SIEMENS-ALLIS

Switchgear

# INSTRUCTIONS

## 5-kV AND 15-kV METAL-CLAD SWITCHGEAR WITH AIR MAGNETIC AND VACUUM CIRCUIT BREAKERS

18X9587-06
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The information contained within is intended to assist operating personnel by providing information on the general characteristics of equipment of this type. It does not relieve the user of responsibility to use sound engineering practices in the installation, application, operation and maintenance of the particular equipment purchased.

If drawings or other supplementary instructions for specific applications are forwarded with this manual or separately, they take precedence over any conflicting or incomplete information in this manual.

# LIST OF ILLUSTRATIONS

# INTRODUCTION

## GENERAL

These instructions cover the installation, operation and maintenance of Siemens-Allis horizontal drawout, metal-clad switchgear. The equipment described in this manual consists of the indoor, *Shelter-Clad* outdoor and conventional outdoor designs in both 5kV and 15kV classes. Figures 1 through 4 show some typical installations. All diagrams, descriptions and instructions 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.

**Figure 1. 5 KV Indoor Switchgear Installation**

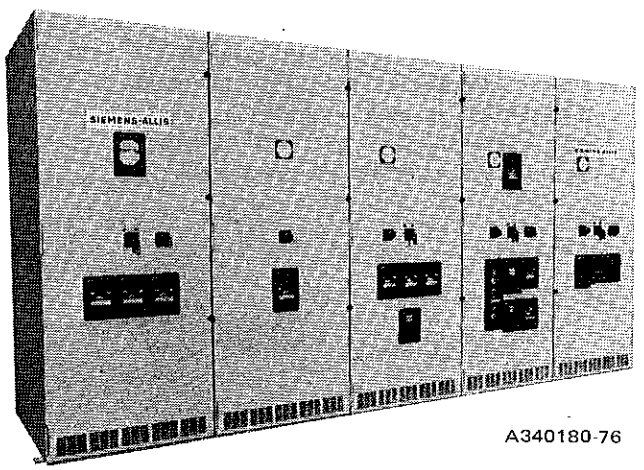



**Figure 2. 15 KV Indoor Switchgear Installation**

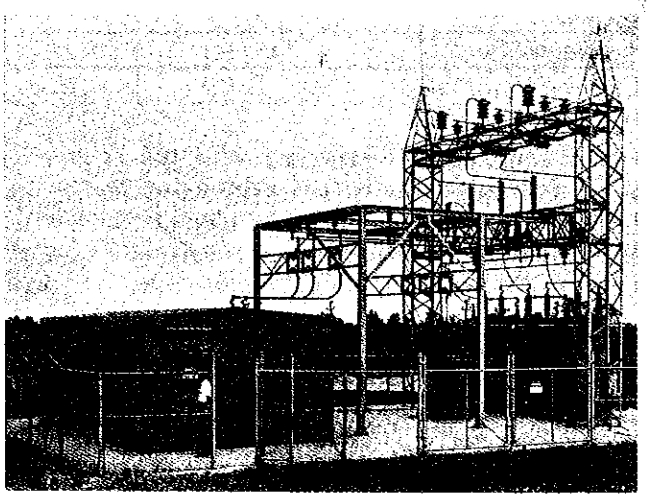


**Figure 3. 15 KV Shelter-Clad Switchgear Installation**

## WARRANTY

For specific warranty coverage, see the sales contract.

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-Allis may be cause of 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 circuits of different potential are also separated by barriers. All primary bus work and joints are completely encased with insulation material to suit the voltage class of the equipment.

Siemens-Allis 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.

**Table 1. Switchgear Designation**

| Design | Class | |
|---|---|---|
| | 5 kV | 15 kV |
| Indoor | D | F |
| *Shelter-Clad* | SD | SF |
| Conventional Outdoor | OD | OF |

Indoor equipment is arranged with the circuit breaker drawout compartment behind the instrument panel. The hinged instrument panel is opened to provide access to the circuit breaker.

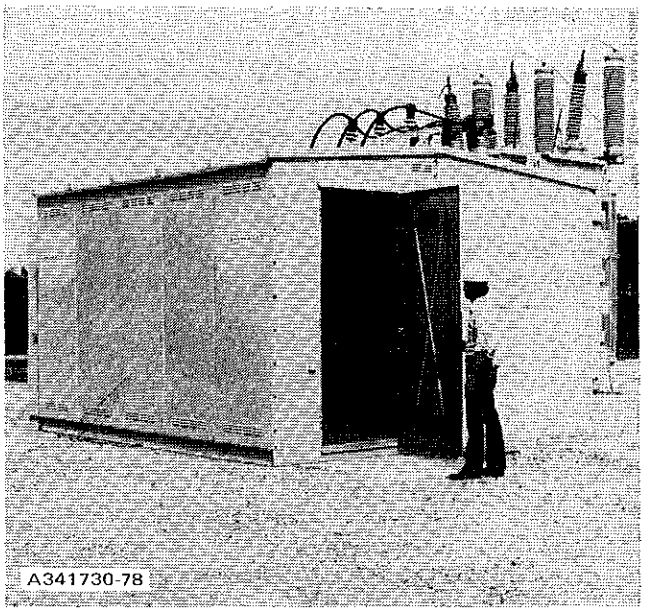



Figure 4. 5 kV Conventional Outdoor Switchgear

*Shelter-Clad* outdoor equipment consists of indoor equipment enclosed in a weatherproof housing complete with an illuminated, walk-in aisle. Circuit breakers can be rolled out into the aisle and control devices checked without exposure to the elements. This equipment is designed to operate outdoors in all types of weather.

Conventional outdoor switchgear is of weatherproof construction. The instrument panel is behind a gasketed outdoor type door, opposite the breaker drawout side of the switchgear. The circuit breaker compartment is also enclosed by a gasketed outer door. Conventional outdoor equipment is used where it is felt that an enclosed aisle is unnecessary.

## SHIPPING DAMAGE CLAIMS

### F.O.B. DESTINATION/JOBSITE

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 tarped and/or protected from the elements. Note trailer number equipment arrived on. 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 vehicle 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-Allis 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 in any event. 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-Allis 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-Allis Sales office. Approval must be obtained by Siemens-Allis 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 judgement 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 followed by the consignee, customer or his agent Siemens-Allis 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.

## SHIPPING DAMAGE CLAIMS

### F.O.B. SHIPPING POINT/FACTORY

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 tarped and/or protected from the elements. Note trailer number equipment arrived on. 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 can not be made on vehicle 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 recept 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. 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 damage on site after unloading.
5. Be sure equipment is properly protected from any further damage by covering it properly after unloading.
6. 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 in any event. If concealed damage is found, the carrier must again be notified and inspection made prior to taking any corrective action to repair.
7. If damage is such that it required the services of an Siemens-Allis serviceman to check the equipment, contact the Siemens-Allis Sales Office.

   Siemens-Allis will require a purchase order to cover cost of service and any parts which may subsequently be ordered for repairs.
8. Notify the carrier in writing of your intent to file a claim.
9. File claim when all costs accumulated.

IMPORTANT: Any adverse judgement 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.

# RECEIVING

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. All moving parts are secured; however, relatively delicate instruments are included and must be handled carefully when unloading.

## IDENTIFICATION

When shipment consists of more than one shipping group or more than one substation, each crate or package is identified by attached tag markings. The drawing number on the crate tag is also on the customer's copy of the shipping list. The shipping list describes the contents as "Unit 1-2-3." 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.

## LIFTING

### General

Each group of switchgear has provisions for attaching lifting equipment. Though the lift points vary in location on indoor, *Shelter-Clad* outdoor, and conventional outdoor designs, all are designed for use with a crane of adequate height and capacity. To determine the required crane capacity multiply the number of cubicles to be lifted by 3,000 pounds.

### 5 kV Indoor Switchgear (See Figure 5)

5kV indoor equipment is provided with lifting channels on top of the switchgear. These channels are normally mounted without lift point spreaders unless an extremely heavy load is within the cubicles. The load angle on lifting cables must be at least 45°; a lesser angle could cause damage to the equipment.

### 15 kV Indoor Switchgear (See Figure 6)

15kV indoor equipment has lifting channels on the top of the switchgear. These channels have spreaders between the lift points for additional strength. The load angle on the lifting cables must be at least 30°; a lesser angle could damage the equipment.

**CAUTION**

DO NOT REMOVE LIFTING CHANNELS ON INDOOR SWITCHGEAR UNDER ANY CIRCUMSTANCES UNTIL THE SWITCHGEAR IS INSTALLED IN ITS FINAL LOCATION. THESE CHANNELS INSURE THE TRUE ALIGNMENT OF THE SWITCHGEAR GROUP UNTIL IT IS LEVELED AND ANCHORED.

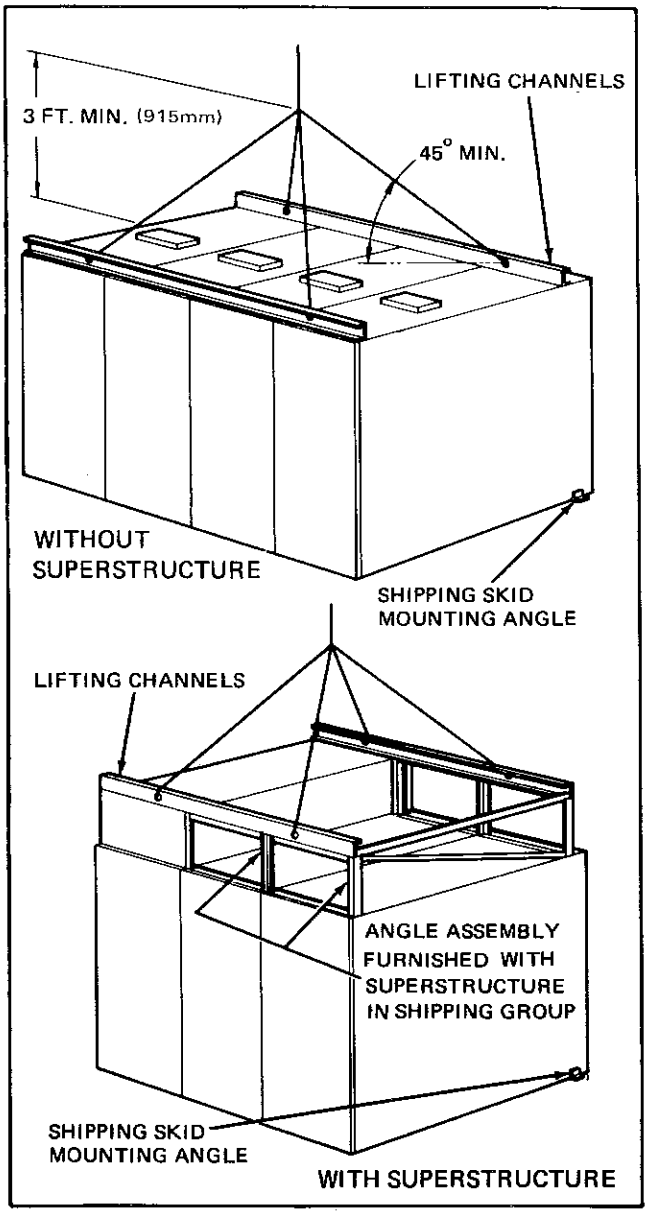



Figure 5. Lifting 5 kV Indoor Switchgear

### 5 kV and 15 kV Shelter-Clad Switchgear (See Figure 7)

Lift *Shelter-Clad* outdoor equipment by placing high strength pipes through holes provided in the supporting beams under the switchgear.

**WARNING**

ALL *SHELTER-CLAD* AND *5-kV CONVENTIONAL* OUTDOOR SWITCHGEAR GROUPS ARE TO BE LIFTED WITH 2.5" (63.5 mm) NOM. XX-STRONG PIPE. THIS EXTRA HEAVY PIPE HAS ACTUAL DIMENSIONS OF 2.875 (73.03 mm) OUTSIDE DIAMETER WITH A .552 (14.02 mm) WALL THICKNESS.

IT IS EXTREMELY IMPORTANT THAT THE CORRECT SIZE LIFTING PIPE BE USED. PIPE OF INADEQUATE STRENGTH WILL BEND, CAUSING POSSIBLE DAMAGE TO THE SWITCHGEAR AND INJURY TO PERSONNEL.

Lift pipes are furnished by customer unless covered by contract. Cable spreaders are required above roof to protect the equipment. Wood cable spreaders, if used, must be timbers of sufficient strength to handle the compressive force of the cables and should have steel bands or studs to prevent splitting. Small groups of switchgear, up to three units, should be carefully checked for balance as distribution of equipment within the cubicles may place the center of gravity high or toward one end. If load is unbalanced use a rope sling or other means to secure the top of the load to lifting cables to prevent tipping or rolling.

### 5 kV Conventional Outdoor Switchgear

Lift 5kV conventional outdoor switchgear the same as 5kV *Shelter-Clad* design using 2.5" (63.5 mm) nom xx-strong (extra-heavy) pipe.

### 15 kV Conventional Outdoor Switchgear

With the greater depth of 15kV conventional outdoor equipment, shipping limitations restrict the maximum group length to three units. Lifting lugs are provided at each end of the front and rear support beams as shown in Figure 8. Wooden clamp blocks are also provided near the top of each end plate. Loosen the screws on the clamp blocks and insert the cable sling between the blocks and screws as illustrated to provide a stable method of lifting.

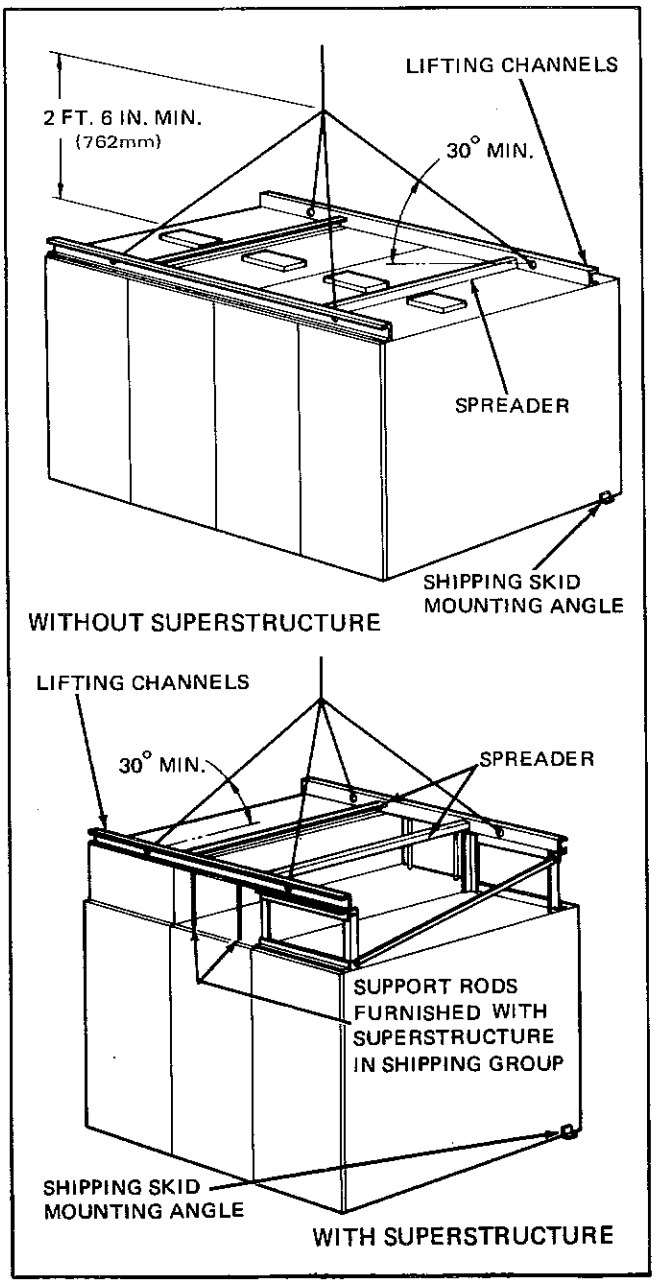



Figure 6. Lifting 15 kV Indoor Switchgear

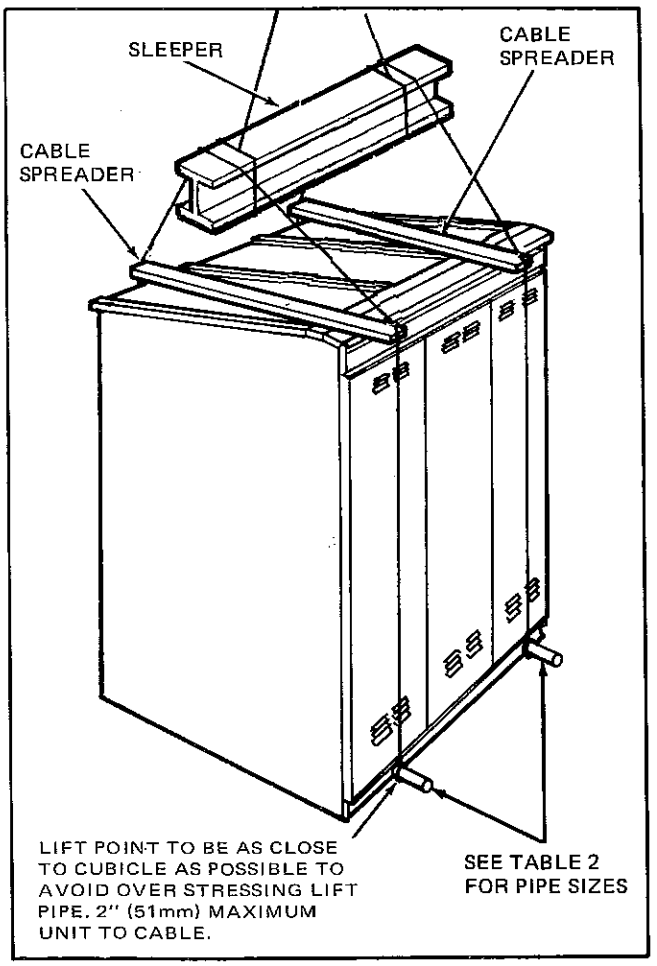



Figure 7. Lifting 5 and 15 Shelter-Clad and 5 kV Conventional Outdoor Switchgear

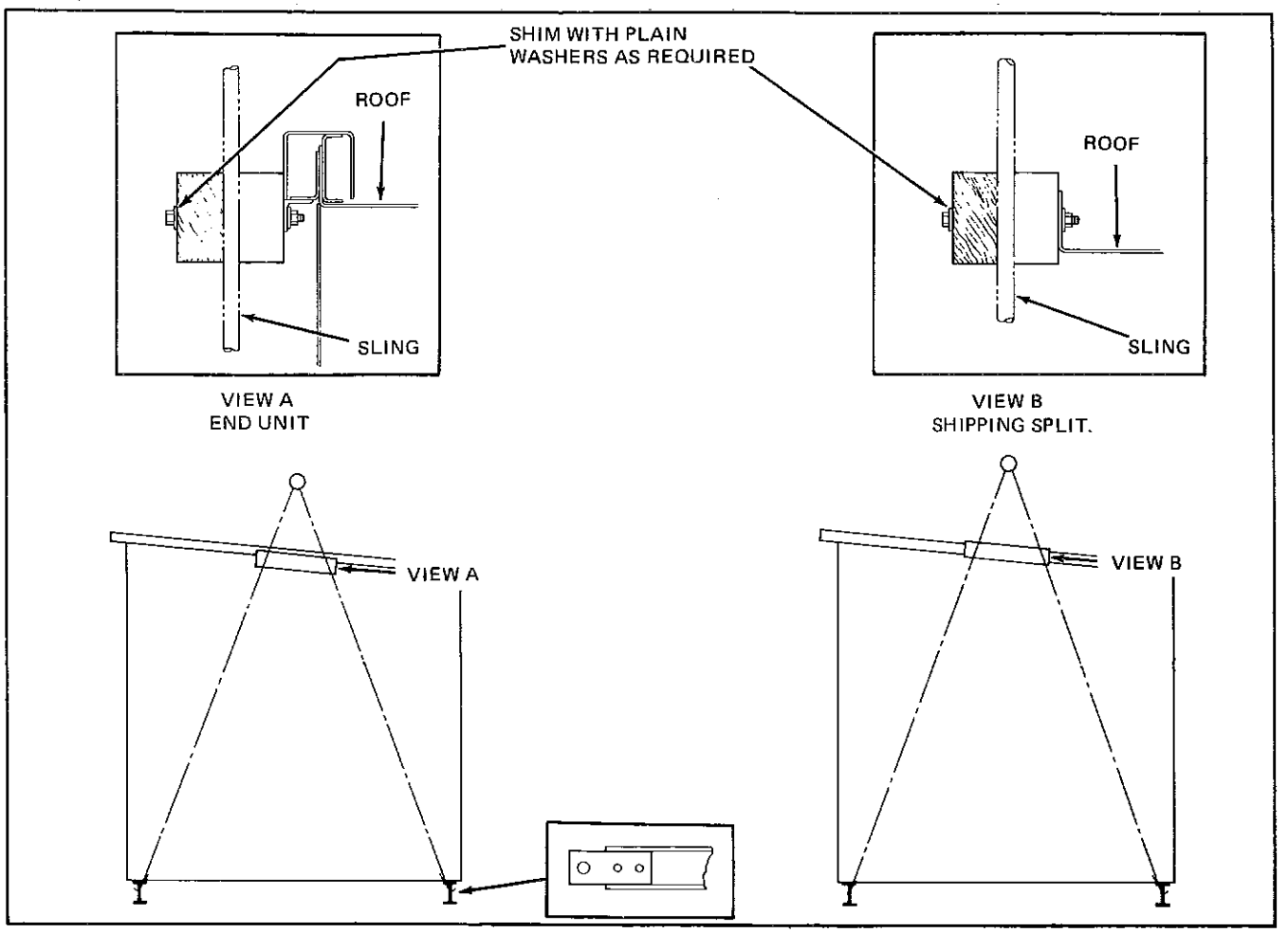



Figure 8. Lifting 15 kV Conventional Outdoor Switchgear

## 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. To prevent distortion of the cubicles, rollers and cribbing of equal height must be used in sufficient number to evenly distribute the load. Remove rollers and lower switchgear carefully. Leave wooden skids (when provided) in place during moving operation until final location is reached. Fork-lift trucks should be used with discretion as improper lift points could cause extreme damage to equipment. Refer to Figures 9, 10 and 11 for the correct jacking methods.

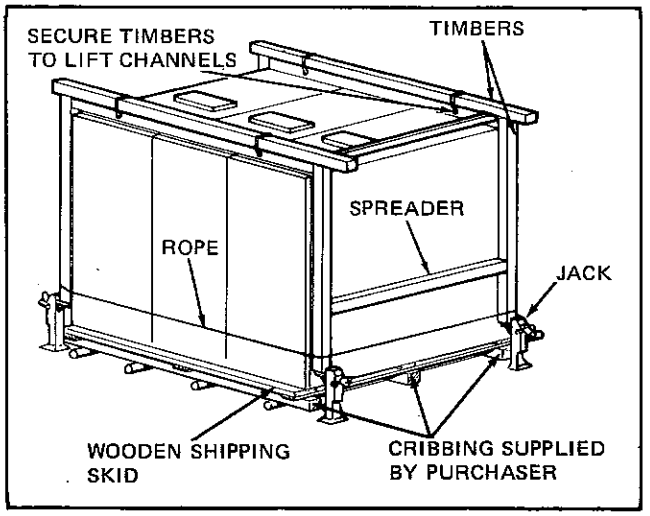



Figure 9. Jacking Indoor Switchgear

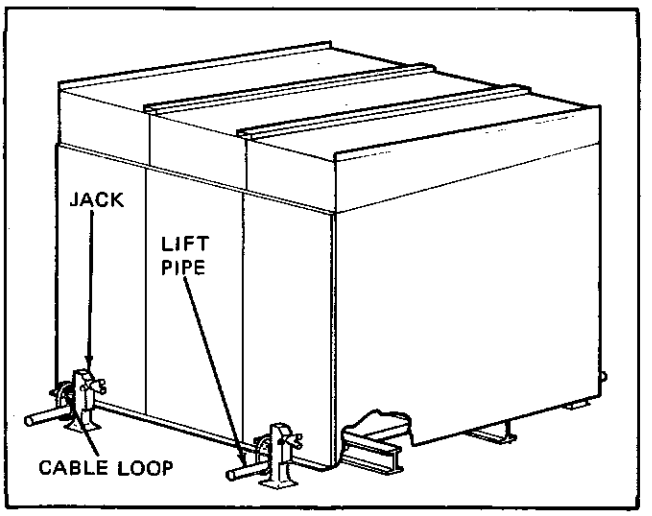



Figure 10. Jacking Shelter-Clad and 5 kV Conventional Outdoor Switchgear

## INSPECTION AND UNCRATING

Inspect the equipment as soon as possible after receiving for any damage that may have occurred in transit. Before uncrating, examine the crate itself; a splintered crate may indicate an area of damage within. Be careful when uncrating equipment. The use of sledge hammers and crowbars may damage the finish, if not the equipment itself. Use nail pullers. After uncrating, 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 representing Siemens-Allis sales office of any shortage or damage.

Unusual circumstances may require partial shipments of switchgear. Should a case of this nature exist, provision is made for easy installation of these portions.

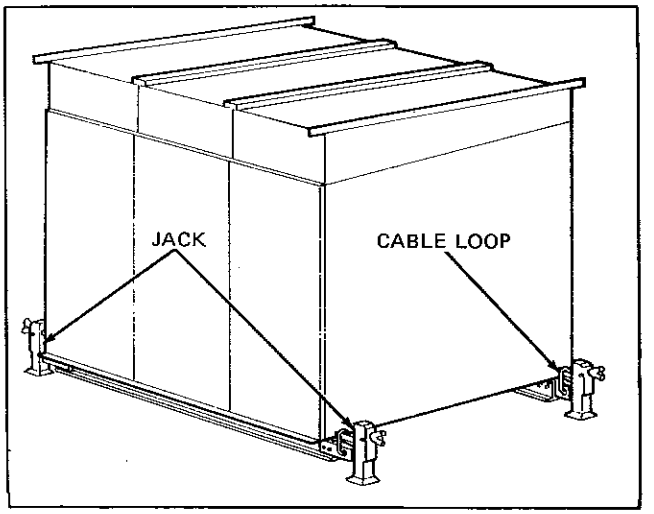



Figure 11. Jacking 15 kV Conventional Outdoor Switchgear

# STORAGE

## INDOOR SWITCHGEAR

When switchgear is not to be erected immediately, it should be uncrated, inspected within 15 days of receipt and stored in a clean dry location. Indoor cubicles are neither weatherproof nor dripproof; therefore, they should be stored indoors. If they must be stored outdoors, or if they are to be kept in a humid, unheated area, provide an adequate covering, and place a heat source of approximately 500 watts output within each cubicle to prevent condensation. Space heaters are not standard equipment on indoor switchgear. Lubricate any moving parts such as hinges, shutter, 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 cubicles 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 (See Page 15) from in front of instrument panels. This is required to gain access to the space heater circuit so that heaters can be energized. Reseal the front or cover it for protection from the weather. Connect batteries (if provided) to a charger. Lubricate hinges, shutters, and other moving parts.

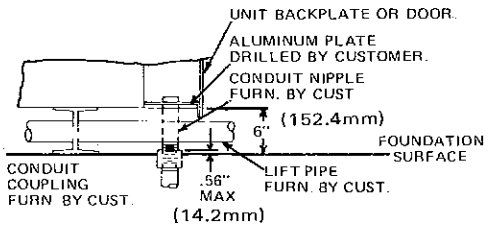
## CONVENTIONAL OUTDOOR SWITCHGEAR

When it is necessary to store conventional 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. Connect batteries (if provided) to a charger. Oil hinges, shutters and other moving parts.

# INSTALLATION

## 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 limitations and instructions. Should location of 2.5" (63.5 mm) nom. X-X strong lift pipe (furnished by customer) interfere with customer's primary conduit, it is suggested that a conduit coupling be installed in this location. The coupling should not project more than .56 (14.2 mm) above surface of foundation. After switchgear has been lowered to foundation and lift pipe has been removed, a conduit nipple may be screwed into coupling.




Floors, sills, piers or 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 (twice the weight of each circuit breaker). Outdoor switchgear groups which have been assembled on 4 x 6 (101.6 x 152.4 mm) beams must be supported along these beams with the maximum span between support points not exceeding nine (9) feet (2743 mm). When switchgear line-up includes 1000 MVA breakers this maximum span must be decreased to six (6) feet (1830 mm). If pilings are used, the diameter of these pilings is to be determined by the customer for proper loading. However, they must not be less than twelve (12) inches (305 mm) for sufficient contact with beam, allowing space for shipping split and space for grouting in of bed plate if used. All shipping splits must be supported and taken into consideration when foundation is constructed.

### CAUTION

In the switchgear primary entrance area, steel reinforcing rods or mesh in concrete must not pass through space shown on general arrangement drawing even though cored or bored holes in concrete may miss rods or mesh. A single phase of a system may not be encircled by ferrous metals where current exceeds 600 amperes.

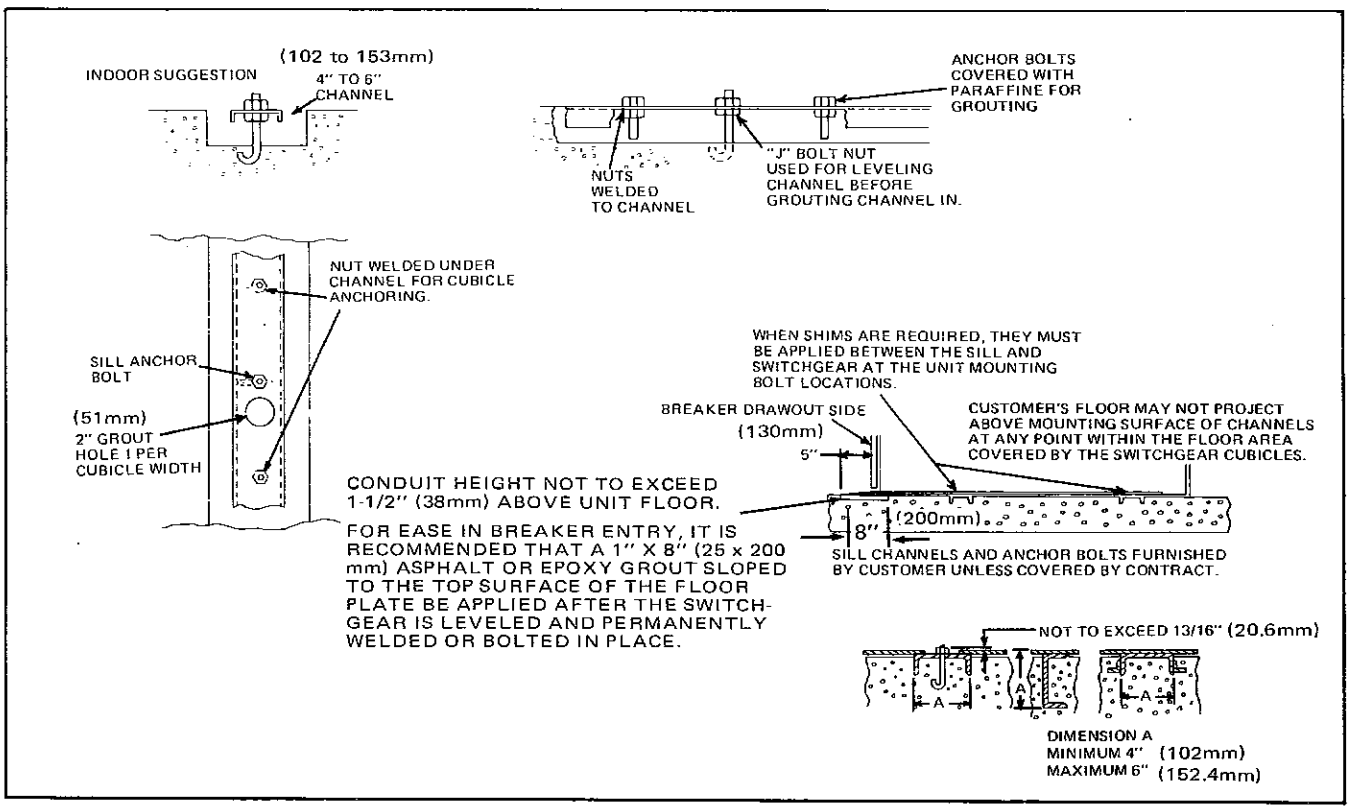



**Figure 12. Setting Channel Sills for Indoor Switchgear**

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

Figure 12 illustrated acceptable methods of setting sill channels for 5kV and 15kV indoor switchgear. Cubicles may be anchored to sills by use of .50" - 13 (metric threads not permitted) nuts welded to bottom of channel. Before grouting channels in place, screws of sufficient length should be placed in anchor holes and coated with a heavy film of paraffin or other suitable coating which will allow the screws to be readily removed after the concrete has set.

