



## **USCO Power Equipment Corporation**

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### **Installation, Operation, and Maintenance Manual**

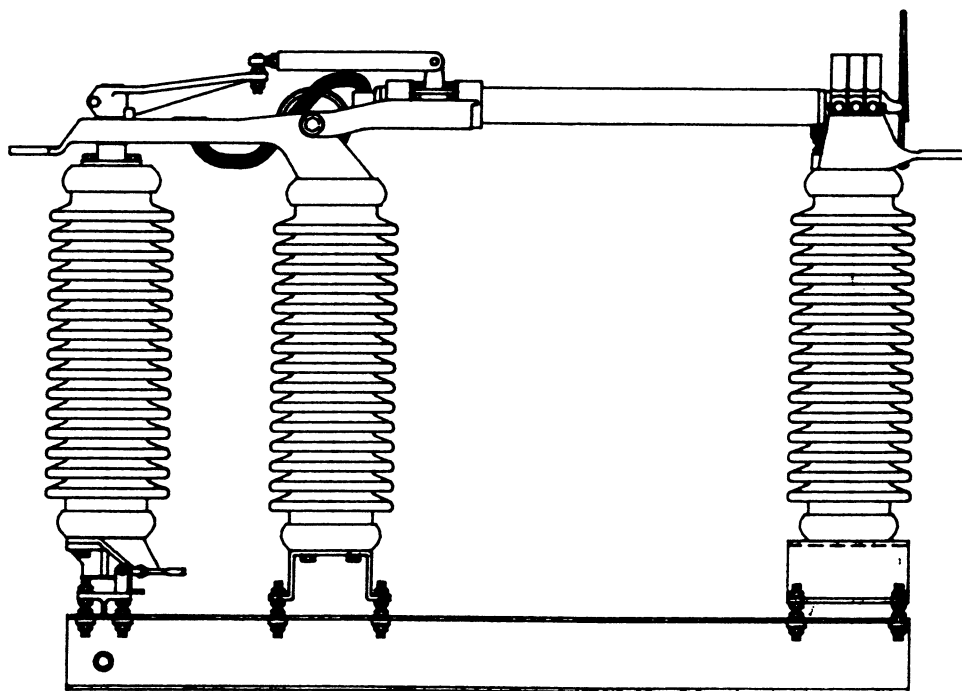
#### **Type AVR**

**Group Operated, Outdoor, Vertical Break**

**Air Switch**

**7.5 through 230 kV**

**1200, 2000, and 3000 Amperes**



**IMPORTANT - Make sure applicable and adjacent equipment is de-energized and properly grounded before performing any installation or maintenance.**

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## **Receiving Inspection**

Each group operated switch shipment normally consists of (1) the crated switch units (three phases), (2) the control parts box, (3) banded operating pipe, (4) special mounting steel if required, and (5) crates of insulators when supplied.

When the shipment is received, check the material against the packing list (in a waterproof package attached to the switch crate). If any of the crates are damaged, check the contents of the crate for broken or missing parts. There is a bill of material in the box containing the control parts to find out if parts are damaged or lost.

If the switch crate is damaged, remove the tie wires on each phase unit and operate the switch a few times, making sure the switch is not affected. If damage is found or suspected, file a claim immediately with the freight company and notify your local USCO representative.

## **Handling and Storage**

Take a reasonable amount of care when handling and storing air break switches. Porcelain insulators are fragile and might be broken with improper handling. The switch live parts could be broken or distorted if handled carelessly.

Air break switches may be stored outdoors or indoors. Protect moisture absorbing cartons, such as wood or cardboard, if you plan to store them outdoors for a long period. Keep all shipments in the crates until assembly and installation.

If the insulators have been installed at the factory, skip to Page 5, "Mounting the Switch and Controls".

