



# Medium Voltage Switchgear Instructions

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## CAUTION

THE MEDIUM VOLTAGE SWITCHGEAR DESCRIBED IN THIS BOOK HAS BEEN DESIGNED AND TESTED TO OPERATE WITHIN ITS NAMEPLATE RATINGS. OPERATION OUTSIDE OF THESE RATINGS MAY CAUSE THE EQUIPMENT TO FAIL, RESULTING IN BODILY INJURY AND PROPERTY DAMAGE.

## PURPOSE

THIS INSTRUCTION BOOK HAS BEEN PREPARED TO HELP ENGINEERS AND TECHNICIANS INSTALL, OPERATE, AND MAINTAIN IEM MEDIUM VOLTAGE SWITCHGEAR. FOR INFORMATION ON THE APPLICATION OF THIS TYPE OF SWITCHGEAR, REFER TO THE PERTINENT ANSI STANDARDS.

## SAFETY

ALL SAFETY CODES, SAFETY STANDARDS, AND SAFETY REGULATIONS MUST BE STRICTLY ADHERED TO WHEN INSTALLING, OPERATING, OR MAINTAINING THIS EQUIPMENT.

## SECTION 1

### RECEIVING, HANDLING AND STORING SWITCHGEAR

#### 1.1 RECEIVING INDOOR SWITCHGEAR

The switchgear is shipped to the customer as completely assembled as possible. Depending on the number of switchgear vertical sections it may be necessary to ship the switchgear in several groups to facilitate handling.

Each switchgear group and all the cartons and crates are labeled with the shop order number and a shipping weight. On one of the groups there will be a shipping packet, securely attached, that contains the shipping lists and storage and handling drawings.

When the switchgear arrives at the installation site, check it to make sure all the parts described on the shipping list have been received. Do this before discarding the packing material to prevent losing parts. If the switchgear has been damaged, file a claim as soon as possible with the carrier and notify the nearest IEM representative.

If the switchgear is going to be installed as soon as it has been received, unpack it and handle it according to the procedure outlined in the following paragraphs. If the switchgear is to be stored, inspect it to make sure the shipment is complete and undamaged. Repack it so it will be protected until it has been installed. (SEE SECTION ON STORAGE OF EQUIPMENT.)

#### 1.2 HANDLING INDOOR OR OUTDOOR SWITCHGEAR

IEM provides a channel base under the switchgear which is an integral part of the gear. Lifting means are supplied at each corner of the shipping section . Lifting must be done as shown in the following diagram.

#### 1.3 OUT DOOR SWITCHGEAR

The switchgear should be immediately installed on the customers prepared foundation and the sections assembled making sure the roof caps are installed at each shipping split. If is not to be energized immediately an outside source of power should be connected to the heater circuit. See shop drawings for voltage and power required.

## 1.4 STORING INDOOR SWITCHGEAR

Packaging for shipping is not suitable for storage. Part of the original packaging may be discarded when switchgear is removed from the carrier. Switchgear bus runs, because of their open connection ends, are particularly vulnerable to moisture and dirt during storage.

If the switchgear must be stored for a while, prepare a suitable storage space. Keep it indoors in a heated building that is clean and dry. The floor should be smooth and level to prevent strain and distortion in the equipment. Be sure the space is well-drained so there is no standing water. Store the switchgear on its skids to keep it off the floor and to allow air to move under it freely.

Take steps to prevent the switchgear against dampness, cement dust, corrosive atmospheres, and extreme temperature changes. To control condensation, make sure the equipment is well ventilated. Install temporary space heaters if necessary.

Switchgear should be checked periodically for any signs of deterioration.

Storing the switchgear outdoors is not recommended.

It is the responsibility of the purchaser to assure protection during storage.

## STORAGE OF SPARE PARTS AND MISCELLANEOUS EQUIPMENT

All parts should be stored with the same care as the main switchgear.

Summary of storage procedures:

1. Check the ventilation of the switchgear itself and of protective coverings. Serious damage can result from a non-ventilated tarpaulin.
2. Check the ventilation of enclosed storage areas of buildings.
3. Check for adequate heat, when in doubt provide heat.
4. Check for distortion.
5. Check for damage and standing water.
6. Check weather protection including open doors, windows, drafts, etc.
7. Avoid outdoor storage.
8. Inspect periodically.