Figure 13 shows a suggested method of anchoring and leveling bed plates for outdoor switchgear of Shelter-Clad or conventional types. Outdoor switchgear, as received, is supported on 4" x 6" @ 12 lbs. per foot (101.6 x 152.4 mm @ 17.9 kg per meter) beams. The maximum span between the support points on which these beams rest must not exceed nine feet (2743 mm). The maximum span for units with 1000 mva breakers is six feet (1830 mm). If pilings are used for foundation, their diameter may not be less than 12 inches (305 mm). Cubicles must be supported at shipping splits. Figure 14 shows a recommended work area for 5kV and 15kV conventional outdoor equipment.

Before setting and erecting the cubicles, determine the correct locations of each shipping group and sequence of installation on the general arrangement drawing. Sweep the mounting surfaces to remove all dirt. Refer to Figures 15 through 21 for additional installation instruction.

Secondary control conduits must not exceed 2-inch nominal pipe size (2.37 o.d.) (60 mm). If conduit extends above floor or slab to enter cubicle and exclude water, it should not exceed 1.50-inches (38 mm) on indoor equipment. On outdoor equipment, the secondary control conduit should extend to a maximum of 7.50 inches (190 mm) and a minimum of 6.75 inches (172 mm) above the slab or base plane. In cases where switchgear cannot be lowered over conduit because of headroom or other restrictions, conduit couplings can be grouted in flush with slab. Conduit nipples can then be added after switchgear is in place. Case should be taken during construction and at all times to keep conduit ends capped to prevent entry of dirt, moisture and vermin.

If primary power conduit is grouted into the foundation, follow instructions outlined above. (This conduit may often enter through trench or planned opening.)

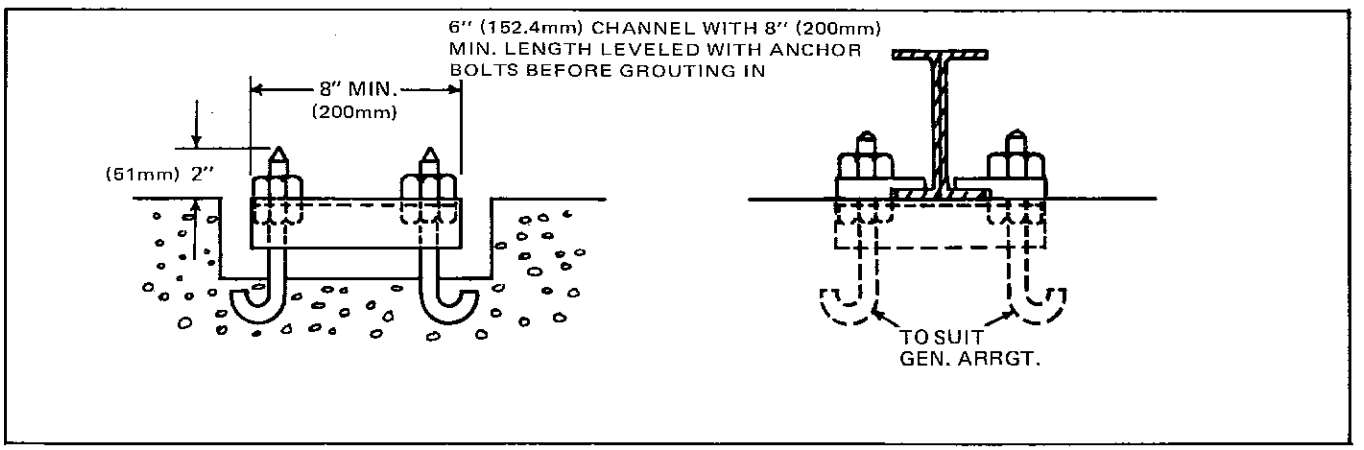



**Figure 13. Securing Outdoor Cubicles**

## ERECTING CUBICLES

The proper erection method depends on whether the units are shipped as one complete group or in two or more sections. In any case, the general arrangement drawing will indicate the shipping groups and their location within the lineup. Units are assembled and wired in accord with the arrangement as in the final installation.

Before setting and erecting the cubicles determine the correct locations of each shipping group on the general arrangement drawing. Sweep the mounting surfaces to remove all dirt. Refer to Figures 15 through 21 for additional installation instructions.

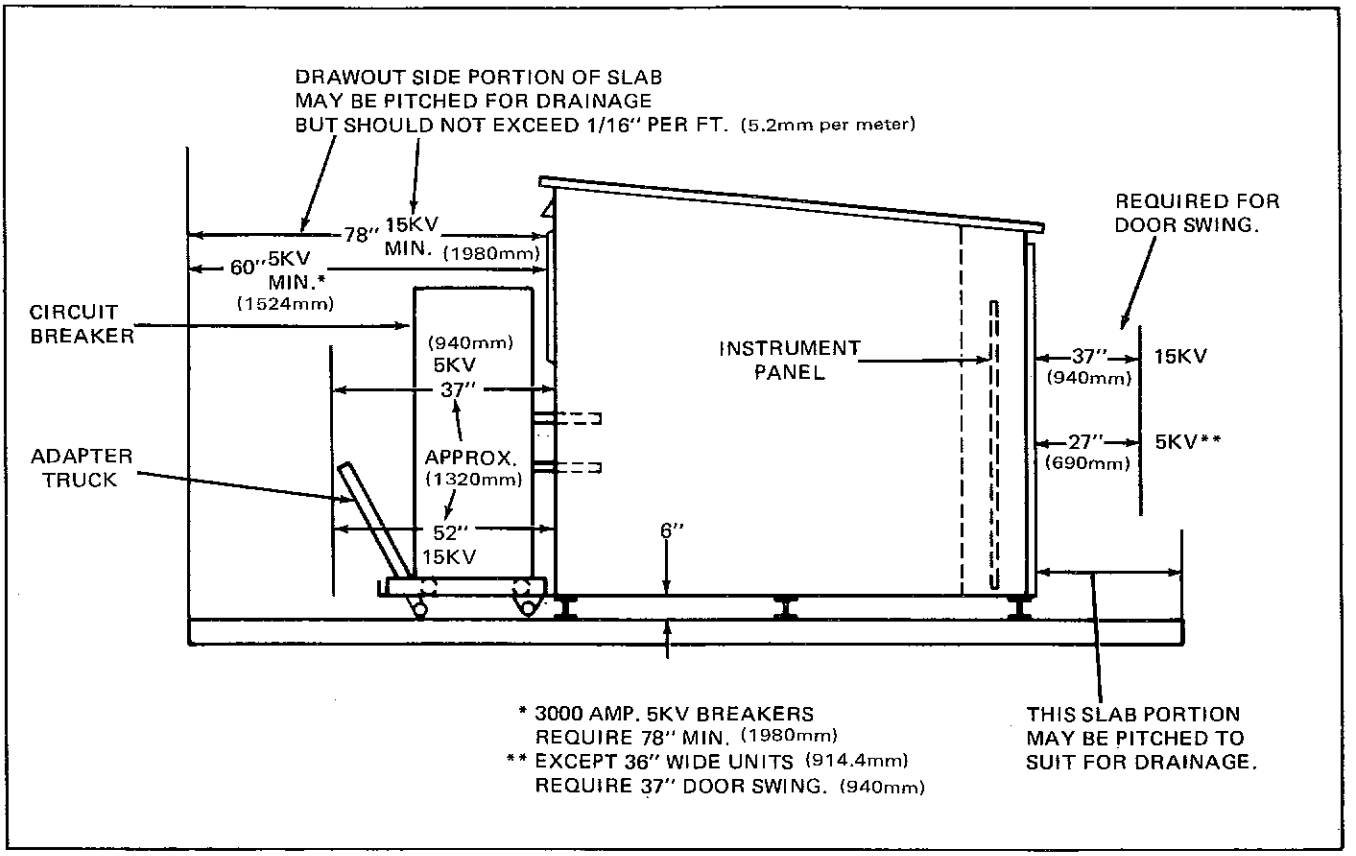



**Figure 14. Recommended Work Spaces for Conventional Outdoor Switchgear**

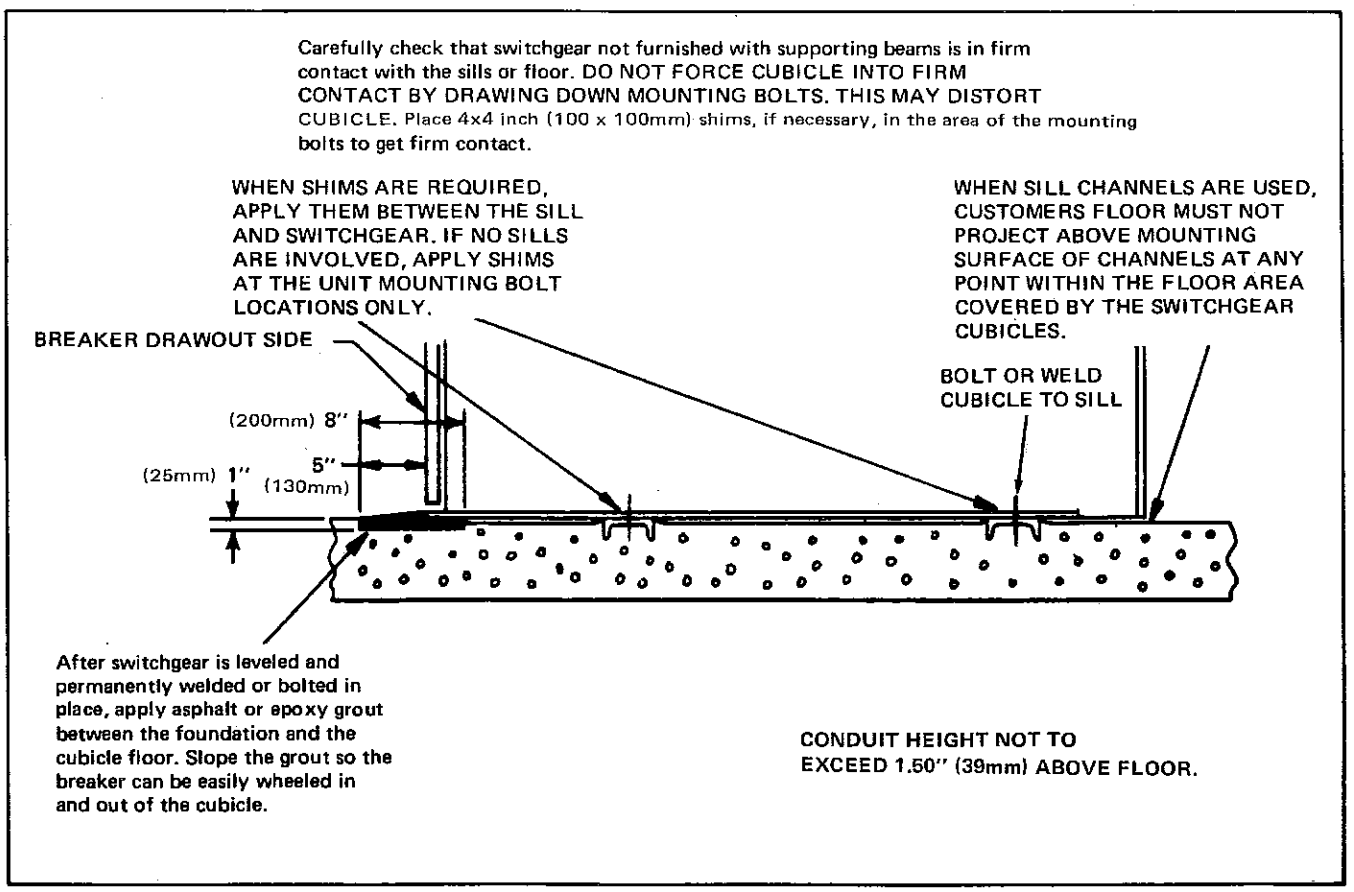



**Figure 15. Setting Indoor Cubicles on Foundation**

| STRUCTURAL DIMENSIONS (Inches) | | | | | | | | BREAKER |
|---|---|---|---|---|---|---|---|---|
| Type | A Width | B Height | C Depth | D Drawout Aisle | E | F | Weight (lbs.) | Type |
| DF | 26 (660.4mm) | 72 (1828.8mm) | 74 (1879.6mm) | 50 (1270mm) | 18.25 (463.6mm) | 13 (330.2mm) | 1200 (545kg) | MA-75 |
| DM | 26 (660.4mm) | 72 (1828.8mm) | 74*(1879.6mm) | 50 (1270mm) | 18.25 (463.6mm) | 13 (330.2mm) | 1200 (545kg) | MA-250 |
| DN | 26 (660.4mm) | 72 (1828.8mm) | 74*(1879.6mm) | 50 (1270mm) | 18.25 (463.6mm) | 13 (330.2mm) | 1200 (545kg) | MA-350 |
| DN | 36 (914.4mm) | 92 (2336.8mm) | 94 (2387.6mm) | 66 (1524mm) | 24.25 (616mm) | 33 (838.2mm) | 1800 (818kg) | FA-350 |

*FOR 3000A BUS, DIMENSION BECOMES 2" (50.8MM) GREATER.

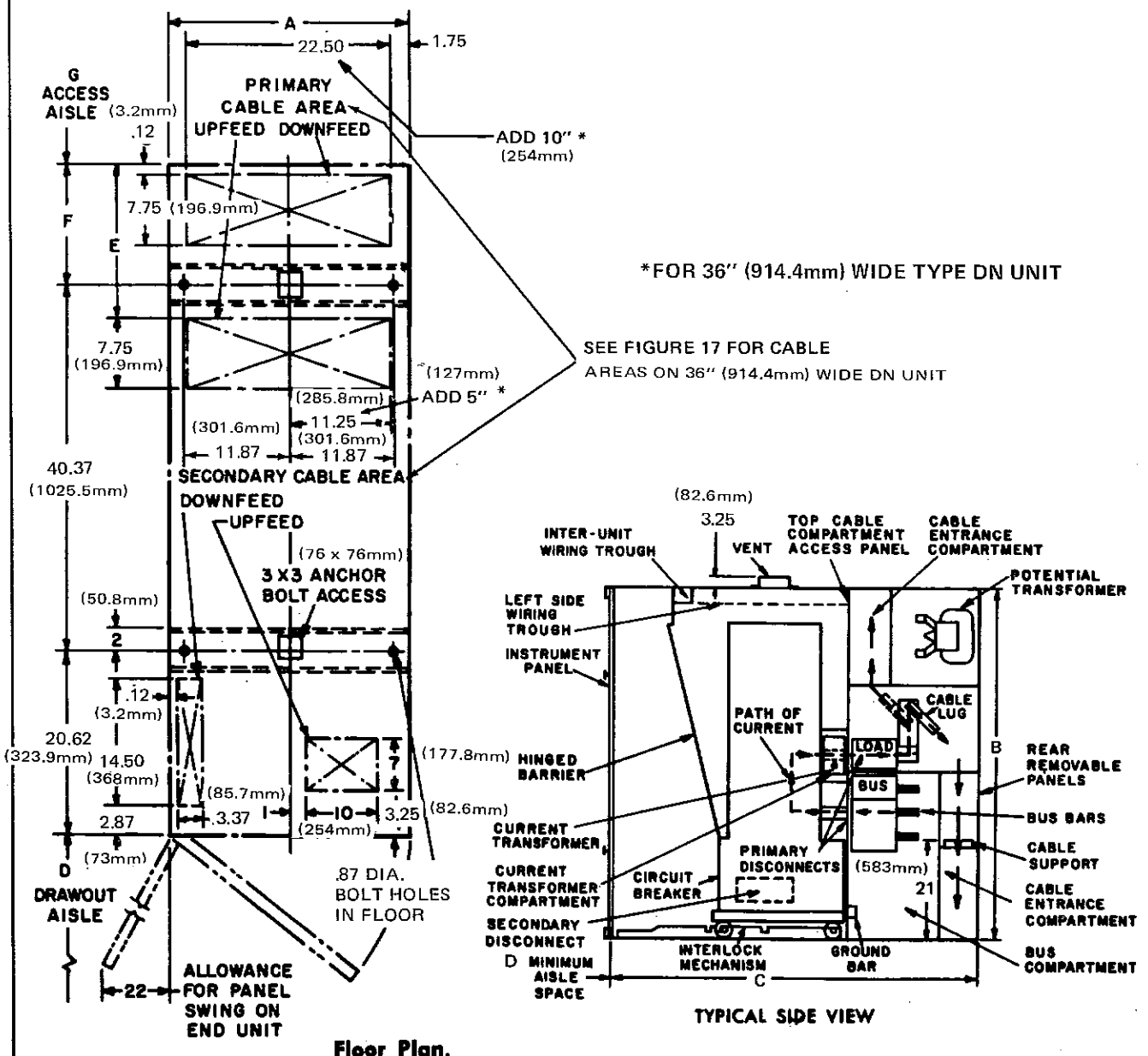
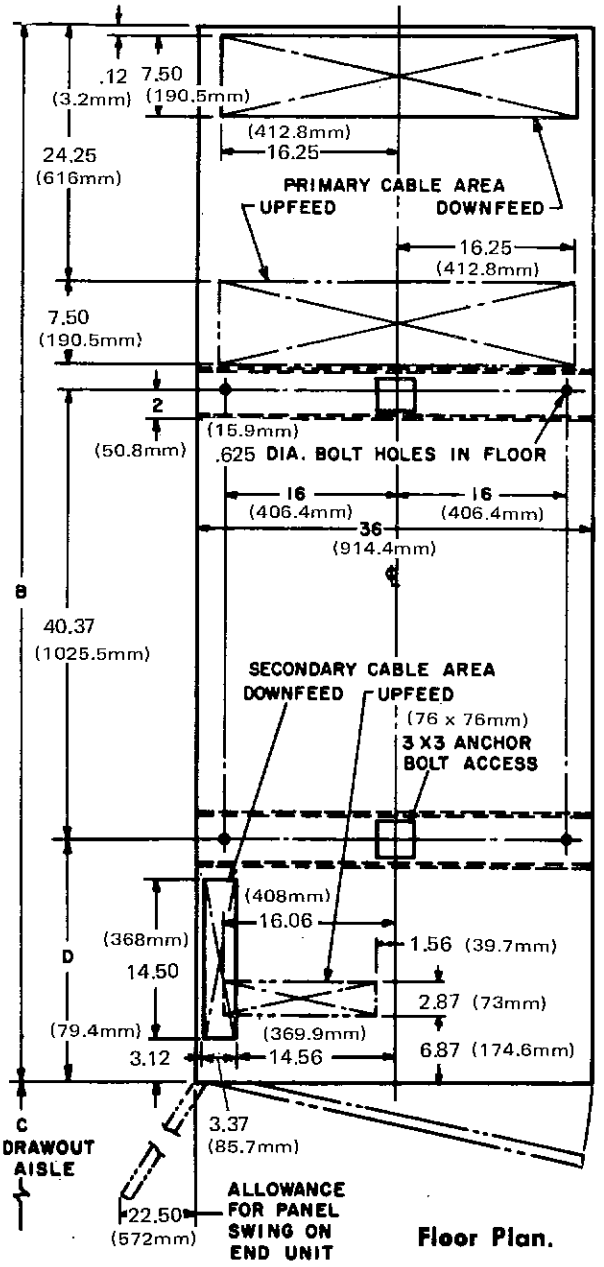



Figure 16. Floor Plan and Typical Side View of 5 kV Indoor Cubicles

| STRUCTURAL DIMENSIONS (Inches) | | | | | | BREAKER |
|---|---|---|---|---|---|---|
| Type | A Height | B Depth | C Drawout Aisle | D | Weight (lbs) | Type |
| FO | 92 (2336.8mm) | 94 (2387.6mm) | 66 (1524mm) | 20.62 (523.9mm) | 1800 (818kg) | FB-5000, FC-5000 or FCV-500 |
| FQ | 92 (2336.8mm) | 94 (2387.6mm) | 66 (1524mm) | 20.62 (523.9mm) | 1800 (818kg) | FC-750, FCV-750 or FKV-750 |
| FR | 100 (2540mm) | 105 (2667mm) | 77 (1956mm) | 31.62 (803.3mm) | 2000 (909kg) | FC-1000 |



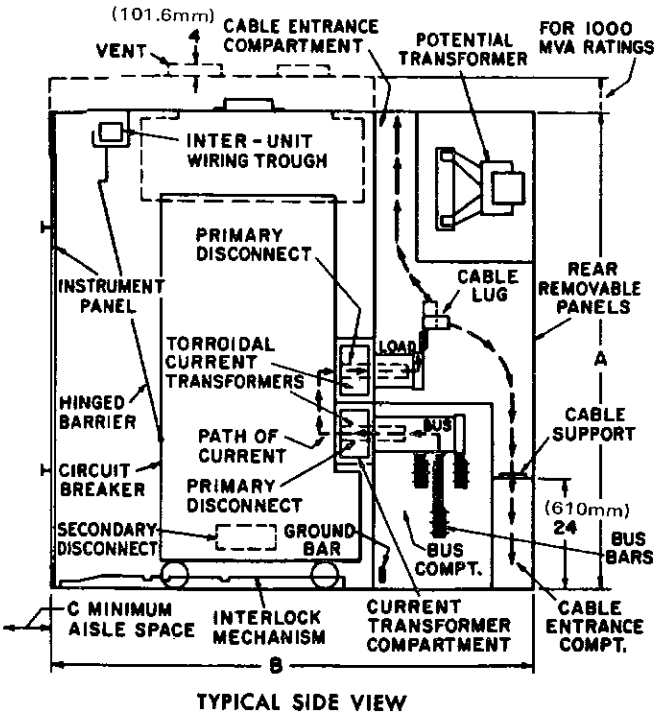
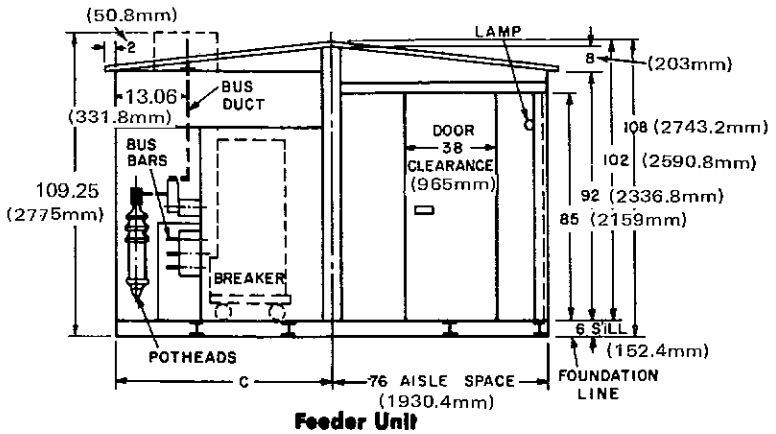
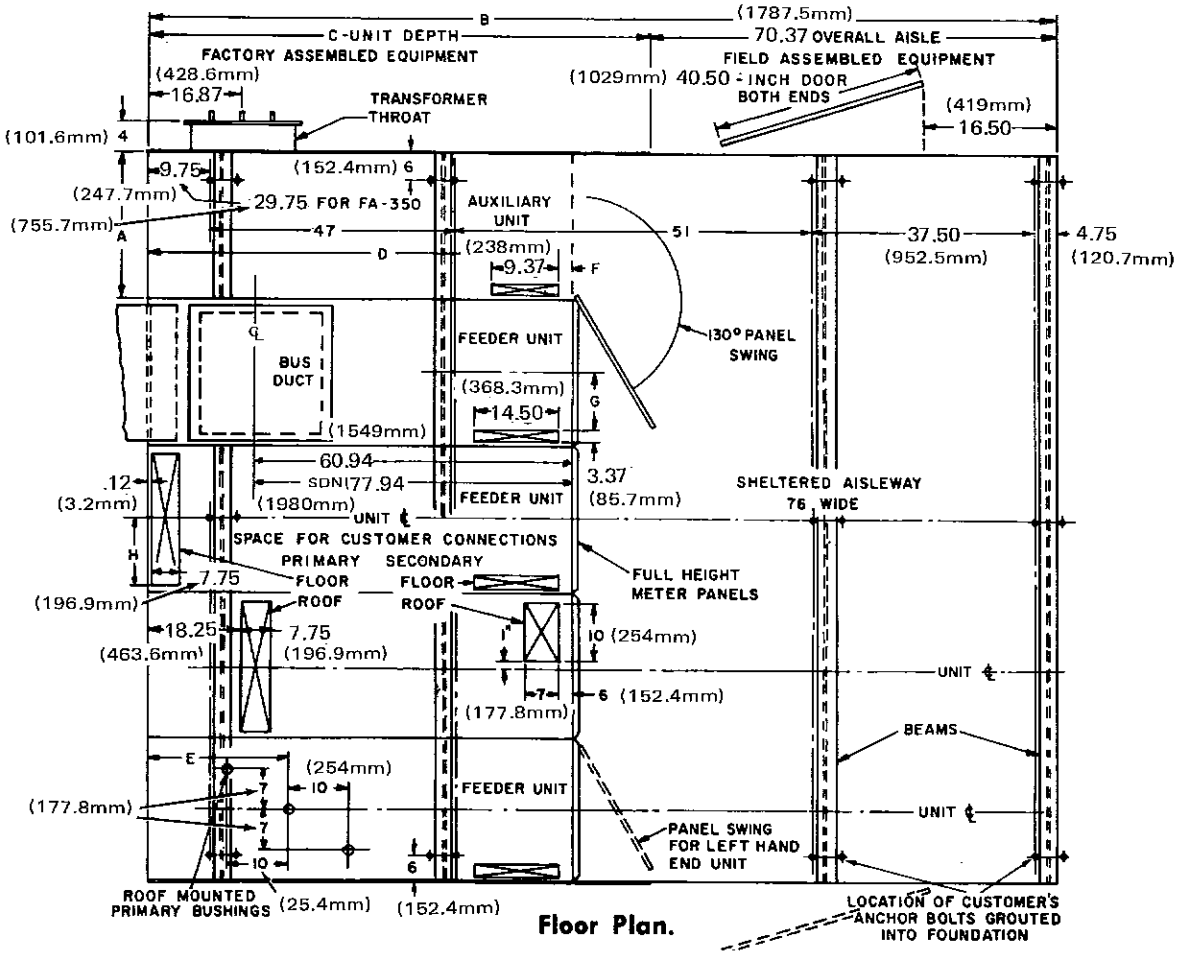




Figure 17. Floor Plan and Typical Side View of 15 kV Indoor Cubicles




**Feeder Unit**

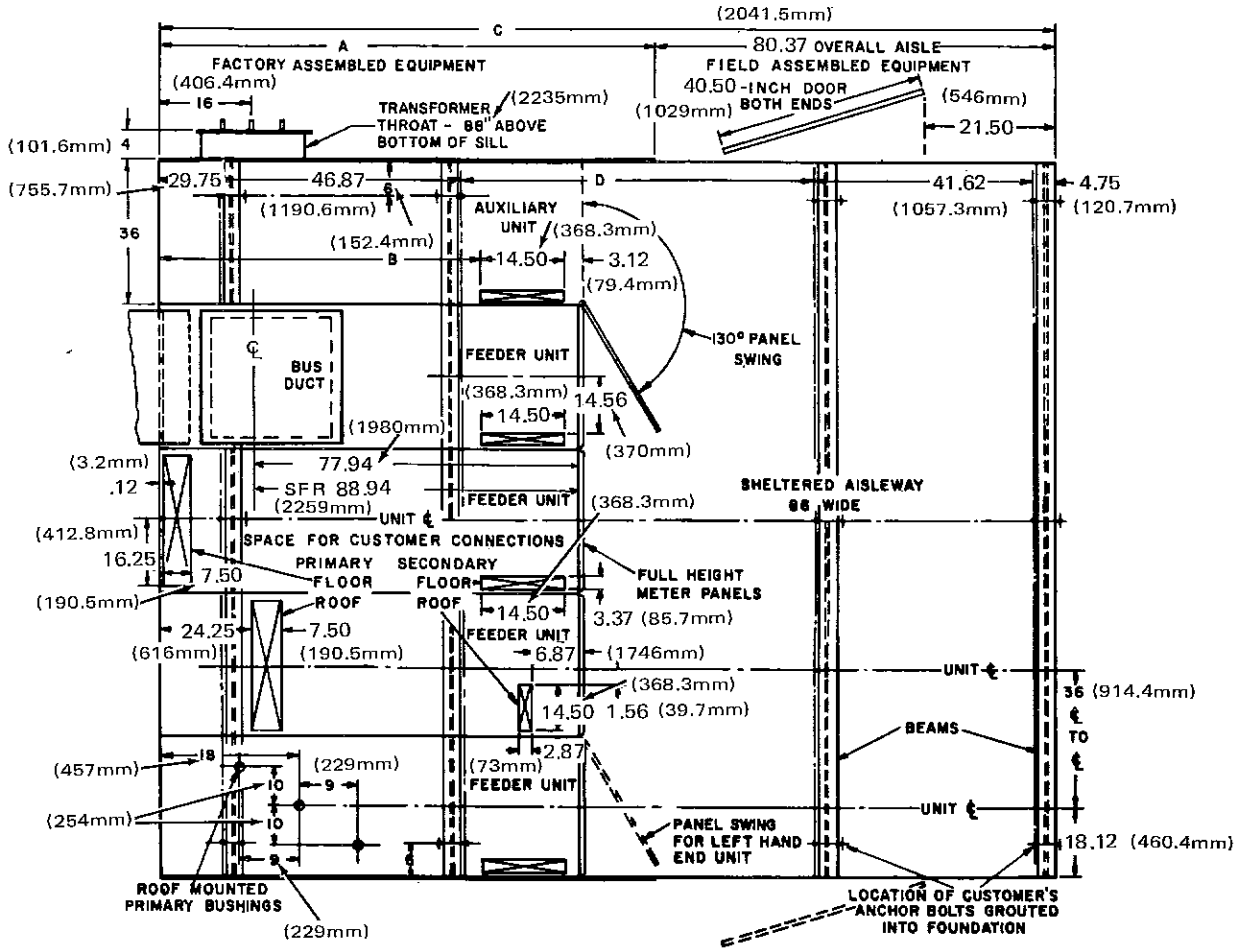



**Floor Plan.**

| STRUCTURAL DIMENSIONS (Inches) | | | | | | | | | | BREAKER |
|---|---|---|---|---|---|---|---|---|---|---|
| Unit Type | A Width | B Depth | C Factory Assb'ld Equip. | D | E | F | G | H | Weight (Including Aisle Lbs. | Type |
| SDF | 26 (660.4mm) | 150 (3910mm) | 79.62 (2022.5mm) | 71.87 (1825.6mm) | 19.50 (495.3mm) | 2.87 (73mm) | 9.56 (242.9mm) | 11.25 (285.8mm) | 1900 (864kg) | MA-75 |
| SDM | 26 | 150* | 79.62 | 71.87 | 19.50 | 2.87 | 9.56 | 11.25 | 1900 | MA-250 |
| SDN | 26 | 150* | 79.62 | 71.87 | 19.50 | 2.87 | 9.56 | 11.25 | 1900 | MA-350 |
| SDN | 36 (914.4mm) | 170 (4318mm) | 99.62 (2530.5mm) | 90.87 (2308.2mm) | | 3.12 (79.4mm) | 14.56 (369.9mm) | 16.25 (412.8mm) | 2700 (1230kg) | FA-350 |

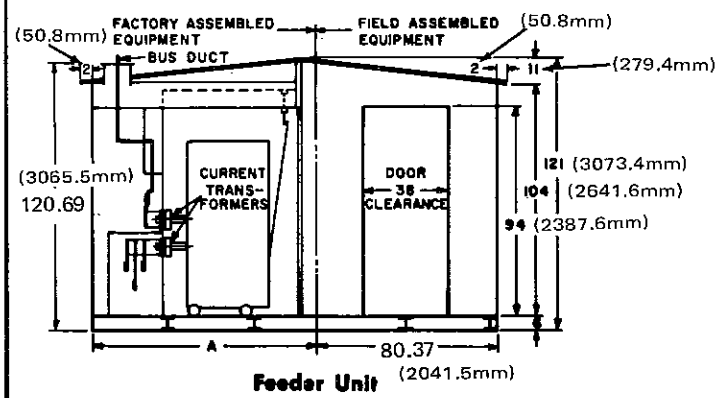
*FOR 3000A MAIN BUS DIMENSION BECOMES 2" (50.8mm) GREATER.

