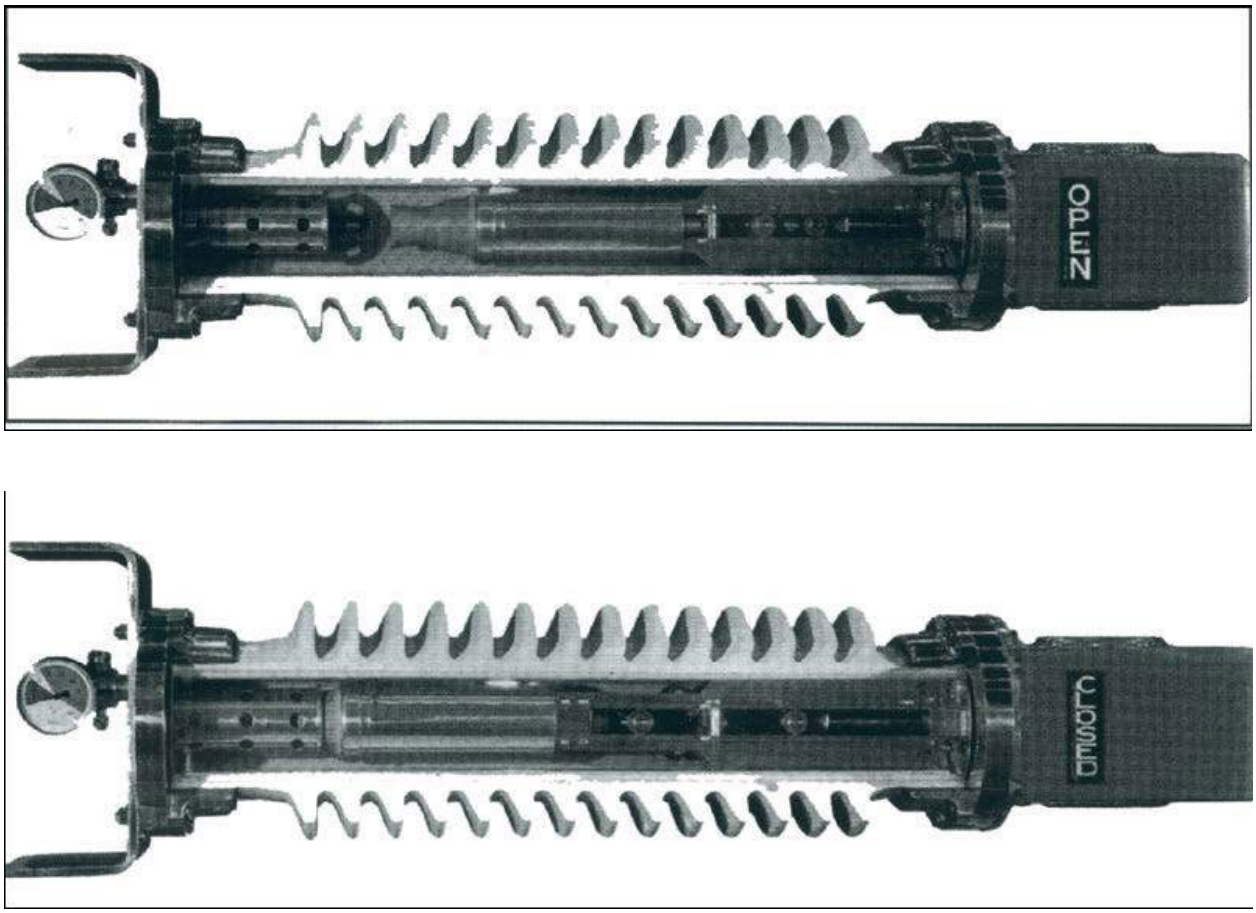
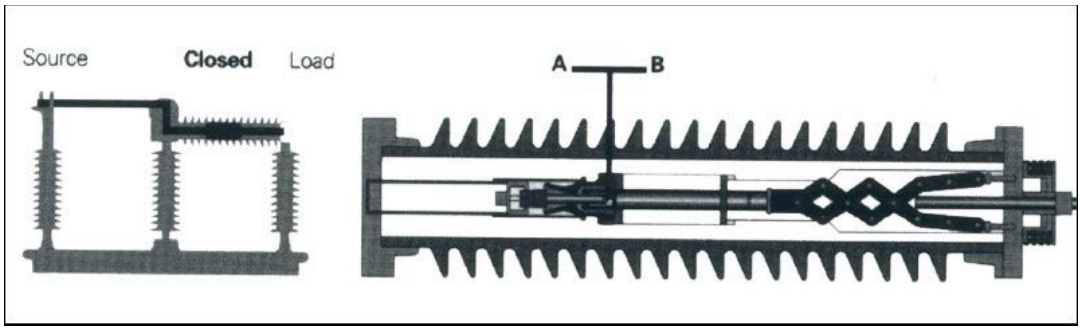


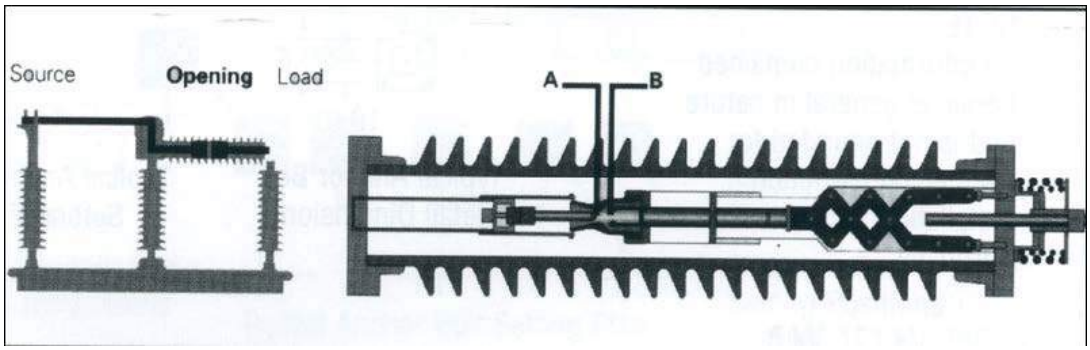

**Figure 4: Interrupter**

1



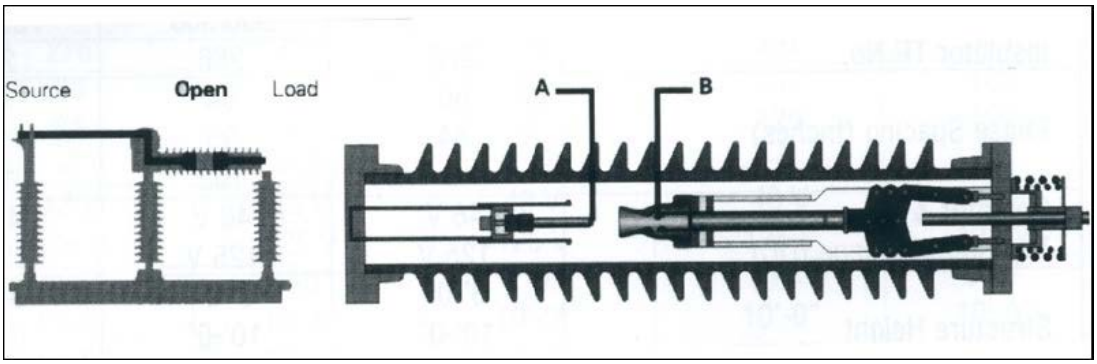

Interrupter trips with contacts “A” and “B” in the closed position. Contacts “A” and “B” remain in contact as “B” travels over “A” and compresses the gas. Gas is ready to flow when contact part.

2



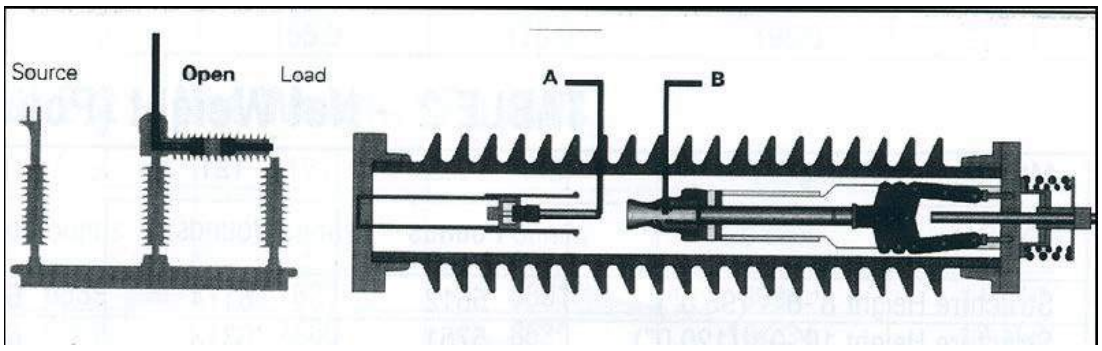

Contacts part – arcing begins – gas flows to extinguish the arc.

3




Gas divides the arc. Interruption complete.

4




**Interrupter in the full open position. Full BIL established. Blade Opens.**

**Figure 5: Interrupter Operating Sequence**

# Operating Mechanism

A typical three-pole arrangement of the CSH-B is shown in Figure 6: Operating Mechanism. The three single pole units are mechanically connected to operate simultaneously from a single operator, similar to group operation of a disconnect switch.

The center insulator of each pole unit acts not only as a support but also as a torsion drive for the operation of the disconnect switch and the interrupter. This center insulator is bolted to the shunt trip mechanism which, in turn, is bolted to the lever and bearing assembly.

The interphase operating pipes connect the outside poles to the center pole. The center pole is driven by means of a group control pipe, outboard bearing, vertical control pipe, and the operator. Operator rotation of about 186 degrees provides an over toggle action at the full open and full close positions of the outboard bearing.

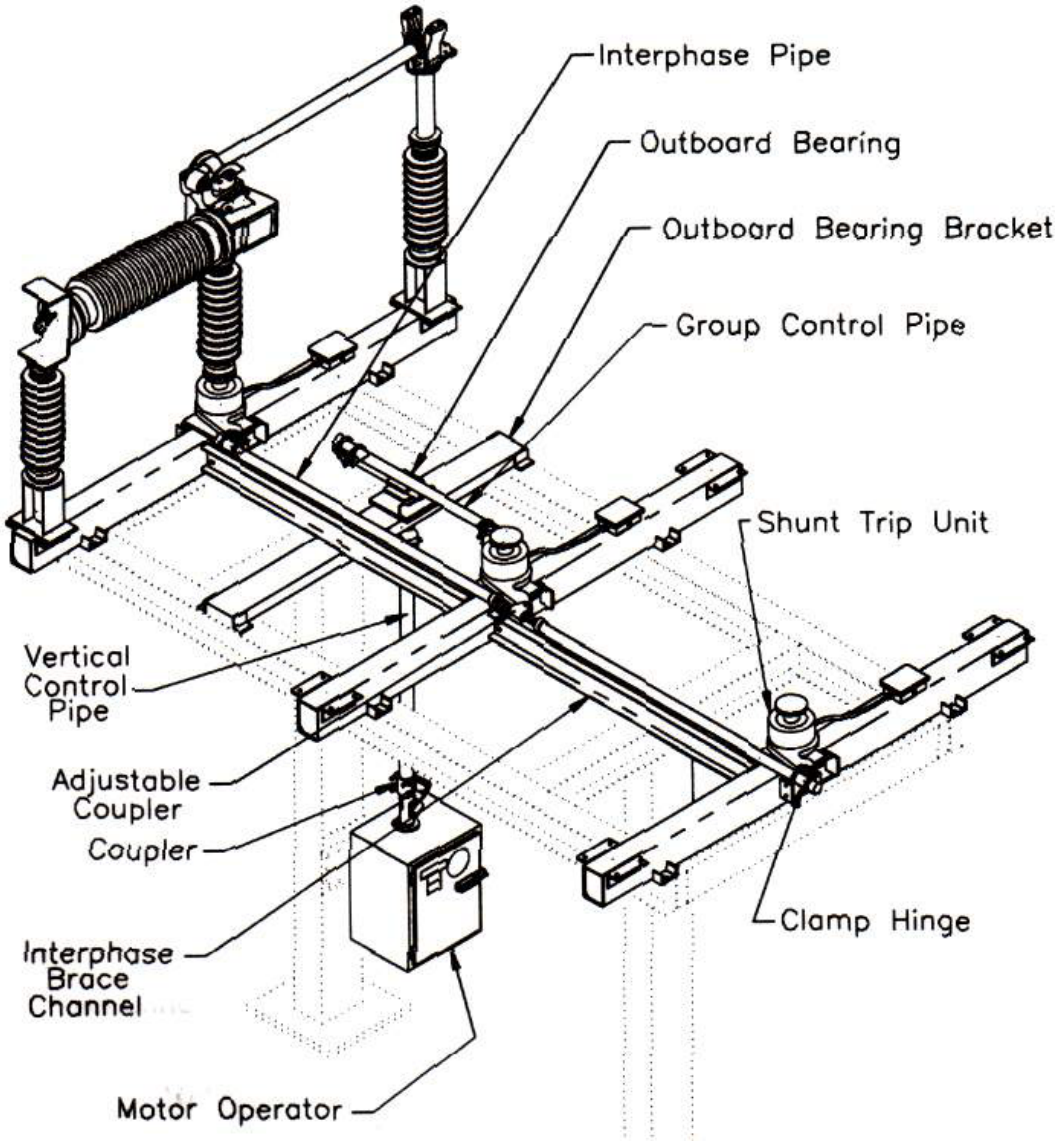



**Figure 6: Operating Mechanism**

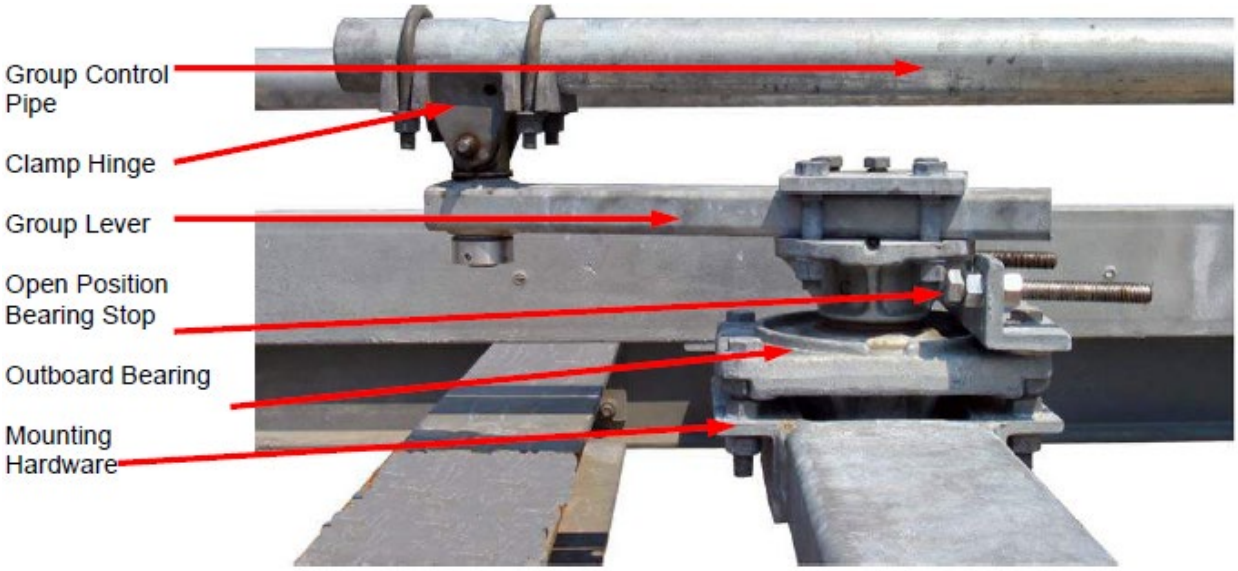



**Figure 7: Outboard Bearing**

# Three Phase Linkage

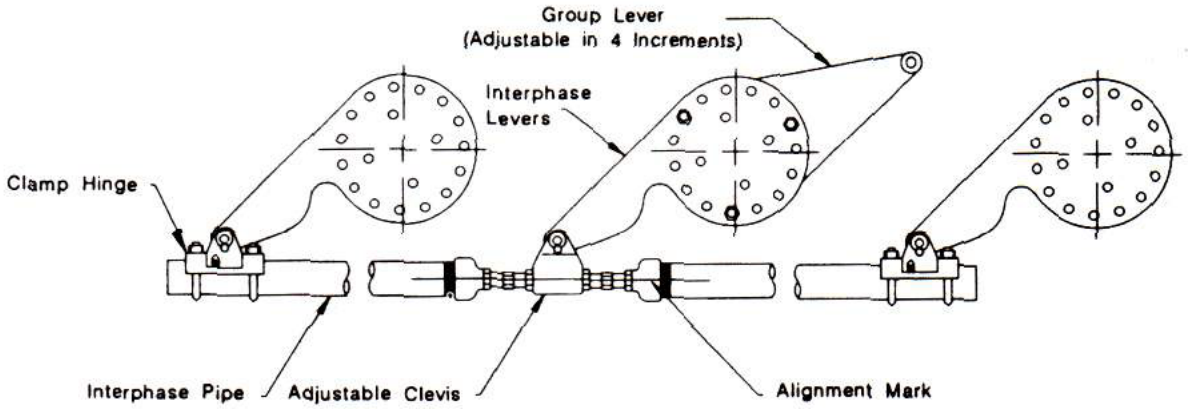



**Figure 8: Three Phase Linkage**

# Driver

The driver mechanism located at the top of the rotating insulator column contains the main closing springs, shunt trip charging bolt, trip latch, and lever system that controls interrupter opening and closing. The main operating shaft of the driver also operates the hinge mechanism of the disconnect switch.

Driver rotational positions are indicated by a green band and a red band shown in **Figure 9: Driver**. These do not indicate interrupter position but are for adjustment purposes described later. A large window on the side of the driver contains a semaphore that indicates interrupter contact position.

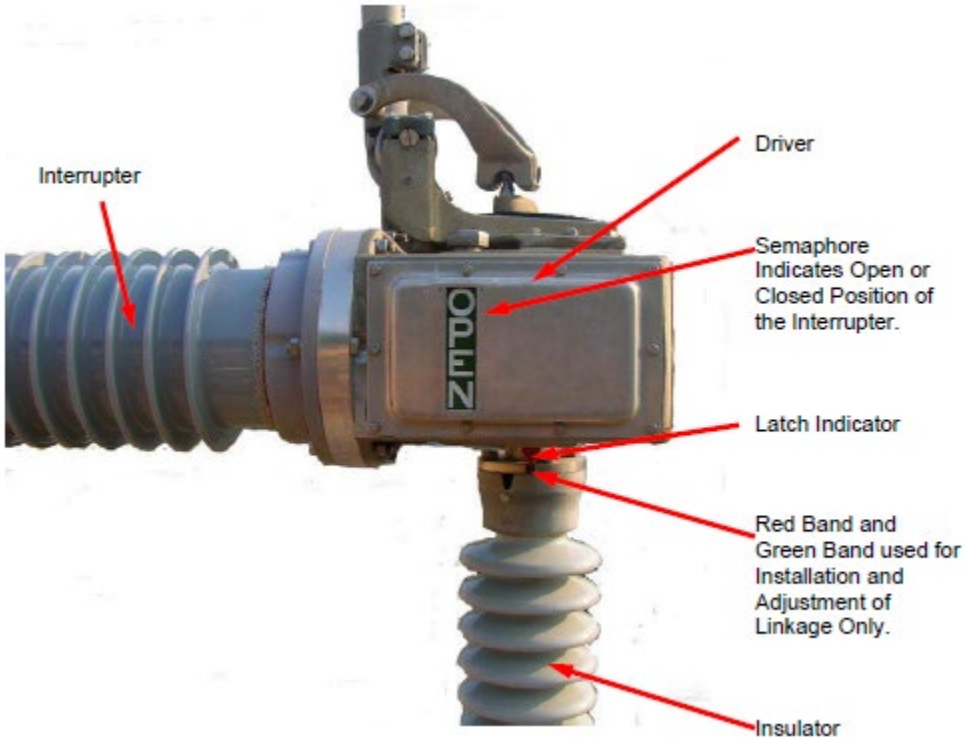



**Figure 9: Driver**

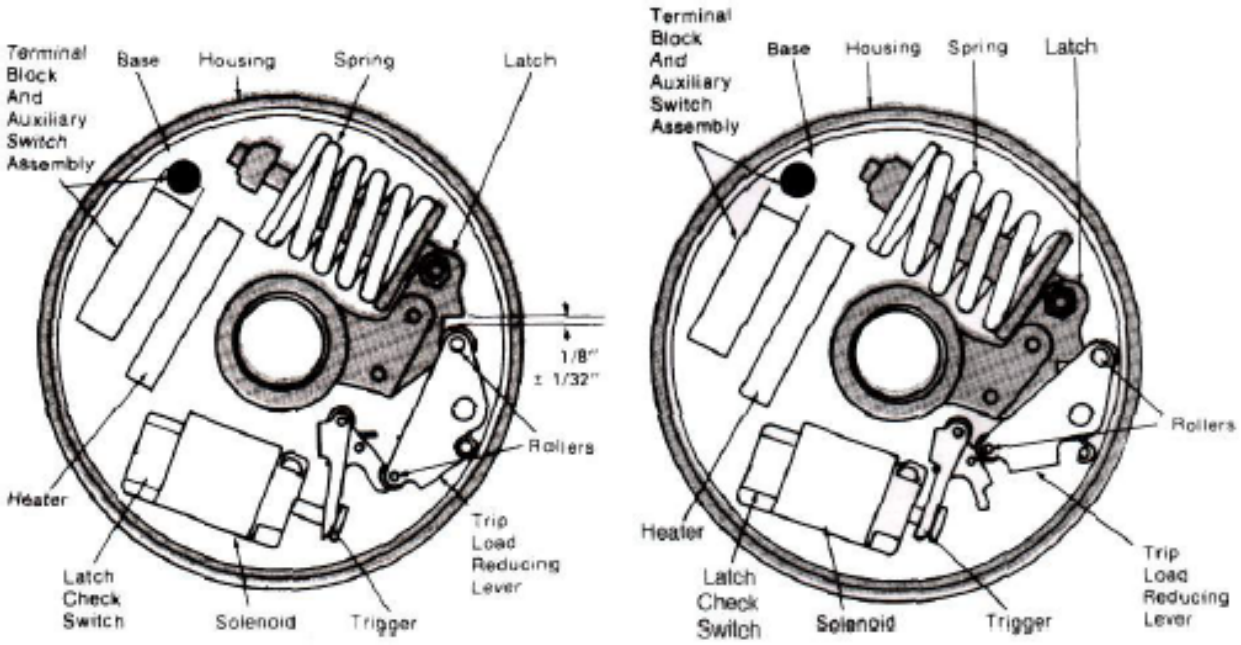
# Shunt Trip

The shunt trip mechanism is a stored energy device with a trip coil that imparts high speed tripping to the interrupter. Energizing the trip coil releases a latch causing a spring to discharge, producing rapid rotation of the insulator (**Figure 10: Shunt Trip**). If the shunt trip mechanism is not activated to trip the interrupter open and the motor operator is signaled to open, the interrupter trips open by a mechanical back-up operation.

Each shunt trip unit contains a trip coil cut-off switch, a space heater, and a latch check switch which senses charged status of the trip unit. A charged shunt trip unit is shown in **Figure 10: Shunt Trip**, representing the full open position of the circuit switcher. Contact with a charging bolt in the driver blocks further rotation of the shunt trip housing as the base plate continues to rotate. The last 12 degrees of opening rotation charges the shunt trip spring. This causes a gap to develop between the trip roller and latch, which in turn permits the latching mechanism to reset. An inspection port is provided to view gap distance (discussed in the Final Adjustments section). The red bands on the shunt trip housing and base plate indicate a charged or discharged shunt trip (See **Figure 11: Shunt Trip Outer View**). Aligned bands indicate the spring is charged; misaligned bands indicate that the spring is not charged and usually occurs when there is insufficient shunt trip gap.

> ⚠ WARNING **If operating the motor operator electrically when decoupled, disconnect the shunt trip circuit by lifting the lead on terminal TA10 to prevent damage to the trip coils.**

> ***NOTICE*** A trip command can only be generated after the circuit switcher closes and energizes the potentially faulted line. Refer to **Appendix E.** Trip-Free Operation/Testing to prevent potential shunt trip damage during opening and closing




Charged Discharged

**Figure 10: Shunt Trip**


**Figure 11: Shunt Trip Outer View**

# Motor Operator

The motor operator is shown in **Figure 12: Motor Operator (Outer)**. The operator has high torque for use with a CSH-B and can be electrically operated from a remote station. Standard features include an all-aluminum enclosure with corrosion resistant fittings, swing out removable doors, local electrical and manual operation, position indicating lights, thermostatically controlled space heater, operations counter, provision for a security lock, a decoupler, and an internal auxiliary switch.

More detailed information can be found in the motor operator's Installation and Instruction Manual.

