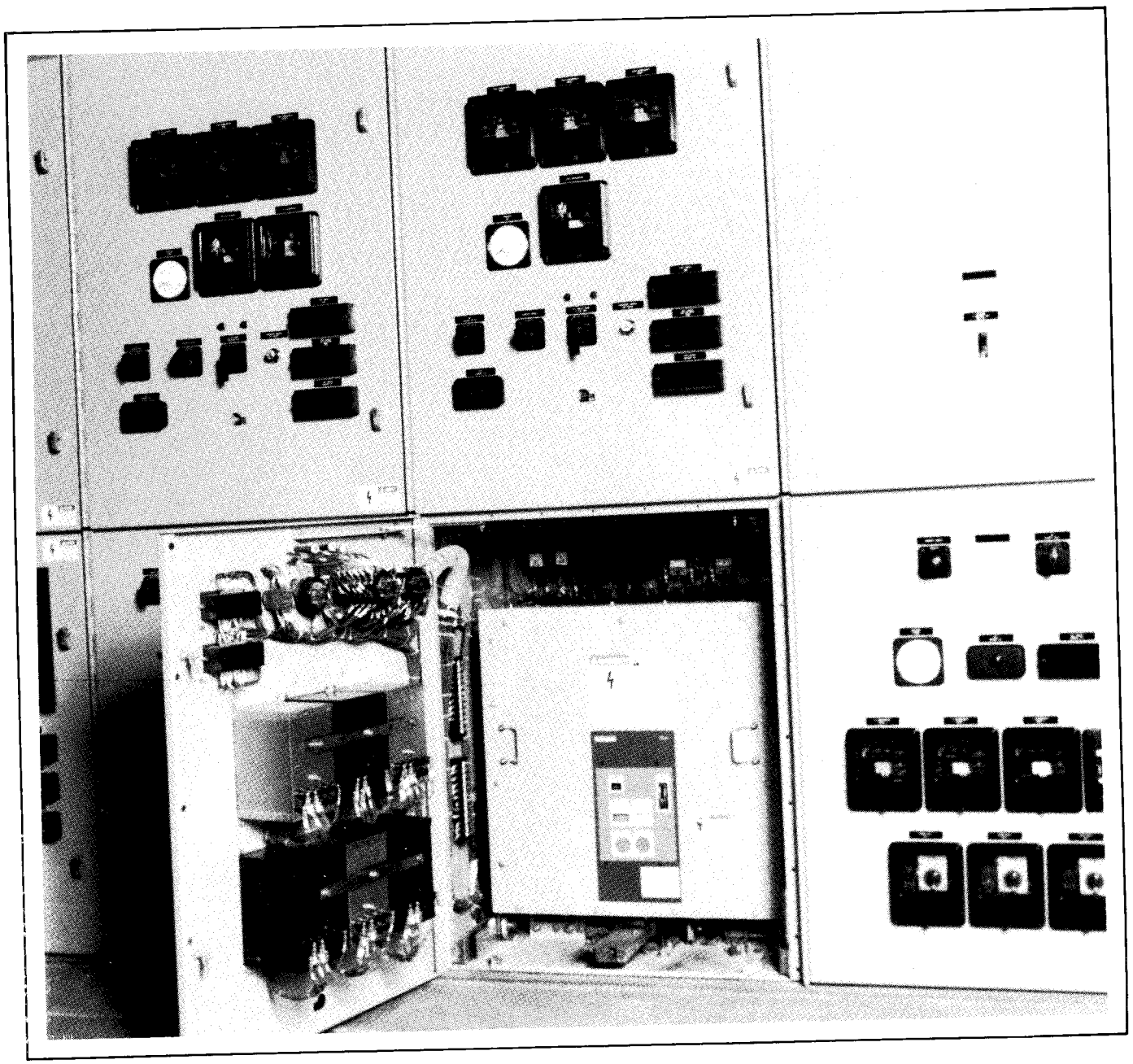
SIEMENS

Metal Clad Switchgear

Type GM 5kV—15kV

Instruction
Installation
Operation
Maintenance
Parts
SG-3258



Introduction

The GM family of vacuum Metal-Clad Switchgear is designed to meet all the applicable ANSI, NEMA and IEEE standards. Successful application and operation of this equipment depends as much upon proper installation and maintenance by the user as it does upon the careful design and fabrication by Siemens.

The purpose of this Instruction Manual is to assist the user in developing safe and efficient procedures for the installation, maintenance and use of the equipment.

Contact the nearest Siemens representative if any additional information is desired.

Safety

This equipment contains hazardous voltages, and remotely controlled mechanical parts which move at high speed. Severe personal injury or property damage can result if safety instructions are not followed.

Only qualified personnel should work on or near this equipment after becoming familiar with all warnings, safety notices and maintenance procedures described in the manuals covering this equipment.

Qualified Person

A "Qualified Person" is familiar with the installation, construction and operation of this equipment. In addition, this person has the following qualifications:

- Training and authorization to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety practices.
- Training in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses, face shields, flash clothing, etc., in accordance with established safety procedures.

Signal Words

The signal words "**Danger**", "**Warning**" and "**Caution**" used in this manual indicate the degree of hazard that may be encountered by the user. These words are defined as:

Danger—Indicates death, severe personal injury or major property damage *will* result if proper precautions are not taken.

Warning—Indicates death, severe personal injury or major property damage *can* result if proper precautions are not taken.

Caution—Indicates some personal injury or property damage may result if proper precautions are not taken.

⚠ DANGER

Power circuit breakers operate at high voltages and have spring-loaded mechanical parts which operate at high speed. When operated improperly, this equipment will cause death, personal injury and property damage.

To avoid electrical shock, burns and entanglement in moving parts this equipment must be installed, operated and maintained only by qualified persons thoroughly familiar with the equipment, instruction manuals and drawings.

Dangerous Procedures

In addition to other procedures described in this manual as dangerous, user personnel must adhere to the following:

1. Always work on a de-energized breaker. Always de-energize a breaker, and remove it from the metal-clad switchgear before performing any tests, maintenance or repair.
2. Always perform maintenance on the breaker after the spring-charged mechanisms are discharged (except for tests of the charging mechanisms).
3. Always let an interlock device or safety mechanism perform its function without forcing or defeating the device.

Field Service Operation

Siemens can provide competent, well-trained Field Service Representatives to provide technical guidance and advisory assistance for the installation, overhaul, repair and maintenance of Siemens equipment, processes and systems. Contact regional service centers, sales offices or the factory for details.

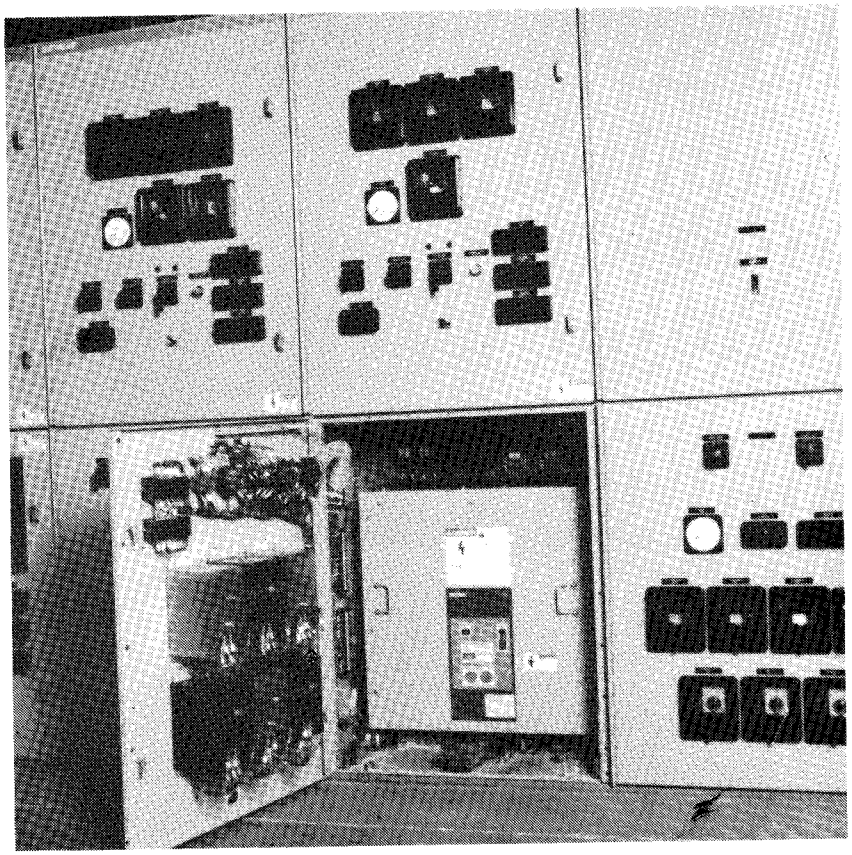


Figure 1. Typical Indoor Type GM Switchgear

Introduction

The successful performance and application of Metal-Clad Switchgear depends as much on proper installation and maintenance as it does on good design, careful manufacture and correct application.

Type GM, Siemens Metal-Clad Switchgear is precision built equipment designed to function efficiently under normal operating conditions. It is designed and manufactured to operate within the ANSI C37 standards for Metal-Clad Switchgear. Performance requirements of these standards have been met or exceeded by these designs. Specific Standards which apply include:

C37.20.2 Metal-Clad Switchgear.

These instructions included in this book are provided to aid you in obtaining longer and more economical service from your Siemens switchgear. For proper installation and operation, this information should be distributed to your operators and engineers.

By carefully following these instructions, difficulties should be avoided. However, they are not intended to cover all details of variations that may be encountered in connection with the installation, operation and maintenance of this equipment.

Should additional information be desired, including replacement instruction books, contact your Siemens representative.

Scope

These instructions cover the installation, operation and maintenance of Siemens type GM vacuum, horizontal drawout, metal-clad switchgear assemblies. The equip-

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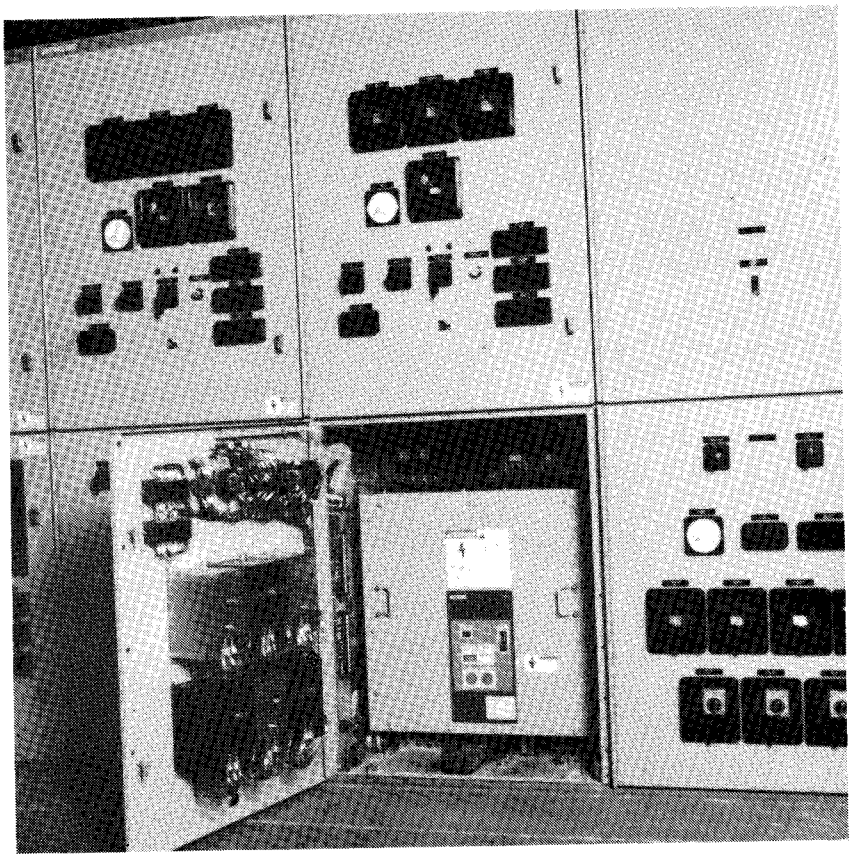

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Scope

These instructions cover the installation, operation and maintenance of Siemens type GM vacuum, horizontal drawout, metal-clad switchgear assemblies. The equip-

ment described in this manual consists of indoor, Shelter-Clad walk-in aisle outdoor, and non-walk-in outdoor designs in 4.76kV, 8.25kV, and 15kV classes. A typical indoor switchgear assembly is shown in **Figure 1**. All diagrams, descriptions and instruction apply to all the above classes and designs unless noted otherwise. Standard construction details of the switchgear, auxiliary equipment and necessary accessories are given in the appropriate sections. Special mechanical and electrical devices, furnished in accordance with purchase order requirements, are covered by supplementary instructions submitted with this instruction book. Ratings described in this manual are in accordance with NEMA, IEEE and ANSI standard requirements.

The equipment furnished has been designed to operate in a system having the circuit capacity specified by the customer. If for any reason the equipment is later used in a different system, or if the short-circuit capacity of the system is increased, the momentary rating of the switchgear, the interrupting capacity of the circuit breakers and the bus capacity must be checked. Failure on the part of the user to receive approval of intended changes from Siemens may cause voiding the warranty.

General Description

The switchgear described in this manual is the metal-clad type. All parts are completely enclosed within grounded metal barriers. Secondary control devices and primary circuits are isolated from each other by shutters or barriers. Primary bus and joints are completely encased with insulation materials to suit the voltage class of the equipment.

Siemens switchgear carries a letter designation as shown in **Table 1**. These designations may appear on drawings and familiarity with them will simplify communications with the factory.

Indoor equipment is arranged with the circuit breaker compartment behind the instrument panel. The hinged instrument panel is opened to provide access to the circuit breaker. Typical indoor switchgear is shown in **Figure 1**.

Table 1. Switchgear Designation

DESIGN	CLASS
Indoor	GM
Shelter-Clad Single Aisle Outdoor	SGM
Shelter-Clad Common Aisle Outdoor	SGM
Non-Walk-In Outdoor	OGM

Shelter-Clad outdoor equipment consists of indoor equipment enclosed in a weatherproof housing complete with an illuminated, walk-in aisle. Circuit breakers can be moved into the aisle with use of a transfer dolly or lift truck and control devices checked without exposure to the elements.

Non-Walk-In outdoor switchgear consists of indoor equipment enclosed in a weatherproof housing complete with a gasketed door over the instrument and relay panel. Circuit breakers can be moved outside of the cubicles with the use of a lift truck. Non-Walk-In outdoor equipment is used where it is felt that an enclosed service aisle is unnecessary or space does not permit its use.

Receiving

Type GM Metal-Clad switchgear is normally shipped with type GMI vacuum circuit breakers in the connected position in their cubicles. (See Instruction Book SG-3268 for type GMI Vacuum Circuit Breaker Information). Each group of switchgear is securely blocked and braced for shipment. It is crated, boxed, or covered as required by shipping conditions. Whatever method of shipment, every precaution is taken to insure its safe arrival. If special handling is required, it is so indicated. Relatively delicate instruments are included and the switchgear assembly must be handled carefully when unloading.

Identification

When shipment consists of more than one shipping group or more than one substation, marking tags are attached to each crate or package for identification. The drawing number on the tag is also on the customer's copy of the shipping list. The shipping list identifies the contents with the unit numbers included in the shipping group. Refer to the general arrangement drawing for the location of each unit within the group line-up. Use this information to simplify the assembly operation and save unnecessary handling.

Inspection and Unpacking

Inspect the equipment as soon as possible after receiving for any damage that may have occurred in transit. Before unpacking, examine the package itself; a damaged package may indicate an area of damage within. Be careful when unpacking equipment. The use of sledge hammers and crowbars may damage the finish, if not the equipment itself. Use nail pullers. After unpacking, examine equipment for any possible damage. Check the shipping manifest to be certain that all items have been received. If there is a shortage, make certain it is noted on the freight bill and contact the carrier immediately. Notify the Siemens sales office of any shortage or damage.

Shipping Damage Claims

Important

The way visible shipping damage is treated by consignee prior to signing the delivery receipt can determine the outcome of the damage claim to be filed.

Notification to carrier within the 15 day limit on concealed damage is essential if loss resulting from unsettled claims is to be eliminated or minimized.

1. When shipment arrives note whether equipment is properly protected from the elements. Note trailer number on which the equipment arrived. Note blocking of equipment. During unloading make sure count agrees with delivery receipt.
2. Make immediate inspection upon arrival for visible damage. This should be done prior to unloading when possible. When total inspection cannot be made on vehicles prior to unloading, close inspection during unloading must be maintained and visible damage noted. Take pictures if possible.
3. Any visible damage must be noted on the delivery receipt and acknowledged with the driver's signature. The damage should be detailed as much as possible. It is essential that a notation "Possible internal damage, subject to inspection" be included on delivery receipt. If driver will not sign the delivery receipt with damage noted, the shipment should not be signed for by the consignee or his agent.
4. Notify the Siemens Sales office immediately of any damage.
5. Arrange for a carrier inspection of damage immediately. **IMPORTANT:** Do not move equipment from point it was set when unloading. Equipment must be inspected by carrier prior to any handling after receipt. This eliminates loss due to claims by carrier that equipment was damaged or further damaged on site after unloading.
6. Be sure equipment is properly protected from any further damage by covering it properly after unloading.
7. If practical make further inspection for possible concealed damage while carrier inspector is on site. If inspection for concealed damage is not practical at the time the carrier inspector is present it must be done within 15 days of receipt of equipment. If concealed damage is found, the carrier must again be notified and inspection made prior to taking any corrective action to repair. Also notify Siemens Sales office immediately.
8. Obtain the original of the carrier inspection report and forward it along with a copy of the noted delivery receipt to the Siemens Sales office. Approval must be obtained by Siemens from the carrier before any repair work can be performed. Before approval can be obtained the documents requested must be in our hands. The carrier inspection report and/or driver's signature on the delivery receipt does not constitute approval to repair.

Important

Any adverse judgment as to whether the equipment was properly loaded or properly prepared by shipper for over-the-road travel cannot be made at the destination. We do not release shipments without a clear bill of lading. We use approved methods of preparation, loading, blocking and tarping of the equipment before it leaves our plant. Damage to the equipment had to occur while enroute due to conditions beyond our control. If the procedure outlined above is not followed by the consignee, customer, or his agent, Siemens cannot be held liable for repairs. We will not be held liable for repairs in any case where the work was not authorized by us prior to being done.

Lifting and Moving

General

Each group of switchgear has provisions for attaching lifting equipment. Though the lift points vary in location on indoor, Shelter-Clad outdoor, and non-walk-in outdoor designs, all are designed for use with a crane of adequate height and capacity. To estimate the maximum required crane capacity, multiply the number of sections to be lifted by 5,000 pounds.

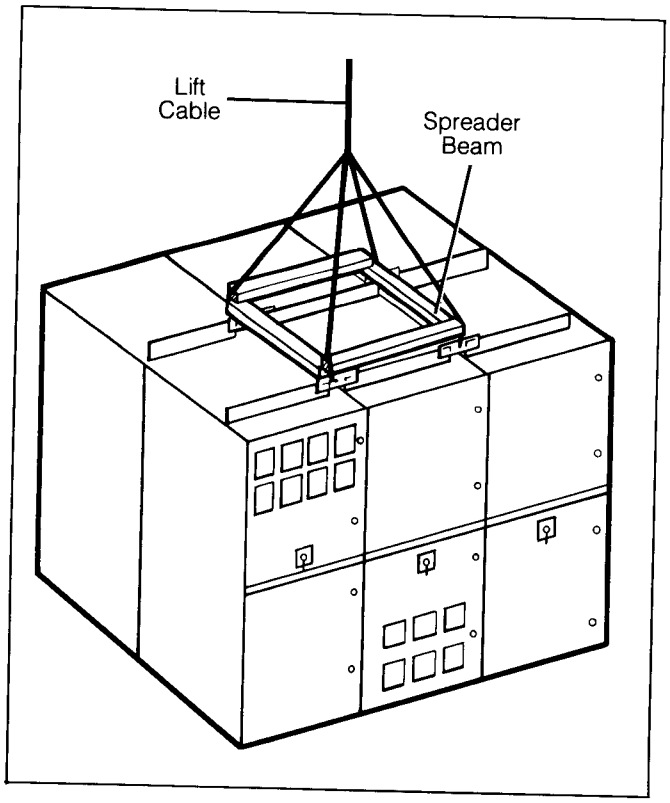


Figure 2. Lifting Indoor Switchgear—with Crane

Indoor Switchgear

Before removing the protective packing materials, indoor equipment may be moved by crane with lift cables attached through the packaging to the lifting bars on the top of the switchgear. If crane facilities are unavailable, or if tight spaces prevent use of a crane, rollers under the skids may be used.

Lifting Indoor Switchgear with Crane

Recommended lifting of indoor switchgear is by means of four cables connected to an overhead crane. The cables are connected to the eyes in the top front and top mid-mounted lifting bars (**Figure 2.**) A crane with sufficient height should be used so the load angle on the lifting cables will be at least 45 degrees, when viewed from the front or the rear. A lesser angle could cause the equipment to be damaged. The lifting cables must have spreaders from front to rear to prevent twisting the lift supports.

Moving Switchgear in Obstructed Areas without a Crane

Within buildings and obstructed areas, where a crane cannot be used, move switchgear with rollers, cribbing, jacks and other such equipment as may be required to meet the situation. Forklift trucks should be used with discretion as improper lift points could cause extreme damage to equipment.

Jacks may be used to lift switchgear which is properly supported by sturdy timbers.

To prevent distortion of the cubicles, rollers and cribbing of equal height must be used in sufficient number to evenly distribute the load.

Figure 3 shows a method of using jacks on indoor switchgear to facilitate the use of rollers under the shipping skid. Care must be used to prevent damage to instruments and to maintain the stability of the timbers.

Remove rollers and lower switchgear carefully. Leave wooden skids (when provided) in place during moving operation until final location is reached.