## Installation of Insulators

1. Uncrate the switch phases and cut the tie wires that hold the switch closed. Operate and inspect each phase for proper operation or any shipping damage.
2. Remove the live parts from the switch base. CAUTION - Keep the live parts toggled in the closed position to prevent injury by rapid movement of the blade from the counterbalance spring(s). Mount the insulators on the switch bearings and base adapters. Hand tighten the insulator bolts.
3. Check that the insulators are level by measuring the centers at the top and bottom. These centers should be the same. A carpenter's level may be used if available. If alignment is needed, use the leveling studs if furnished. Use of leveling studs is explained on Page 10. If leveling studs are not furnished, the insulators should be shimmed.
4. Place the live parts on top of the insulators. Line up the painted match mark on the lower operating arm with the mark on the upper drive arm to insure proper alignment. Hand tighten the upper insulator bolts.
5. Center the live parts on the switch base using the slots in the base adapters and the live parts. Make sure that the lower operating arm is against the closed stop, and the upper drive arm is against the closed stop. Tighten all insulator bolts, starting with the lower bolts and working up. Check to make certain that the operating and upper drive arms stay against the closed stops. Even 1/16" clearance can affect the timing of the switch, and affect the position of the blade in the open position.
6. Operate the switch phase from the fully closed to the fully open position, then bring the blade back down to make sure the blade end enters the contact in the center of the jaw. If adjustment is needed right or left, loosen the bolts under the center insulator and slide the insulator to center the blade in the contact. Tighten the insulator bolts. If further adjustment is needed, loosen the bolts under the jaw insulator and slide the insulator as necessary. The leveling studs on the center insulator can then be used for fine tuning the blade entry. Check that the contact bar on the blade end enters the jaw contact with the same length of bar in front and back of the contact fingers. If necessary, slide the jaw contact in the mounting slots, adjust the leveling studs, or shim the insulators to move the jaw contact in or out as needed.

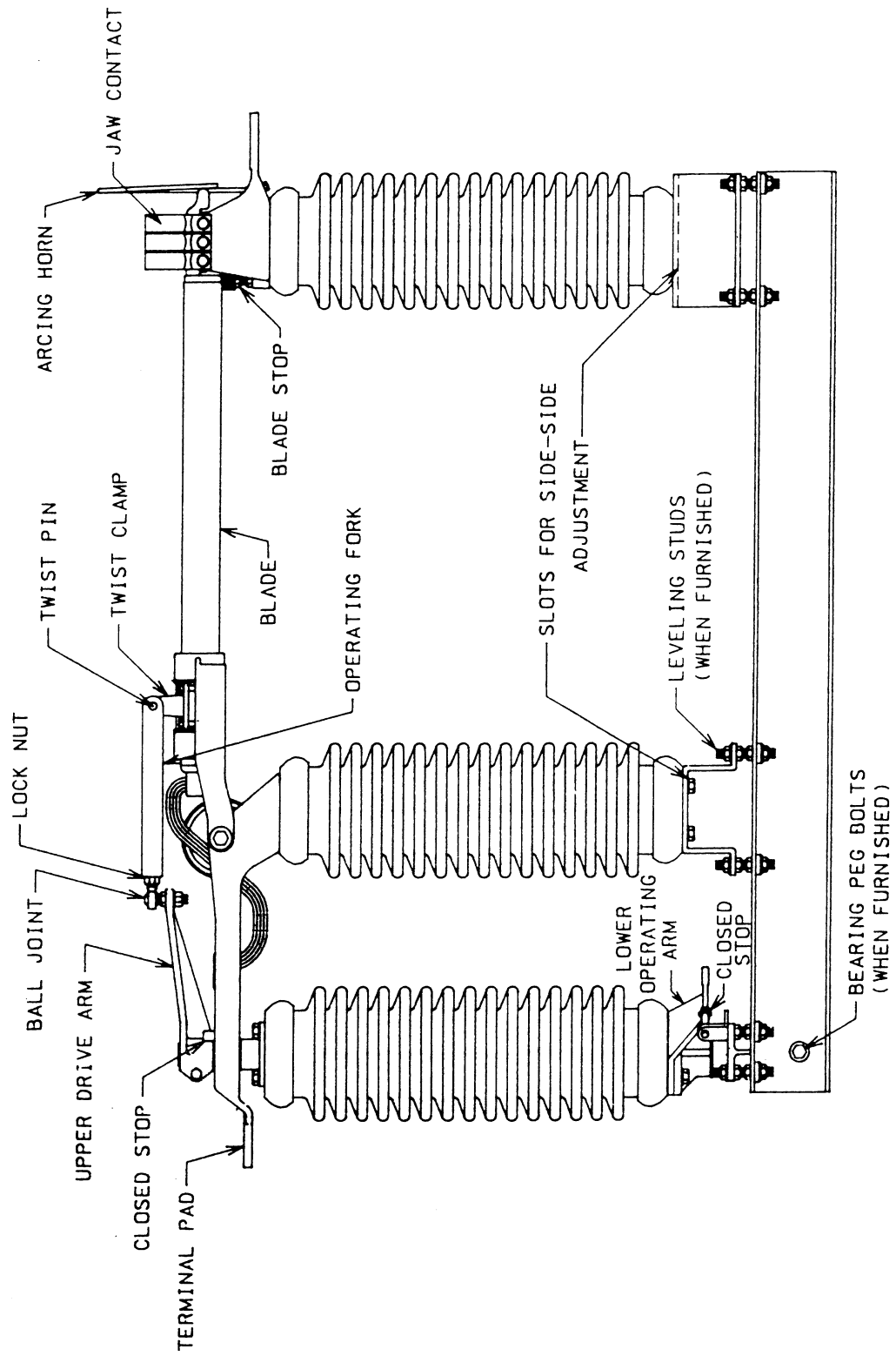


Figure 1 - Typical Phase Unit

## Mounting the Switch and Controls

**IMPORTANT - Make sure applicable and adjacent equipment is de-energized and properly grounded before performing any installation or maintenance.**