## RECOMMENDED SAFETY PRACTICES

The only people who should be allowed to install, operate, or maintain its equipment are those who meet the qualification requirements described in the National Electric Safety Code.

To perform work on this type of equipment, one must be trained and experienced in working with high-voltage circuits. They should be familiar with the construction and operation of this equipment and aware of the hazards involved.

Before attempting to do any maintenance, always be sure to de-energize both the primary and secondary circuits.

Never leave a breaker in an intermediate position in its compartment. Always crank the breaker into the fully connected or withdrawn position.

Before removing a bolted-on cover first make sure that all the circuits have been de-energized.

Never try to disconnect or open the secondary circuit of a current transformer that is carrying load current. In this situation the transformer develops a dangerous high voltage. Before attempting work either de-energize the circuit by opening the breaker or short-circuit the secondary of the current transformer.

## SECTION 2 INSTALLING INDOOR SWITCHGEAR

### 2.1 OUTLINE OF INSTALLATION PROCEDURE

1. Prepare the installation foundation. It is recommended that floor channels be imbedded in the foundation to maintain a level surface.
2. At the factory the switchgear system may have been divided into groups to facilitate shipping. At the installation site the groups must be rejoined to form the switchgear system. Align the groups, side by side, on the tie bolt holes.
3. Bolt the groups together through the tie bolt holes.
4. Bolt or weld the base members of the vertical section frame, front and rear, to the foundation channels.
5. Remove all shipping braces.

6. Connect the ground bus.
7. Install the primary bus supports, insulated phase conductors, and rubber snubbers removed for shipping.
8. Reconnect the wiring between shipping groups. Run the control wiring for remote apparatus through the conduits in the foundation (or on top of the vertical sections).
9. Replace the metal barriers in the bus compartments.
10. Connect the main power cables and fully insulate the terminals for the voltage class (SEE SECTION 10 & FIG. 14 FOR GUIDELINES).
11. Replace the rear covers on all the vertical sections.
- 12.. Check the operation of the levering-in system in the breaker compartments.
13. Check the potential transformers and the control power transformers in the auxiliary compartments.
14. Perform loading check on both control and primary circuits to assure the system is ready for operation.

## 2.2 DETAILS OF THE INSTALLATION

### 1. PREPARE THE FOUNDATION

REVIEW THE INSTRUCTION BOOKS AND DRAWINGS CAREFULLY.

- A. Locate the switchgear so there is enough aisle space at the front and rear of the system. The amount of space recommended is shown in Fig. 2.
- B. Leave enough space so the doors can be opened and the breakers and transformers can be pulled out for inspection and maintenance. Leave enough space at the rear so there will be room to install the cables and to perform whatever inspection and maintenance that may be necessary.

FOR MINIMUM CLEARANCES REFER TO SHOP DRAWINGS

- C. Make sure the foundation is flat and level.

- D. Design the foundation so it will be strong enough to support the weight of the switchgear without sagging. Table 1 gives the weights of the various ratings of switchgear and breakers. Be sure to take into account the shock or impact weight that occurs when the breaker trips and when it closes. The impact weight is 1.5 times the weight of the breaker.

The weights in the tables are only an approximation. The actual weight will vary, depending on the type and the amount of equipment in the switchgear. Use adequate safety factors.

- E. The recommended foundation consists of steel channels embedded in a level concrete floor. The channels must lie in a flat and level plane. (A slope of 0.125 inch in 3 feet in any direction is acceptable.) In no case may the non-supporting areas of the foundation be higher than the tops of the steel channels.

The anchor bolts, channels, and other materials are to be furnished by the purchaser of the switchgear. A 4-inch structural channel is recommended as the minimum size for the average indoor switchgear system.

## 2. ALIGN THE SHIPPING GROUPS SIDE BY SIDE ON THE FOUNDATION.

- A. Remove the crating and packaging material from the groups of switchgear that are going to be installed.
- B. Let the shipping skids remain on each group until the group has been moved into its final installation position. (The skids help protect the switchgear and reduce the risk that it will be damaged or distorted during the move.)
- C. If an odd number of groups is to be installed, install the middle one first. Then install the other groups, working out from the middle.