Figure 18. Floor Plan and Typical Side View of 5 kV Single Aisle Shelter-Clad Cubicles



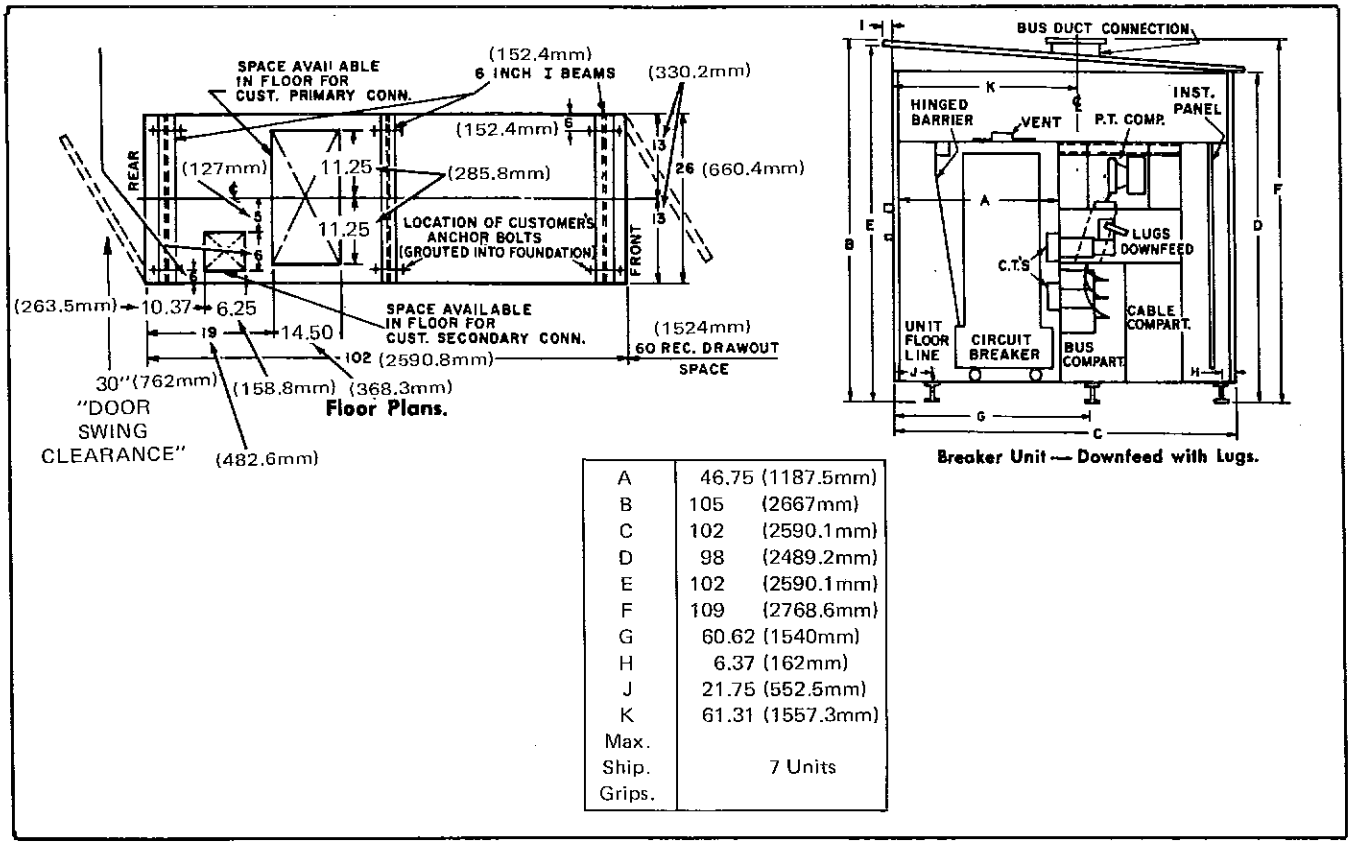

**Floor Plan.**

| STRUCTURAL DIMENSIONS (Inches) | | | | | | BREAKER |
|---|---|---|---|---|---|---|
| Unit | A Factory Assb'ld Equip. | B Secondary Opening Location | C Overall Depth of Housing | D Anchor Bolt | Weight (Including Aisle) Lbs. | Type |
| SFO | 100 (2540mm) | 76.37 (1940mm) | 108.37 (2753mm) | 57.37 (1457mm) | 2800 (1273kg) | FB-500, FC-500 or FCV-500 |
| SFQ | 100 (2540mm) | 76.37 (1940mm) | 108.37 (2753mm) | 57.37 (1457mm) | 2800 (1273kg) | FC-750, FCV-750 or FKV-750 |
| SFR | 111 (2820mm) | 87.37 (2219mm) | 191.37 (4861mm) | 68.37 (1737mm) | 3000 (1364kg) | FC-1000 |



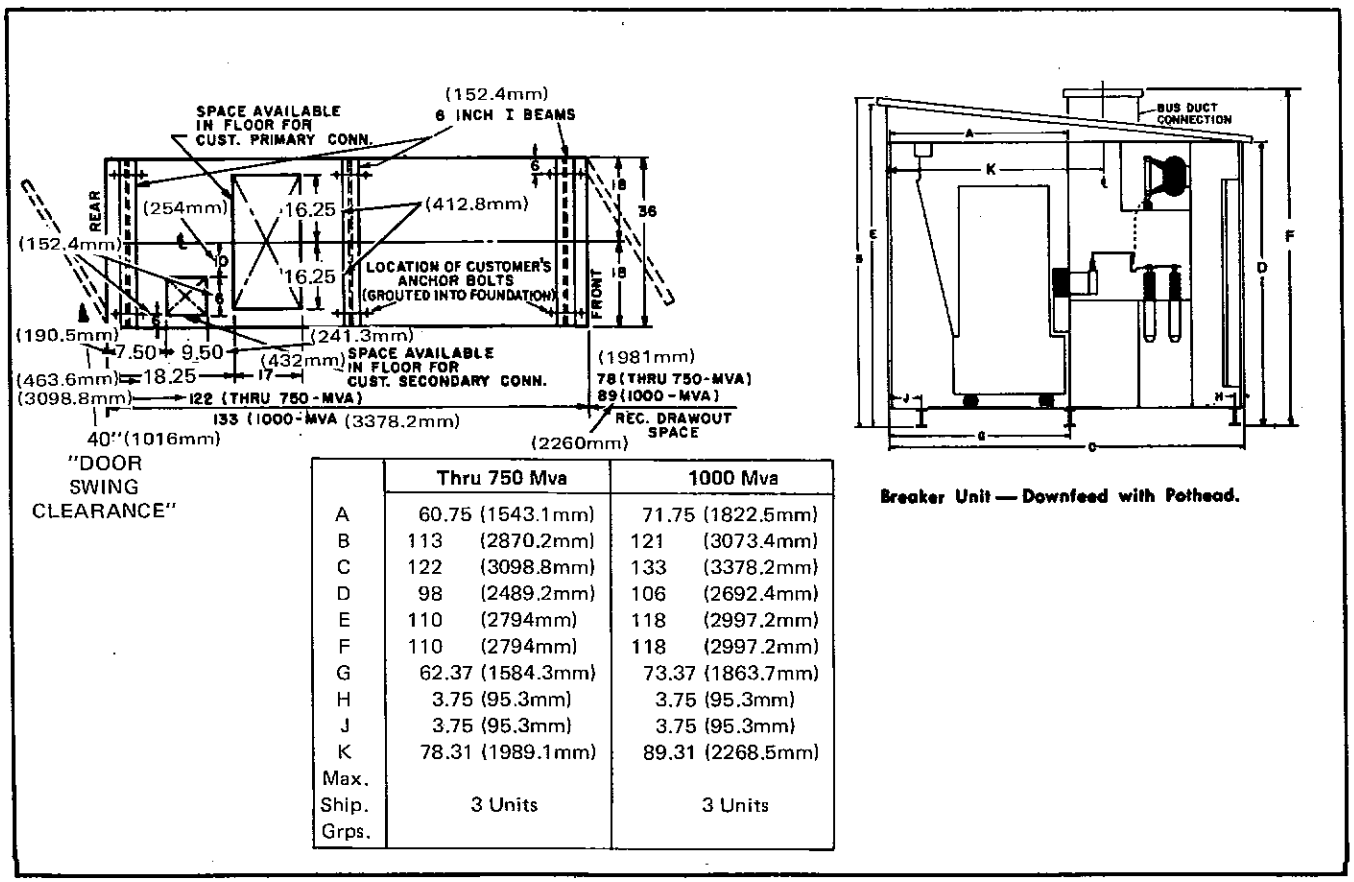

**Feeder Unit**

Figure 19. Floor Plan and Typical Side View of 15 kV Single Aisle Shelter-Clad Cubicles




| | |
|---|---|
| A | 46.75 (1187.5mm) |
| B | 105 (2667mm) |
| C | 102 (2590.1mm) |
| D | 98 (2489.2mm) |
| E | 102 (2590.1mm) |
| F | 109 (2768.6mm) |
| G | 60.62 (1540mm) |
| H | 6.37 (162mm) |
| J | 21.75 (552.5mm) |
| K | 61.31 (1557.3mm) |
| Max. Ship. Grips. | 7 Units |

Figure 20. Floor Plan and Typical Side View of 5 kV Conventional Outdoor Cubicles




| | Thru 750 Mva | 1000 Mva |
|---|---|---|
| A | 60.75 (1543.1mm) | 71.75 (1822.5mm) |
| B | 113 (2870.2mm) | 121 (3073.4mm) |
| C | 122 (3098.8mm) | 133 (3378.2mm) |
| D | 98 (2489.2mm) | 106 (2692.4mm) |
| E | 110 (2794mm) | 118 (2997.2mm) |
| F | 110 (2794mm) | 118 (2997.2mm) |
| G | 62.37 (1584.3mm) | 73.37 (1863.7mm) |
| H | 3.75 (95.3mm) | 3.75 (95.3mm) |
| J | 3.75 (95.3mm) | 3.75 (95.3mm) |
| K | 78.31 (1989.1mm) | 89.31 (2268.5mm) |
| Max. Ship. Grps. | 3 Units | 3 Units |

Figure 21. Floor Plan and Typical Side View of 15 kV Conventional Outdoor Cubicles

## ERECTING CUBICLES WITH TRANSFORMER IN LINE-UP

When a transformer is part of the equipment, the switchgear is positioned next to the transformer as shown in Figure 22. Keep the cubicles just high enough to clear conduits, approximately 2.50 inches (64 mm) above floor or base line. If the cubicles are raised too high, the throat on the switchgear will not clear the opening in the transformer terminal chamber (as in liquid-filled MCS transformers). Move the switchgear toward the transformer until the cubicle throat projects approximately 2 inches (51 mm) into the transformer terminal chamber and the anchor bolts and conduits below the switchgear are in proper alignment. With all points now in alignment, conduit caps and floor plate conduit covers removed, carefully lower the cubicles to their permanent location. It is important that this first group be accurately positioned and leveled as each successive group will depend on the first. Do not draw sliding throat collar into place until leveling and anchoring operations are complete, and then tighten only enough to compress gasket.

## ANCHORING AND LEVELING INDOOR SWITCHGEAR

Indoor switchgear shipping groups are held in true alignment by lifting channels across the top of the group and by bolts holding the cubicles to each other. The entire shipping group is to be anchored and levelled as a single element without loosening any hardware or removing lifting channel until entire shipping group is levelled and anchored.

Verify anchor bolt locations per general arrangement drawing and sweep area clean of any construction debris. Check general arrangement drawing for position of first shipping group and sequence of installation if arrangement consists of more than one shipping group.

Refer to Pages 3, 4 and 5, Lifting and Handling, and move switchgear to its final location.

1. The switchgear equipment represented 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 mounting 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 customers floor or grouted sill channels do not meet this requirement it will be necessary to shim in the following manner. The four (4) 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 cubicle. Do not force cubicle into firm contact by drawing down mounting bolts as such drastic means will distort cubicles. Add 4" (100 mm) square shims adjacent to anchor bolts until firm contact is achieved. Check each bolt location, 4 per cubicle, and tighten bolts. (See Figure 15.)

2. Tighten anchor bolts.

3. Check group for plumb. The first breaker cubicle in from each end of every shipping group

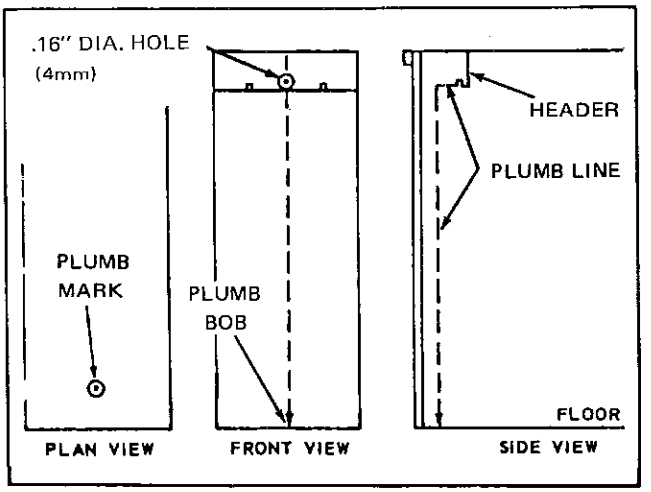



**Figure 23. Plumbing Switchgear Units**

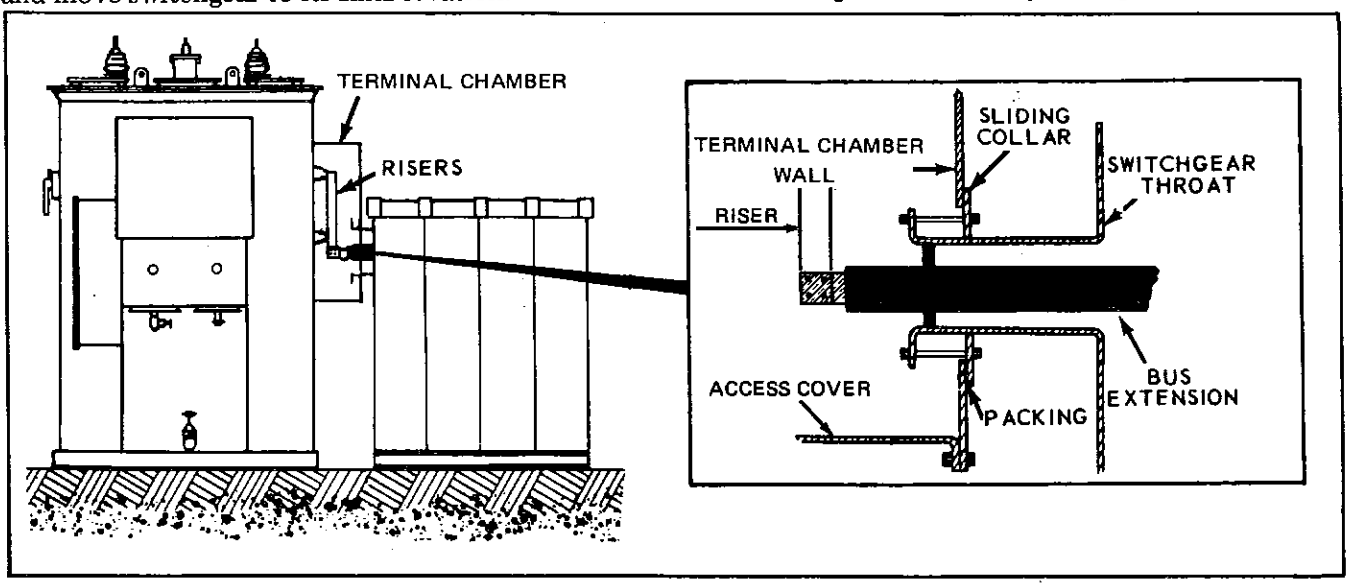



**Figure 22. Connecting Transformer and Switchgear on Typical Outdoor Installation**

will have a plumb mark stamped on the floor plate. This mark is located inside the breaker drawout compartment and is represented by a center punch mark with a circle around it. Directly above this mark is a .16" (4 mm) dia. hole in the header of the breaker compartment, as illustrated in Figure 23. Insert the plumb bob line through this hole toward the inside of the compartment, and tie off line with plumb bob hanging free. The point of the plumb bob must be within .12" (3.2 mm) of the factory installed plumb mark represented by the center punch. The circle around the punch has no meaning and is only an aid to locate the punch mark. All plumb readings should be taken with anchor bolts tight. If it is not within .12" (3.2 mm), it could be due either to unlevel sills or the cubicles being damaged in shipment. Check first to insure that sills are level. If sills are not level, add 4" x 4" (100 x 100 mm) steel shims on top of sill, adjacent to the anchor bolts, as necessary to achieve a level floor in all cubicles and to insure that all cubicles are in firm contact with the foundation at each anchor point. Tighten the anchor bolts. If plumb bob point is still not within .12" (3.2 mm) after floor leveling, proceed to step No. 5 below.

Do not loosen any hardware until after it has definitely been verified that floors are level and in firm contact with sills.

4. If lineup 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 for plumb as on previous group and bolt groups together with hardware provided. Repeat for any additional groups. Check that the cubicles are in firm contact with the foundation at each anchor point. Add 4" x 4" (100 x 100 mm) shims as necessary. Tighten the anchor bolts.

5. Should problem still exist, and it has been determined that foundation is level and in the same plane, it can be assumed that the shipping group has been distorted by abusive handling or a shipping mishap. This step is to be considered only after careful consideration of the previously described conditions and the foundation has been proven to be level and in the same plane as constructed or by the addition of shims.

(a) Tighten anchor bolts holding cubicles to foundation (if not already tight).

(b) Check "plumb" marked cubicles to determine direction of distortion. This may be checked by diagonal measurements of drawout compartment door frame or by use of carpenter's frame square. Is the direction of lean the same as that of the error in plumb bob location?

(c) Loosen, but do not remove, all hardware holding the "plumb" marked cubicle to its adjacent cubicles, and open all panels or doors. Do not loosen any hardware holding cubicles to foundation! With the use of diagonal jacking in door frame, force frame back to rectangular shape until plumb bob point is in line with punch mark. It may be necessary to allow for slight spring-back when jacking so that plumb reading is correct when jack is released. It may also be necessary to loosen hardware holding successive cubicles together to allow for more freedom and movement during frame straightening.

(d) Tighten all hardware.

(e) Remove lifting channels.

(f) Check all breaker cubicles for free movement of shutters.

## ANCHORING AND LEVELING OF SHELTER-CLAD SWITCHGEAR

In Shelter-Clad arrangements the switchgear, as received, is true and in correct position relative to its support beams. The beams are a permanent part of the switchgear, and are not to be loosened or moved from position.

Verify anchor bolt locations in concrete as shown in Figure 13, and at all points shown on general arrangement plan view. Sweep foundation to make certain it is free of pebbles or other debris. Check general arrangement drawing for positioning of switchgear and sequence of installation if arrangement consists of more than one shipping group.

Single aisle *Shelter-Clad* cubicles are shipped with the aisle wall covering the breaker drawout compartment. This wall may be removed before moving the switchgear into position on its foun-

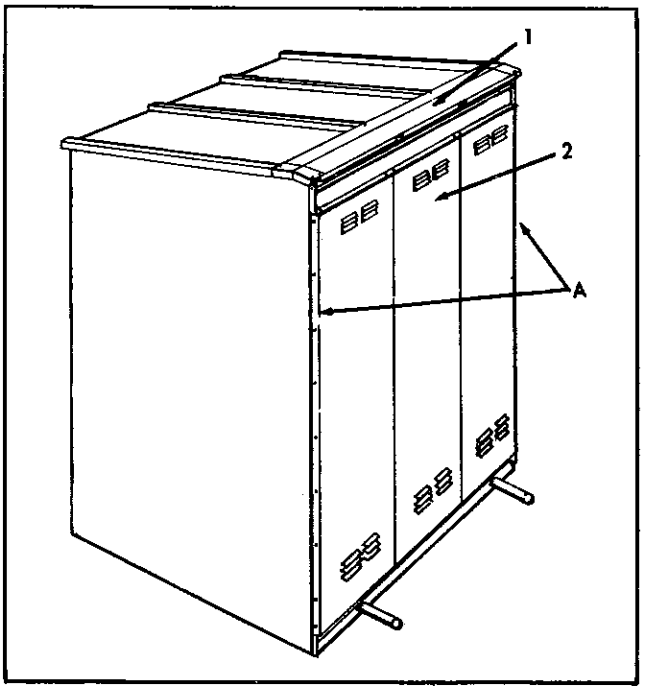



**Figure 24. Aisle Wall Removal**

dation, if conduit clearance is in doubt, or if aisle is to be assembled immediately after leveling. See Figure 24.

1. Remove seal material at top of wall (2).

2. Unbolt and remove roof gable (1).

3. Support wall (2) with crane or other means (Figure approximately 125 lb. (57 kg) per unit) and remove all the bolts (A) at each end of the group which hold the aisle wall in place. Carefully lay roof gable and aisle wall aside until needed for aisle assembly.

4. Remove nuts from all anchor bolts, remove caps from all secondary conduit stubs, and remove covers from secondary openings in cubicle floor plates and anchor bolt access covers from each end of line up.

Refer to Pages 3, 4 and 5 for Lifting and Handling *Shelter-Clad* switchgear. The arrangement may consist of a single complete shipping group, or may be broken down into a number of shipping sections as in a long line-up. Refer to general arrangement drawing for instructions as to which shipping group should be installed first, and in what sequence the remaining groups are to be installed. Using 2.50" (63.5 mm) nom. X-X strong (extra-heavy) pipe (do not substitute a member of less strength) move the first group into position as dimensioned on general arrangement drawing.

5. The switchgear equipment represented 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's 4 x 6 (101.6 x 152.4 mm) beams must be level and in the same plane within .06" (1.6 mm). If concrete, grouted channels, pier support plates, etc. do not meet this requirement, or if there is any projection higher than the support points in line with beams, shims must be installed in the following manner to provide equivalent true surface for switchgear support. 5kV and 15kV outdoor switchgear groups which have been assembled on 4 x 6 (101.6 x 152.4 mm) beams must be supported along these beams with the maximum span between support points not exceeding nine (9) feet (2743 mm). When switchgear line-up includes 1000 MVA breakers this maximum span must be decreased to six (6) feet (1830 mm). If shims are required use 4" (100 mm) square strips placed between bottom of beam and foundation, in the anchor bolt area where they will be clamped firmly in place.

6. Add clamp washers and nuts to anchor bolts and tighten securely.

7. The first breaker cubicle in from each end of every shipping group will have a plumb mark stamped on the floor plate (aisle wall must be off). This mark is located inside the breaker drawout compartment and is represented by a center this mark is a .16" (4 mm) dia. hole in the header of the breaker compartment, as illustrated in Figure 23. Insert the plumb bob line through this hole toward the inside of the compartment, and tie off line with plumb bob hanging free. The point of the plumb bob must be within .12" (3.2 mm) of the factory installed plumb mark represented by the center punch. The circle around the punch has no meaning and is only an aid to locate the punch mark. If the plumb bob reading exceeds the .12" (3.2 mm) limitation, does the position of the deviation in each end breaker cubicle read the same direction and approximately the same distance from the punch mark? If this condition exists it would normally indicate that the slab, piers or pilings, as the case may be, are not level and/or are not in the same plane. The addition of shims between foundation and the bottom of the beam should bring shipping group to level showing plumb reading within the .12" (3.2 mm) tolerance. Note all plumb readings are to be taken with anchor bolts tight.

8. Should problem still exist, and it has been determined that foundation is level and in the same plane, it can be assumed that the shipping group has been distorted by abusive handling or a shipping mishap. This step is to be considered only after careful consideration of the previously described condition, and the foundation has been proven to be level and in the same plane as constructed or by the addition of shims.

(a) Tighten anchor bolts holding beams to foundation (if not already tight).

(b) Check "plumb" marked cubicles to determine direction of distortion. This may be checked by diagonal measurements of drawout compartment door frame or by use of carpenter's frame square. Is the direction of lean the same as that of the error in plumb bob location?

(c) Loosen, but do not remove, all hardware holding the "plumb" marked cubicle to its adjacent cubicles, and open all panels of doors. Do not loosen any hardware holding cubicles to supporting beams! With the use of diagonal jacking in door frame, force frame back to rectangular shape until plumb bob point is in line with punch mark. It may be necessary to allow for slight spring-back when jacking so that plumb reading is correct when jack is released. It may also be necessary to loosen hardware holding successive cubicles together to allow for more freedom and movement during frame straightening.

(d) Tighten all hardware.

(e) Check all breaker cubicles for free movement of shutters.

9. When a switchgear line-up has more than one shipping group, a temporary plate is bolted to the end plate of each group at the shipping split.

This plate was used to support the aisle wall during shipment. Remove and scrap these plates, and remove any hardware which would interfere with a tight fit when the next group is moved into position. Make sure that all anchor nuts of the first section installed are tight and have produced a true plumb reading before moving the next group into position.

10. Move the next group into position. The front edge of the cubicle floor plates should be in line with those of the previously installed group. This will insure a good fit with aisle floor plates.

Make certain that the end of the group being installed is tightly against the previous installation. Repeat steps 5., 6., 7. and 8. and install all shipping split hardware.

11. If there are additional groups in line-up, repeat step 8. and then 5., 6., 7., and 8. for each group. Replace covers for anchor bolt access at each end of line-up.

## ANCHORING AND LEVELING OF CONVENTIONAL OUTDOOR SWITCHGEAR

In conventional outdoor switchgear arrangements the switchgear, as received, is true and in correct position relative to its support beams. The beams are a permanent part of the switchgear and are not to be loosened or moved from position.

Verify anchor bolt locations in concrete, as shown in Figure 13, and at all points shown on general arrangement plan view. Sweep foundation to make certain it is free of pebbles or other debris. Check general arrangement drawing for positioning of switchgear and sequence of installation if arrangement consists of more than one shipping group.

1. Remove anchor hardware from anchor bolts.

2. Remove caps and covers from conduit stubs so that they will clear openings in cubicle floor plates.

3. Open rear door and inner instrument panel of each cubicle and remove entrance opening covers in floor plates. Close and secure instrument panel and rear door so they will not be damaged during lifting.

Refer to pages 4, 5 and 6 for lifting and handling of conventional switchgear. Switchgear may consist of a single complete shipping group, or may be broken down into a number of shipping sections as in a long line-up. Refer to general arrangement drawings for instructions as to which shipping group should be installed first and in what sequence the remaining groups are to be installed. 5 KV conventional switchgear must be lifted using 2.50" (63.5 mm) nom. x-x strong (extra heavy) pipe. (Do not substitute a member of less strength.) 15kV conventional switchgear is lifted with lifting lugs and cable clamps as shown in Figure 8.

Move the first group into position as dimensioned on the general arrangement drawing.

4. The switchgear equipment represented 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's 4 x 6 (101.6 x 152.4 mm) beams must be level and in the same plane within .06" (1.6 mm). If concrete, grouted channels, pier support plates, etc. do not meet this requirement, or if there is any projection higher than the support points in line with beams, shims must be installed in the following manner to provide equivalent true surface for switchgear support. 5kV and 15kV outdoor switchgear groups which have been assembled on 4 x 6 (101.6 x 152.4 mm) beams must be supported along these beams with the maximum span between support points not exceeding nine (9) feet (2743 mm). When switchgear line-up includes 1000 MVA breakers this maximum span must be decreased to six (6) feet (1830 mm). If shims are required use 4" (100 mm) square strips placed between bottom of beam and foundation, in the anchor bolt area where they will be clamped firmly in place.

5. Add clamp washers and nuts to anchor bolts and tighten securely.

6. The first breaker cubicle in from each end of every shipping group will have a plumb mark stamped on the floor plate. This mark is located inside the breaker drawout compartment and is represented by a center punch mark with a circle around it. Directly above this mark is a .16" (4 mm) dia. hole in the header of the breaker compartment, as illustrated in Figure 23. Insert the plumb bob line through this hole toward the inside of the compartment, and tie off line with plumb bob hanging free. The point of the plumb bob must be within .12" (3.2 mm) of the factory installed plumb mark represented by the center punch. The circle around the punch has no meaning and is only an aid to locate the punch mark. If the plumb bob reading exceeds the .12" (3.2 mm) limitation, does the position of the deviation in each end breaker cubicle read the same direction and approximately the same distance from the punch mark? If this condition exists, it would normally indicate that the slab, piers or pilings, as the case may be, are not level and/or are not in the same place. The addition of shims between foundation and the bottom of the beam should bring shipping group to level showing plumb reading within the .12" (3.2 mm) tolerance. Note all plumb readings are to be taken with anchor bolts tight.