1. Using the control details furnished to determine the correct placement of the individual phases, mount the switch on the structure. Slings or rigging used for lifting should be attached to the switch base. Avoid lifting from the insulators or live parts because damage could occur.
2. Install the outboard bearing support and bearing. On the single row ball bearing, slide the vertical pipe up through the bearing to the proper height, and tighten the set screws to hang the pipe. Do not pierce the vertical pipe. On the double row ball bearing, remove the through bolts on the end of the vertical pipe, slide the pipe up on the bearing shaft, and replace the through bolts.
3. Check the control drawing for the location of pipe guides, interlocks and other accessories on the vertical pipe. Slide these items up on the pipe (in the order shown on the drawings) and mount them.
4. Attach the operating handle or gearbox. Leave 1/2" clearance between the operating handle clamp and the support plate. For the gearbox, make sure the vertical pipe and gearbox coupler do not rest on the gearbox hub. The outboard bearing should support the full weight of the vertical pipe. Tighten the clamp bolts on the operating handle or the gearbox coupler. Tighten the set screws, but do not pierce the pipe. If necessary, the directional indicator on the gearbox handle may be reversed by removing the two mounting screws, and flipping the indicator over.
5. If a single row ball bearing is used, slide the adjustable arm over the top of the vertical pipe. Do not tighten the set screws at this time. Double row ball bearings already have the adjustable arm attached.
6. Fasten clevises on the phase operating arms, and install the interphase pipe. Tighten the clevises on the interphase pipe, starting with the phase farthest from the vertical operating pipe. While tightening, keep pressure against the closed stops.
7. Connect the reach rod as shown on the control drawing. If necessary, slide the adjustable arm up to the proper elevation and rotate it to the correct position (as shown on the control drawing), and pierce the set screws to hold the adjustable arm.