If an even number of groups is to be installed, start with either group on either side of the middle shipping break.

If a unit substation or a power center is being installed, line up the power transformer and the adjacent switchgear group first. Set them in the position called for on the drawing of the base plan. Then install the rest of the groups.

- D. Handling the switchgear by crane is the preferred method.

Move the first group into position. Line up the bolt holes in the base of the vertical sections with the bolt holes in the steel channels in the foundation.



A few inches in front of the line-up draw a base line along the length of the intended location of switchgear. As the groups are maneuvered into place, keep the front of each group parallel to the base line.

E. A bolt at each end of the wooden skids holds them to the base of the group. Lift and remove the bolts, and discard the skids.

F. Set the group into its installation position. Use a level to make sure the group is level both across its width and along its length. Use a plumb line to make sure the group is plumb. (To level or plumb the group use shims at the points where the vertical sections will be bolted to the floors.)

Move each group into position and repeat the preceding steps.

G. If no crane is available the groups may be moved on the skids and rollers.

### 3. BOLT THE GROUPS TOGETHER THROUGH THE TIE BOLT HOLES.

A. Remove the back covers from the vertical sections at the shipping group. Insert and tighten tie bolts in the rear upright members.

B. Open the front panels on these vertical sections. Insert and tighten tie bolts between the front upright members.

### 4. BOLT OR WELD THE ENTIRE SWITCHGEAR SYSTEM TO THE CHANNELS IN THE FOUNDATION.

Check the system again to make sure it is level and plumb.

### 5. REMOVE ALL THE SHIPPING BLOCKS OR BRACES.

A. Examine all the meters, relays, etc. and remove any shipping blocks or braces. The time dials on the relays are set at zero in the factory so the relay contacts will be closed during shipping.

### 6. CONNECT THE GROUND BUS.

A. The ground bus in the switchgear is assembled in sections. There is a joint in each housing. Solderless terminals are provided on the ground bus (See the shop order drawing for their location). Use these terminals to connect the ground bus to the station ground. Make the connection as direct as possible. It should be large enough to carry the ground fault current of the installation. Never house it in a metal conduit.

B. The standard ground bus is a .25-inch X 2-inch copper bus bar bolted to the cross members of the frame in the bottom of each enclosure. The ground bus runs through the center of each section through the length of the entire switchgear system. Where the system is split for shipping, a splice plate (and hardware) is furnished to bridge the shipping break when the system is installed.

NOTE: THE IMPORTANCE OF ADEQUATE GROUNDING CANNOT BE OVERSTRESSED. FOR THE DESIGN AND INSTALLATION OF A GROUNDING SYSTEM REFER TO "ELECTRIC POWER DISTRIBUTION FOR INDUSTRIAL PLANTS" (IEEE STD. 141); "GROUNDING OF INDUSTRIAL POWER SYSTEMS (IEEE PUBLICATION 141, FORMERLY AIEE 953); AND THE NATIONAL ELECTRIC CODE, ARTICLES 100, 200, AND 250.

FOR GENERATING STATIONS AND LARGER SUBSTATIONS, THE GROUND RESISTANCE SHOULD BE ONE OHM OR LESS. FOR INDUSTRIAL PLANTS AND SMALL SUBSTATIONS, THE GROUND RESISTANCE SHOULD BE LESS THAN FIVE OHMS. (THE NATIONAL ELECTRIC CODE STATES THAT THE GROUND RESISTANCE SHOULD NEVER EXCEED 25 OHMS.)

7. RECONNECT THE HIGH VOLTAGE BUS WHERE IT WAS DISMANTLED BETWEEN GROUPS.

A. Remove the horizontal and vertical metal barriers from the cable compartment. Remove the main bus barrier. (Also remove any other components such as potheads, surge suppressors, etc. that interfere with access to the bus compartment.)

B. Obtain the section of bus that was removed to separate the groups for shipping. Each section is labeled and shipped in the carton with the details.