7. Should problem still exist, and it has been determined that foundation is level and in the same plane, it can be assumed that the shipping group has been distorted by abusive handling or a shipping mishap. This step is to be considered only after careful consideration of the previously described conditions and the foundation has been proven to be level and in the same plane as constructed or by the addition of shims.

(a) Tighten anchor bolts holding beams to foundation (if not already tight).

(b) Check "plumb" marked cubicles to determine direction of distortion. This may be checked by diagonal measurements of drawout compartment door frame or by use of carpenter's frame square. Is the direction of lean the same as that of the error in plumb bob location?

(c) Loosen, but do not remove, all hardware holding the "plumb" marked cubicle to its adjacent cubicles, and open all panels of doors. Do not loosen any hardware holding cubicles to supporting beams! With the use of diagonal jacking in door frame, force frame back to rectangular shape until plumb bob point is in line with punch mark. It may be necessary to allow for slight spring-back when jacking so that plumb reading is correct when jack is released. It may also be necessary to loosen hardware holding successive cubicles together to allow for more freedom and movement during frame straightening.

(d) Tighten all hardware.

(e) Check all breaker cubicles for free movement of shutters.

8. Before moving the next group into alignment (when shipment consists of more than one section) check shipping split end of previously installed group for protruding hardware used to plug holes in shipping, and on 15 KV remove the lifting lugs. Make certain that all anchor nuts are tight and a true plumb reading exists.

9. Move the next shipping group into position. 15 KV conventional switchgear may not be moved directly into position, as can the 5 KV, because of the protruding lift lugs. 15 KV must be placed on skids or rollers high enough to clear conduits and in line with previously installed group. The lift lugs at the split must be removed and the group pushed against that previously installed. Jacks may be used to remove skids or rollers and to lower group to foundation. Repeat steps 4., 5., 6. and 7., and install shipping-split hardware.

10. If there are additional groups in line-up, repeat step 8. and then 4., 5., 6., and 7. Replace covers for anchor bolt access at each end of line-up.

## ASSEMBLY OF *SHELTER-CLAD* OUTDOOR SWITCHGEAR

### Single Aisle

Table 3 lists the standard components supplied for single aisle *Shelter-Clad* outdoor switchgear. The item numbers in the table are used in all instructions pertaining to this procedure. Assemble as follows:

1. Temporarily support the aisle wall assembly (removed for the plumb bob check) in its permanent position as shown in the general arrangement drawing (see Figure 25). Remove the aisle beam (3) from top of the wall assembly (2) and place the beam, with clip angles near the top, in position B.

2. Put roof covers (4) in place to hold top of aisle wall in place. Do not tighten hardware. Remove and discard the buffer angles at the bottom of the unit. These angles are installed to prevent bending

**Table 3. Standard Components – Single Aisle Switchgear**

| ITEM | DESCRIPTION | 5 kV | | 15 kV | |
|---|---|---|---|---|---|
| | | PART NO. | MK | PART NO. | MK |
| 1 | ROOF GABLE ASSEM. | 18-177-200 | | 18-184-208 | |
| 2 | FRONT PLATE ASSEM. | 18-657-280 | 584 | 18-657-276 | 547 |
| 3 | BEAM | 18-712-418 | | 18-702-162 | |
| 4 | ROOF COVER ASSEM. (AISLE) | 18-177-195 | 501 | 18-299-861 | 501 |
| 5 | FLOOR PLATE ASSEM. | 18-652-057 | 502 | 18-294-120 | 501 |
| 5A | FLOOR PLATE ASSEM. | | | 18-657-246 | 554 |
| 6 | FLOOR PLATE ASSEM. | 18-652-057 | 501 | 18-294-121 | 501 |
| 6A | FLOOR PLATE ASSEM. | | | 18-657-246 | 555 |
| 7 | DOOR ASSEM L.H. | 18-657-280 | 587 | 18-657-276 | 577 |
| 7A | DOOR ASSEM R.H. | 18-657-280 | 588 | 18-657-276 | 578 |
| 8 | ANGLE | 18-657-223 | 573 | 18-657-206 | 513 |
| 9 | BRACKET | 18-176-985 | 001 | 18-184-206 | 001 |
| 10 | ANGLE | 18-177-261 | 001 | 18-184-213 | 004 |
| 11 | ROOF CHANNEL ASSEM. | 18-176-983 | 501 | 18-299-862 | 501 |
| 12 | END GABLE ASSEM. | 18-177-259 | 501 | 18-184-218 | 501 |
| 13 | COVER (FORMED) | 18-287-990 | | 18-184-210 | |
| 14 | COVER OR PLATE | 18-177-174 PLATE | 001 | 18-184-217 COVER | 001 |
| 15 | ANGLE | 18-178-032 | 001 | 18-178-032 | 001 |
| 16 | CLAMP WASHER | 18-657-511 | 532 | 18-657-511 | 532 |

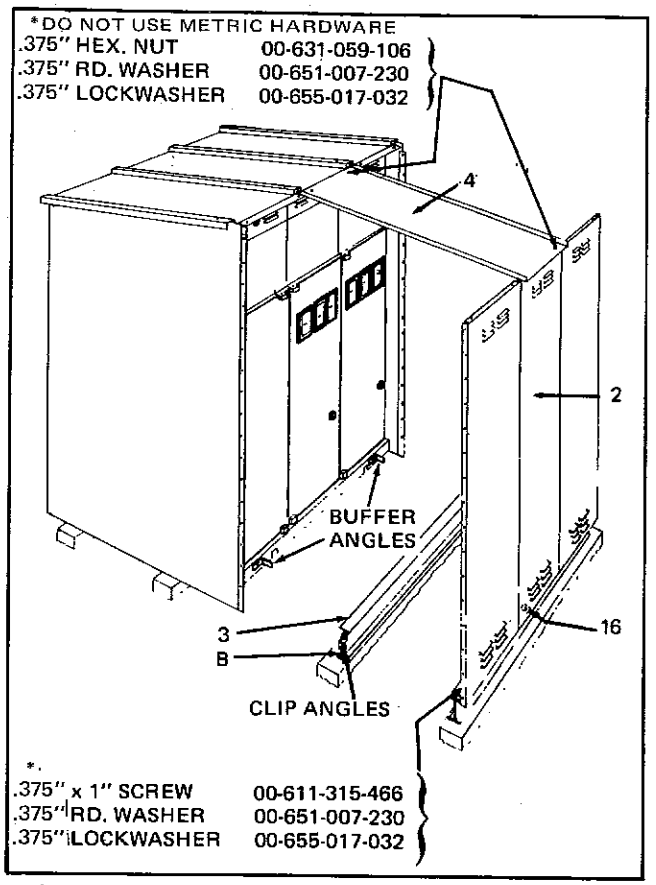



**Figure 25. Aisle Wall Assembly — Single Aisle Layout**

of the aisle wall during shipping. If not removed, they may interfere with installation of floor plates.

3. Align the ends of the aisle wall, aisle beam and switchgear. Place two sets of floor plates in position between the switchgear and the wall. Install each set next to the end position between the switchgear and the wall. (See Figure 26 for location of floor plates.) With floor plates set tightly against switchgear floor plates, check and adjust center beam and aisle wall beam location to provide a good fit with minimum size cracks between plates and a smooth surface. Check that aisle wall is square with switchgear by diagonal measurements at floor level — corner to corner distances should be equal. Tighten anchor bolts to secure beam locations.

4. With roof cover hardware loose, plumb front wall and tighten attaching hardware.

5. Install all floor plates using 5 kv or 15 kv pattern as shown in Figure 26. Each plate overlaps the supporting member of the next plate; therefore, determine sequence of installation accordingly. Place each set of floor plates to equalize the space between floor plates and prevent a wide crack at end of group.

6. Install weather stripping at points "C" and "D". Use .50-inch (12.7 mm) sealant tape. Place the tape so that one edge is on the vertical centerline of the holes and the other edge is toward the seam which will be exposed to the weather.

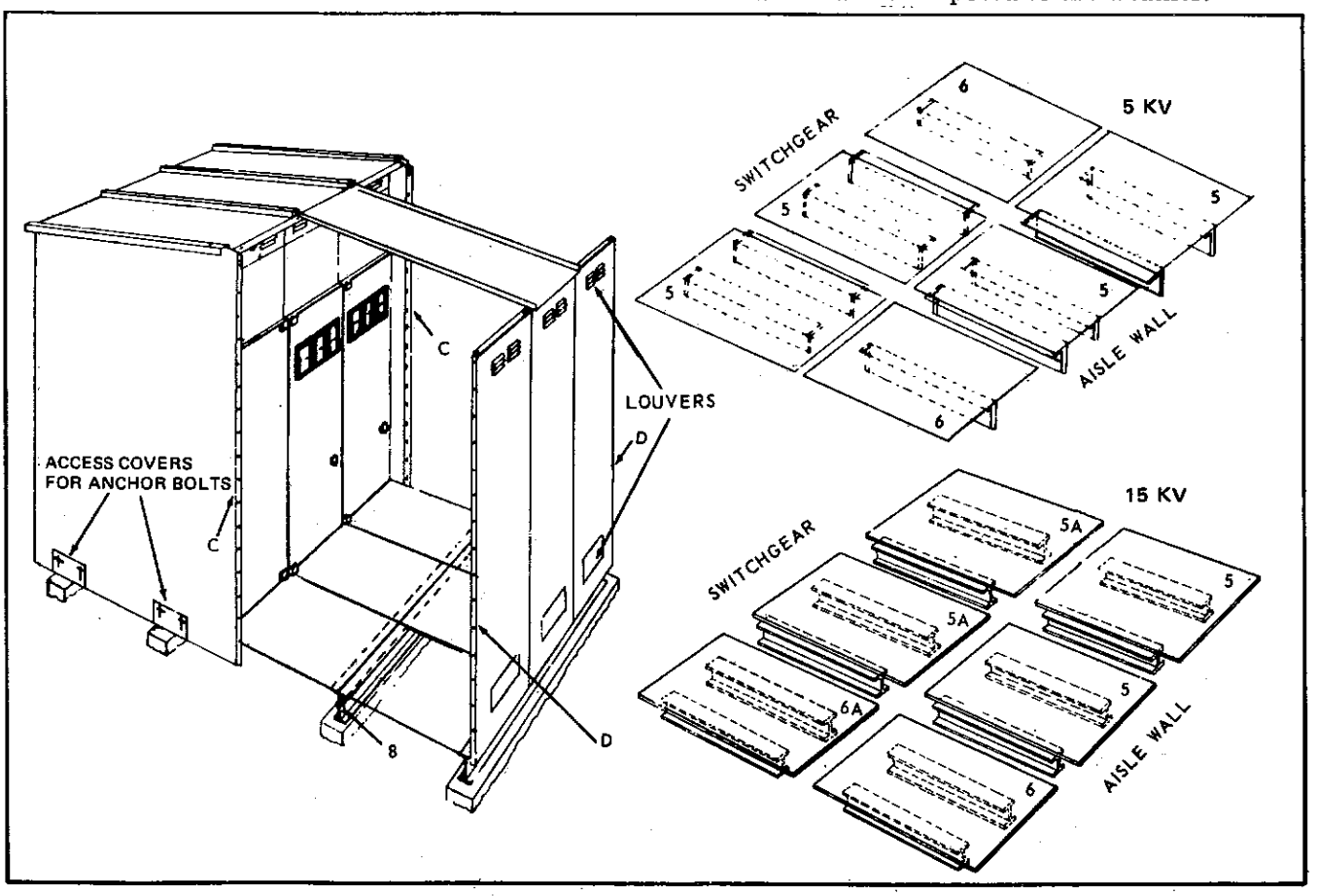



**Figure 26. Floor Plate Installation — Single Aisle Layout**

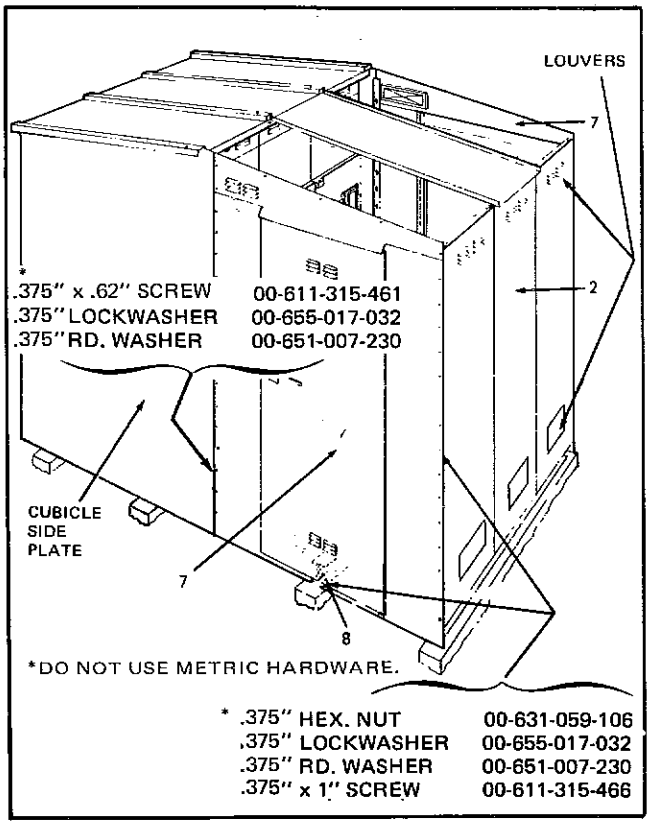



**Figure 27. Door Installation – Single Aisle Layout**

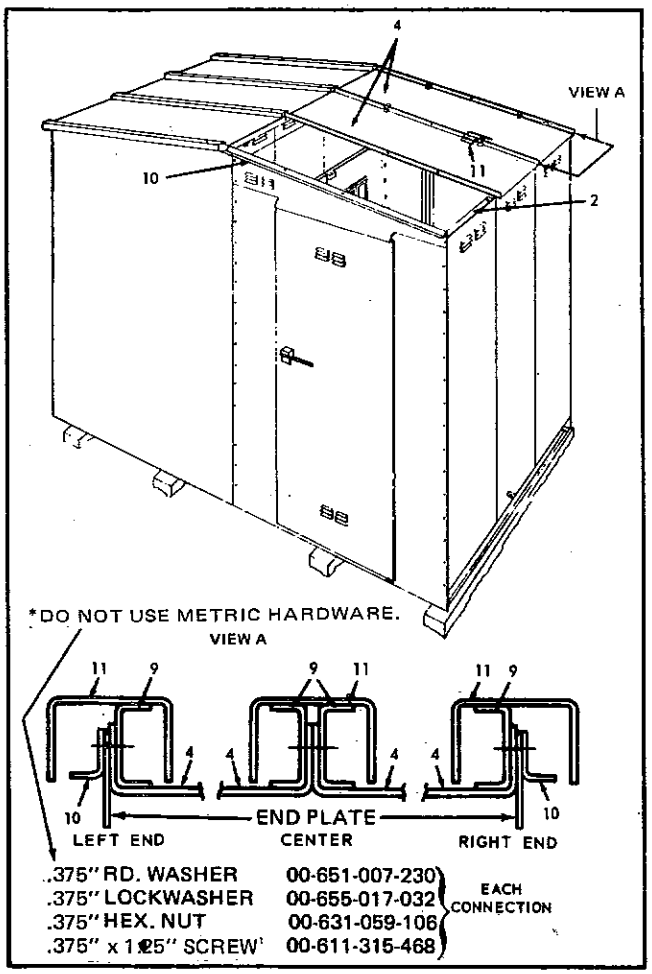



**Figure 28. Roof Covers Installation – Single Aisle Layout**

7. Set door assemblies (7) in place (See Figure 27). Bolt the doors to the aisle wall (2) and to side plate of the cubicle.

8. See Figure 28. Put all roof covers (4) in place and bolt to aisle wall assembly (2) and roof support.

9. Fasten roof covers together using bracket (9) at positions "E" (two per joint) See view "A".

10. Install a trim angle (10) at each end of aisle.

11. See Figure 29. Set roof channels (11) over roof cover joints. Slide the channel toward the roof peak until the clip inside the channel engages the bracket (9).

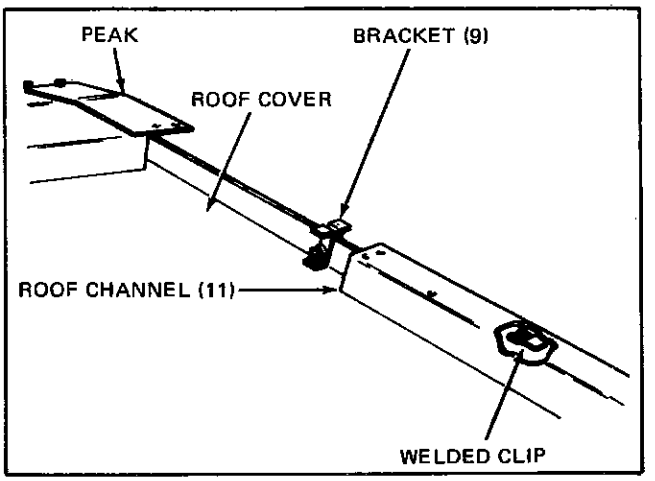



**Figure 29. Roof Channel Installation – Single Aisle Layout**

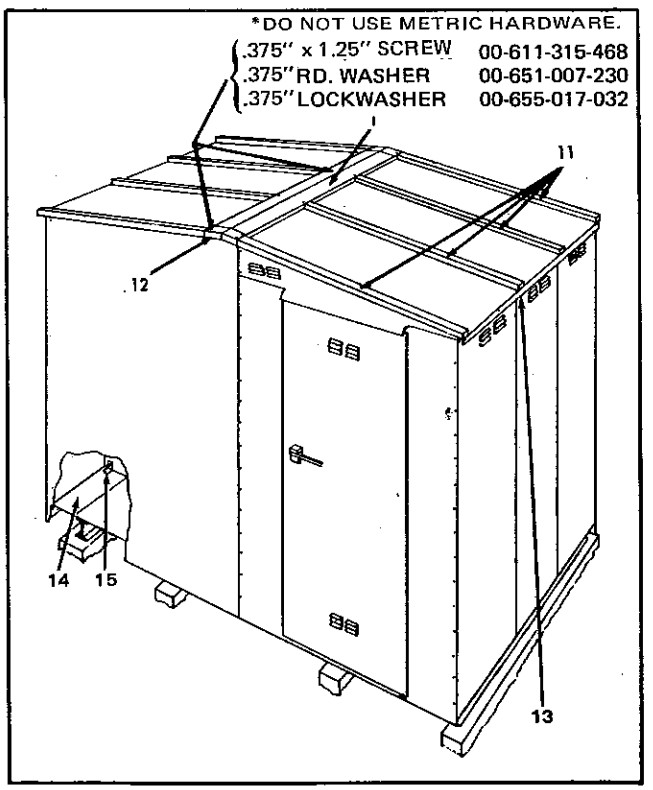



**Figure 30. Roof Gable Installation – Single Aisle Layout**

12. See Figure 30. Install roof gable assembly (1). Adjust the position of the gable and the channels (11) so that the channels fit into the notches of the gable.

13. Bolt roof gable assembly (1) into place using weld nuts in roof channels (11).

14. Add end gable assembly (12) at each end. Fasten cover (13) to roof.

15. Drill cable cover (14) to suit conduit installation. Clamp the cover in place with angle (15).

16. Mount aisle conduit, switches, receptacle and wire to junction box at each end unit. See conduit arrangement.

17. If equipment consists of more than one shipping group, caulk vertical shipping split at back of switchgear with metal filler provided.

## Common Aisle

Table 4 lists the standard components supplied for common aisle *Shelter-Clad* outdoor switchgear. The item numbers in the table are used in all instructions pertaining to this procedure. Assemble as follows:

1. Place aisle beam (3) in position "B" and secure with anchor bolts. (See Figure 31).

2. Attach angle (2) to ends of aisle beam (3) as shown.

3. See Figure 32. Install all floor plates using 5 kv or 15 kv pattern shown. Each plate overlaps the supporting member of the next plate; determine sequence of installation. Place each set of floor plates to equalize the space between the floor plates and prevent a wide crack at end of group.

4. Assemble and connect bus run (7). See Figure 33.

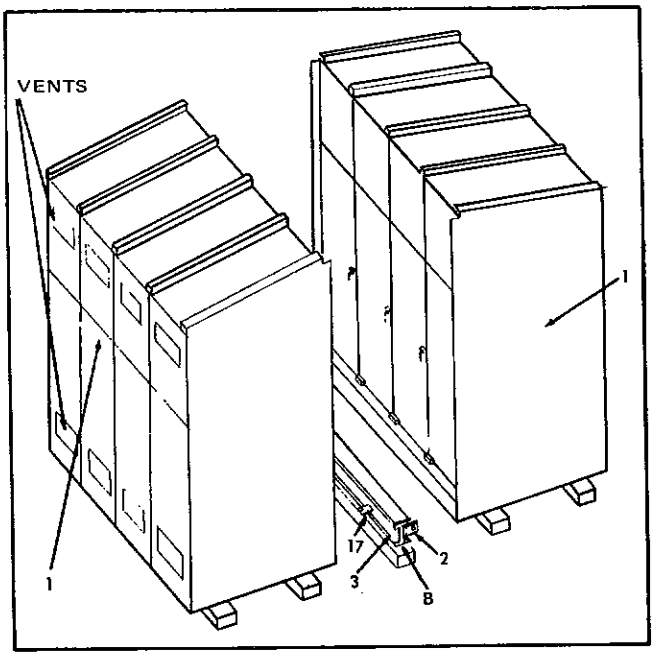



**Figure 31. Initial Positioning — Common Aisle Layout**

**Table 4. Standard Components — Common Aisle Switchgear**

| ITEM | DESCRIPTION | 5 kV | | 15 kV | |
|---|---|---|---|---|---|
| | | PART NO. | MK | PART NO. | MK |
| 1 | FACTORY ASSEM. EQUIPMENT | | | | |
| 2 | FORMED — ANGLE | 18-657-223 | 573 | 18-657-206 | 513 |
| 3 | BEAM | 18-193-151 | | 18-193-151 | |
| 4 | DOOR ASSEM. | 18-657-280 | 589 | 18-657-307 | 519 |
| 5 | FLOOR PLATE R.H. & INTER. | 18-652-059 | 501 | 18-299-880 | 501 |
| 6 | FLOOR PLATE — L.H. | 18-652-059 | 502 | 18-299-881 | 501 |
| 7 | BUS RUN | SEE GENERAL ARRG'T. | | SEE GENERAL ARRG'T. | |
| 8 | | | | | |
| 8A | COVER | 18-179-735 | 001 | 18-190-433 | 001 |
| 9 | ROOF DECK | 18-288-735 | 501 | 18-299-878 | 501 |
| 10 | COVER | 18-179-730 | 501 | 18-190-430 | 501 |
| 11 | HOOD | 18-288-739 | 001 | 18-701-569 | 001 |
| 12 | BRACKET | 18-176-985 | 001 | 18-184-206 | 001 |
| 13 | ANGLE | 18-179-733 | 001 | 18-190-438 | 001 |
| 14 | WIRE DUCT | 18-191-039 | 002 | 18-657-655 | 884 |
| 15 | COVER OR PLATE | 18-177-174 PLATE | 001 | 18-184-217 COVER | 001 |
| 16 | ANGLE | 18-178-032 | 001 | 18-178-032 | 001 |
| 17 | CLAMP WASHER | 18-657-511 | 532 | 18-657-511 | 532 |

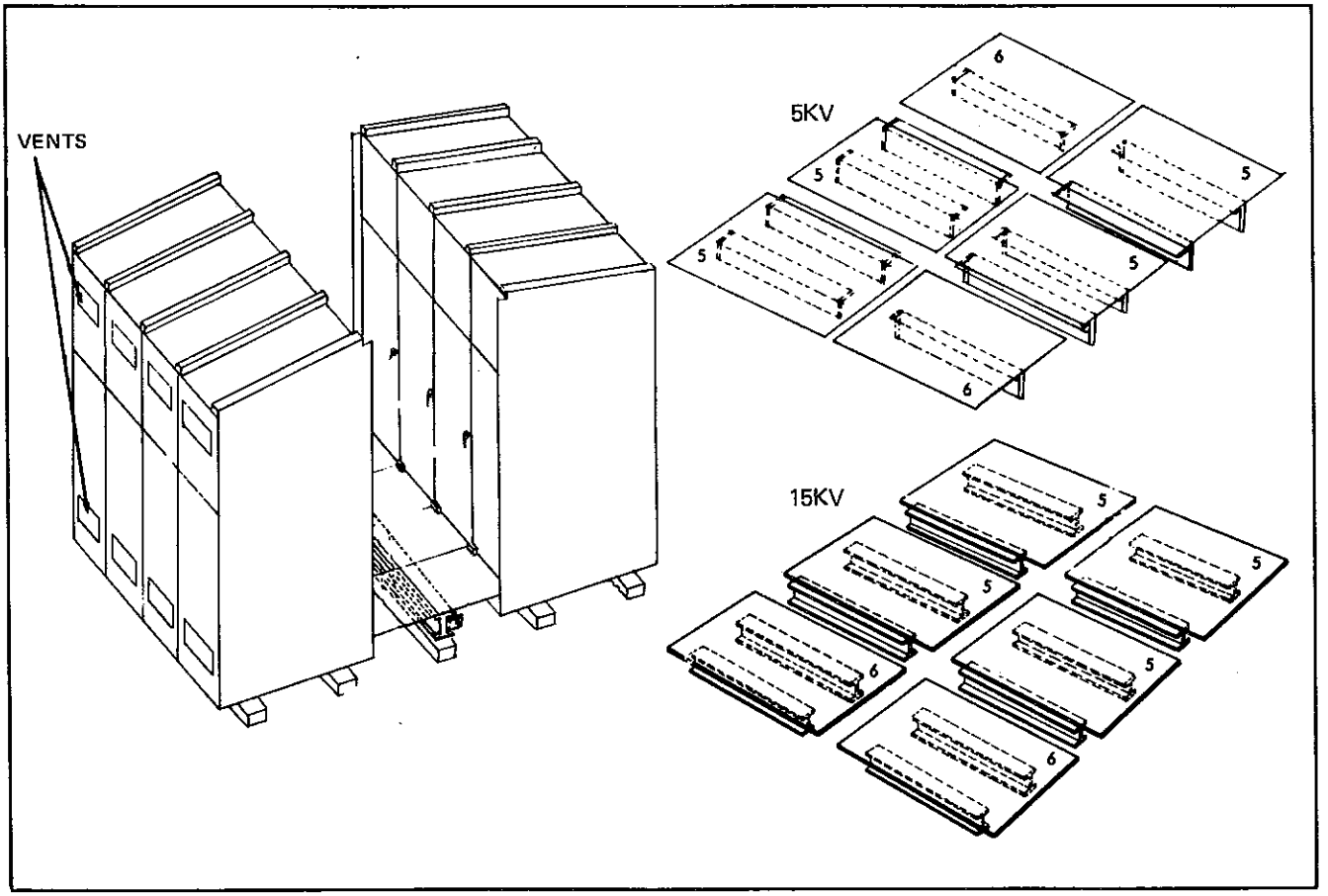



**Figure 32. Floor Plate Installation – Common Aisle Layout**

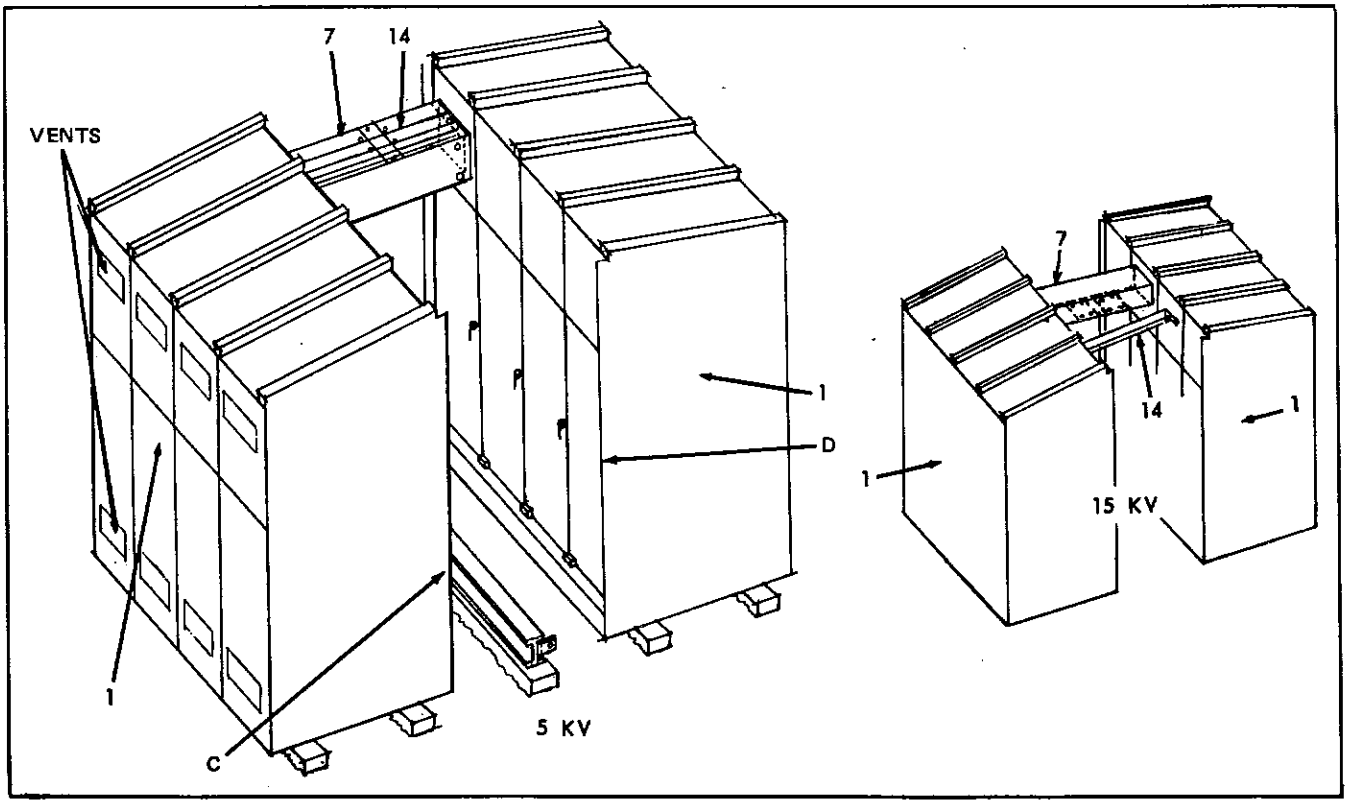



**Figure 33. Bus Run Installation – Common Aisle Layout**

**NOTE**

Leave all bolts hand tight until shelter is completely assembled. Mount bottom covers on bus duct after shelter assembly is complete. When bus run (7) is omitted, wire duct (14) is to be located over 3 x 3-inch cutouts and bolted in place.

5. Install weather stripping at points "C" and "D". Use .50-inch (12.7 mm) sealant tape. Place the tape so that one edge is on the vertical centerline of the holes and the other edge is toward the seam which will be exposed to the weather.

6. See Figure 34. Raise door assemblies (4) into place. Bolt doors to side plates of cubicles. Bolt to aisle sill using angle (2).