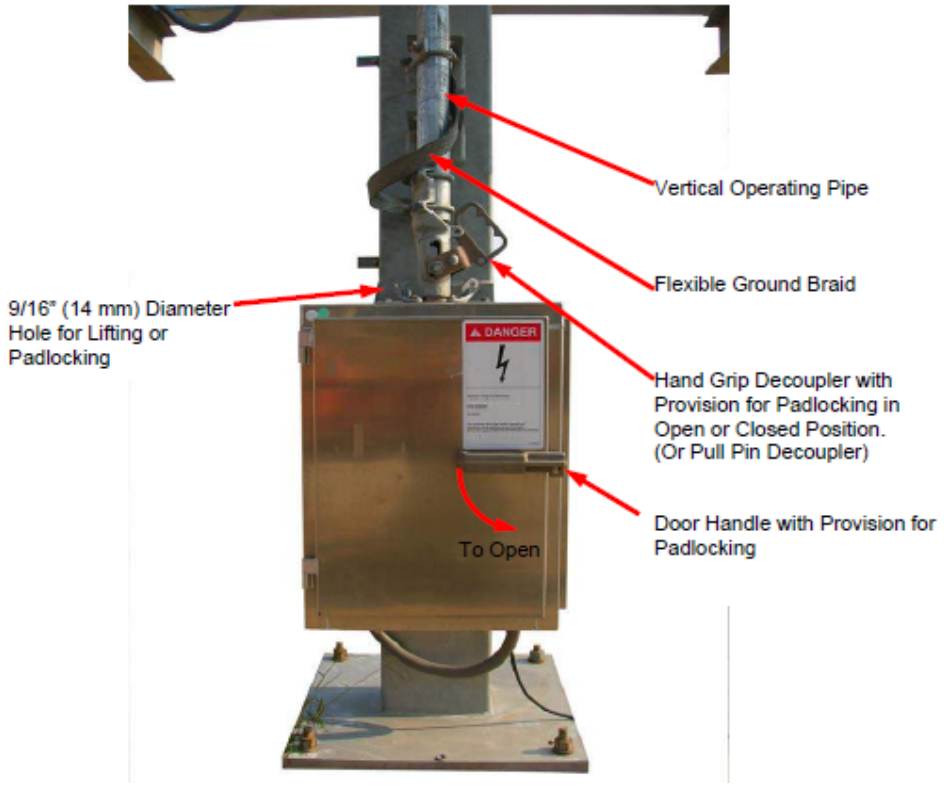



**Figure 12: Motor Operator (Outer)**

## Feature Location

A. Indicating Lights
B. Open & Close Pushbuttons
C. Operations Counter
D. Local-Remote Selector Switch
E. Hand Crank Interlock Switch
F. Motor, 48 VDC or 125 VDC
G. Auxiliary Switches
H. Anti-Pump Relay, Time Delay Relay, and Reversing Contactor
I. Terminal Blocks (4)
J. Fused Pullouts
K. Dynamic Braking Resistor
L. TA10 Shunt Trip Circuit

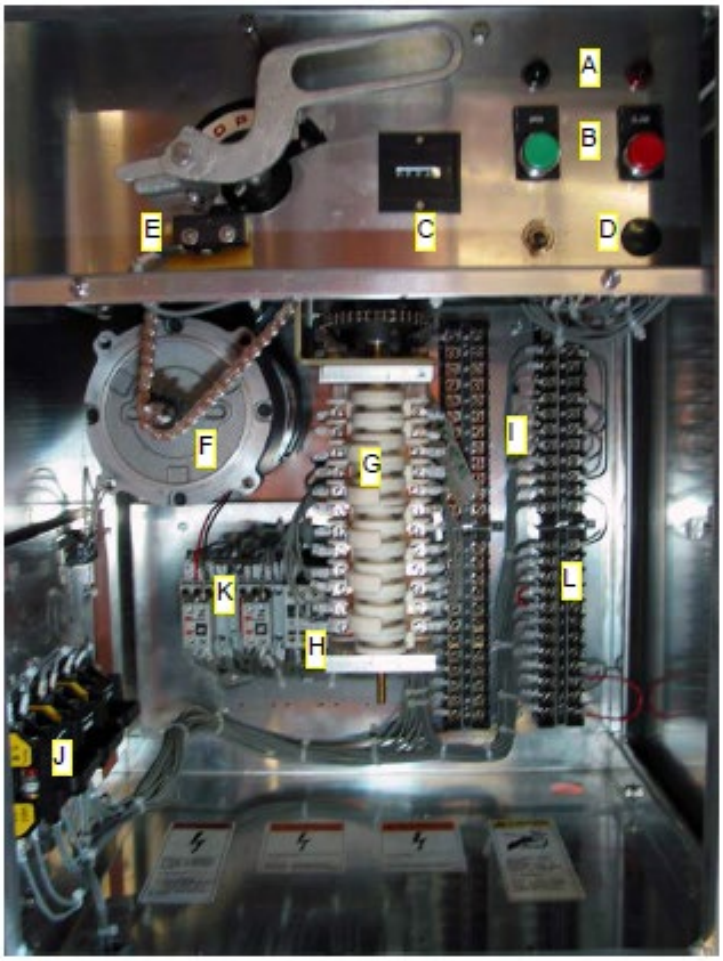



**Figure 13: Motor Operator (Shown with Dead Front Panel Removed)**

# Decoupler

A decoupling device is provided to permit testing of the motor operator without operating the CSH-B. The hand grip decoupler, locking pin, and lock brackets are shown in **Figure 14: Decoupler and Lock Brackets**. The pull pin type decoupler is shown in **Figure 15: Pull Pin Type Decoupler**. In order to assure the coupling is always in the right position, the slot in the output shaft is off center 1/16-inch. This prevents coupling 180 degrees out of phase. With the handle in the up position, as shown, the locking pin is engaged in the output shaft slot. Because of the force imposed by the shunt trip charging springs when the CSH-B is in the open position, it is necessary to use the hand crank to decouple. One or two turns of the crank will relieve the load on the decoupler pin so that decoupling can take place.

**⚠ WARNING Decouple only in the full open or closed positions with outboard bearing against bearing stop. Relieve any remaining load on decoupler pin by partial turn of the hand crank.**

**If operating the motor operator electrically when decoupled, disconnect the shunt trip circuit by lifting the lead on terminal TA10 to prevent damage to the trip coils.**

# Lock Brackets

The lock brackets are adjustable. Their positions are determined by the full close and full open positions of the CSH-B. Matching holes in the brackets and the hand grip decoupler permit locking in either the coupled or decoupled positions. The lock brackets are strong enough to lift the operator; however, operating torque does not allow the lock brackets to stop operator shaft rotation. At the limits of rotation, there should be about ⅛" clearance between the lock brackets and the decoupler handle.

**⚠ WARNING Do not operate the CSH-B with the hand grip decoupler locked to the CM-4. Doing so could damage CSH-B.**

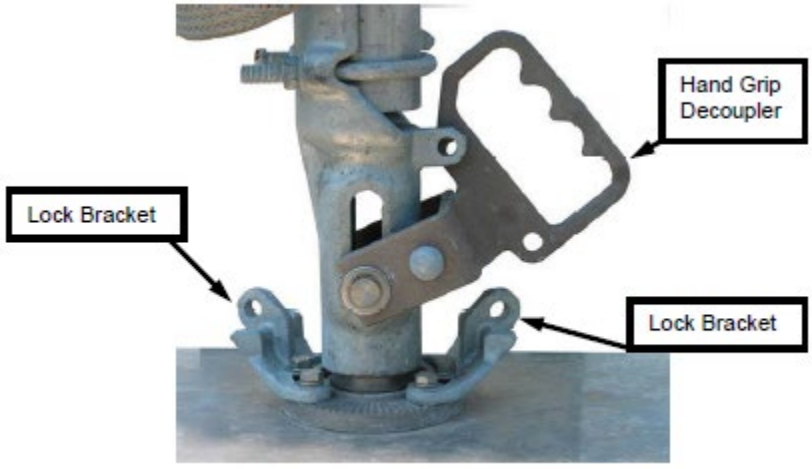



**Figure 14: Decoupler and Lock Brackets**

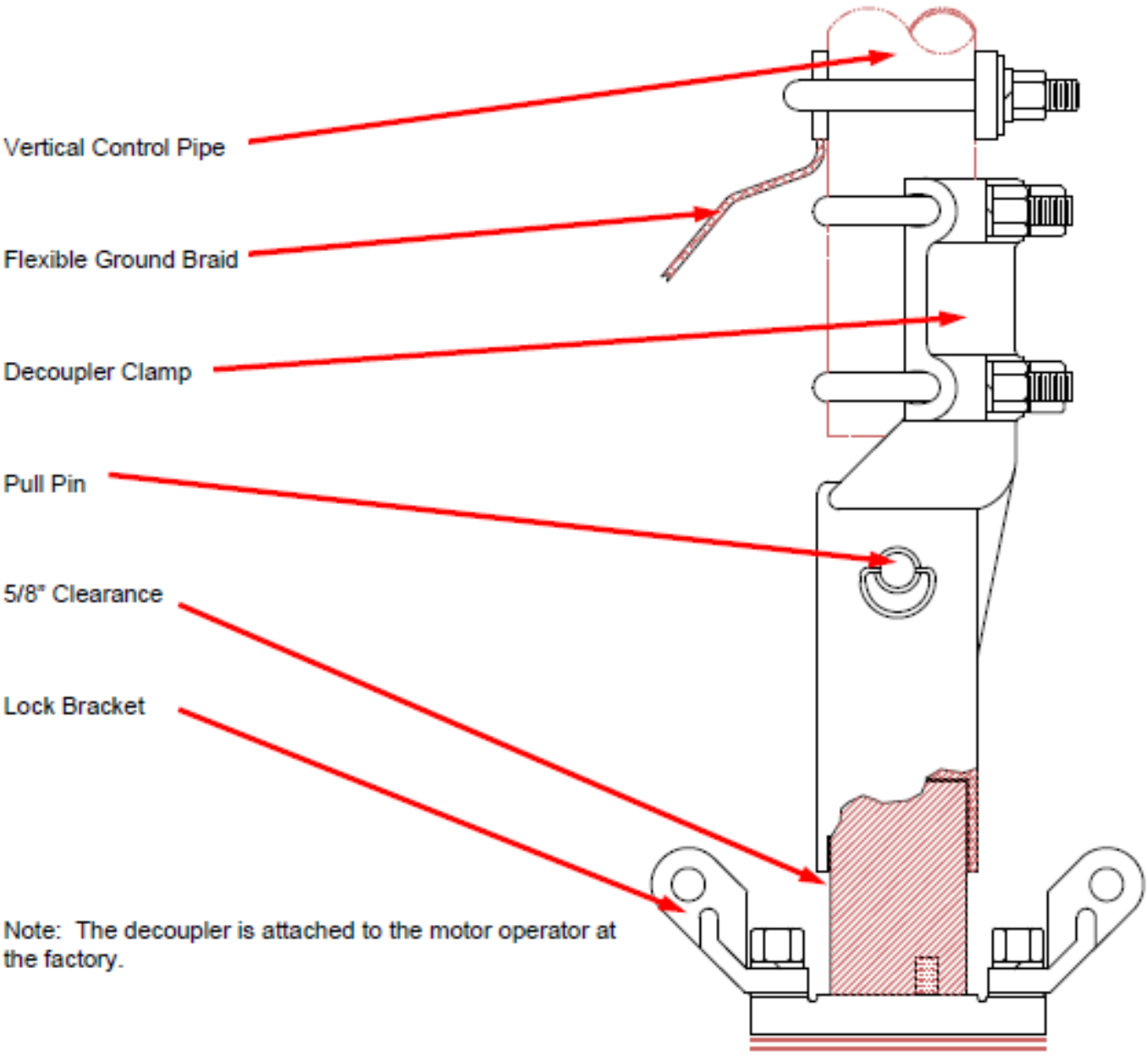



**Figure 15: Pull Pin Type Decoupler**

# Limit Switches

Limits of rotation are controlled by cam operated limit switches that are adjustable from 150 degrees to 200 degrees. The upper most cam and limit switch is always the open position limit switch and the lower cam and limit switch is always the close position limit switch. The steep rise of the cam activates the limit switch roller as the cam rotates in a direction from the hinged end of the limit switch roller towards the roller end (**Figure 16: Limit Switch**). Limit switch cams are adjusted by the use of a 3/16-inch hex wrench in the socket head clamping bolt. Limit switch actuation can be heard except when operating electrically. **Figure 17** shows the Limit Switches inside the Motor Operator.

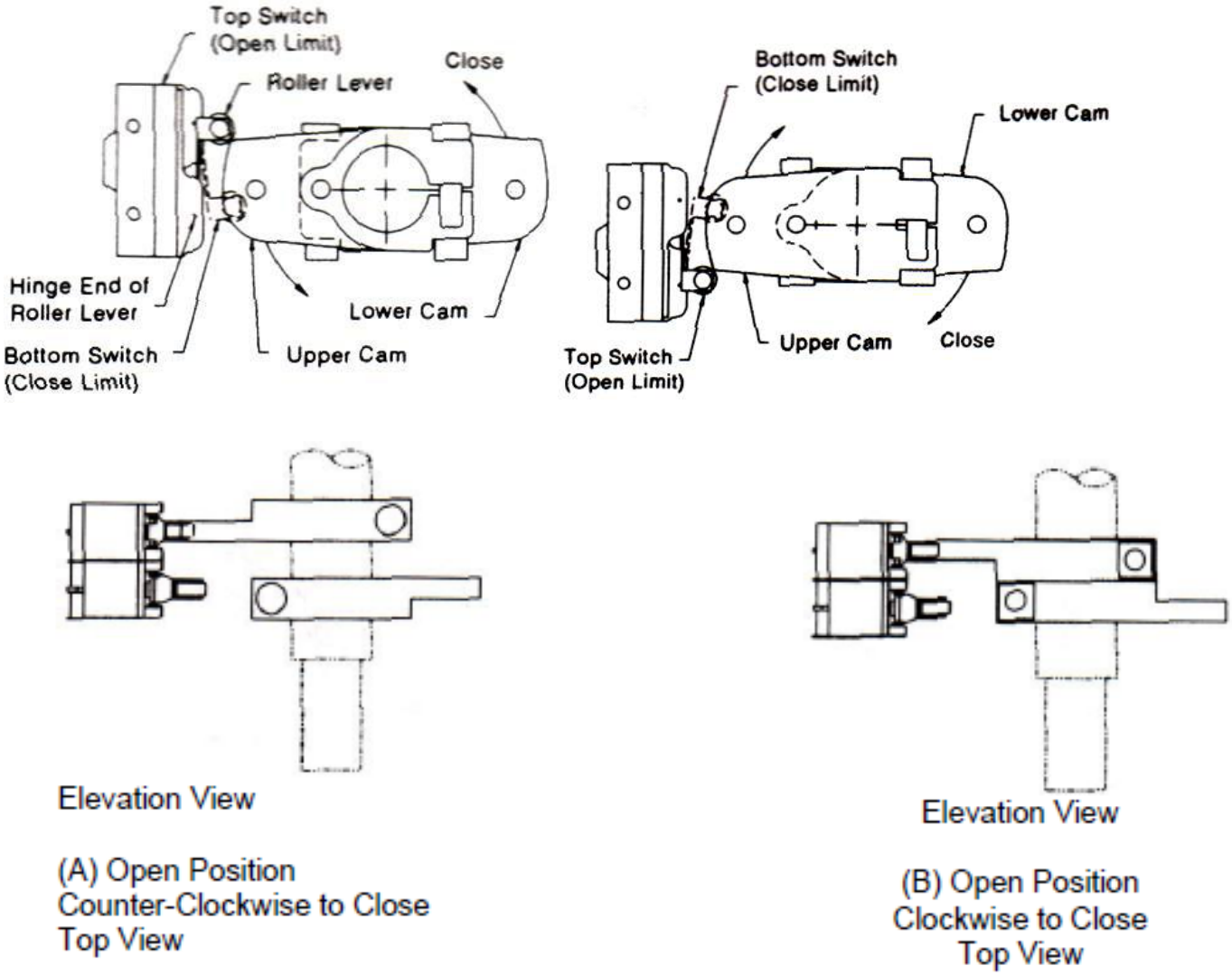



**Figure 16: Limit Switch**

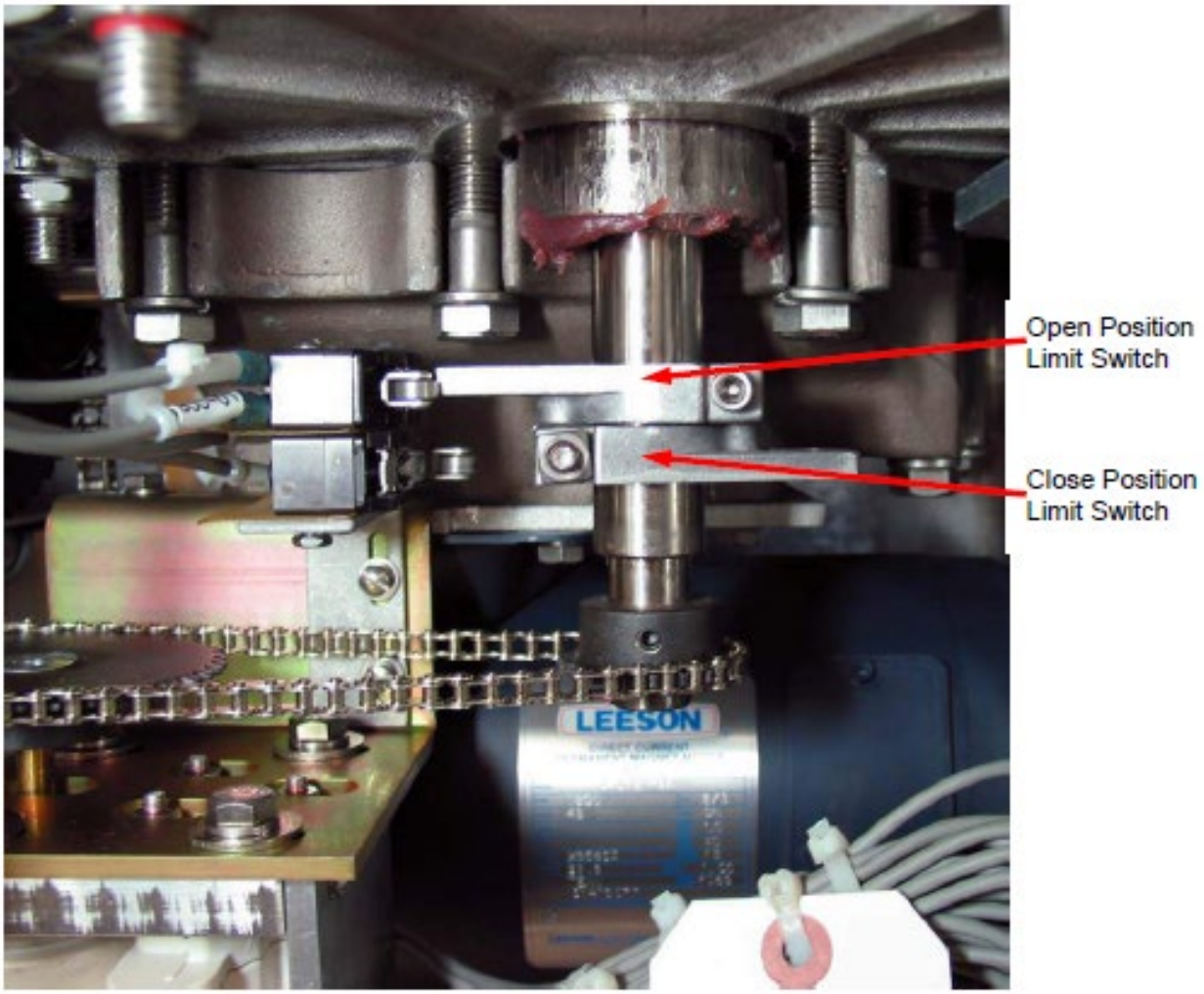



**Figure 17: Limit Switches as seen from Side Door of Motor Operator**

# Position Indicators

The three indicators on each phase verify the status of the CSH-B (See **Figure 18: Position Indicators**).

A mechanical semaphore on each phase, in the driver unit window, is directly connected to the interrupter operating rod and indicates the OPEN-CLOSED position of the interrupter contacts. THIS SEMAPHORE HAS NO REFERENCE TO THE POSITION OF THE DISCONNECT BLADE.

There is a latch indicator on the underside of the housing of each driver. The painted marks serve to indicate limits of travel of the driver shaft and are used during installation and adjustment of the CSH-B operating linkage. They have no other function and should not be used for any other purpose.

Each shunt trip housing has a red semaphore. Alignment of the housing semaphore with the base semaphore indicates the charged (spring loaded) position of the shunt trip device.

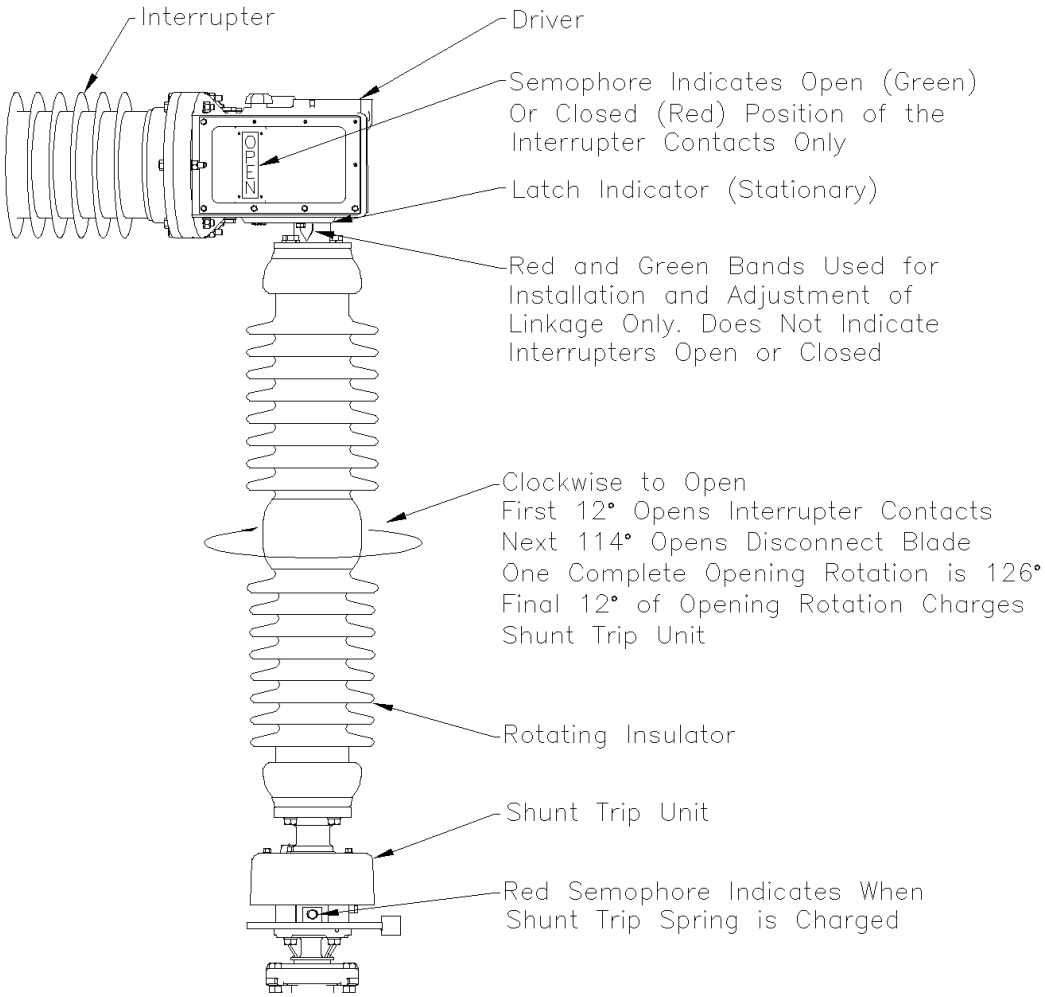



**Figure 18: Position Indicators**

# Manual Operation

A hand crank is provided for completing required adjustments of the motor operator and CSH-B before any electrical operations are attempted. The interlock handle must be moved downward in order to insert the hand crank. See **Figure 19: Manual Operation**. This safety feature disconnects the motor power source when the hand crank is in use. The interlock handle also serves as an emergency stop when operating electrically. Hand cranking during initial setup and adjustment can be made easier by disconnecting one end of the dynamic braking resistor found on the front of the reversing contactor. The resistor must be reconnected before operating electrically to prevent over travel.

To open the CSH-B, operate the crank handle in the direction indicated on the sticker above the hand crank insertion point. Approximately three turns will open the interrupter. Crank from stop to stop on the outboard bearing lever in order to properly complete an opening or closing sequence.

To permit closing, a latch must reset in the driver. This occurs in the final few degrees of opening rotation. To close, operate in the opposite direction. Be sure to crank from stop to stop. With shunt trip units, observe semaphores to determine shunt trips charged before closing. This applies to both manual operation (worm gear) and hand cranking through the motor operator when control power is not available.