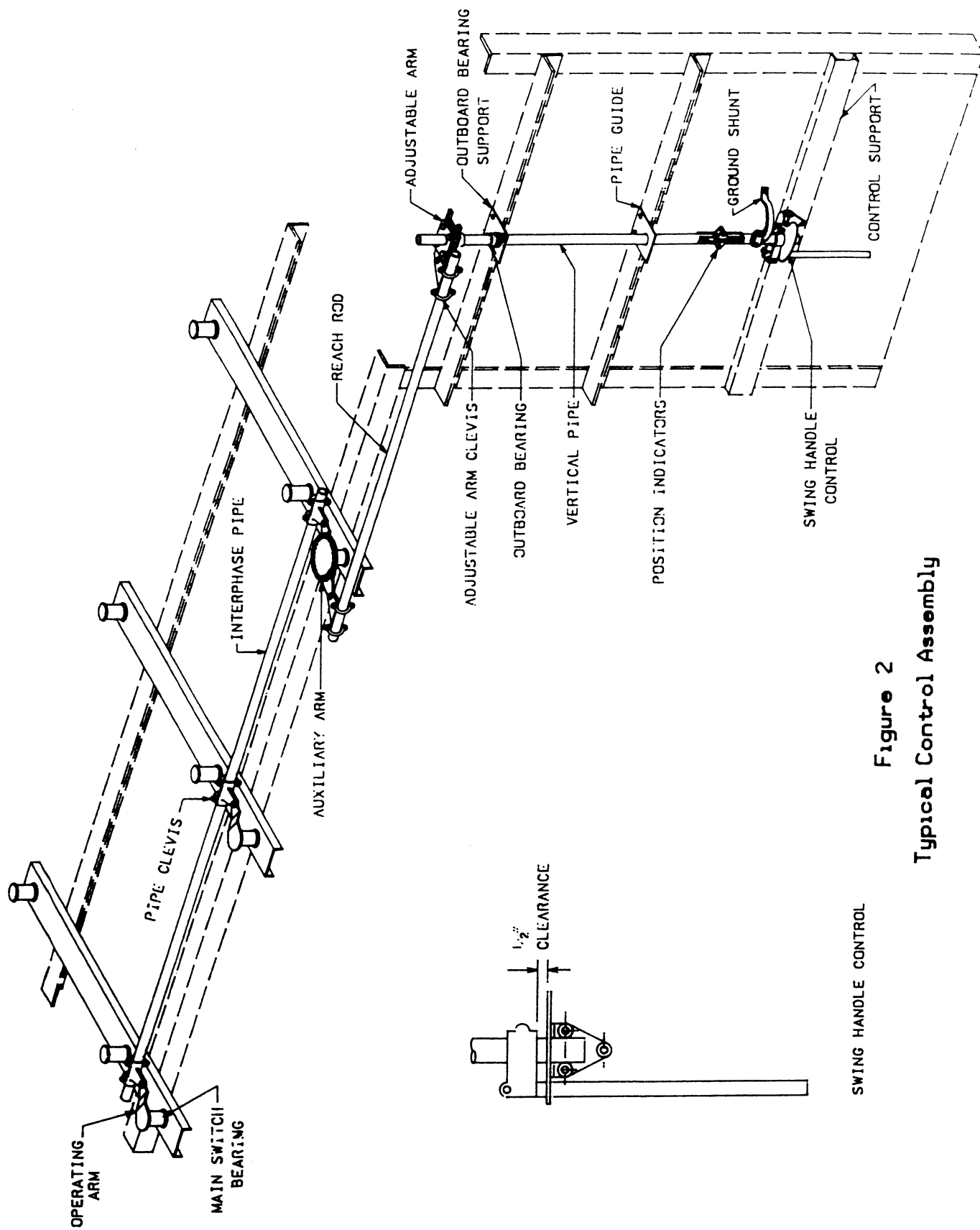


Figure 2  
Typical Control Assembly

SWING HANDLE CONTROL

## Switch and Control Adjustment

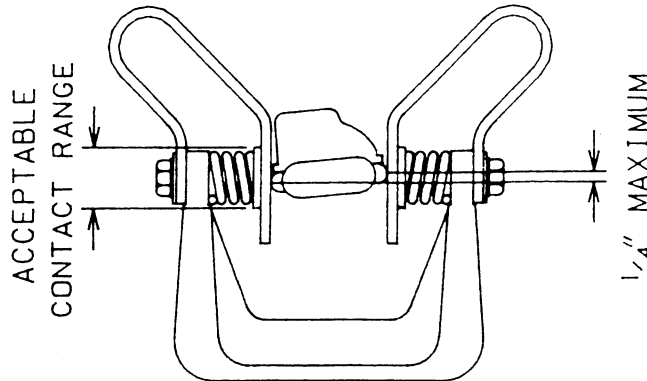
1. The adjustable arm normally will be set at a trial radius to travel 180 degrees, and toggle in the open and closed positions. Check the arm trial radius given on the control drawing.
2. Operate the switch. If the adjustable arm does not travel 180 degrees, but the switch is fully open, the trial radius length is too long. If the adjustable arm travels 180 degrees, but the switch is not fully open, the trial radius length is too short. Close the switch, loosen the clevis on the adjustable arm, loosen the four clamp bolts and adjust the length of the arm  $1/4$ " as needed. Reset and tighten the clevis. Check the operation - a few tries are usually necessary to fine tune the switch.
3. Check the position of the blade with the switch open. On upright mounted switches, the blades should travel slightly past top dead center. Make adjustments by loosening the cap bolts in the rotating insulator, push the blade to the desired position, and tighten the bolts. Vertically mounted switches will be set to open approximately 70 degrees.
- ④. While closing the switch, check the blade alignment at the jaw contact. The blade contact bar should strike the jaw contact in the center. Use the leveling studs at the base of the jaw insulator to make adjustments.
5. Due to control linkage clearances, there may be differences in the angle of the blade contact on each phase. With a scale, measure the height of each side of the blade contact. If these two measurements are within  $1/4$ ", no further adjustment is needed.
6. If the blade roll over must be adjusted, first close the switch. With a pencil, mark the blade at the twist clamp. Loosen the four nuts on the twist clamp. Bump the twist clamp on the blade or rotate the blade in the clamp by the amount needed at the contact. A  $15/16$ " open end wrench on the jaw tip of the blade may be used to rotate the blade. Check the pencil mark at the twist clamp to make sure the blade moved in the clamp. Tighten the four nuts in the twist clamp and check operation. Readjust if necessary. When the blade rotation is acceptable, remember to securely tighten all four nuts in the twist clamp.

## Arcing Horn Inspection and Adjustment

Check the arcing horn, if furnished, insuring that continuous contact is made during the opening and closing of the switch. If not, slightly bend the arcing horn to make contact.