7. Mount 4 covers (8A) in place.

8. Mount aisle conduit, switches, receptacle and wire to junction boxes. See conduit arrangement.

9. See Figure 35. Place roof decks (9) in position and fasten with the bolts provided.

10. Fasten roof decks together using bracket (12). See view "A".

11. Add trim angle (Item 13) at each end of group.

12. Set channel-shaped covers (10) over the joints of roof decks and slide up the covers so the clips on the inner surface (See Figure 29) engage the brackets (12).

13. Bolt hoods (11) in place.

14. Tighten all bolts to complete assembly.

15. Drill cable cover (15) to suit conduit. Clamp the cover in place with angle (16).

16. If equipment consists of more than one shipping group, caulk vertical shipping split at back of switchgear with metal filler provided.

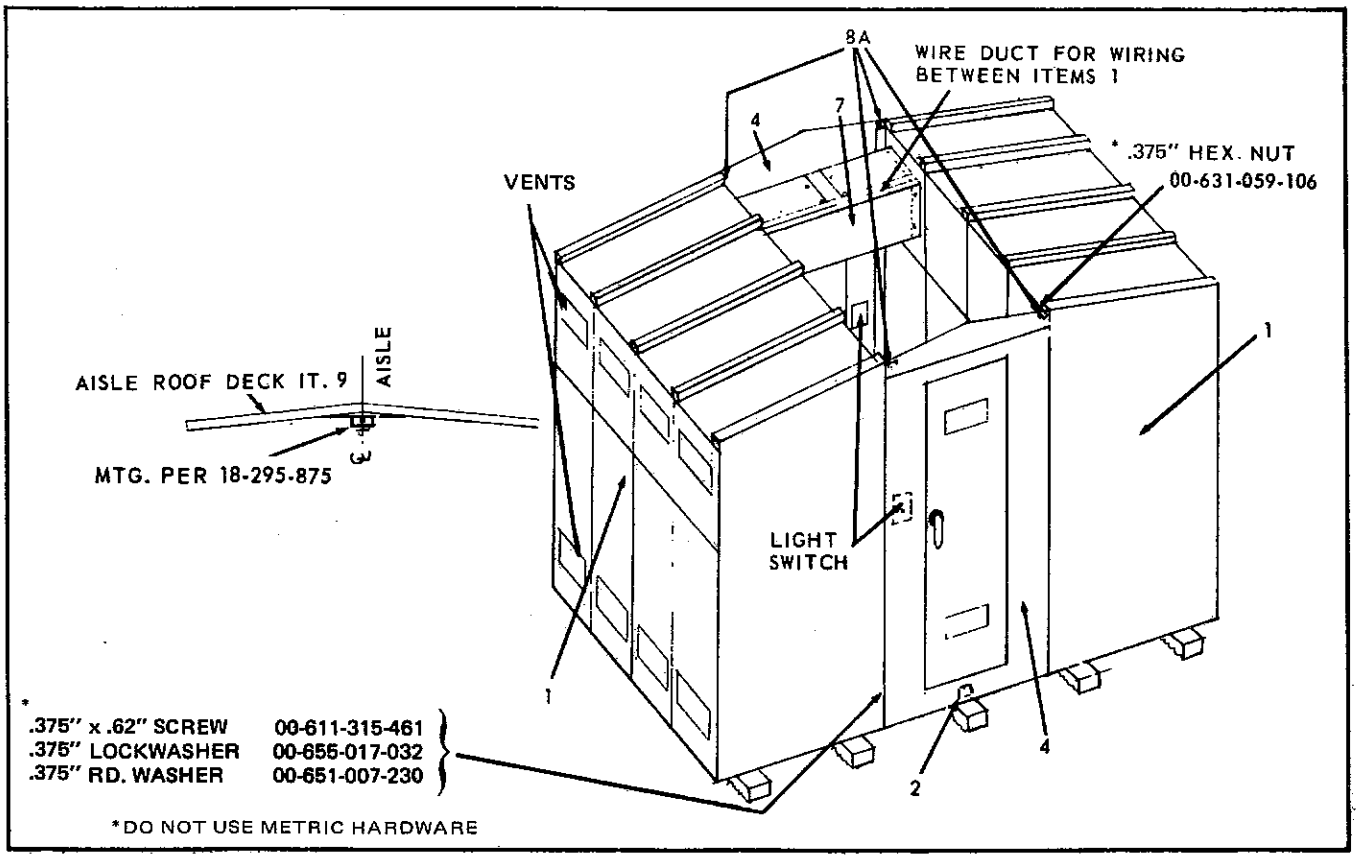



**Figure 34. Door Installation — Common Aisle Layout**

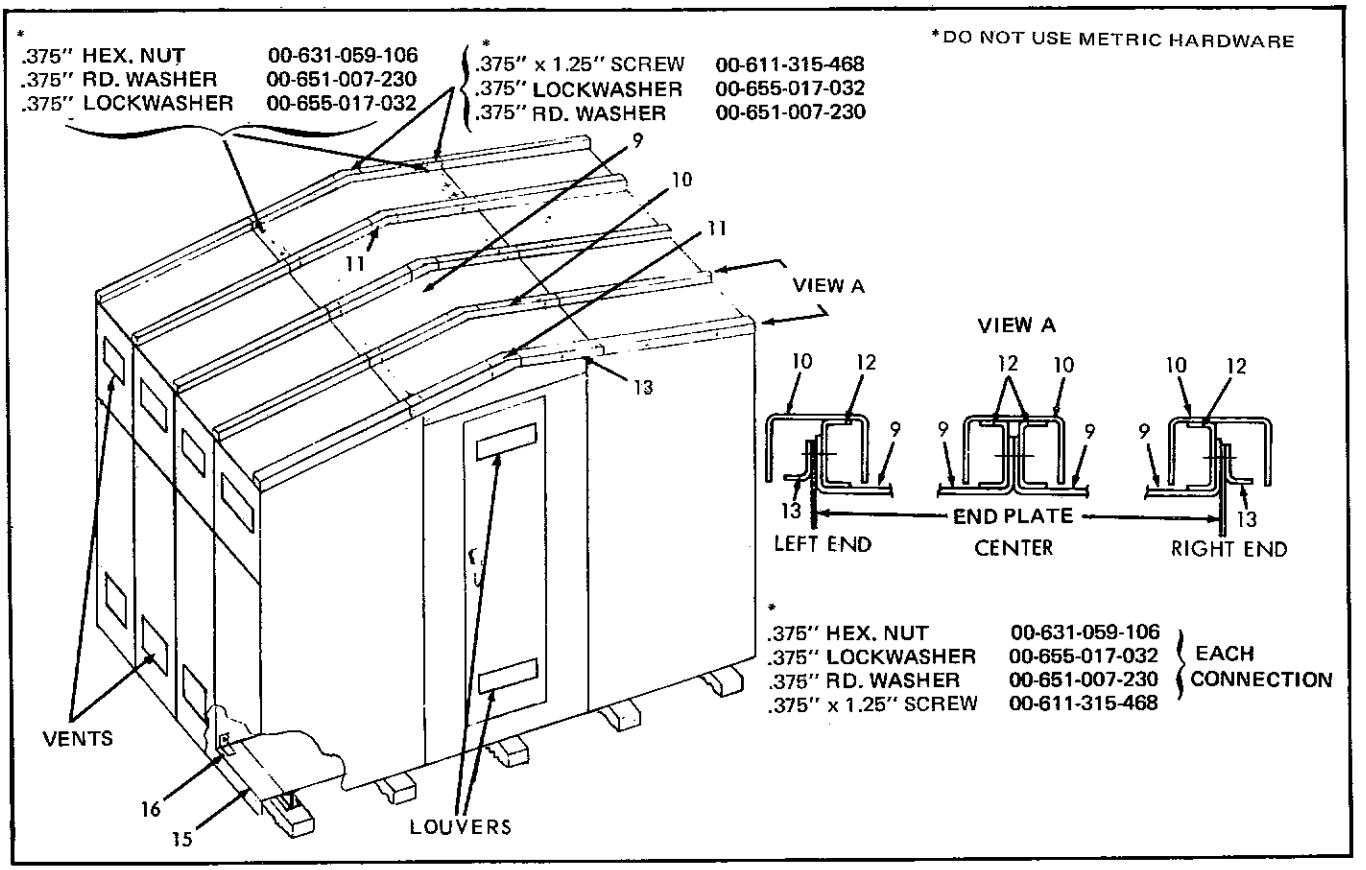



**Figure 35. Roof Deck Installation – Common Aisle Layout**

## Single Aisle with Work Space – 5 kV

Table 5 lists standard components supplied for single aisle with work space *Shelter-Clad* outdoor switchgear. The item numbers in the table are used in all instructions pertaining to this procedure. Assemble as follows:

1. Mount aisle end plate at the end opposite the work space. (See Figure 36).

2. Move aisle wall to its permanent location as indicated on the general arrangement drawing.

3. Remove aisle I-beam from the top of the aisle wall and mount in place on footing.

4. Remove the end plate from the switchgear unit and proceed as instructed in Step 11. to mount it at end of work space.

5. See Figure 37. Put the work aisle and work space beams (1, 7 and 11) in position as indicated on the general arrangement drawing.

6. Assemble aisle walls (3). See general arrangement drawing for location of special panels for fans, etc. Apply .50-inch (12.7 mm) sealant tape at the joints of the wall sections.

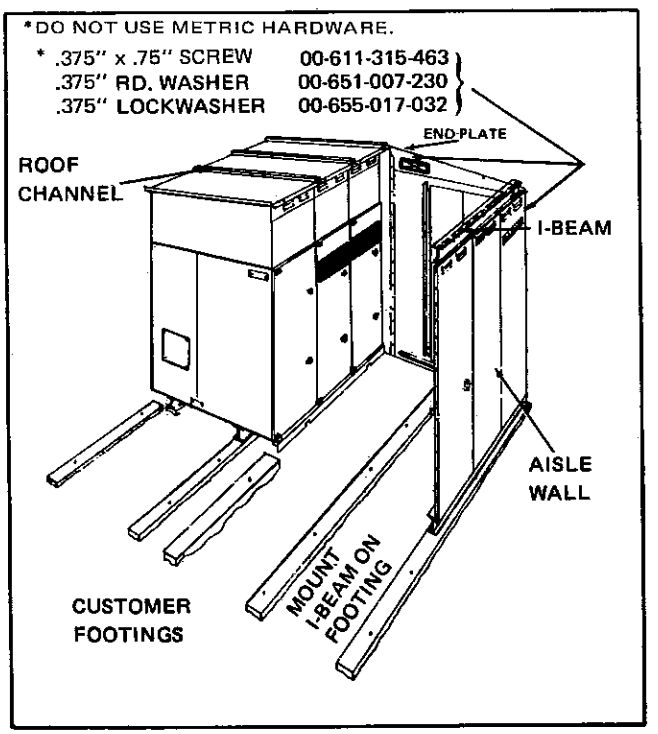



**Figure 36. Initial Positioning – Single Aisle with Work Space**

Table 5. Standard Components — Single Aisle, With Work Space

| ITEM | DESCRIPTION | 5 kV | | 15 kV | |
|---|---|---|---|---|---|
| | | PART NO. | MK | PART NO. | MK |
| 1 | BEAM | 18-195-382 | 003 | 18-193-157 | 001 |
| 2 | WEATHERSTRIP SEALANT TAPE | 00-333-450 | 005 | 00-333-450 | 005 |
| 3 | PLATE ASSY. | 18-657-280 | 584 | 18-657-276 | 547 |
| 4 | END PLATE L.H. | 18-657-281 | 582 | 18-657-278 | 575 |
| 5 | COVER | 18-650-504 | 001 | 18-650-504 | 001 |
| 6 | ANGLE MTD. ON IT. 3 | — | — | 18-657-410 | 288 |
| 6A | ANGLE MTD. ON IT. 3 | — | — | 18-657-353 | 160 |
| 7 | BEAM | 18-657-430 | 124 | 18-193-158 | 001 |
| 8 | ANGLE ASSY. | 18-657-385 | 581 | — | |
| 9 | ANGLE OR FRAME | 18-179-167 ANGLE | 501 | 18-364-274 FRAME | 501 |
| 10 | ANGLE | 18-184-139 | 001 | 18-191-509 | 001 |
| 11 | BEAM | 18-193-151 | 002 | 18-193-151 | 009 |
| 14 | BEAM ASSY. | — | — | 18-646-894 BEAM | 501 |
| 15 | ROOF SUPPORT | 18-657-422 | 501 | 18-646-895 | 001 |
| 17 | FLOOR PLATE ASSY. | 18-652-057 | 502 | 18-294-120 AISLE SIDE | 501 |
| 17A | FLOOR PLATE ASSY. | — | — | 18-657-246 UNIT SIDE | 554 |
| 18 | FLOOR PLATE ASSY. | 18-652-057 | 501 | 18-294-121 AISLE SIDE | 501 |
| 18A | FLOOR PLATE ASSY. | — | | 18-657-246 UNIT SIDE | 555 |
| 19 | ROOF CHANNEL | 18-176-983 | 501 | 18-294-115 UNIT SIDE | 503 |
| 19A | ROOF CHANNEL | — | — | 18-299-862 AISLE SIDE | 501 |
| 20 | BRACKET | 18-176-985 | 001 | 18-184-206 | 001 |
| 21 | CLAMP WASHER | 18-657-511 | 532 | 18-657-511 | 532 |
| 22 | DOOR MTG. L.H. | 18-657-280 | 587 | 18-657-276 | 577 |
| 23 | ROOF COVER (UNIT SIDE) | 18-177-195 | 501 | 18-294-114 UNIT SIDE | 503 |
| 23A | ROOF COVER (AISLE SIDE) | 18-177-195 | 501 | 18-299-861 AISLE SIDE | 501 |
| 24 | ROOF GABLE ASSY. | 18-177-200 | 502 | 18-184-208 | 502 |
| 25 | GABLE COVER INT. | 18-176-981 | 001 | 18-176-981 | 001 |
| 26 | FORMED COVER | 18-287-990 | 002 | 18-184-210 | 002 |
| 27 | FLOOR PLATE ASSY. | 18-656-890 | 520 | 18-700-518 | 502 |
| 27A | | — | — | 18-700-519 | 506 |
| 27B | | — | — | 18-700-519 | 507 |
| 28 | | 18-656-890 | 519 | 18-700-520 | 505 |
| 28A | | — | — | 18-700-520 | 506 |
| 28B | | — | — | 18-700-520 | 507 |
| 29 | ANGLE | 18-179-171 | 002 | 18-179-171 | 002 |
| 31 | ANGLE | 18-177-261 | 001 | 18-184-213 | 002 |

7. Bolt plates (3) together, to switchgear unit and to beam (1).

8. Attach .50-inch (12.7 mm) sealant tape at all joints.

9. Attach angles (10) to ends of beams.

10. See Figure 38. Install angles (8 and 9) at the end of the work space. Secure the angles together with 00-615-331-466 flat head screws.

11. Install end plate (4) and attach it to plate (3) and angles (8), (9), and (10).

12. Install floor plates (17 and 18) in the same arrangement as that for single aisle layouts (see Figure 26). Install floor plates (27 and 28) as shown in Figure 38. Install cover (5).

13. Apply .50-inch (12.7 mm) sealant tape to door frame assembly (22) and bolt it in place. Place tape so that one edge is on the vertical centerline of the mounting holes and the other edge is toward the point of weather exposure (Figure 39).

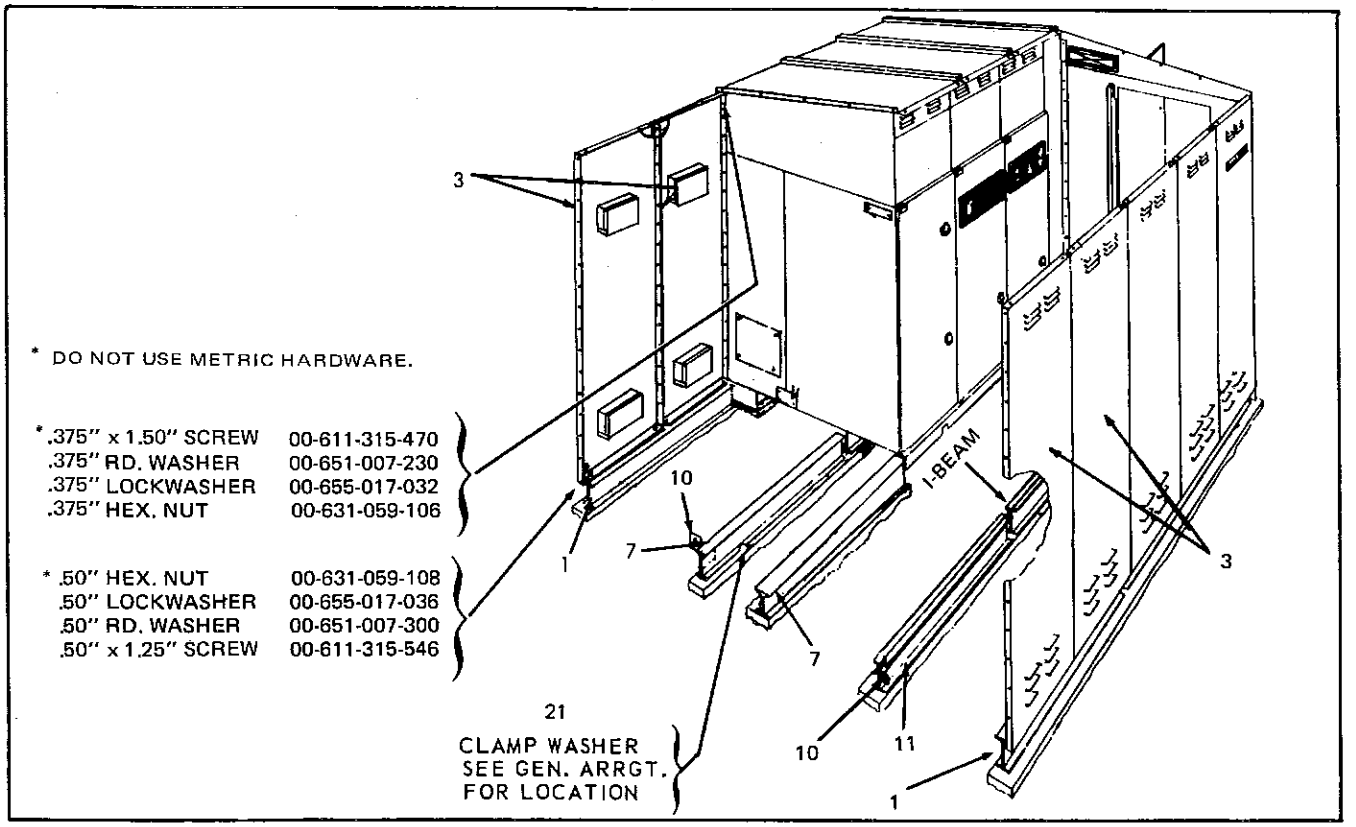



Figure 37. Beam Placement (5 kV) – Single Aisle with Work Space

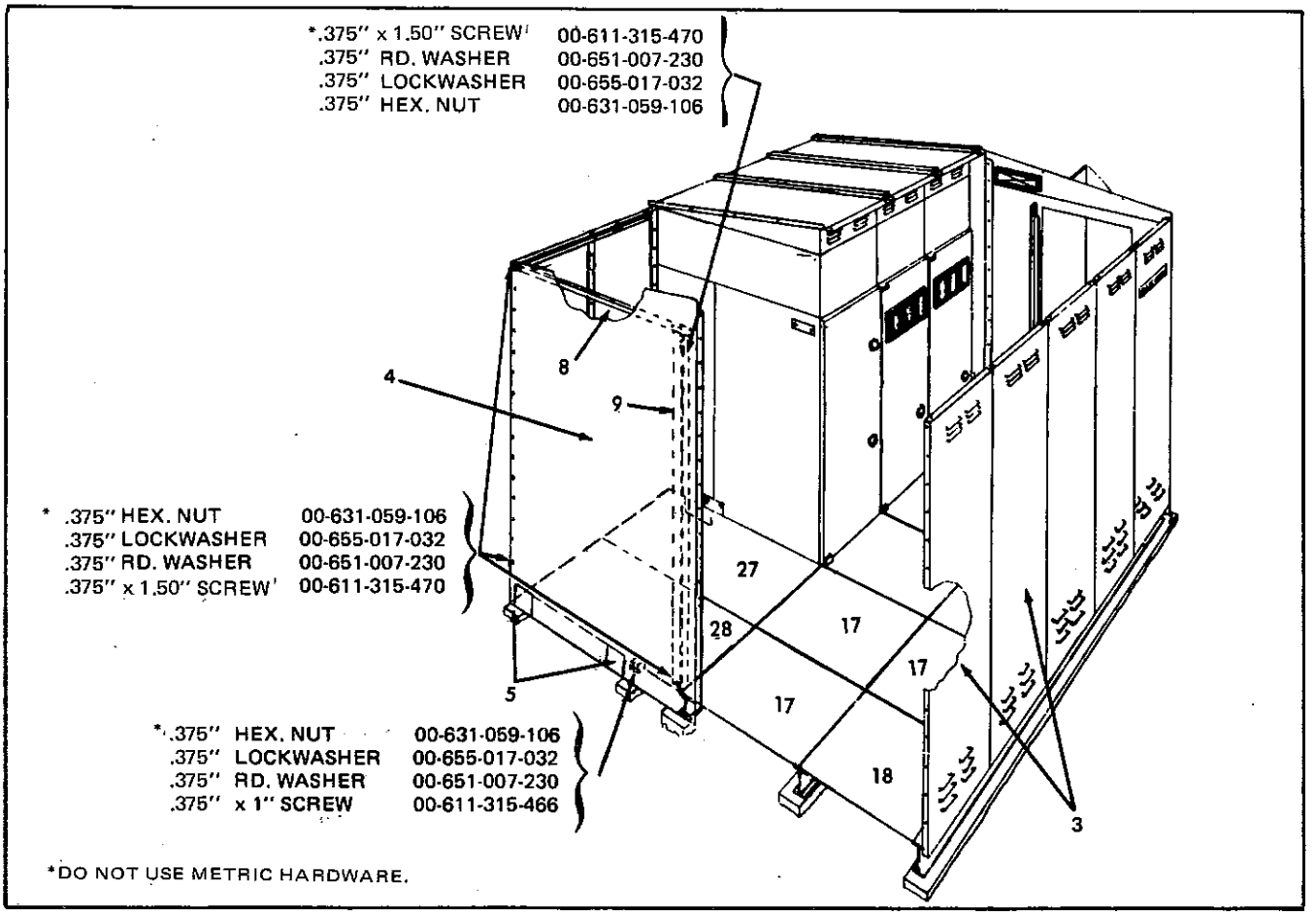



Figure 38. End Cover Installation (5 kV) – Single Aisle with Work Space

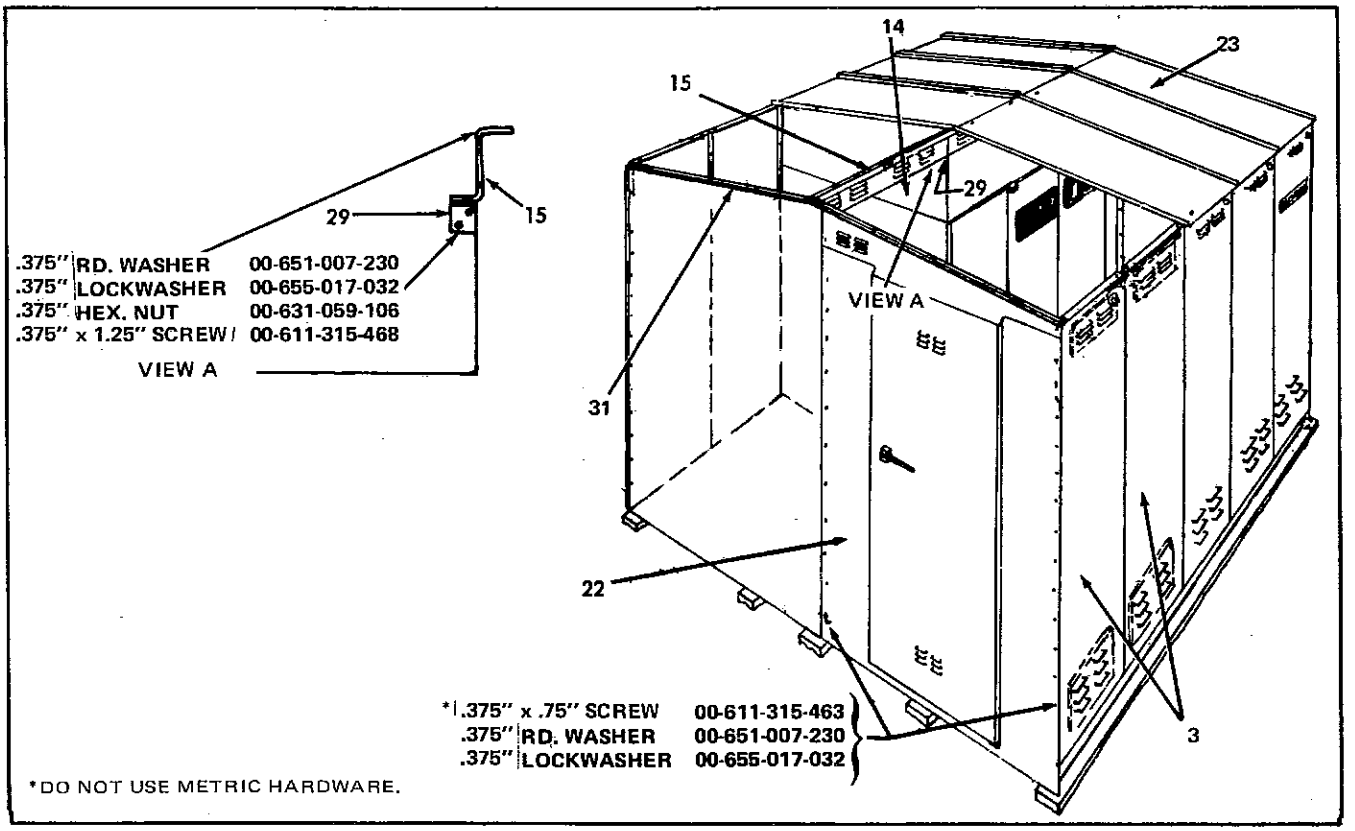



Figure 39. Door and Roof Support Installation (5 kV) — Single Aisle with Work Space

14. Remove trim angle (31) from end of cubicle and attach angle (29) to end of switchgear. Install roof support (15) from cubicle to end of work space. See view "A" for attaching support (15) to angle (29).

15. Put all roof decks (23) in place and bolt to the top of the end plate and to the roof support (15). Leave hardware finger tight until step 17 is complete.

16. Fasten roof decks (23) together using bracket (20). See view "A", Figure 40.

17. Mount trim angle (31). Tighten bolts.

18. Set roof channels (19) over roof deck joints. Slide the channels toward the roof peak until the clip inside the channel (see Figure 29) engages the bracket (20).

19. Install roof gable (24). Adjust position of gable and channels (19) so that channels fit into notches of gable.

20. Install gable covers (25) at gable joint.

21. Bolt gable into place using welded nuts in channels (19). Mount covers (26) to underside of roof covers (23).

22. Mount aisle conduit, switches, receptacle and wire junction boxes. Mount and connect lights per wiring diagram. See conduit arrangement.

23. If equipment consists of more than one shipping group, caulk vertical shipping split at back of switchgear with metal filler provided.

