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ABB Power T&D Company Inc.  
North America Distribution Systems Group

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## **Installation and Maintenance Instructions**



# **K-Line *Plus*<sup>TM</sup>**

## **Low Voltage Switchgear**



INSTRUCTIONAL BOOKLET

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# **K-Line *Plus*™ Low Voltage Switchgear**

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# Table of Contents

## **INTRODUCTION TO K-LINE PLUS™ LOW VOLTAGE SWITCHGEAR ..... 1**

GENERAL INSTRUCTIONS .....	1
SCOPE OF INSTRUCTIONS .....	1

## **IMPORTANT SAFETY NOTES AND WARNINGS..... 3**

SAFETY NOTATIONS.....	3
-----------------------	---

## **RECEIVING AND HANDLING ..... 6**

RECEIVING .....	6
HANDLING.....	6
STORAGE.....	7

## **SITE PREPARATION..... 9**

GENERAL.....	9
LOCATION .....	9
FOUNDATION .....	10

## **INDOOR/ OUTDOOR INSTALLATION ..... 11**

GENERAL.....	11
MOVING BY JACKS AND ROLLERS .....	11
RAISING BY SLINGS .....	15
REMOVAL OF SHIPPING BASE .....	16
CIRCUIT BREAKER OVERHEAD LIFTING DEVICE....	17
OPERATION OF THE CIRCUIT BREAKER OVERHEAD LIFTING DEVICE.....	20
UNIT SUBSTATIONS .....	21
CONNECTIONS .....	22
CONNECTION TO GROUND BUS .....	23
CONNECTION TO CONTROL SOURCE.....	24
SECONDARY AND CONTROL CONNECTIONS .....	24
INSTALLATION OF BUS BAR CONNECTIONS BETWEEN GROUPS .....	24

## **OUTDOOR INSTALLATION ..... 26**

GENERAL.....	26
BUS DUCT FLANGE .....	26
JOINING THE SHIPPING SPLITS.....	28
TRANSFORMER TRANSITION UNIT.....	33

## **TESTING AND FINAL INSPECTION..... 35**

TESTING .....	35
CONTROL CIRCUIT CHECKOUT .....	37
FINAL INSPECTION .....	40

## **PLACING SWITCHGEAR INTO SERVICE....45**

SAFETY PRECAUTIONS .....	45
ENERGIZING THE MAIN BUS .....	46

## **STANDARD CONSTRUCTION.....47**

STANDARD COLOR .....	47
GALVALUME .....	47
BUS SUPPORT INSULATION .....	47
PRIMARY DISCONNECT DEVICE .....	48
SECONDARY DISCONNECTING DEVICES .....	48
GROUND BUS AND CONTACTS .....	48
CONTROL WIRES .....	49
CIRCUIT BREAKERS .....	49

## **MAINTENANCE .....51**

GENERAL .....	51
SEMI-ANNUAL INSPECTION .....	52
ANNUAL INSPECTION .....	53
18 TO 36 MONTH INSPECTION.....	54
10 YEAR MAXIMUM INSPECTION .....	54
SUSPECT JOINT MAINTENANCE.....	55
CARE OF FINISH.....	55
RENEWAL PARTS .....	56

## **DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITY .....57**

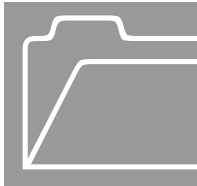


# Introduction to K-Line Plus™

## Low Voltage Switchgear

### GENERAL INSTRUCTIONS

Read these instructions carefully before installation and use as a guide during installation and initial operation.



File these instructions with other instruction books, drawings and descriptive data of the switchgear. Keep this book available for the installation, operation, and maintenance of this equipment. Use of the instructions will facilitate proper maintenance of the equipment, and prolong its useful life.

### SCOPE OF INSTRUCTIONS

The instructions are general in nature. They cover requirements for installation, setup, checkout and maintenance as applied to ABB K-Line Plus Metal Enclosed Low Voltage Power Circuit Breaker Switchgear. These instructions do not attempt to cover all variations and combinations of equipment and installations.

Information on particular installations appears in the following:

- Bills of Materials that list electrical devices and equipment
- Front view showing layout of relays, instruments and circuit breakers
- Single line drawings showing power connections
- Floor plan showing available space for power and control conduits
- Special construction details
- Elementary and schematic diagrams
- Connection diagrams





## Important safety notes and warnings

Switchgear operation depends on proper handling, installation, and maintenance. Neglecting fundamental requirements may lead to personal injury, failure of the switchgear, and property damage.

Safety as described in this instruction book involves two conditions:

- Personal injury
- Product or property damage

See important “Disclaimer of warranties and limitation of liability” on page 58.

### SAFETY NOTATIONS



Safety notations alert personnel to possible death, injury, or property damage situations. The safety notations appear before the step in which the condition applies. The four hazard levels are:

#### **DANGER**

**"Danger"** indicates a hazardous situation that has a **high probability of death or severe injury** and substantial property damage.

#### **WARNING**

**"WARNING"** indicates a hazardous situation that has **some probability of death or severe injury** and substantial property damage.

#### **CAUTION**

**"CAUTION"** indicates a hazardous situation that **may result in minor or moderate injury** and/or property damage.



**"NOTICE"** indicates a statement of company policy as it relates directly to the safety of personnel or protection of property.

Personnel installing, operating, or maintaining this equipment must have thorough knowledge of all applicable local, regional, industry, governmental, and OSHA safety procedures as well as commonly accepted safe working practices. Personnel working in, on or around this equipment must also exhibit common sense and good judgment regarding the potential hazards for themselves and other personnel in the area. These instructions are intended for use by fully qualified personnel and are not a substitute for adequate training, experience, and supervision.

Should clarification or additional information be required, refer the matter to your ABB Power T&D Company sales office. When communicating with ABB regarding the product covered by this Instruction Book, always reference the ABB assigned Shop Order (S.O.) number or Circuit Breaker Serial Number.



## Receiving and Handling

### RECEIVING

Before shipment, the switchgear is inspected and marked with its number and position. The factory ships circuit breakers separately.

Upon receipt of the switchgear, examine the shipment for damage or loss. Check the contents against the packing list before discarding any packing material. Notify ABB and the carrier at once of any discrepancies. If there is damage from improper handling, file a claim for damages at once with the carrier and notify ABB.

**Note:** ABB standard shipments are "FOB factory." ABB is not responsible for damage, after delivery of the equipment to the carrier.

### HANDLING



*For structural integrity, all doors and panels must be in place and securely fastened before moving the equipment*



*Do not move or transport the switchgear with the circuit breakers installed.*



*Before energizing the heaters, remove all the packing materials from the switchgear. Open the circuit breaker or cutout device that controls the heaters when using a separate power source.*

## STORAGE

Leave the equipment on the shipping base.

Store all equipment indoors in a well-ventilated area.

The storage building should have a well-drained paved floor. The temperature should be above 60°F. The air should be dry (50% maximum humidity).

The sections ship wrapped in plastic for protection during shipment only. Remove the plastic wrap after placing into storage. Cover with heavy wrapping paper or other moisture barrier. Do not use materials that would trap moisture inside the unit. Do not cover louvered or filtered openings.

When storing for a long period of time or in high-humidity, use heaters to keep the interior dry. Bring the power for the heaters to the load terminals of the device that controls the heater circuits.