C. The surfaces in the bus joints are tin or silver plated. Clean the plated surfaces of the bus section by brushing them lightly with crocus cloth only if necessary. Then wipe clean.

D. Slide the section of bus through the supports in the side of the vertical section. Slide the rubber snubber along the bus until it fits inside the opening in the bus support.

When the bus section is disconnected for shipping, the splice plates and hardware are left bolted to the end of the bus in each of the adjoining vertical sections. Sandwich the end of the disconnected section between the splice plates and fit the other end of the section between the splice plates on the end of the bus in the adjacent section. Bolt the splice plates together on each end of the bus section.

Repeat these steps for each section of bus at each shipping break.

Tighten the bolts in the splice plate to the torque values shown in table 2.

Cover joint with insulating boot (or tape) provided.

8. RECONNECT THE WIRING WHICH WAS DISCONNECTED AT THE FACTORY FOR SHIPPING. THE WIRING IS LABELED.
  - A. Connect the wiring to the remote apparatus and to the terminal blocks mounted within the front of the vertical sections.
9. REPLACE THE METAL BARRIERS AND ANY OTHER PARTS THAT MAY HAVE BEEN REMOVE TO GIVE ACCESS TO THE BUS COMPARTMENTS.
10. CONNECT THE MAIN POWER CABLES.
  - A. Before connecting a cable, determine its phase. The switchgear system is usually supplied with connections for phasing 1-2-3 left to right (viewed from the front). Check the shop order drawing to make sure because sometimes another phasing may have been specified.
  - B. If two systems are to be paralleled, make sure the phase rotation and the phase angle are the same. They must be the same to prevent damaging the equipment. The phase rotation must conform to the phase rotation on the shop order drawing so that the instruments, meters, and relays will operate properly.
  - C. When forming cables to fit inside the cable compartment, avoid bending it sharply or kinking it. Make sure it doesn't rest on sharp corners or edges that could damage the insulation.

Table 2 - Bolt Tightness for Bus Connections  
Torque in Foot--Pounds

Bolt Material	for Bolt Size				
	.25-20	.31-18	.38-16	.50-13	.6-11
High Strength Steel	5	12	20	50	95
Silicon Bronze	5	10	15	40	55

- D. Follow the instructions of the cable manufacturer to determine what minimum bending radii is permitted. Follow the instructions on insulating the joints so the insulation will taper properly through the correct gradient. The insulation will vary with the type and size of cable and with the service voltage for which it was designed.
  - E. Solderless connectors are usually furnished. The connection must be insulated according to the recommendation of the cable manufacturer.

F. If potheads or other types of terminators are furnished, follow the instructions of the manufacturer when connecting the cable to them. Use the flexible connectors to connect the aerial lugs to the conductors. This will keep strain off the insulators of the pothead or the terminator. Tape (or otherwise insulate) the entire joint (including the flexible connectors). SEE SECTION 10

G. If zero sequence current transformers are used, pass the power cables through the transformer. Connect it to the terminals or to a pothead.

11. REPLACE THE REAR COVERS ON ALL THE VERTICAL SECTIONS.

12. Insert draw-out extension rails per fig. 3 to install breakers.

13. Install the breakers per fig. 3A using optional portable lifter shown, or other device.

14. Test breaker and cell interface per section 4 of breaker I.B. 32-255-1.

15. Check the voltage transformers, control power transformers and drawout fuses in the auxiliary compartments.

A. The potential transformers and control transformers (If supplied) are mounted in compartments below their respective disconnect switches. Refer to KEY INTERLOCK SYSTEM- PT SECTION AND KEY INTERLOCK SYSTEM-CPT SECTION for access to the PTS and CPT and interlock system . Do not attempt to defeat the interlocking as injury and or damage could occur.

## SECTION 3

### INSPECTION AND MAINTENANCE

#### 3.1 SAFETY PRECAUTIONS

When inspecting, repairing, and performing maintenance on high voltage switchgear, the fact that dangerous voltages may exist must be kept in mind; and precautions must be taken to insure that personnel do not come in contact with energized high voltage parts. Failure to do so could result in personal injury or property damage.