Outdoor Switchgear

The method of lifting non-walk-in or Shelter-Clad outdoor equipment is shown in **Figure 4**. The load angles on the lifting cables, as viewed from the front or rear, must be at least 45 degrees. A lesser angle could damage the equipment. The lifting cables must have spreaders front to back

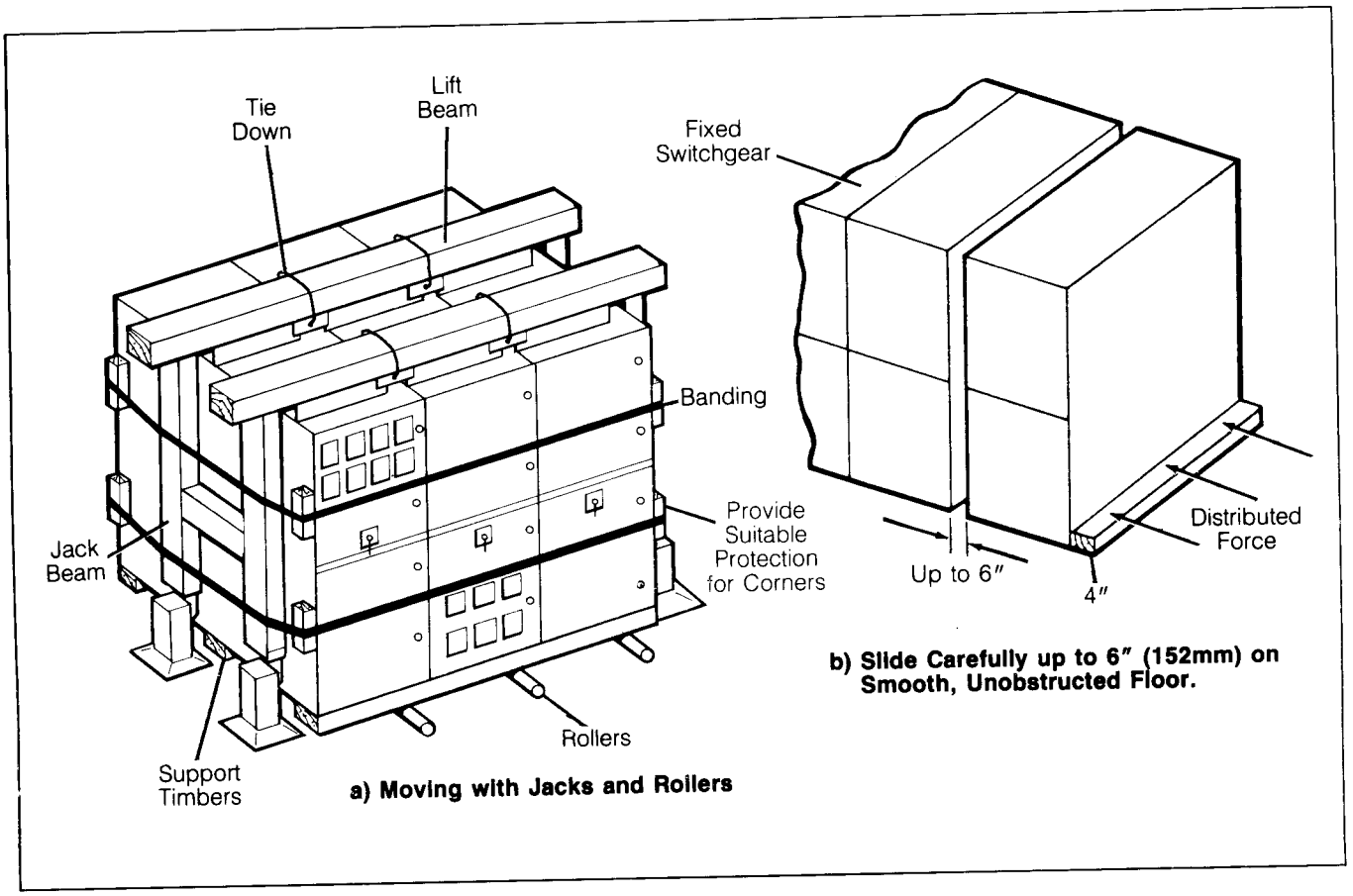


Figure 3. Moving Indoor Switchgear

and side to side to protect the equipment. The lifting pipe sizes are:

1-4 Units	2-1/2" XX-Strong (Extra Heavy)
5 or More Units	2-1/2" XCX-Strong (Extra Heavy)

Figure 5 shows a method of using jacks on outdoor switchgear to facilitate the use of rollers under the shipping skid. Care must be used with this method to prevent damage to the doors and to maintain stability of the timbers. Refer to previous section for additional information.

Final Movement of Assembly

Proper final movement and connection of the assembly requires that several items be completed:

- Preplan sequence of installation movements and connections.
- Where equipment must be slid into final location, start with the left end shipping group and continue in sequence. Secondary conduits which stub-up above floor level may block sliding in either direction.
- Protect equipment and external items from damage during movements. Be sure to have smooth, unobstructed surfaces where the equipment is to be slid. Keep access openings clear.
- Prepare for the connections across shipping splits before the equipment is moved into final position. Interunit bus supports and bus joint boots should be

removed using side, rear and front access options as required. Note the mounted position and orientation and save hardware for use in reinstallation.

- Thread coiled wires across shipping splits into inter-unit wire trough as equipment is moved into its final position.
- Where top lift capability is available, shipping pallets and other packaging materials may be removed before the last move into the equipments final position.
- Where top lift capability is not available, protect the switchgear bottom with support timbers and move with jacks and rollers just to the side of its final position. Remove rollers, shipping pallets and other packaging materials and remove jacking facilities. Clear any obstructions. The equipment may be slid sideways up to 6 inches (152mm) to join the shipping split. Any sliding force must be carefully applied across the bottom 4 inches (100mm) of the switchgear side with proper cribbing to fully distribute the force across the full depth of side.
- See "Installation" section for additional important information.

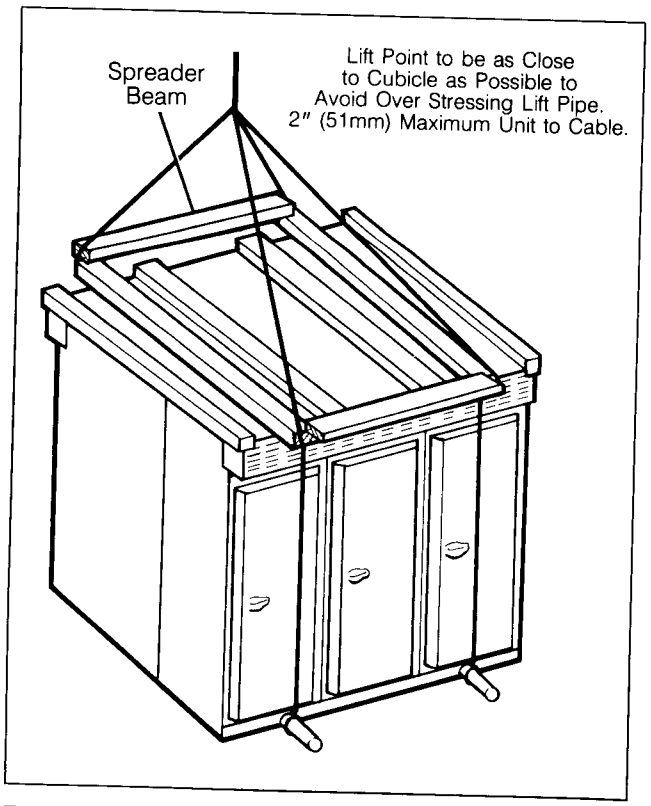


Figure 4. Lifting Outdoor Switchgear—with Crane

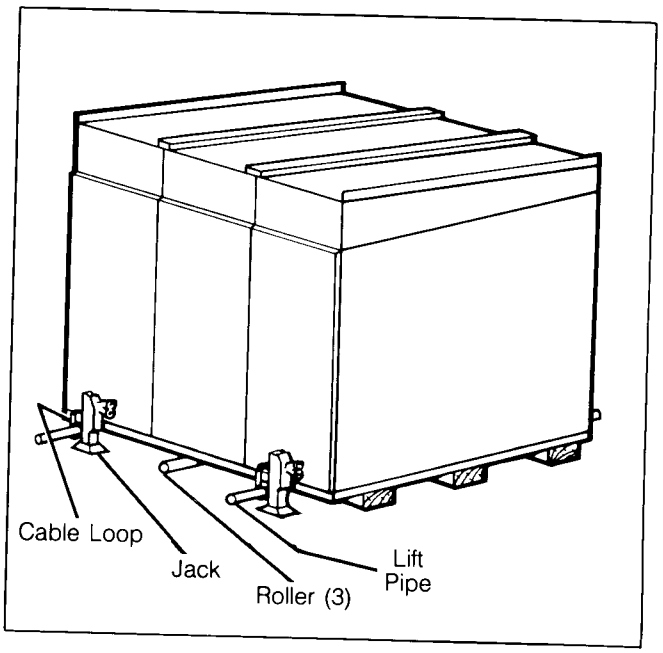


Figure 5. Lifting Outdoor Switchgear—with Jacks and Rollers

Indoor Switchgear

When Switchgear is not to be elected immediately, it should be unpacked, inspected within 15 days of receipt and stored in a clean dry location. Indoor switchgear is neither weather-proof nor drip-proof, therefore, it should be stored indoors, or if it is to be kept in a humid, unheated area, provide an adequate covering, and place a heat source of approximately 500 watts output within each vertical section to prevent condensation. Space heaters are not standard equipment on indoor switchgear. Lubricate any moving parts such as hinges, shutters, etc., if storage is for an extensive period of time. When batteries are supplied, connect them to a charger.

Shelter-Clad Outdoor Switchgear

When it is necessary to store Shelter-Clad outdoor equipment in a location exposing it to the weather or in a humid location, energize the space heaters provided within the sections and make certain that louvers and vents are uncovered to allow air to circulate. If at all possible, erect the aisle section and the switchgear at the permanent location even though it may be some time before the equipment is used. Regardless of what method of storage is used, break

the shipping seal and remove the aisle wall from in front of instrument panels. This is required to gain access to the space heater circuit so that heaters can be energized. Refer to wiring diagram drawing for space heater circuit connections. Reseal the front or cover if for protection from the weather. Connect batteries (if provided) to a charger. Lubricate hinges, shutters, and other moving parts.

Non-Walk-In Outdoor Switchgear

When it is necessary to store non-walk-in outdoor switchgear in an area exposed to the weather or under humid conditions, energize the space heaters provided and make certain that louvers and vents are uncovered to allow air to circulate. Access to the heater circuit is gained by opening the door to the instrument panel compartment. Refer to wiring diagram drawing for space heater circuit connections. Connect batteries (if provided) to a charger. Lubricate hinges, shutters, and other moving parts.

GMI Vacuum Circuit Breakers and Lift Truck

Vacuum circuit breakers, if not installed in their respective switchgear compartments, must be stored indoors. Outdoor storage of circuit breakers (other than inside their respective switchgear compartments) is NOT RECOMMENDED.

If furnished, the lift truck for handling circuit breakers should be stored indoors. The lifting mechanism can be damaged by outdoor storage.

Foundation

Extreme care should be taken in layout of foundation or floor. Refer to general arrangement drawing for exact location of anchor bolts, area for secondary and primary conduits, other limitation and instructions. Conduit couplings should be stubbed to below the finished floor level. After the switchgear has been lowered to the foundation and set in place, conduit nipples may be screwed into couplings.

Floors, sills, piers and pilings, whichever type of foundation is used, must have a smooth level surface and be in the same plane. The surface of the foundation must not protrude above the grouted sills or bed plates at any point. Grouted sills or bed plates must be set true and level and be in the same plane to each other. Care and accuracy at this point will simplify or eliminate shimming when switchgear is installed. Foundations must be sufficiently strong to support the weight of the cubicles and breakers plus the impact loading of the circuit breakers (equal to about 10% of the weight of each circuit breaker).

Outdoor switchgear groups which have been assembled on formed baseplates must be supported with the maximum span between support points not exceeding six (6) feet (1828mm). If pilings are used, the diameter of these pilings is to be determined by customer for proper loading. However, they must not be less than twelve (12) inches (305mm) for sufficient contact with the base, allowing space for shipping split and space for grouting in bed plate if used. All shipping splits must be supported and taken into consideration when foundation is constructed.

⚠ CAUTION

Currents induced in ferrous metal encircling individual phases can result in personal injury or property damage.

Do not allow an individual phase of a multiphase system to be encircled by ferrous metal.

In the switchgear primary entrance area, steel reinforcing rods or mesh in the concrete must not pass through the space shown on the general arrangement drawing even though cored or bored holes in concrete may miss rods or mesh. A single phase of a system should not be encircled by ferrous metals.

All sill channels, bed plates, shims and anchoring hardware are furnished by customer unless covered by contract.

Figure 6 illustrates location for sill channels for anchoring indoor switchgear. Cubicles may be anchored to sills by use of 1/2" (12mm) diameter anchor bolts or welded in position.

Anchoring, Leveling, and Assembling Indoor Switchgear

Indoor switchgear shipping groups are held in true alignment by bolts holding the vertical sections to each other.

The entire shipping group is to be anchored and leveled as a single element without loosening any hardware until entire shipping group is leveled and anchored.

1. The switchgear equipment was accurately aligned on level steel bed plates at the factory. This care insures proper operation and fit of mating parts. Supporting surfaces for the switchgear at each anchoring bolt location must be level and in the same plane. There must not be any projection above this plane within the area covered by the switchgear cubicles. If customer floor or grouted sill channels do not meet this requirement it will be necessary to shim in the following manner. The six (6) anchor bolt locations in each cubicle must freely rest in firm contact with the mounting support surfaces. There must not be any projection or obstruction in other areas which may distort the cubicle. Do not force cubicle in firm contact by drawing down anchoring bolts as such drastic means will distort cubicles. Add 4" (100mm) square shims adjacent to anchor bolts until firm contact is achieved. Check each anchor bolt location, 6 per cubicle. (See **Figure 6**.)
2. Tighten anchor bolts or weld to sills.
3. If line-up consists of multiple groups, move the next group into position, with the front of units in line and tight against the adjacent group. Do not bolt groups together at this time. Check that the cubicles are in firm contact with the foundation at each corner and anchor point and that bolt holes are in alignment. Add 4" (100mm) square shims as necessary. Tighten the anchor bolts. Now bolt groups together.
4. After installation is complete, the lifting bar between units may be removed and the unit lift bars pushed down inside the units. Note that bolts inside the units which clamp the lift bars in place must be loose to allow movement of the lift bar.

Anchoring, Leveling and Assembling Outdoor Switchgear

For information on the anchoring, leveling and assembling of single or common Walk-In-Aisle Shelter-Clad and Non-Walk-In Outdoor switchgear, refer to supplemental instruction book SG-3258-OD.

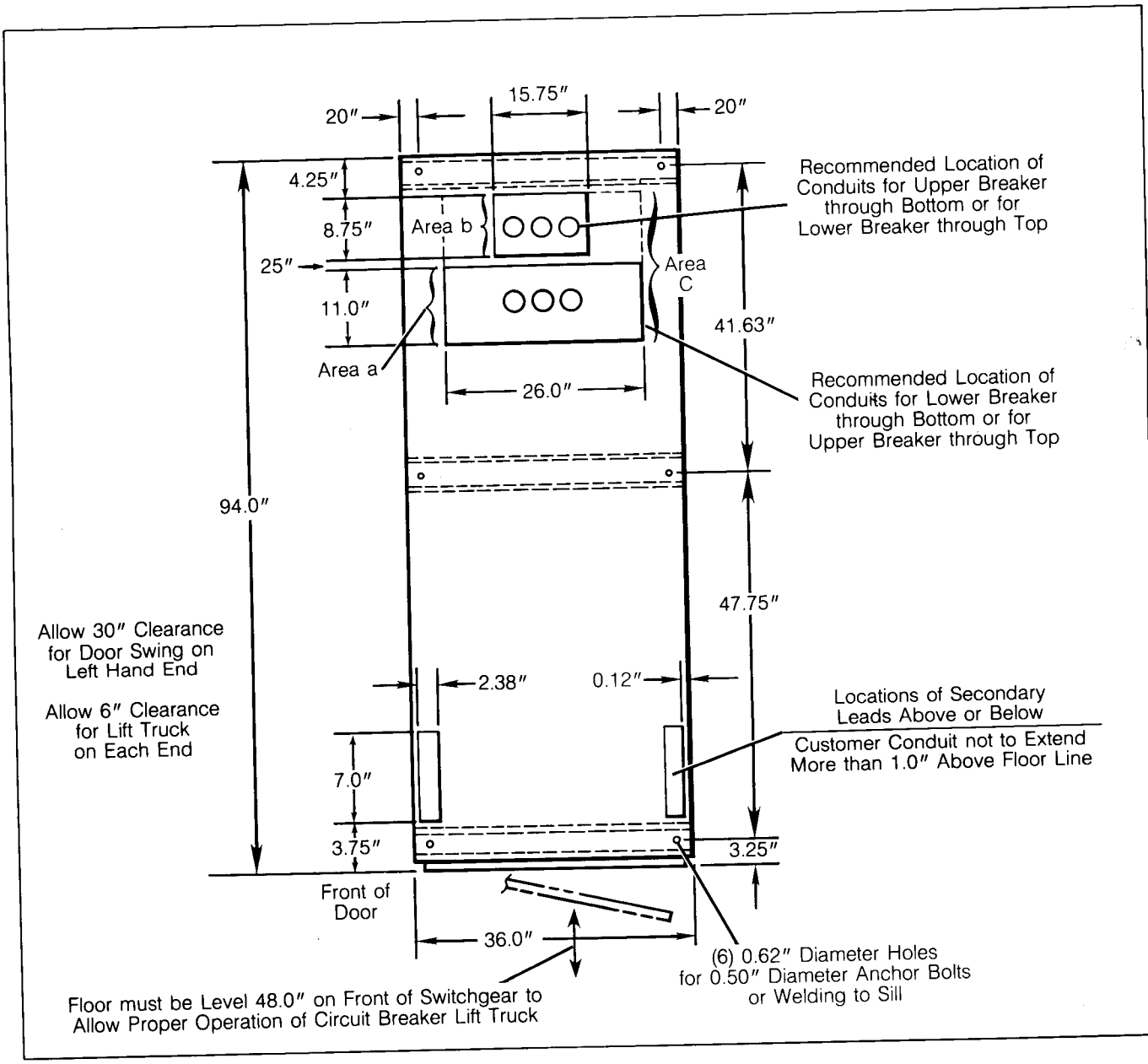


Figure 6. Anchoring Indoor Switchgear—Typical

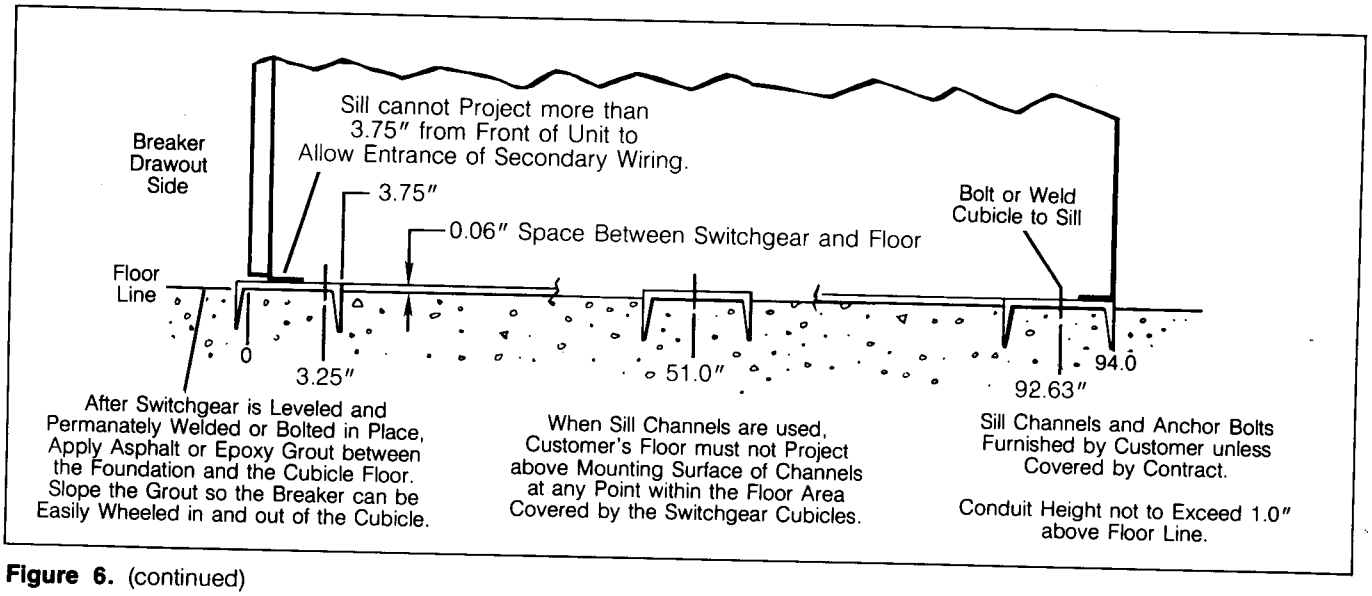


Figure 6. (continued)

Notes—Figure 6

1. Sill Channels, 4 inch (by customer).
2. Clearance between bottom of switchgear and floor. Customer floor may not project above the mounting surface of channels at any point within the floor area covered by the switchgear cubicles.
3. Floor to be smooth and level in front of switchgear for 48 inches (recommended 76 inch) for breaker drawout.
4. Conduits height above bottom of unit. Final position of conduits not to exceed.1" (25mm) above unit floor. Zero sequence current transformers may require conduits for multiple bottom entrance cables be recessed.
5. Front of unit—breaker drawout side.

Cable Areas—Maximum Area Available for Cables from:

Area a —	26.0"x11.0" deep (666x2798mm)	For cables from either: Top breaker out top (when bottom breaker also exits top); or Bottom breaker out bottom (when top breaker also exits bottom).
Area b —	15.75"x8.75" deep (400x222mm)	For cables from either: Top breaker out bottom (when bottom breaker also exits bottom); or Bottom breaker out the top (when top breaker also exits top).
Area c —	26.0"x20.0" deep (660 x 514mm)	For cables from either: Nearest breaker out the top (when only this breaker exits top); or Nearest breaker out the bottom (when only this breaker exits bottom).

Bus Bar

Bus bar is the normally furnished connection between many of the high voltage items within the switchgear enclosure, such as: the main bus, circuit breakers, pads for cable lugs or terminators and current transformers. Draw-out trays for voltage and control power transformers and fuses are cable connected.

Standard bus bar material is aluminum with tin-plating. Copper bus bar with silver-plated joints for electrical connections may be furnished as an option to aluminum bus bar.

Both bus bar materials are normally coated with an epoxy insulation applied by the fluidized bed method. Bus bar joints are insulated with molded insulation "boots" or taped insulation.

Additional insulation is provided by clearance thru air and glass polyester bus supports. In some locations, stand off insulators are used. Porcelain insulator rings mounted in glass polyester supports, porcelain stand off insulators and/or porcelain primary disconnect bushings may be furnished as an option.

⚠ DANGER

Contact with energized high voltage conductor insulation which is not designed to prevent shock will cause death, personal injury and property damage.

Before working on or near high voltage conductors within the switchgear be sure they are de-energized and properly grounded.

Bus Joints

When a switchgear group is split for shipping purposes, the primary bus and ground bus connections must be made when installing the switchgear. These bolted connections are relatively simple to make. However, refer to **Figures 7** and **8** and these instructions:

Access to the main bus from the cable termination area is achieved by removing barrier R, **Figure 16a**. Access from the breaker compartment is achieved by removing barrier F, **Figure 16a.** For some arrangements it may be necessary to remove items between the main bus barriers and the rear of the unit in order to gain full access. After completion of the bus assembly, these items should be reassembled in reverse sequence.

1. Molded plastic insulation boots for bus bar joints are normally shipped factory installed at shipping splits. Note their location and orientation, so they may be properly reinstalled after the joint is bolted together. Carefully remove and save the nylon hardware and the boot. In some cases a snap closure is molded into the boot and replaces some of the nuts and bolts.

2. All surfaces must be free of dust, dirt or other foreign material.

   Do not use any abrasive cleaner on plated contact surfaces. Cleaning is normally not necessary and should not be done unless parts are badly tarnished. If cleaning is necessary, use a mild cleaner and thoroughly rinse the parts to remove all residue. Keep cleaning agent off insulation.

3. Before assembling any bus bar joint, check that the bar is inserted through bus supports (when required) and interunit bus supports, including the neoprene grommets and porcelain insulator rings where that option is furnished. Grommets are used to support the bus bars in the porcelain insulator rings. Observe factory positioning of these grommets when connecting at shipping splits to insure that bus bars will line up properly. Normally the bus bar is oriented in the porcelain ring toward the front. Neoprene grommets are to be installed centered in the porcelain ring.