**The device must remain open when using a separate power source .**

Store circuit breakers upright in their original shipping carton. Do not stack. Do not store circuit breakers in the switchgear

## Site Preparation

### *GENERAL*

Before installing, consult all drawings furnished for the particular order. The drawings show top and front views of the switchgear, primary and secondary connection diagrams, and Bills of Materials. Study these drawings and the following recommendations before preparing the site plan drawings.

### *LOCATION*

Locate the switchgear in accordance with local regulations. Clearances at the front should allow the installation and removal of the circuit breakers. Allow enough rear clearance to open the rear doors. Provide rear access for making connections before startup and for periodic inspections. The recommended minimum clearances appear on the drawings.

### *FOUNDATION*

The factory supplies floor plan drawings for each installation. The concrete floor must be straight and level within  $\frac{1}{4}$  inch over the entire length of the line-up.

The design of the floor may include iron sills in the concrete. The sills must be straight and level within  $\frac{1}{4}$  inch over their full length, and correctly spaced. Bolt ties between the sills and shim the lower flange of each sill to proper height.

Install power and secondary (control) conduits before moving the switchgear to the site. Available space for the conduits appears on the floor plans supplied with the switchgear. Conduits should not extend more than one (1) inch above the station floor level. Plug conduit openings before pouring concrete.



## Indoor/ Outdoor Installation

### GENERAL

Metal-enclosed switchgear ships in sections. Sections up to 96 inches ship on heavy timber bases or on optional throw away steel bases

Unload the switchgear as close to the installation site as possible. Raise the switchgear with jacks and move on rollers with the shipping bases in place or with an overhead hoist and spreader bar. See pages 15 and 16.

### MOVING BY JACKS AND ROLLERS



*Use of forklift trucks for jacking or placing the jacks other than as described may result in stress distortions and irreparable damage to the switchgear.*



*Do not remove the shipping bases until the units are set in place. Moving the units without the shipping base will cause irreparable damage and a hazardous condition.*



In many locations the best way of moving the switchgear is with jacks and rollers.

- 1. Do not remove the shipping base** . Move the unit near the site. Raise the unit by jacks placed under the front and rear corners. See Figure 1. Note: Some sections are on throw away steel bases.



Figure 1. Position jacks under the front and rear corners, inside the shipping base.

2. Raise the unit enough to position a roller under the shipping base. Repeat the operation at the other end. See Figure 2

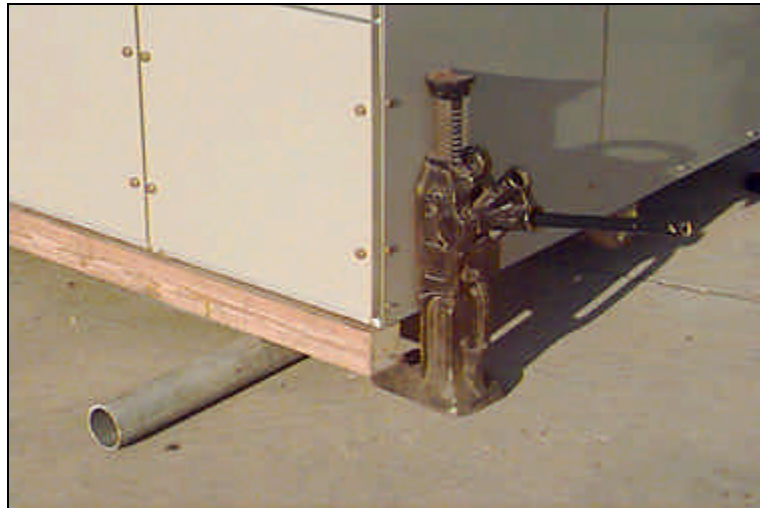
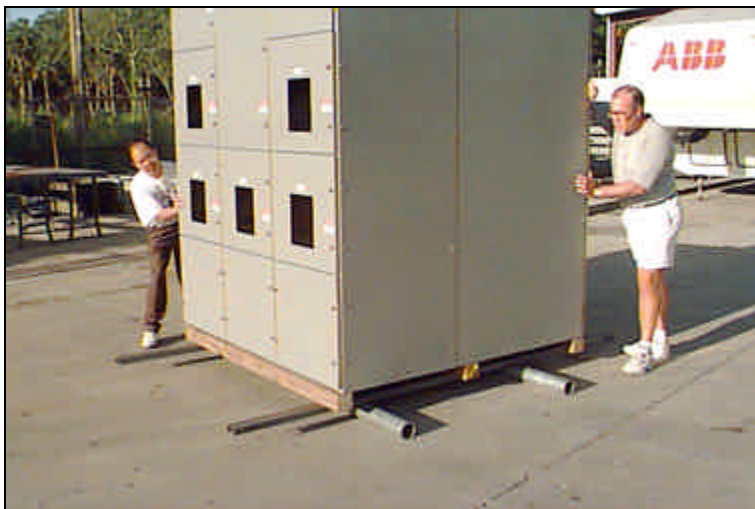


Figure 2. Raise the unit enough to position a roller under the shipping base.

3. Push the switchgear toward its final position, while another person puts a third roller under the forward end. Keep moving a roller from the rear to the front until the unit is in place.
4. For lateral moving, raise the units by jacks as described in step 1. Place the rollers laterally with steel channels (not furnished) on the rollers. See Figure 3 and **Error! Reference source not found.** Carefully push the unit onto a third roller and move a roller from the rear to the front until the unit is in place.



**Figure 3. Position rails on rollers as shown for lateral moving.**



**Figure 4, Carefully push the unit onto a third roller.**

- 5.** Locate the units in their final position. Raise the units to clear the rollers and channels.

## *RAISING BY SLINGS*

1. Attach the optional lifting plates to the 4 holes provided in the top of the units as shown in Figure 5. They provide a large hole at each end for attaching a sling and spreader bar assembly.



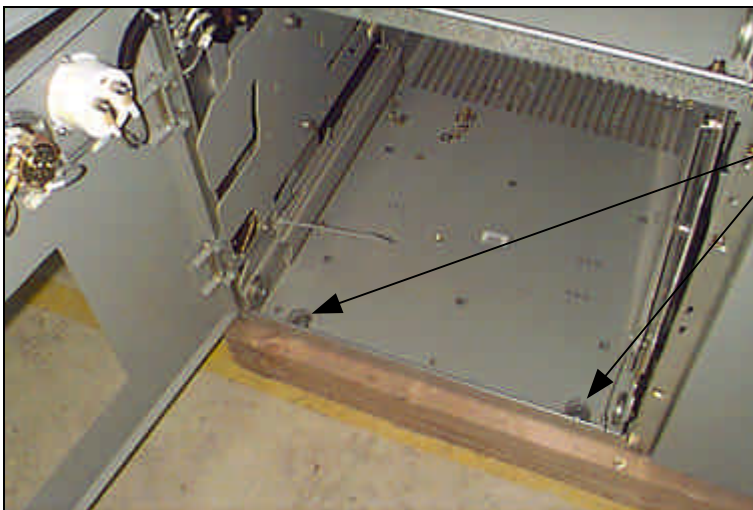
**Figure 5. End view showing extended lifting eye, with optional Drip Proof Roof.**

2. Use a spreader bar to keep the legs of the sling vertical.
3. Lift and move the switchgear to its final place. Once the unit is set in place, remove the shipping base as described on page 16.