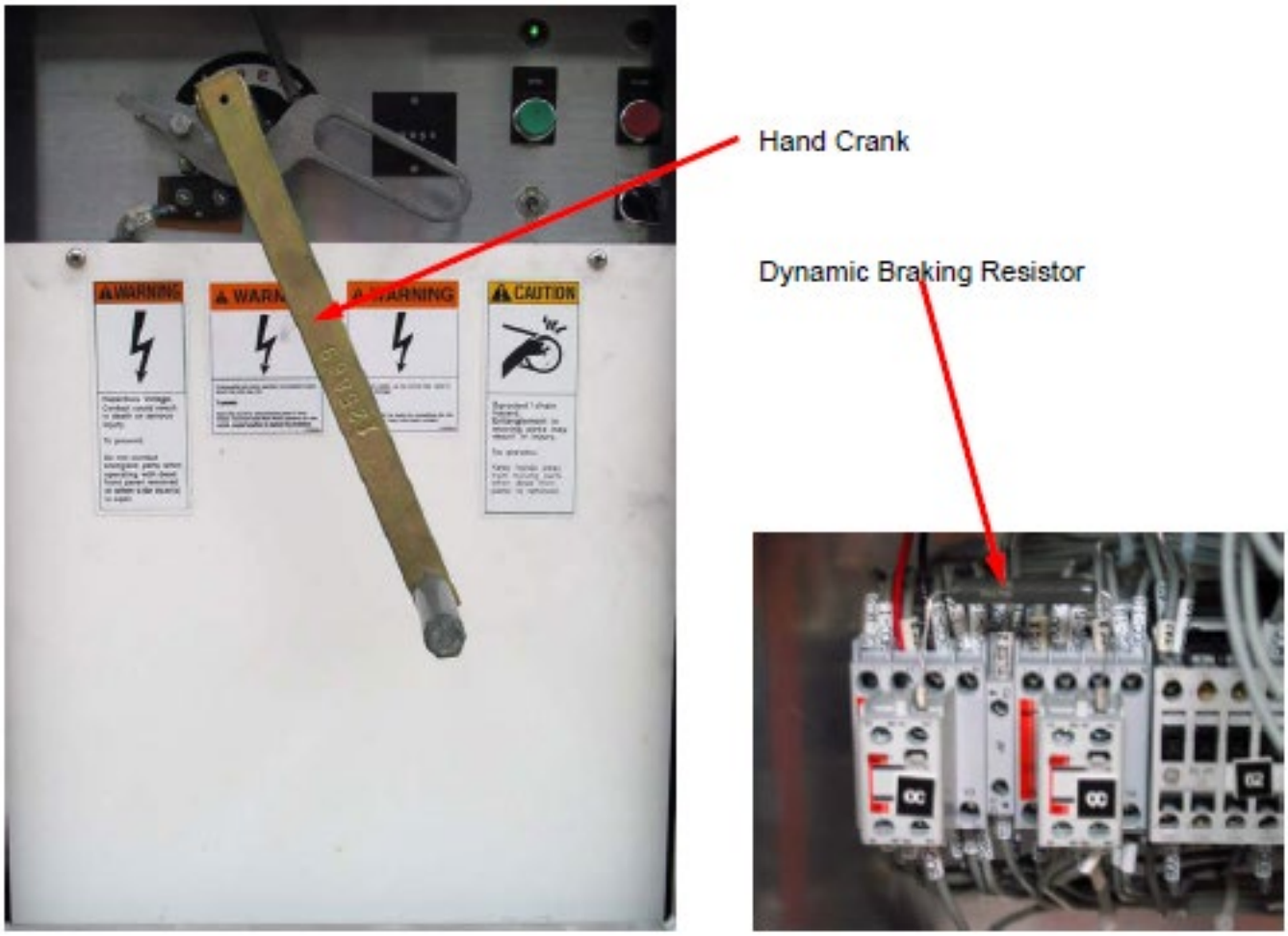



**Figure 19: Manual Operation**

# Control Circuits

SCHEMATIC LEGEND

| | |
|---|---|
| 01/O | PUSH BUTTON OPEN |
| 01/C | PUSH BUTTON CLOSE |
| 3Y | ANTI–PUMP RELAY |
| 05 | HAND CRANK INTERLOCK SWITCH |
| 08–1 | CONTROL POWER DISCONNECT |
| 08–M | MOTOR POWER DISCONNECT |
| 08–H | HEATER POWER DISCONNECT |
| 9/CC | CLOSE CONTACTOR |
| 9/OC | OPEN CONTACTOR |
| 23 | THERMOSTAT |
| 33a | TRIP COIL CUTOFF SWITCH (CLOSED WHEN SHUNT TRIP UNIT IS CHARGED) |
| 43 L/R | LOCAL REMOTE SWITCH |
| 62 | TIME DELAY (FIXED) RELAY |
| 84M | MOTOR |
| 84a & 84b | INTERNAL AUXILIARY SWITCHES |
| 86 | CUSTOMER LOCK OUT RELAY |
| CAB LT | INTERIOR CABINET LIGHT |
| CS/O | CUSTOMER CONTROL SWITCH (OPEN) |
| CS/C | CUSTOMER CONTROL SWITCH (CLOSE) |
| CTR | OPERATIONS COUNTER |
| D 1,2,3 | DIODES |
| G | GREEN INDICATING LIGHT |
| R | RED INDICATING LIGHT |
| SW1 | CABINET LIGHT SWITCH |
| REC | VOLTAGE RECTIFIER |
| LCS | LATCH CHECK SWITCH (CLOSED WHEN SHUNT TRIP UNIT IS CHARGED) |
| TC | TRIP COIL (SHUNT TRIP) |
| TLS–1aa | LIMIT SWITCH, OPEN EXCEPT IN OPERATOR FULLY CLOSED POSITION |
| TLS–1bb | LIMIT SWITCH, CLOSED EXCEPT IN OPERATOR FULLY CLOSED POSITION |
| TLS–2aa | LIMIT SWITCH, OPEN ONLY IN OPERATOR FULLY OPEN POSITION |
| TLS–2bb | LIMIT SWITCH, CLOSED ONLY IN OPERATOR FULLY OPEN POSITION |

| | |
|---|---|
| ∅ | TERMINAL BLOCK POINTS IN MOTOR OPERATOR |
| ⊗ | TERMINAL BLOCK POINTS IN SHUNT TRIP UNITS |
| ○ | TERMINAL POINT ON DEVICE |

NOTE:

1. SHOWN WITH MOTOR OPERATOR IN THE OPEN POSITION AND ALL DEVICES DEENERGIZED
2. ALL WIRING #14 AWG, TYPE "SIS" (GRAY).
3. TO INTERLOCK THE CLOSE CIRCUIT, INSTALL INTERLOCK DEVICE BETWEEN TA8 AND TA9, AND REMOVE SHOP JUMPER.
4. "84" AUX. SWITCHES ADJUSTED AS FOLLOWS:
   (a) AFTER 160° OF CLOSING ROTATION SET "a" CONTACT CLOSED TO PERMIT OPERATION OF ANTI–PUMP (3Y) RELAY.
   (b) AFTER 170° OF CLOSING ROTATION SET "a" CONTACT CLOSED TO
5. SHUNT TRIP COIL CURRENTS AND MOTOR INRUSH CURRENTS ARE SEQUENTIAL.
6. MOTOR CONNECTIONS SHOWN FOR CW ROTATION OF MOTOR OPERATOR TO CLOSE THE CIRCUIT SWITCHER. TO REVERSE ROTATION, SEE INSTRUCTION MANUAL.
7. SHOWN FOR 120 VAC HEATER CIRCUIT WITH HEATERS CONNECTED IN PARALLEL TO CONNECT FOR 240 VAC, REMOVE JUMPERS TE1 TO TE3 & TA12 TO TA14. RECONNECT WIRE ON TE2 TO TE3. PARALLELED SHUNT TRIP HEATERS MUST BE CHANGED TO SERIES CONNECTION. (ie NO. 6 ON POLE 1 TO NO. 5 ON POLE 2, etc.). APPLY NEUTRAL TO TA12 FOR CABINET LIGHT (AND RECEPTACLE IF PRESENT).

Further detail can be found in the motor operator's instruction book and in the customer drawings.

This is a typical arrangement; consult customer drawings for the actual wiring of this particular CSH-B.

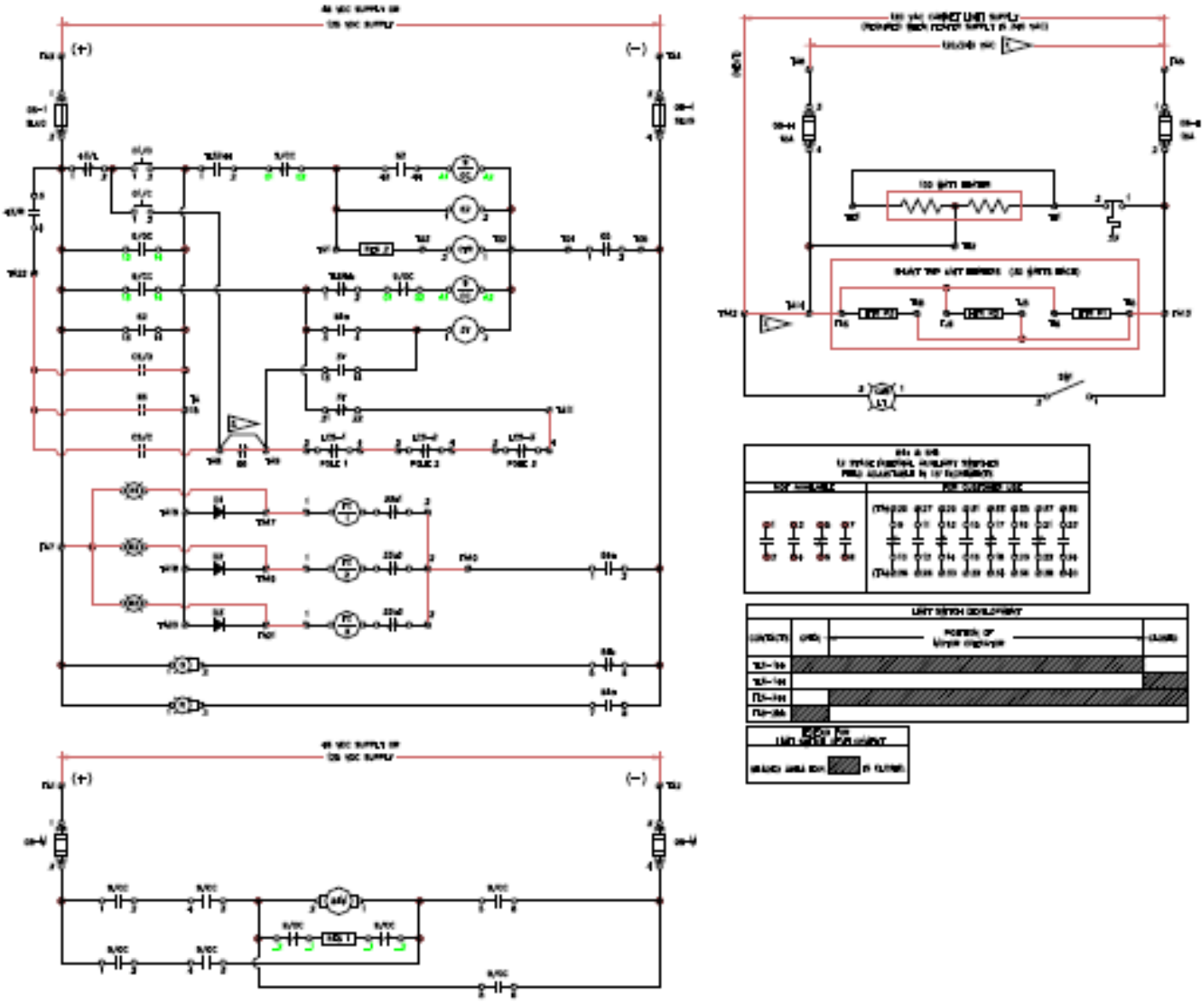


**Figure 20: Control Circuits (Typical)**

# Typical Gas System

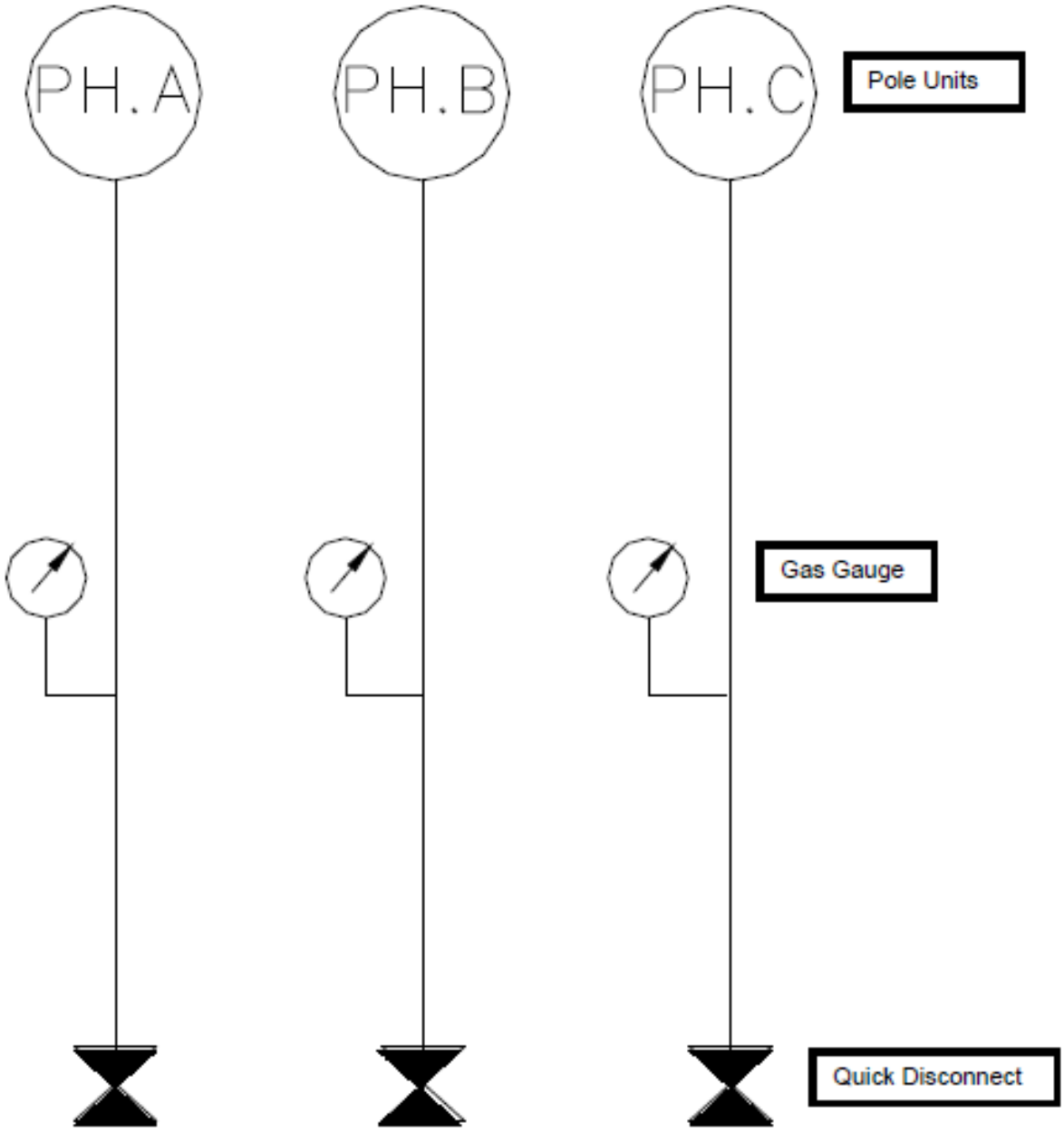



**Figure 21: Typical Gas System**

# How to Read the $SF_6$ Density Gauge

The Southern States CSH-B interrupter unit is equipped with a temperature compensated pressure gauge. The temperature compensated pressure gauge displays a constant pressure reading over the ambient temperature range of the switcher. Refer to **Figure 22: Gauge Face**.

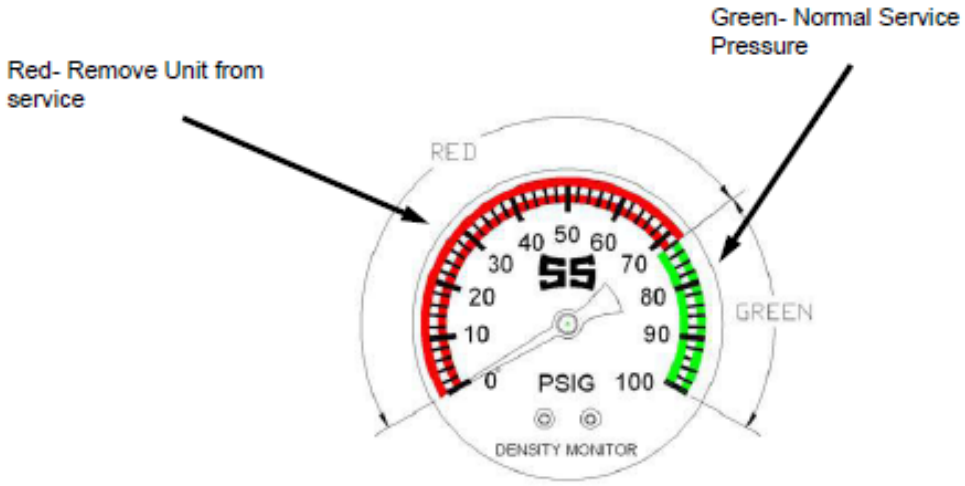



**Figure 22: Gauge Face**

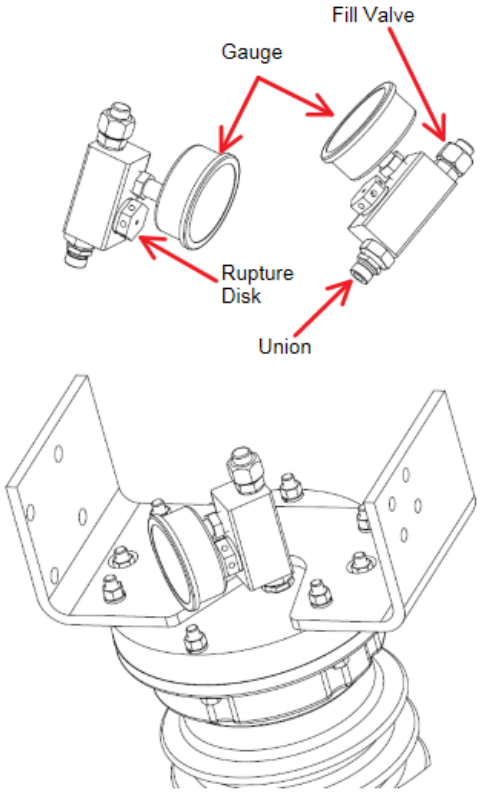



**Figure 23: Manifold Components**

# Receiving, Handling, & Storage

## Receiving

**⚠ WARNING** Interrupter housings contain pressurized $SF_6$ gas. Do not strike, shock, strain or in any way damage the housings. Such damage may cause the interrupter to rupture. Improper handling may result in death, serious injury, or equipment damage.

**⚠ WARNING** The center of gravity of the horizontal frame with interrupters is above the lifting eyes. Follow instructions in this book for lifting. Use caution when handling to avoid personal injury or equipment damage.

**⚠ DANGER** $SF_6$ gas is heavier than air. Do not get caught in a low area with $SF_6$ gas present. The $SF_6$ can displace the oxygen. Death by suffocation is possible.

The Southern States CSH-B is packaged for shipment by the following two methods. Structure members (structural frame and support columns), when furnished by Southern States, are in a separate shipping group.

A. Individual pole units are mounted on shipping channels. This shipping assembly consists of:
    1. Interphase pipe, group control pipe, and vertical control pipe banded together.
    2. Outboard bearing bracket and interphase brace channels.
    3. Motor operator within its crate.
    4. Control parts box containing $SF_6$ fill kit, outboard bearing assembly, and hardware.
B. Assembled pole units with control pipe and outboard bearing assembly are mounted on the top platform of the structure. This shipping assembly consists of:
    1. Vertical control pipe.
    2. Motor operator within its crate.
    3. Control parts box containing $SF_6$ fill kit and hardware kits.

# Handling & Unpacking

## Lifting a 1 Pole Arrangement

When lifting 1 pole at a time, remove the shipping braces, motor operator, pipe, and interphase brace assemblies. Sling each pole with 4 lifting straps as shown in **Figure 24: Lifting 1 Pole Unit**. Unbolt the pole unit from the shipping channels before lifting. Also, ensure the pole units remaining on the shipping channels are stable and do not tip over. The maximum weight of a pole unit is 2,700 pounds.

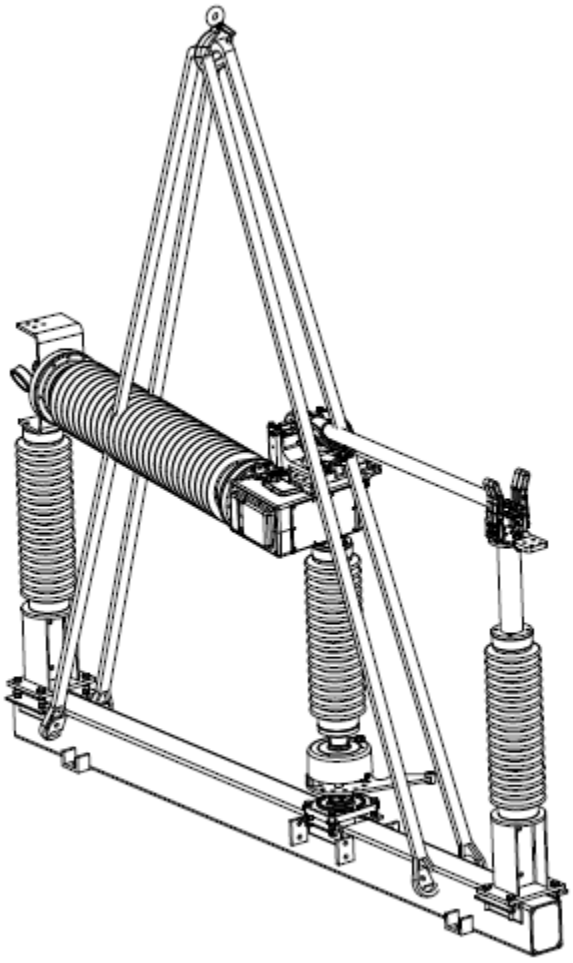


**Figure 24: Lifting 1 Pole Unit**

## Lifting an Assembled CSH-B

When lifting all 3 pole units at once, remove the motor operator, pipe, and interphase brace assemblies. Do not remove the shipping braces. Sling the pole units with 4 lifting straps as shown in **Figure 25: Lifting 3 Pole Units**. The maximum weight of the 3 pole units is 9,200 pounds.

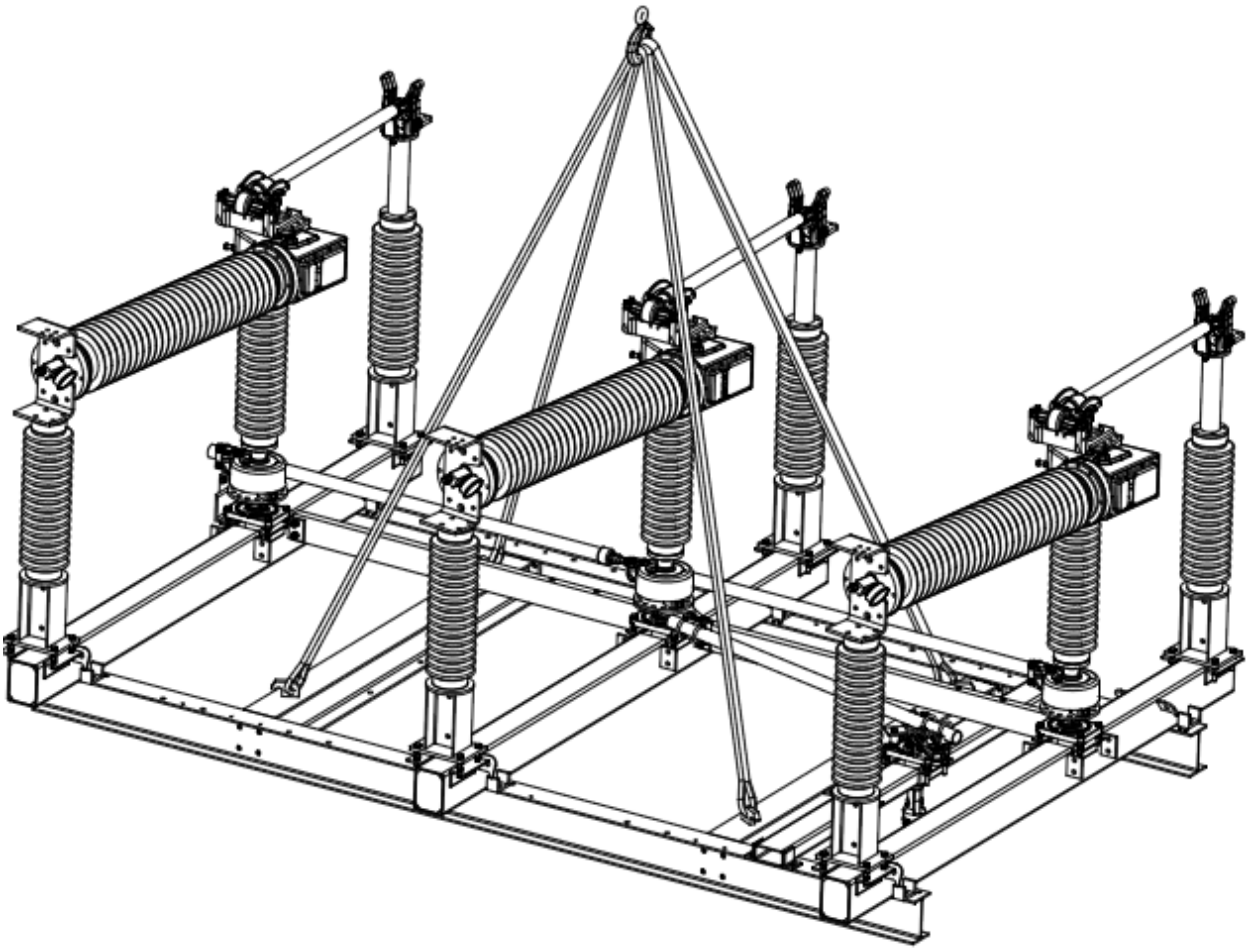


**Figure 25: Lifting 3 Pole Units**

## Lifting the Motor Operator

The motor operator unit has two factory installed adjustable lock brackets on either side of the output shaft. Use appropriate cables or chains to lift into mounting position (**Figure 26: Lifting Motor Operator**). The motor operator weighs approximately 250 lbs.


**Figure 26: Lifting Motor Operator**

# Storage

After the receiving inspection, if immediate installation is not scheduled the equipment should be repacked and stored in a protected area. To maintain the "as new" condition the components, accessories, and spare parts should be stored indoors in a dry, clean place.

## Short Term Storage (Less Than 3 Months)

Protect unit from being immersed in water at all times.

The gas system is sealed at the factory. Ensure that the interrupters remain sealed and filled with a positive pressure of dry $SF_6$ gas.