4. Observe the relationship of the bus bar to the breaker riser (i.e. whether bus bar is above or below riser). Maintain this relationship when connecting bus bars. Spacers are required in some bus joint connections.

5. Assemble all joints with the parts dry. Do not use any grease or "no-oxide" product—even where aluminum bus is used. Aluminum bus is tin-plated and can be applied directly to other tin-plated aluminum bar or to silver-plated copper without the use of a "no-oxide" product.

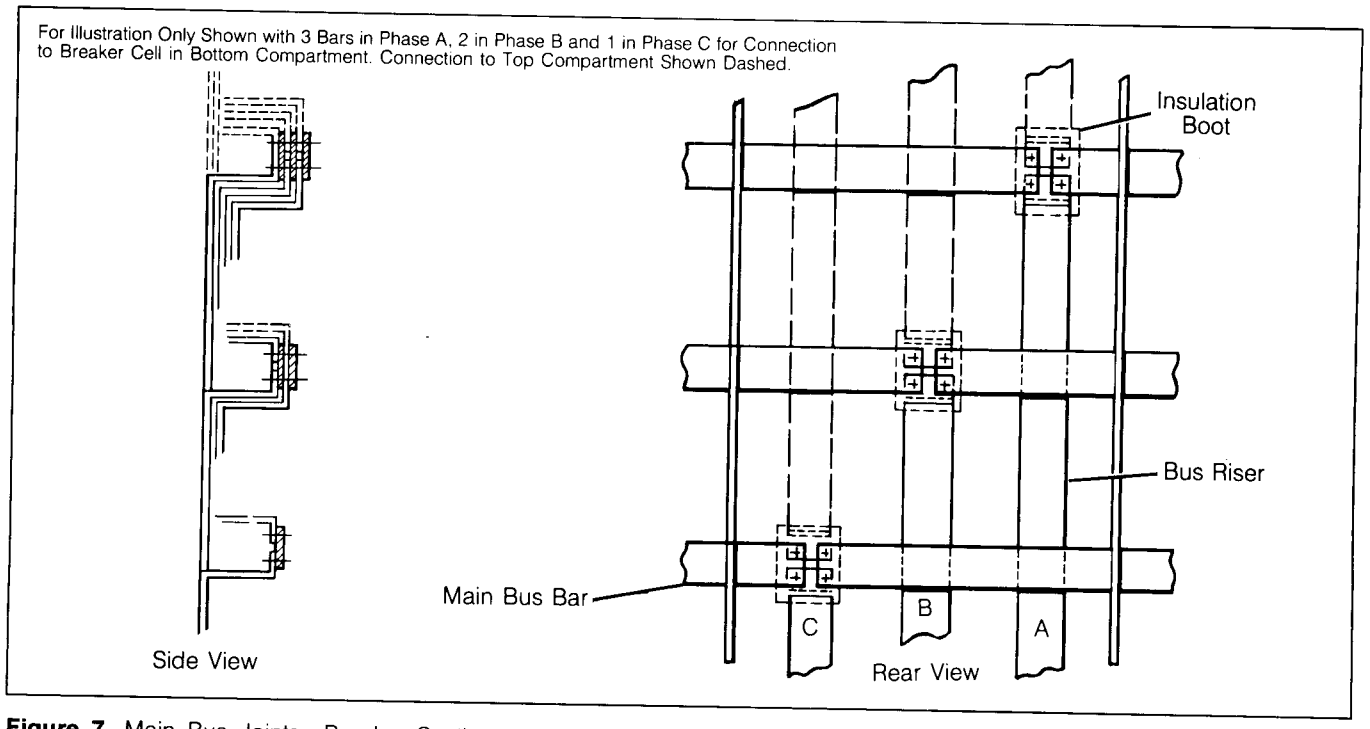


Figure 7. Main Bus Joints—Breaker Section

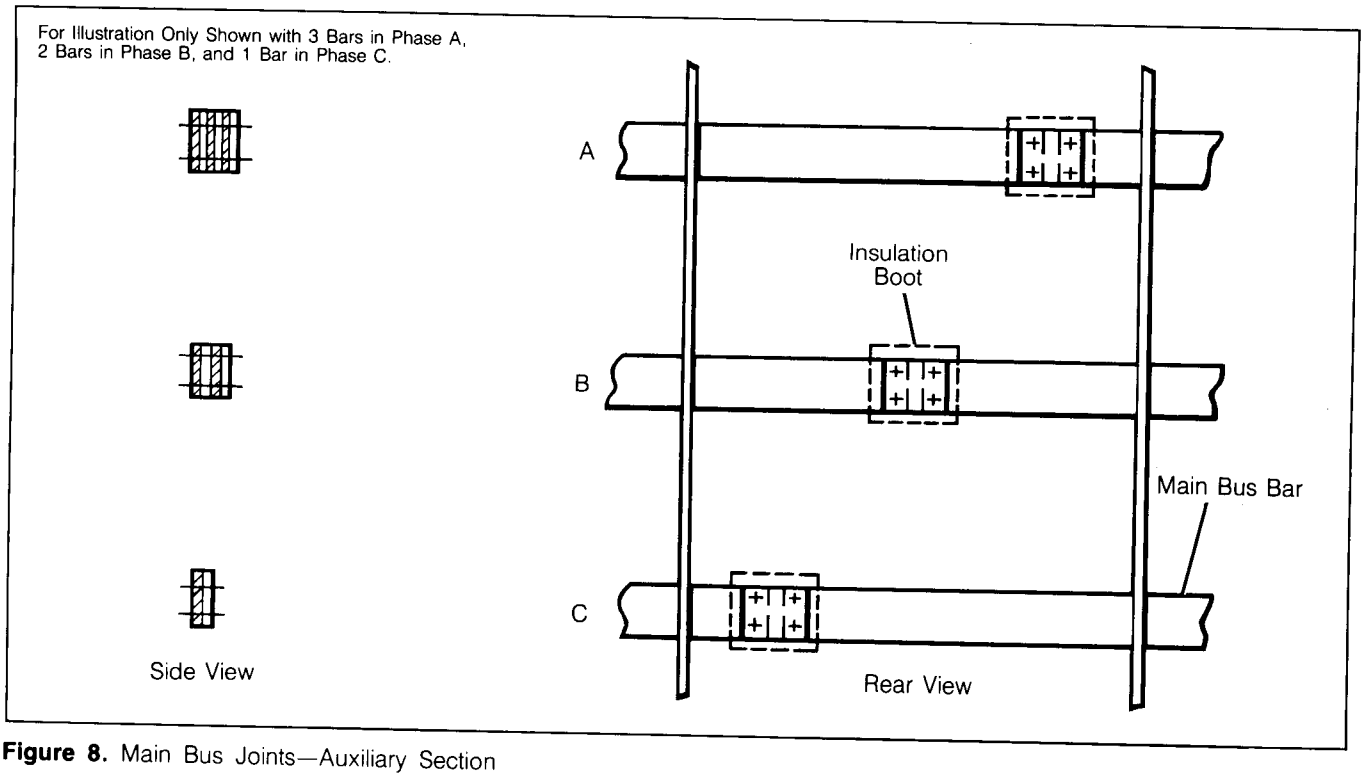


Figure 8. Main Bus Joints—Auxiliary Section

NOTE

All main bus hardware furnished is plated high-strength steel. Cap screws are .50" (12.7mm)-13 SAE Grade 5. Do not substitute with smaller or lower grade hardware than supplied.

6. Use proper hardware.

   Heavy flat washers are used on both sides of the bus bar joint—under the cap screw head as well as under the nut and lockwasher. These washers insure an evenly distributed force around each screw, producing a low resistance joint. Proper torque value produces a joint of adequate pressure without cold flow.

7. Assemble all joints as shown in **Figure 7** thru **10**.

   Install all hardware the same way that factory bus connections were installed. Hardware must be aligned properly or molded insulation boots may not fit over the joints.

   a. Place a flat washer on the cap screws (bolt) and insert the cap screw through the bus joint towards rear of unit.

   b1. On copper-aluminum or on all aluminum bus bar joints a "Belleville" spring washer is placed under the nut with its concaved side against the bus bar.

   b2. On joints with ALL copper-bus bar, a flat washer is placed against the bar with a lockwasher between the flat washer and the nut.

   c. Spacers on links are required at certain bus joints to insure the cross sectional area of the joint. The conditions where these spacers are required vary with the type of bus joint. Refer to **Figure 9**.

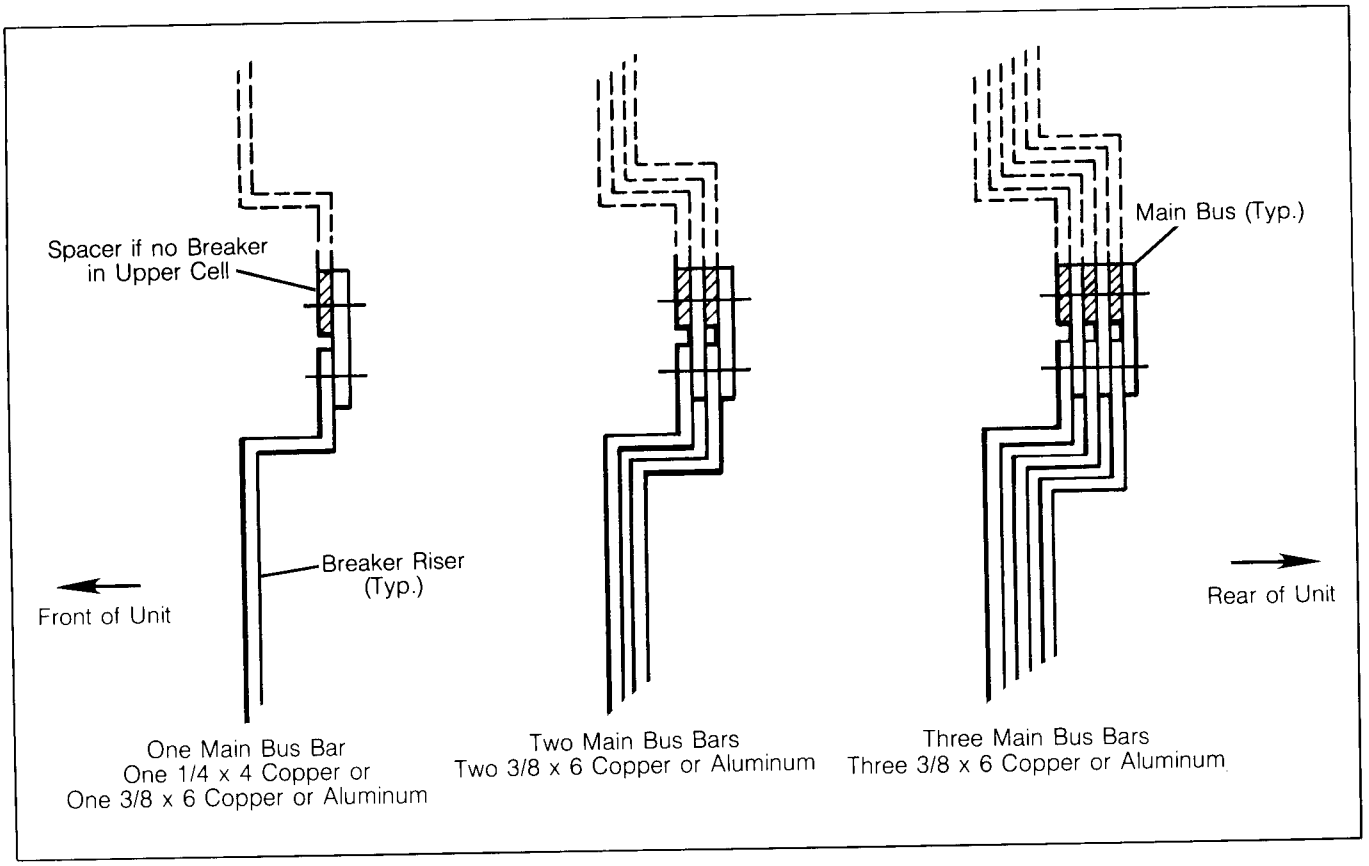


Figure 9. Main Bus Joint Connection Configurations

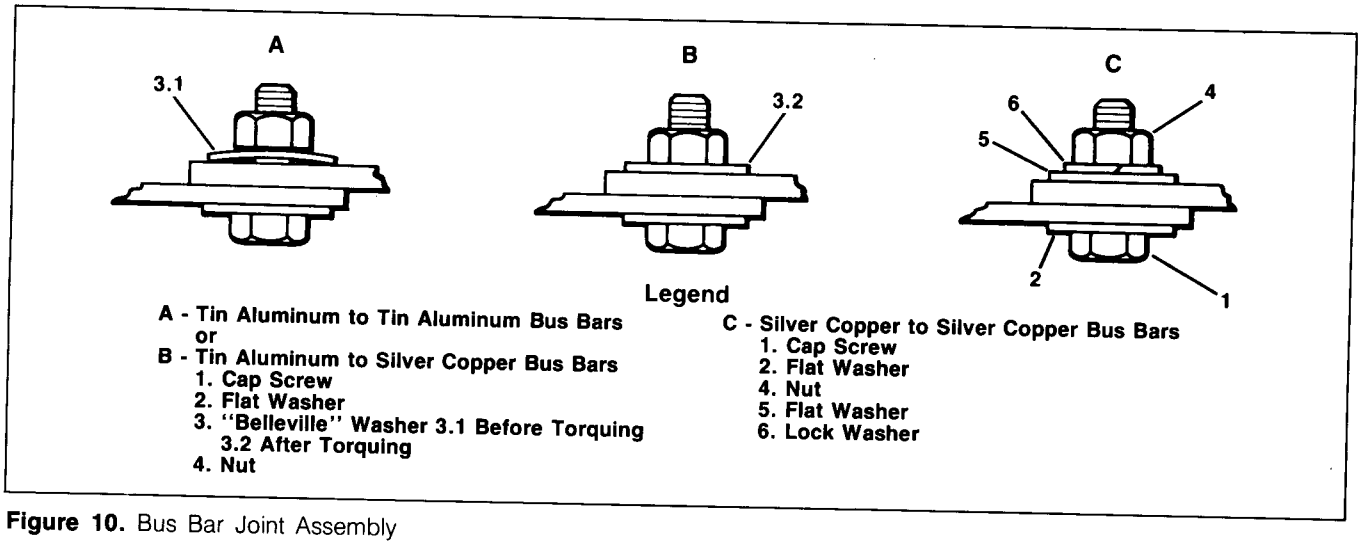


Figure 10. Bus Bar Joint Assembly

8. Torque the .50" (12.7mm) SAE Grade No. 5 cap screws to within a 50 to 75 lb. ft. (67.8 to 101.7 Nm) torque. (If special hardware is required by an order, other torque values will be supplied with field assembly drawings.)
9. Install insulation boots or tape joints where required per instructions in following sections.
10. Connect ground bus. See **Figure 22.** Insert bar in side wall opening to overlap the ground bus in adjacent cubicles.
11. Torque the SAE Grand 5 cap screw used in the ground bus to within a range of 25 to 40 lb. ft. (33.9 to 54.2 Nm).

⚠ DANGER

Contact with energized high voltage conductor insulation which is not designed to prevent shock will cause death, personal injury and property damage.

Before working on or near high voltage conductors within the switchgear be sure they are de-energized and properly grounded.

Bus Insulation

Bus and connections are insulated in metal-clad switchgear as part of a coordinated insulation system: air or creep distance plus bus insulation combines for the needed insulation level. BUS INSULATION IS NOT DESIGNED TO PREVENT SHOCK.

Epoxy insulation applied in a fluidized bed process is normally furnished on the bus bars. Bus joint insulation is normally boots. Taping is also used for bus joint insulation.

See ANSI C37.20.2-6.2.3 which is quoted as follows: "This insulating covering is a requirement of metal-clad switchgear and is provided to minimize the possibility of communicating faults that would result if foreign objects momentarily contacted bare bus. This insulating covering is usually only a part of the primary insulation system and in such cases the outer surface of this insulating covering will not be at ground potential. It should **NOT** be assumed, therefore, that personnel can contact this insulating covering with complete safety."

Bus Joint Insulation—Boots

Standard and repetitive bus bar joints are normally provided with insulation boots installed at the factory. See **Figure 11**. After they are completed in the field, bus bar joints at shipping splits must be insulated as part of the total insulation system. Normally "boots" are provided for field completed shipping split joints and are shipped in the location where they will finally be installed. See **Figure 12**.

Before removal of the "boot" to complete the joint, observe the location and orientation of the boot and hardware. This should make reinstallation easier.

Nylon nuts and bolts and flat washers are used to hold the boot closed after it is installed. Some boots may use molded-in threaded stems to provide a snap type closure, in addition to nylon nuts and bolts. Carefully remove the insulation boot and save all hardware.

After the bus bar joint has been properly assembled, reinstall the insulation boot. Secure the boot closed with the nylon nuts and bolts. Completed boot installation should be flush with the bus bar insulation and overlap it by at least 1-1/2 inches (38mm). In those cases where the boot does not close flush with the bus bar insulation or the overlap is less than 1-1/2 inches (38mm), apply one layer of tape (15-171-987-001) 1/2 lapped overlapping the bar insulation and boot by 1-1/2 inches (38mm).

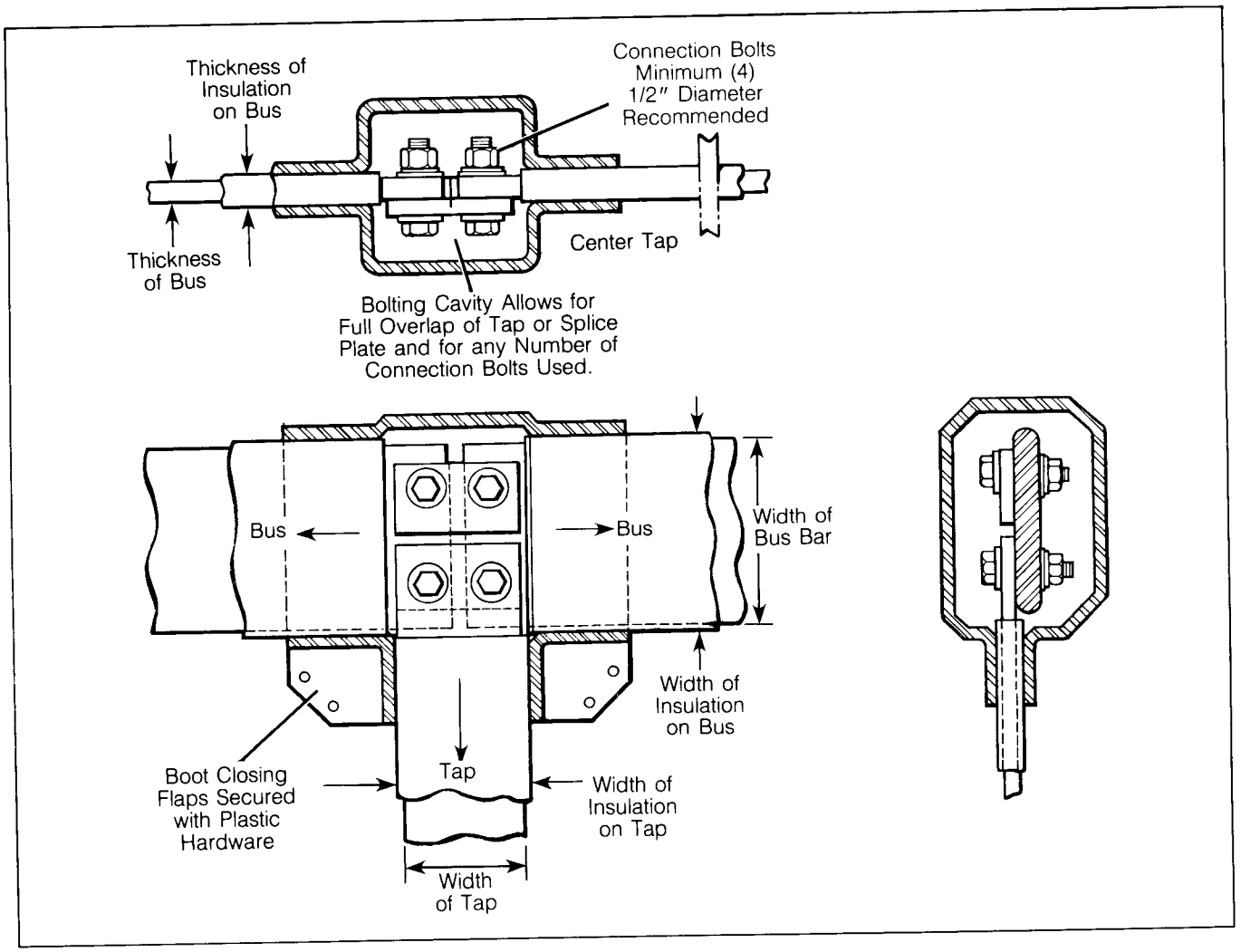


Figure 11. Typical Installation of Boot

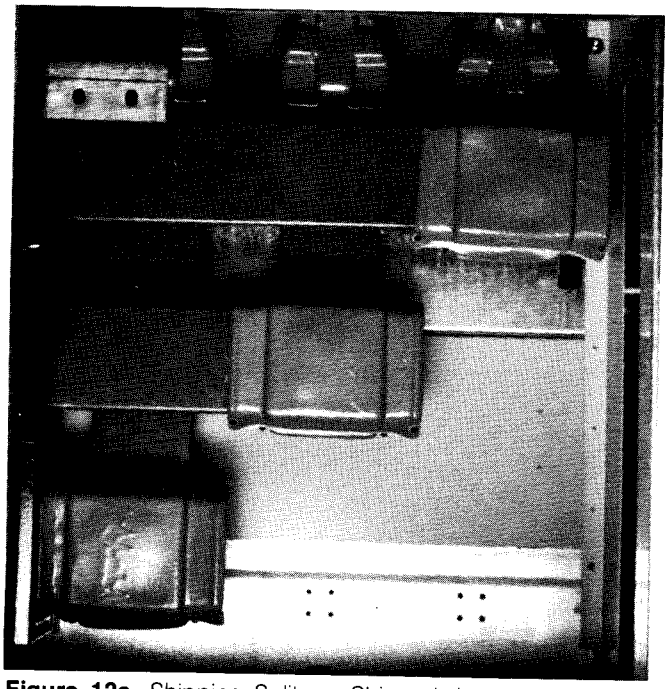


Figure 12a. Shipping Split, as Shipped. Insulation boots installed in proper locations. Bus bars (to extend towards right) shipped with accessories.

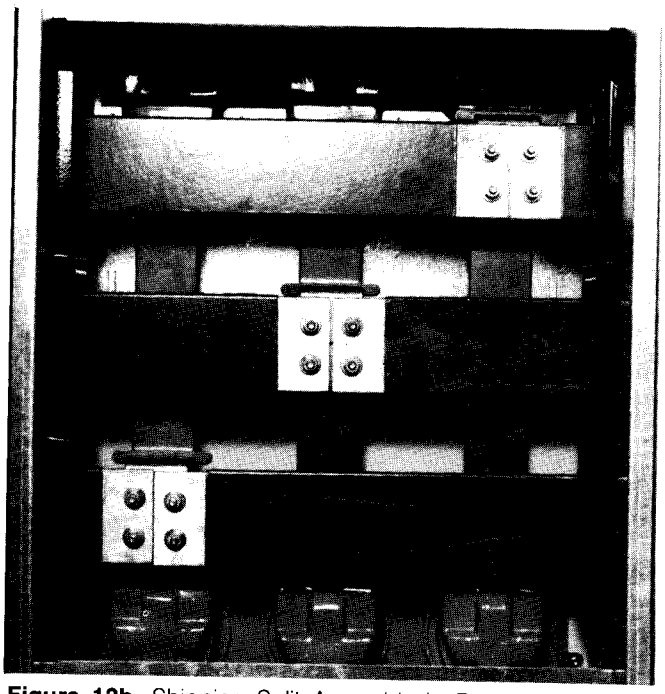


Figure 12b. Shipping Split Assembly in Progress. Insulation boots are removed, and bus bars have been installed. Connection bolts have been correctly torqued. Unit is ready for reinstallation of boots.