## REMOVAL OF SHIPPING BASE

Once the units are in their final place, remove the shipping bases.

1. Open the switchgear doors. Remove the bolts holding the shipping bases to the switchgear. **Secure all doors and panels before going to the next step.**
2. Raise the switchgear to a height that allows removal of the base. Use four jacks for this operation to keep the units uniformly level and prevent distortion.
3. Remove and discard the shipping bases.
4. Select four pieces of wood thick enough to permit removal of the jack after lowering. Place one at each corner. Slowly lower one side of the switchgear until it rests on the wood. Repeat this process on the other side. The switchgear should now be sitting on the four pieces of wood.
5. Use a crowbar to lift each corner and remove the four pieces of wood.



Bolts holding the switchgear to the shipping base.

Use these holes (front and rear) when anchoring the unit in place.

Figure 6. View of front mounting provisions.

## CIRCUIT BREAKER OVERHEAD LIFTING DEVICE

For ease of handling K-Line Plus circuit breakers, a traveling overhead lifting device is available. The front section of the switchgear provides support for the lifting device. The hoist travels the full width of the switchgear. The breaker lifts from the floor or from a completely withdrawn circuit breaker cradle with a lifting yoke. A worm driven mechanism and wire rope, operated by a removable hand crank provide lifting power. Although the driving mechanism allows for easy hand operation, the weight of the circuit breaker cannot accidentally move the mechanism. See ABB drawing 962141 for detailed operating instructions.

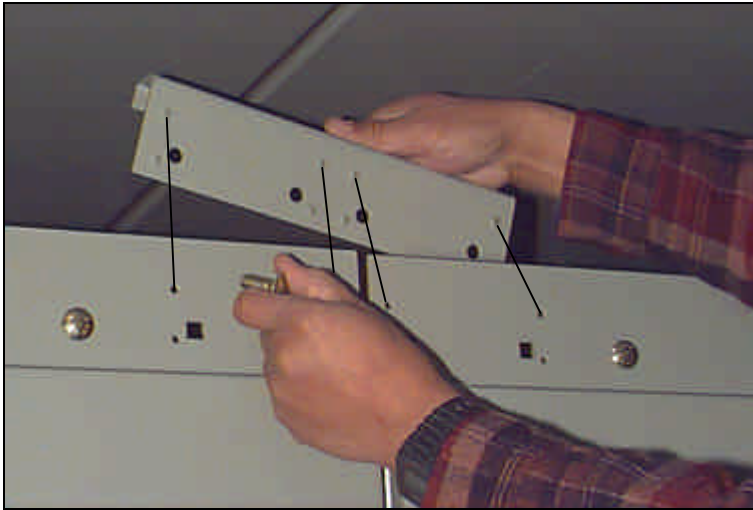
### Installation

1. Remove the lifting eye, Drip Proof Roof side panel, and Carriage Stop from one end of the lineup.



Figure 7. Remove the Lifting Eye, Carriage Stop and End Panel.

2. Loosen all rails for the overhead lift device. Mount the Locator Plates as shown in Figure 8. Note that the plates have 8 round bosses that mate with holes in the rails. Adjust the rails as required to loosely secure the locator plates in place with the 8 bosses in their mating holes. After mating all Locator Plates in place with the rails, secure the locator plates and the rails.



**Figure 8. Mount Location Plate behind the rail.**



**Figure 9. Secure plates and rails for a smooth and continuous transition between sections.**

2. Position Overhead Lift device on the tines of forklift.

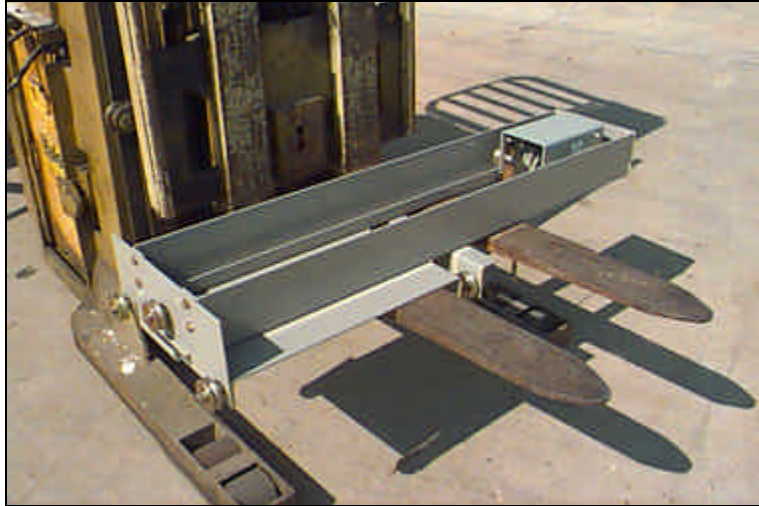


Figure 10. Position Overhead Lift Device on tines of fork lift.

3. Align the rollers on the Overhead lift device with the rails on the frame.

Adjust the upper rear wheel to minimize vertical movement.

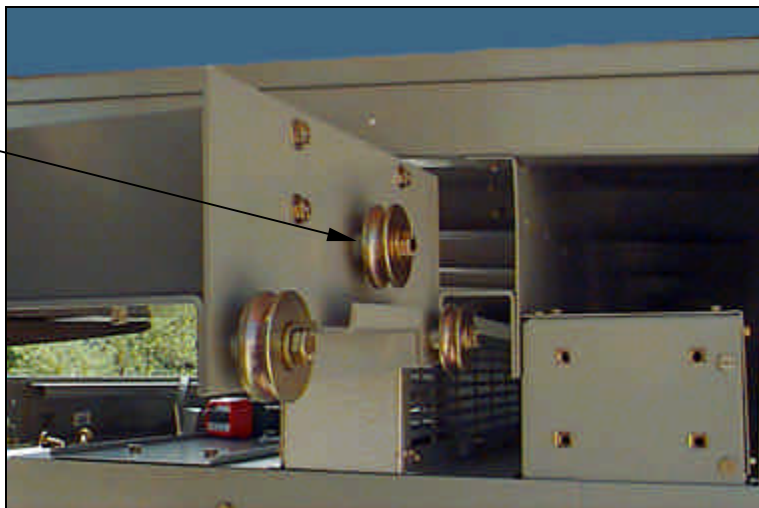


Figure 11. Align wheels on the front rail and behind the rear rail as shown.



4. Push the Overhead lift device off the fork-lift onto the rails.



Figure 12. Push the Overhead Lift Device onto the rails.

5. Re-install the carriage stop bracket, the end plate, and the lifting eye.



Figure 13. Install the items removed in Step 1.

## *OPERATION OF THE CIRCUIT BREAKER OVERHEAD LIFTING DEVICE*

Observe the following requirements when operating the circuit breaker lifting device.

1. The wheels must be properly set on track.
2. Do not depend upon the drum attachment to support full weight. Allow 4-5 wraps of wire rope to remain on the drum.
3. Prevent snarling, kinking or knotting the wire rope.
4. Lift only circuit breakers.
5. Do not alter the lifting device or the circuit breaker lifting yoke.
6. Never walk or stand under a circuit breaker suspended by wire rope.
7. Do not leave a circuit breaker suspended on the wire rope.

## *UNIT SUBSTATIONS*

Unit substations are power transformers with primary and secondary switchgear. They are field assembled to make a complete unit. Install the transformers and switches next to the switchgear as shown on coordination drawings.