## Single Aisle with Work Space — 15 kV

Table 5 lists standard components supplied for single aisle with work space *Shelter-Clad* outdoor switchgear. The item numbers in the table are used in all instructions pertaining to this procedure. Assemble as follows:

1. Mount aisle end plate at the end opposite the work space. (See Figure 86).

2. Move aisle wall to its permanent location as indicated on general arrangement drawing.

3. Remove aisle I-beam from top of aisle wall and mount in place on footing.

4. Remove the end plate from the switchgear unit and mount at end of work space as instructed in Step 11.

5. See Figure 41. Put the work aisle and work

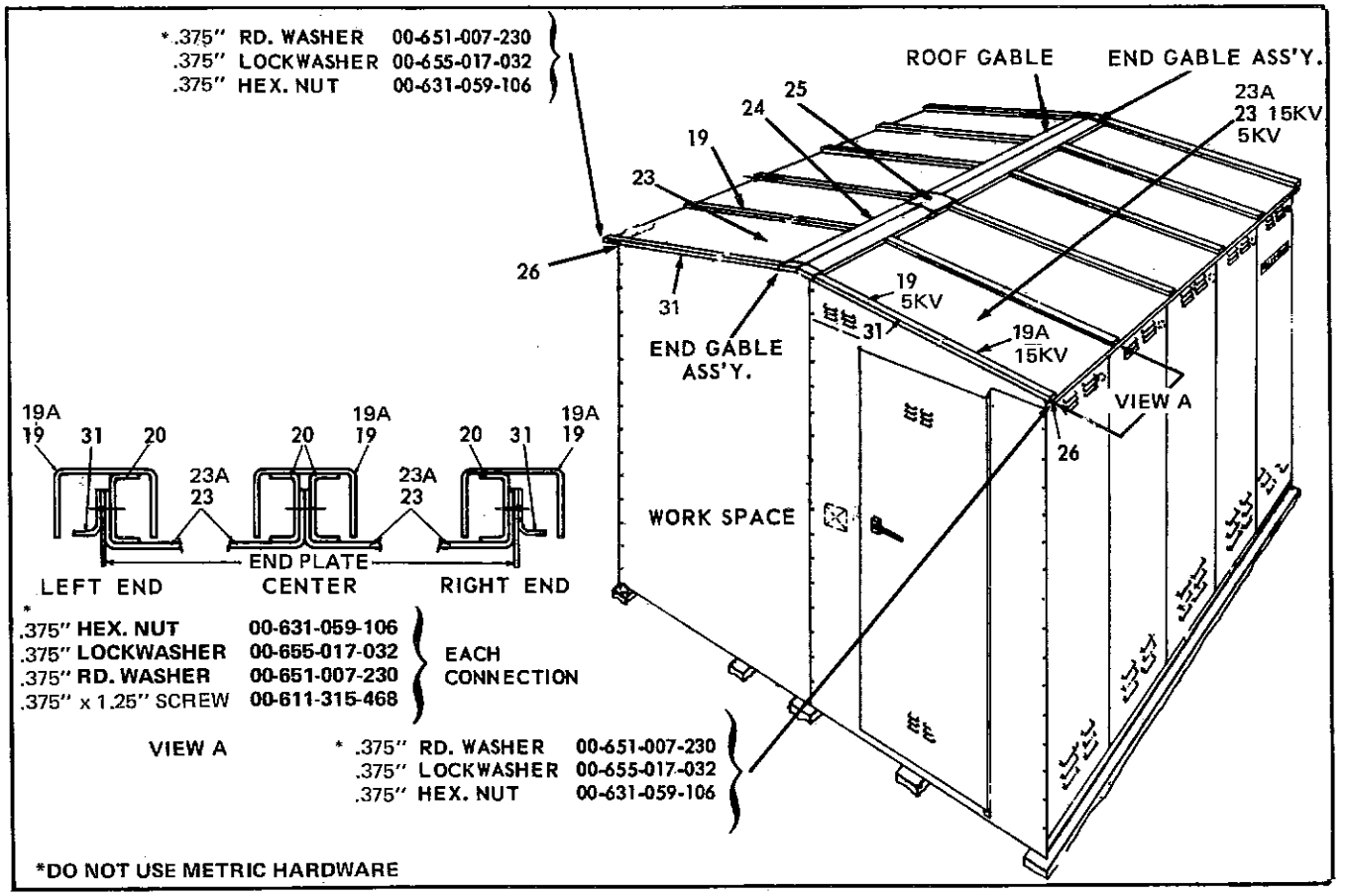



Figure 40. Roof Assembly (5 kV and 15 kV) — Single Aisle with Work Space

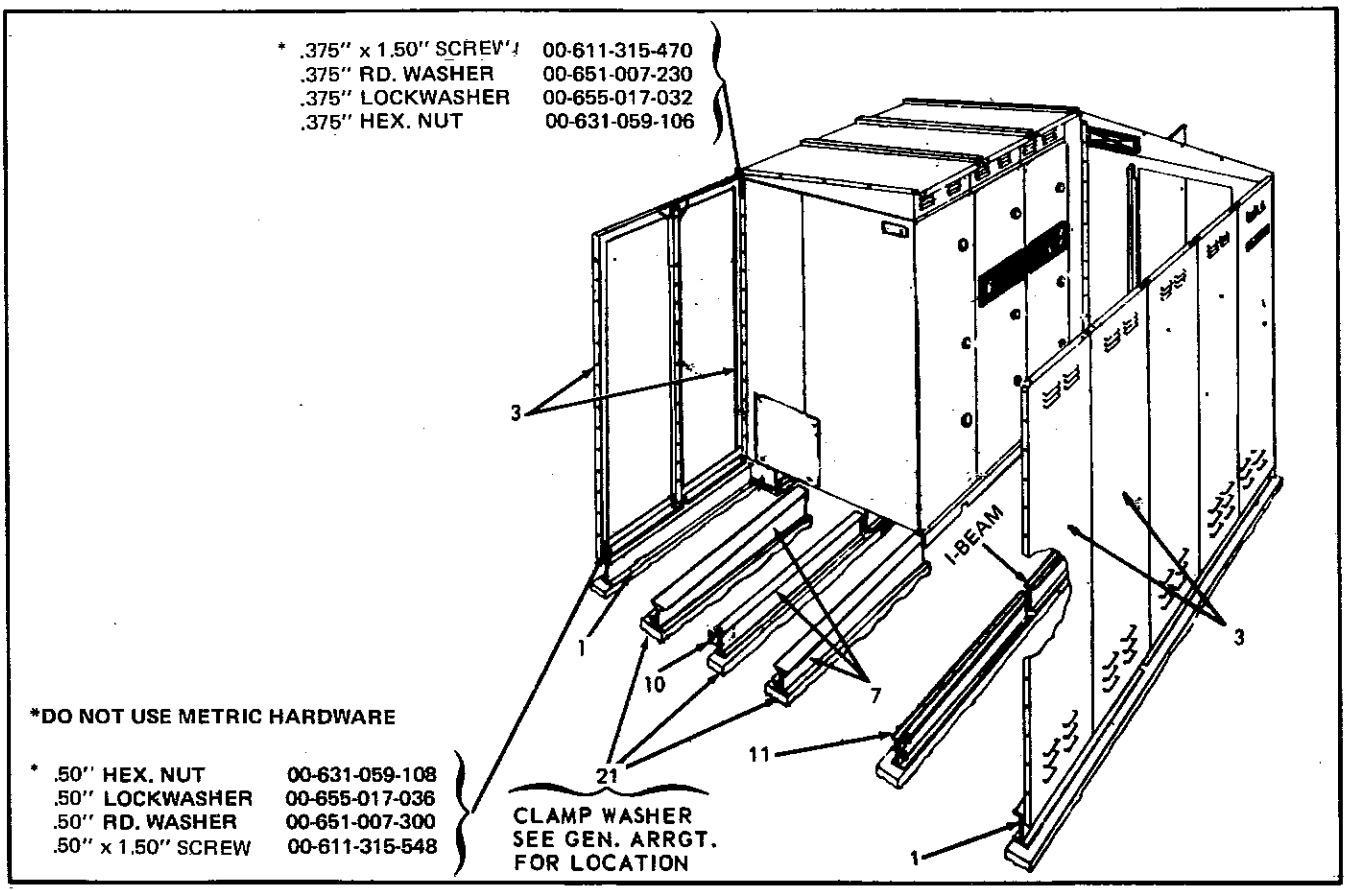



Figure 41. Beam Placement (15 kV) — Single Aisle with Work Space

space beams (1, 7 and 11) in position as indicated on the general arrangement drawing.

6. Assemble aisle walls (3). See general arrangement drawing for location of special panels for fans, etc. Apply .50-inch (12.7 mm) sealant tape to the joints. Place the tape so that one edge is on the vertical centerline of the holes and the other edge is toward the seam which will be exposed to the weather.

7. Bolt plates (3) together, to switchgear unit and to beam (1). Apply .50-inch (12.7 mm) sealant tape to the joints.

8. Attach angles (10) to ends of beams.

9. See Figure 42. Mount beams (14) between walls at each joint (view "F").

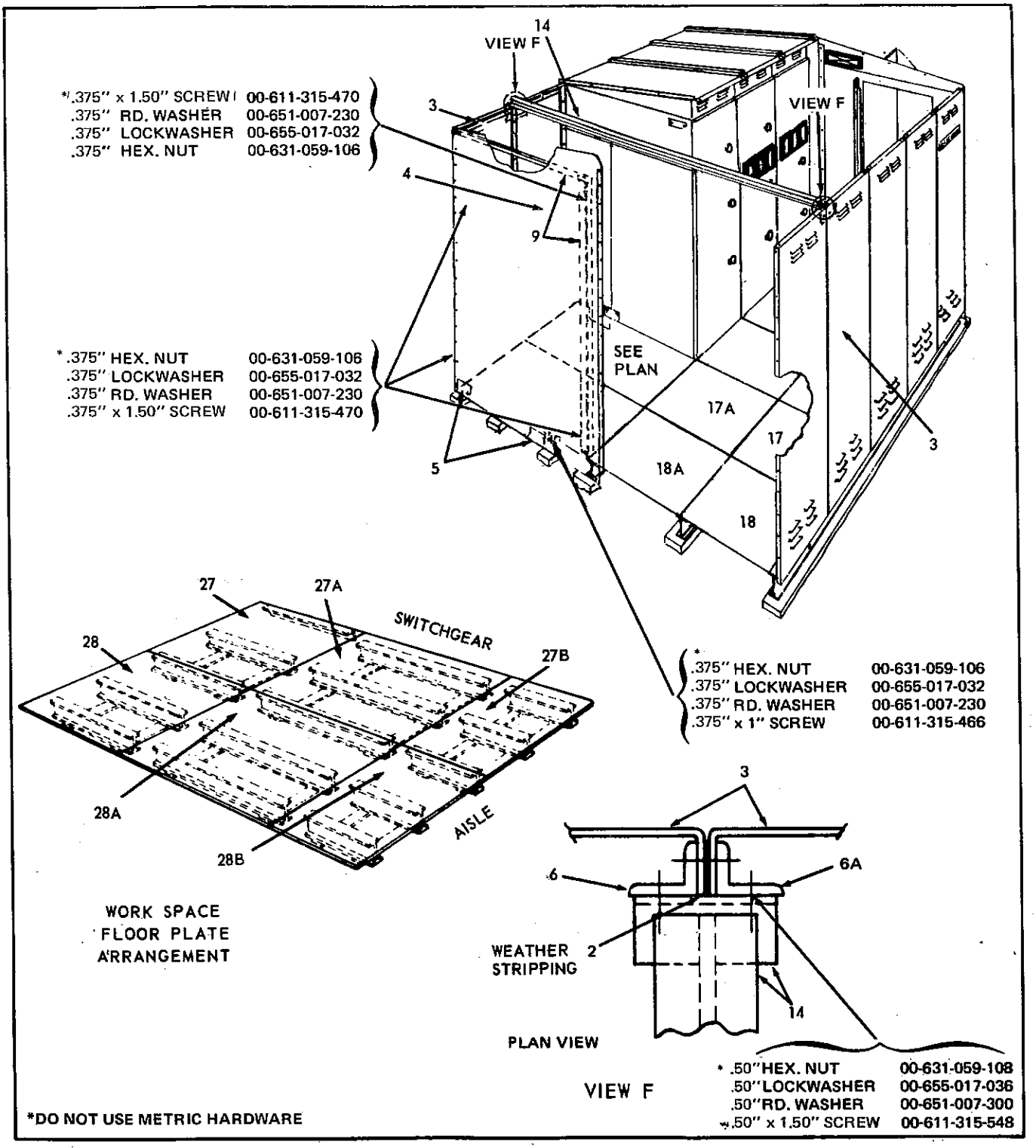



Figure 42. Floor Plate Installation (15 kV) — Single Aisle with Work Space

10. Mount frame (9) at end of work space.

11. Install end cover (4) and attach it to rear plate (3), frame (9) and to angles (10).

12. Install floor plates (17, 17A, 18 and 18A) in the same arrangement as that for single aisle layouts (see Figure 26). Install the floor plates in the work area as shown in Figure 42. Install covers (5).

13. See Figure 43. Position and bolt the door frame assembly (22) into place. Apply .50-inch (12.7 mm) sealant tape so that one edge is on vertical centerline of mounting holes and other edge is toward point of weather exposure.

14. Remove angle (31) from L.H. end of cubicle (see Figure 40). Attach angle (29) to end of switchgear, Figure 39. Install roof supports (15) from cubicle across beam (14) to end of work space. See view "A" for attaching support (15) to angle (29).

15. Put all roof decks (23A) in place and bolt to the top of the end plate and to the roof supports (15). Leave hardware finger tight until Step 17 is complete.

16. Mount trim angle (31).

17. Fasten roof decks (23) together using brackets (20). See view "A". Figure 40. Tighten bolts.

18. Set roof channels (19 or 19A) over roof deck joints. Slide the channels toward the roof peak until the clip inside the channel (see Figure 29) engages the bracket (20).

19. Install roof gable (24). Adjust position of gable and channels (19 or 19A) so that channels fit into notches of gable.

20. Install gable cover (25) at gable joint.

21. Bolt gable into place using welded nuts in channels (19 or 19A). Mount cover (26) to underside of roof cover (23).

22. Mount aisle conduit, switches, receptacle and wiring junction boxes. Mount and connect lights in accord with wiring diagrams. See conduit arrangement.

23. If equipment consists of more than one shipping group, caulk vertical shipping split at back of switchgear with metal filler provided.

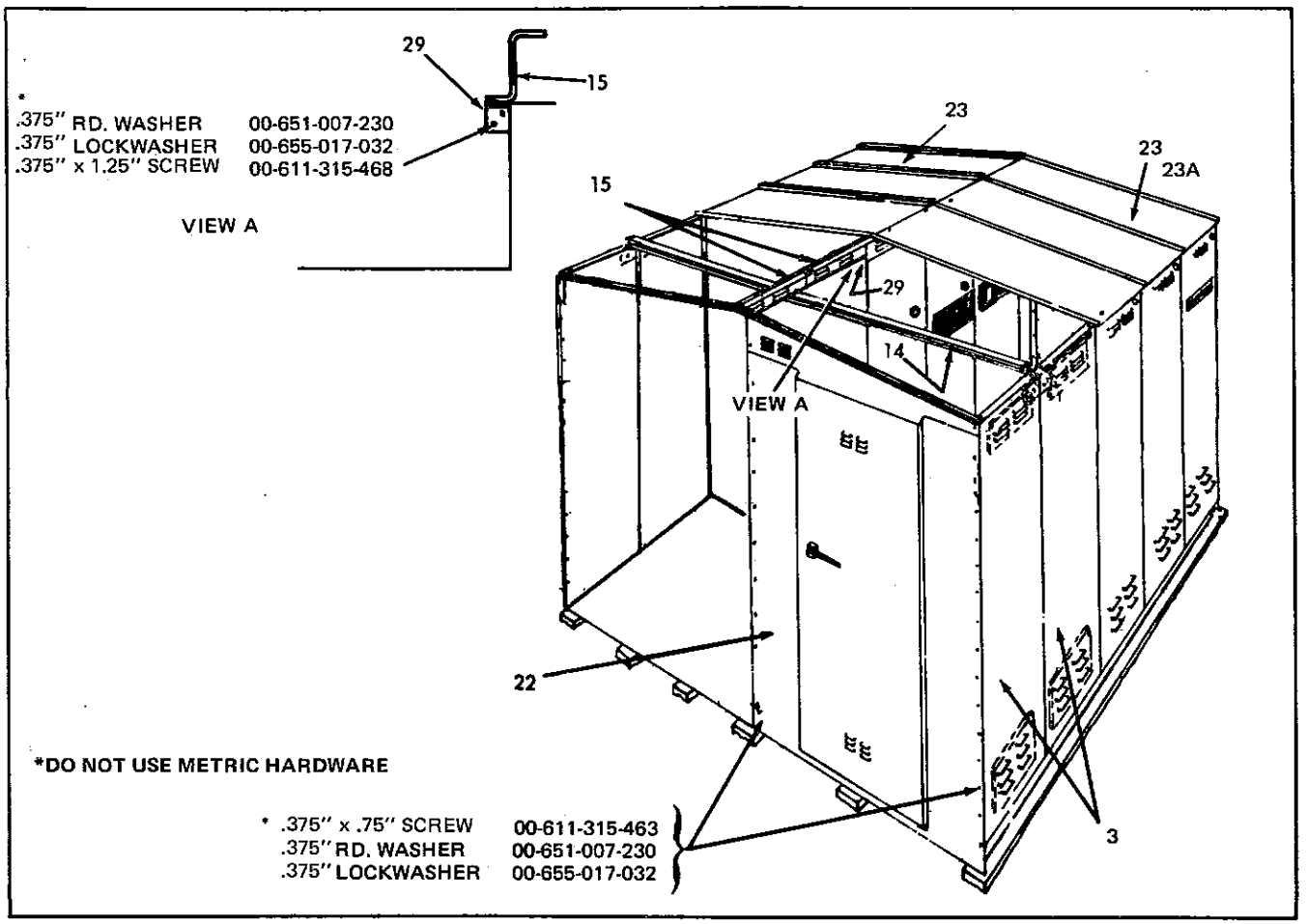



Figure 43. Door and Roof Support Installation (15 kV) – Single Aisle with Work Space

## Expanding Single Aisle to Common Aisle

Table 6 lists standard components supplied to expand an existing single aisle line-up to a common aisle line-up. The item numbers in the table are used in all instructions pertaining to this procedure. Assemble as follows:

1. See Figure 44. From the existing switchgear remove the gable ends (1), and roof gable (2). Discard these parts.

2. Remove the roof channels (3), roof covers over aisle (4), formed cover (5) and all associated hardware. On 5 KV switchgear save all these pieces. On 15 KV switchgear save only the cover (5) and associated hardware.

3. Remove and discard plates (6 and 6A) from above the door, each end.

4. Remove front plates (7) by unbolting from door frames (8 and 8A) and from I-Beam (9). Discard plates (7) but retain filter (11).

5. Move new switchgear into position as shown on the general arrangement floor plan. See Figure 45.

6. Bolt switchgear to door frames (8 and 8A) at both ends of the line-up. Apply .50-inch (12.7 mm) sealant to door frame with one edge on vertical center line of mounting holes and other edge toward point of weather exposure.

7. Install new plates (10). Mount filter (11) salvaged from front plate (7).

**Table 6. Standard Components—Expanding Single Aisle to Common Aisle**

| ITEM | DESCRIPTION | 5 KV | | 15 KV | |
|---|---|---|---|---|---|
| | | PART NO. | MK | PART NO. | MK |
| 1 | GABLE END ASSY. | 18-177-259 | 501 | 18-184-218 | 501 |
| 2 | ROOF GABLE ASSY. | 18-177-200 | | 18-184-208 | |
| 3 | ROOF CHANNEL ASSY. | 18-176-983 | 501 | 18-299-862 | 501 |
| 4 | ROOF COVER ASSY. | 18-177-195 | 501 | 18-299-861 | 501 |
| 5 | FORMED COVER | 18-287-990 | | 18-184-210 | |
| 6 | PLATE – L.H. | 18-297-103 | 501 | 18-657-279 | 558 |
| 6A | PLATE – R.H. | 18-297-103 | 502 | 18-657-279 | 559 |
| 7 | FRONT PLATE | 18-657-280 | 584 | 18-657-276 | 547 |
| 8 | DOOR MTG. – L.H. | 18-657-280 | 587 | 18-657-276 | 577 |
| 8A | DOOR MTG. – R.H. | 18-657-280 | 588 | 18-657-276 | 578 |
| 9 | I-BEAM | 18-712-418 | | 18-702-162 | |
| 10 | PLATE | 18-288-740 | 502 | 18-657-279 | 557 |
| 11 | AIR FILTER MTG. | 18-652-217 | 801 | 18-652-217 | 801 |
| 12 | FLOOR PLATE (INTERMED) | 18-179-742 | 001 | 18-657-465 | 192 |
| 13 | BRACKET | 18-176-985 | 001 | 18-184-206 | 001 |
| 14 | ANGLE | 18-177-261 | 001 | 18-184-213 | 002 |
| 15 | PLATE | 18-177-174 | 001 | 18-184-217 | 001 |
| 16 | ANGLE | 18-178-032 | 001 | 18-178-032 | 001 |
| 17 | DECK | 18-288-735 | 501 | 18-299-878 | 501 |
| 18 | ROOF SUPPORT | 18-287-025 | 001 | 18-294-113 | 501 |
| 19 | SQ. BEVEL WASHER | 00-659-035 | 414 | 00-659-035 | 414 |
| 20 | COVER | 18-179-730 | 501 | 18-190-430 | 501 |
| 21 | ANGLE | 18-179-733 | 001 | 18-190-438 | 001 |
| 22 | HOOD | 18-288-739 | 001 | 18-701-569 | 001 |
| 23 | COVER | 18-179-735 | 001 | 18-190-433 | 001 |
| 24 | END PLATE ASSY.L.H. | 18-657-281 | 582 | 18-657-278 | 575 |
| 24A | END PLATE ASSY.R.H. | 18-657-281 | 583 | 18-657-278 | 576 |

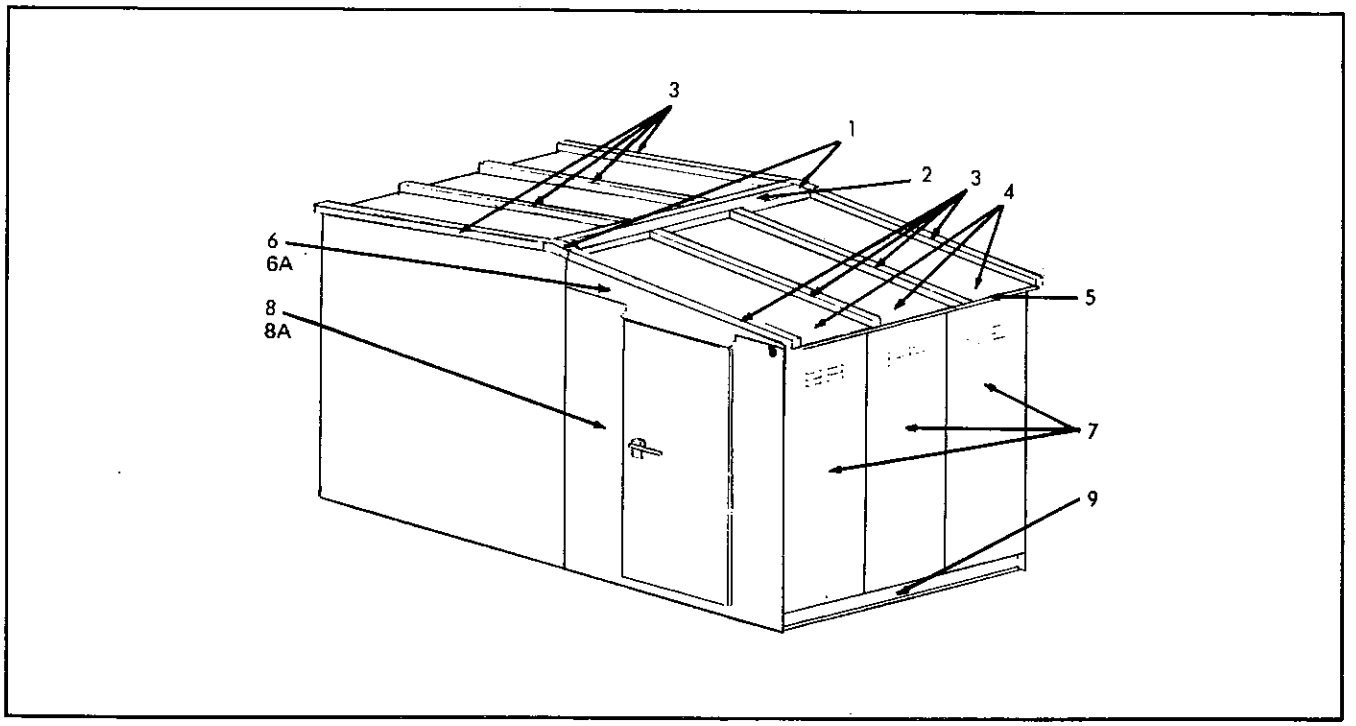



**Figure 44. Removing Components from Existing Switchgear**

8. Install adaptor floor plates (12) between the new units and the I-beam (9).

9. Mount roof covers (4) on the new units, bolting together using special channel brackets (13) similar to the aisle construction just disassembled.

10. Add trim angle (14) at each end of the group. (On 15 KV equipment items 4, 13 and 14 are shipped assembled).

11. When installing conduit, drill plate (15) to suit. Clamp plate with angle (16).

12. See Figure 46. Place aisle roof decks (17) in position. Bolt them to the roof support (18) using bevel washers (19). See inset.

13. Bolt roof decks (17) together with brackets (13). See view "A". Leave hardware finger tight until Step 15 is complete.

14. Set channel-shaped covers (20) over the joints of roof decks and slide up the covers so the clips on the inner surface (See Figure 46) engage the brackets (13).

15. Add trim angle (21) to each end of the aisle. Tighten bolts.

16. Bolt hoods (22) over the roof channels.

17. Add four covers (23) to seal crack between top of door frame (8) and end plate (24 and 24A) joint. Mount light as shown.

18. Mount aisle conduit switches, receptable and wire to junction boxes. See conduit arrangement.

19. Revise conduit arrangement in accord with drawing.

20. If new equipment consists of more than one shipping group, caulk vertical shipping split at back of switchgear with metal filler provided.

## Expanding Length of Existing Shelter-Clad Switchgear by Addition of Units

The new extended foundation — be it slab, pier or pilings — must be constructed in the same careful manner as described under "Installation".

The new foundation must be level and in the same plane as the existing foundation.

Certain items will be removed from the existing installation as described in the following instructions. Remove these items carefully and store them for re-mounting in the expanded set up.

**CAUTION**

Be certain switchgear is de-energized before removing covers to high voltage compartments.

1. Remove end gable assembly (1, Figure 44) from single aisle equipment. Remove the end hood (22, Figure 46) if switchgear has a common aisle.

2. Remove the channel-shaped covers (20) over roof joints from both aisle and switchgear unit. Do this by removing hardware from peak end of the

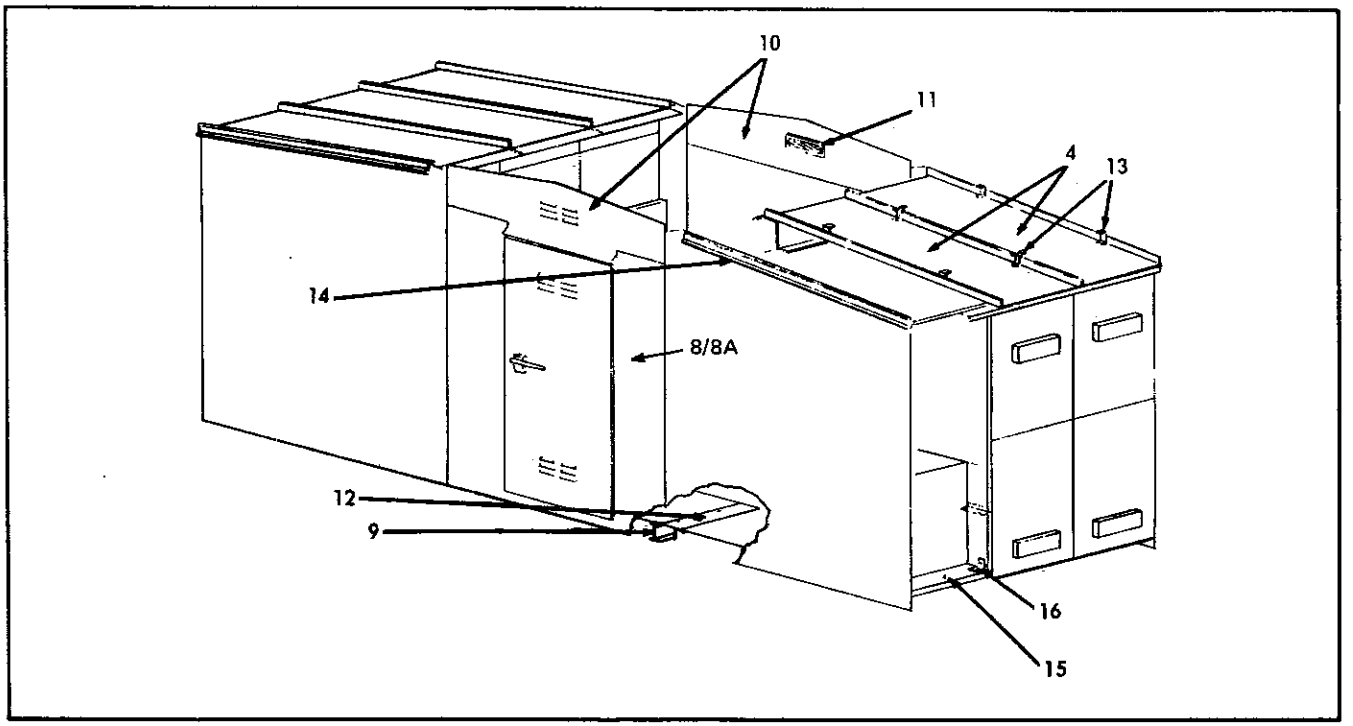



**Figure 45. Installing New Equipment**

cover and sliding the cover towards the eave to disconnect the holding clips on the underside of the cover.

3. Remove the trim angle (21) from the outer edge of the roof deck and remove the channel support brackets (13).

4. Remove the back plates to provide access to the hardware securing the end cover. Remove the end cover with associated parts and save for later installation.

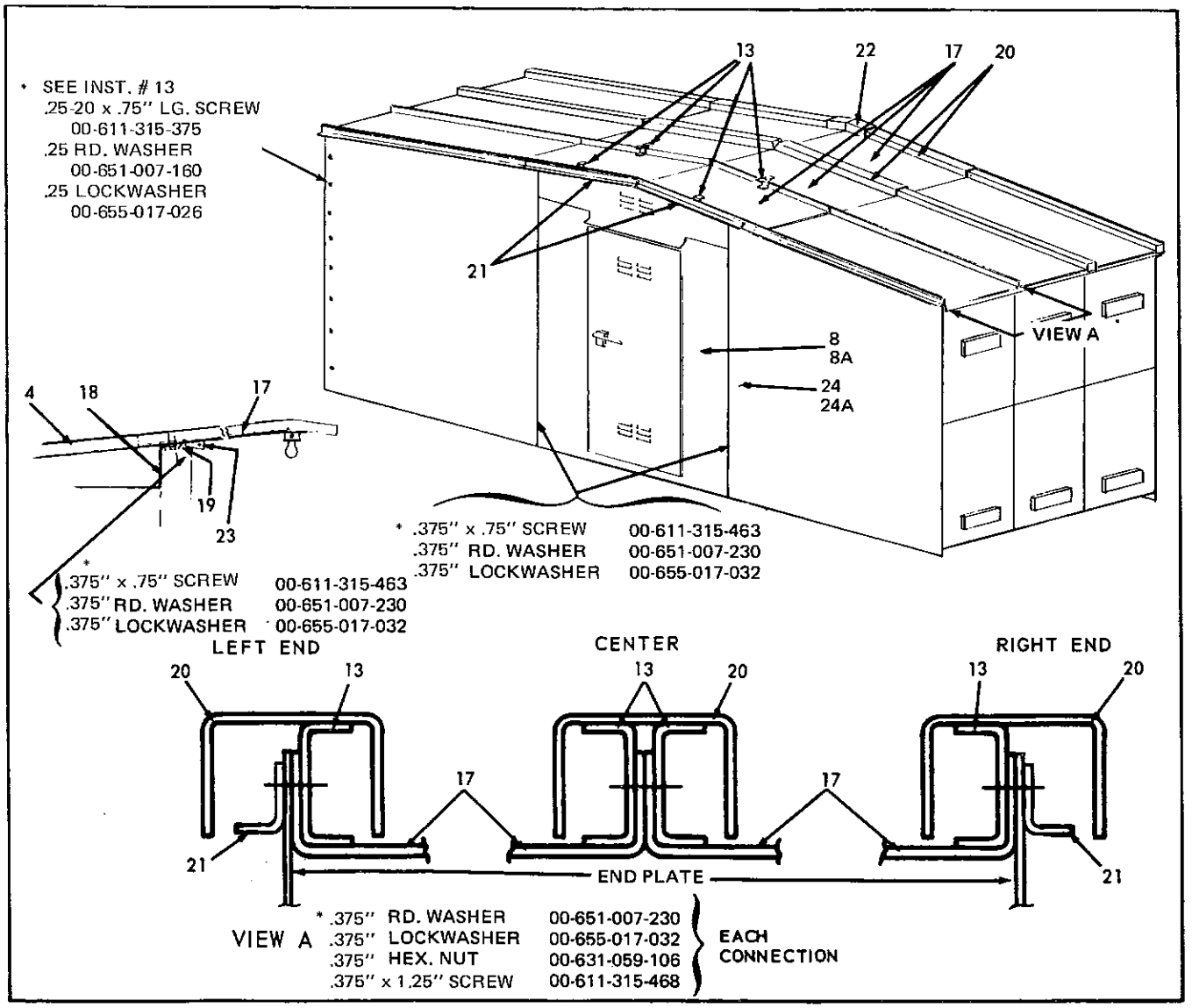
5. Disconnect aisle conduit.

6. Remove bolt located under aisle door. This bolt secures end plate to aisle center beam.

7. Remove all hardware securing side plate to switchgear frame and hardware securing aisle end plate to aisle wall. It may be necessary to tap knife blade down vertical seam between aisle wall and end plate to cut sealant tape. Sealant tape is soluble in kerosene which may be used to clean surfaces after parting. Remove entire sections from both switchgear and aisle.

8. Remove aisle floor plates from in front of this end unit. These plates must be re-installed in front of the new end unit. (If new end unit is of a different width and existing floor plates are not suitable for intermediate units, these floor plates must be replaced or modified. This will vary, depending on which end is extended.)

9. Before moving new equipment into place, drill a .81" (20.6 mm) dia. hole through drawout compartment top plate into interunit wiring trough area. Install grommet in hole and mount four-pole terminal block on the underside of the barrier. Connect aisle wiring leads to terminal block for future connection to new end unit. Plug old hole in header with knockout seal.