Figure 12c. Insulation Boots Installed. Unit is ready for reinstallation of main bus barrier (R, **Figure 16a**).

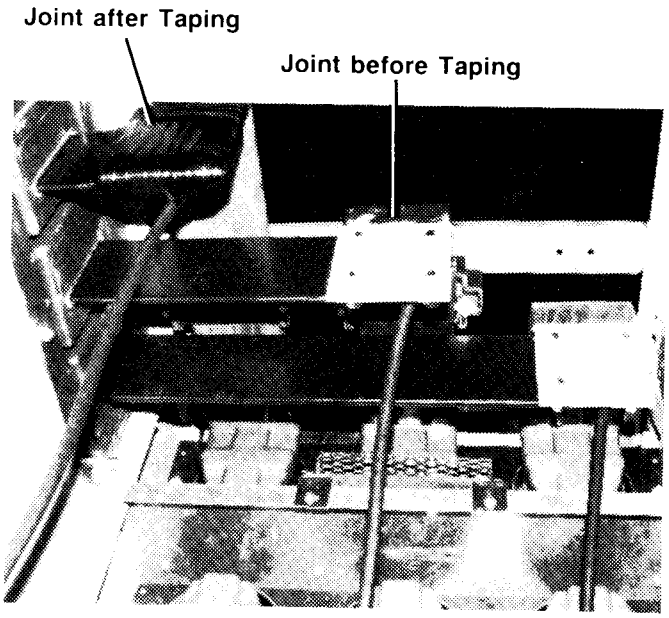


Figure 12d. Taped Bus Joint Insulation—Transition Bus Bar to Transformer Connection.

Bus Joint Insulation—Taping

Insulation boots are normally provided for repetitive or standard bus joint conditions. Where boots are not provided, the bus joints must be carefully taped to the required insulation level as described below. See **Figure 12d**.

Step 1. Inspect bolted joints to insure they are correctly assembled, bolt heads in proper direction and hardware has been torqued to proper value. All surfaces must be free of dust, dirt or other foreign material.

Step 2. Apply a mastic pad over nuts and a second pad over the screw heads. Use either small (15-171-988-001:3.25"x4.50") (83mm-x114mm) or large (15-171-098-002:4.50"x-6.50") (114mmx164mm) size pad most suitable for joint involved. Remove backing and press adhesive side down and mold in place covering all sharp projections. Cover hardware and sharp edges of bus bar if any will be against the tape.

Step 3. Apply half-lapped layers of 4" (102mm) wide tape (15-171-987-002) or 1" (25mm) wide tape (15-171-987-001), over the joint. Each layer should overlap the bus bar insulation by at least 1-1/2 inches (38mm). Stretching of tape 10% to 15% in problem areas may help in eliminating voids and wrinkles.

For 5kV class equipment use two half-lapped layers of tape over mastic pads. For 8.25kV and 15kV class equipment use three half-lapped layers of tape over the mastic pads.

Avoid excessive pressure on the completed bus joint insulation. If bus joints are on standoff insulators, apply tape per the above procedures except the half-lapped tape should overlap the insulator by 1.7 +0.1 inch (43 +3mm).

Transformer Bus Joints—Insulation

The typical transformer to switchgear bus joint shown in **Figure 13** is different from other bus joints in the switchgear main bus. In the transformer bus joints, there is a transition from the fully insulated switchgear system to the transformer where the spacing between conductors is great enough so that the conductors need not be insulated. The use of flexible connectors in this area insures correct alignment of the switchgear conductors to the wider spaced transformer conductors. If the installed spacing is less than "D" in **Figure 13**, the joint must be insulated.

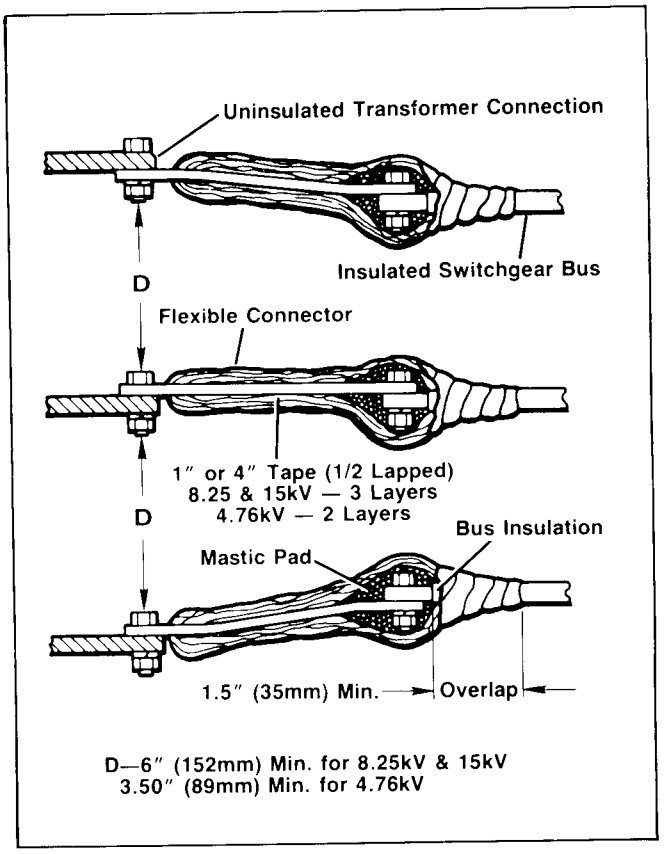


Figure 13. Joint Insulation—Bus to Transformer

See **Figure 13**, make bus joint connections and tape as outlined previously under Bus Joint Insulations—Taping.

Primary Cable Connections

All cable connections to metal-clad switchgear must be fully insulated. Recommendations of the cable supplier should be followed for the installation, however, suggested minimums are indicated for the typical cable connection shown in **Figure 14**.

Because of considerable variations in customer requirements and available cables, Siemens furnishes a double-bolt, double-clamp, terminal lug only. All insulating and

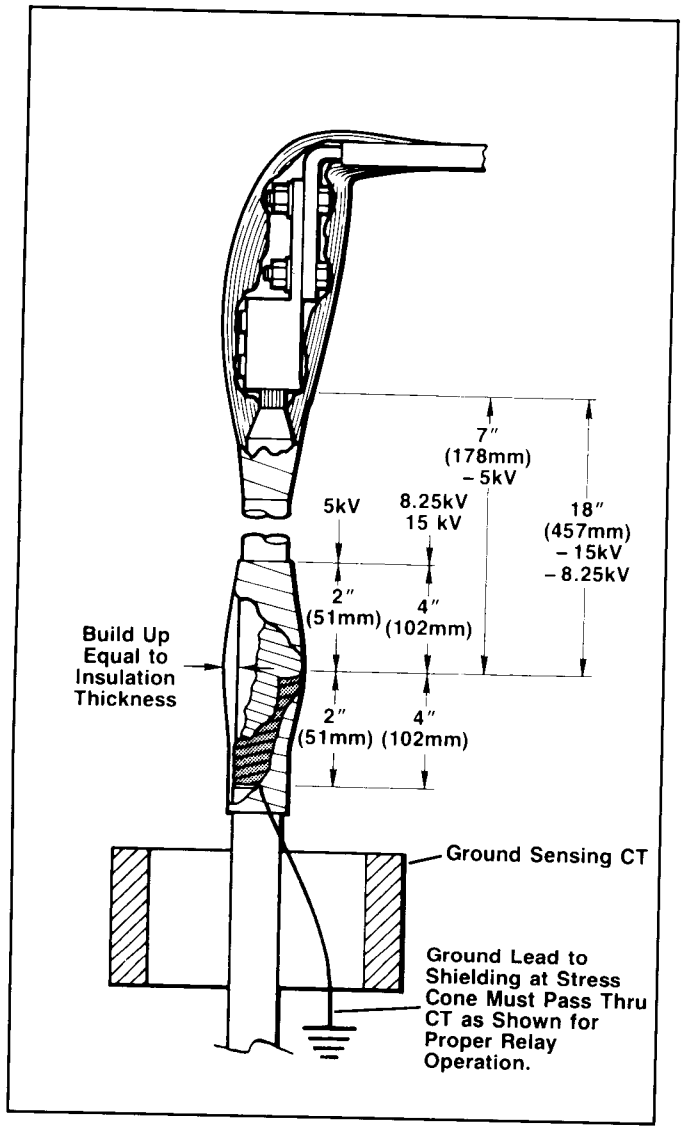


Figure 14. Primary Cable Connection

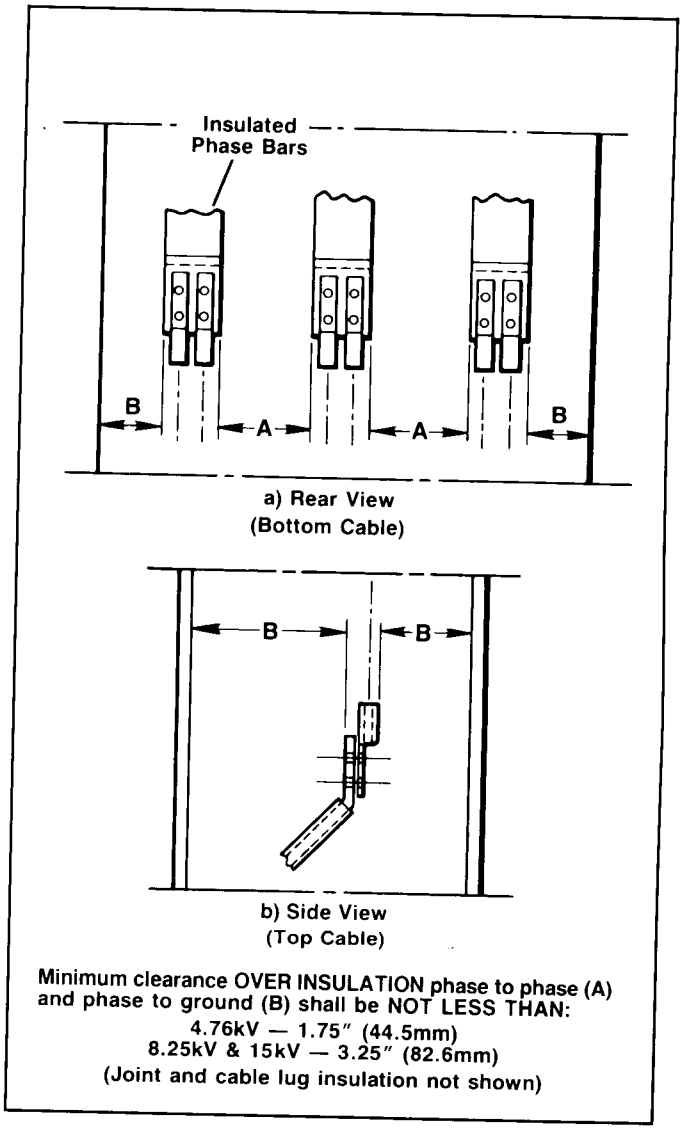


Figure 15. Typical Primary Cable Lug Mounting

terminating materials other than terminal lugs and cable supports are to be furnished by the customer.

Two-High Cable Connection

The proper sequence of pulling and connecting power cables will make for an easier installation, especially where more than one set of cables exit the same side of a vertical section. With back covers removed, the power cable trough may be removed for access to the cable termination location farthest from the back of the cubicle. For upfeed, these would be the top circuit breaker lugs at the typical elevation in **Figure 16a**. For downfeed these would be the bottom circuit breaker lugs at the typical elevation in **Figure 16b**. Cables to these lugs should be pulled and terminated first and necessary ground connections made.

The cables to the termination location nearest to the back of the cubicle must be routed through the reinstalled power cable trough assembly. This will provide the installed metal-

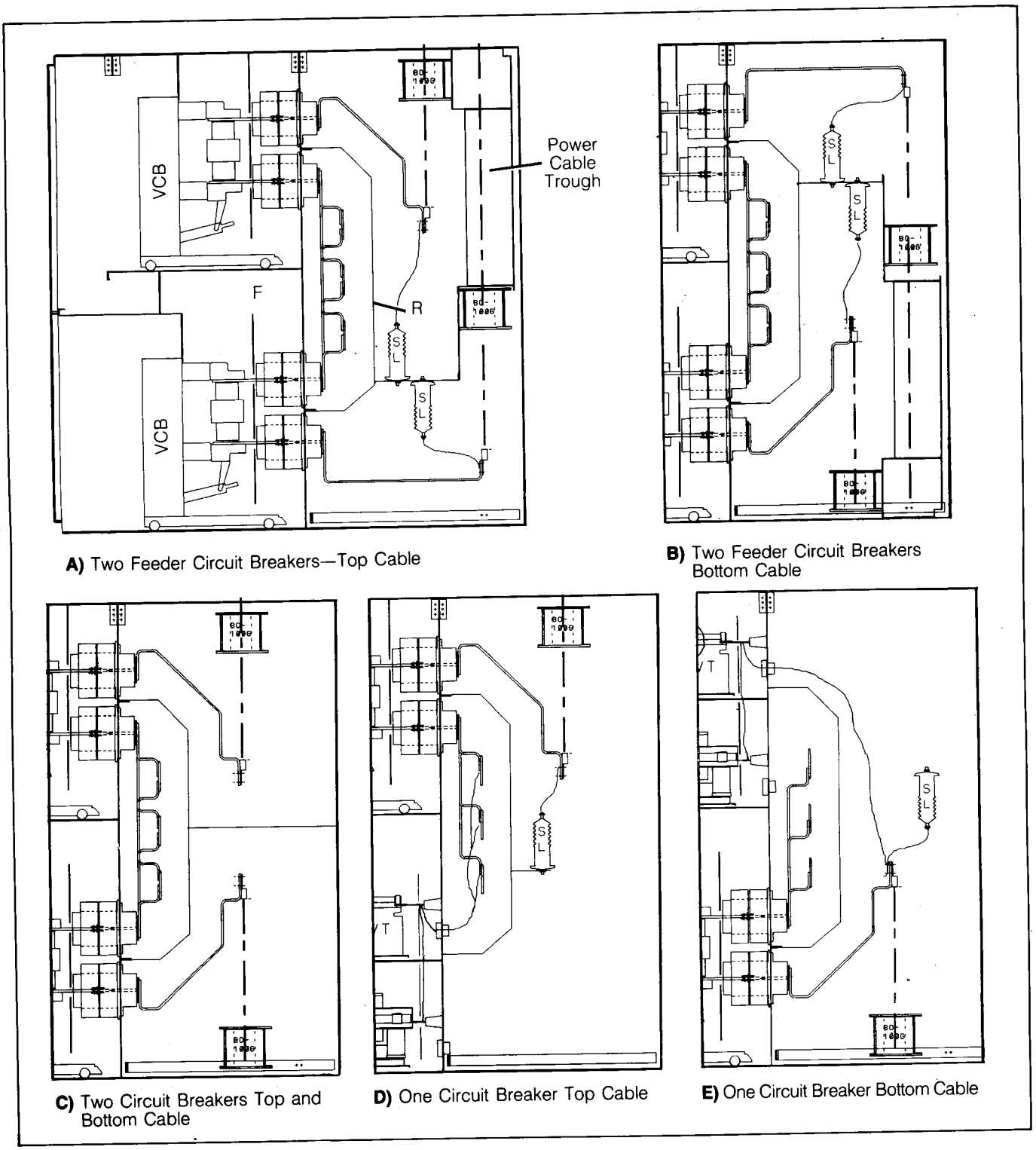


Figure 16. Normal Cable Configuration

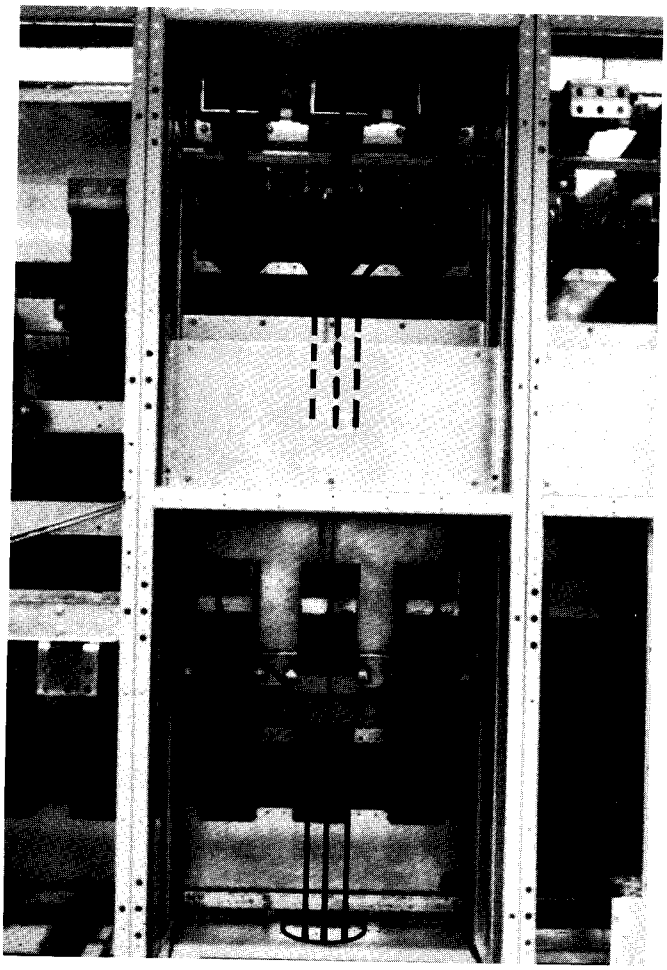


Figure 17. Typical Cable Routing

clad separation of the two feeder circuits. After proper cable termination and ground connection, replace the cable trough covers, barriers and cubicle back covers.

Secondary Control Wiring

Secondary Control wiring is carefully installed and tested at the factory. Inter-group wiring at shipping splits can be readily connected by referring to wire markings. These wires are not terminated and are of sufficient length to be routed to their termination point after cubicles are bolted together. Terminals for these leads are furnished by the customer to suit his line of crimping tools. Terminal block hardware is furnished with the switchgear. All wiring diagrams needed for installation are furnished in advance.

Wires can be easily traced on a wiring diagram chart similar to those shown in **Figures 18** and **19**. Each device is illustrated and identified with a letter. Each terminal on each device is identified by a number. The wire list adjacent to each device on the diagram indicates the device and terminal number to which each wire is connected at the next connection point. For example, the destination list for device BS states that wire No. 12 connects from terminal Point 2 of device BS to terminal 4 of device DB in **Figure 18**.

All secondary control wiring installed by the factory is neatly bundled and cleated to the cubicle side plate. Make all field connections in a similar manner. Check that the circuit breaker, its components and panel clear any additional wiring installed. **Figure 20** shows a typical secondary control cable installation. All customer wiring is to be routed behind the cable retainer which is removable for installation purposes. **Figure 21** shows the physical location of the maximum number of terminal blocks. Customer blocks CA, CB, and CC are located above secondary cable entrance on the right hand side. Terminal blocks for customer connection to MOC and TOC switches are mounted horizontally to the left of blocks CA, CB, and CC. These are shown to guide customer in designing conduit entrance layouts or control cable locations. Use plastic or nylon ties to secure all field installed wires to the cubicle structure.

Ground Connections

A common ground bus is incorporated in all units for properly grounding the equipment after installation. (**Figure 22**).

The ground bus extending through the switchgear is accessible in the primary cable area of each unit. The interunit connector has provisions for two bolts at each end. For ease of assembly, install bottom bolts first. Insure that ground bar to circuit breaker cell is also bolted to interunit bar.

Provision for connecting this ground bus must be made in such a manner that a reliable ground connection is obtained. Consult latest National Electrical Code for ground connection standards.

Temporary Ground Connections

It is recommended that no work be done on current carrying parts until these parts have been disconnected from the system and solidly grounded. One method of solidly grounding the high voltage circuit is by use of a grounding device. This device is placed in a cubicle in the same manner as a breaker and provides a path to ground. It is furnished only when specified in the contract.