In multi-unit substations, physically identical transformers may have disconnect switches that are key interlocked with secondary breakers. Group the disconnect switches, transformers and switchgear sections by their key interlock. The interlock sequence depends upon having the locks on the switch and breaker operated by the same key.

**Avoid unnecessary rework by checking the key numbers before moving each piece of equipment into its final position.**

## CONNECTIONS

### WARNING

*Before making primary source connections verify that the primary cables are de-energized.*

Unit substations ship in separate sections. Each transformer is a separate section. The factory splits the buses for shipment. Secondary and control wiring end at terminal blocks located at the shipping split. Wire markings match the markings on the terminal blocks.

Bolt the separate units together. Reconnect the bus and control wiring at the shipping splits. Follow the connection diagram when replacing secondary and control wiring. Bolted joints must be tight. See Table 1.

Table 1

Torque Values for Low Voltage Equipment Hardware	
Bolt Size (Inches)	Foot-Pounds (Dry Threads)
3/8	15-35
1/2	30-45

Complete all internal connections. Make the external connections to control power sources and circuits, to secondary and potential circuits, to feeders, power sources and to ground.

**After completing all connections to secondary (control) circuits, follow these circuits and remove temporary connections from current transformer secondaries.**

Temporary jumpers protect against voltages that may occur if the current transformer primaries carry currents while the secondary circuits are still not complete. With the secondary circuits connected, remove the jumpers. Failure to remove the jumpers will interfere with meters, relays, or other devices in these circuits.

If shorting Terminal Blocks are used, review Connection Diagram for position of shorting screws. See Figure 22 on page 39.

Make incoming power connections after all other connections are complete. A note on the connection diagram indicates devices that are phase sensitive. Verify the phase sequence of the incoming power source before making connections.

### *CONNECTION TO GROUND BUS*

The factory bolts the ground bus bars to each frame. Connect the ground bus bars to the station ground by means of a cable or bus of larger gage than the housing ground bus.

Do not run cable or bus in conduit. The cable or bus should take the most direct path to station ground.

### *CONNECTION TO CONTROL SOURCE*

The control source wiring should be of larger gage than the rest of the control wiring. Connect the control source leads to the terminal blocks. **CHECK THE ELECTRICAL PHASING BEFORE CONNECTING.**

## SECONDARY AND CONTROL CONNECTIONS

The factory wires the secondary and control connections using the connection diagram. The outgoing secondary and control connections terminate at terminal blocks. The terminal blocks for customer connections are accessible from the control conduit area.

Openings in the side of the switchgear allow control connections between housings. When shipped in groups of several units each, the factory installs cross connections between groups. The factory then disconnects and tags one end of each of the connections. Reconnect according to the connection diagram when the sections are together again.

## INSTALLATION OF BUS BAR CONNECTIONS BETWEEN GROUPS

The factory assembles the main bus bar in each section. The splices at the shipping splits are unbolted for shipment. Refer to the Connection Diagram.



**Do not use alcohols or freons.** Limit the use of solvents to removing grease and contamination from primary conductors, insulation, and unpainted metallic surfaces. Use an OSHA approved, non-flammable solvent with a threshold limit of 300 PPM or higher in accordance with local regulations. Use solvents in well-ventilated areas.

The contact surfaces of the bus at bolted joints are plated. Clean contact surfaces with a clean cloth and an OSHA approved solvent. Limit the use of solvents to removing grease and contamination from primary conductors and insulation, and from unpainted metallic surfaces. Bolt the bus together. Conductivity of a joint depends upon the pressure or torque applied. See Table 1 on page 55.

**Take care not to remove plating.**

K-Line Plus

**Torque the  $\frac{1}{2}$  inch bus hardware to 30-45 foot-pounds.**

## Outdoor Installation

### *GENERAL*

Outdoor and indoor installations are similar. Outdoor units are on permanent bases. Use jacks to raise the units for positioning the rollers.

The bases have lifting holes in each end for over head lifts. See Figure 20 on page 32. Use spreader bars with slings attached in the lifting holes. This prevents damage to the unit tops.

Before assembling "Walk-In" units, see the "Erection Procedure" drawings.

For weatherproofing instructions, see the "Gasket Application" drawings.

For anchoring the units to the concrete base, see the "Erection Procedure drawings.

### *BUS DUCT FLANGE*

Mount the bus duct flange when installing the switchgear.

1. Place the gasket between the roof and the flange. Use the adhesive as a binder between each of the parts.
2. Cement the gasket to the roof.
3. Cement the flange over the gasket.
4. Bolt the flange to the structure.
5. Apply a bead of sealer to the exposed edges of the gasket.

### *JOINING THE SHIPPING SPLITS*

For installations of more than three shipping splits, carefully locate the center section in its final position and add the remaining units on either end.

Locate the shipping splits together in their final location relative to the floor anchor arrangement if used. It may be difficult to make position adjustments without damage, after bolting the units together.

Allow space to install gasket material supplied with the unit if not already installed.

- 1.** Apply gasket material as shown on the Gasket application drawings. See Figure 14 and Figure 17.
- 2.** Loosely bolt the sides of the unit together. See Figure 15.
- 3.** Install the angle supplied to the roof seam and secure. See Figure 17 and Figure 18.
- 4.** Tighten the bolts in the sides of the units. Pay attention to the relative position of the units to the floor anchor arrangement if used.
- 5.** Install the roof end caps as shown in Figure 19, and apply sealant where required.





Figure 14. Install gasket material between shipping splits before bolting together.

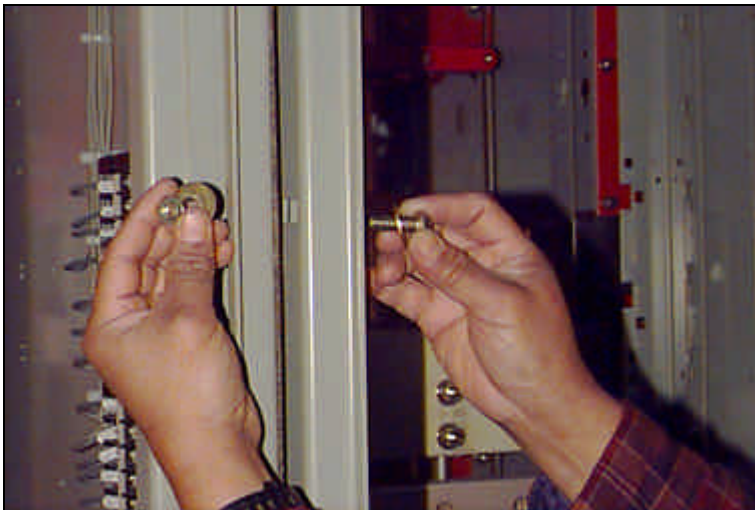
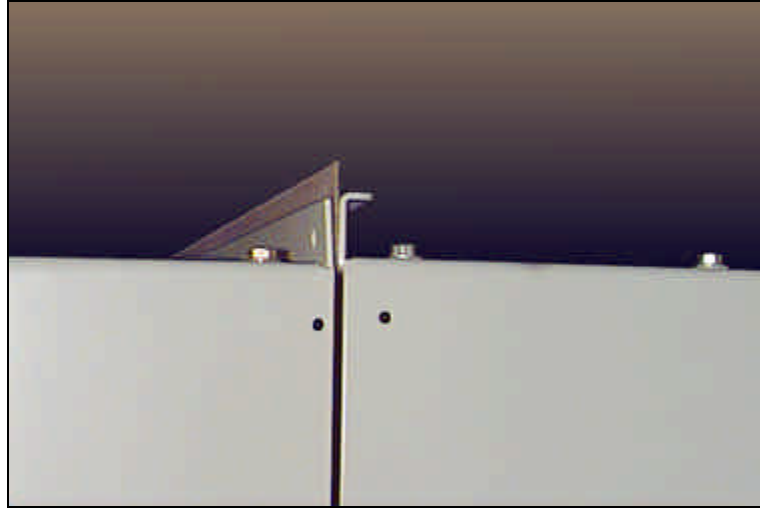