## Jaw Contact Tolerances



## Terminal Connections

For non-plated terminal pads, clean the terminal pads with a stiff wire brush until there is a clean metallic surface. For plated surfaces, do not wire brush, but clean lightly with steel wool. Immediately coat the connection surfaces with a non-gritted corrosion inhibiting joint compound such as no. 2 EJC. Wire brush the pad surface again through the compound, attach the conductor terminals to the switch terminal pads, and torque the connection bolts. Do not wipe off the excess compound which squeezes out. This will serve as a moisture seal for the connection.

### Minimum Recommended Torque Values for 1/2" Diameter Bolts

Bolt Material	Lubricated Threads Foot-Pounds	Dry Threads Foot-Pounds
Aluminum	25	35
Steel, Galvanized or Stainless	40	45

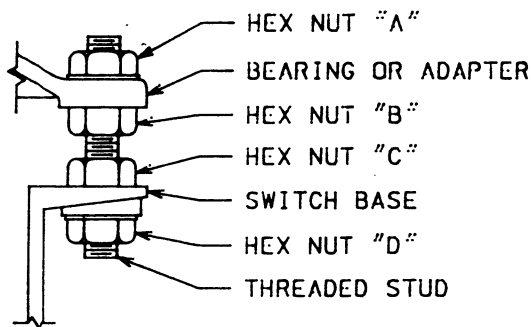
## Final Checklist

1. As a final check, operate the switch, checking that (1) the blades line up in the open position, (2) when closing, the blades strike the arcing horn or enter the jaw contact at approximately the same time, and (3) when closed, the blade contact is aligned in the jaw contact and fully rotated within tolerance.
2. After all adjustments are completed, tighten all set screws to pierce the pipe.
3. Do not apply grease to the jaw contacts. The contacts have been lubricated at the factory with dry graphite.

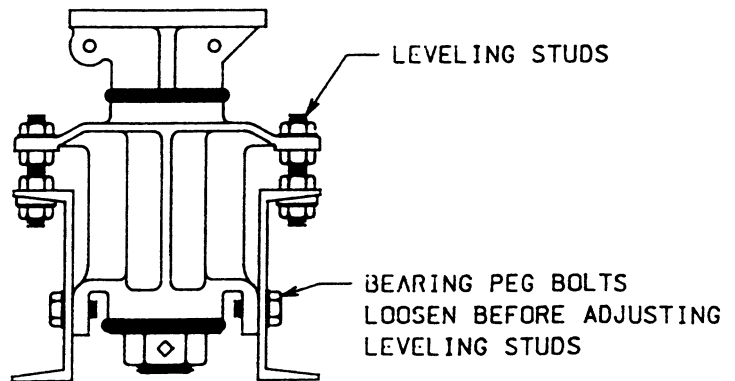
## Use of Leveling Studs

Switches 69 kV and above have leveling studs to adjust insulators and contacts during the installation. When equipped, there will be 4 leveling studs under each insulator, either on the switch base adapter or the switch base bearing.

1. To adjust the leveling studs, loosen the top nuts (nut A) on the pair opposite the direction of desired movement of the insulator. If the leveling studs are mounted on the switch bearing, check the side of the switch base for peg bolts. Loosen these bolts before attempting adjustment.
2. Turn nut B on each stud counterclockwise until the adjustment is made. Note that tall insulators will only require a slight movement at the leveling studs to move the insulator several inches. Tighten nut A (and the peg bolts if equipped.)



LEVELING STUD



## Installation Troubleshooting

These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connection with installation, operation, or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, contact the local USCO representative or the factory.

**Problem:** In the closed position, the operating arms are against the closed stops, but in the open position, the switch phases are not fully open and the operating arms are not against the open stops.

**Solution:** With the switch closed, loosen the U-bolts on the adjustable arm clevis (or remove the pin on a threaded clevis), loosen the clamp bolts on the adjustable arm, and lengthen the adjustable arm by about 1/4". Tighten the clamp bolts and the clevis U-bolts (for threaded clevises, reset the length of the turnbuckle and pin the clevis), and operate the switch. If the operating arms still do not hit the stops, lengthen the adjustable arm some more. If the operating arms hit the stops too hard, shorten the adjustable arm slightly. It may take a few tries to fine tune the switch operation.

**Problem:** In the closed position, the operating arms are against the stops, but when opened, the operating arms push the open stops hard, and the adjustable arm will not toggle.

**Solution:** With the switch closed, loosen the U-bolts on the adjustable arm clevis (or remove the pin on a threaded clevis), loosen the clamp bolts on the adjustable arm, and shorten the adjustable arm by about 1/4". Tighten the clamp bolts and the clevis U-bolts (for threaded clevises, reset the length of the turnbuckle and pin the clevis), and operate the switch. If the operating arms still hit the stops hard, shorten the adjustable arm some more. If the operating arms do not hit the open stops, lengthen the adjustable arm slightly. It may take a few tries to fine tune the switch operation.