*DO NOT USE METRIC HARDWARE

**Figure 46. Roof Installation**

10. The lineup is now ready for installation of the new unit or units. Follow the instructions outlined under "INSTALLATION," page 7. If the foundation was carefully constructed, there should be no problems with lineup of beams or matching the level of existing equipment.

11. With new units in true alignment with existing units and properly leveled, bolt units together with .50-inch (12.7 mm) hardware provided.

12. Run aisle wiring from terminal block in existing end unit, through barrier and header to junction box area.

13. Mount unit side plate and using side plate as template drill #7 (.201") (5.1 mm) dia. holes in back frame angle of new cubicle. Using .25-20 (do not use metric tap) tap cut threads in these holes. Add and secure hardware (see Figure 46). The addition of these holes may be omitted if existing cubicle had vertical corner trim angle in which case side plate would not have these extra holes.

Mount other parts removed from existing equipment and caulk all external seams with metal filler.

14. Make all electrical connections as instructed on pages 35 through 50.

15. Caulk vertical split at back of switchgear between existing equipment and new addition with metal filler. Replace bus compartment barriers and install back plates.

### Expanding the Length of Existing Conventional Outdoor Switchgear

Expanding the length of existing conventional outdoor switchgear by field addition of units should be handled in the same manner as *Shelter-Clad* switchgear with the exception that there is not a shelter aisle with which to be concerned. Refer to page 30. Follow instructions given under EXPANDING LENGTH OF EXISTING SHELTER-CLAD SWITCHGEAR BY ADDITION OF UNITS. However, note that only roof channels, bus compartment barriers and end plates need be removed on conventional switchgear.

# ELECTRICAL CONNECTIONS

## BUS BARS

When making bus bar connections between groups of switchgear, observe the relationship of the bus bar to the breaker taps (i.e. whether bus bar is above or below tap; towards draw-out or towards rear). Maintain this relationship when connecting bus bars. Porcelain insulators may be used to support bus bars between units of 15 kv switchgear. An off-set insulator may be used for a 1200-ampere bus in this equipment. Observe factory positioning of these insulators when connecting at shipping splits to insure that bus bars will line up properly. Install all hardware the same way that factory bus connections were installed (i.e., head of cap screws either toward drawout or rear). Hardware must be aligned properly or molded plastic insulation boots will not fit over the joints.

Bolt all bus bar joints as follows:

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

2. Assemble all joints as shown in Figure 47.

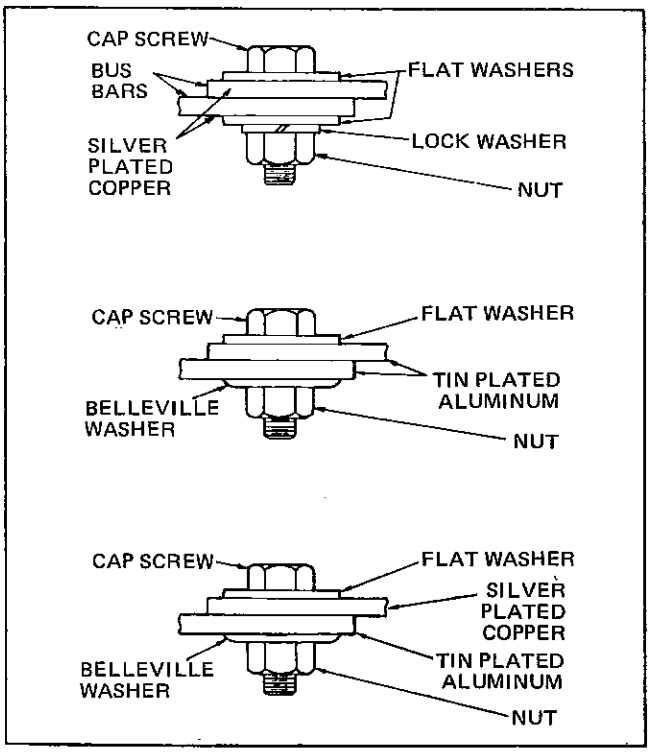



**Figure 47. Bus Bar Joint Assembly**

**NOTE**

All hardware furnished is plated high-strength, steel. Cap screws are .50 (12.7 mm) -13SAE Grade 5. Hexagon nuts are SAE Grade 2. Do not substitute with smaller or lower grade hardware than supplied.

3. Torque .50 (12.7 mm) -13 steel hardware to 50 to 75-lb. ft. (67.8 to 101.7 N·m).

Notice in Figure 47 heavy 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. The torque value of approximately 50-lb-ft produces a joint of adequate pressure without cold flow.

## 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 connections are relatively simple to make. However, refer to Figure 48 for instructions and pay attention to the following:

1. 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.

2. 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.

3. Before assembling any bus bar joint, check that the bar is threaded through bus supports (where required) and that insulation sleeving is on bus bars, and in the case of 15 kV, that procelain window type insulators are on bus bars.

4. The cap screws used in making up bus joints are heat treated, SAE Grade No. 5. Tighten these .50" screws to within a torque range of 50-75 ft-lbs. (If special hardware is required by an order, other torque values will be supplied with the field assembly drawings). In most cases, the direction in which the bolt is inserted through the bus joint is important. In the case of 5 kv switchgear, where connector caps are used for insulation, the hardware should be arranged to provide the best clearance to the connector cap. This normally would be with the nuts on the bottom of phase 3 and on the top of phases 2 and 1. On 15 kv switchgear, where insulation boots are used, put the nuts on the side with the deepest boot cavity. This normally would have the screw heads toward the back of the cubicle. Arrange the hardware as shown in Figure 47 with a round washer on each side of the joint and a lockwasher between the round washer and the nut. The only exception to this arrangement occurs when aluminum bus is used. In this case one "Belleville" spring washer replaces the round washer and the lockwasher under the nut with the concave side against the bus joint. When using 2000A and 3000A bus work certain spacers or links are required at bus joints to insure the current density of the bus. The conditions where these spacers are required vary with the type of bus joint. See Figure 48.

5. Connect the ground bus connection in 5 kv and 15 kv cubicles in the same manner as the other cubicles in the line up; that is, overlap the link in the adjacent cubicle and install .50" capscrew, lockwasher and round washer with screw threading into weld nut on cubicle frame. In the case of an aluminum ground bus, a .50" (12.7 mm) "Belleville" spring washer (concave side against the bus) replaces the round washer and lockwasher used above.

Torque the .50 " (12.7 mm) SAE Grade No. 5 cap screws as used in the ground bus to within a range of 50 to 75 ft.-lbs. (67.8 to 101.7 N·m).

6. Install connector caps or insulation boot as required. On 15 kv switchgear caulk all bus supports as shown in Figure 54.

### INSULATION CAPS – 5 kV CLASS

After bus bar connections are complete install a molded insulation cap over the joint as shown in Fgure 49. A reusable nylon rivet is used to fasten the insulation cap to the primary disconnect bushing. See Figure 50 and insert nylon rivet as follows:

1. Align hole in insulation cap with hole in primary disconnect bushing.

2. Insert rivet, consisting of a pin (A) and a prong (B), into aligned holes.

3. Drive pin into prong with a small hammer. The fingers of the prong are spread by pin, firmly fastening insulation cap to primary disconnect bushing.

### INSULATION BOOTS – 15 kV CLASS

After bus bar connections are completed, install molded plastic insulation boots as shown in Figure 51. Molded plastic boots are secured with vinyl tape after being placed over bus bar joints. Figure 52 gives positioning and taping instructions for molded plastic boots.

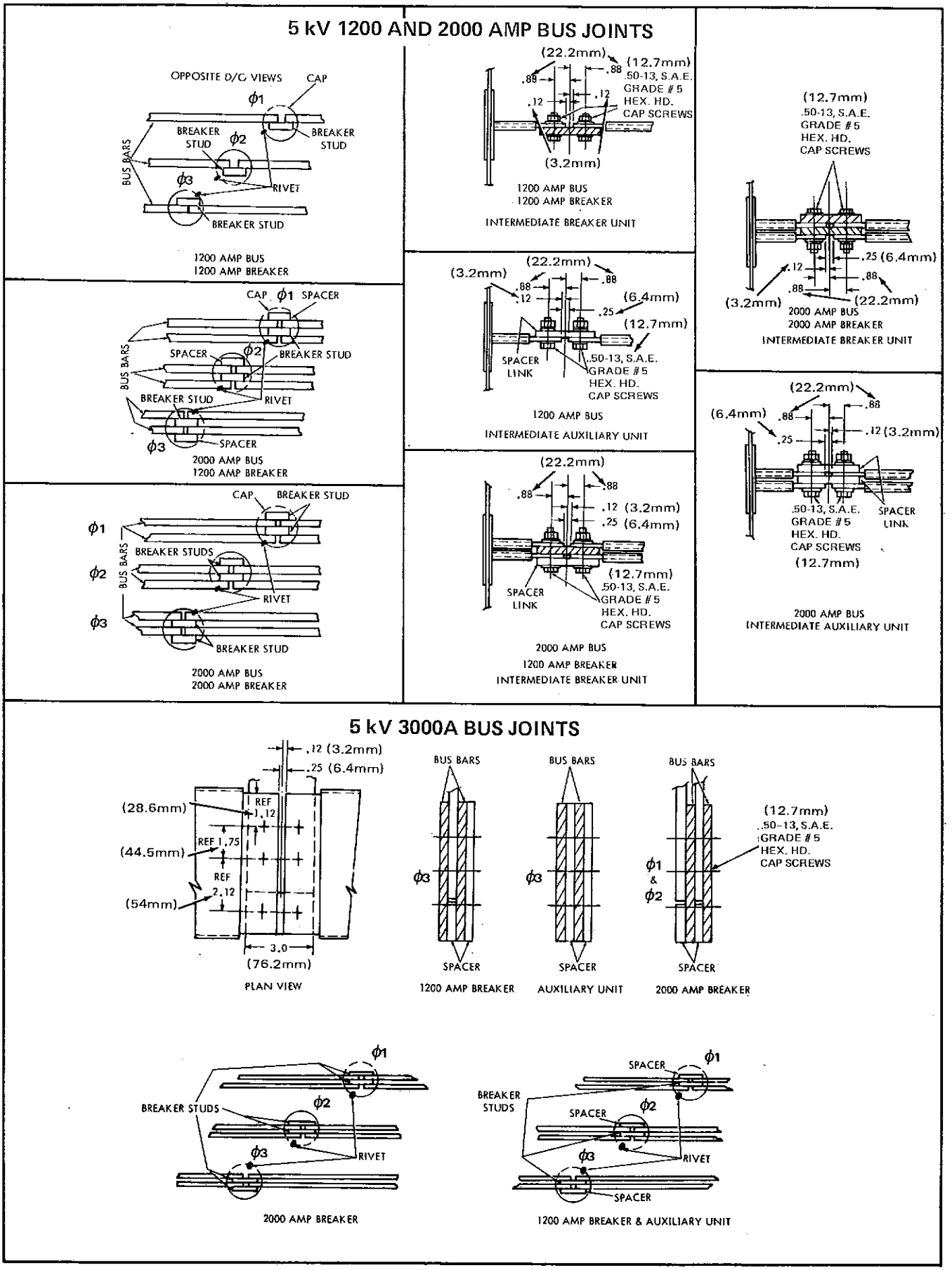



**Figure 48. (Sheet 1) Connecting 5 kV Bus Joints**

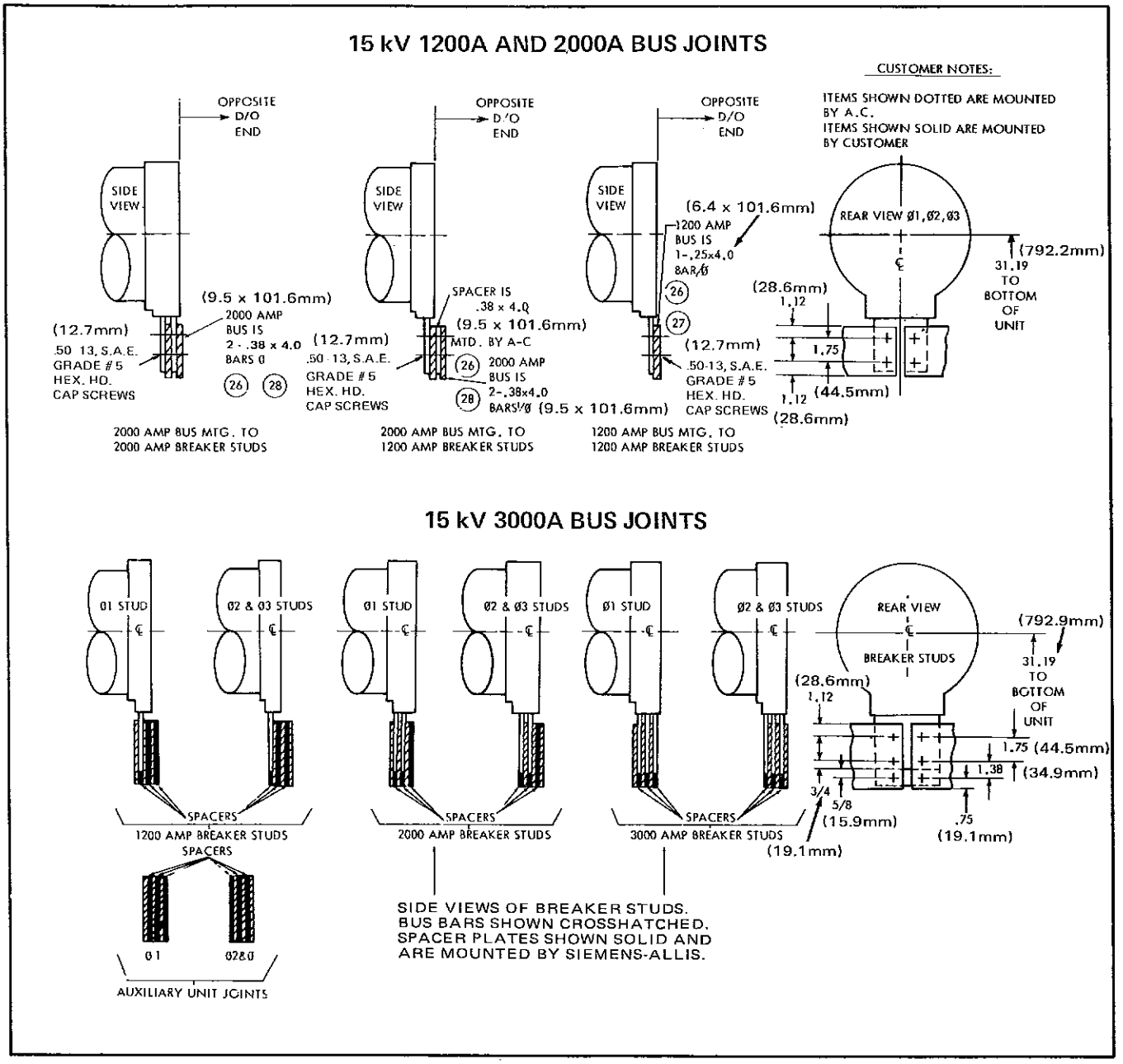



Figure 48. (Sheet 2) Connecting 15 kV Bus Joints

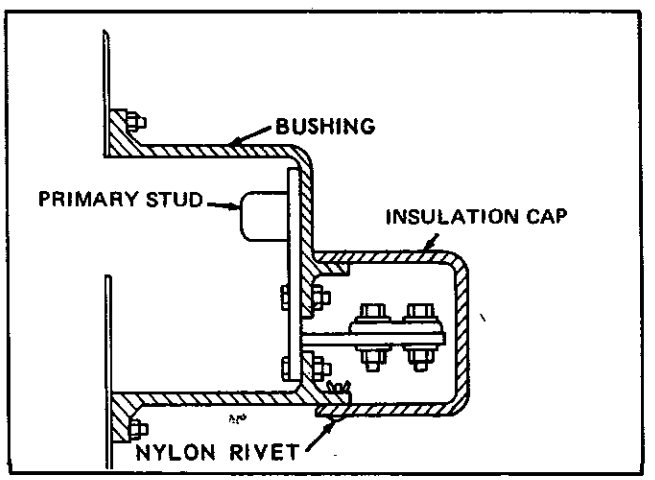



Figure 49. Insulation Cap Installation – 5 kV Bus Joints

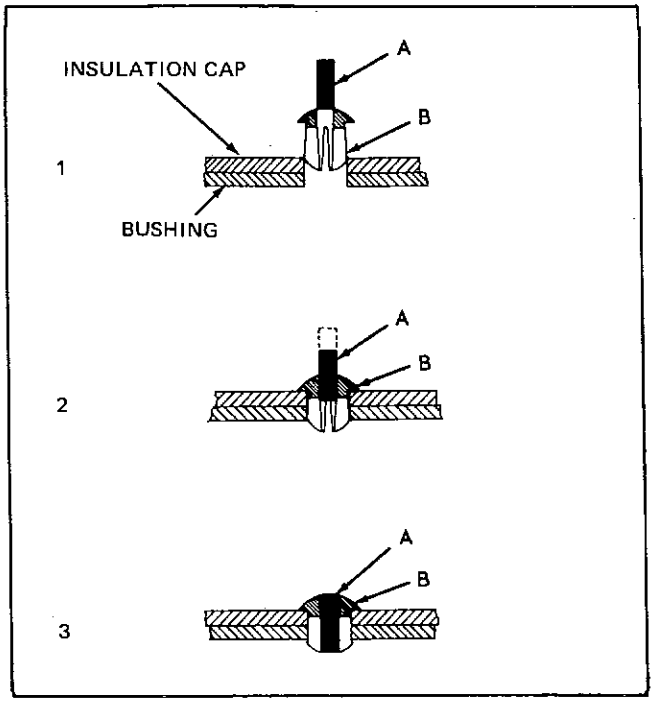



Figure 50. Inserting Nylon Rivel – 5 kV

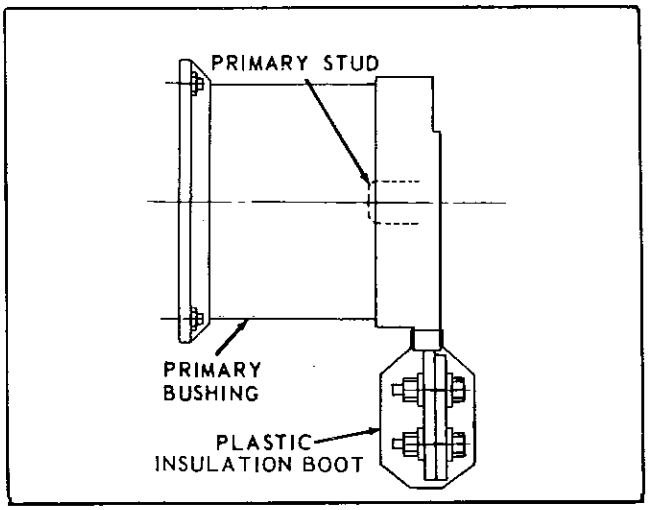



Figure 51. Installing Molded Plastic Boot - 15 kV

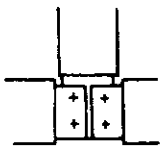
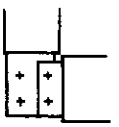
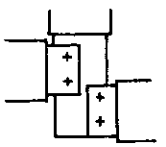
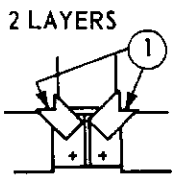
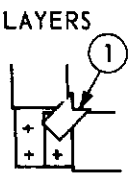
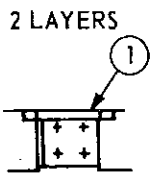
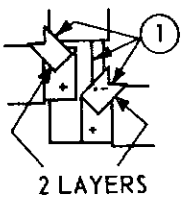
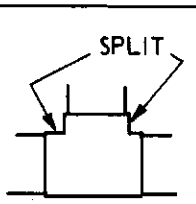
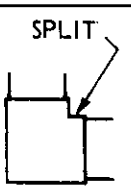
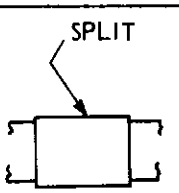
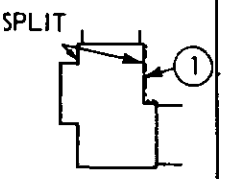
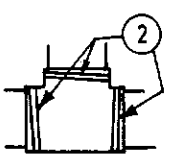
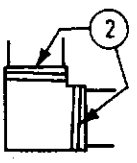
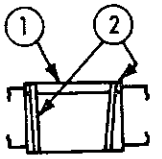
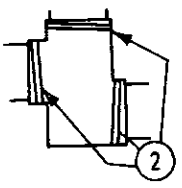
| | T CONNECTION | L CONNECTION | THRU CONNECTION | OFFSET CONNECTION |
|---|---|---|---|---|
| **STEP 1**<br>Make bus bar joints as instructed. Observe carefully the required placement of bolts through the joint. |  |  |  |  |
| **STEP 2**<br>Place two layers of 2-inch (50.8mm) wide black vinyl tape ① in corners or over edge as shown, one on top of the other. Form a sharp corner over the bus bar tape or tubing. The ends of the tape should extend equally over the front and back of the joint. |  |  |  |  |
| **STEP 3**<br>Place the plastic boot on the joint and align to produce the minimum gap at the split. Locate the split over the 2-inch (50.8mm) wide black vinyl tape. |  |  |  |  |
| **STEP 4**<br>Apply single layer 1/2 lap .75-inch (19mm) wide maroon vinyl tape ② as shown to hold the boot in place. On the thru-connection, place a third layer of the 2-inch (50.8mm) black vinyl tape over the split before securing the boot with the .75-inch (19mm) tape. |  |  |  |  |

**Figure 52. Instructions for Positioning and Taping Molded Plastic Boots**

## BUS JOINT INSULATION-TAPING

Insulation boots are provided for repetitive or standard bus joint conditions, however, where boots are not provided, the bus joints must be carefully taped to the required insulation level as described below.

1. Wrap approximately two feet (610 mm) of no-corona tape over screw heads and nuts to form a smooth surface.

2. Wrap three layers of insulating cloth around the connection. Overlap the adjoining insulation by three inches. Let the end of the cloth on the third layer overlap the starting end by three inches. Stagger the overlapping of the ends along the joint. Secure the layers firmly with bias-cut, yellow cloth tape (.010 inches thick by .75" (.25 x 19 mm) wide.)

3. Perform this insulating operation with the insulating cloth twice for 5 KV class equipment and three times for 15 KV class.

4. Tape joints with one layer, half lapped, of flame retardant, vinyl, electrical tape.

## TRANSFORMER BUS JOINTS—INSULATION

The typical transformer to switchgear bus joint shown in Figure 53 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.

See Figure 53, make bus joint connections and tape as outlined previously.

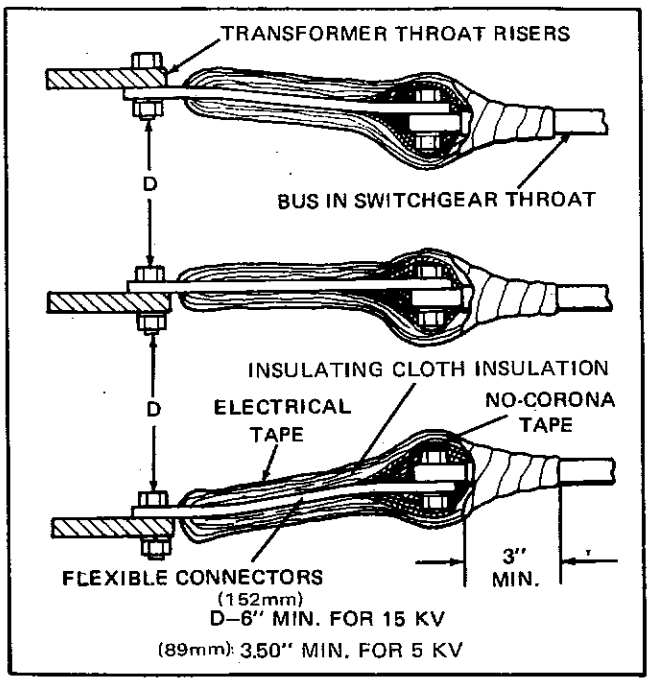



**Figure 53. Insulating Transformer-to-Bus Bar Joints**

## BUS SUPPORTS – CAULKING – 15 kV CLASS

When switchgear is received as a number of shipping groups, the bus supports at the shipping splits must be caulked after bus connections are completed. A two-part caulking material Siemens-Allis Part Number 00-331-531-014) is supplied for the purpose. When mixed, the materials produce one pound (.45 kg) of caulking material. Each bus support requires approximately 1/6-pound (.08 kg) for each phase, or 1/2-pound (.23 kg) for the three-phase arrangement. Proceed as follows:

1. Mix the materials as furnished in the proportion of five parts A to one part B by weight.

**NOTE**

The entire contents of one can may be mixed with the entire contents of the other if that quantity of material is needed.

2. Apply caulking material to make a continuous fillet completely around the bus bar insulation at the support (Figure 54). Make sure all air voids between insulation and support are filled. The material will cure completely in 24 hours at room temperature. Pot life is approximately 45 to 90 minutes.

**NOTE**

Curing time and pot life are based on a temperature of approximately 72°F (22.2° C). These times will increase slightly for lower temperatures and decrease slightly for higher temperatures.

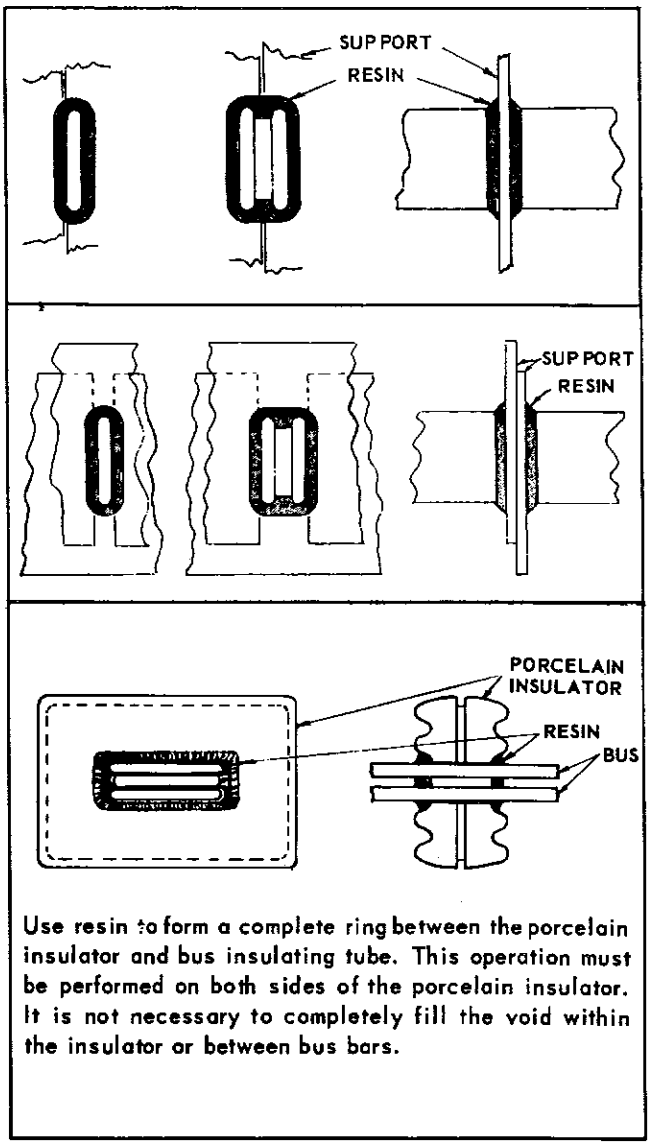



Figure 54. Caulking Bus Supports

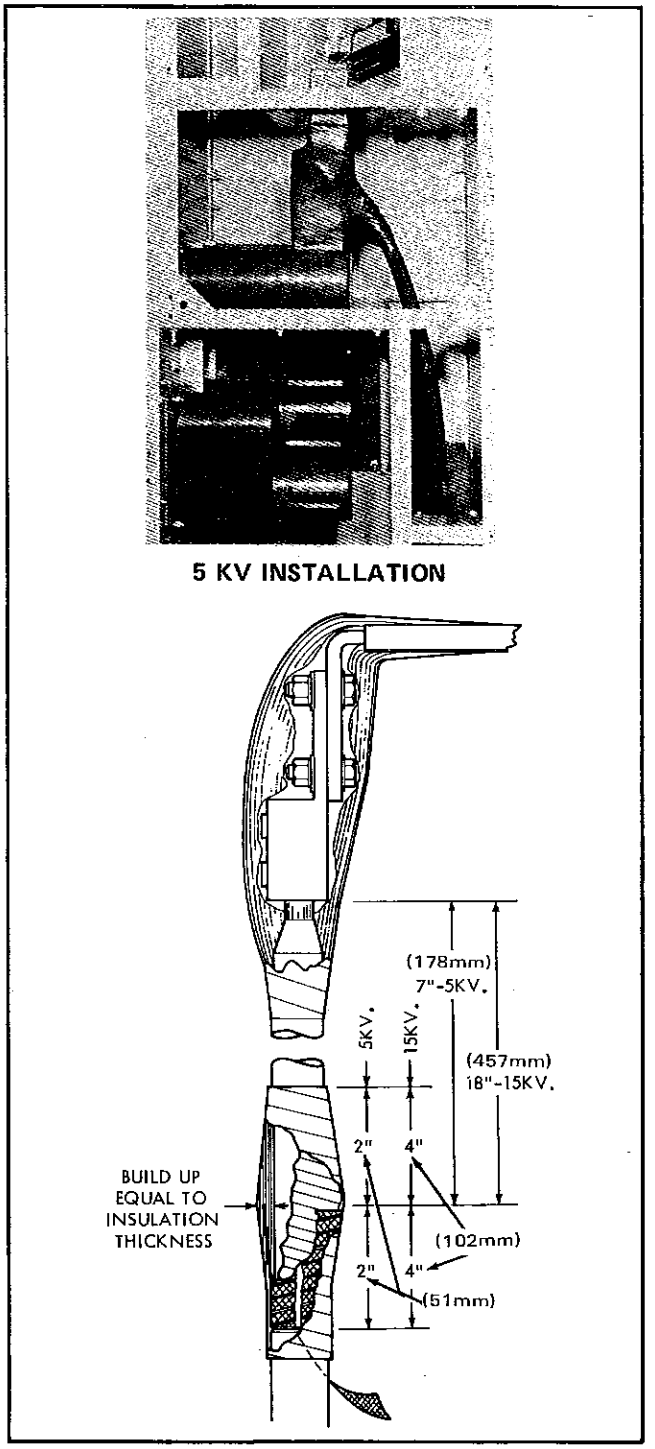



Figure 55. Primary Cable Connections

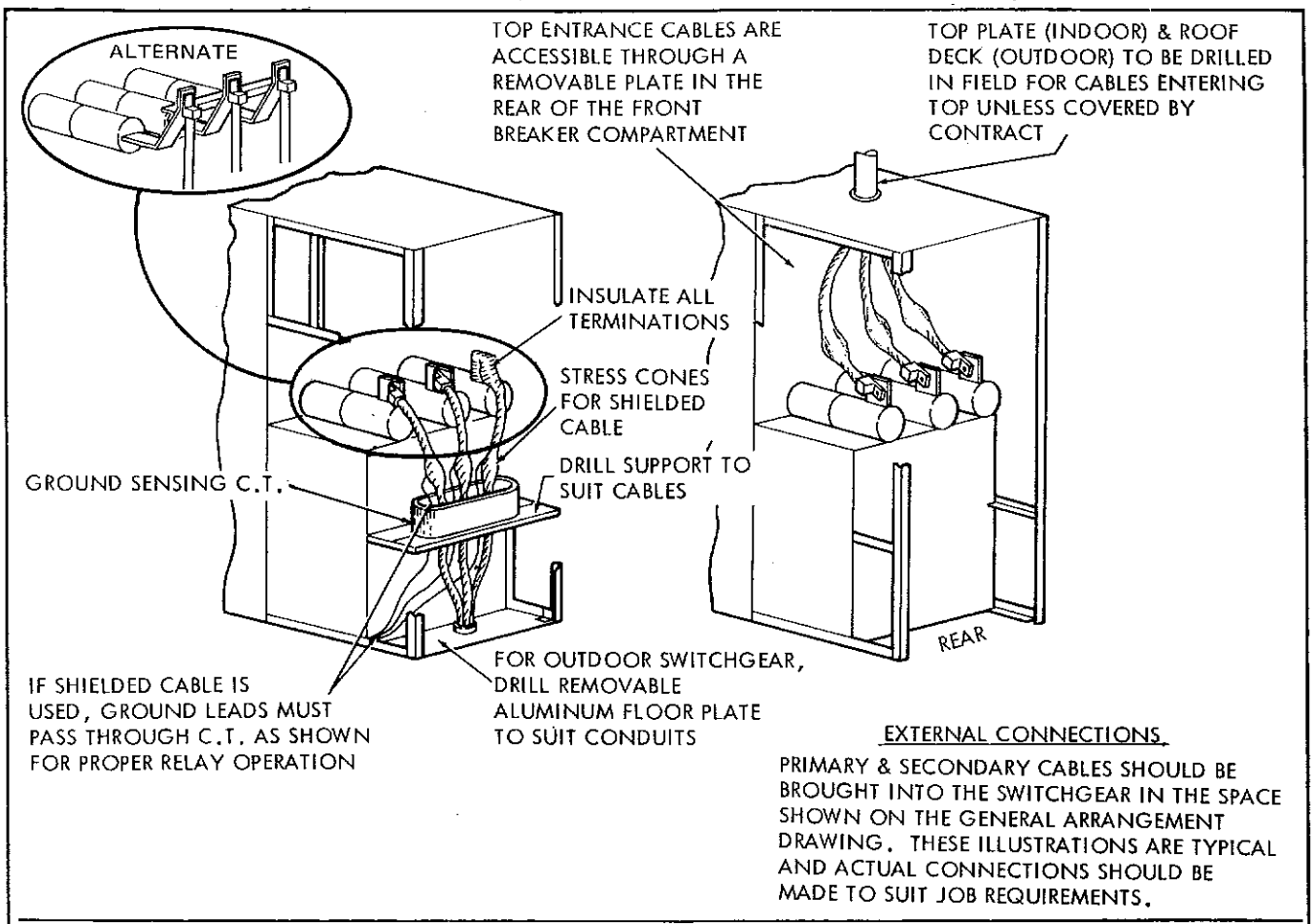
## PRIMARY CABLE CONNECTIONS

All cable connections to metal-clad switchgear must be fully insulated. Typical cable connections are shown in Figure 55. Because of considerable variations in customer requirements and available cables, Siemens-Allis furnishes a double-bolt, double-clamp, terminal lug only. All insulating and terminating materials other than terminal lugs and cable supports are to be furnished by the customer.