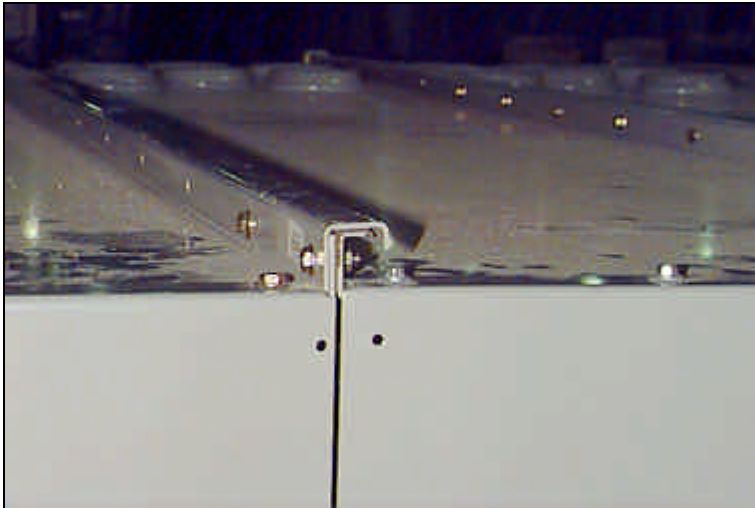
Figure 15. Bolt shipping splits together.



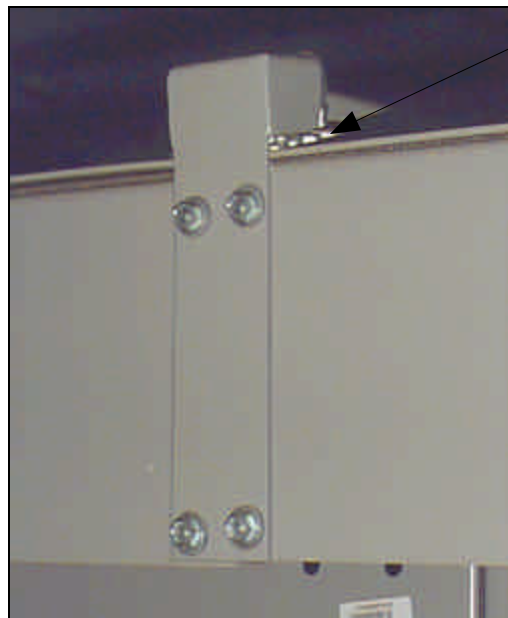
**Figure 16. Install gasket material between shipping splits.**



**Figure 17. Loosely install the shipping split angle as shown.**



**Figure 18. Tighten the shipping split angle evenly.**



Apply sealant  
all around

**Figure 19. Install roof end caps as shown.**



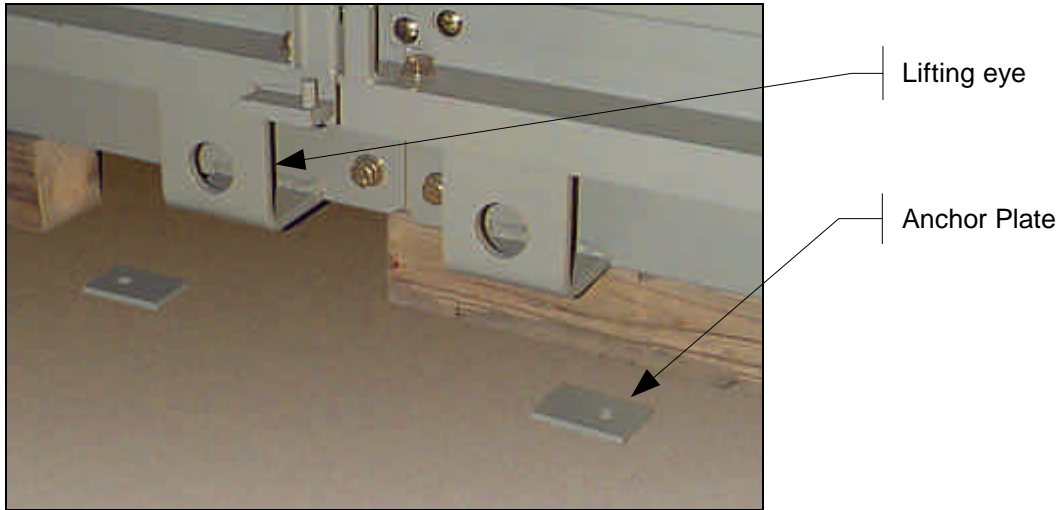


Figure 20. Lifting eyes with anchor plates.

### *TRANSFORMER TRANSITION UNIT*

The transformer transition unit bolts to either end of the line-up. The unit completely disassembles allowing the transformer to be moved into position and aligned with the bus. Once positioned, make the connections and loosely re-assemble the slotted panels. Adjust the panels for best fit and secure the hardware.



**Figure 21. Outdoor K-Line Plus with transformer transition unit.**



## Testing and Final Inspection

### TESTING

#### **DANGER**

*Disconnect the primary power source during testing.*

*Do not exceed the listed voltages for the voltage class of the equipment under test.*

*Disconnect the shunt-connected coils such as potential transformers.*

*Do not test solid state sensors or relays with high voltage. Disconnect solid state sensors and relays before applying voltage.*

With the switchgear erected, assembled, and connected, do the following:

1. Remove packing and shipping materials.
2. Make sure that all internal parts are clean and dry. If moisture is present, dry with moving air and heat.
3. Remove shipping blocks from relays.
4. To check for damaged insulation, apply potential tests to the primary bus. Potential tests should be conducted phase -to-phase and phase -to-ground.



60 HZ, RMS WITHSTAND VOLTAGES (PRIMARY CIRCUITS) (1 MINUTE)			DC WITHSTAND <sup>1</sup>
Rated Voltage 240v, 480v, 600v	Factory Test 2200 volts	Field Test 1650 volts	Field Test 2300 volts

<sup>1</sup> The Column headed DC WITHSTAND is a reference for those using dc tests to verify the integrity of connected switchgear. It represents values believed to be appropriate and approximately equivalent to the corresponding power frequency withstand test values specified for each voltage class of switchgear. The presence of this column in no way implies any requirements for a dc withstand test on ac equipment. Also, it does not imply that a dc withstand test is an acceptable alternative to ANSI C37.20 for design, production, or conformance tests. When making dc tests, raise the voltage to the test value in discrete steps and hold for one (1) minute.

5. With the main circuit dead, check the continuity of all circuits after installing the circuit breakers. Energize the control source and operate the equipment. Indicating instruments verify the continuity of current transformer circuits after energizing the main circuit.