Do not allow moisture or dust to enter the gas system. Contact the factory if the parts have been exposed. If the interrupters have reached atmospheric pressure or the seal is disturbed, the absorbent must be replaced.

All operating mechanisms and master control enclosures should be protected from moisture and corrosion by keeping the housing door closed, vents sealed, and the included desiccant material inside the housing.

Mechanisms should be stored with the Close and Open Springs discharged. This requirement is for the safety of personnel in handling the equipment while in storage and subsequent installation.

## Long Term Storage (More Than 3 Months)

***Standard crating is intended for storage less than 1 year*. If long term storage is required please notify factory at time of order placement so that special crating options can be discussed and added.**

Indoor Storage – To maintain the "as new" condition, it is essential to store the equipment indoors in a clean, dry area to protect it from moisture and corrosion where possible.

Do not remove the packaging from the insulator sheds until installation is complete. This will help protect the insulator sheds from damage during storage and installation. Interrupters are sealed at the factory and filled with a positive pressure of dry $SF_6$ gas. In some cases the interrupters are shipped fully pressurized. Ensure that the interrupters remain sealed and filled with $SF_6$ gas at all times. Do not allow moisture or dust to enter the interrupters.

Mechanism/control/cabinet enclosure(s), motor operators and trip units should have their space heaters energized to maintain the interior as dry and free from corrosion. {Failure to do so can void the warranty.}

Crates/boxes containing components must be stored indoors.

Care should be taken to avoid corrosion, degradation of packaging, etc.

Inspect all packing material thoroughly prior to storage.

**Inspect all packing material thoroughly prior to handling after storage.**

**Handling of equipment in damaged or compromised packing materials can be dangerous or cause damage to equipment.**

# Installation & Adjustment Procedures

The CSH-B is shipped from the Southern States factory fully adjusted and ready for installation.

The CSH-B is shipped with the intent to minimize gas handling during installation. Each CSH-B interrupter is shipped with 5 to 10 psig $SF_6$ gas for safety during transportation and installation and is ready to be filled with gas once installation is complete and prior to operation.

**⚠ DANGER** Never lift the assembly by the insulators

**⚠ DANGER** Be careful when lifting the horizontal frame with interrupters. Tie the lifting straps as shown in the Lifting section to keep the assembly from falling over.

The CSH-B, complete with insulators, is factory adjusted and timed on a 3-pole basis at the specified phase spacing and outboard bearing location. The unit has been operated at the factory via its motor operator by means of a temporary short section of vertical operating pipe.

Minimum disassembly has been done to accommodate shipping clearance restrictions. Major assemblies are numbered and/or match marked for ease of reassembly. The interrupters are shipped in the open position; blades closed and shunt trip units charged.

The following step-by-step instructions take into consideration different ratings and structure types. The bolts, washers, nuts, etc., required for each assembly step have been supplied in the accessory box organized by size.

**Do not use a sharp tool** to remove the packing from the insulator sheds. All 1/2-inch hardware should be tightened to 55 lbs/ft. and all 5/8-inch hardware should be tightened to 90 lbs/ft. An anti-seize compound should be used on all stainless steel bolt threads. All-purpose grease should be used on both the point and threads of piercing screws to aid in piercing the pipes.

Disconnecting the Dynamic Braking Resistor will ease manual operation for installation and adjustment. Disconnecting the shunt trip circuit lead at terminal TA10 will prevent damage to the trip coils while operating the motor in the decoupled position.

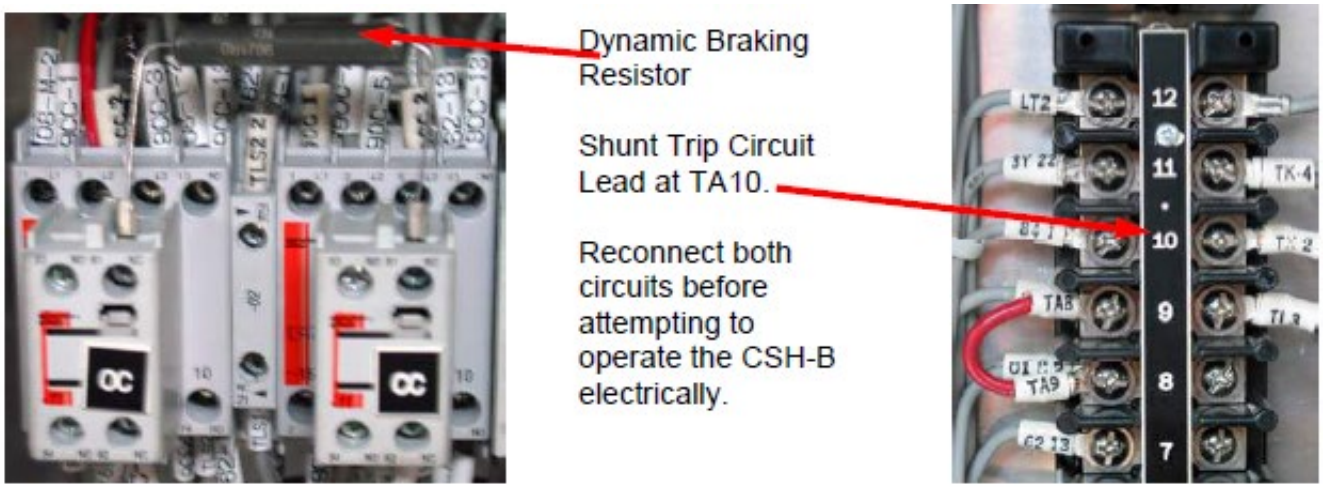



**Figure 27: Circuit Disconnects**

# Initial Assembly

1. Mount the columns
   1.1. Ensure orientation of columns are correct (refer to drawing)
   1.2. Ensure columns are plumb
2. Mount platform to the top of the columns
   2.1. Ensure orientation of the platform is correct per the drawing
   2.2. Level the platform
3. Tighten all column and platform hardware & Torque per specified value
4. Mount Motor Operator
   4.1. Level the Motor Operator, place level on top of output shaft
   4.2. Install the De-coupler to the output shaft of the Motor Operator
   4.3. Space De-coupler 5/8" from serrated casting (use aluminum spacer provided)

**Figure 28: Mounting Motor Operator**

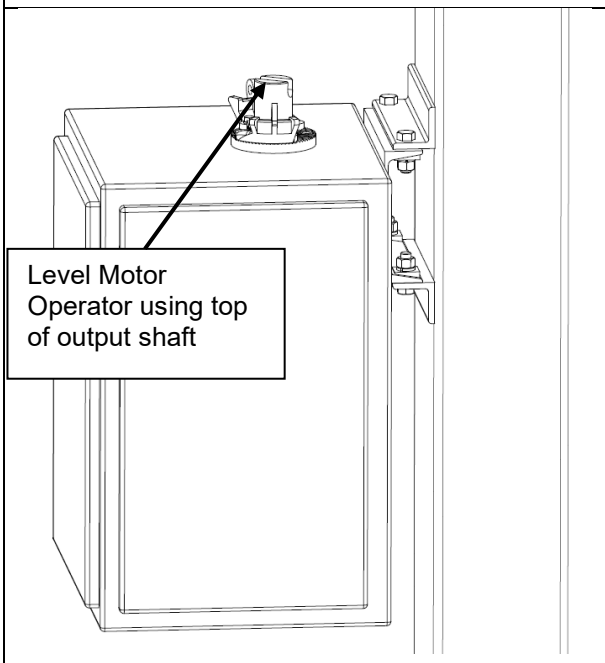
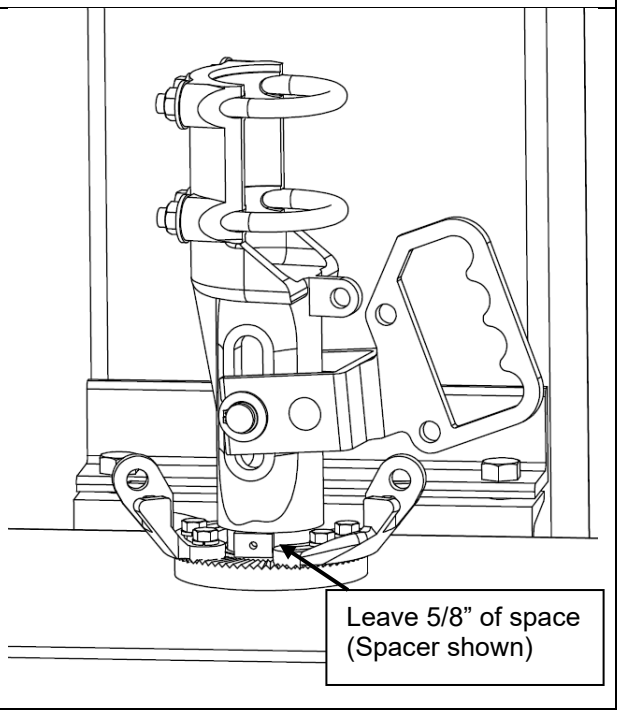
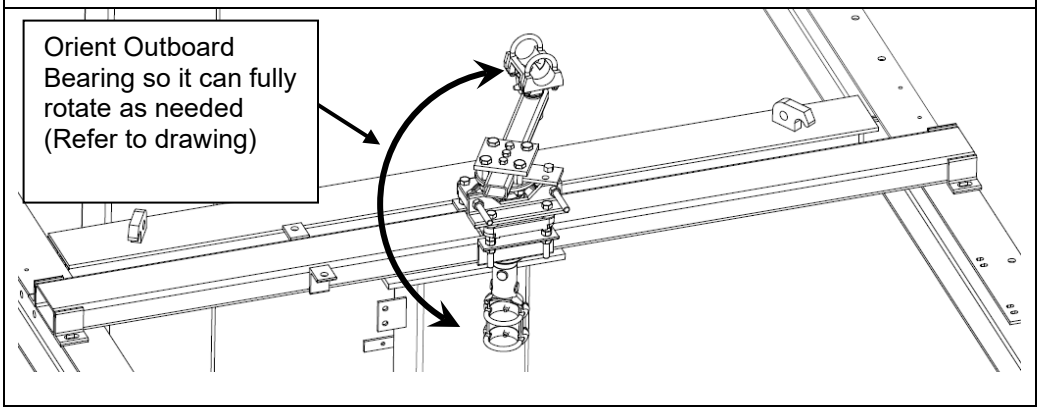



**Figure 29: Installing De-coupler**



5. Mount the Outboard Bearing Assembly
   5.1. Orient the Outboard Bearing and bracket to allow rotation of the bearing as shown on drawing

**Figure 30: Mounting Outboard Bearing**



6. Install the Vertical Control Pipe between the Outboard Bearing Clamp and the Motor Operator Clamp
   6.1. Ensure the Vertical Control Pipe is against the stop of the Outboard Bearing Clamp
      - This prevents the weight of the Vertical Control Pipe from resting on the Motor Operator
      - It may be necessary to trim the Vertical Control Pipe
   6.2. Tighten the U-bolts and then pierce vertical control pipe with piercing bolts on the Outboard Bearing clamp side
   6.3. Leave the U-bolts and piercing bolts loose at the Motor Operator side

**Figure 31: Installing Vertical Control Pipe**

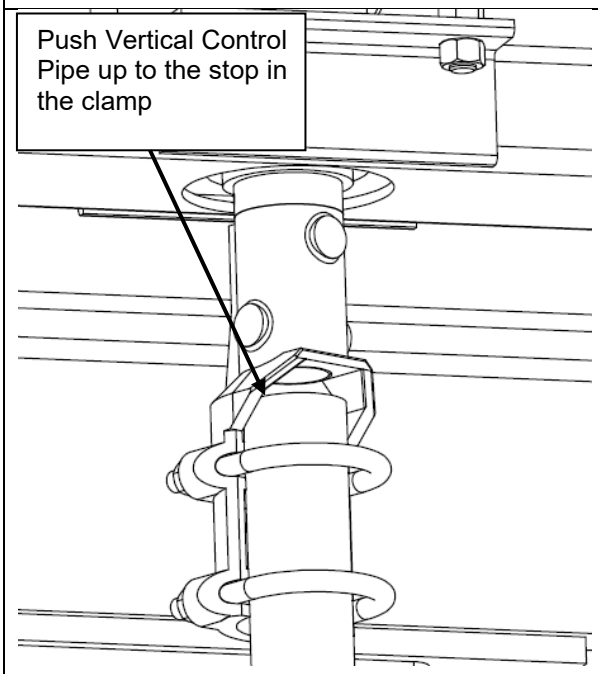
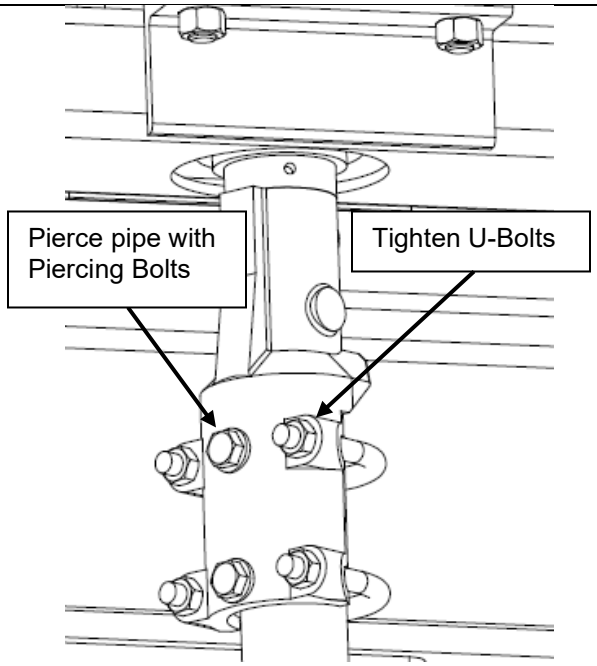



**Figure 32: Securing Vertical Pipe to Outboard Bearing**

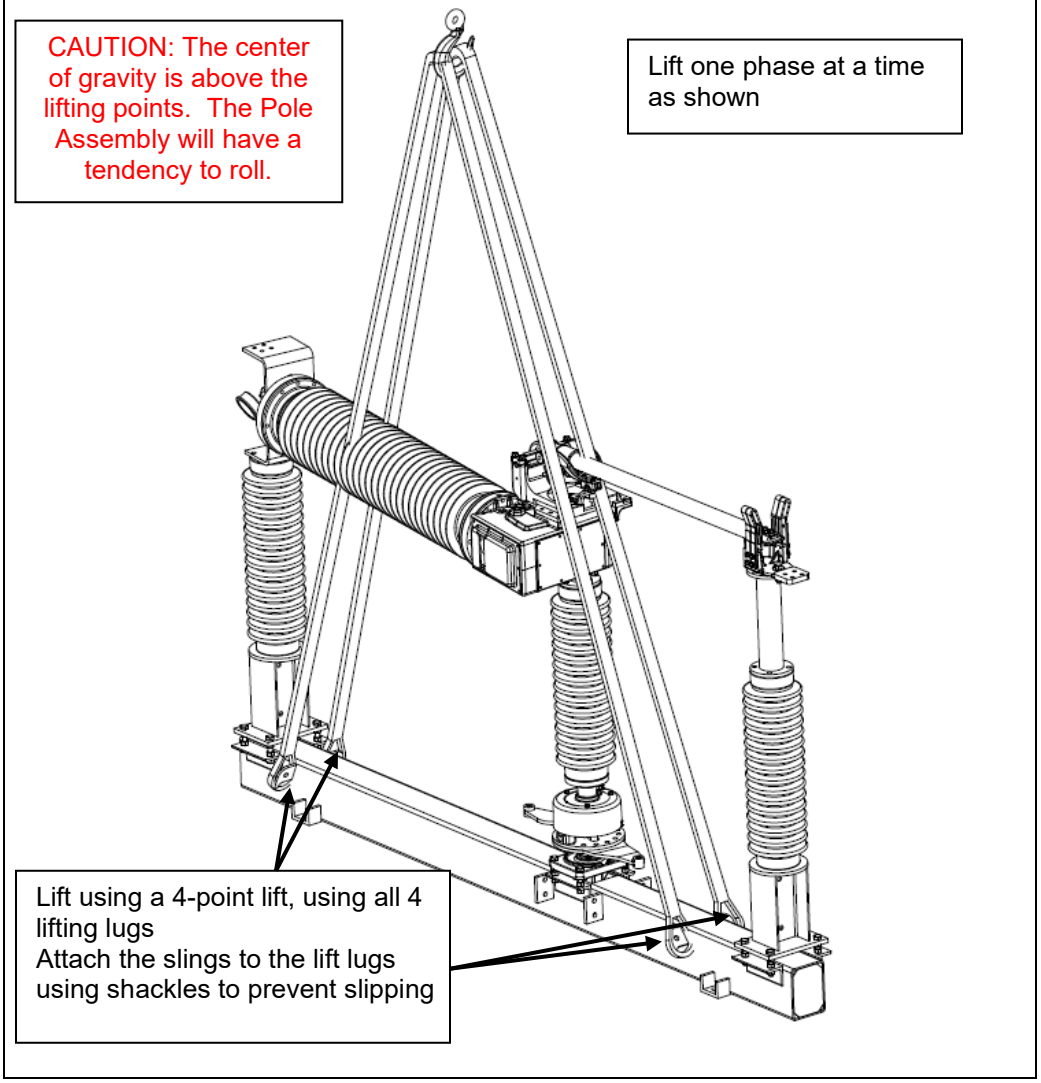


7. Mount Pole Assemblies
   7.1. Lift one pole assembly at a time
   - Lift Pole Assembly using a 4-point lift, utilizing all four lifting lugs
   - Attach the slings to the lift lugs using shackles to prevent the sling from slipping off during the initial lift.

| ⚠ CAUTION | The center of gravity is above the lifting points. The Pole Assembly will have a tendency to roll. |
|---|---|

   7.2. Match pole assembly number with number labeled on platform
   7.3. Orient pole assemblies according to drawing
   7.4. Position poles as indicated with yellow position indicators on the platform

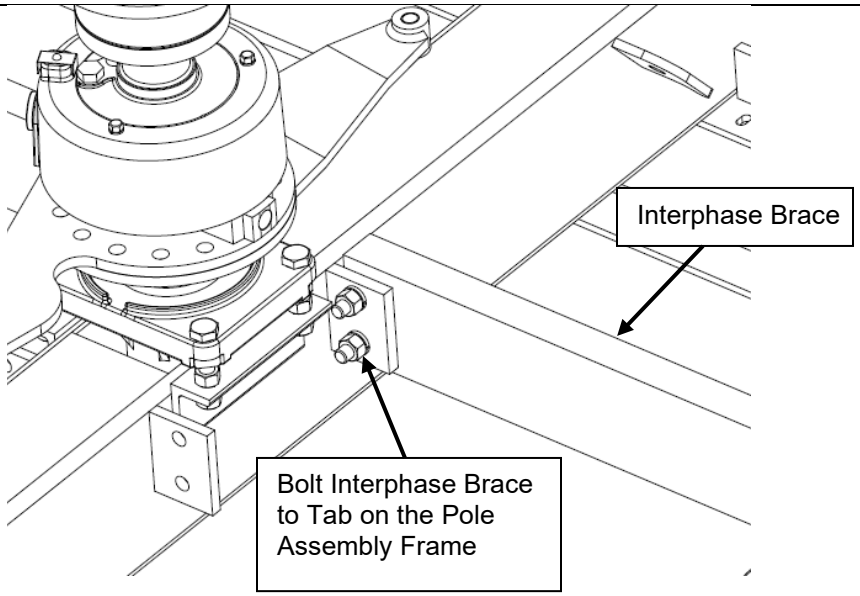
**Figure 33: Lifting Pole Assembly**



7.5. Install Interphase Braces between the Pole Assemblies
- Refer to the outline drawing to determine which tab the Interphase Brace should be attached to
  - Generally, the tab on the same side as the Interphase Pipe Assembly should be used
- The braces establish the correct centerline distances between poles. If the braces do not fit when the poles are positioned correctly, contact Southern States.

7.6. Tighten the Interphase Brace hardware and torque per specification
7.7. Tighten pole assembly mounting hardware and torque per specification

**Figure 34: Installing Interphase Braces**



8. Install the Interphase Pipe Assembly
   8.1. Match numbers on pipe assembly to the numbers marked on each pole assembly

**Figure 35: Installing Interphase Pipe Assembly (Connecting to Center Phase)**

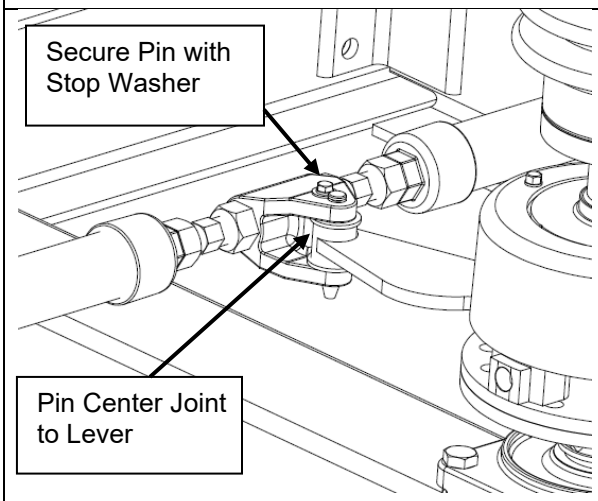
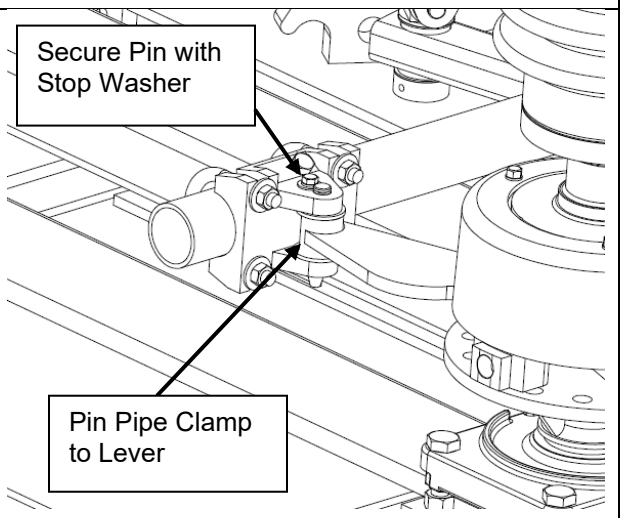
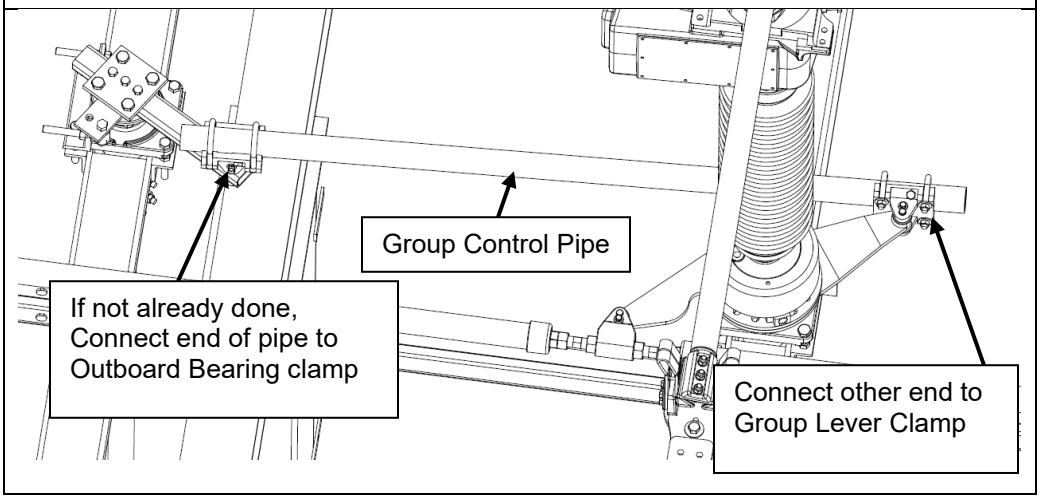



**Figure 36: Installing Interphase Pipe Assembly (Connecting to Outer Phase)**



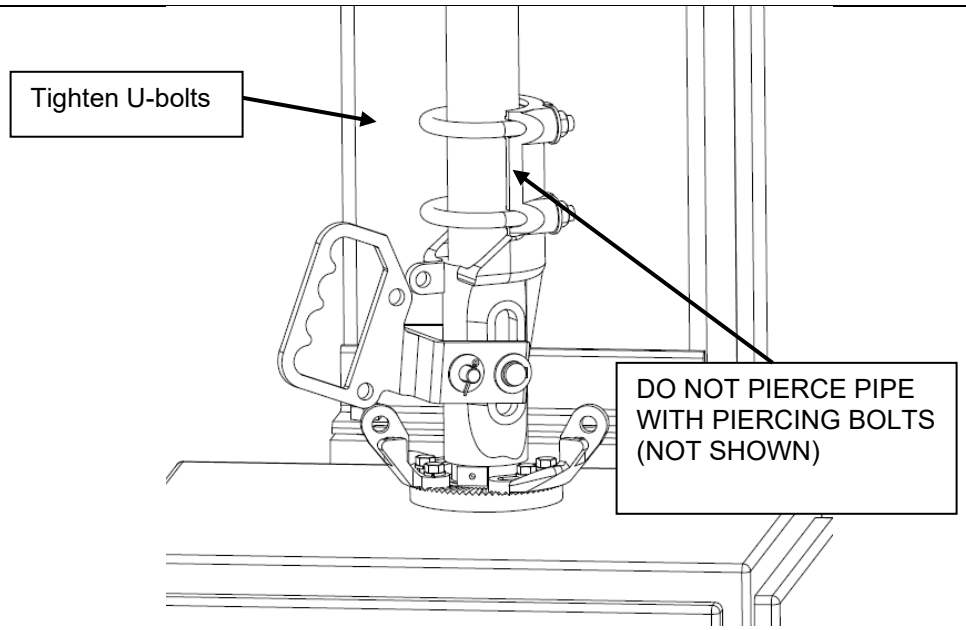

9. Install the Group Control Pipe
   9.1. If not shipped assembled, connect one end of the Group Control Pipe to the Outboard Bearing
   9.2. Connect the other end of the Group Control Pipe to the Group Lever