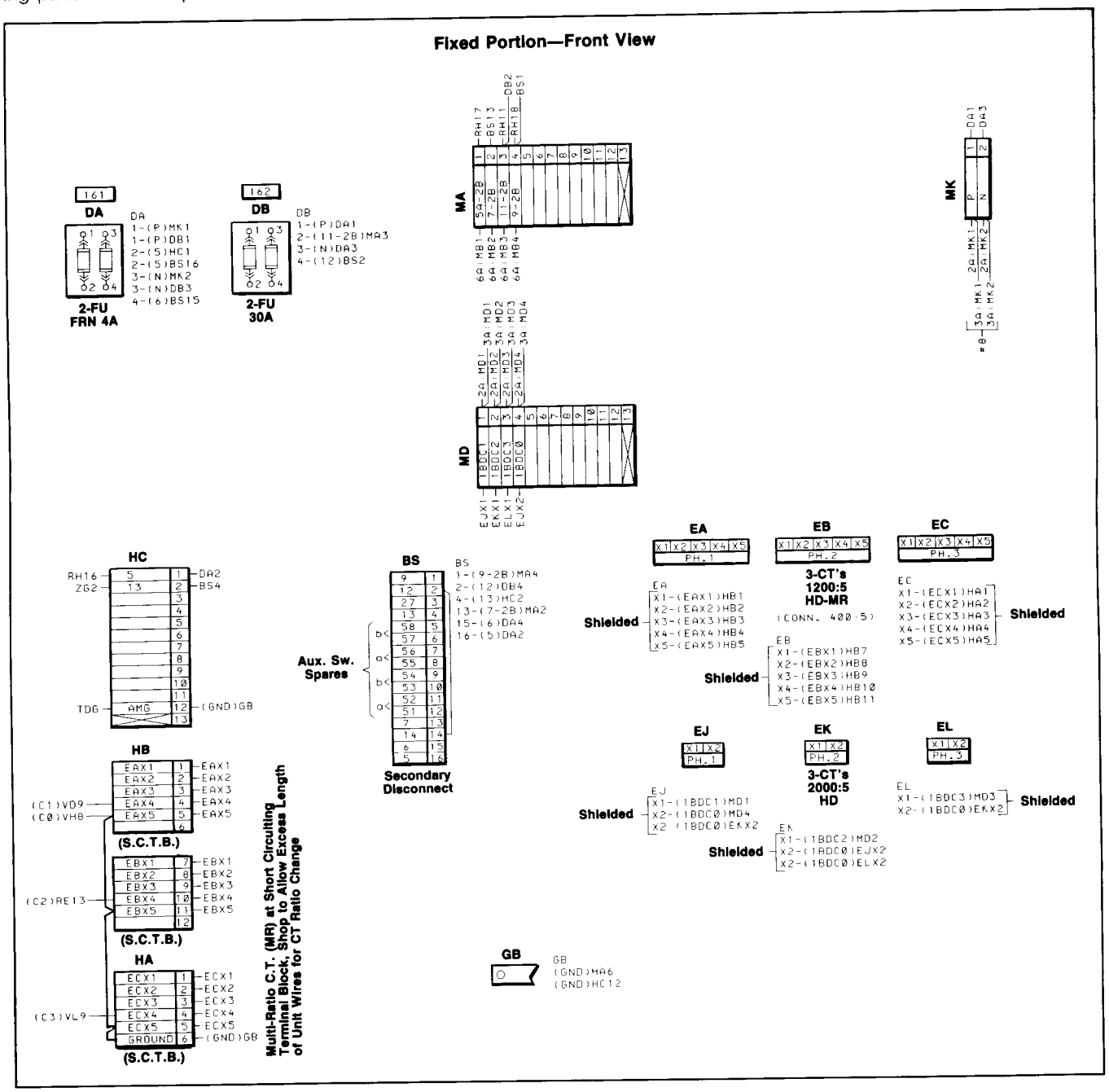


Figure 18. Typical Fixed Portion Wiring Diagram Shown for Cell "A"

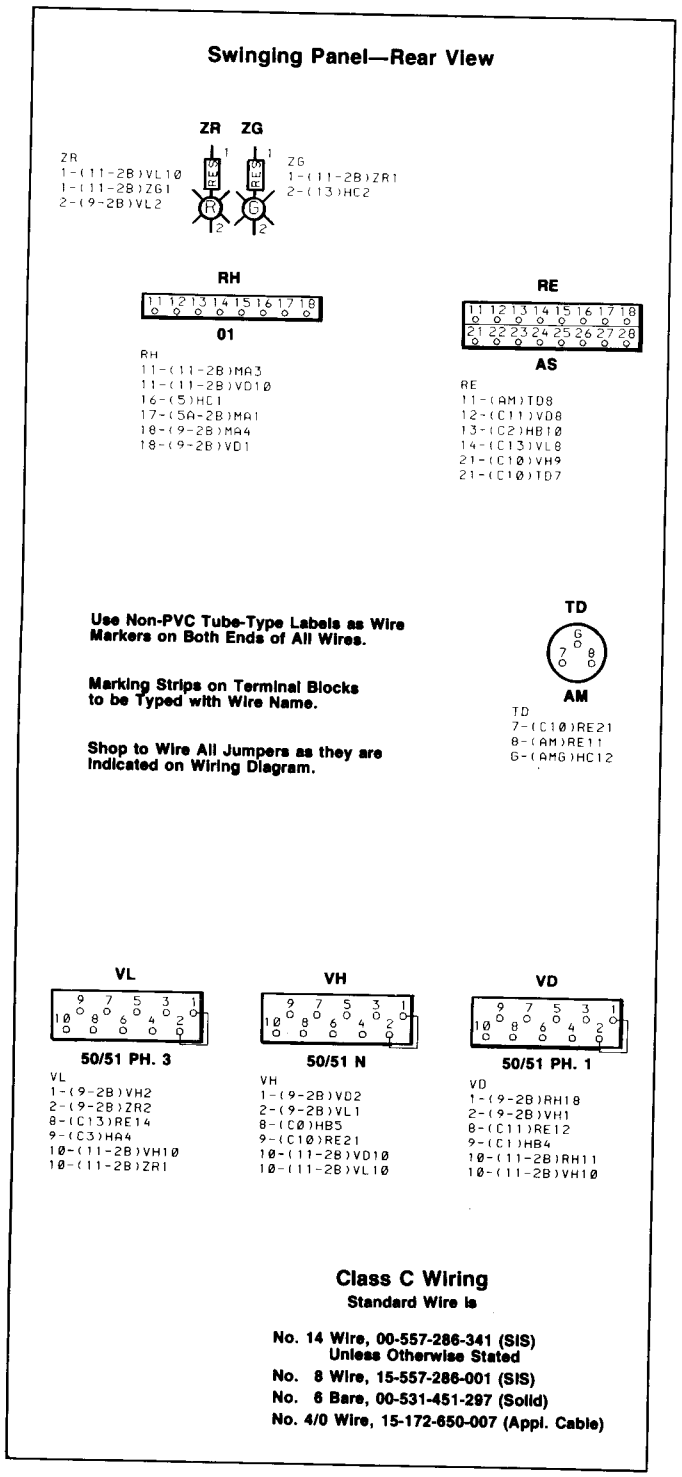


Figure 19. Typical Swinging Panel Wiring Diagram Shown for Cell "A"

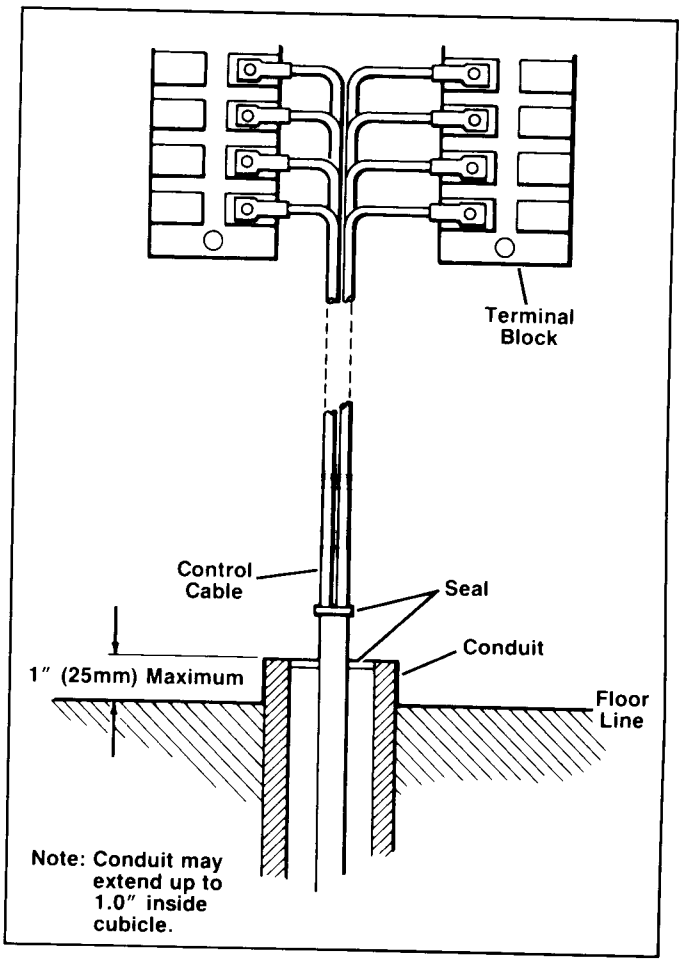


Figure 20. Secondary Control Cable Connections

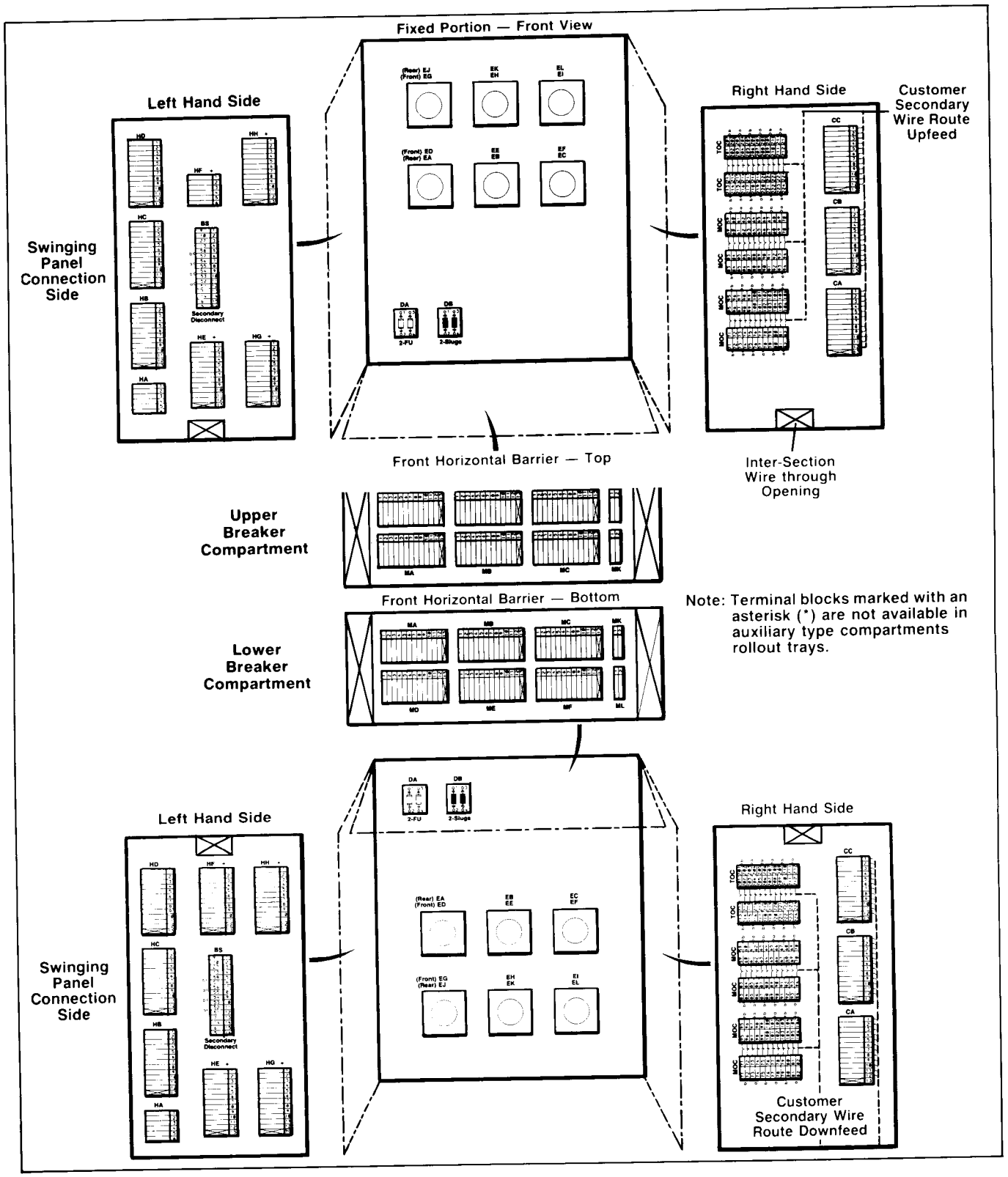


Figure 21. Terminal Block Arrangement

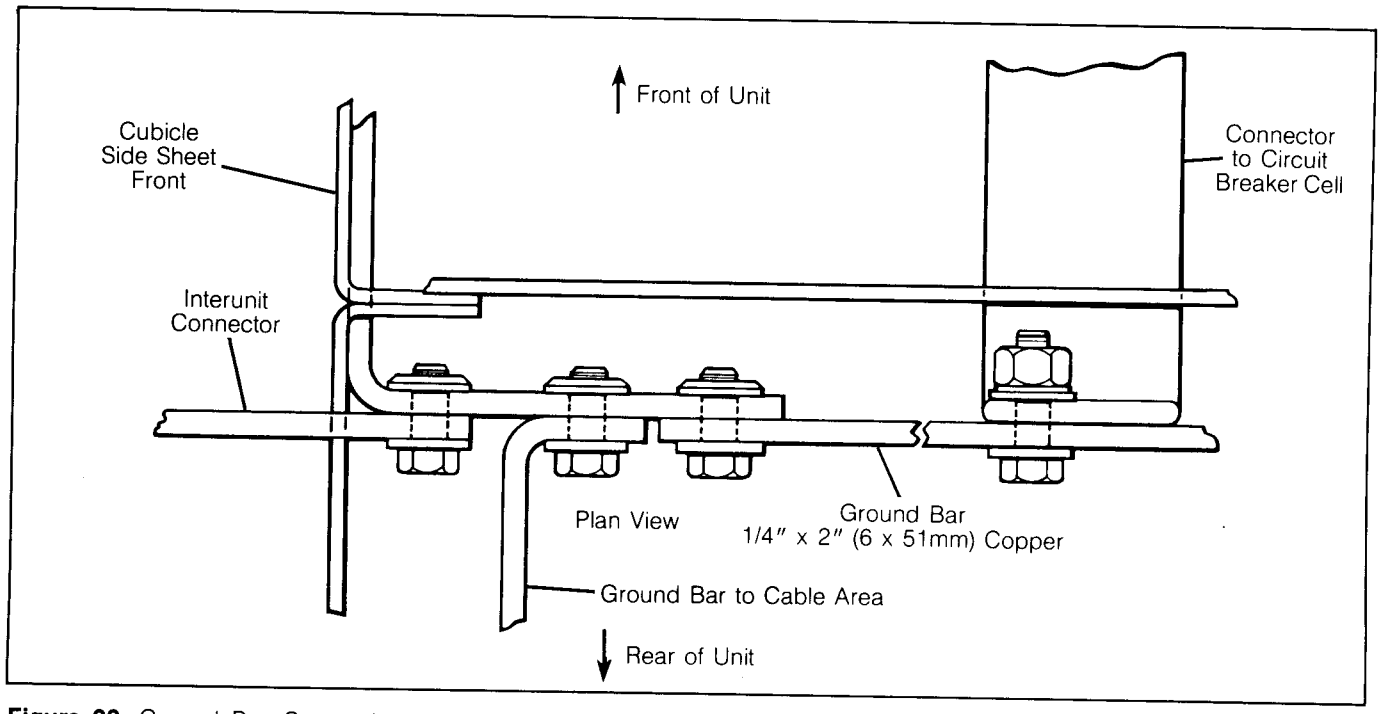


Figure 22. Ground Bus Connection

Control Power and Voltage Transformers—General Information

When required, voltage transformers (VT) or control power transformers (CPT) or fuses for CPT's can be mounted on a withdrawable roll-out tray. Each auxiliary cell ("A" or "B") can contain up to two roll-out trays. See **Table 2** for various tray positions. Roll-out trays are designed with metal extensions on each end of the transformer(s) primary fuses. These extensions wipe across a flexible copper strap mounted on the cubicle as the drawout tray is withdrawn. This action will ground each side of the primary fuses to remove any residual charge from the fuses or transformers.

Voltage Transformers

One, two, or three voltage transformers with primary fuses may be mounted on the roll-out tray located in positions C, D, E and/or F. See "operating sequence" section for disconnecting, connecting or withdrawal instructions.

Table 2. Transformer Positions

Cell	Position	Roll-Out Tray May Be Used for:
"A" (Upper)	"C"	Voltage Transformer (VT)
	"D"	Voltage Transformer or Control Power Transformer (CPT)
"B" (Lower)	"E"	Voltage Transformer
	"F"	Voltage Transformer or Control Power Transformer or Fuses for Control Power Transformer

Typical roll-out tray locations are shown in side views **Figures 23** and **24**.

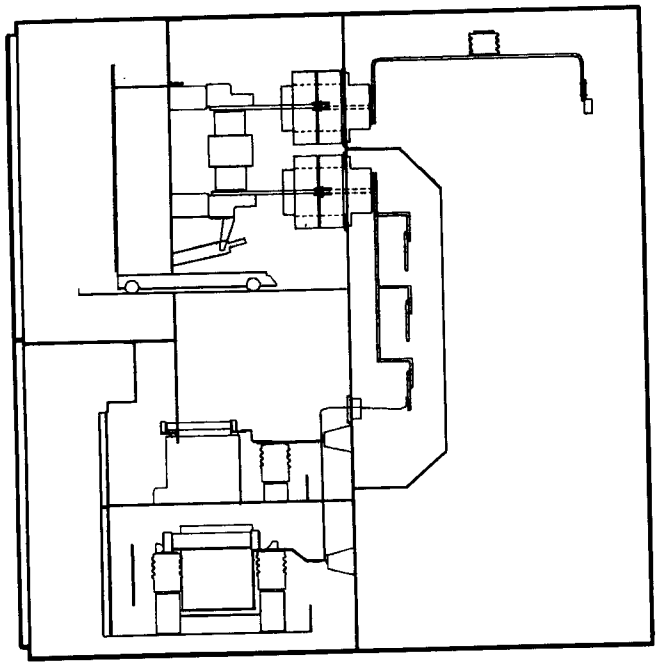


Figure 23. Side View Circuit Breaker/Auxiliary

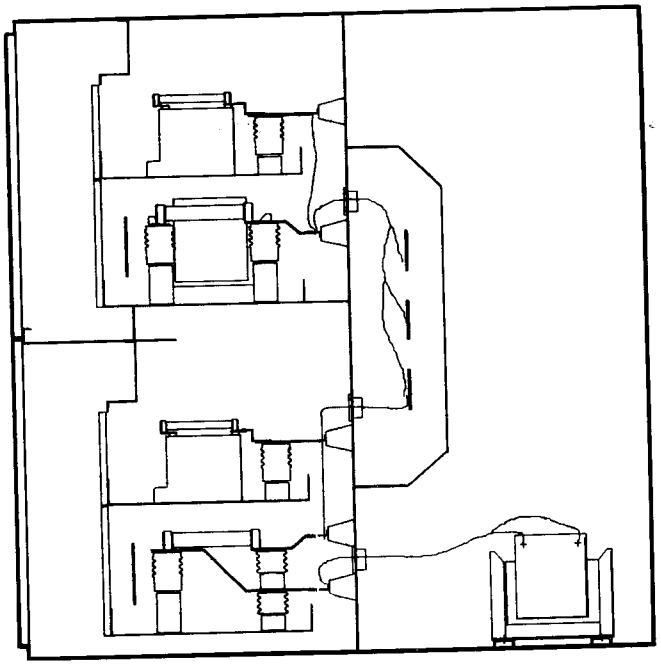
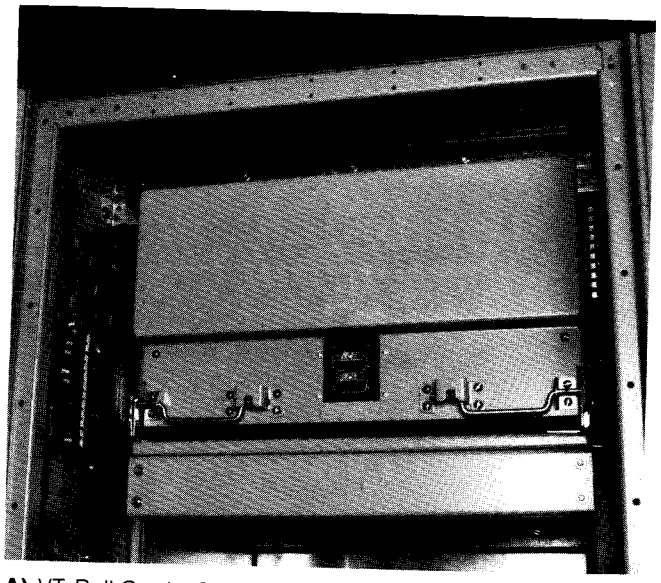


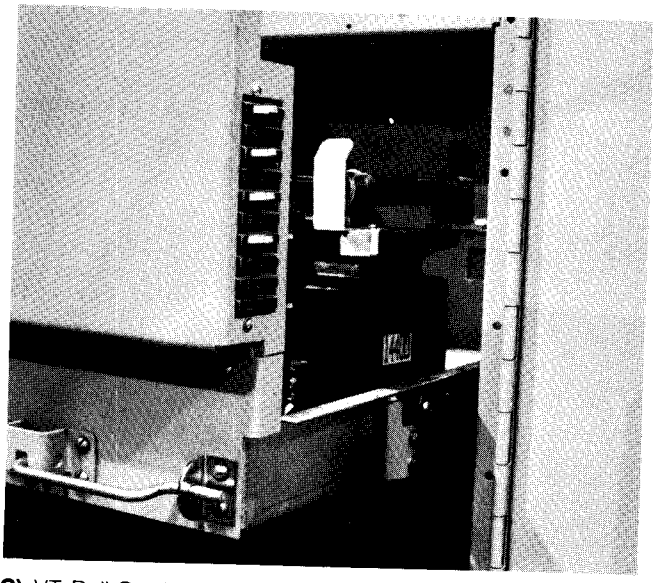
Figure 24. Side View Auxiliary/Auxiliary

Control Power Transformer

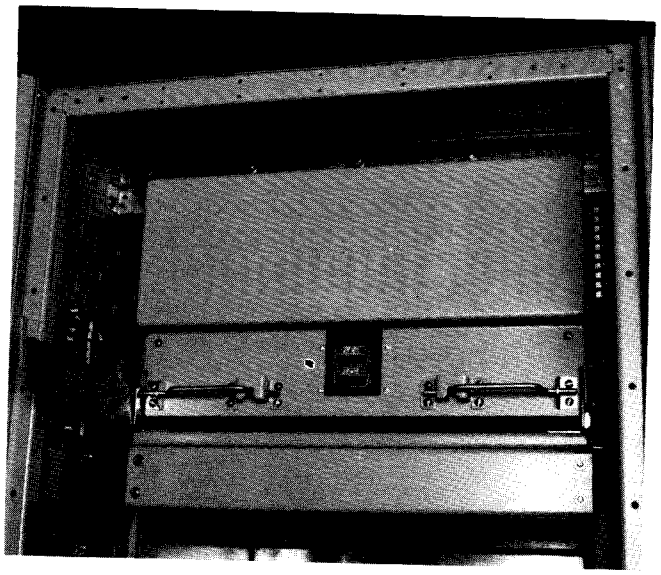
Control power transformers, up to 15kVA single phase, with primary fuses, may be mounted on roll-out tray in positions "D" and "F." Larger than 15kVA and all three phase control power transformers are fixed mounted in the rear of the vertical section. Primary fuses (**Figure 26**) for the rear mounted control power transformers (**Figure 27**) are mounted on a roll-out tray in Position "F" (**Figure 24**). Secondary circuit breakers are normally mounted at the front of the CPT roll-out tray. They are positioned so they must be open before the roll-out tray can be withdrawn. In some cases the secondary circuit breakers may be located on the interior device panel and key interlocked with the roll-out fuse tray (**Figure 28**).



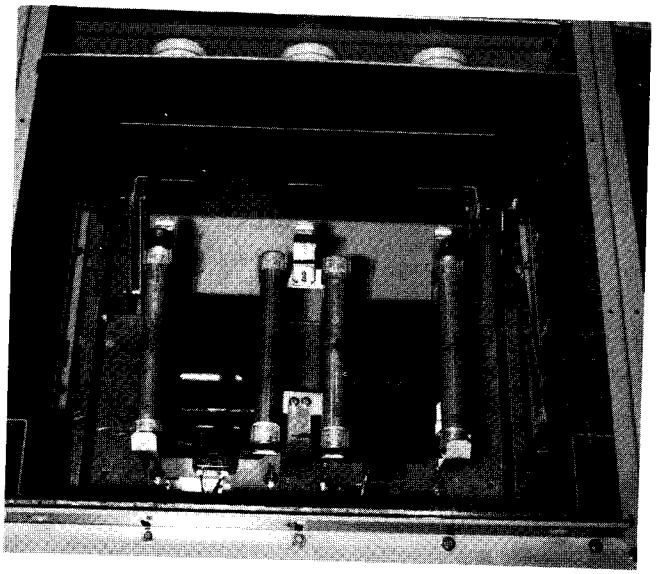
A) VT Roll-Out in Connected Position



C) VT Roll-Out in Disconnected Position



B) VT Roll-Out Ready to Withdraw (Rails Extended)



D) Glass Polyester Shutter Closes as VT Roll-Out is Withdrawn

Figure 25. Transformer/Fuse Trays

Operating Sequence

To Disconnect Transformers or Fuses

For disconnecting voltage or control power transformers or fuses from the primary circuit, grip both interlock bars (left and right) and move horizontally toward center to disengage the bars from the side guide blocks. This will trip secondary breaker on CPT tray. After disengagement, the extension rails may be withdrawn to allow pulling of the roll-out tray to the disconnect position. See **Figure 25**.