## CONTROL CIRCUIT CHECKOUT

### **DANGER**

*The breaker or cutout device of the local control power circuit must remain open when using a separate control power source.*

The preferred method to check the control circuit is to furnish a separate temporary source of control power of the required control voltage rating. The temporary source must have a properly coordinated backup protective device in the circuit. Set the device to clear faults that might occur. Initially all circuit breakers should be in the DISCONNECT position and the main circuit de-energized. When ac control power is from control power transformers in the switchgear, remove all fuses in the transformer circuits. On electrically operated circuit breakers, discharge the springs and the motor-disconnect-switch should be in the OFF position.

### **DANGER**

*OPEN the circuit breaker before racking.*

6. Rack drawout breakers to the DISCONNECT position.
7. Open all normal control power source disconnects, if supplied.
8. Check each control switch or push-button. Make sure that it is in the OPEN position.
9. Connect a temporary control power source to the circuit load terminals in the switchgear. Energize the control circuit from the temporary control power source.
10. Rack one circuit breaker into the TEST position. When the on-off switch is in the ON position, the charging of the closing springs of an electrically operated circuit breaker indicates connection to the control power.

11. Rack the remaining circuit breakers into the TEST position, one at a time.
12. Test all electrically and manually operated breakers for closing and tripping, while they are in the TEST position. Use the optional test set available with the trip unit for testing solid state tripping.
13. De-energize the control circuit. If ac control power is from transformers in the switchgear, remove the temporary separate source of control power. Reinstall all fuses in the transformer circuit.
14. Set all relays, regulators, and other devices for proper operation of loads. The factory does not set the relays.
15. Remove shorting screws from the terminal blocks in the current transformer circuits. See **Figure 22** on page 39. Store screws in the tapped holes in the corners of the blocks.

**Verify the proper phasing of all main circuits according to diagram.**

To open the short circuiting device :

1. Make sure that the current transformer secondary circuits are complete.  
Do not open circuit the secondary of an energized breaker.
2. a) **Single Ratio** - Remove and store the shorting screw ①.  
Do not remove the ground screw ②.
- b) **Multi Ratio** - Remove the shorting screw ①.  
Insert shorting screw ① according to connection diagram.  
Do not remove the ground screw ②.

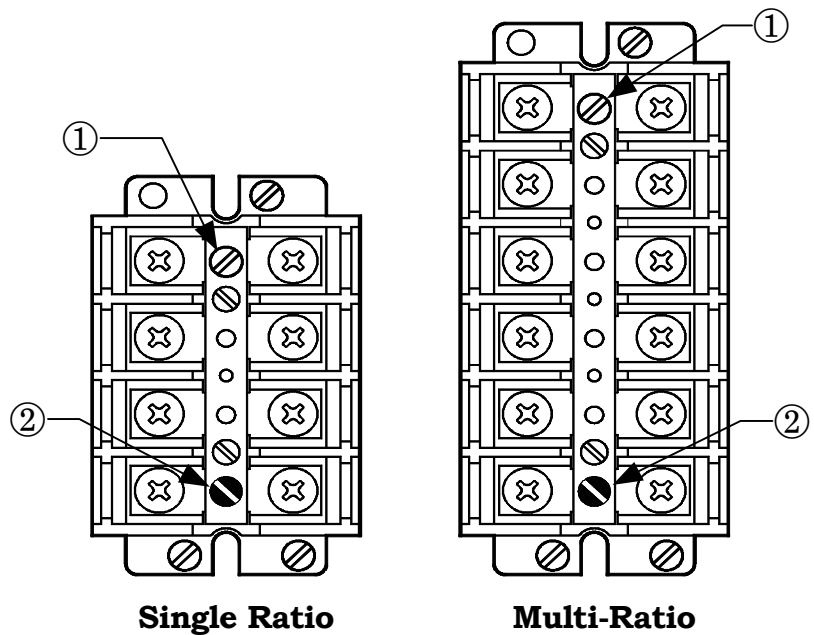


Figure 22. Short Circuiting Device

## FINAL INSPECTION

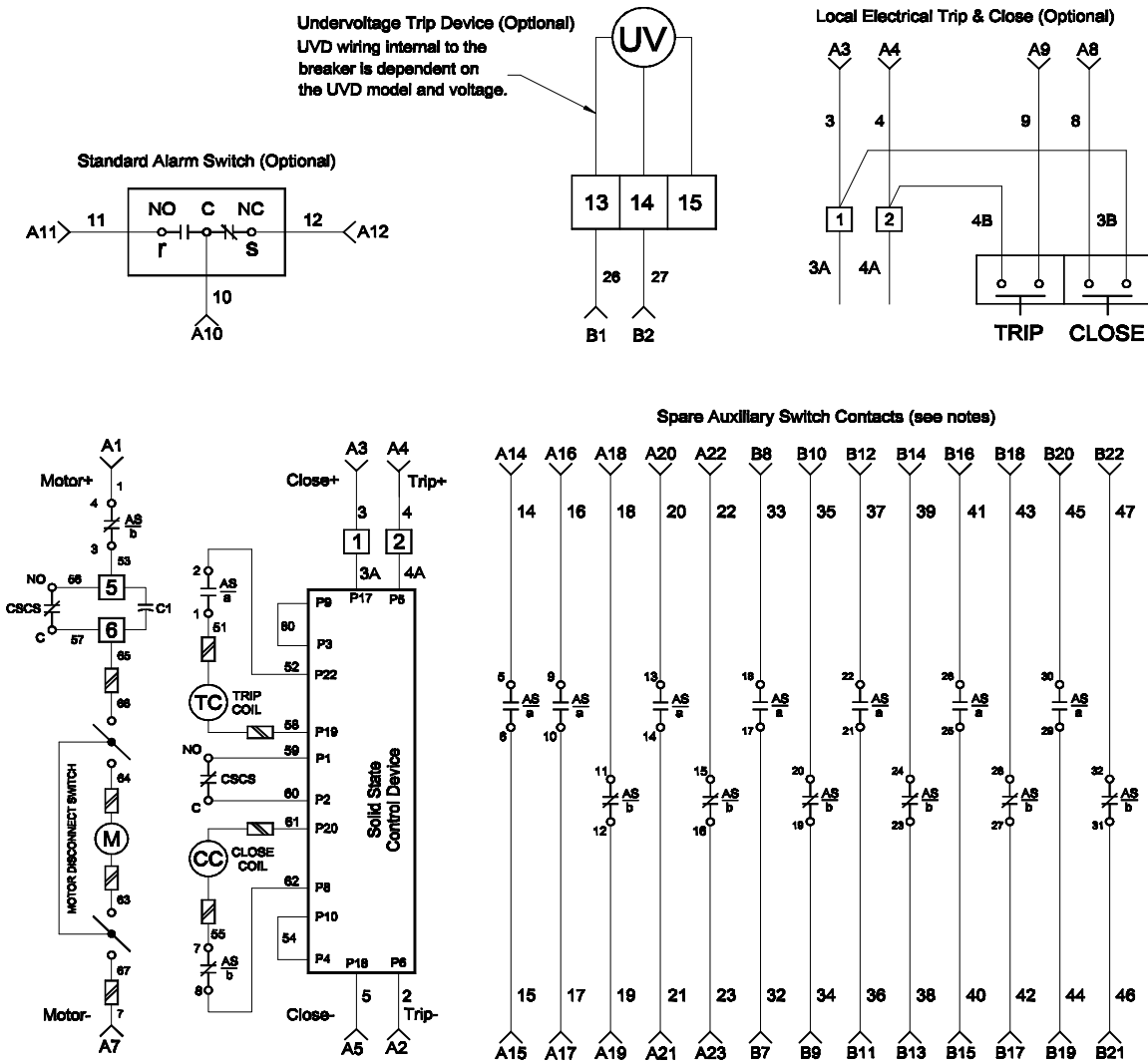
### **DANGER**

*There are hazards of electrical shocks and/or burns whenever working in or around electrical equipment. Turn off power ahead of the switchgear before performing any maintenance operations. Check incoming line terminals to verify that the equipment is de-energized. Check out-going terminals to ensure that no back-feed condition exists.*