**Figure 37: Installing Group Control Pipe**



10. Tighten the U-bolts that connect the Motor Operator De-coupler to the Vertical Control Pipe - DO NOT PIERCE PIPE

**Figure 38: Tightening U-Bolts on Motor Operator De-coupler**

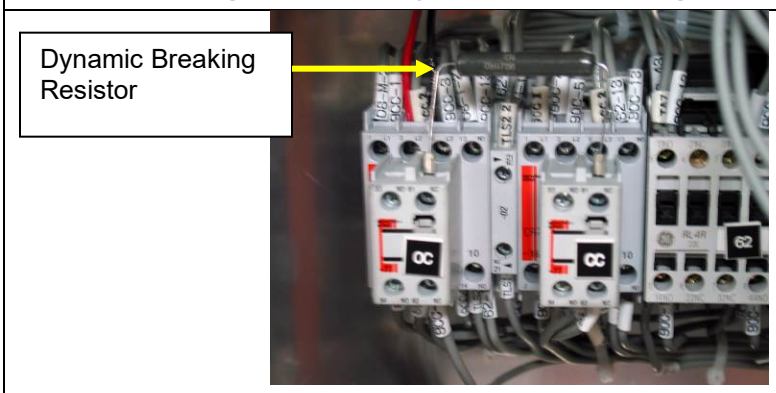



11. Remove any tie wraps and foam padding temporarily holding the Disconnect Blades to the Jaws

**Figure 39: Tie Wraps and Foam Padding on Disconnect Blades and Jaws**

12. Disconnect one end of the Dynamic Braking Resistor
    12.1. Fill Interrupter with SF6 per instructions set forth in the section **SF6 Fill Instructions** on page **63**

**Figure 40: Dynamic Braking Resistor**




13. Manually operate the CSH/CSH-B to the full open position
    13.1. Check the Over-toggle angle of the Outboard Bearing Lever
        13.1.1. Ensure the De-coupler handle is in the Up (coupled) position (**Figure 41**)
        13.1.2. Insert the Manual Crank Handle and crank in the direction indicated by open arrow in the Motor Operator
        13.1.3. Stop cranking when the Outboard Bearing Stop reaches the Stop Bolt

**Figure 41: De-Coupler in Coupled Position**

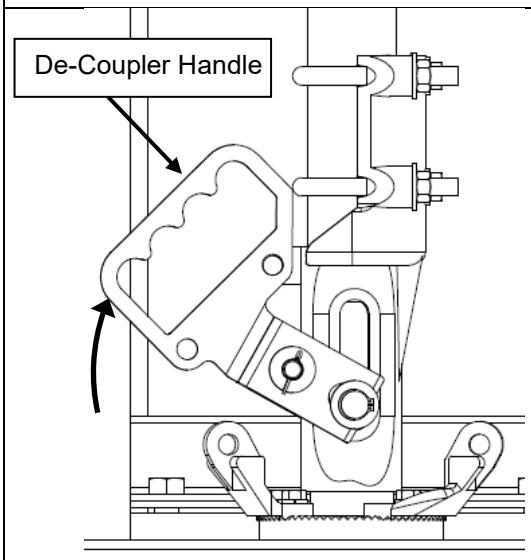
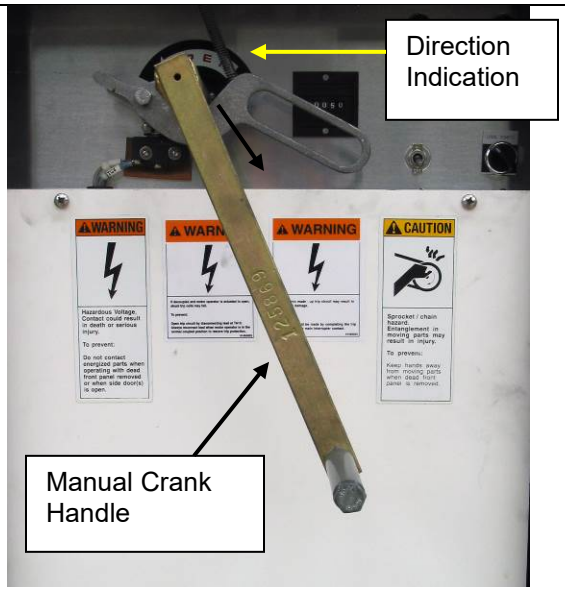



**Figure 42: Manually Cranking Motor Operator**



13.2. Verify that the Outboard Bearing Lever is over-toggled between 4 to 6 degrees
13.2.1. If the over-toggled angle of the Outboard Bearing Lever is not as specified, adjust the Outboard Bearing Stops to achieve the correct angle

**Figure 43: Over-toggle Angle of Outboard Bearing Lever**

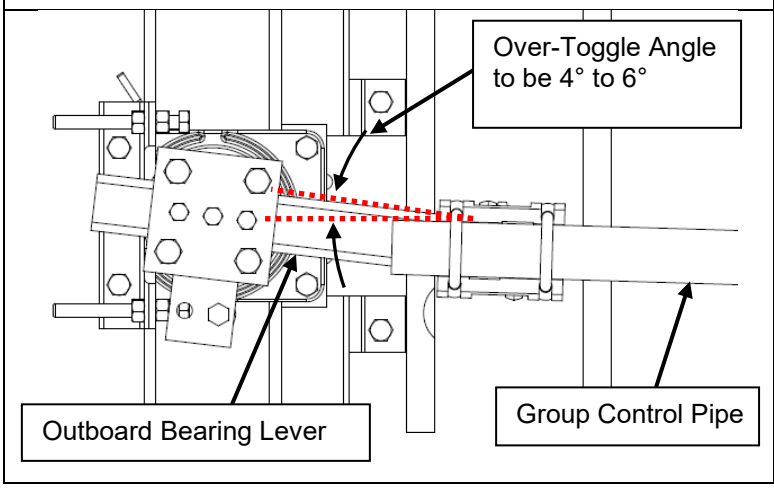
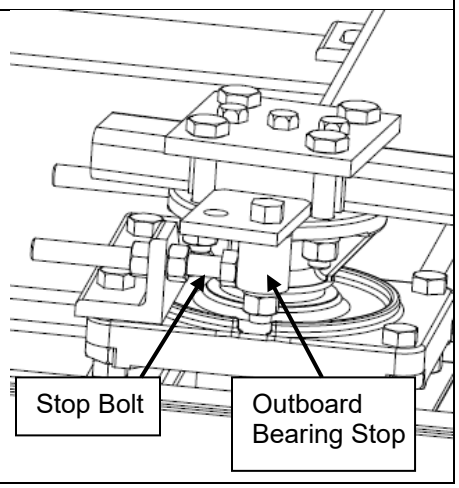



**Figure 44: Adjusting Stop Bolt**




14. Align the De-coupler with the Motor Operator and ensure proper Alignment of the Motor Operator with the Outboard Bearing
14.1. Loosen the U-bolts on the De-coupler and manually crank the Motor Operator until the De-coupler Hand Grip aligns with the nearby Lock Bracket
14.2. Re-tighten the U-bolts on the De-coupler
14.3. Verify that the De-coupler Hand Grip moves down to the full de-coupled position with minimal effort
14.4. If the hand grip can be engaged and dis-engaged with minimal effort, tighten and torque Motor Operator mounting hardware
14.5. If the hand grip cannot be engaged and dis-engaged easily, the Motor Operator and the Outboard Bearing must be re-aligned per the following:
14.5.1. Slightly shift the position or shim the angle of the Motor Operator, depending on type of misalignment
14.5.2. After re-alignment, tighten and torque the Motor Operator mounting hardware
14.6. Ensure U-bolts on the De-coupler are tight and snug the piercing bolts but DO NOT YET PIERCE THE PIPE
14.7. Match mark the Vertical Control Pipe and the De-coupler

**Figure 45: Aligning De-Coupler with Lock Bracket**

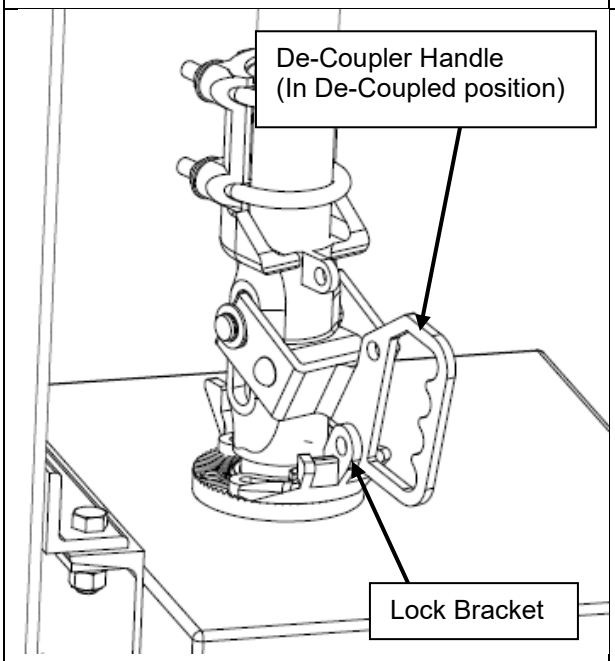
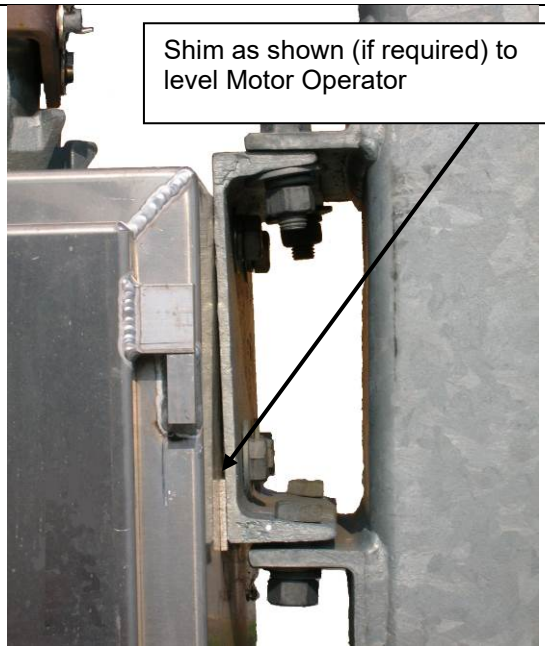



**Figure 46: Shimming Motor Operator**




15. Fill the interrupters with gas to the specified fill pressure

| ⚠ WARNING | Interrupters must be filled with gas before operating the switch |
|---|---|

16. Install all wire conduits supplied for connection between the Motor Operator and Shunt Trip Junction Boxes.
    16.1. Consult customer drawings for wiring details

# Final Adjustments:

17. Check/Adjust the Shunt Trip Gap, the rotational stroke of the Driver Mechanism, and the Disconnect Blade centering in the Stationary Contact Jaws
    17.1. Check the location of the indicator with respect to the green band and the shunt trip gap
    - The indicator should have travelled ½ to ¾ of the distance into the green band (rotating counter-clockwise viewed from underneath)
    - The shunt trip gap (between the roller and latch plate) is to be between 1/8" to 3/16" Note: The Shunt Trip Roller should be ¾" away from the inside of the Shunt Trip Housing. If the Shunt Trip Roller is pushed up against the housing, the roller is on top of the latch, which means there is insufficient gap.

**NOTICE** A trip command can only be generated after the circuit switcher closes and energizes the potentially faulted line. Refer to **Appendix E.** Trip-Free Operation/Testing to prevent potential shunt trip damage during opening and closing

**Figure 47: Indicator in Green Band**

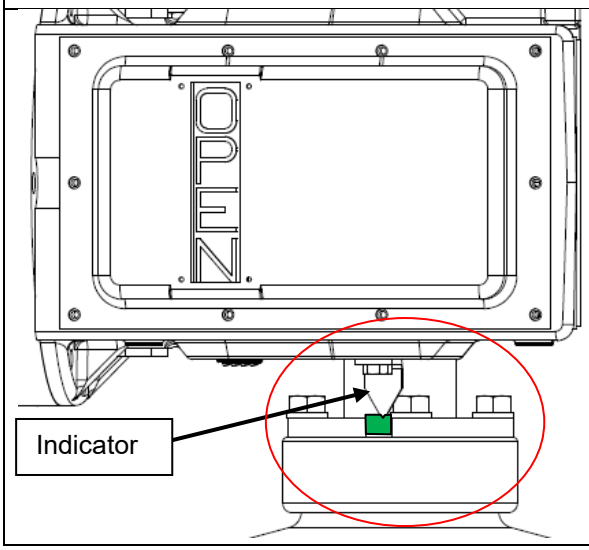



**Figure 48: Close-up of Indicator in Green Band**

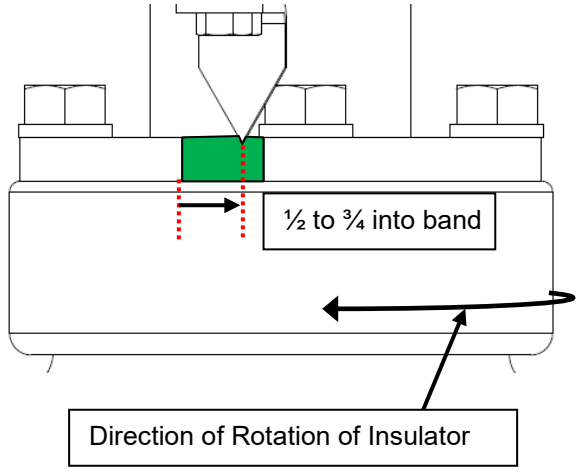


**Figure 49: Shunt Trip View Port**

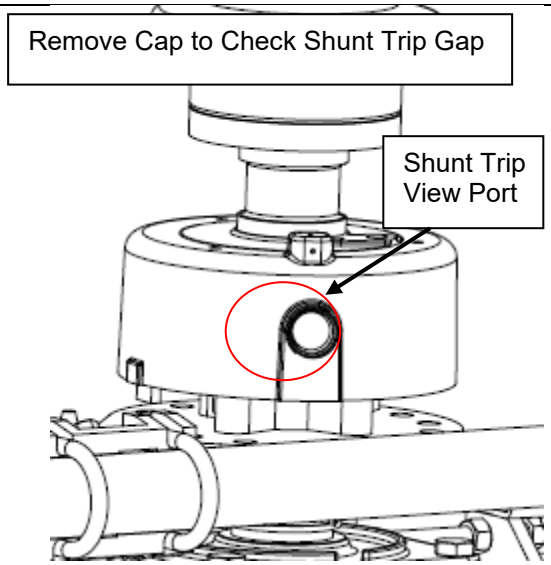
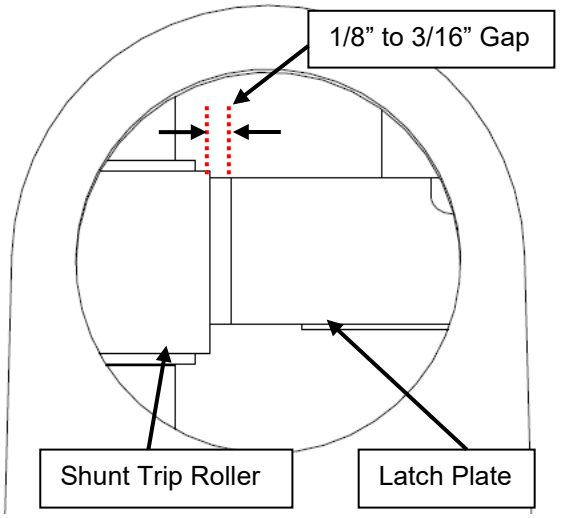



**Figure 50: Shunt Trip Gap**



17.2. For any shunt trips that are not latched or do not meet the gap criteria above, perform the following steps:

| ⚠ WARNING | DO NOT THREAD THE CHARGING BOLT IN TOO FAR. There should be a minimum of 1 ¼" of the bolt sticking out of the casting. |
|---|---|

17.2.1. Manually crank the Motor Operator 5 rotations towards the closed position to remove load from the shunt trip

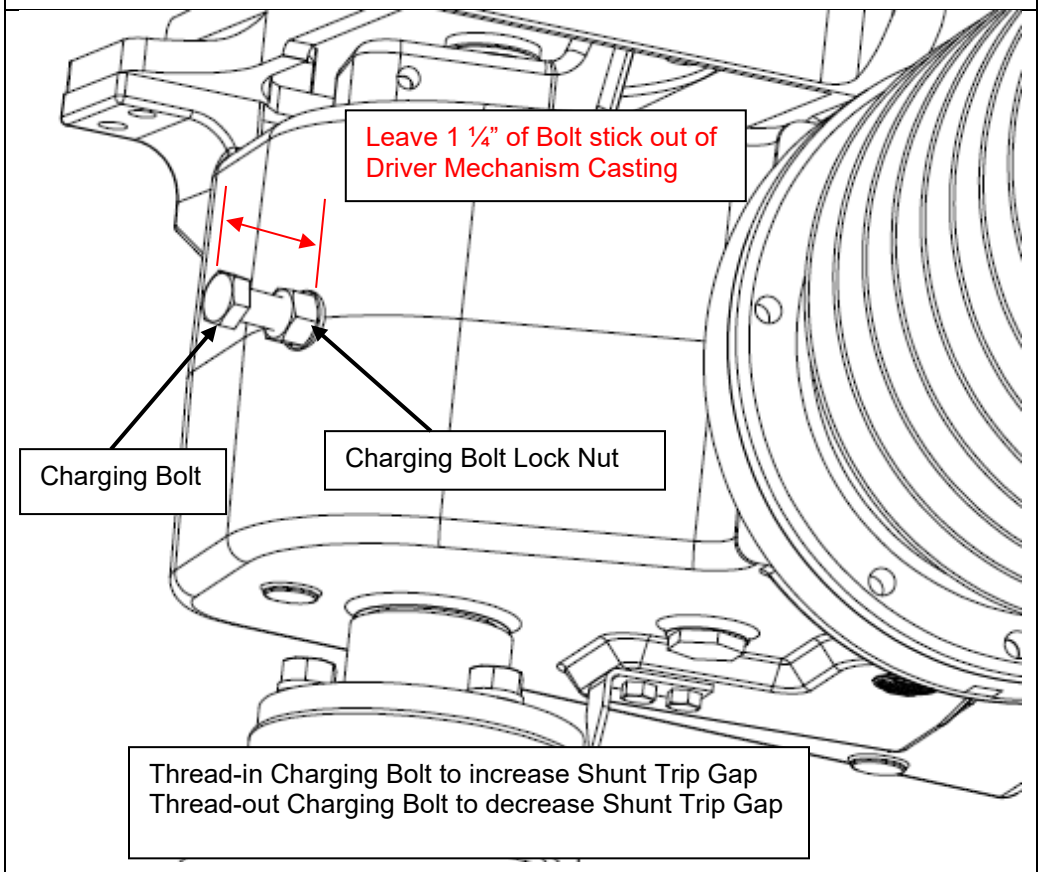
17.2.2. Loosen the jam nut on the charging bolt

17.2.3. Tighten or Loosen the charging bolt ½ turn

- Thread-in the charging bolt to increase the Shunt Trip Gap
- Thread-out the charging bolt to decrease the Shunt Trip Gap

17.2.4. Re-tighten the jam nut

**Figure 51: Adjusting Charging Bolt**




17.2.5. Manually crank the Motor Operator back to the full open position

17.2.6. Check the shunt trip gap, repeat steps until the gap is correct

17.2.7. After shunt trip gaps are all correct, re-check the location of the indicator with respect to the green bands

17.3. Note the location of the indicators in the green bands again (information to be used later)
- The location of the indicator will change if the shunt trip gap is adjusted

17.4. Center the Disconnect Blades vertically in the Stationary Contact Jaws
17.4.1. Manually crank the Motor Operator towards the closed position.
17.4.2. As the Disconnect Blades enter the Stationary Contact Jaws, verify that the blades are centered in the jaws
17.4.3. If not centered, adjust the jacking bolts at the bottom of the Post Insulator that support the Stationary Contact Jaws.
17.4.4. Verify that the Disconnect Blades close first, followed by the interrupter

**Figure 52: Vertical Alignment of Blade and Jaw**

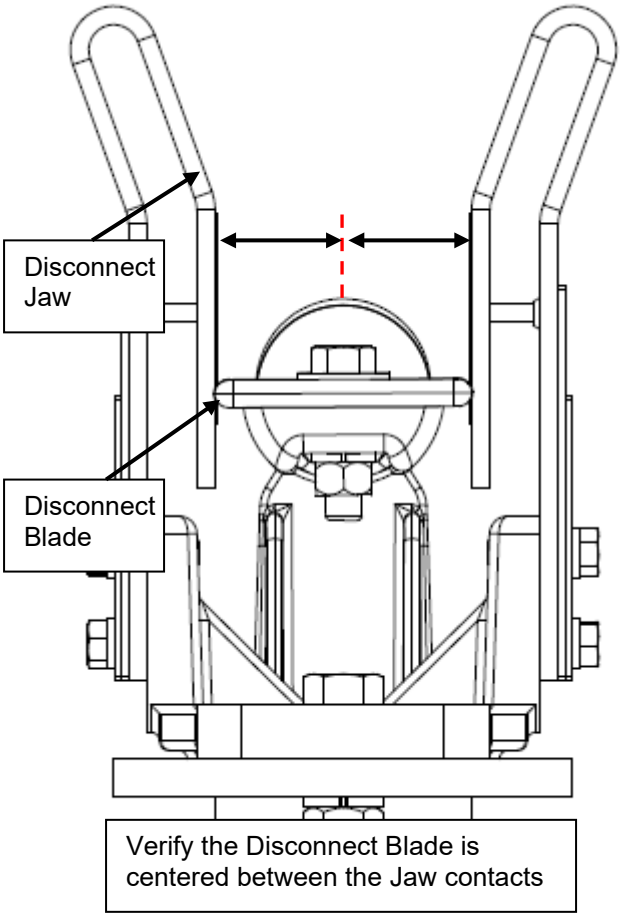
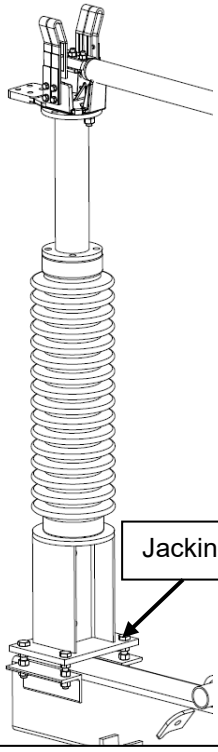



**Figure 53: Adjusting Stationary Jaw**

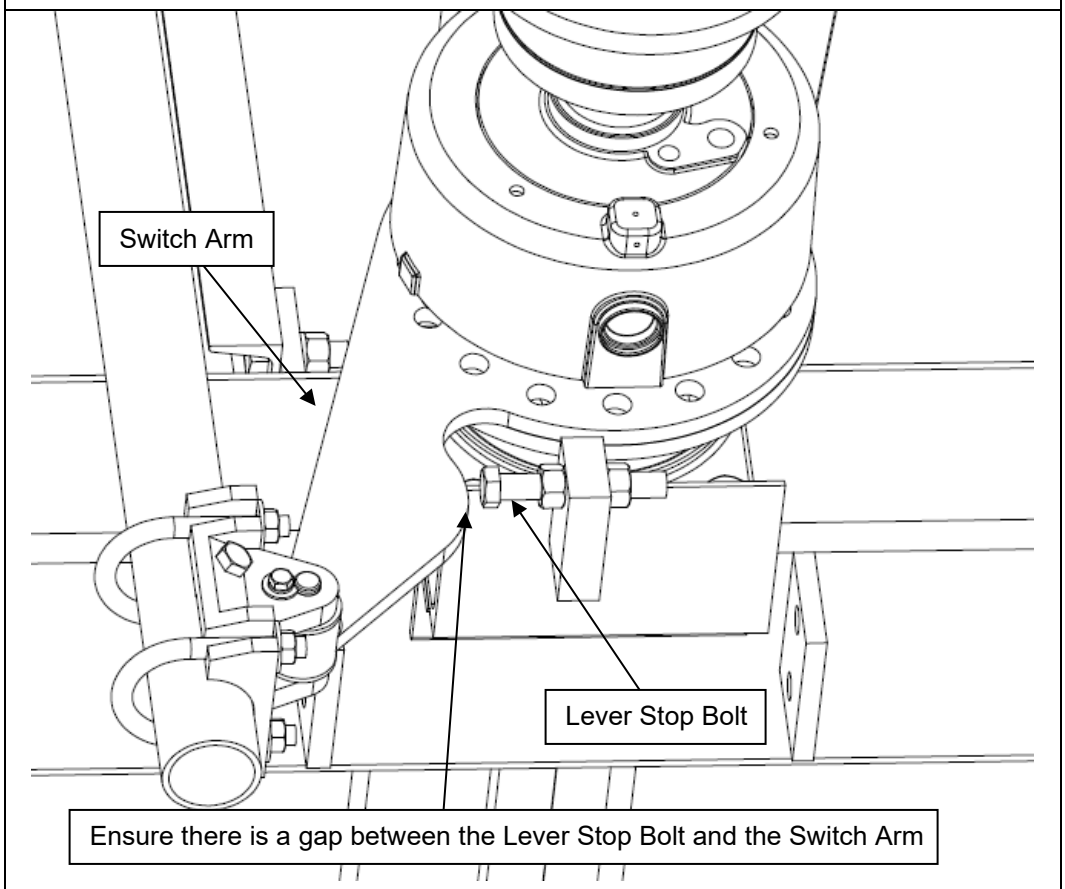



17.5. Re-Check the over-toggle angle of the Outboard Bearing Lever
17.5.1. Continue manually cranking the Motor Operator until Outboard Bearing stop reaches the stop bolt
17.5.2. Verify Outboard Bearing lever is over-toggled between 4 to 6 degrees
17.5.2.1. If the over-toggled angle of the Outboard Bearing Lever is not as specified, adjust the Outboard Bearing Stops to achieve the correct angle