#### SOME COMMON GENERAL PRECAUTIONS FOR HIGH VOLTAGE WORK ARE:

1. All connections should be considered energized until the crew expecting to work on them is assured that the circuits are de-energized, and until every possible precaution has been taken to see that there is no chance of a circuit being energized while the crew is working.

2. Switches which have been opened to de-energize a circuit to permit work on equipment should be locked or blocked open and a suitable visible warning device placed on them.

3. Do not work on parts normally carrying current at high voltage until these parts have been disconnected and grounded to the ground bus. Provision should be made by the purchaser for connecting adequate flexible ground leads to every part of the switching equipment.

4. A good and reliable ground connection is necessary for every switchgear installation. It should be of sufficient capacity to take care of any abnormal condition that might occur on the system and should be independent of the grounds used for any other apparatus. SEE GROUND BUS CONNECTIONS.

### 3.2 ACCESS TO SWITCHGEAR PARTS 1 HIGH VOLTAGE PARTS

IEM HIGH VOLTAGE SWITCHGEAR is designed so that internal compartments provide metal isolation between the circuit breaker compartment, the main bus, and the primary line terminations. Access to high voltage parts is provided by removable covers and barriers which should not be removed unless the parts to be exposed are de-energized.

#### 2. MAIN CONTACTS AND CURRENT TRANSFORMERS

Both the stationary main disconnecting contacts and the ring-type current transformers are located behind the glass polyester CT barrier.

Upper and/or lower contacts and transformers are easily exposed (See figure 10). For this reason caution must be exercised. Do not expose any contacts or transformers unless all upper and lower high voltage parts are de-energized. Failure to do so could cause personal injury or property damage.

#### 3. DISCONNECTING TRANSFORMERS AND FUSES

Simply opening the disconnect automatically disconnects and grounds the moving high-voltage parts. See KEY INTERLOCK SYSTEM-CPT SECTION.

**CAUTION: DO NOT ATTEMPT TO REMOVE THE BACK COVERS, THE DISCONNECTING ASSEMBLIES OR BARRIERS UNLESS THE HIGH VOLTAGE CIRCUIT TO THE COMPARTMENT IS DE-ENERGIZED AND PRECAUTIONS TO PREVENT RE-ENERGIZED HAVE BEEN TAKEN. FAILURE TO DE-ENERGIZE THE CIRCUIT AND TO TAKE PRECAUTIONS TO PREVENT RE-ENERGIZING IT COULD RESULT IN BODILY INJURY OR ELECTROCUTION. WHEN ENERGIZED, CIRCUIT CARRIES LETHAL HIGH VOLTAGES.**

## 4. CONTROL EQUIPMENT

With the exception of apparatus such as current transformers and rear-mounted heaters, control equipment and wiring is, generally accessible without exposing high voltage parts.

### 3.3 INSPECTION AND MAINTENANCE SCHEDULE

To assure high quality service, a definite maintenance schedule, systematically followed, is essential. Plant, operating, and local conditions vary to such an extent that the schedule must be prepared to suit the conditions. However, the following general requirements should be helpful in setting up the program.

**CAUTION: BEFORE ATTEMPTING ANY INSPECTION OR MAINTENANCE BE SURE THAT ALL PRIMARY AND CONTROL CIRCUITS HAVE BEEN DE-ENERGIZED AND GROUNDED AS REQUIRED AND THAT PROPER STEPS HAVE BEEN TAKEN TO BE SURE THAT THEY WILL REMAIN DE-ENERGIZED UNTIL ALL WORK IS COMPLETED. FAILURE TO DO SO COULD RESULT IN BODILY INJURY OR ELECTROCUTION. WHEN ENERGIZED, CIRCUIT CARRIES LETHAL HIGH VOLTAGES.**

#### 1. INDIVIDUAL DEVICES

The maintenance schedule for individual devices such as circuit breakers, relays, etc. should be based upon recommendations contained in the individual instruction book for the device. These operations should be coordinated with the overall program to result in the least operating inconvenience and circuit shutdown.