Once installed and all interconnections made, perform a final check and test on the switchgear and its controls. Check for correct equipment installation and that all connections are complete. Use extreme care to prevent the controlled equipment from being connected to the system while the preliminary tests are being conducted.

Disconnect the line leads if disconnecting switches are not part of the equipment. The test equipment needed depends on the installation

## Typical K-Line Plus Composite Schematic (Electrically Operated)



**NOTES:**

1. This wiring diagram includes optional features not found on all K-Line Plus breakers, including an alarm switch, undervoltage trip device, LET/LEC, and spare auxiliary switch contacts.
2. Secondary disconnect numbers begin with a letter that indicates in which plug the disconnect resides. The "A" plug is the right-hand plug when viewed from the rear of the breaker.
3. The spare contacts in secondary disconnect "A" are standard on EO breakers. Those routed through plug "B" are optional.



## Placing Switchgear into Service

### SAFETY PRECAUTIONS

#### **DANGER**

*There are hazards of electrical shocks and/or burns whenever working in or around electrical equipment. Turn off power ahead of the switchgear before performing any maintenance operations. Check incoming line terminals to verify that the equipment is de-energized. Check out-going terminals to ensure that no back-feed condition exists.*

The circuit breakers should be in the TEST position. When working on switchgear, de-energize and ground the main bus.

Before energizing any part of the switchgear make a complete check of mechanical operation of all devices. Remove blocking wedges from relays, circuit breakers, meters, etc. Manually operate all circuit breakers and relays. Moving parts should not bind. Verify that there are no foreign objects in the rear of the equipment. Use an air hose to clean all inside and outside surfaces.

**The secondary circuits of energized current transformers should never be open circuited.**



## *ENERGIZING THE MAIN BUS*

After completing the control circuit checkout, energize the switchgear main bus.

- 1.** Energize the incoming bus to the switchgear main circuit breaker. Observe if operation of instruments and relays are correct.
- 2.** Energize the separate control power source, if furnished.
- 3.** Energize the switchgear main bus by closing the main circuit breaker. Observe if operation of relays and instruments is correct.
- 4.** Close the desired feeder and tie breaker circuit breakers.
- 5.** Verify that all door panel screws are tight.
- 6.** Rack all drawout type circuit breakers to the CONNECTED position.

## Standard Construction

### *STANDARD COLOR*

The standard paint color is ANSI #61. This finish is electro-static powder paint applied over an iron phosphate coating. This process achieves a smooth, uniform paint finish that conforms to all UL requirements.

### *GALVALUME*

Unpainted parts are made of Galvalume™. Galvalume™ is a cold rolled sheet steel with a hot dipped coating of aluminum, zinc and silicon. Galvalume® greatly exceeds the paint qualifications of ANSI C37.20.2-5.2.8.

### *BUS SUPPORT INSULATION*

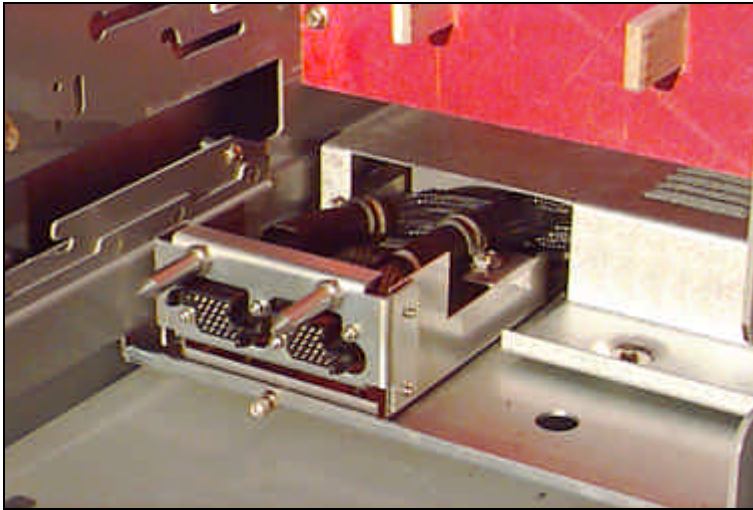
The switchgear bus supports are glass filled polyester laminate. The supports ensure safe operational clearances of bus under normal and abnormal (short circuit) conditions.

### *PRIMARY DISCONNECT DEVICE*

Each circuit breaker primary contact consists of a circle of fingers compressed by a garter spring, or a set of inline fingers compressed with springs. The fingers can be inspected on a withdrawn circuit breaker. The primary contacts are high pressure, self aligning devices. The parts are plated to reduce resistance. The springs are outside the current path.

## *SECONDARY DISCONNECTING DEVICES*

Circuit breakers have self-aligning disconnects sized for the required current. They make contact in the CONNECTED and TEST position, without the need for a test jumper.



**Figure 23. Self-aligning Secondary Disconnects.**

## *GROUND BUS AND CONTACTS*

The ground bus contacts are on the rear of the circuit breaker. The circuit breaker is grounded in all positions.

## *CONTROL WIRES*

The main control leads are in the rear of the bus compartment. All electrically operated equipment connects to these control wires through a control circuit protective device.

## *CIRCUIT BREAKERS*

Circuit breakers ship separately. The factory installs blocks in the movable parts of breakers with under-voltage release.

On each switchgear all circuit breakers of like rating are interchangeable unless the secondary (control) circuit requires otherwise.

Circuit breakers have three positions in the housing.

- 1.** The DISCONNECT position disengages the main and control disconnecting devices on the breaker. They are a safe distance from the stationary part of the devices located on the housings.
- 2.** The TEST position disengages the main disconnecting devices, and engages the control contacts. This position allows operation of the circuit breaker for testing.
- 3.** The CONNECTED position engages the main and control disconnecting devices on the breaker.

Mechanical interlocks prevent moving a circuit breaker from one position to another unless the breaker is open. The interlocks also prevent closing the breaker between positions.

For handling, inserting and removing circuit breakers, refer to IB6.2.11.1-1A, Installation/Maintenance Instructions for Low Voltage Power Circuit Breakers.



## Maintenance

### GENERAL

Inspect all switchgear installations at frequent intervals. Perform a visual inspection, front, and rear, to see that there is no evidence of loose parts, warping, or undue vibration. Take steps to remedy any deficiencies of this nature that may appear. Keep the assembly dry. Cover to prevent moisture from dripping on the equipment. Do not block vents.