17.6. Verify that all three interrupters have closed when Motor Operator is in the full closed position.

17.7. Ensure the Lever Stop Bolt is not against the Switch Arm.

**Figure 54: Gap between Lever Stop Bolt and Switch Arm**



17.8. Check and note the location of the indicator with respect to the red band

- The indicator should have travelled ½ to ¾ of the distance into the red band (rotating clockwise viewed from underneath) if properly adjusted

**Figure 55: Indicator in Red Band**

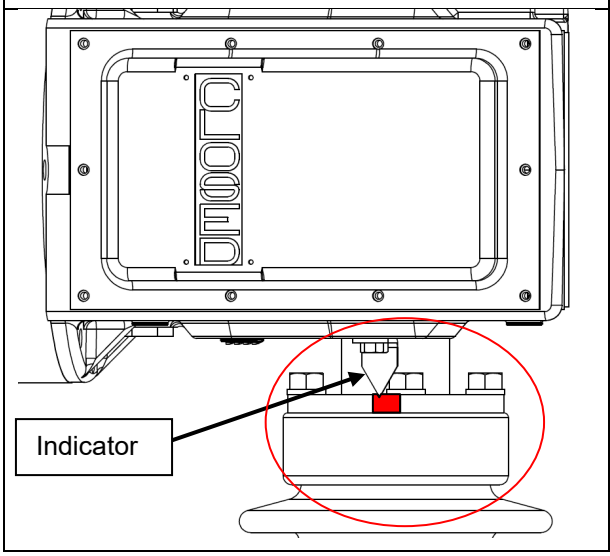
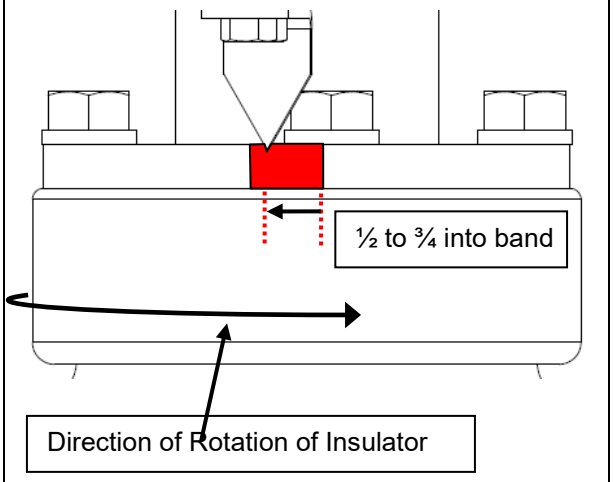



**Figure 56: Close-up of Indicator in Red Band**




17.9. If the location of the Indicators were as specified below and all three interrupters have closed when Motor Operator is in the full closed position, no further adjustment is needed. Go directly to step 18

- Open Position: Indicator to have travelled ½ to ¾ into the Green Band
- Closed Position: Indicator to have travelled ½ to ¾ into the Red Band

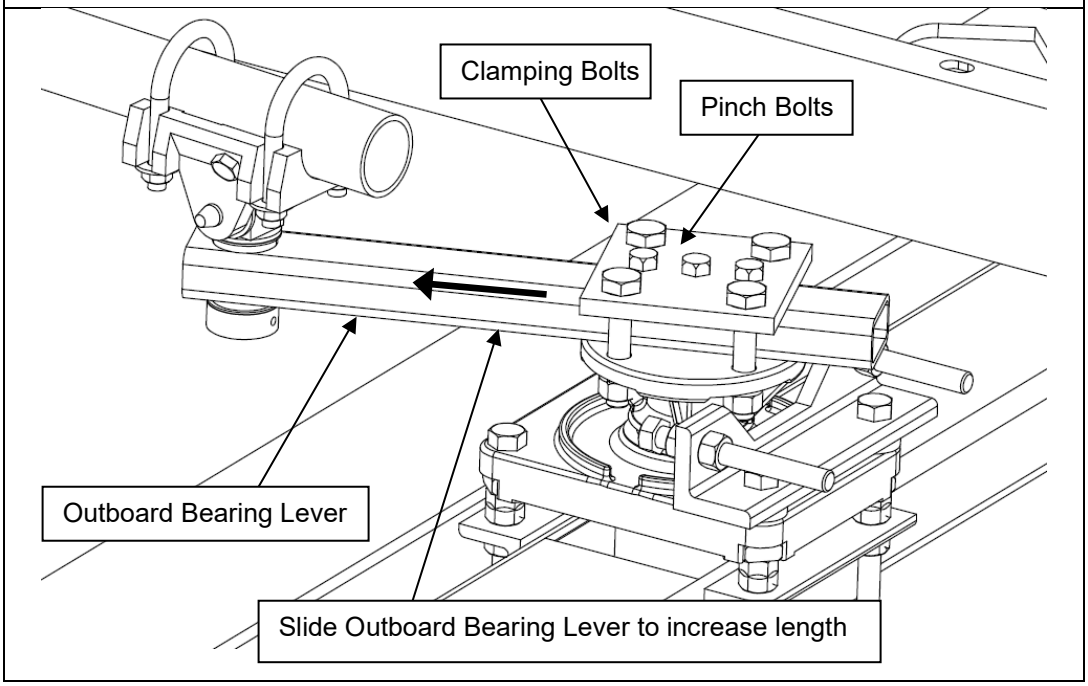
If the location of the indicators were not as specified, proceed to either 17.10, 17.11, 17.12, or 17.13 depending on the case:

- If the indicator was less than ½ into both the green and red band, proceed to step 17.10
- If the indicator was more than ¾ into both the green and red band, proceed to step 17.11
- If the indicator is less than ½ into the green band and more than ¾ into red band, proceed to step 17.12
- If the indicator is less than ½ into the green band and more than ¾ into red band, proceed to step 17.13

17.10. If the indicator was less than ½ into both the green and red band the stroke must be increased by increasing the length of the Outboard Bearing lever:

17.10.1. Manually crank the Motor Operator to the full open position
17.10.2. Manually crank the Motor Operator towards the closed position until the Outboard Bearing moves freely and there is no load on the Outboard Bearing Lever
17.10.3. Loosen the 3 pinch bolts on the Outboard Bearing lever plate
17.10.4. Mark the location of both sides of the plate on the Outboard Bearing Lever for reference
17.10.5. Loosen the 4 bolts clamping the plate to the lever
17.10.6. Slide the Outboard Bearing lever to increase the length by ¼".
17.10.7. Re-tighten the 4 clamping bolts and 3 pinch bolts.

**Figure 57: Increasing Length of Outboard Bearing Lever**




17.10.8. Manually crank the Motor Operator to the full open position
17.10.9. Re-check and re-adjust the shunt trip gap as described above to achieve the specified gap.

***NOTICE*** Excessive shunt trip gap or overdriving on open can result in damage to shunt trip as shown below. Shunt trip gap should be 1/8" to 3/16". Refer to **Appendix E.**

17.10.10. After adjusting the shunt trip gap, re-check the position of the indicator in the green band.
17.10.11. If the indicator is not positioned in the green band as specified, go back to the beginning of step 17

17.10.12. If the indicator is located properly in the green band, manually crank the Motor Operator to the full closed position and check the location of the indicator in the red band.

17.10.13. If the indicator is not positioned in the red band as specified, go back to the beginning of step 17

17.11. If the indicator was more than ¾ into both the green and red band the stroke must be decreased by decreasing the length of the Outboard Bearing lever:

17.11.1. Manually crank the Motor Operator to the full open position

17.11.2. Manually crank the Motor Operator towards the closed position until the Outboard Bearing moves freely and there is no load on the Outboard Bearing Lever

17.11.3. Loosen the 3 pinch bolts on the Outboard Bearing lever plate

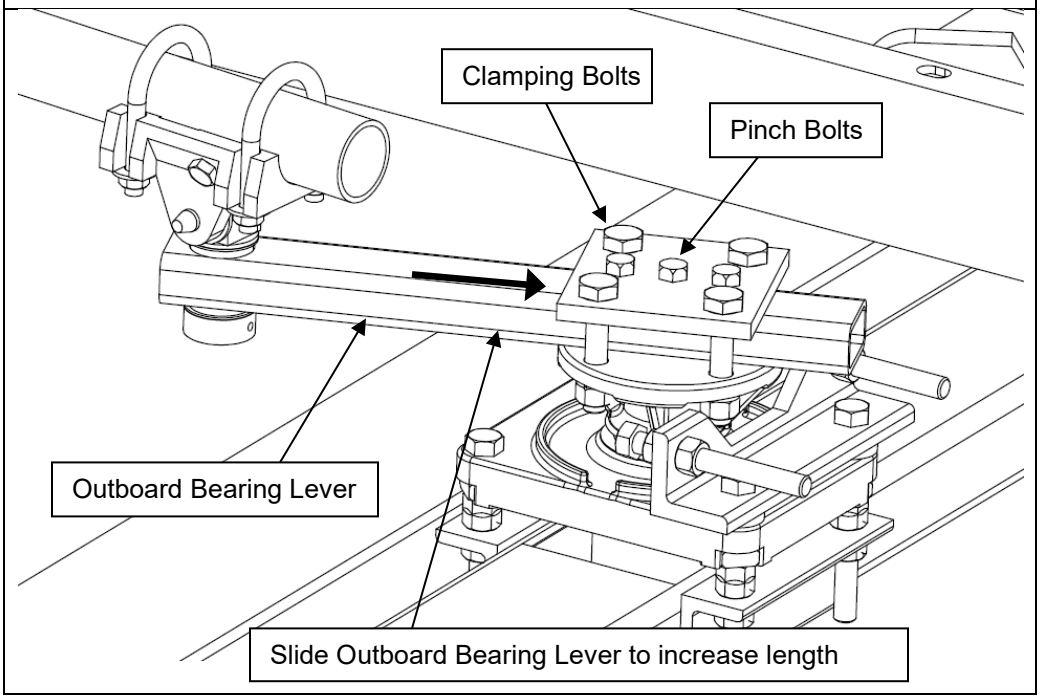
17.11.4. Mark the location of both sides of the plate on the Outboard Bearing Lever for reference

17.11.5. Loosen the 4 bolts clamping the plate to the lever

17.11.6. Slide the Outboard Bearing lever to decrease the length by ¼".

17.11.7. Re-tighten the 4 clamping bolts and 3 pinch bolts.

**Figure 58: Decreasing Length of Outboard Bearing Lever**




17.11.8. Manually crank the Motor Operator to the full open position

17.11.9. Re-check and re-adjust the shunt trip gap as described above to achieve the specified gap

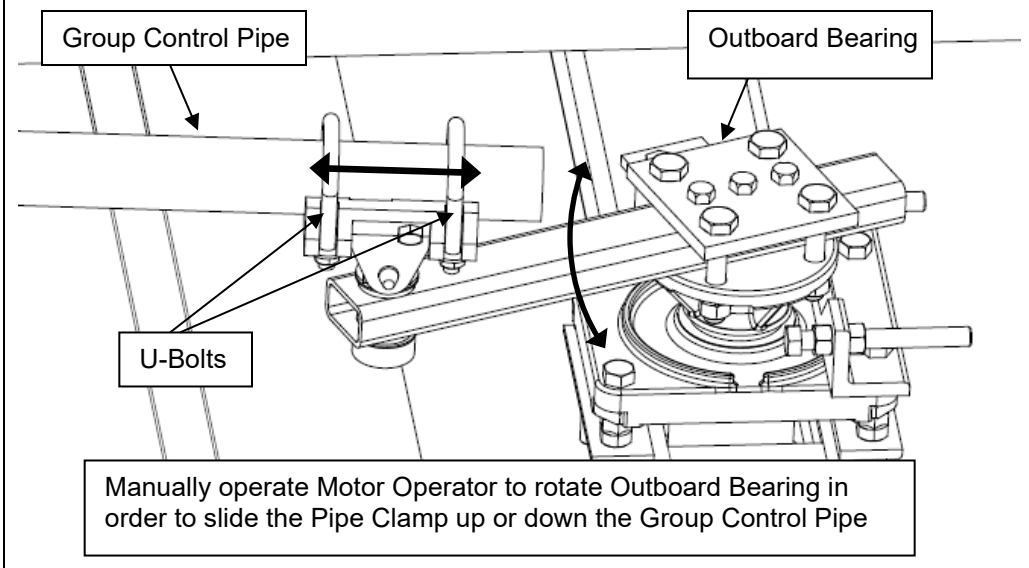
17.11.10. After adjusting the shunt trip gap, re-check the position of the indicator in the green band.

17.11.11. If the indicator is not positioned in the green band as specified, go back to the beginning of step 17
17.11.12. If the indicator is located properly in the green band, manually crank the Motor Operator to the full closed position and check the location of the indicator in the red band.
17.11.13. If the indicator is not positioned in the red band as specified, go back to the beginning of step 17

17.12. If the indicator is less than ½ into the green band and more than ¾ into red band, the group control pipe must be adjusted as follows:
17.12.1. Manually crank the Motor Operator to the full open position
17.12.2. Manually crank the Motor Operator towards the closed position until the Outboard Bearing moves freely and there is no load on the Outboard Bearing lever
17.12.3. Mark the location of the U-bolts on the Outboard Bearing end of the group control pipe
17.12.4. Loosen the U-bolts on Outboard Bearing end of the group control pipe
17.12.5. Verify piercing bolt is also loose
17.12.6. Modify the length of the group control pipe by manually cranking the Motor Operator.
- If pushing to open, the group control pipe must be lengthened by ¼"
- If pulling to open, the group control pipe must be shortened by ¼"

17.12.7. Re-tighten the U-bolts and snug the piercing bolt

**Figure 59: Adjusting Length of Group Control Pipe**



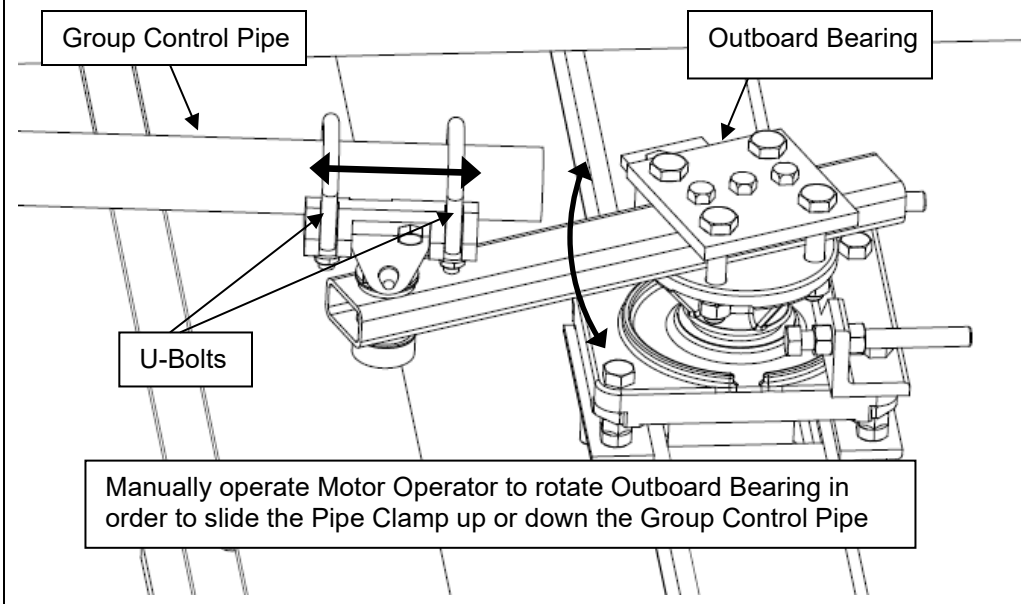

17.12.8. Manually crank the Motor Operator to the full open position
17.12.9. Re-check and re-adjust the shunt trip gap as described above to achieve the specified gap
17.12.10. After adjusting the shunt trip gap, re-check the position of the indicator in the green band.

17.12.11. If the indicator is not positioned in the green band as specified, go back to the beginning of step 17
17.12.12. If the indicator is located properly in the green band, manually crank the Motor Operator to the full closed position and check the location of the indicator in the red band.
17.12.13. If the indicator is not positioned in the red band as specified, go back to the beginning of step 17

17.13. If the indicator is more than ¾ into the green band and less than ½ into the read band, the group control pipe must be adjusted as follows:
17.13.1. Manually crank the Motor Operator to the full open position
17.13.2. Manually crank the Motor Operator towards the closed position until the Outboard Bearing moves freely and there is no load on the Outboard Bearing lever
17.13.3. Mark the location of the U-bolts on the Outboard Bearing end of the group control pipe
17.13.4. Loosen the U-bolts on Outboard Bearing end of the group control pipe
17.13.5. Verify piercing bolt is also loose
17.13.6. Modify the length of the group control pipe by manually cranking the Motor Operator.
- If pushing to close, the group control pipe must be lengthened by 1/4"
- If pulling to close, the group control pipe must be shortened by 1/4"

17.13.7. Re-tighten the U-bolts and snug the piercing bolt

**Figure 60: Adjusting Length of Group Control Pipe**




17.13.8. Manually crank the Motor Operator to the full open position
17.13.9. Re-check and re-adjust the shunt trip gap as described above to achieve the specified gap

17.13.10. After adjusting the shunt trip gap, re-check the position of the indicator in the green band.
17.13.11. If the indicator is not positioned in the green band as specified, go back to the beginning of step 17
17.13.12. If the indicator is located properly in the green band, manually crank the Motor Operator to the full closed position and check the location of the indicator in the red band.
17.13.13. If the indicator is not positioned in the red band as specified, go back to the beginning of step 17

18. Check/Adjust the rotation of the Disconnect Blades to be parallel with the terminal pads and Adjust the length of the Disconnect Blades such that the Blade Contact is centered lengthwise in the Contact Shoe
    18.1. Manually crank the Motor Operator to the full closed position
    18.2. Check that the blades are parallel with the terminal pads within 5 degrees
    18.3. Check that the contact shoe is centered (lengthwise) on the blade contact

**Figure 61: Rotational Alignment of Disconnect Blade**

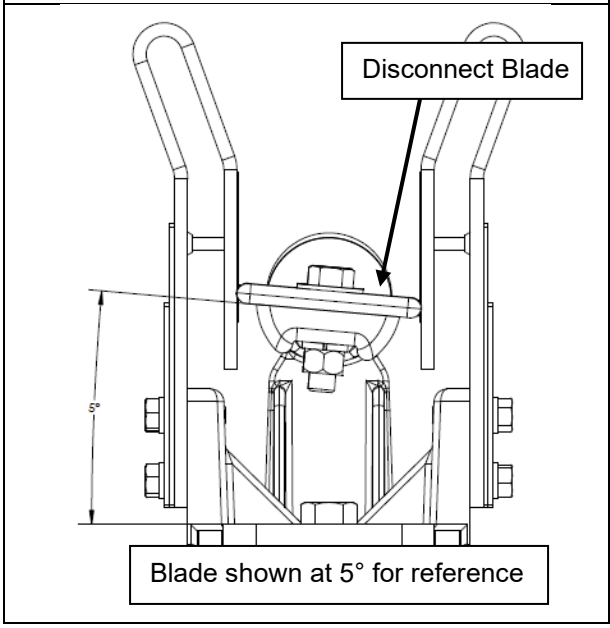
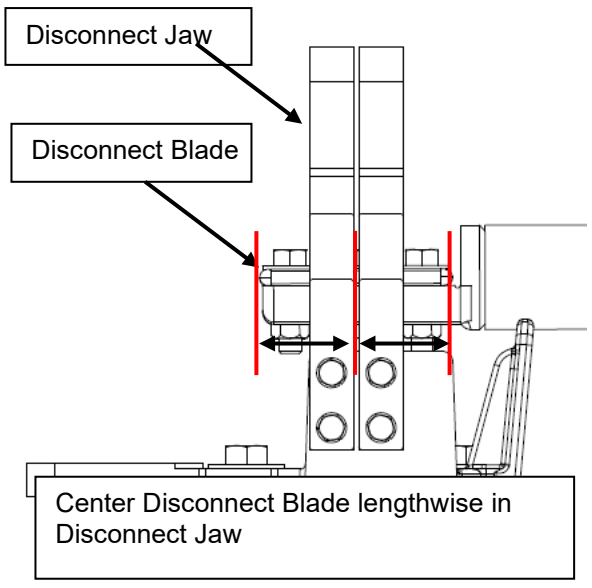
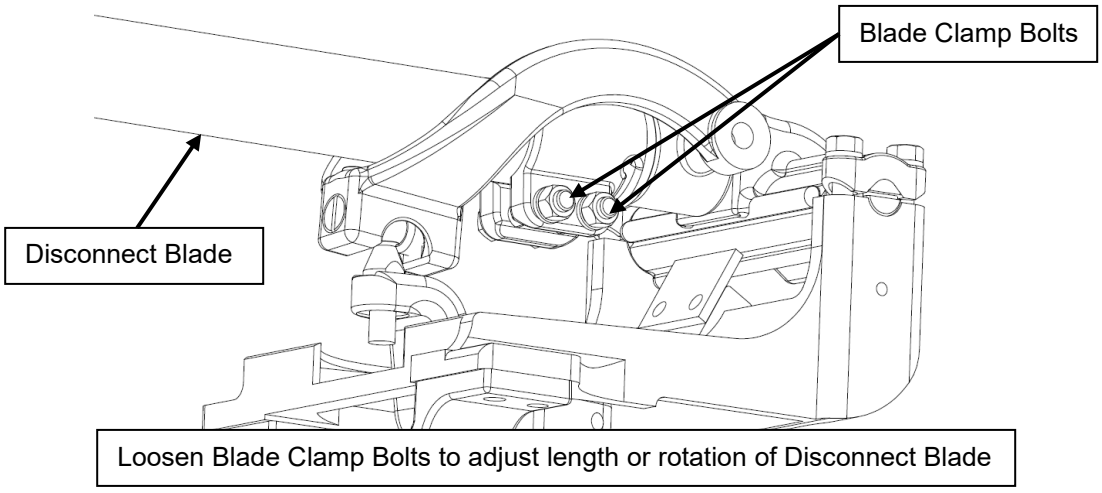



**Figure 62: Lengthwise Alignment of Disconnect Blade**



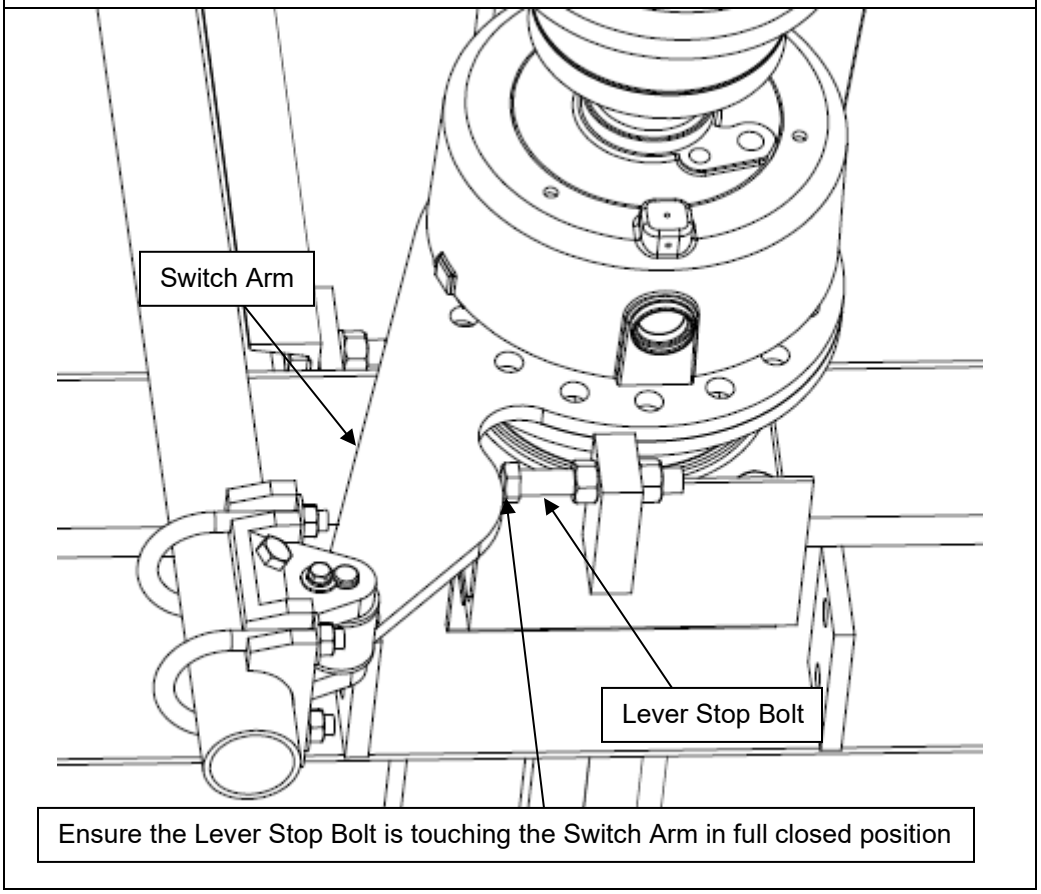
18.4. If either of the above are not correct, adjust the Disconnect Blade
- 18.4.1. Loosen the blade clamp bolts using a ¾" wrench/socket
- 18.4.2. To lengthen the blade, rotate the contacts to the vertical and slide the blade in or out as required.
- 18.4.3. Rotate the blade back such that it is parallel with the terminal pads within 5 degrees
  - To rotate the blade, use a 3/4" box end wrench on the Blade Contact Plate Bolt as leverage and roll the blade in the required direction
- 18.4.4. Retighten the blade clamp bolts