**Problem:** One or two of the phase operating arms are against the open or closed stops, but the other phase(s) are not.

**Solution:** With the switch closed, loosen the clevises on the interphase pipe, and push all operating arms against the closed stops. While keeping pressure against the stop, tighten the clevis. (For threaded clevises, release the locknut and turn the turnbuckle nut to push the operating arm against the stop.)

**Problem:** In the open position, the blades do not line up when viewed from the side.

**Solution:** First, check each phase to see that the operating arm is against the open stop. If necessary, close the switch and reset the clevises on the interphase pipe so the operating arms are against the closed stops. Then open the switch and check the alignment of the blades. If the operating arms are against the open stops, loosen the insulator cap bolts at the top of the rotating insulator, pull the blade back to the desired open position, and tighten the insulator bolts. Additional adjustment, if needed, is available by loosening the lower insulator cap bolts, moving the blade, and retightening the insulator bolts. Note that this may affect the blade end contact position adjustment. Check this in the closed position and adjust as necessary.

**Problem:** In the closed position, the contact at the blade end does not roll over within the 1/4" tolerance.

**Solution:** Because of linkage clearances, the switch phase(s) farthest away from the reach rod may not roll over properly into contact. With the switch closed, mark the blade at the clamp for reference, and loosen the four twist clamp bolts on the switch blade. Bump the twist clamp on the blade or place a 15/16" open end wrench over the blade tip, and roll the blade in the direction needed. Check the mark back at the clamp to make sure the blade moved in the clamp. It may be necessary to overrotate the blade during adjustment to move it in the clamp. Tighten the clamp bolts and check switch operation.

**Problem:** While closing the switch, the switch blades do not penetrate the contact down into the spring area.

**Solution:** Open the switch just to the point where the blades begin to rise out of the jaw contact. On the affected phase(s), loosen the locknut on the ball joint, remove the cotter pin on the twist pin, and remove the twist pin. Rotate the operating fork 1/2 turn to lengthen the linkage. Replace the twist pin and check operation. If necessary, lengthen the linkage some more. Make this adjustment in 1/2 turns, because lengthening the linkage too much could cause the switch to bind during operation. When adjustment is complete, remember to replace the cotter pin and tighten the locknut on the ball joint.

**Problem:** While closing the switch, the switch blade strikes the jaw contact stop hard, and binds when rolling into contact.

**Solution:** Open the switch just to the point where the blades begin to rise out of the jaw contact. On the affected phase(s), loosen the locknut on the ball joint, remove the cotter pin on the twist pin, and

remove the twist pin. Rotate the operating fork 1/2 turn to shorten the linkage. Replace the twist pin and check operation. If necessary, shorten the linkage some more. When adjustment is complete, remember to replace the cotter pin and tighten the locknut on the ball joint.

## **Considerations for the Installation of High Voltage Disconnecting Switches ANSI C37.35-1976**

### **5. Installation**

**5.1 Personal Safety During Installation** - Safety precautions should be carefully followed.

When erecting switches, particular care should be given to the following:

- (1) Make absolutely sure that the line on which men are working or erecting equipment is de-energized.
- (2) Protect the workers, if required, from adjacent live parts by barriers, screens, etc.
- (3) If energized equipment is in the accessible vicinity of the installation, a specific person, preferably at the ground level, should be responsible to observe the movements of the installers continuously to alert of movement in the direction of the energized equipment.
- (4) Follow ANSI C2-1990, as well as local and OSHA requirements.

**5.2 Instructions for Assembly** - For satisfactory service, manufacturer's instructions for assembly and equipment drawings should be carefully followed.

**5.3 Alignment** - Switches should be carefully aligned on the supporting structure. The surface on which the switch bases are mounted should be flat and true, otherwise the bases may become twisted when bolted to the structure. Such twisting could cause the switch to be difficult to operate, could cause operating parts to be out of alignment and could cause undue strain on the insulator stacks. See 5.9 for adjustment considerations.

**5.4 Rigidity** - All switch bases and associated stationary parts should be rigidly bolted in place.

**5.5 Line Conductors** - Conductors should not subject the switching equipment to undue strains which could cause contact misalignment.

**5.6 Bus Conductors** - Bus conductors are acted upon by forces due to dimensional changes with temperature and by electromagnetic forces. Bus conductors should be so supported and connected to the switches

that these forces will not impair the electrical or mechanical function of the switches.