#### **DANGER**

*There are hazards of electrical shocks and/or burns whenever working in or around electrical equipment. Turn off power ahead of the switchgear before performing any maintenance operations. Check incoming line terminals to verify that the equipment is de-energized. Check the out-going terminals to make sure that no feedback conditions exist.*

#### **CAUTION**

*Limit the use of solvents to removing grease and contamination from primary conductors, insulation, and from unpainted metallic surfaces. **Do not use alcohol or freons.** Use OSHA approved solvents in accordance with local regulations. Use a non-flammable solvent with a threshold limit of 300 PPM or higher. Use solvents in well-ventilated areas.*

## *SEMI-ANNUAL INSPECTION*

At least twice yearly, perform a thorough inspection of the switchgear. Emphasize the following checks:

- 1.** Perform an overall visual inspection.
- 2.** Check all indicators, meters, and instruments for proper operation.
- 3.** Make sure all bolted panels are secure.
- 4.** Verify operation of heaters and thermostats, if used.
- 5.** Check for undue noise or vibration that might loosen bolted connections.
- 6.** Look for evidence of moisture in the switchgear.

## *ANNUAL INSPECTION*

- 1.** Bolted connections should be tight. Discoloration, excessive corrosion, embrittled or discolored insulation may indicate an overheated connection. If found, follow the procedure described under the section "Suspect Joint Maintenance."
- 2.** Inspect all cables for tight connections and ample support.
- 3.** Inspect control wiring for signs of wear and damage. Replace wires wherever doubtful.
- 4.** Examine resistors and other devices prone to over heating.
- 5.** Open all hinged panels and remove all bolted panels.
- 6.** Clean insulation thoroughly.
- 7.** Withdraw all drawout components and clean. (Refer to Circuit Breaker Instruction Booklet before cleaning circuit breakers)
- 8.** Clean the stationary portion of the switchgear by wiping with a clean cloth. Compressed dry-air is useful in the inaccessible areas.
- 9.** Remove the covers of all panel devices where possible. Check wiring for secure connections. Clean contacts on relays and switches wherever necessary. Replace covers.
- 10.** Remove air filters when used. Flush with water if necessary. Coat filters with Randolph Products', Super Coat Adhesive, or equivalent.
- 11.** Inspect the gearing of the overhead lifting device when used. Keep well lubricated. For normal operation use a heavy gear lubricant. In very dirty or gritty conditions, use a dry lubricant.
- 12.** Follow the recommendations of any individual device instructions furnished for maintenance of the device.



## *18 TO 36 MONTH INSPECTION*

Perform the following at 18 to 36 month intervals or sooner if required by local conditions or regulations.

- 1.** Clean the circuit breaker stationary primary contacts. See IB6.2.11.1-1A, "Installation/Maintenance Instructions for Low Voltage Power Circuit Breakers." Inspect for evidence of excessive heat, arcing, or corrosion. If found, follow the procedure described under "Suspect Joint Maintenance" on page 55.
- 2.** Inspect secondary wiring bundles for signs of discoloration because of heat or chafing. Check for cracked or embrittled insulation. Replace wire whenever doubtful.
- 3.** Inspect primary insulation system for accumulated contamination. Clean insulation with a dry cloth, dry-air, vacuum, or if necessary with an OSHA approved solvent.
- 4.** Check the calibration of protective relays approximately every two years.

## *10 YEAR MAXIMUM INSPECTION*

- 1.** Disassemble, inspect, clean, lubricate, adjust, and calibrate circuit breaker mechanisms.
- 2.** Torque all primary conductor connection bolts to recommended values. See Table 1.
- 3.** Tighten all secondary control wire connections. Check for loose lug crimps and broken wire strands.

## *SUSPECT JOINT MAINTENANCE*

1. Open joint and inspect connection surfaces.
2. Clean surfaces with an OSHA approved solvent. Dress contact surfaces that show minor corrosion or pitting by lightly rubbing with a polishing cloth such as "3M Scotch Brite." Take care to minimize the removal of plating.
3. Replace parts that show signs of heavy corrosion, arcing or melting.
4. Replace contact finger springs after exposure to excess heating at the breaker disconnect.
5. Before assembly, protect contact surfaces with "No-Ox-Id Special A Compound," a product of Sanchem Chemical Co., or equivalent.
6. Use proper torque in tightening bolted connections.

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### **Torque Values for Low Voltage Equipment Hardware**

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Bolt Size (Inches)	Foot-Pounds (Dry Threads)
3/8	15-35
1/2	30-45

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## *CARE OF FINISH*

The finish on the switchgear is strong and durable. Always keep the switchgear clean. Wiping with a clean dry cloth will usually suffice. To remove oil and grease marks, use warm water and soap, wiping dry with a soft clean cloth.

Because the color and finish on the exterior may vary, consult the front sheet of the Bill of Material before using touch up paint . The standard paint color is ANSI 61, light gray. A 12 ounce aerosol can of ANSI 61 touch-up paint is available from ABB under part number 887878A00.

### *RENEWAL PARTS*

Previous experience and the number of vertical sections in service are the best guidelines for determining the stocking of replacement parts. Order factory original replacement parts from ABB Power T&D Company Inc., Distribution Systems Division, Sanford, FL. Specify quantity, part numbers, description, and nameplate data of the device requiring the replacement parts. Obtain standard hardware such as nuts and bolts from local sources.



**For replacement parts, call toll free: 1-800-929-SWGR.**

## Disclaimer of Warranties and Limitation of Liability

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# Index

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## A

AIR FILTERS ..... 49

## B

BILL OF MATERIAL ..... 52

BUS  
 ground ..... 21, 44  
 Supports ..... 43

BUS DUCT FLANGE ..... 24

## C

CHECKOUT ..... 1, 42

CIRCUIT BREAKERS ..... 45

CLEARANCES ..... 7

CONTROL CIRCUIT  
 checkout ..... 35

CONTROL WIRING ..... 44, 49

## D

DRAWINGS  
 arrangement ..... 1  
 erection procedure ..... 24  
 footprint ..... 7  
 lifting device ..... 15  
 site plan ..... 7

## G

GALVALUME™ ..... 43

## H

HEATERS ..... 6

## I

INSPECTIONS  
 semi-annual ..... 48

INSTALLATION ..... 1, 3

clearances ..... 7

conduits ..... 7

foundation ..... 7

## J

JACKS ..... 9

JUMPERS ..... 21

## L

LIFTING DEVICE

drawings ..... 15

lubricant ..... 49

operation ..... 19

overhead ..... 15

## M

MAINTENANCE ..... 1, 3

suspect joint ..... 51

MOVING ..... 10

## P

PAINT

care of ..... 51

color ..... 43

touch-up ..... 52

PHASE ..... 21

PRIMARY DISCONNECTS ..... 43

## R

RECEIVING ..... 5

claims ..... 5

REPLACEMENT PARTS ..... 52

RESISTORS ..... 49

ROLLERS ..... 9

**S**

SAFETY.....3, 4

SECONDARY DISCONNECTS .....44

SETUP ..... 1

SHIPPING BASES

    removal ..... 14

    steel.....9

    wood.....9

SITE PLAN

    drawings .....7

SLINGS ..... 13

STORAGE.....6

**T**

TESTING .....33

TORQUE VALUES .....20, 51

TRANSFORMER TRANSITION UNIT .....31

**W**

WEATHERPROOFING .....24





**K-LINE PLUS**



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