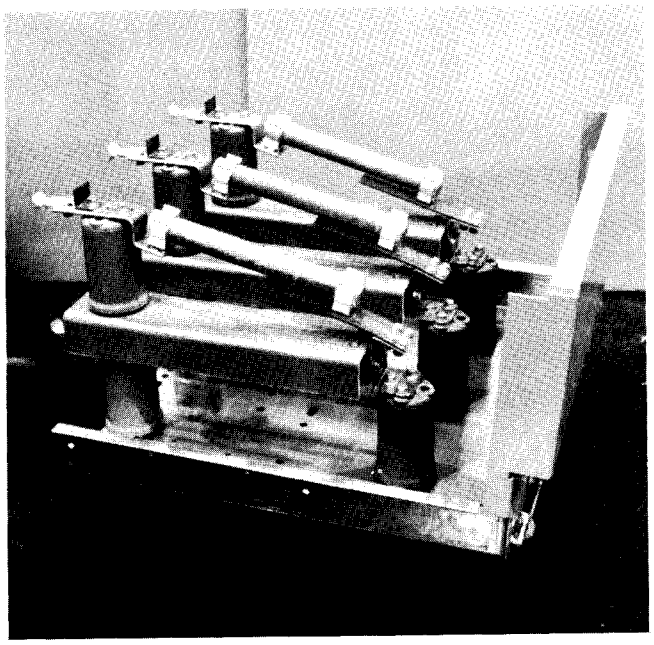


Figure 26. Fuse Tray

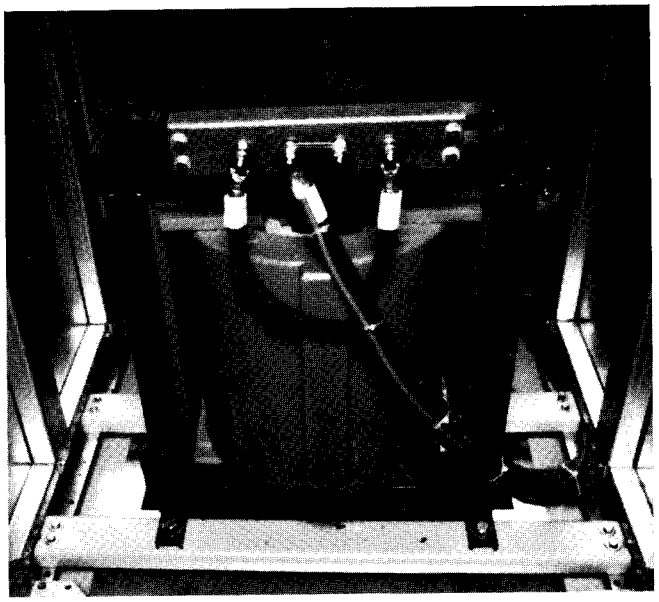


Figure 27. Stationary Control Transformer

To Connect Transformers or Fuses

To reconnect transformers or fuse tray to the primary circuit, grip both interlock bars (left and right) and move horizontally toward center of tray until stopped (**Figure 25**). While holding the bars in this position, push the roll-out tray in until stopped. Now release bars, push in extension rails, and slide bars to outside to engage the side guide blocks. Now for CPT roll-outs, slide the actuator plate to the left side. This action will close the secondary circuit breaker, if mounted on the roll-out tray (**Figure 25**). For remote mounted secondary circuit breaker, after roll-out tray is in connected position and interlock bars are engaged in the side guide blocks, operate the key to lock the interlock bar in the engaged position. The key may now be released to allow closing the remote secondary circuit breaker.

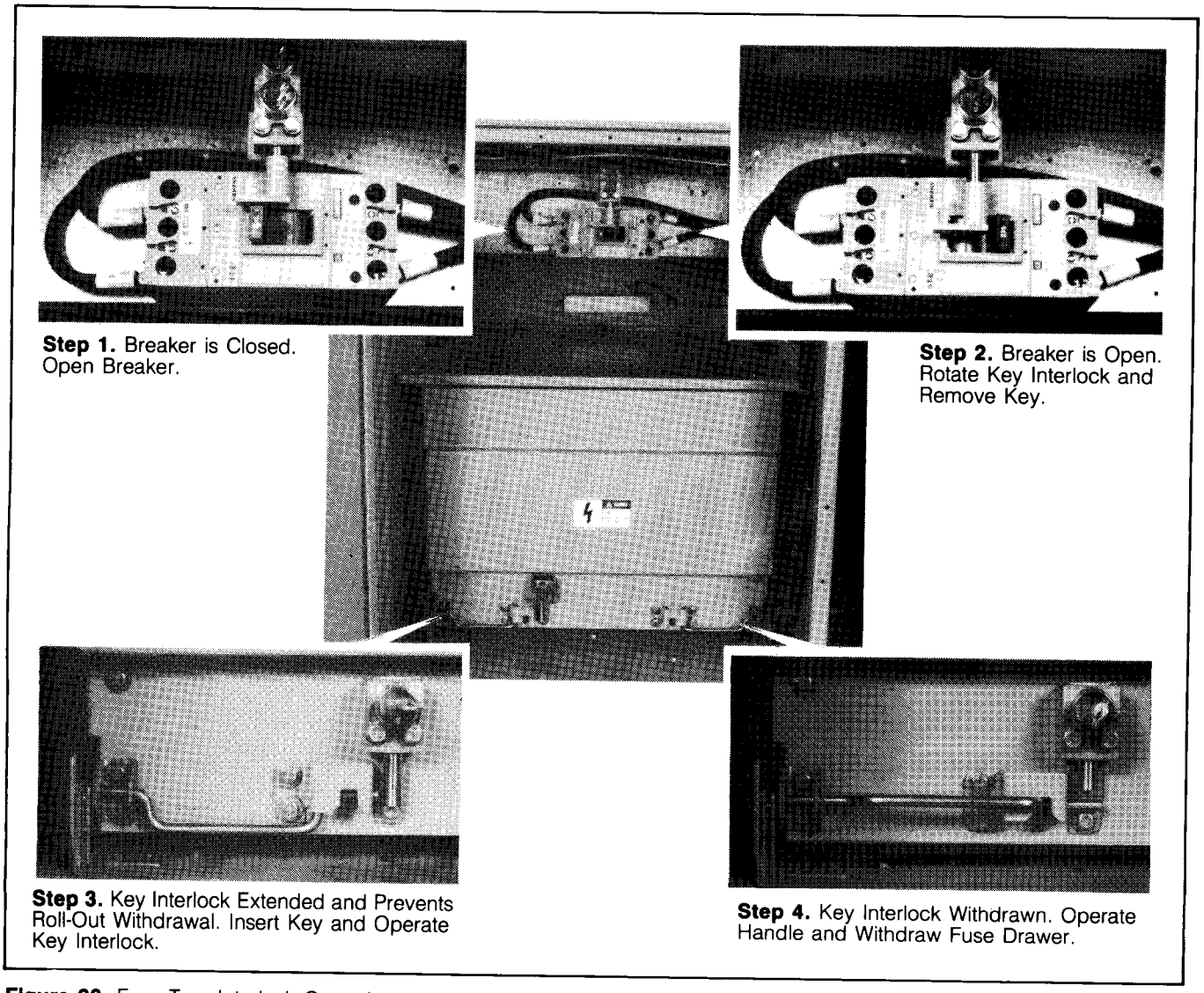
⚠ WARNING

Dangerous voltage may be present within partially rolled-out trays which can cause death, personal injury and property damage.

Do not place hands or objects into trays until fully rolled out. When opening or closing any roll-out tray, always complete the action in one continuous motion with handles held towards the center.

Current Transformers

The torroidal current transformer shown in **Figure 29** is the type extensively used in switchgear equipment. The circuit breaker primary bushings pass through the transformers when in the connected position. Type "HD" current transformers are of the torroidal type mounted in the circuit breaker compartment behind the shutter barrier. Up to two standard accuracy or one high accuracy current transformer may be mounted around each primary insulator tube. Up to 4 current transformers per phase may be furnished. See **Figure 30**.



Step 1. Breaker is Closed. Open Breaker.

Step 2. Breaker is Open. Rotate Key Interlock and Remove Key.

Step 3. Key Interlock Extended and Prevents Roll-Out Withdrawal. Insert Key and Operate Key Interlock.

Step 4. Key Interlock Withdrawn. Operate Handle and Withdraw Fuse Drawer.

Figure 28. Fuse Tray Interlock Operation

The primary bushings of the circuit breaker serve as the primary bar of the current transformer. Therefore, removing the circuit breaker actually removes the primary bar.

Current transformers are built to NEMA and IEEE standards. Each current transformer has a nameplate with the following information: type, serial number and rating. When contacting the factory about transformers, include the nameplate information and identify the cubicle in which the transformer is mounted. Nameplates are located on the transformer near the angled terminal corner.

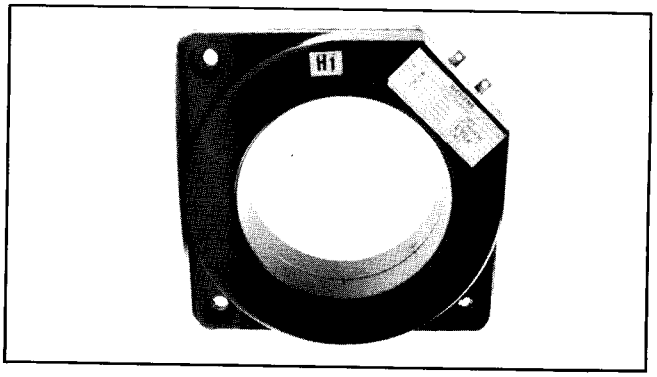


Figure 29. Type "HD" Torroidal Current Transformer

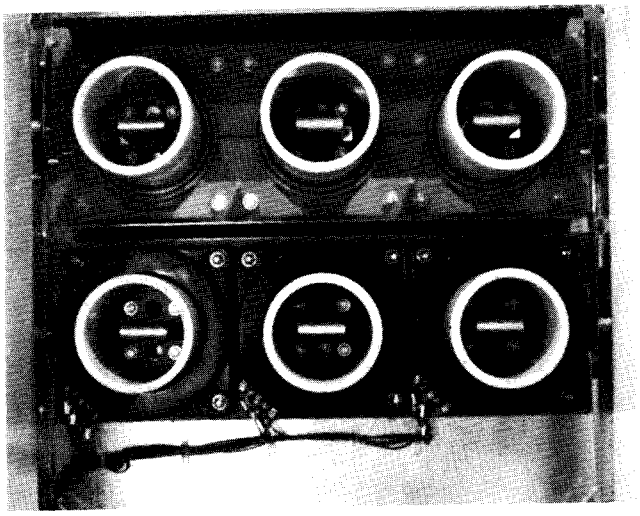


Figure 30. Type "HD" Mounting

An elliptical shaped torroidal current transformers, **Figure 31**, is furnished for ground sensing circuits. This transformer is mounted in the primary cable area at a convenient height for receiving customer's cables. Zero sequence current transformers may require conduits for multiple bottom entrance cables be recessed.

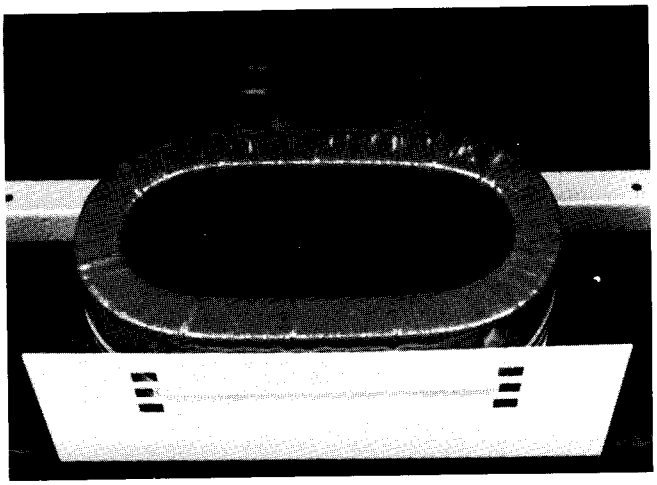


Figure 31. Type BO-100G Zero Sequence Current Transformer

⚠WARNING

High voltages developed on secondaries of open-circuited current transformers can cause death, personal injury and property damage.

Do not operate any current transformer with secondaries open-circuited.

Cell Preparation

The cell contains the positioning, interlocking and operating devices described below and shown in **Figures 32** thru **34**. These devices must be checked for placement and freedom of operation.

Racking Device

The racking device is centered below the circuit breaker. It functions in conjunction with the trip-free interlock on the circuit breaker, to hold the circuit breaker trip-free between positions. Three positions are provided: Disconnect, Test, and Connect.

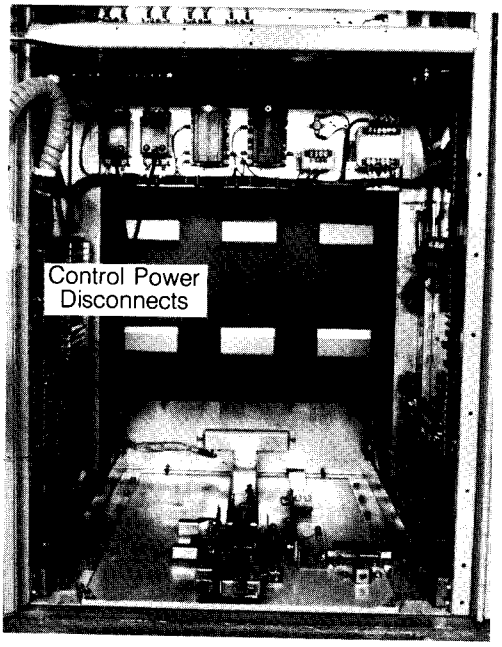


Figure 32. Circuit Breaker Compartment

Interference Blocking Plate

This plate is mounted vertically on the bottom of the cell to allow only the properly rated breaker into the designated cell (i.e.) a 1200-ampere circuit breaker to enter a 1200-ampere cell and a 2000-ampere circuit breaker to enter a 2000-ampere cell depending on the voltage, interrupting, and close and latch ratings. Normally the cubicle and circuit breaker rating plate combinations will be identical.

⚠WARNING

Hazardous voltages and currents, associated with the insertion and operation of circuit breakers in cubicles of higher ratings than the breaker can cause death, severe personal injury, and substantial property damage.

Verify that circuit breakers and cubicles have appropriate ratings and properly located interference blocking plates and angles before attempting insertion.

However the plates are designed to allow a higher rated breaker to be used in a lower rated cell; e.g. 2000-ampere circuit breaker in 1200-ampere cell and 750MVA circuit breaker in 500MVA cell.

The coordinating interference plate on the circuit breaker is shown in **Figure 41**.

Secondary Disconnect

The secondary disconnect contains all the electrical control circuit connections for the circuit breaker. It mates with the secondary disconnect block on the circuit breaker. The circuit breaker contacts slide against the cell contact strips. The secondary contacts are automatically mated in the test and connect positions.

Mechanism Operated Cell Switch (MOC)

This switch is operated by a roller on the circuit breaker. The breaker engages the MOC auxiliary switch only in the connected (operating) position unless an optional test position pickup is specified in the contract. If a test position pickup is included, the breaker will engage the auxiliary switch in both positions. (**Figure 34**). Up to 24 stages may be provided.

Truck Operated Cell Switch (TOC)

This switch is operated by an extension of the top plate at the right top corner of the circuit breaker. This switch is operated only as the circuit breaker is moved to or from the

connected position. (**Figure 34**). Up to 12 stages may be provided.

Circuit Breaker Ground Connection

A sliding contact finger assembly for grounding the circuit breaker frame is mounted underneath the breaker truck frame (**Figure 33**). This assembly engages the ground bar mounted in the cell and maintains a solid ground contact with a continuous wipe through all positions. The contact is broken when the breaker passes the disconnect position while being removed from the cell.

Shutter Operation

Two shutter operating levers are driven down by the engagement of the wheels on the circuit breaker frame. This opens the shutters as the circuit breaker is moved into the connected position and allows the shutters to close when the circuit breaker is withdrawn. The shutters are fully closed with the breaker at the test position. (**Figure 35**).

To open, both the top and bottom shutters move upward.

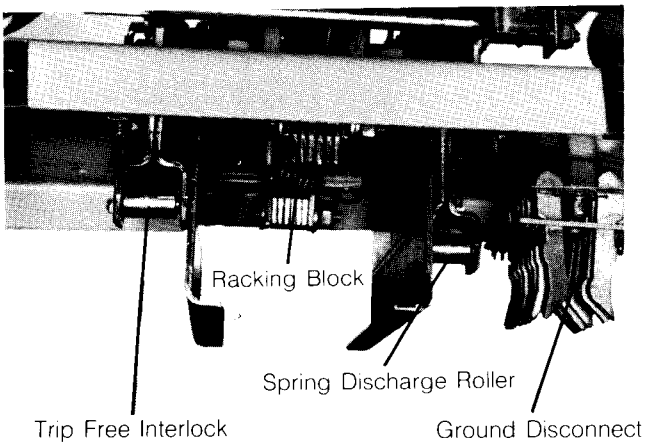


Figure 33. Interlocks at Bottom of Mechanism

Breaker Installation and Removal

Type GMI Vacuum Interrupter Circuit Breakers are normally shipped assembled in the metal-clad switchgear cells.

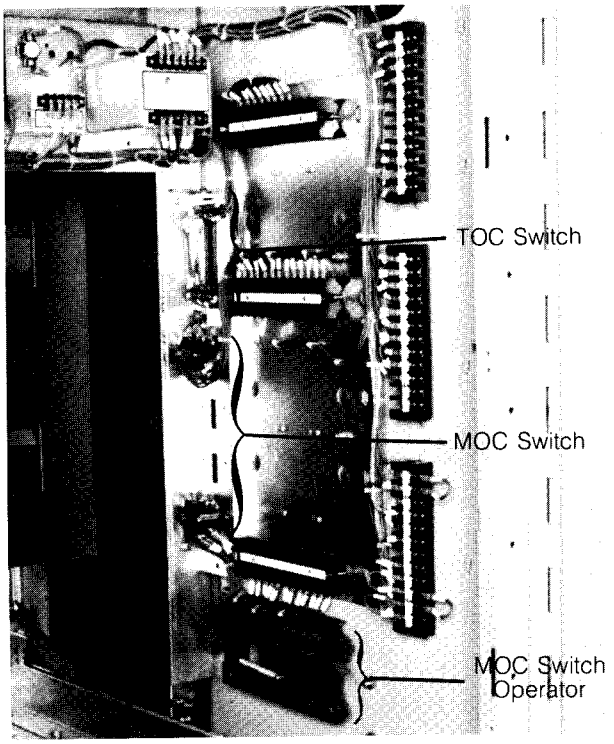


Figure 34. MOC and TOC Switches

They are also normally shipped with their primary contacts open and their springs discharged. However, it is critical to *first* verify the discharged condition of the spring-loaded mechanisms after de-energizing control power.

De-Energizing Control Power in Switchgear Mounted Circuit Breakers

When the circuit breaker is mounted in switchgear, open the control power disconnect device in the metal-clad switchgear cubicle. **Figure 32** shows the location of this disconnect in a standard two-high switchgear assembly.

NOTE

All figures of switchgear in this manual show the switchgear front hinged panel in the open position.

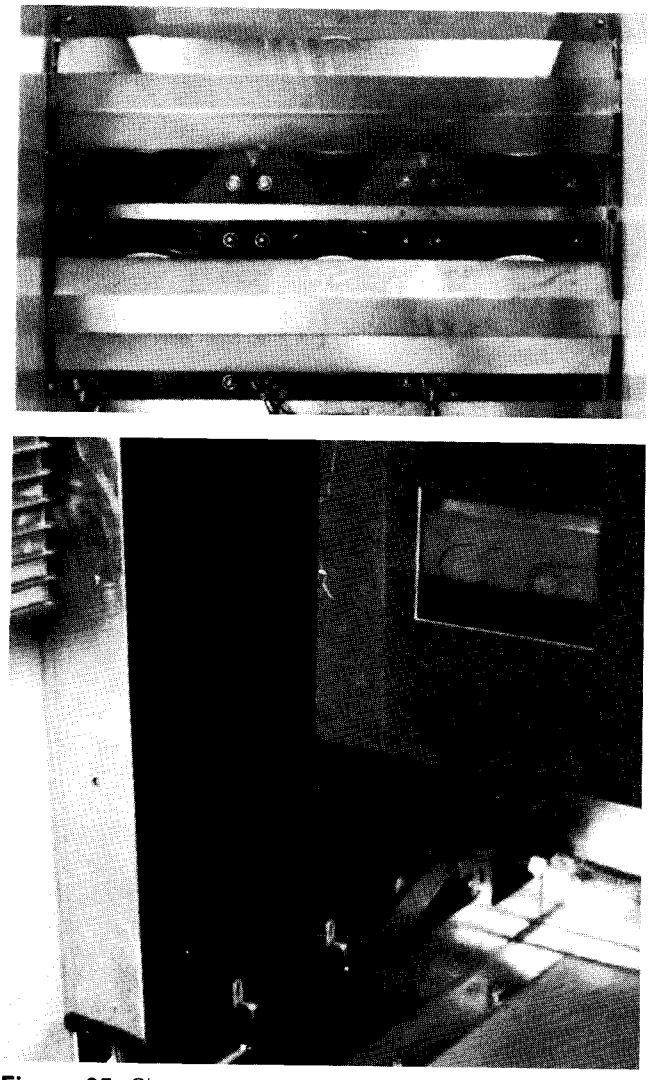


Figure 35. Shutters and Operating Linkage (For illustration, glass polyester CT barrier has been removed for top photo.)

The control power disconnect device is located on the device panel above the lower circuit breaker and below the upper circuit breaker. **Figure 32** shows pullout type fuse holders. Removal of the fuse holders de-energizes control power to the circuit breaker in the respective switchgear compartment. In some switchgear assemblies, molded case circuit breakers are used in lieu of the pullout type fuse holders. Opening these circuit breakers accomplishes the same result: control power is disconnected.

Spring Discharge Check

Perform the Spring Discharge Check *before* removing the circuit breaker from the pallet or removing it from the switchgear.

⚠ DANGER

Hazardous voltages and high-speed mechanical parts will cause death or severe personal injury and property damage.

Read instruction manuals, observe safety instructions and use qualified personnel.

The spring discharge check consists of simply performing the following tasks in the order given. This check assures that both the tripping and closing springs are fully discharged.

1. Press red Trip pushbutton.
2. Press green Close pushbutton.
3. Again press red Trip pushbutton.
4. Verify Spring Condition Indicator shows "DISCHARGED"
5. Verify Main Contact Status Indicator shows "OPEN"

Removal From Lower Cell (Indoor and Shelter-Clad Outdoor Switchgear)

After performing the Spring Discharge Check (with control power de-energized), remove the circuit breaker from its switchgear cubicle.

1. Push the racking interlock latch in and insert the racking crank on the racking screw on the floor of the breaker cell as shown in **Figure 36A**. (Upper cell) or **Figure 40A/40B** (Lower cell).
2. With constant pressure on the racking crank, rotate *counterclockwise* until the breaker is in the Disconnect position.
3. Movement of the Breaker Release Latch to the left will allow removal of the circuit breaker from the cubicle.
4. The circuit breaker is then free to be rolled out using the handles as shown in **Figure 38**. The wheels of the circuit breaker are virtually at floor level, and one person can easily handle the unit.

Removal from Upper Cell (Indoor and Shelter-Clad Outdoor Switchgear)

Removal of the upper breaker in a two-high assembly is similar to removal of a breaker from a lower cell, with several additional steps.