**5.7 Equipment Connections** - Contact surfaces should be clean and smooth. Excess strains should be carried by auxiliary supports. When dissimilar metals are combined in a current-carrying joint, adequate protection against galvanic and chemical action must be provided.

**5.8 Ground Connections** - The bases of all switches should be grounded.

**5.9 Adjustments** - When the equipment is in place, adjustment should be made with normal weight or strain on the insulators and current-carrying parts.

**5.10 Cleaning Equipment** - After the switching equipment has been installed, connected, and adjusted, the insulators, contacts, and moving parts should be cleaned in accordance with the manufacturer's instructions.

**5.11 Inspection** - After being installed but before being placed in service, the equipment should be carefully inspected, checked, and adjusted in accordance with the applicable drawings. The following are suggested as the most important inspections and checks:

- (1) Examine all insulator units for cracked or defective parts.
- (2) Check all contacts for fit, proper pressure, and alignment.
- (3) Check all bolted connections for tightness.
- (4) Examine all switch locks for security, positiveness, and ease of operation.
- (5) Check operating mechanism for proper operation, lubrication, and travel; also for lost motion, mechanical connections, and excessive deflection of controls or mounting.
- (6) Check the adjustment of arcing horns on horn-gap switches.
- (7) Check break distances, clearances between live parts and travel of all switches.
- (8) Check phase-to-phase clearances and phase-to-ground clearances between live parts of switching equipment and adjacent structures.

**5.12 Load Interrupter Switches** - Follow the manufacturer's instructions for erection and adjustment of interrupter switches.

# **Guide for the Operation of High Voltage Disconnecting Switches**

## **ANSI C37.35-1976**

### **6. Operation**

**6.1 Air Switches** - High-voltage disconnecting switches, grounding switches, and horn-gap switches are given no interrupting rating. Load interrupter switches may have limited load interrupting rating. Appropriate safety rules should be followed and the following general rules apply.

#### **6.1.1 General**

- (1) Instructions and procedures for opening and closing an air switch, whether by direct hookstick or indirect operating handle, gear box, or power operator, should be given to every person who will operate the switch.
- (2) After operating a switch, each blade should be checked visually to verify it is fully closed and latched or fully open, as intended.
- (3) Undue force should not be used to operate a switch. The operating mechanism is designed properly for the switch and any undue force in the nature of an extension of the operating handle, or an extra person on the operating handle of switch stick, may cause severe damage to the switch or operating mechanism. A few sharp raps on the vertical operating pipe or suddenly applied tugs on the operating handle may help to free an iced switch mechanism.
- (4) Power-operated switches should be operated periodically to be sure that the switches and their mechanisms and control features are functioning properly. Where circuit conditions will not permit operating an energized switch and the circuit cannot be de-energized for this purpose, the operating mechanism should be disengaged from the linkage. The control circuits and mechanism should be checked in this manner unless the overall adjustments are affected.

#### **6.1.2 Disconnecting, Grounding, and Horn-gap Switches**

- (1) Prior to operating a disconnecting or horn-gap switch, check that no load is being carried by the switch.
- (2) Prior to opening a grounding switch, check to determine that operation does not remove necessary safety grounds. Prior to closing, check the circuit to confirm that it is not energized.
- (3) Disconnecting switches should be operated rapidly to reduce arcing time and possible burning of contacts.

NOTE: It is common practice to use these devices for interrupting small currents such as the charging current of a short length of transmission or distribution line, transformer magnetizing currents, parallel and loop currents, and light load currents. Such operations result in unconfined arcs which, under unfavorable weather or circuit conditions, may cause a system fault. These duties impose varying degrees of switching severity upon the switch. If circuit

interruption is contemplated, care should be taken to understand the circuit conditions with particular regard to current magnitude and the transient recovery voltage that will appear across the switch immediately following current interruption to determine what degree of success may be expected.

Devices such as arcing horns, quick-break horns, and air or gas blast attachments, are available for aiding the interrupting capability of a disconnecting switch. It should be recognized that some of these situations may require the use of an interrupter switch. For specific current interrupting applications, the switch manufacturer should be consulted.

**6.1.3 Load Interrupter Switches** - Interrupter switches have specific capabilities for switching one or more of the following circuit types: 0.8 minimum lagging power factor load, parallel or loop load, transformer magnetizing, line charging, cable charging, and capacitor bank. Follow the manufacturer's instructions when operating interrupter switches.