**Figure 63: Adjusting Disconnect Blade Length or Rotation Angle**



19. Check/Adjust the simultaneity of the interrupters (for closing operation)
    19.1. Verify that the Lever Stop Assembly Bolt is touching the switch arm (or has very little gap)
        19.1.1. If not, adjust Lever Stop Assembly Bolt

**Figure 64: Lever Stop Bolt touching the Switch Arm**




    19.2. Manually crank the Motor Operator to the full open position
    19.3. Manually crank the Motor Operator towards the closed position until the first interrupter closes
        19.3.1. Slow down as the blade reaches the jaw to prevent closing more than one interrupter
        19.3.2. Note the orientation of the Manual Crank Handle
        19.3.3. Continue cranking until the last interrupter closes and note the new orientation of the Manual Crank Handle

19.4. If the amount of rotation of the Manual Crank Handle between closing the first interrupter and the last interrupter is more than half a turn (180 degrees) the timing of the interrupters must be adjusted as follows:

19.4.1. Complete the close cycle and re-crank to the full open position

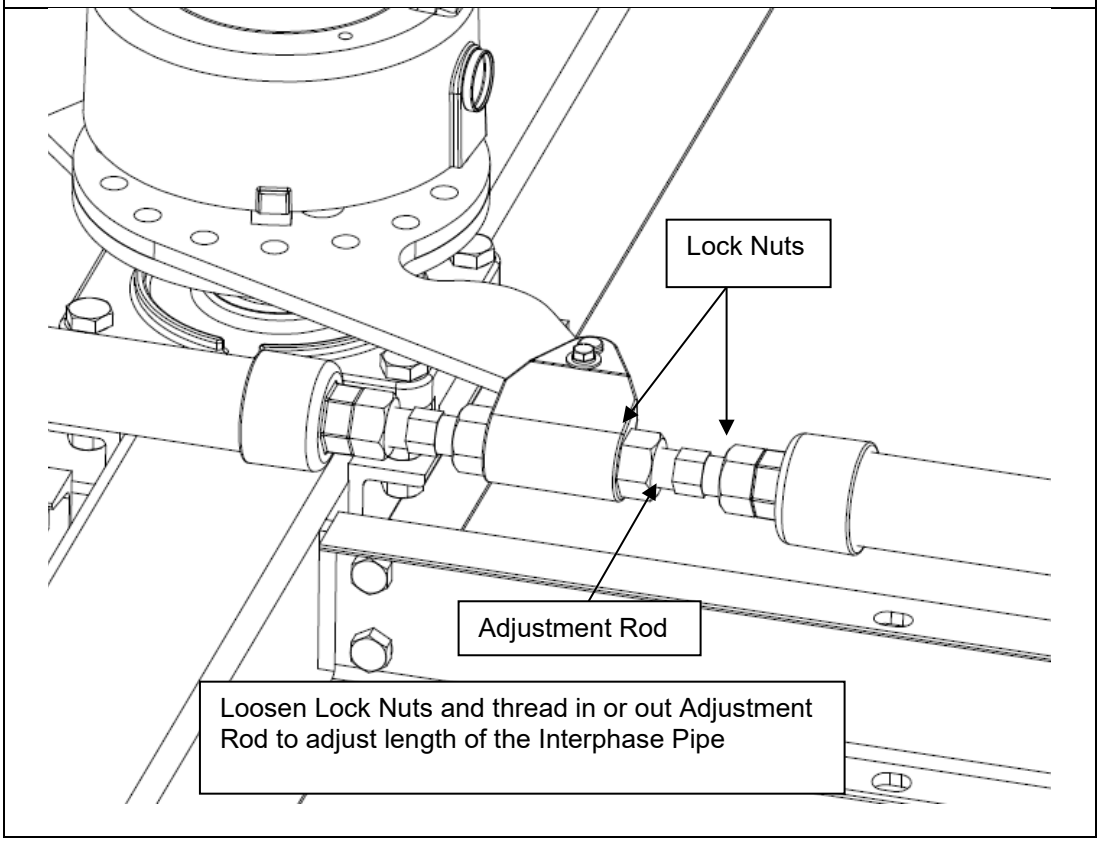
19.4.2. Manually crank the Motor Operator towards the closed position until the first interrupter closes

19.4.3. If the first interrupter to close is not the driven phase, adjust the Adjustable Clevis on the Interphase Pipe 2 full turns (to make the driven phase the first to close)

- If the first interrupter to close is being pulled to close, lengthen the Interphase Pipe
- If the first interrupter to close is being pushed to close, shorten the Interphase Pipe

19.4.3.1. If the Adjustable Clevis was adjusted, Go back to step 19.4.1

**Figure 65: Adjustable Clevis on Interphase Pipe Assembly**




19.4.4. If the first interrupter to close is the driven phase, adjust the adjustable Clevis on the Interphase Pipe until the other two phases close

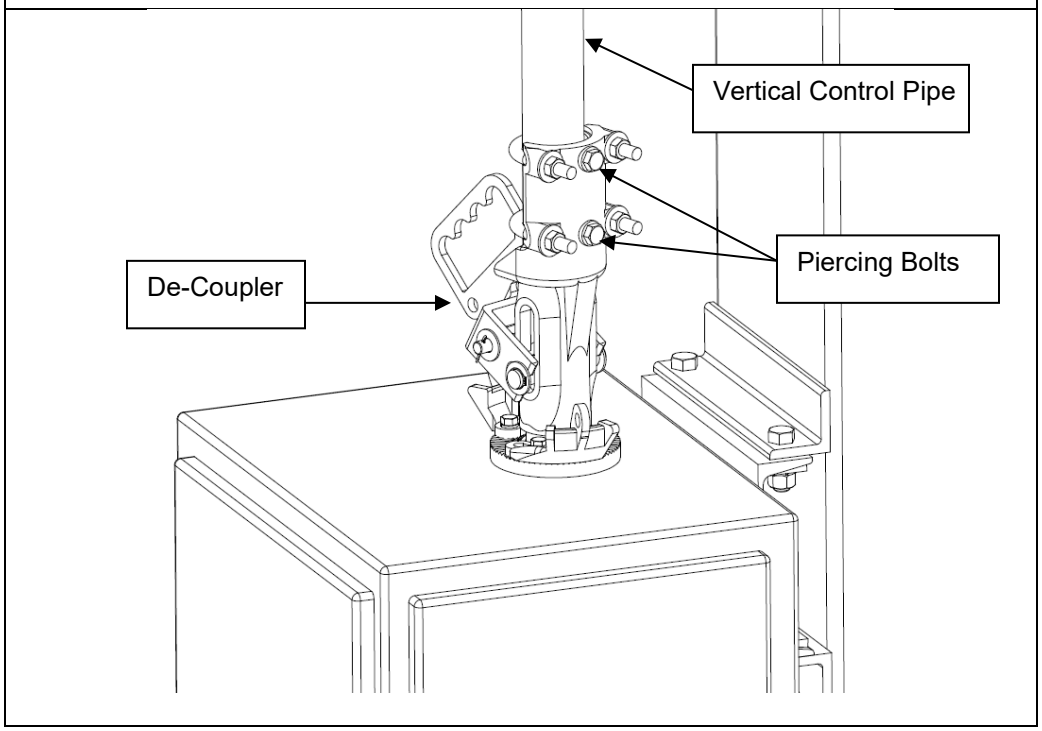
19.4.4.1. If other poles are being pulled, shorten Interphase Pipe

19.4.4.2. If other poles are being pushed, lengthen Interphase Pipe

19.5. If adjustments were made, re-check the simultaneity of the interrupters by restarting step 19

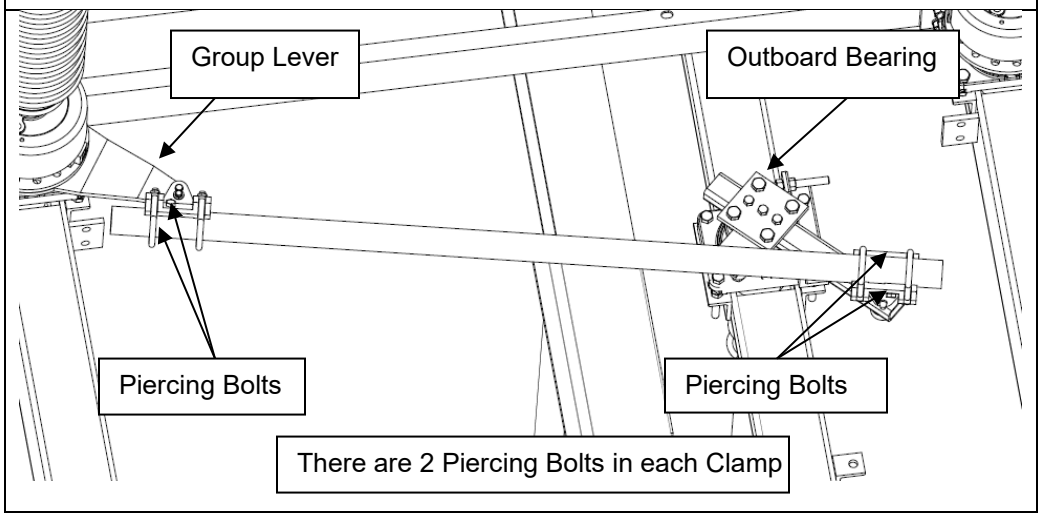
19.6. Re-verify the location of the indicator in the green band and the shunt trip gap
19.6.1. If adjustment is required, repeat step 17 as needed
20. Pierce Vertical Control Pipe with the piercing bolt on the Motor Operator/De-coupler end

**Figure 66: Piercing Vertical Control Pipe at Motor Operator/De-coupler**



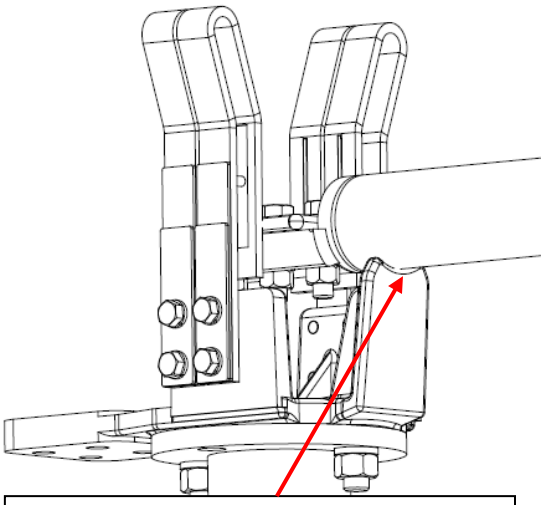

21. Pierce the Group Control Pipe with piercing bolts on both ends

**Figure 67: Piercing Group Control Pipe at both ends**



22. Check that the Disconnect Blade rests on the Blade Stop when in the full closed position and verify that there is proper down-force on the Disconnect Blade.

**Figure 68: Disconnect Blade Resting on Blade Stop**




22.1. If not done, manually crank the Motor Operator to the full closed position
22.2. If the Disconnect Blade is not resting on the Blade Stop, adjust the angle of the blade with the Ball Joint Adjusting Screws. (step 22.4)
22.3. Push up on the Disconnect Blade, lifting it up 1" to 2" and allow it to come back to rest.
- If the Disconnect Blade comes back to rest on the Blade Stop, no adjustment is needed
- If the Disconnect Blade cannot be pushed up by hand, there is too much downward pressure on the Disconnect Blade and it must be adjusted (step 22.4)
- If the friction of the Jaw holds the Disconnect Blade up off of the Blade Stop, the downward pressure on the Disconnect Blade must be adjusted (step 22.4)

22.4. If required, adjust the angle of the Disconnect Blade or downward pressure on the Disconnect Blade

22.4.1. Loosen the setscrew in the fork

22.4.2. To Lower the blade, or increase the down-ward pressure, thread the Ball Joint Adjusting Screw “C” in while threading screw “D” out. The opposite should be done to decrease the down-ward pressure on the Disconnect Blade.

22.4.3. After the Disconnect Blade is resting on the Blade Stop, screw “C” should be tight against the ball stud. Tighten screw “D” against the ball, then back out by 1/8 of a turn.

22.4.4. Tighten the setscrew to lock the adjusting screws position.

**Figure 69: Disconnect Hinge Assembly**

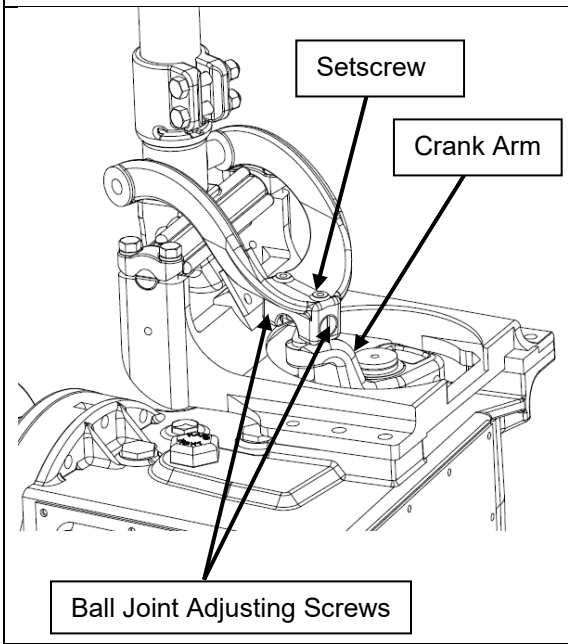
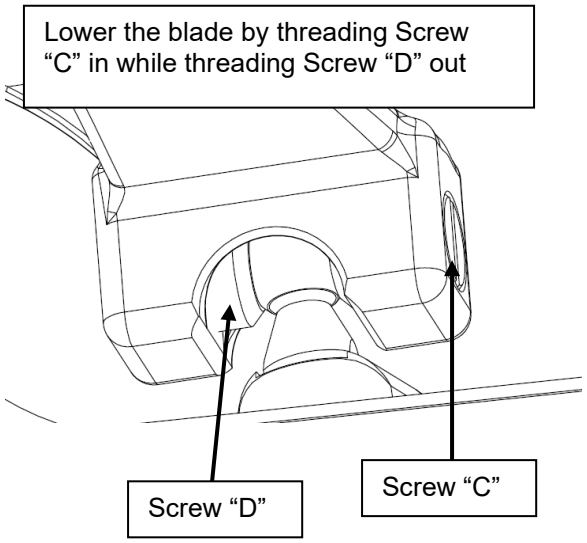



**Figure 70: Crank Arm Adjusting Bolts**



23. Check the vertical position of the Disconnect Blade such that it is at least 90 degrees from the Jaw
    23.1. If not done, manually crank the Motor Operator to the full open position
    23.2. If the Disconnect Blade is less than 90 degrees from the Jaw, adjust the angle of the Disconnect Blade by the following:
    - One bolt must be threaded out while the other bolt is threaded in
    - After adjustment is complete, tighten the locknut on one bolt and turn other bolt in until snug, then back out 1/8 of a turn and tighten its locknut

**Figure 71: Vertical Position of Disconnect Blade in Full Open Position**

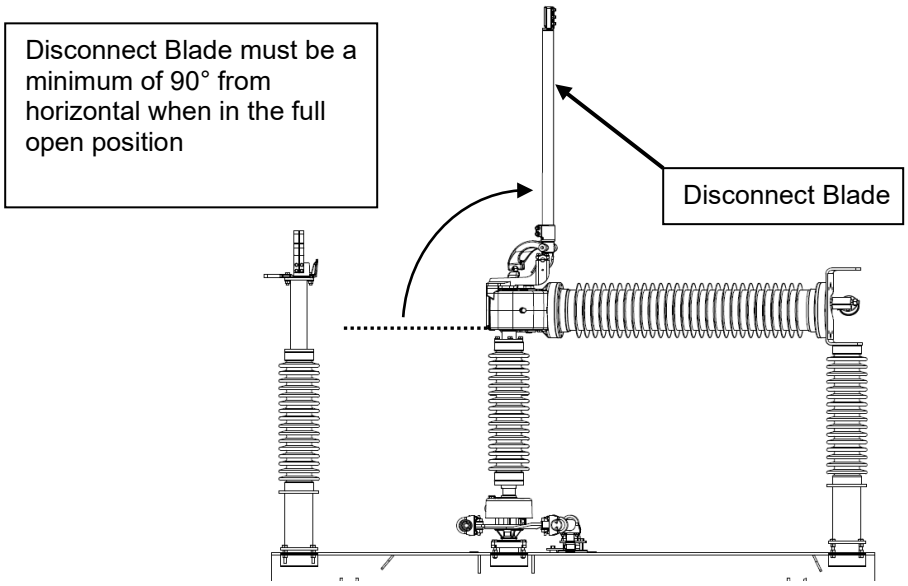


**Figure 72: Disconnect Hinge Assembly**

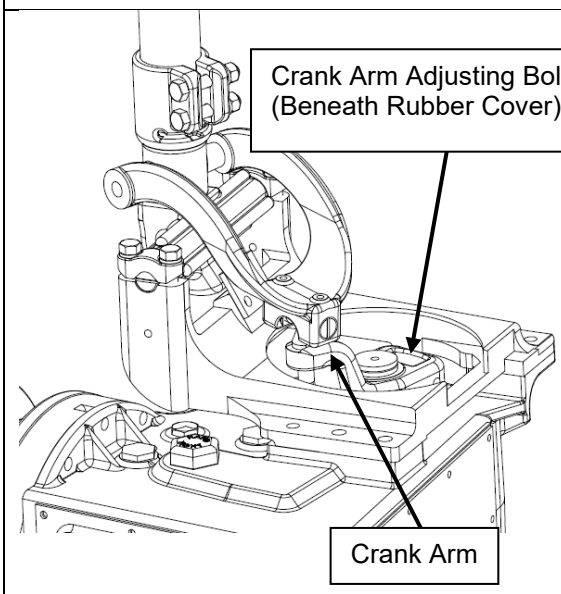
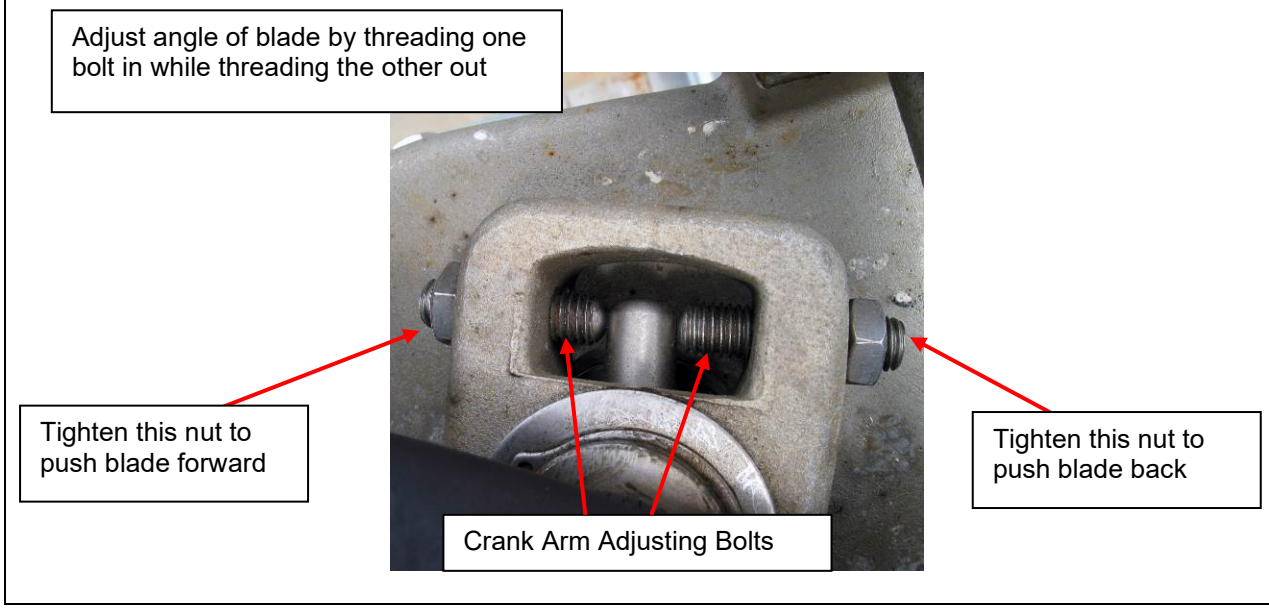
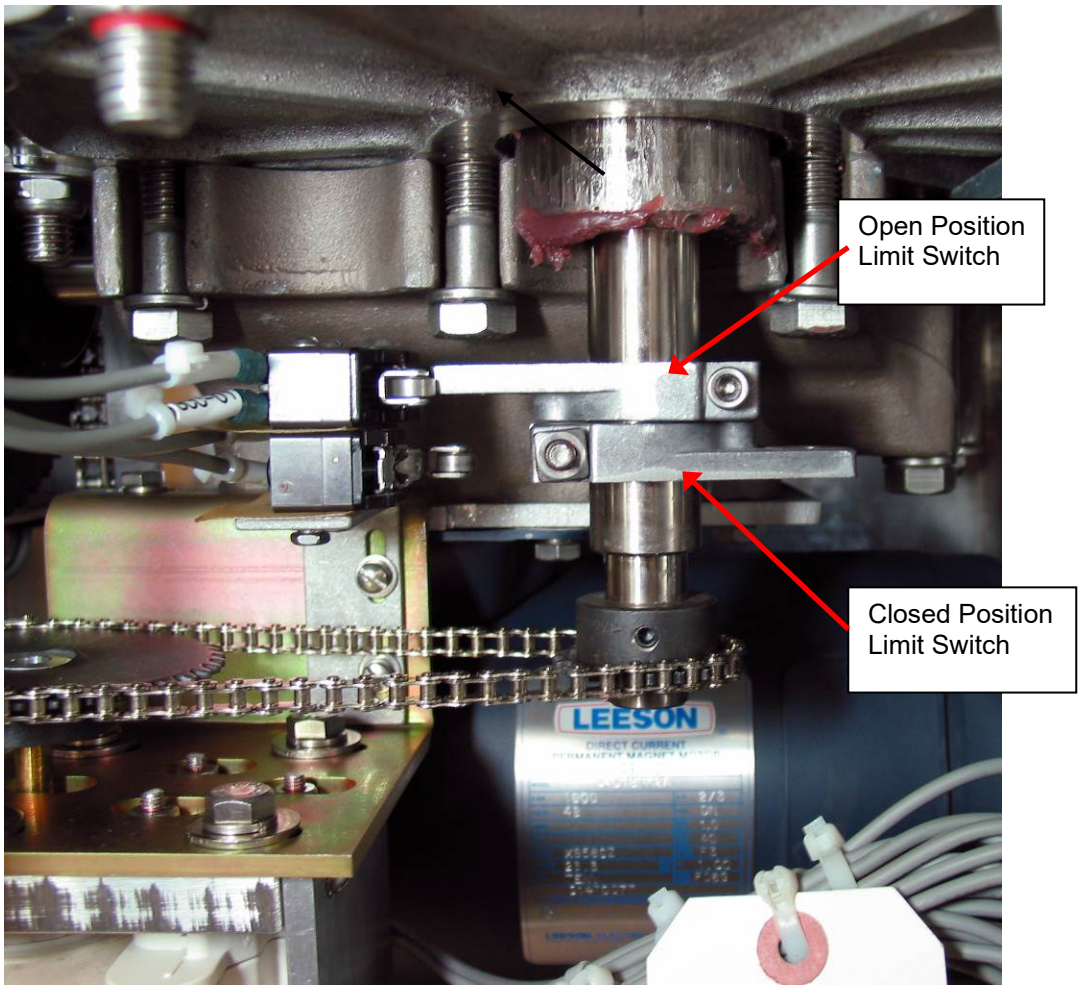



**Figure 73: Crank Arm Adjusting Bolts**



24. Adjust the open limit switch on the Motor Operator
    24.1. If not done, manually crank the Motor Operator to the full open position
    24.2. Loosen the limit switch Cam using a 3/16" hex wrench
    24.3. Rotate the Limit Switch Cam until it clicks.
    24.4. Re-tighten the Limit Switch Cam
25. Adjust the close limit switch on the Motor Operator
    25.1. If not done, manually crank the Motor Operator to the full closed position
    25.2. Loosen the limit switch Cam using a 3/16" hex wrench
    25.3. Rotate the Limit Switch Cam until it clicks.
    25.4. Re-tighten the Limit Switch Cam
    25.5. Adjust the Lever Stop Bolt such that it is against the Switch Arm.