Figure 37 shows the two breaker extension rails that are inserted into the fixed rails within the upper cell of two-high switchgear equipment. The rails engage locking pins in the fixed rails to secure them in position.

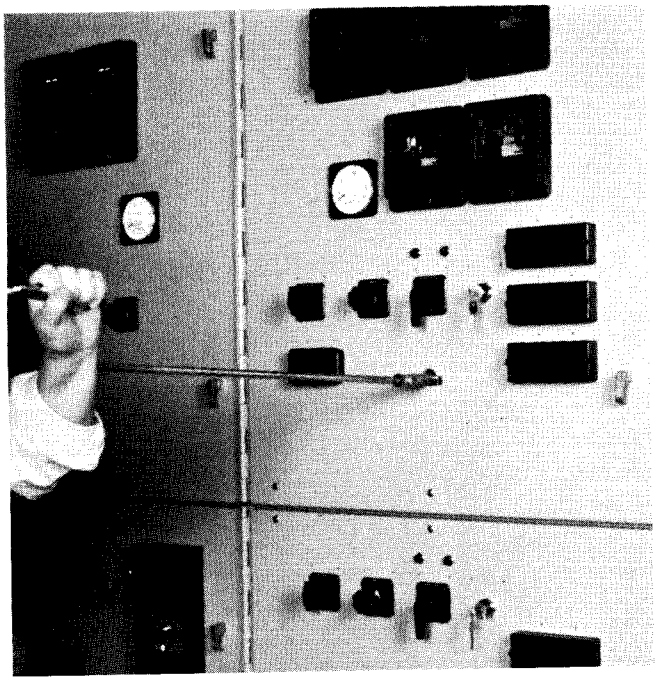


Figure 36A. Racking Position

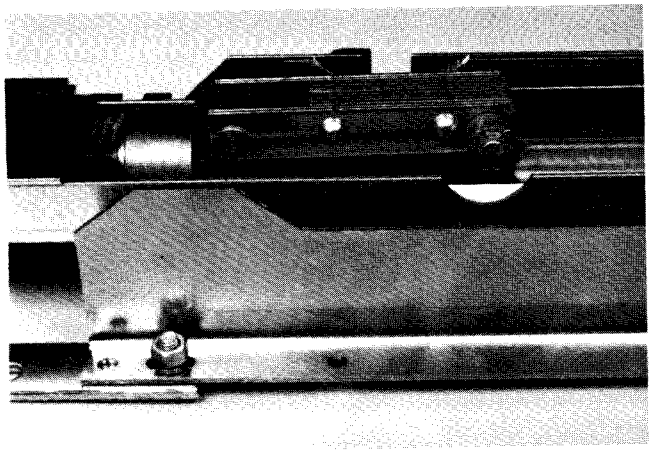


Figure 36B. Racking Mechanism with Racking Block Down

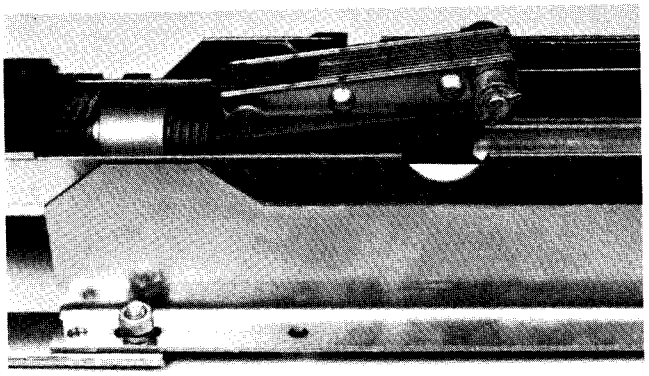


Figure 36C. Racking Mechanism with Racking Block Up

The procedure for removal of an upper circuit breaker is:

1. Insert the two upper support rails into the fixed rails. Be sure rails are properly secured in place. (This can be done after Step 3 if preferred.)
2. Push the racking interlock in and insert the racking crank on the racking screw into the upper breaker as shown in **Figure 36A**.
3. With constant pressure on the racking crank, rotate *counterclockwise* until the breaker is in the Disconnect position.
4. Move the breaker release latch to the left. The breaker is then free to be rolled out on the two support rails using the handles.
5. Remove the breaker from the two extension rails using the approved Siemens breaker lifting device.
6. Lift the two extension rails and withdraw them from the switchgear.

Removal from Upper and Lower Cell in Outdoor Non-Walk-In Enclosures

Because the floor level in non-walk-in outdoor enclosures is approximately 6 inches above grade (foundation) level, the lower breaker in either a one-high or two-high section of switchgear must be removed using the preceding procedure for upper breaker removal.

The approved breaker lifting device should be used for removal of both lower and upper breakers in outdoor non-walk-in enclosures.

⚠WARNING

Movement of breaker out from disconnect position without extension rails installed can cause damage to equipment and personal injury.

Do not move Breaker Release Latch until extension rails are properly engaged in the fully inserted position.

Type GMI circuit breakers weight between 385 and 575 pounds, depending upon their ratings. The breaker can be moved using a properly rated crane, slings and a spreader bar. Slings can be attached to the breaker, and then used to hoist the circuit breaker vertically clear of the extension rails. When clear, remove the rails and lower the circuit breaker to the floor.

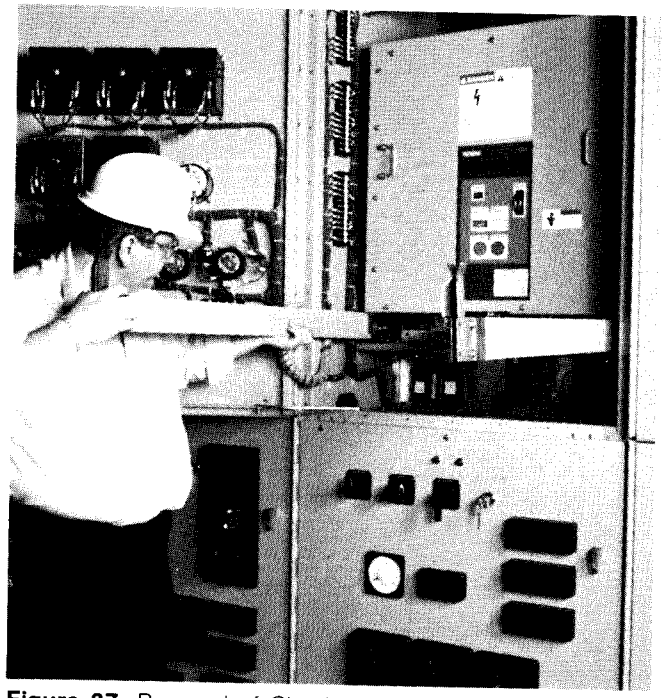


Figure 37. Removal of Circuit Breaker

⚠WARNING

A lift truck with a raised circuit breaker which becomes unstable and overturns can cause death, severe personal injury or substantial property damage.

Raise the breaker on the lift truck just before insertion and lower just after withdrawal. Do not move lift truck any distance with breaker raised.

Breaker Racking

When inserting a circuit breaker into a cell, be sure that the racking block is in the lowered position as shown in **Figure 36B**. In this position, the racking position indicator should show a green square with the letter "D" for disconnect position. If the racking block is in the raised position, **Figure 36C**, use the racking crank to move the racking block to the lowered position.

Figure 38. Racking Latch

⚠ CAUTION

Failure to follow instructions could result in damage to equipment.
Return racking mechanism to the "D" position before inserting circuit breaker.

The circuit breaker racking method has been designed to be used with the instrument door either open (**Figure 40a**) or closed (**Figure 40b**). Moving the breaker between the "CONNECT" and "TEST" or "DISCONNECT" positions with the door closed provides additional protection to the operator and is the recommended procedure.

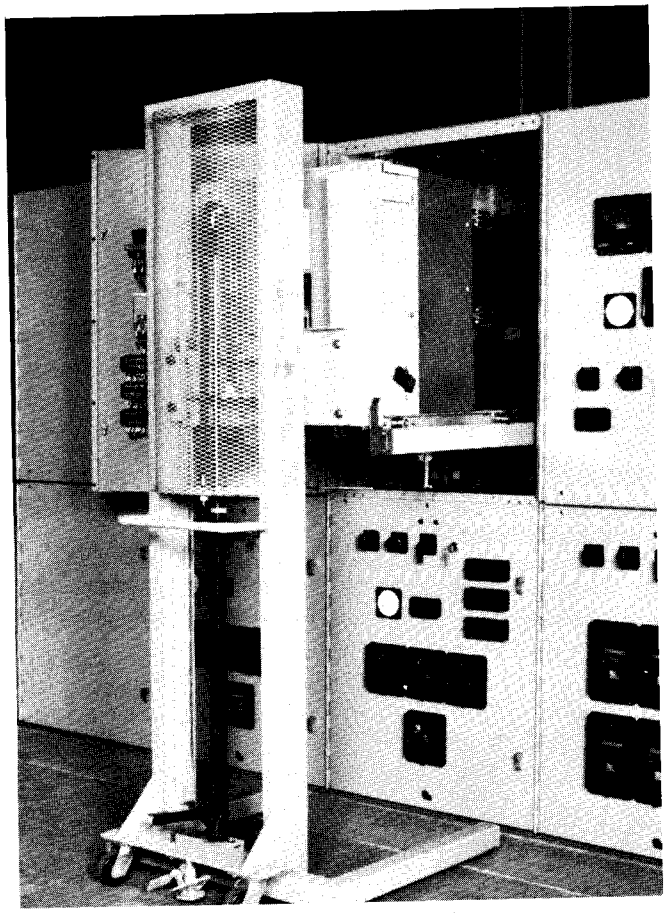


Figure 39. Lift Truck—with Circuit Breaker

Racking into "Connect" Position

1. Check the position indicator shows "D" for Disconnect position.
2. Check that the circuit breaker is fully pushed into the cell to the Disconnect position.
3. Check that the circuit breaker is OPEN.
4. Secondary disconnects will automatically connect as the circuit breaker moves to the Test and Connect position.
5. Close instrument door.
6. Insert racking crank through round opening at bottom of door and onto the racking screw.
7. Push the racking crank forward to move the closed breaker racking interlock slide back which will allow the socket to engage the hex head on the racking screw. Do not force slide as it is interlocked to prevent sliding forward when the circuit breaker is closed.
8. With constant pressure on the racking crank, rotate clockwise about 54 times until a positive stop is felt and the position indicated shows "C" for the Connect position. The indicator will show "T" when the circuit breaker is in Test position.

Racking to Test or Disconnect Position

1. This procedure is essentially the same as racking to connected position procedure except the rotation is counterclockwise.
2. Check that the circuit breaker is open.
3. Close instrument door.
4. Insert racking crank and with steady pressure to maintain hex head engagement rotate *counterclockwise* about 54 times to a position stop and the position indicator indicates "D" for Disconnect position. The intermediate Test position is indicated by "T."

Contact Penetration

Make certain all electrical connections to both the line/load and bus disconnects are de-energized and locked out. This can be verified by blocking the shutters open and using a

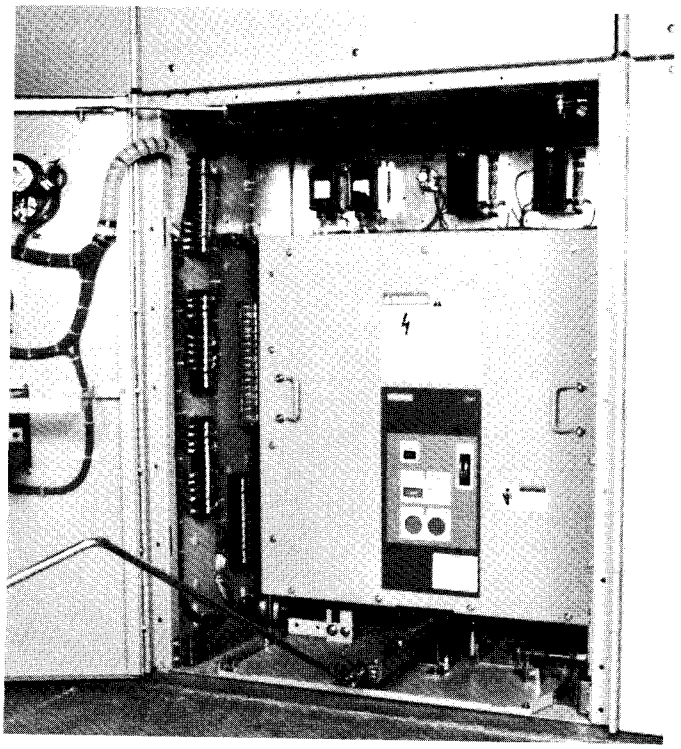


Figure 40A. Breaker Racking (Door Open)

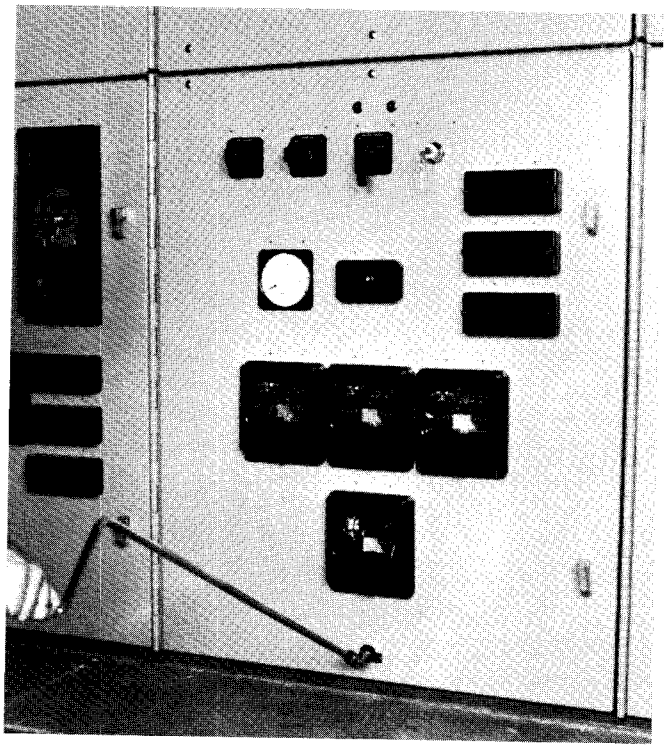


Figure 40B. Breaker Racking (Door Closed)

hot stick potential device to double-check that all disconnects are de-energized. Rack the breaker completely into the "CONNECT" position and then withdraw it from the cell. Check that the contact wipe is about 3/8" (10mm) on the cell primary disconnects, for all breaker ratings.

Closed Breaker Racking Interlock

The closed breaker racking interlock is designed to prevent a breaker from being racked from "TEST" to "CONNECT" and vice-versa with the primary contacts closed. Only an open circuit breaker is to be moved between these positions. **Figure 42b**.

The trip free interlock slide has angle-shaped members (**Figure 42A**, **Item 60**) that project from the left side of the racking mechanism and engage an interlock member from the circuit breaker. The circuit breaker interlock extends down to prevent movement of the trip free interlock slide with the circuit breaker closed. When engaged the racking screw is not accessible to the racking crank until the breaker has been opened.

NOTE

Racking handle must be removed, allowing the interlock slides to return to their initial position. The breaker may now be closed mechanically or electrically.

Racking Access Interlock

The racking interlock slide (**Figure 42A**, **Item 62**) has provisions for three padlocks to prevent engagement of the racking crank to the racking screw. This allows locking of the circuit breaker in Disconnect, Test, or Connect positions. Key interlocking (**Figure 42A**, **Item 42**) can be provided for racking sequence interlocking of dummy breakers, etc. When locked in the Disconnect position, the circuit breaker or dummy can be removed for servicing.

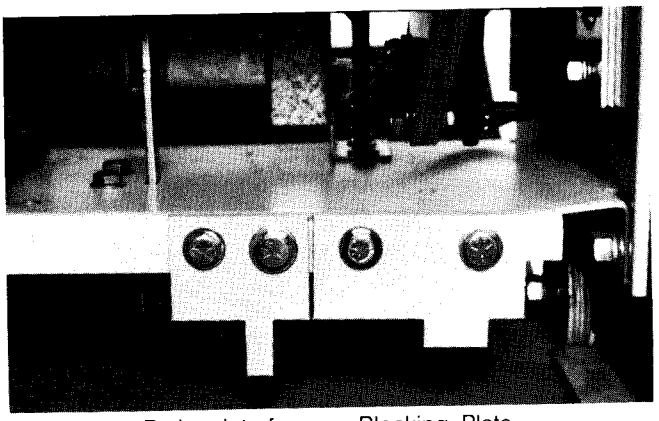


Figure 41. Rating Interference Blocking Plate

Trip-Free Interlock

The trip-free interlock slide prevents a circuit breaker from being closed between the "TEST" and "CONNECT" positions by maintaining a mechanical and electrical trip-free condition (**Figure 42B**).

As the breaker moves between the "TEST" and "CONNECT" positions, the trip-free roller engages the trip-free rail of the racking device. As the roller travels the trip-free rail between positions, the roller activates the trip linkage which holds the circuit breaker in a mechanically trip-free condition.

In order to lock the circuit breaker trip-free in either the "TEST" or "CONNECT" positions, the breaker must be opened and the trip-free interlock slide assembly pushed away to lift the trip-free roller on the breaker. This position permits the use of a key interlock (**Figure 42A, Item 41**) or padlocks (up to 3) to maintain the mechanism in trip-free position. The circuit breaker can be removed for servicing while interlocked in the trip-free position.

The interlock can be tested by racking the circuit breaker to a position between the "TEST" and "CONNECT" position with the closing springs charged. Activating the "CLOSE" function either electrically or manually will cause the springs to discharge and the interlock should prevent the circuit breaker from closing. This is also true when the breaker is in either the "TEST" or "CONNECT" positions and the trip-free interlock slide is pushed away and key interlocked or padlocked. The breaker will operated trip-free when closing is attempted.

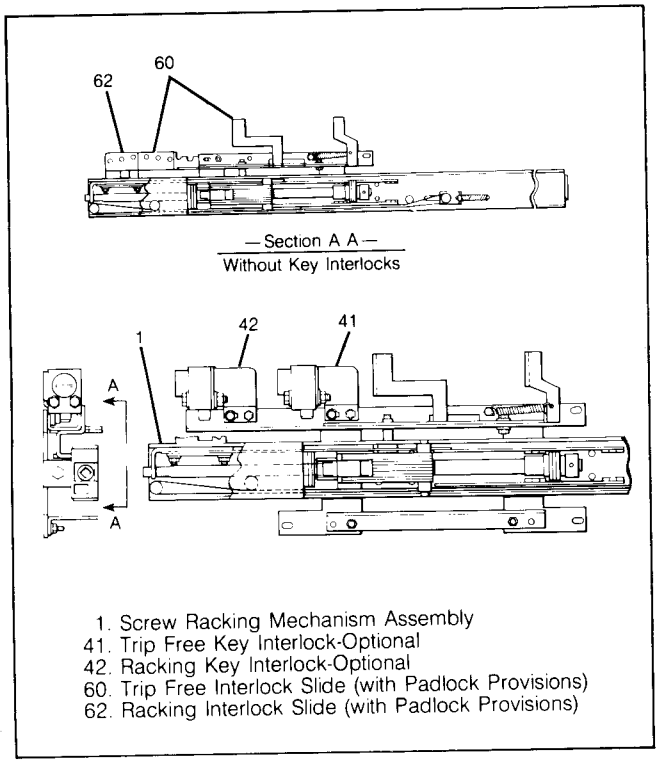


Figure 42A

Spring Discharge Interlock

The closing spring discharge interlock prevents the insertion or removal of a circuit breaker with a charged mechanism. The spring dump roller rides up a rail releasing the closing springs while held trip-free. This discharges the closing springs without closing the breaker primary contacts. (**Figure 33**).

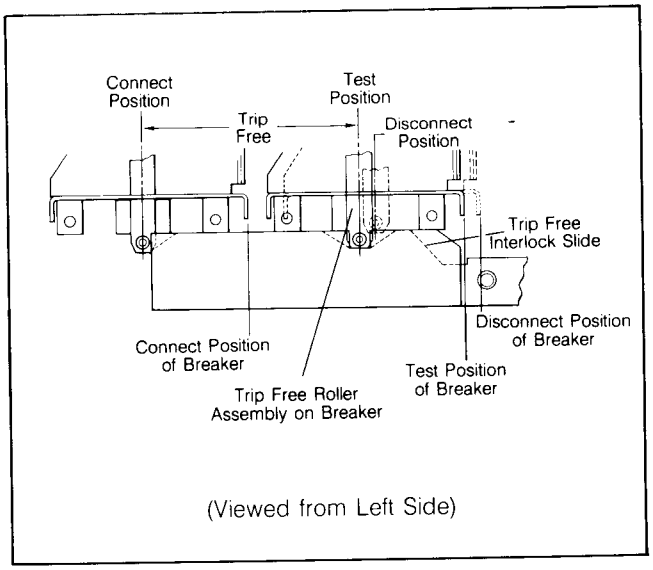


Figure 42B

Inspection and Testing

Before the equipment is energized, it must be thoroughly inspected and tested. Correct any deviations immediately before energization.

Inspection

Check the following points:

1. High voltage connections properly insulated.
2. Electrical disconnecting contacts, machine parts, shutter, etc., checked for lubrication and operation.
3. Blockings, supports and other temporary ties removed from breakers, instruments, relays, etc.
4. Proper fuses correctly placed.
5. Temporary wiring jumpers (used on the secondaries of current transformers tied to external devices, as shown on wiring diagrams) removed.
6. Ground connections properly made.
7. Incoming primary and secondary connections properly made and checked for shorts or undesired grounds.
8. All equipment, removed during assembly, replaced.
9. Relays coordinated with other relays, etc., on the system. Refer to relay instruction book before making any adjustments. Consult local power company before making any connections to the power supply.
10. Storage battery fully charged and provided with recharging facilities.
11. Interlocks performing properly.
12. Circuit breakers checked and prepared per instruction books.
13. All filters in vent areas are clean and free of shipping or construction material.

Testing

1. A megger test is made on the high voltage circuit to be sure that all connections made in the field are properly insulated. A megger test is also advisable on the control circuit. There are no rule-of-thumb formulas for exact values of insulation resistance owing to the variations in materials used, moisture, temperature, surface leakage, etc. For many years maintenance personnel have used 1 megohm per kV plus 1 megohm, with a 1 megohm minimum as a general guide. This could be acceptable, in some cases, for energization. Our experience has shown that 200 megohms on 5 & 15kV class is typical. These values are with the breakers removed; 150 megohms is typical with breakers in connect position and closed on the 5 & 15kV equipment. **IMPORTANT:** When meggering each phase to ground, look for any differences in readings. The readings for all three phases to ground should be very close, and if not, look for the cause and correct.
2. A dielectric test, if possible, should be made on the high voltage circuit for one minute at one of the following voltages corresponding to the rated volts of the equipment. (Voltage transformers, control power transformers, surge arresters, surge capacitors, and surge limiters must be disconnected during this test).