## **Guide for Maintenance of High Voltage Disconnecting Switches ANSI C37.35-1976**

**IMPORTANT - Make sure applicable and adjacent equipment is de-energized and properly grounded before performing any installation or maintenance.**

### **Introduction**

High voltage disconnecting switches are assigned certain ratings and standard tests are conducted to assure the user that the switch, when new, will perform within the ratings shown on the nameplate. It should be recognized that the switch in service will perform within these ratings only if properly operated and maintained. Prescribed safety rules should be followed at all times when operating or maintaining high voltage disconnecting switches. At least once a year, these switches should be inspected and maintained.

### **7. Maintenance**

**7.1 Disconnecting Switches** - These switches are not readily serviced at frequent intervals. This does not, however, relieve the user of the responsibility for care and inspection. Frequency of inspection will



be a function of atmospheric contamination, use of contamination control coatings, frequency of operation, fault current exposure, etc, and a suitable program must be established and followed by the user.

If a switch cannot be maintained on a periodic basis, its service life may be affected. The switch should be opened and closed several times if practicable in order to clean the contacts and free the moving parts. A visual inspection of a switch when wet, or the use of a temperature-scanning detector may indicate hot spots which are possible sources of trouble. Directional microphones or ultrasonic detectors can be used to locate local corona sources on switches and these sources can then be removed during normal switch maintenance. Live line servicing and maintenance procedures may be used.

The following procedures are suggested for maintaining de-energized switches:

- (1) Be sure that the switch is disconnected from all electric power sources before servicing.
- (2) Ground leads or their equivalent should be attached to both sides of the switch. All safety precautions of 5.1 Personal Safety During Installation, including local and applicable OSHA regulations, should be followed.
- (3) Inspect the insulators for breaks, cracks, burns, or cement deterioration. Clean the insulators particularly where abnormal conditions such as salt deposits, cement dust, or acid fumes prevail. This is necessary to avoid flashover as a result of the accumulation of foreign substance on the insulator surfaces.
- (4) Check the switch for alignment, contact pressure, eroded contacts, corrosion, and mechanical malfunction. Replace damaged or badly eroded components. If contact pitting is of a minor nature, smooth the surface with clean, fine sandpaper (not emery) or as the manufacturer recommends. **(Do not grease the contacts. If lubrication is desired, spray the contacts with a dry graphite aerosol.)** Inspect arcing horns for signs of excessive arc damage and replace if necessary.
- (5) Check the blade lock or latch for adjustment.
- (6) Inspect all live parts for scarring, gouging, or sharp points which could contribute to excessive radio noise and corona. Check corona balls and rings for damage which could impair their effectiveness.
- (7) Inspect interphase linkages, operating rods, levers, bearings, etc, to assure that adjustments are correct, all joints are tight, and pipes are not bent. Clean and lubricate the switch parts only when recommended by the manufacturer. Check for simultaneous closing of all blades and for proper contact in the closed position. Check gear boxes for moisture which could cause damage due to corrosion or ice formation. Inspect the flexible braids or slip-ring contacts used for grounding the operating handle. Replace braids showing signs of corrosion, wear, or having broken strands.
- (8) Power-operating mechanisms for switches are usually of the motor-driven, spring, hydraulic, or pneumatic type. The particular manufacturer's instructions for each mechanism should be followed.

Check the limit switch adjustment and associated relay equipment for poor contacts, burned out coils, adequacy of supply voltage, and any other conditions that might prevent the proper functioning of the complete switch assembly.

(9) Inspect overall switch and operating mechanism for good working condition. Check that the bolts, nuts, washers, cotter pins, and terminal connectors are in place and in good condition. Replace items showing excessive wear or corrosion. Inspect all bus cable connections for signs of overheating or looseness.

(10) Inspect and check all safety interlocks and test for proper operation.

**7.2 Load Interrupter Switches** - Interrupter switches should be periodically inspected to make certain that they are in condition to function properly. Many interrupter switches are so designed that material is consumed from the walls which are exposed to the electric arc. Particular attention should be given to such parts, and they should be maintained or replaced in accordance with the manufacturer's instructions.

In addition, since interrupter switches sometimes include all the features of disconnecting switches, the maintenance procedures for such interrupter switches should include the procedures outlined in 7.1.

## Switch Identification

When contacting the factory, refer to the W.O. (Work Order) number shown on the nameplate. All pertinent information on the switch is filed under this number.

USCO POWER EQUIPMENT CORP.	
BIRMINGHAM, ALABAMA	
ACCC DESIGNATION-D06	
TYPE	W.O.
AVR	34567
NOM.KV.	BIL
115	550
CONT.AMPS	MOM.AMPS
2000	100000
MAX.DES.KV.	PO.ORDER NO.
121	H-1328PY

## Renewal Parts and Factory Service

An inventory of renewal or spare parts is usually not necessary or recommended. Contact the factory for spare parts and factory service requirements.



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