#### 2. OVERALL INSTALLATIONS

The switchgear installation should be given a thorough overall maintenance check at the end of the first year in service because it provides an opportunity to evaluate conditions at an early point in the life of the equipment. Where conditions are abnormal, more frequent inspection and maintenance is necessary, where conditions warrant, a longer period of time between maintenance periods may be used. The following require attention:

#### 3. BUSES AND CONNECTIONS

De-energized primary circuits and remove cover plates from the primary compartments. Before cleaning take "MEGGER" readings between phases and to ground. Inspect for signs of overheating or weakened insulation. Remove dust from buses, connections, supports, and enclosure surfaces. A vacuum cleaner with a long nozzle will be of assistance. Wipe clean with a warm soap water solution, wipe dry.

After buses have been dusted and wiped clean, take "MEGGER" readings again between the buses and ground and between phases. Keep a record of these readings for future reference in determining when trends occur that would indicate a lowering of the insulation resistance.

Periodic high potential tests are not required and are recommended only after repair of high voltage buses or installation, or when the trend of megger readings indicates it to be advisable. This field test should be made before the main cables are connected and should not exceed 14.25 kV, 60 HZ, 1 Minute, for 4.76 kV switchgear, a 27 kV, 60 HZ, 1 Minute for 8.25 kV and 15.0 kV switchgear AND 45KV, 60HZ, 1 minute for 25KV switchgear. Transformer primary fuses should be removed and surge protective devices such as capacitors and arresters disconnected during high potential tests.

#### 4. MAIN DISCONNECTING CONTACTS AND SUPPORTS

Remove each breaker from its compartment. De-energize primary circuits and expose primary contacts and their supports. Wipe clean with a cloth moistened in a non-flammable solvent. Inspect for abnormal wear or overheating. Discoloration of the surfaces is not harmful unless corrosion due to Atmospheric conditions is severe, leaving deposits on the surface. If necessary, these can be removed by a light application of crocus cloth. Check each breaker while it is out of the housing for all items recommended in the instruction book applying to that particular type of breaker. SEE INSTRUCTION BOOK 32-255-1.

#### 5. OTHER DISCONNECTING CONTACTS

Inspect all primary and secondary disconnecting contacts such as those on drawout transformers for abnormal wear, fatigue, or overheating. Replace if necessary. Otherwise treat the same as main disconnecting contacts above.

#### 6. CONTROL CONTACTORS

Contacts should be inspected and dressed or replaced when the surface becomes pitted. Unless repetitive duty has been experienced, little attention should be required.

#### 7. INSTRUMENTS, RELAYS AND OTHER PANEL MOUNTED DEVICES

Individual devices should be maintained according to the specific instructions supplied for each device. Remove all relay covers and inspect the interiors for dust or dirt. This operation can most readily be performed by relay test personnel during period relay tests.

## 8. SECONDARY WIRING

Check all wiring connections for tightness including those at the current and potential transformers and at the terminal blocks where circuits leave the switchgear. Make sure that all secondary wiring connections are properly connected to the switchgear ground bus where so indicated.

## 9. MECHANICAL PARTS

Visually check and manually operate mechanical moving parts such as the shutter, TOC and MOC switch assemblies, the position interlock, hinged doors. Examine mechanical mating parts such as the breaker secondary contacts blocks, side rails and trippers.

## 10. VENTILATION

Check all labyrinths, grillwork, and air passages for obstructions and accumulations of dirt.

## 11. BATTERY AND CHARGING EQUIPMENT ( IF SUPPLIED)

The control battery is such an important item in switchgear operation that it must be given special periodic attention if it is to give reliable service for a long period of time. Periodic inspections and tests are recommended in the battery supplier(s) instructions. At the same time the battery is checked, inspect the battery charger and remove accumulations of dust and dirt. On all chargers having a manual transfer switch for setting the charging rate, check carefully to be sure that the selector switch is returned to the value appropriate for a floating charge at the end of the periodic inspection. Serious damage to the control battery can occur if the charger is left on a high charging rate for an extended period of time.