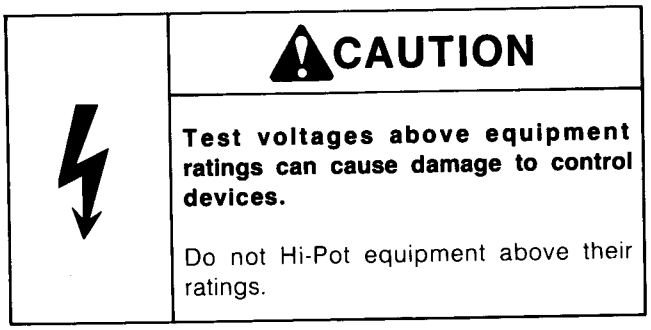
Rated Maximum Voltage kV (rms)	Power Frequency Withstand kV (rms)	Field Test Voltage kV (rms)	Field Test Voltage kV (dc)*
4.76	19	14.25	20.2
8.25	36	27.00	38.2
15.00	36	27.00	38.2

In accordance with ANSI C37.20.2 Paragraph 5.5 Field Dielectric Tests are also recommended when new units are added to an existing installation or after major field modifications. The equipment should be put in good condition prior to the field test. It is not expected that equipment shall be subjected to these tests after it has been stored for long periods of time or has accumulated a large amount of dust, moisture, or other contaminants without being first restored to good condition.

*The DC test voltage is given as a reference only for those using DC tests to verify the integrity of connected cable installations without disconnecting the cables from the switchgear. It represents values believed to be appropriate and approximately equivalent to the corresponding power frequency withstand test values specified for each voltage rating of switchgear. The presence of this column in no way implies any requirement for a DC withstand test on AC equipment or that a DC withstand test represents an acceptable alternative to AC withstand tests. When making DC tests, the voltage should be raised to the test value in discrete steps and held for a period of one minute.

A dielectric test on secondary and control circuits should be made for one minute at 1125V AC or 1590 DC. The above voltages are in accordance with NEMA Standards.

Disconnect electronic devices (such as solid-state relays) before conducting this test.



⚠CAUTION

Test voltages above equipment ratings can cause damage to control devices.

Do not Hi-Pot equipment above their ratings.

Certain control devices such as charging motors, pushbuttons, bell alarms, etc., may have only a 900 volt rating. Field HI-POT testing at 75% of rating allows only 675 volts AC or 954 volts DC.

3. With breaker in the test position make the following tests on each unit:
   a. Trip and close the circuit breaker with the control switch.
   b. Trip the breaker by passing sufficient amps (or volts) through the coils of protective relays.
   c. Trip and close the breaker from any remote control positions.
   d. Operate auxiliary devices.
   e. Test the phase sequence of polyphase high voltage circuits, particularly those used for motor starting.

Placing Equipment into Service

To place equipment in service for the first time proceed as follows:

1. Check that all circuit breakers are open and all control circuits energized.
2. Connect primary incoming power source to equipment.

NOTE

The primary incoming power source should be at the lowest voltage possible and gradually brought up to normal.

3. Check all instruments, relays, meters, etc., during this time.
4. Connect as small a load as possible and observe instruments.

NOTE

Allow several minutes before connecting additional load.

5. Gradually connect more load to the equipment while observing instruments until full load is connected.
6. Check for overheating of primary and secondary circuits and satisfactory operation of all instruments during the first week of operation.

Introduction

Thorough, periodic inspection is important to satisfactory operation. Inspection and maintenance frequency depends in installation, site, weather and atmospheric conditions, experience of operating personnel and special operation requirements. Because of this, a well-planned and effective maintenance program depends largely on experience and practice.

FAILURE TO PROPERLY MAINTAIN THE EQUIPMENT CAN RESULT IN SEVERE PERSONAL INJURY AND PRODUCT FAILURE. THE INSTRUCTIONS CONTAINED HEREIN SHOULD BE CAREFULLY REVIEWED, UNDERSTOOD AND FOLLOWED. THE FOLLOWING MAINTENANCE PROCEDURES SHOULD BE PERFORMED REGULARLY:

- General visual inspection of de-energized switchgear.
- Keep equipment clean and adequately lubricated.
- Keep insulation materials dry and clean.
- Keep connectors in place and properly adjusted.
- Repair or replace any items functioning improperly.
- Check switchgear for smooth and correct operation before turning to service.

Once a year, a general visual inspection should be performed on de-energized switchgear, and if necessary, the exposed insulating parts wiped with a rag.

Where application imposes dusty or other severe ambient conditions and/or frequent switching operations the following inspection checks should be more frequently applied for normal maintenance.

THESE INSTRUCTIONS DO NOT REPRESENT AN EXHAUSTIVE SURVEY OF MAINTENANCE STEPS NECESSARY TO ENSURE SAFE OPERATION OF THE EQUIPMENT. PARTICULAR APPLICATIONS MAY REQUIRE FURTHER PROCEDURES. SHOULD FURTHER INFORMATION BE DESIRED OR SHOULD PARTICULAR PROBLEMS ARISE WHICH ARE NOT COVERED SUFFICIENTLY FOR THE PURCHASER'S PURPOSES, THE MATTER SHOULD BE REFERRED TO THE LOCAL SIEMENS SALES OFFICE.

THE USE OF UNAUTHORIZED PARTS IN THE REPAIR OF THE EQUIPMENT, OR TAMPERING BY UNQUALIFIED PERSONNEL, WILL RESULT IN DANGEROUS CONDITIONS WHICH CAN CAUSE SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE. FOLLOW ALL SAFETY INSTRUCTIONS CONTAINED HEREIN.

⚠ WARNING

Hazardous voltages and high speed mechanical parts can cause death or severe personal injury and property damage.

Read instruction manual, observe safety instructions and limit use to qualified personnel.

Switchgear assemblies are enclosed on all sides and top with sheet metal. Access into the enclosure is provided by doors or removable covers. Although the bus and connections are insulated in metal-clad switchgear assemblies, it is a coordinated insulation system; insulation plus air or creep distance equals a given insulation level.

⚠ DANGER

Contact with energized high voltage conductor insulation which is not designed to prevent shock will cause death, personal injury and property damage.

Before working on or near high voltage conductors within the switchgear be sure they are de-energized and properly grounded.

See ANSI C37.20.2-6.2.3 which is quoted as follows: "This insulating covering is a requirement of metal-clad switchgear and is provided to minimize the possibility of communicating faults that would result if foreign objects momentarily contacted bare bus. This insulating covering is usually only part of the primary insulation system and in such cases the outer surface of this insulating covering will not be at ground potential. It should **NOT** be assumed, therefore, that personnel can contact this insulating covering with complete safety."

⚠ DANGER

Hazardous voltages and moving parts associated with the application of this equipment will cause death, personal injury, and property damage.

Do not work on energized equipment. Unauthorized personnel should not be permitted near energized equipment.

Plan the time for maintenance with operating and other appropriate personnel so that the switchgear can be safely de-energized and grounded.

General

Before any maintenance work is performed within primary compartments, make certain that the equipment is completely de-energized, tested, grounded, tagged or properly identified and released for work in an authorized manner.

Before starting work on the switchgear, the following should be completed on any equipment that will affect the area of the work:

- Disable remote control and automatic transfer schemes.
- De-energize all direct and back feed power and control sources, test and ground.
- Disconnect all voltage and control power transformers.
- Open all disconnects.

Include the following items in your inspection procedure:

1. Check general condition of switchgear installation.
2. Inspect switchgear interior for accumulation of dust, dirt or any foreign matter.
3. Clean air filters by washing in any mild household detergent.
4. Examine indicating lamps and replace as required.
5. Check terminal block contacts for loose connections.
6. Check instrument and control switches and inspect their contacts.
7. Check for proper condition of instrument transformers. Replace burned out fuses, if any. Check primary and secondary connections.
8. Remove dust from all de-energized insulators.
9. Inspect bus bars and connections for proper condition. If bus bars are overheating check for poor or loose connections or for overload. Main bus may be accessed from the front after removing the inspection barrier in the lower breaker cell. (Barrier F **Figure 16a**)
10. Examine automatic shutters for proper operation.
11. Examine all safety interlocks.
12. Perform maintenance of circuit breakers as outlined on circuit breaker instruction manual.
13. Check space heaters and thermostat (if equipped) for proper operation.
14. Maintain other equipment per their respective instruction book requirements.
15. Replace, reassemble, re-insulate, return all items to proper operating conditions and remove grounds prior to energization.

Inspection Frequency

Thorough inspections at periodic intervals are important for satisfactory operation. The frequency of inspection depends on installation conditions and is determined by experience and practice. Make inspections at least once a year—more frequently if local conditions require. Conditions affecting inspection and maintenance scheduling are weather and atmosphere, unusual number of operations, experience of operating and maintenance personnel and special operating requirements.

After the frequency of inspection has been established, include the following items in your inspection procedure.

Lubrication

It is essential that switchgear be lubricated carefully and properly to guard against corrosion and to insure that all operating parts work freely.

A tube lubricant, for this purpose, is furnished by Siemens packed with accessories. Old grease should be removed annually and parts relubricated. Relubricate at more frequent intervals if required. Lubricant Part No. 15-171-370-001.

Moving Parts

Lubricate shutter guide, bearings, roll-out transformer trays, etc. with dry spray lubricant Siemens Part No. 15-171-270-001.

NOTE

Use of lubricant not suitable for the application will make the mechanism very difficult to operate.

⚠ DANGER

Contact with energized high voltage conductors thru open shutters will cause death, personal injury and property damage.

Do not open shutters unless both line/load and bus are first de-energized.

Electrical Contacts

Lubricate stationary silver-surfaced contacts with electrical contact lubricant Part No. 15-171-370-002 furnished by Siemens prior to use, as follows:

1. Wipe contacts clean.
2. Apply lubricant to contact surfaces.
3. Wipe off excess lubricant, leaving a film.

Avoid getting lubricant on insulation.

Cleaning Insulation

Most of the plastics and synthetics used in insulation systems are attacked by solvent containing aromatics or halogenated hydrocarbons. The use of these may cause crazing and deformation of the material reducing the dielectric strength. ISOPROPYL ALCOHOL IS THE ONLY RECOMMENDED SOLVENT CLEANER.

⚠ WARNING

Reduced dielectric strength of insulation caused by use of improper solvents can cause electrical faults resulting in death, personal injury and property damage.

Use only recommended solvents for cleaning insulation materials.

Corrosive Atmospheres

This switchgear is designed to give top performance when installed in normal indoor or outdoor locations. Where abnormal conditions, such as corrosive atmospheres, are encountered, special precautions must be taken to minimize their effect. Exposed metallic surfaces—non-insulated bus bars, disconnect switches, primary and secondary disconnecting contacts, wire ends, instrument terminals, etc.—must be protected. At each maintenance inspection all of the old grease should be wiped off of the contacts and new lubricant applied to all sliding surfaces. Apply the material in a layer between .03" and .06": (1-2mm) thick. Use only Siemens Electrical Contact Lubricant, Part No. 15-171-370-002, available in 8 oz. (.23kg) tubes. Other exposed members can be protected with a coat of glyptol or other corrosion-resistant coating.

When old grease becomes dirty, wipe the parts clean and apply new grease immediately.

Relays and Instruments

To insure satisfactory operation of relays and instruments do not leave device covers off longer than necessary. When a cover has been broken, cover the device temporarily and replace broken glass as soon as possible.

Equipment Surfaces

Inspect the painted surfaces and touch up scratches as necessary. Use the paint furnished with the unit. This paint matches the unit and is thinned and ready for use in one pint ($473mm^3$) spray cans. One can is normally furnished for each three units.

Split Plug Jumper Test Device

When specified, a split plug jumper test device is supplied. This device allows a circuit breaker to be operated from the control switch on the instrument panel while the circuit breaker is outside of and adjacent to its cell.

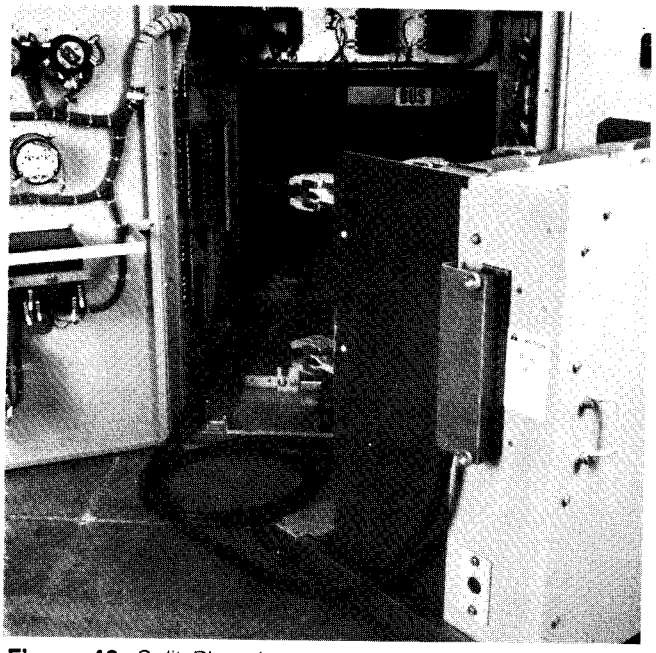


Figure 43. Split Plug Jumper

The split plug jumper consists of a length of flexible cable with terminal plugs on each end. These terminals can be connected to the secondary disconnects on the circuit breaker and in the cell. When connected the circuit breaker can be opened or closed electrically from the instrument panel control switch.

Test Cabinet

When specified, a test cabinet is supplied. This device allows a circuit breaker to be operated from a control switch in a cabinet, which is wall mounted by the purchaser. A length of flexible cable is connected to the cabinet and has a terminal plug on the other end which may be connected to the secondary disconnects on the circuit breaker. When connected, the circuit breaker can be opened or closed electrically from the control switch on the test cabinet, which is connected to a suitable power supply by purchaser.

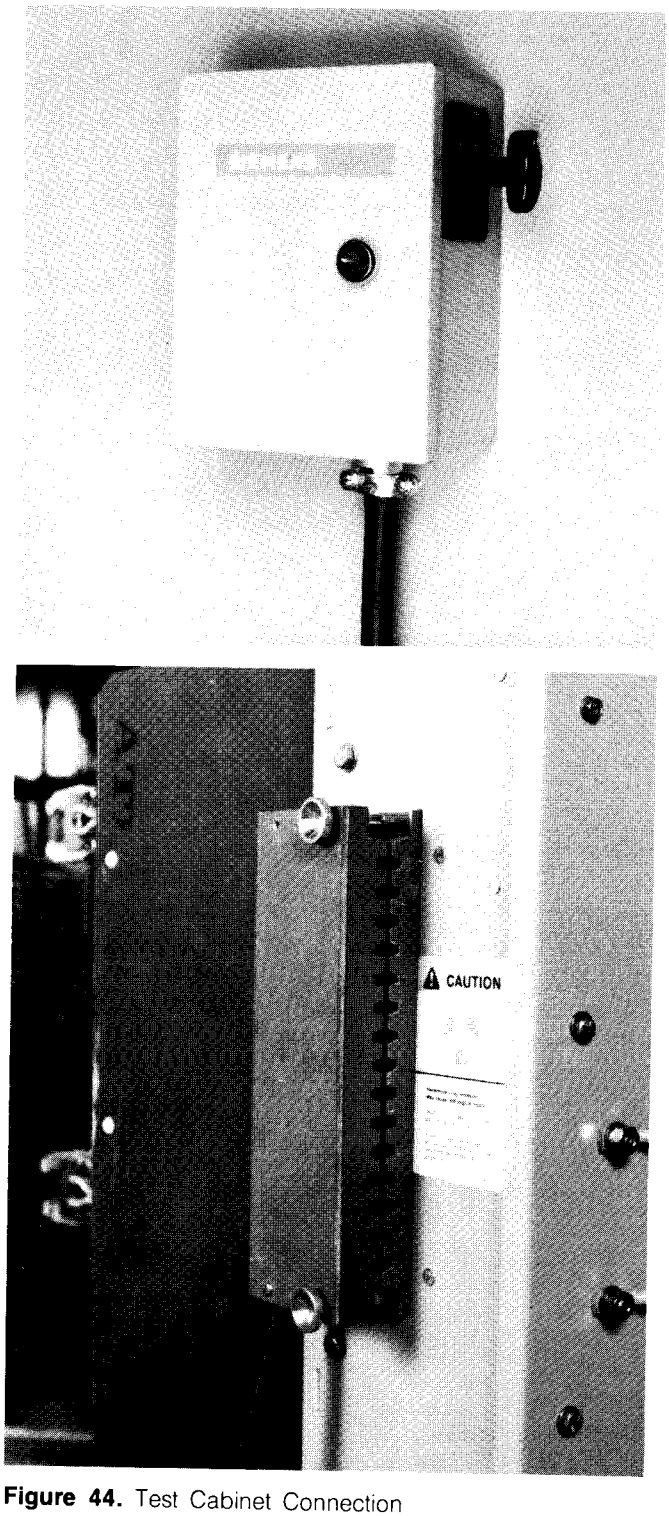


Figure 44. Test Cabinet Connection

Type 3EF Surge Limiters

The Type 3EF Surge Limiter is used with vacuum circuit breakers and contactors to prevent the development of excessive overvoltages due to multiple re-ignitions or virtual chopping. This is primarily of concern during the starting of motors and the switching of reactive loads. If an overvoltage does occur, the magnitude of the voltages will be limited to the values indicated in the following table. Recommended service voltages for each limiter are also shown in **Table 3**.

Surge limiters are intended to be used in cable network systems to protect motors, transformers and reactors from the effects of voltage surges associated with breaker operations. If lightning surges may be present, the equipment must be properly protected by the means of surge arrestors. Surge arrestors on the incoming lines or main bus of the equipment will protect the surge limiters located on the load side of the circuit breakers from the effects of any potential lightning surges.

The surge limiters must be disconnected from the equipment before any high potential testing is performed. The one-minute test period for the application of these voltages will destroy the surge limiters.

Surge limiters which have continuous operating voltages greater than the maximum line-to-ground voltage do not require a series gap within the limiter. This is typified by the 3, 9, and 11kV limiters. Limiters that are used on delta or high-resistance grounded systems which have line-to-line voltages greater than the continuous operating voltage of the zinc oxide element have a series spark gap within the limiter to protect the zinc oxide element. This is typified by surge limiter ratings of 6, 7.5, and 15kV.

⚠ CAUTION

High voltages during switchgear testing exceeds the acceptable levels for surge limiters and can cause minor personal injury or property damage.

The surge limiters must be disconnected from the equipment before any high potential testing is performed. The one-minute test period for the application of these voltages will destroy the surge limiters.

Field Service

Technical guidance and advisory assistance can be provided by Siemens Field Service Operation. The services of well-trained Field Service Representatives are available for installation, checkout, commissioning maintenance and servicing of Switchgear products and other Siemens equipment, processes and systems. Contact your local Siemens representative, sales office, regional service center or factory for details of the services available to help you.

Table 3. Surge Limiters

Type		3EF1			3EF2		
Rated Voltage	kV	3	6	7.5	9	11	15
MCOV of Z_nO Element	kV	2.6	3.9	5.2	7.8	9.1	10.4
Series Gap Spark Over Voltage 1.2 x 50 Wave	kV	—	10	15	—	—	30
0.5KA Switching Surge Discharge Voltage 8 x 20 Wave	kV	7.4	11.1	14.8	22.2	25.9	29.6
1.5KA Discharge Voltage 8 x 20 Wave	kV	8.3	12.4	16.5	24.7	28.9	33.0
Grounded Wye System Applications	kV	4.16	—	8.32	12.0 12.47	13.2 13.8	—
Delta System Applications	kV	2.4	4.16 4.8	6.9	—	—	13.8
High Resistance Grounded Wye System Application	kV	—	4.16	—		8.32	12.0 12.47 13.2 13.8

Table 4. Interrupting Capacity Auxiliary Switch Contacts

Type Auxiliary Switch	Continuous Current Amperes	Control Circuit Voltage				
		120 Ac	240 Ac	48 Dc	125 Dc	250 Dc
		Non-inductive circuit interrupting capacity in amperes				
Breaker Auxiliary Switch	20	20	20	20	10	2
TOC Auxiliary Switch	15	15	10	0.5	0.5	0.2
MOC Auxiliary Switch	20	15	10	10	10	5
		Inductive circuit interrupting capacity in amperes				
Breaker Auxiliary Switch	20	20	20	20	10	2
TOC Auxiliary Switch	15	15	10	0.5	0.5	0.2
MOC Auxiliary Switch	20	15	10	10	10	5

Table 5. Voltage Transformers

Voltage Class	Ratio	Accuracy Class @ 120V Sec.			Volt-Amp Thermal Rating
		W,X,Y	Z	ZZ	
5kV	2400/120	0.3	1.2	—	500
	4200/120	0.3	1.2	—	500
	4800/120	0.3	1.2	—	500
15kV	7200/120	0.3	0.3	1.2	1000
	8400/120	0.3	0.3	1.2	1000
	12000/120	0.3	0.3	1.2	1000
	14400/120	0.3	0.3	1.2	1000

Current Transformers

Table 6. Type HD Torroidal Standard Accuracy

Ratio	1 Sec. Thru Current	Momentary Current RMS-AMPS	60 Hz Metering Accuracy at Burden				Relay Class
			B0.1	B0.5	B1.0	B2.0	
100:5	Breaker Rating		2.4*	—	—	—	C 15
150:5	Breaker Rating		0.6	2.4	—	—	C 20
200:5	Breaker Rating		0.6	1.2	—	—	C 25
250:5	Breaker Rating		0.6	1.2	2.4	—	C 35
300:5	Breaker Rating		0.6	0.6	1.2	2.4	C 40
400:5	Breaker Rating		0.3	0.6	1.2	2.4	C 60
500:5	Breaker Rating		0.3	0.3	0.6	1.2	C 75
600:5	Breaker Rating		0.3	0.3	0.6	1.2	C100
800:5	Breaker Rating		0.3	0.3	0.6	0.6	C130
1000:5	Breaker Rating		0.3	0.3	0.3	0.3	C170
1200:5	Breaker Rating		0.3	0.3	0.3	0.3	C200
1500:5	Breaker Rating		0.3	0.3	0.3	0.3	C180
2000:5	Breaker Rating		0.3	0.3	0.3	0.3	C210
2500:5	Breaker Rating		0.3	0.3	0.3	0.3	C300
3000:5	Breaker Rating		0.3	0.3	0.3	0.3	C240

*Exceeds ANSI C37.20.2 Accuracy Limit

Table 7. Type HD Special Accuracy (2 Connected in Series)

Ratio	1 Sec. Thru Current	Momentary Current RMS-AMPS	60 Hz Metering Accuracy at Burden				Relay Class
			B0.1	B0.5	B1.0	B2.0	
75:5	Breaker Rating		2.4*	4.8	—	—	C 20
100:5	Breaker Rating		1.2	4.8	—	—	C 25
150:5	Breaker Rating		1.2*	1.2	—	—	C 45
200:5	Breaker Rating		0.6	1.2	2.4	4.8	C 60
250:5	Breaker Rating		0.6	1.2	2.4	2.4	C 75
300:5	Breaker Rating		0.6	0.6	0.6	1.2	C 95
400:5	Breaker Rating		0.3	0.3	0.6	1.2	C130
500:5	Breaker Rating		0.3	0.3	0.3	0.6	C160
600:5	Breaker Rating		0.3	0.3	0.3	0.3	C200
800:5	Breaker Rating		0.3	0.3	0.3	0.3	C270
1000:5	Breaker Rating		0.3	0.3	0.3	0.3	C350
1200:5	Breaker Rating		0.3	0.3	0.3	0.3	C410
1500:5	Breaker Rating		0.3	0.3	0.3	0.3	C370
2000:5	Breaker Rating		0.3	0.3	0.3	0.3	C420
2500:5	Breaker Rating		0.3	0.3	0.3	0.3	C530
3000:5	Breaker Rating		0.3	0.3	0.3	0.3	C530

*Exceeds ANSI C37.20.2 Accuracy Limit

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