**Figure 74: Limit Switches (as seen from side door of Motor Operator)**




26. Re-connect the Dynamic Breaking Resistor

# Post-Setup Checklist

| STRUCTURE | Complete | Initials |
|---|---|---|
| Anchor Bolts have been torqued | | |
| Platform mounting hardware has been torqued | | |
| All Interphase Brace mounting hardware has been torqued | | |
| All Pole Assemblies have been position to have the correct phase-to-phase distance | | |
| All Pole Assembly mounting hardware has been torqued | | |
| **LINKAGE** | | |
| U-bolts on both ends of the Vertical Control Pipe have been tightened | | |
| Vertical Control Pipe has been pierced with piercing bolts on both ends | | |
| U-bolts on both ends of the Group Control Pipe are tight | | |
| Group Control Pipe has been pierced with piercing bolts on both ends | | |
| Clamping Bolts and Pinch Bolts retaining the Outboard Bearing Lever are tight | | |
| Adjustable Clevis Locking Nuts are tightened on the Interphase Pipe Assembly | | |
| Over-toggle angle of the Outboard Bearing Lever is 4 to 6 degrees | | |
| Lever Stop Assembly Bolt is touching the Switch Arm (or has very little gap) | | |
| Outboard Bearing Roller reaches the head of the Open Stop Bolt when the Motor Operator is in the full open position | | |
| Outboard Bearing Roller reaches the head of the Close Stop Bolt when the Motor Operator is in the full closed position | | |
| **MOTOR OPERATOR** | | |
| Motor Operator mounting hardware has been torqued | | |
| De-coupler can be engaged and dis-engaged with Lock Brackets easily when the Motor Operator is in the full open and closed positions | | |
| Dynamic Breaking Resistor has been re-connected | | |
| The Open Limit Switch is set to open when the Motor Operator reaches the full open position | | |
| The Close Limit Switch is set to open when the Motor Operator reaches the full closed position | | |
| **SHUNT TRIP** | | |
| A 1/16” to 1/8” gap exists between the Shunt Trip Roller and the Shunt Trip Latch when the Motor Operator is in the full closed position | | |
| **INTERRUPTERS** | | |
| Indicator travels ½ to ¾ into the Green Band when Motor Operator reaches the full open position | | |
| Indicator travels ½ to ¾ into the Red Band when Motor Operator reaches the full Closed position | | |
| All three interrupters close by the time the Motor Operator reaches the full closed position | | |
| All three interrupters close within one half turn (180 degrees) of the Manual Crank Handle of each other | | |

| DISCONNECT | Complete | Initials |
|---|---|---|
| Blade Clamp Bolts are tight | | |
| Disconnect Blades are parallel to the Terminal Pads to within 5 degrees | | |
| Disconnect Blades are centered between the Jaws | | |
| Stationary Contact Shoes are centered on the Disconnect Blades lengthwise | | |
| Disconnect Blades are resting on the Blade Stop | | |
| Disconnect Blade has sufficient down-ward force to come back to rest on the Blade Stop after being lifted 1” to 2” | | |
| Disconnect Blades are at least 90 degrees from the Stationary Contact Jaw when in the full open position | | |
| Disconnect Blades close before the interrupters close | | |

# $SF_6$ Fill Instructions

Typically, a fill kit is provided with the CSH-B. There is no need to pull vacuum unless the unit is no longer filled with pure $SF_6$ gas. Refer to **Removal of SF6 Gas** for more details on removing gas from the CSH-B.

> ⚠ CAUTION **Gas should escape only from the loose female quick disconnect.**

Check to be sure that the gas gauge shows a positive pressure 5 to 10 psig. It is not necessary to pull vacuum unless the unit has lost pressure and is no longer filled with pure $SF_6$.

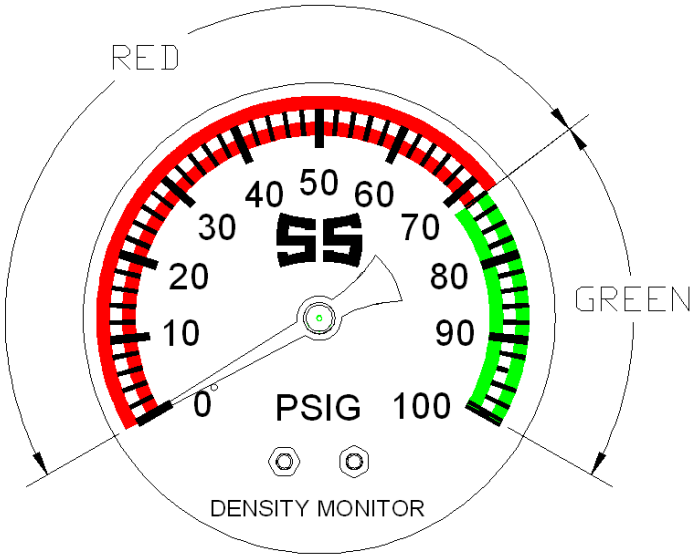
1. Remove the cap from $SF_6$ fill bottle and loosely attach the $SF_6$ adapter.
2. Remove the cap from the male quick disconnect on the interrupter fill valve and attach the female quick disconnect. Gas should now be escaping from the loose $SF_6$ fill bottle connection.
   Note: The $SF_6$ gas should only escape from the loose $SF_6$ fill bottle connection.
3. Let the $SF_6$ bleed for 5-10 seconds.
4. Tighten the $SF_6$ fill bottle connection.
5. Open the $SF_6$ fill bottle valve slowly and charge the interrupter to the rated pressure.
6. After the rated pressure (specific pressure can be found in the customer drawings) is obtained shut the $SF_6$ fill bottle valve and remove the female quick disconnect.
7. Replace the cap on the male quick disconnect.

Repeat above steps for each interrupter.

**NOTE: The CSH-B is shipped with 5 to 10 psig dry $SF_6$ Gas. If the CSH-B arrives with the proper pressure of $SF_6$ gas, do not remove gas or vacuum evacuate--simply add dry $SF_6$.**

# Gas Fill Pressures

**Table 1: $SF_6$ Gas Fill Pressures**




| TYPE | MAX DESIGN VOLTAGE | PRIMARY BUS FAULT INT RATING | TEMPERATURE RANGE | NOMINAL FILL PRESSURE @ 20°C |
|---|---|---|---|---|
| CSH & CSH-B | 170 kV & Below | All Ratings | -40°C TO +50°C | 81 psig |
| | 242 kV | All Ratings | -30°C TO +40°C | 86 psig |
| CSH2 & CSH2-B | 145 kV & Below | 31.5 kA | -40°C TO +50°C | 76 psig |
| | | 40 kA | -30°C TO +50°C | 91 psig |

# Measuring Contact Resistance

Interrupter Contact Resistance is measured from A to B.
Blade Contact Resistance is measured from B to C.
Overall Contact Resistance is measured from A to C.

The maintenance and inspection tests call for the interrupter contact resistance. Use 100 A DC to test the contact resistance.

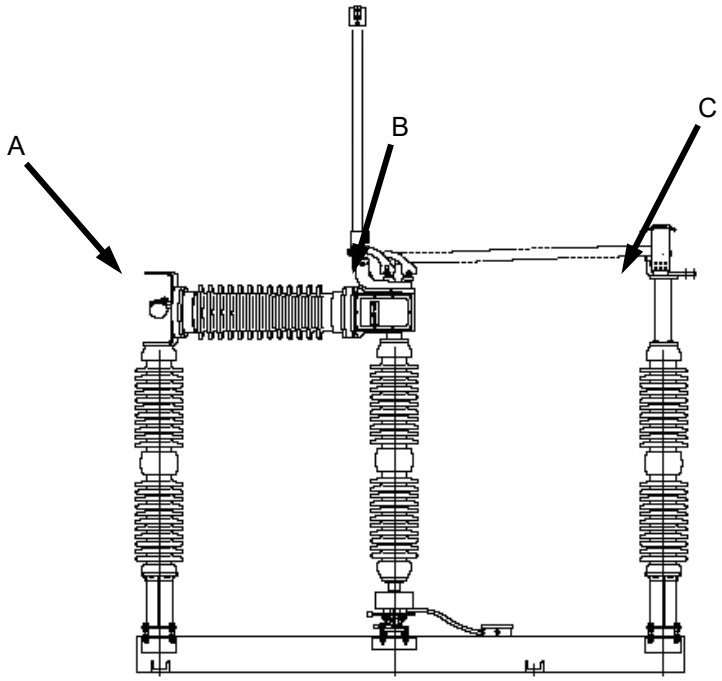



**Figure 75: Measuring Contact Resistance**

# Recommended Inspection and Maintenance

## Post-Installation Checklist

**Substation Information:**

| | | |
|---|---|---|
| Substation Name: | Date of Installation: | |
| Switcher Type | Rating kV amp | |
| Mechanism Type | Serial – J.O. | |
| Location: | | |
| Address: | City: | State: |

**Ratings Information:**

| | |
|---|---|
| System Voltage | kV |
| Control Voltage | V |
| Heater Voltage | V |
| Operating pressure @20ºC **(for -40$^0$C Applications)** | psig to psig |
| Operating pressure @20ºC **(For -30$^0$C Applications)** | psig to psig |

**Visual Inspections:** Check for damage or shortages

| Material | Comments |
|---|---|
| Insulators | |
| Interrupters | |
| Motor Operator | |
| Support Columns | |
| Instruction Books | |
| Drawings | |
| Control Parts | |
| $SF_6$ Fill Kit | |
| Other | |

**Column Checks**

| Item | Done (√) |
|---|---|
| a. Circuit Switcher is installed level on foundation | |
| b. Foundation bolts secured | |
| c. Ground leads secured to ground pads | |

**Record:**

| | | | |
|---|---|---|---|
| Record Initial Operation Counter Number: | | | |
| Ambient Air Temperature: | | | °F / °C |
| $SF_6$ GAUGE: | A Phase | B Phase | C Phase |

**Cabinet Check:**

| Item | Done (√) |
|---|---|
| Inspect Field Wiring | |
| Cabinet Wiring Secure | |
| Check that all Mechanical Connections are Secure | |
| Ensure that there are no additional parts on the floor of the cabinet | |
| Inspect Motor Operator for loose parts | |
| Is the Heater energized and/or does the thermostat work? | |

**Timing Tests (Normal Operating Voltage)**

| | |
|---|---|
| Trip command until contacts part ( ≤ 6 cycles)<br>Simultaneity ≤ 12 msec | |
| Close command until contacts touch ( ≤ 15 sec )<br>Simultaneity ≤ 16 msec | |

**Interrupter Contact Resistance Check**

| Interrupter Contact Resistance @<br>100 A DC:<br>38-121 kV ≤ 90 μΩ<br>145-169 kV ≤ 105 μΩ<br>242 kV ≤ 120 μΩ | A PHASE | B PHASE | C PHASE |
|---|---|---|---|
| | | | |

**$SF_6$ Leak Checks**

| | Leak YES/NO | Comments |
|---|---|---|
| $SF_6$ Gauge | | |
| Quick Disconnect | | |
| Interrupter Housing | | |
| Rupture Disk | | |

**$SF_6$ Moisture Levels (Optional) (less than 500 ppm): Level _____ ppm**

| | |
|---|---|
| Record Final Operations Counter: | Date: |

ADDITIONAL COMMENTS:

INSPECTION BY: _____ DATE OF INSPECTION: _____ WITNESS SIGNATURE: _____

# Maintenance Schedule

The CSH-B has been designed to operate with low maintenance. Periodic inspection is important for satisfactory operation. Frequency of inspection and maintenance depends on the installation site, weather and atmospheric conditions, experience of operating personnel, and special operational requirements.

**Table 2: Recommended Installation and Maintenance Table**

| | | Installation Tests | Patrolling Inspection 6 month | Routine 3 Year or 1,000 Operations | Periodic 6 Year or 2,000 Operations |
|---|---|---|---|---|---|
| **Record** | Mechanism Counter | X | X | X | X |
| | Gas Pressure | X | X | X | X |
| | Ambient Temperature | X | X | X | X |
| **Insulators** | Contamination | X | X | X | X |
| | Damage | X | X | X | X |
| | Inspect RTV sealant on sandband – reseal as needed | | | X | X |
| **Cabinet** | Any loose parts on the floor of the cabinet? | X | X | X | X |
| | Wiring Secure | X | X | X | X |
| | Mechanical Connections Secure | X | X | X | X |
| | Inspect Motor Operator for loose parts | X | X | X | X |
| | Heater Energized | X | X | X | X |
| | Inspect RTV sealed joints – reseal as needed | | | | |
| **Mechanical** | Operational Tests | X | | X | X |
| **Electrical** | Measure Interrupter Contact Resistance | X | | X | X |
| **$SF_6$** | $SF_6$ Leak Checks | X | | X | X |
| | Moisture Level | **Optional** | | X | X |
| | Check Gauge | X | | X | X |
| **Mechanical** | Timing Tests | | | | X |

# Periodic Inspection Checklist

| | |
|---|---|
| Periodic Inspection ChecklistStation | Date of Inspection: |
| Circuit Switcher Type | Rating kV amp |
| Mechanism Type | Serial – J.O. |
| Instruction Books | Control Diagram |
| Control Voltage V | Heater Voltage V |

## Monthly Inspection

| Item | Done (√) |
|---|---|
| Check general condition of circuit switcher | |
| Ensure that there are no additional parts on the floor of the motor operator cabinet | |
| Inspect motor operator for loose parts | |
| Is the Heater energized and/or does the thermostat work? | |

| | | | | |
|---|---|---|---|---|
| $SF_6$ Gauge Pressure | A Phase | B Phase | C Phase | Ambient Temperature |
| Record Value on Operations Counter: | | Date: | | |

## Additional Check at 6 month intervals

| Item | Done (√) |
|---|---|
| Check all labels and nameplates are securely fastened and readable. | |

## Additional Check at 1 year intervals

| | |
|---|---|
| Trip command until contacts part ( < 6 cycles)<br>Simultaneity ≤ 12 msec | |
| Close command until contacts touch ( < 15 sec )<br>Simultaneity ≤ 16 msec | |

## Additional Comments:

# 3-Year Inspection Checklist

| | |
|---|---|
| Station | Date of Inspection: |
| Circuit Switcher Type | Rating kV amp |
| Mechanism Type | Serial – J.O. |
| Instruction Books | Control Diagram |
| Control Voltage V | Heater Voltage V |

**⚠ WARNING** Prior to performing inspection of the circuit switcher, ensure that there is rated $SF_6$ in the pole units before testing the unit. Additionally, trip the circuit switcher and open adjacent circuit switcher disconnect switches, solidly ground all terminals to remove residual electrical charge, and open all A-C and D-C switches.

| Item | Done (√) |
|---|---|
| Inspect Field Wiring | |
| Cabinet Wiring Secure | |
| Check that all Mechanical Connections are Secure | |
| Ensure that there are no additional parts on the floor of the cabinet | |
| Inspect Motor Operator for loose parts | |
| Is the Heater energized and/or does the thermostat work? | |
| Check Hand Crank and Interlock Handle | |
| Foundation bolts secured | |
| Ground leads secured to ground pads | |

| | | | |
|---|---|---|---|
| Interrupter Contact Resistance @ 100A DC: 38-242kV ≤ 150μΩ | A PHASE | B PHASE | C PHASE |
| | | | |
| Final Operation Counter Number: | | | |
| $SF_6$ GAUGE Pressure | A Phase | B Phase | C Phase |

# 6-Year Inspection Checklist

| | |
|---|---|
| Station | Date of Inspection: |
| Circuit Switcher Type | Rating kV amp |
| Mechanism Type | Serial – J.O. |
| Instruction Books | Control Diagram |
| Control Voltage V | Heater Voltage V |

**⚠ WARNING** Prior to performing inspection of the circuit switcher, ensure that there is rated $SF_6$ in the pole units before testing the unit. Additionally, trip the circuit switcher and open adjacent circuit switcher disconnect switches, solidly ground all terminals to remove residual electrical charge, and open all A-C and D-C switches.

| Item | | Done (√) | |
|---|---|---|---|
| Inspect Field Wiring | | | |
| Cabinet Wiring Secure | | | |
| Check that all Mechanical Connections are Secure | | | |
| Ensure that there are no additional parts on the floor of the cabinet | | | |
| Inspect motor operator for loose parts | | | |
| Is the Heater energized and/or does the thermostat work? | | | |
| Check Hand Crank and Interlock Handle | | | |
| Foundation bolts secured | | | |
| Ground leads secured to ground pads | | | |
| Mechanical Operation Check for interference | A Phase | B Phase | C Phase |
| | | | |

| | | | |
|---|---|---|---|
| Trip command - Opening Time (Rated Voltage)<br>< OR = 100 ms @ 48 VDC<br><br>< OR = 80 ms @ 125 VDC<br>Simultaneity ≤ 12 msec | | | |
| Close command until contact touch ( ≤ 15 sec )<br>Simultaneity ≤ 16 msec | | | |
| Interrupter Contact Resistance @ 100 A DC:<br>38-242 kV ≤ 150 µΩ | A Phase | B Phase | C Phase |
| | | | |
| Final Operation Counter Number: | | | |
| $SF_6$ GAUGE Pressure | A Phase | B Phase | C Phase |

# Appendix

## Appendix A. Description of $SF_6$ Gas

$SF_6$, sulfur hexafluoride, is a colorless, odorless and chemically very stable gas. This gas has a high molecular weight of 146 and is five times heavier than air making it one of the heaviest known gasses. $SF_6$ has excellent properties for use in high voltage products. The dielectric strength and arc quenching properties are unique and far superior to all other known gasses. The $SF_6$ provides the dielectric insulation across the interrupter gap and it provides the means to interrupt current.

The performance of $SF_6$ gas is based on the density of the gas not the pressure. As the temperature drops so does the pressure.

### Environmental and Handling Warnings

$SF_6$ has been determined to be a greenhouse gas but not an ozone depleting gas. All users should minimize emissions to the atmosphere. For proper gas handling procedures, see Appendix B. Handling $SF_6$ Gas on page **75**.

### Arc Decomposition By-Products

During current interruption the $SF_6$ gas in the arc is exposed to very high temperatures. Under these conditions $SF_6$ breaks down into its various by products and combines with metals in the interrupter to create various gaseous and solid by-products. These by-products consist of $CuF_2$, $AlF_3$, $WF_6$, $CF_4$, HF, $SO_2$ and $SOF_2$ and others.

The solid by-products deposit on the inside of the interrupter as a white powder. This white powder will not cause any problems with the internals of the interrupter as long as the unit is sealed, pressurized, and contains adsorbent.

### Corrosive Effects of $SF_6$ By-Products

$SF_6$ in its pure dry form is chemically very stable and causes no corrosion. When the by-products come into contact with moisture, corrosive compounds can form. The ***CSH-B*** has adsorbent in the gas volume to keep the gas dry; therefore, these corrosive effects are not an issue for units as delivered to the field.

**NOTE:** Opening the interrupters exposes the by-products to moisture. It is necessary to remove the by-products. The by-products can be neutralized with an alkaline solution of lime ($Ca(OH)_2$), Sodium Carbonate ($Na_2CO_3$) or Sodium Bicarbonate ($Na\ HCO_3$).

If a unit requires service then follow on page 75**.**

> ⚠ DANGER $SF_6$ is heavier than air. Do not get caught in a low area with $SF_6$ gas present. The $SF_6$ gas can displace the oxygen. Death by suffocation is possible.

# Appendix B. Handling $SF_6$ Gas

NOTE: The CSH-B is shipped with 5 to 10 psig of dry $SF_6$ Gas. If the CSH-B arrives with the proper pressure of $SF_6$ gas, do not remove gas or vacuum evacuate.

## Removal of $SF_6$ Gas

If it is necessary in the life of the product to remove the gas please use a gas removal system specially designed for $SF_6$ collection. Companies like Dilo, Enervac, Cryoquip and others make these gas carts. These carts will remove the gas, filter it through various media and compress it for storage in various containers.

## Replacing the $SF_6$ Gas; Evacuate and Fill

This only applies if the gas system has been opened to the atmosphere. For the $SF_6$ to have maximum electrical properties it needs to be pure. To accomplish this, the gas system must be evacuated before filling with $SF_6$.

- Pull vacuum down to below 1 torr and hold for 15 min. Be careful not to turn off the pump before closing the valve between the vessel and the vacuum pump. If the valve is not closed first the vacuum in the gas system can pull the oil out of the vacuum pump into the CSH-B.

- Before filling please be sure that the fill hose is filled with $SF_6$ gas. This is accomplished by bleeding a little gas through the hose before opening the valve to the gas system.

## Filling Unit With Gas

- Fill pressure @ +20°C (+68°F): see Table 1: $SF_6$ Gas Fill Pressures
- **Do not fill $SF_6$ gas when temperature is lower than -20°C**. Contact Southern States customer service.
- Quantity of gas required is 6 lbs per interrupter is 18 lbs per three-phase unit.
- Use only high quality $SF_6$ per Specification:

| LIMITS OF IMPURITIES | NEW $SF_6$ (Bottle) | NEW $SF_6$ (Shipping Pressure ~ 10 psig) | NEW $SF_6$ (Nominal Fill Pressure) | USED $SF_6$ (In Service) |
|---|---|---|---|---|
| Assay WT. % | 99.7% Min | 99.7% Min | 99.7% Min | 97.0% Min |
| Dew Point | -32°C (-25 °F) {50 $PPM_v$) | -20°C (-4 °F) {600 $PPM_v$) | -18°C (0 °F) {200 $PPM_v$) | -8°C (18 °F) {500 $PPM_v$) |
| Air as Nitrogen, WT. % | 0.1 Maximum* | 0.1 Maximum* | 0.1 Maximum* | 0.1 Maximum* |

* Nitrogen WT % does not apply to $SF_6/N_2$ mixed gas

**NOTE:** Ensure testing equipment is rated for the conditions in which it is being used. Measuring $SF_6$ moisture content outside the test equipment's recommended conditions will yield inaccurate results.

## Leak Detection Methods

If a leak is suspected there are various ways of discovering it:

1. Pressure gauge dropping over time – This is the easiest method of detecting a leak. The only drawback is that it takes time and does not locate the leak.
2. Bubble Test using a liquid soap – This is a very good method for locating the position of a leak.
3. Halogen detectors – Common halogen detectors as used for Freon will detect $SF_6$ leaks.
4. $SF_6$ detectors – These specialized devices can detect leaks down to below one part per million.

# Appendix C. Doble Power Factor Testing

Power Factor Testing on Southern States $SF_6$ products

Southern States manufactures and test our products following the guidelines of ANSI and IEEE standards. This includes 60 Hz dielectric power frequency testing per ANSI C37.016. We perform an additional standard test for gas moisture. Both of these test values are recorded on the test report that is supplied with the product. These methods have been used for years at Southern States with great success to qualify production units for installation in the field.

Doble power factor testing was developed in a time where most internal insulation systems were oil and paper. Moisture contamination was a real problem as it caused heating. A good measure of this moisture was the power factor. Also paper deterioration could be detected. In these systems, there is a high capacitance and the resistance ratio gave numbers that were quite consistent and reproducible with moisture as a contamination agent.

With solid and $SF_6$ insulation the capacitance is very low. In the case of $SF_6$ equipment the Doble Insulation Analyzer generates readings at the very bottom of its scale. The readings are very small, and not very stable and are very hard to repeat and interpret. We do not feel that these Doble tests offer a real value to Southern States or our customers for our $SF_6$ products.

Doble has collected data for “normal” live tank breakers of various designs. They use this data to compare specific test results and they determine acceptable limits on the basis on what they call “normal.” There is no data available to show at what levels problems actually arise in solid dielectric and $SF_6$ equipment and certainly none on Southern States equipment. Simple deviation from normal or nominal is not indicative of insulation health. Most of the watts loss will be from surface contamination of the housing or support insulator or simple variation in the hook up of the leads and other measurement variables. Many users are considering eliminating Doble testing of $SF_6$ equipment, unless there are grading capacitors inside. In the case of grading capacitors, the Doble test may be of some value in checking the “health” of the grading capacitors.

Southern States does not recommend the use of power factor testing on our $SF_6$ equipment.

# Appendix D. Troubleshooting Guide

| Apparent Problem | Possible Solutions |
|---|---|
| An Outside Pole Does Not Close | Insufficient shunt trip gap in the open position. Adjust for gap with the shunt trip charging bolt. Screwing in on the charging bolt to obtain more gap reduces rotation into the green band. Correction by charging bolt adjustment may require more open direction rotation. REFERENCE PAGE 40.<br><br>Insufficient rotation into the green band. REFERENCE PAGE 39.<br><br>Insufficient rotation into the red band. REFERENCE PAGE 44. |
| Center Pole Does Not Close. (assuming switch is center phase driven) | Check for above condition. Increase amount of rotation on either the group control pipe or the outboard bearing radius. Either method will change the adjustments on outside poles. REFERENCE PAGE 45. |
| Motor Does Not Run to Close Circuit Switcher | Latch check switch sensing a discharged shunt trip unit. Hand crank close about five turns while observing the red band indicators on the shunt trip housing. If the bands do not stay in line, insufficient shunt trip gap exists in the full open position. Adjust charging bolt to provide required gap. REFERENCE PAGE 40.<br>Sticking trigger and/or main trip latch in shunt trip. Clean and lubricate to ensure resetting of latches. REFERENCE PAGE 10. |
| Delayed Opening of One Pole | Check trip circuit continuity and trip coil resistance on delayed pole. REFERENCE PAGE 21 FIG 20 |
| Circuit Switcher Opens 1 Second After Trip Initiation | Trip circuit electrical problem. Check continuity.<br>REFERENCE PAGE 21 FIG 20 |
| Low $SF_6$ Pressure | Check for leak at gauge end of interrupter. Can be field repaired. Otherwise, replacement unit recommended. |
| Inconsistent Pole Simultaneity | Check Lever Stop Bole or loose hardware on rotating insulator, interphase brace channels and all interphase pipe clamps.<br>REFERENCE PAGE 51 |

# Appendix E. Trip-Free Operation/Testing

The Southern States Type CSH(2) and CSH(2)-B horizontal circuit switchers are designed so that, if inadvertently closed into a fault, the switcher will immediately open and interrupt the fault. The opening springs and the shunt trips are charged at the end of the opening stroke. So, when a closing operation is commanded, the opening mechanism is already set to open the interrupters. Functionally, a trip command can only be generated after the circuit switcher closes and energizes the potentially faulted line.

**NOTICE** Shunt trip damage will occur if during TRIP-FREE testing, the interrupters are not closed prior to initiating the TRIP signal.

When there are requirements for the circuit switcher to be ***Trip-Free*** tested it is imperative that the trip signal not be initiated until the interrupters have closed. The interrupter contacts should be in series with the trip signal/command. This will ensure the circuit switcher rotating insulator/shunt trip has stopped rotating before trip command initiates opposite rotation. If trip command is given while circuit switcher is still rotating closed it can damage the rotating insulator or shunt trip. The photo below shows damage to a shunt trip due to trip command given while circuit switch was closing.

**Figure 76: Shunt Trip Damage Due to Improper Trip Command on Close**

## Shunt Trip Gap/Overdrive on Open

**NOTICE** Excessive shunt trip gap or overdriving on open can result in damage to shunt trip as shown below. Shunt trip gap should be 1/8” to 3/16”.

**Figure 77: Damage from Shunt Trip Gap/Overdrive on Open**

Southern States

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