## 12. RECORDS

The condition of each switchgear unit at the time of inspection should be listed in a permanent record to become a guide for anticipating the need for replacements or for special attention between the regular maintenance periods. Megger tests are suggested for checking the insulation. A series of these tests will indicate any tendency toward a reduction in dielectric strength of the insulation. Megger readings should be taken before and after cleaning the equipment and, where possible, under similar conditions at successive periods. Records should include the megger reading, the temperature and the humidity. The readings will vary with the extent and design of the bus structure. In contrast with a small installation, the longer switchgear assemblies will have a more extensive bus structure with a greater number of insulators and thereby, a larger number of parallel insulation resistance paths to ground which will tend to decrease megger



readings. This variation in insulation resistance between different switchgear assemblies emphasizes the value of a series of readings which can be charted to establish a normal insulation level so that progressive weakening of the insulation can be recognized.

### 13. ABNORMAL CONDITIONS

Local conditions such as high humidity, salt-laden atmosphere, corrosive gases, heavy dust, or severe circuit operating conditions, are considered to be abnormal; And will require more frequent inspections.

It should be emphasized that a series of inspections should be made at quarterly intervals until the progressive facts of the local conditions can be analyzed to determine a schedule which will maintain the equipment in satisfactory condition.

In some locations conditions may be so bad that the frequency of maintenance will interfere with operating and production schedules. In such cases, consideration should be given to the possibility of enclosing the switchgear equipment in a relatively tight room and to supplying a sufficient quantity of clean air to maintain a positive pressure in the room. Under such conditions maintenance schedules may then be established on a more normal basis. Such an arrangement might also provide for cooling the air where the ambient temperature is relatively high, thus further improving operating conditions.

## SECTION 4 LUBRICATION

IEM high voltage switchgear is designed so that lubrication is not required under normal conditions. However, abnormal local conditions such as high humidity, salt-laden atmosphere, corrosive gases, or severe circuit operating conditions may demand the use of lubricants. In such cases a dry or powder lubricant should be used on moving or mating mechanical parts and a thin film of Vaseline on disconnection contacts. The application of the lubricants should be held to a minimum to reduce the accumulation of the dust and dirt.

## SECTION 5 RENEWAL PARTS

When ordering renewal or spare parts, include as much information as possible. In many cases the style number of the new part can be obtained from identification on the old part. Always include a description to the part. Specify the rating, housing number, and shop order number of the metal-clad housing in which the part is to be used.

## SECTION 6

### 6.1 SAFETY FEATURES

IEM high voltage switchgear is manufactured with several built in interlocks. These interlocks are intended to protect persons, working on the equipment. Never make these interlocks inoperative. Doing so can damage property and cause severe injury.

FOLLOWING ARE TWO OF THE INTERLOCKS:

#### 1. CODING PLATES

A coding plate is fastened to the bottom front edge of the breaker compartment. There is also a coding plate fastened to the front of the breaker. If the breaker has a lower interrupting rating than the rating of the compartment, or if the voltage and continuous current characteristics don't match, the coding plate on the compartment will prevent the entrance of the breaker into the compartment.

NOTE: EVEN WITH THE CODING PLATES IT IS POSSIBLE TO PUT INTO THE COMPARTMENT A BREAKER WHOSE CONTROL WIRING IS NOT COORDINATED WITH THAT OF THE COMPARTMENT. ALWAYS CHECK THE SHOP ORDER DRAWING TO MAKE SURE THE CONTROL WIRING OF THE BREAKER AND THE COMPARTMENT ARE BOTH THE SAME.

#### 2. AUTOMATIC SHUTTER

An automatic shutter, shown in Fig. 9, covers the primary disconnecting contacts when the breaker is withdrawn from the operating position. The shutter prevents persons who are working on the switchgear from accidentally touching the primary contacts. Shutters also cover the stationary disconnects for draw-out transformers and primary fuses.

### 6.2 INTERRUPTER POLE UNIT MOUNTING

Each mounting is made of two glass polyester moldings backed up by a steel barrier.

#### CONTACT STUD

May be flat, as shown, or round, dependent on amperage rating.

### 6.3 RING-TYPE CURRENT TRANSFORMERS

The ring-type current transformers are mounted so they slip over the primary contact insulating tube on the rear wall of the breaker compartment. There is space for a max. of four standard accuracy transformers per phase (2 on each side of the breaker). A polyester CT barrier restricts unconscious access to the CT's.

They are mounted so they can be reached from the front of the enclosure . This makes it possible to add or to change transformers when the switchgear is de-energized

without handling high voltage connections or breaking the primary insulation. The polarity marks on the transformers show the relative instantaneous polarity in the primary and secondary windings. The diagrams show how to connect the transformers to give polarity needed to operate relays and instruments.

**CAUTION: DO NOT MANUALLY RAISE OR REMOVE SHUTTER UNLESS MAIN CONTACTS ARE DE-ENERGIZED AND SAFETY PROCEDURES HAVE BEEN INITIATED TO MAKE SURE THE CIRCUITS CAN NOT BE RE-ENERGIZED. FAILURE TO EXERCISE CAUTION MAY RESULT IN BODILY INJURY AND PROPERTY DAMAGE.**

#### 6.4 AUTOMATIC SHUTTER

The automatic shutter closes when the circuit breaker is withdrawn from the compartment. The shutter covers the primary contacts and keeps workmen from coming into contact with them. The shutter is raised by a roller on the breaker when the breaker is levered into the connected position. When the breaker is levered out, the shutter closes by positive action.

#### 6.5 KEY INTERLOCKS

Keylock interlocks are often supplied in conjunction with disconnecting switches, dummy elements and special compartments to which access is to be denied unless the circuit breakers controlling the power to these no-load-switching devices have been withdrawn to the test position. The operation of key interlock schemes is generally described by a note or keying chart on the shop order assembly drawings.

**CAUTION: TO FACILITATE MANUFACTURE AND INSTALLATION PROCEDURES, A KEY IS USUALLY SUPPLIED WITH EACH LOCK. BEFORE PLACING SWITCHGEAR WITH KEY INTERLOCKS IN OPERATION, THE KEY SCHEME MUST BE CAREFULLY CHECKED; AND ONLY THE PROPER KEYS LEFT IN THE LOCKS. ALL EXTRA KEYS MUST BE REMOVED AND DESTROYED OR STORED WHERE NOT AVAILABLE TO OPERATING PERSONNEL. THIS PROCEDURE IS NECESSARY SINCE IMPROPER USE OF SPARE KEYS WILL DEFEAT THE INTERLOCKING SCHEME.**

### SECTION 7 ADJUSTING AND TESTING

1. After the switchgear has been installed and connected to the apparatus it is to control give it a final check before it is put into service. (Make sure the apparatus being controlled is not connected to the system while the tests are being carried out.)

The testing equipment will depend on the, size and type of installation. Use portable voltmeters. Rig up some simple device for "ringing" or "lighting out" circuits.

2. Examine all wiring circuits to make sure they have not been damaged or loosened during shipment or installation.
3. Make sure all the connections are correct before the equipment is operated. 'light out' connections between the switchgear and remote apparatus such as instrument transformers, auxiliary switches and remote control and interlock circuits.
4. Coordinate the settings of the relays with other parts of the system in accordance with the standards or operating practice of the purchaser.
- S. If the covers are removed from meters, relays, or other devices for installation or test, handle them carefully. Replace the covers as soon as possible to keep out dust and dirt.
6. Perform a loading check of the control circuits.
- A- Before energizing the control circuits, check the control bus with an ohmmeter to make sure there are no short circuits in the control wiring. If an ohmmeter is not available, connect a small fuse in series with the source of the control power. This will protect the control wiring against damage. (The fuse should be one-fourth the normal rating of the circuit).

## SECTION 8 OPERATION OF THE SYSTEM

1. Install the circuit breakers and check their operation.
2. Study and be sure to understand the diagrams furnished with each switchgear system.
3. NOTE: AS CHECKS ARE BEING MADE THE BREAKERS SHOULD BE IN THE TEST POSITION WITH THE SECONDARIES MADE UP.
4. A green light on the hinged instrument panel on the front of the breaker compartment shows the breaker is open. A red light shows the breaker is closed. In a D-C control scheme the red light supervises the trip coil and indicates the trip coil circuit has continuity.
5. The details of the breaker control schemes vary from one installation to another. They comply with the requirements set forth by IEEE, NEMA, and ANSI. All of the schemes are designed to coordinate electrically with the mechanical design of the breaker.