Figure 56 illustrates recommended cable placement.

## TYPICAL LUG MOUNTING

Figures 57 and 58 illustrate typical lug mountings for 5 kv and 15 kv switchgear.



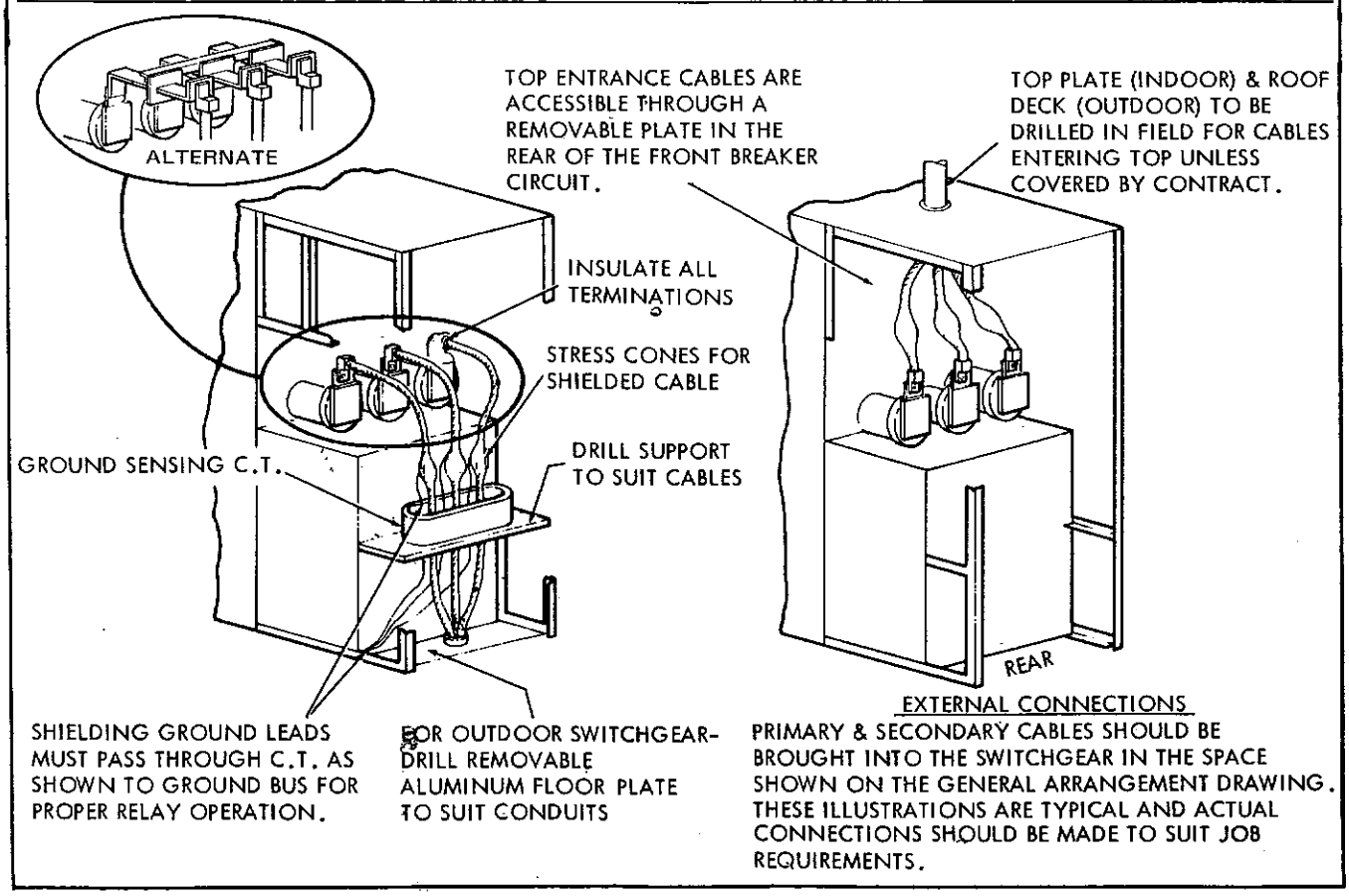




**Figure 56. Recommended Placement of Cables**

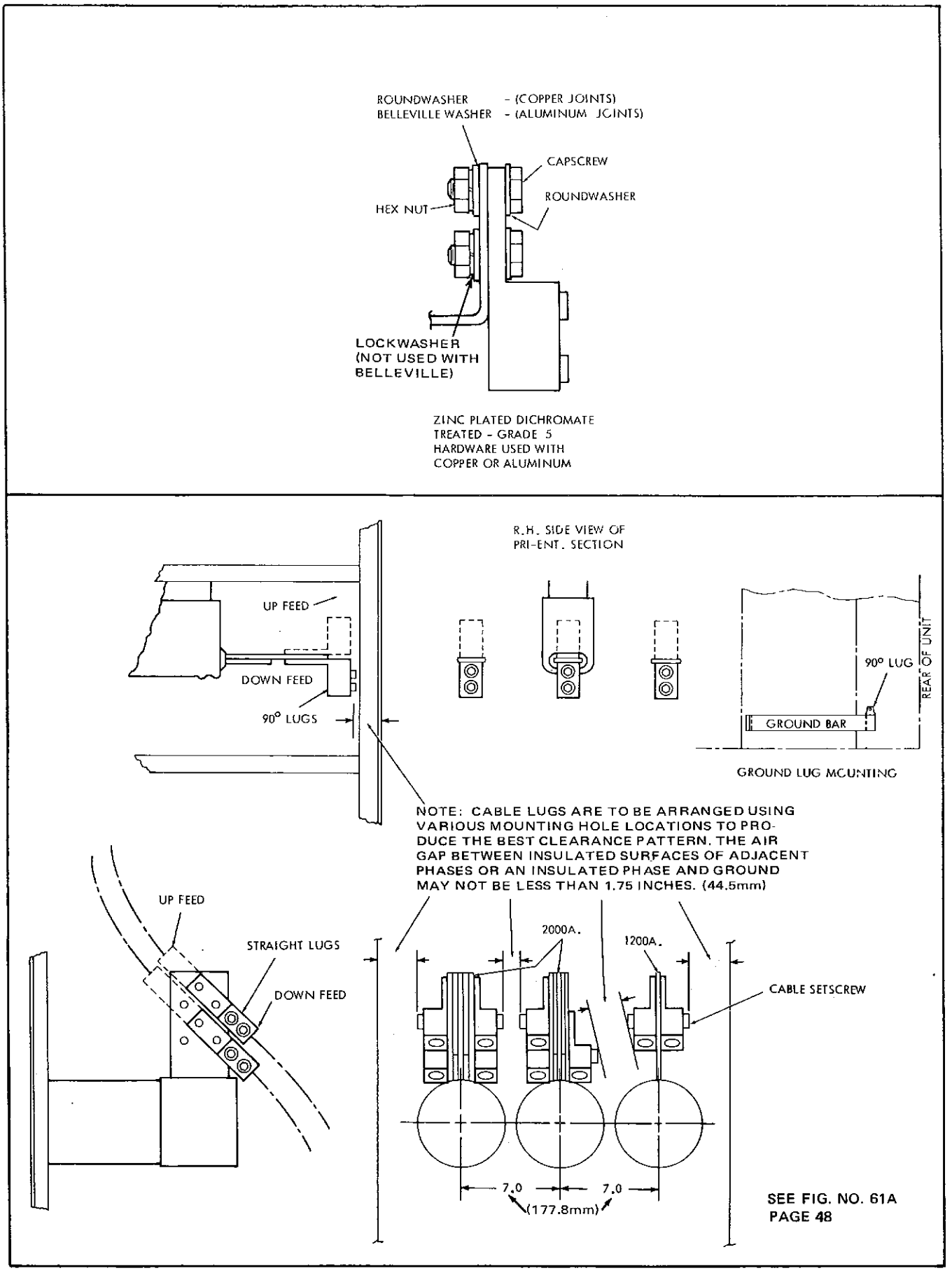



**Figure 57. Typical Lug Mountings – 5 kV Switchgear**

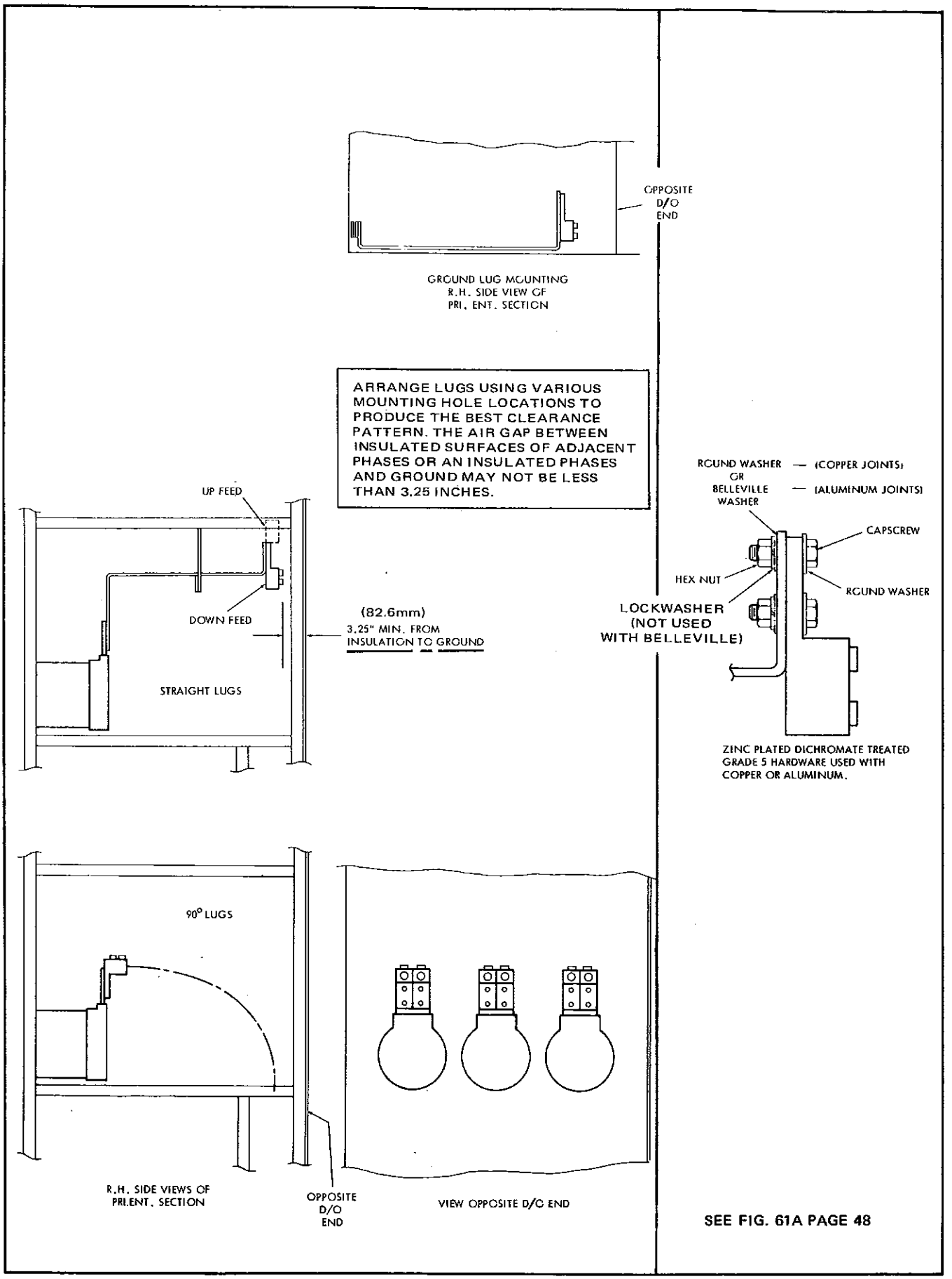



**Figure 58. Typical Lug Mountings – 15 kV Switchgear**

## POTHEAD CONNECTIONS

Potheads must be coordinated with other switchgear components to meet space, dielectric, momentary current and thermal current requirements. Siemens-Allis potheads meet these requirements when installed as a component of metal-clad switchgear.

In standard Siemens-Allis switchgear units, the pothead mounting is such that the pothead may be removed from the mounting without disassembly. Each three-conductor pothead, or group of three single-conductor potheads, is on a separate mounting plate.

The manner in which potheads are mounted makes it possible to connect cable outside the unit or on the floor of the unit. Cables may also be installed in the mounted position. Sufficient distance between the pothead entrance and the floor of the unit permits dropping the pothead body over the cables to make the stress cones.

Pothead bodies are furnished in two types only: a single-conductor body or a three-conductor body. One single-conductor body will accept all cable sizes up to approximately 1,000 MCM (500 $mm^2$). One three-conductor body will accept all sizes up to approximately 750 MCM (380 $mm^2$). This permits the installation of larger cables if the load outgrows the originally selected cable sizes.

The body of the three-conductor pothead is offset. If two potheads are mounted in one unit, the offsets are therefore in opposite directions. This provides more work space when wiping lead to the wiping sleeve of the pothead and the lead jacket of the cable. Pothead dimensions and parts are shown in Figure 59.

Potheads are an integral part of switchgear and are required to withstand the same tests as other switchgear components. The following materials, with the exception of insulating compound and tarred rope, are needed but are not supplied by Siemens-Allis unless specified in the contract. (A cable termination kit may be obtained from the cable manufacturer):

Insulating compound.
Solder (50-50) for connectors.
Solder (60-40) for wiping joints.
Stearine for solder and wiping flux.
Insulating tape for reinforcing cable conductor insulation and for stress relief cones.

**NOTE**

Follow recommendations of cable manufacturer for type of insulating tape.

Copper tinsel braid for stress relief cones, if required.
Dry cotton tape.
Tarred rope for filling clamp-type cable glands.

### Tools and Equipment Required

The tools and equipment required for installing potheads are:

Kit of cable jointer tools, including hacksaw, knife and wrenches.
Blow torch.
Gasoline furnace for heating solder and compound.
Solder pot and ladle.
Melting vessel for melting compound.
Funnel, filling and vent pipes for compounding.
Thermometer (200 to 500°F) (93 to 260°C).

### General Instructions

1. Keep conductor insulation and internal parts of the pothead clean and free of moisture.

2. Avoid sharp bends in insulated conductors.

3. Remove lead sheath carefully to avoid cutting the insulation. Tear off the last few layers of paper insulation to prevent cutting the individual conductor insulation.

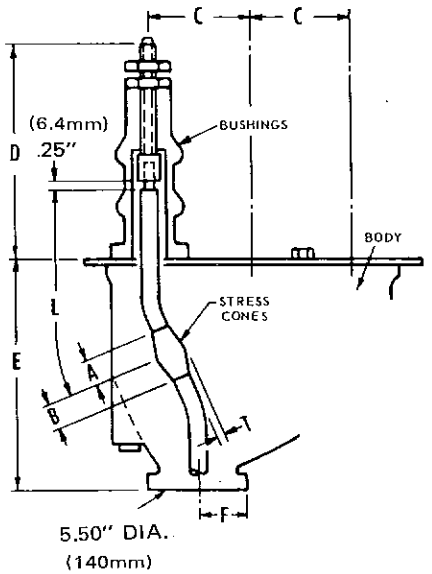
4. If the temperature is below 15°F (-9.4°C), cable must be warmed prior to bending. Always heat potheads to prevent compound from congealing too quickly on cold surfaces. Avoid direct application of heat on porcelains or on parts with porcelain inserts.

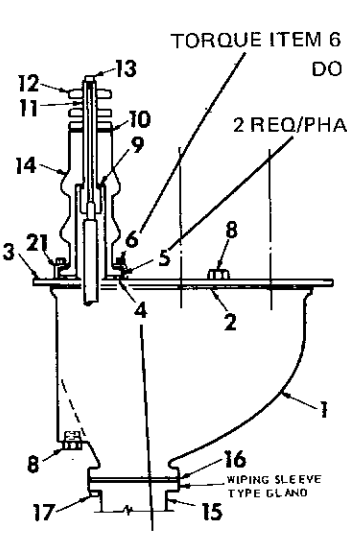
5. Carefully follow the dimensions given.

6. In all cases, avoid the formation of air and gas pockets.

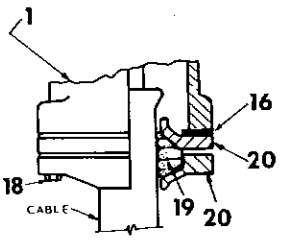
7. Fill the potheads with compound from the bottom up. This will allow compound to rise evenly and force air up and out at the top, thereby eliminating voids. Clean off all surplus and spilled compound.

8. After pothead has cooled, retighten all bolts.




ITEM 4 MUST BE CENTERED ON SUPPORT PLATE HOLE



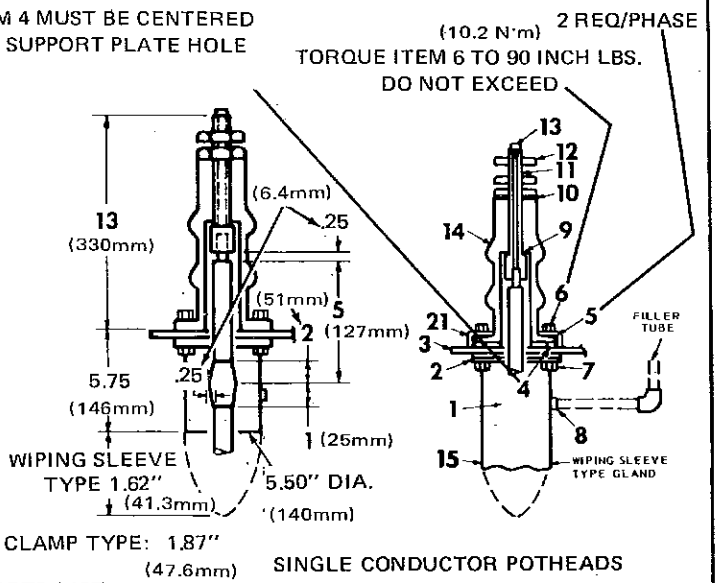

CLAMP TYPE CABLE GLAND

| | A | B | C | D |
|---|---|---|---|---|
| 5 KV | 1 (25mm) | 1 (25mm) | 5.37 (136.4mm) | 10.62 (270mm) |
| 15 KV | 2 (51mm) | 1 (25mm) | 7.37 (187.2mm) | 13 (330mm) |

| | E | F | L | T |
|---|---|---|---|---|
| 5 KV | 12 (305mm) | 3 (76mm) | 3 (76mm) | .12 (3.2mm) |
| 15 KV | 17 (436mm) | 3.50 (89mm) | 5 (127mm) | .25 (6.4mm) |

## MAXIMUM CABLE SIZE FOR A-C POTHEADS

Single cable entering porcelain .... 2.50" (63.5mm)
Bare cable entering connectors ..... 1.37" (34.8mm) max., .25" (6.4mm) min.
Cable entering wiping sleeve ..... 3.25" (82.6mm)
Cable entering conduit support ... 2.75" (70mm)
Cable entering packing ring ..... 3" (76mm)




CLAMP TYPE: 1.87" (47.6mm)

SINGLE CONDUCTOR POTHEADS

## PARTS LIST

| Item | Name | **Conductors | Dwg. No. |
|---|---|---|---|
| 1 | Pothead Body | (3C)<br>(3C)<br>(1C)<br>(1C) | 18-446-161-001<br>18-446-206-001*<br>18-446-151-001②<br>18-230-399-001① |
| 2 | Gasket | (3C)<br>(3C)<br>(1C) | 18-240-443-001<br>18-240-252-001*<br>18-140-471-001 |
| 3 | Support Plate | (3C)<br>(3C)<br>(1C)<br>(1C) | 18-172-856-001<br>18-178-221-001*<br>18-172-856-001<br>18-178-221-001* |
| 4<br>5<br>6 | Gasket<br>Gasket<br>* Cap Screw .375" x 2.25"<br>Screw (Brass)<br>Lock Washer<br>Washer (Brass) | (1C)<br>(3C) | 18-140-469-001<br>18-140-469-002<br>00-611-345-476<br>00-655-017-036<br>00-655-059-200<br>14-104-595-018 |
| 7<br>8 | * Hex Nut .375"<br>* Pipe Plug 1"<br>* Gasket<br>* 1" Washer | | 00-631-059-106<br>00-711-497-006<br>18-140-469-005<br>00-651-027-480 |
| 9<br>10 | Gasket<br>Gasket<br>Key Washer<br>11 Stud Terminal<br>12 Hood Nut<br>13 Vent Screw<br>Washer<br>Gasket | | 18-140-469-003<br>18-140-469-004<br>18-140-468-001<br>18-270-769-002<br>18-631-859-006<br>00-615-471-417<br>00-615-007-196<br>18-140-469-006 |
| 14 | Insulator | | 18-363-987-001<br>18-363-734-001* |
| 15 | Wiping Sleeve | (1C)<br>(3C) | 18-230-399-001<br>18-261-493-001 |
| 16<br>17<br>18<br>19<br>20<br>21 | Gasket<br>* Cap Screw .375" x 1"<br>* Cap Screw .375" x 1.50"<br>Hemp Rope<br>Packing Ring<br>Insulator Support | | 18-160-750-001<br>00-611-289-466①<br>00-611-289-470②<br>(Tarred)<br>18-261-494-001<br>18-240-300-001 |

*Denotes 15 kv part, all other Nos. are common to both 7.5 kv and 15 kv.
**(1C) Single Conductor; (3C) Three Conductor.
①Wipe ②Clamp

**Figure 59. Pothead Dimensions and Parts Lists**

## Cable Installation

1. Check cable gland and stud to see that they fit the cable. These items may be furnished with pilot holes only. Drill out if necessary with a clearance of approximately .06-inch (1.6 mm) oversize of cable sheath and conductor.

2. Slide cable gland, cable gasket and pothead body down over cable.

3. Train cable into proper position, allowing sufficient length to make connections.

4. Mark cable sheath approximately 1 to 1.50-inch (25 to 40 mm) above the bottom of the gland.

5. Remove lead sheath from the cable to point marked, being careful not to damage insulation. Bell out lead sheath as shown in Figure 60. For braided cables, remove braid down to point marked.

6. Remove outer layer of insulation around all conductors from the cable end to point "X" above the lead bell, being careful not to damage insulation underneath. (Three-conductor only.)

7. Fan out conductors into final position, avoiding sharp bends (three-conductor only). Cut off conductors to proper length to fit into studs. Remove cable insulation from end of conductor at least .25-inch (6.4 mm) longer than depth of hole in stud.

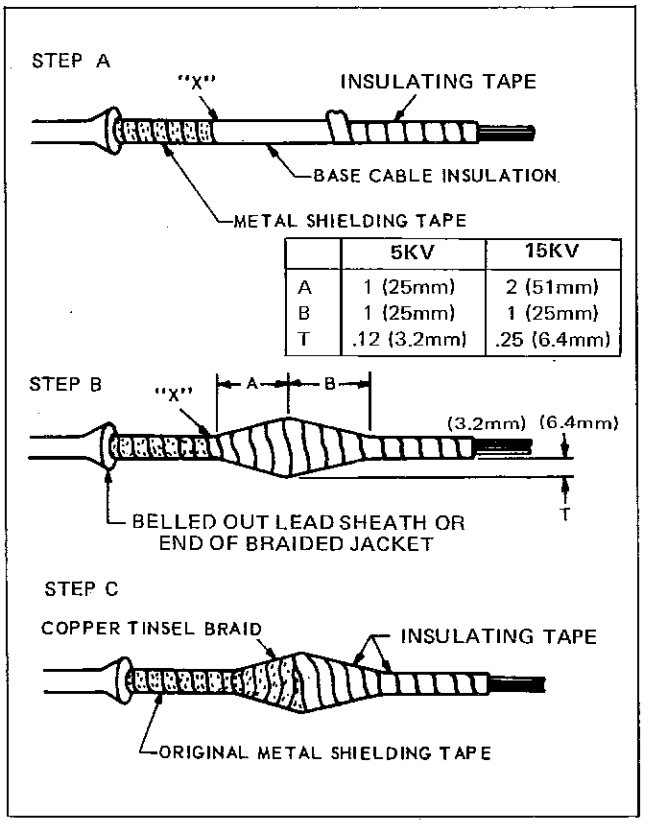
8. Solder cables solidly into the studs. (For voltages above 7500, make stress cones on cables as shown in Figure 60.) If stress cones are not desired proceed directly to Step 9.

## Stress Relief Cones

Stress relief cones (see Figure 59) increase the strength of the cable insulation against puncture at the end of the grounded shielding. They also increase overall internal dielectric strength and reliability of the cable termination. Stress cones are recommended for all shielded cables and the higher voltage single-conductor lead covered cables. Belling out lead sheath is usually sufficient for lower voltage lead covered cables.

On paper or varnished cambric-insulated cables, a double cone of half-lapped insulating tape is built up. The lower slope is wrapped with copper tinsel braid, tucked under the bell at the end of lead sheath and soldered to the lead sheath and/or to the cable shielding tape. On rubber-insulated cables, the double cone may be built up of insulating tape and shielded with standard copper tinsel braid.

Step A — Preparing the Cable — Determine the length of each conductor to extend from the position of the wiping sleeve or packing gland to the point of connection to the stud terminal. Establish location of stress relief cone on the cable so that it will be approximately in the center of the pothead body.




| | 5KV | 15KV |
|---|---|---|
| A | 1 (25mm) | 2 (51mm) |
| B | 1 (25mm) | 1 (25mm) |
| T | .12 (3.2mm) | .25 (6.4mm) |

**Figure 60. Preparing Cable**

Remove shielding and conducting tapes down to bottom of stress cone (point "X", Figure 60). Bare the end of the conductor and solder to stud terminal.

Step B — Building the Stress Relief Cone — Starting at the terminal end, wrap insulating tape, half-lapped, down to the edge of the metal shielding tape. Continue wrapping back and forth until the double cone of proper diameter is obtained. Finish by wrapping the final layer of tape on the conductor and on up to the stud terminal.

Step C — Shielding — Starting slightly below the middle of the double cone, apply copper tinsel braid to the lower half. Wrap so that the upper edge is even and continue wrapping down the cone — over cable shielding or tuck under lead sheath. Solder the tinsel braid between turns and to ground connecting wire.

**NOTE**

Follow recommendations of cable manufacturer for type of insulating tape.

9. Install studs in insulators with gaskets centered and key washers in place. Bolt insulators firmly to their mounting plate, to a torque of 90 inch lbs. (10.2 N·m). Tighten nut next to key washers on studs.

10. Bolt pothead body against insulator plate with gasket in place.

11. Bolt cable gland to pothead body with gasket in place.

## Wiping Sleeve Cable Gland or Clamp Type Cable Gland

Upright Pothead (cable leading down) — Wipe joint between cable and wiping sleeve, or pack stuffing box, and pull up tight to seal against cable sheath.

Inverted Pothead (cable leading up) — Wipe joint between cable and wiping sleeve, inserting a greased wire next to cable sheath. After wiping, remove greased wire to provide an air vent when filling pothead with compound.

If packing gland is used, do not pack until after filling.

## Filling Potheads

Upright Pothead — Remove vent screws from top of studs. Insert standpipe into body and extend it above highest point of pothead. Melt compound as instructed and fill pothead body. Wait for compound to solidify. Remove standpipe and insert plug and gasket.

Inverted Pothead — Do not remove vent screws in studs. Make sure they are tight. Venting is provided by hole left in wiped joint or through packing space, depending on type of gland used. Insert standpipe above highest point of pothead. Melt compound per instructions and fill body until compound reaches vents. Keep standpipe hot and full until compound in body solidifies. Remove standpipe and insert filling hole plug and gasket. Solder hole in wiped joint or insert packing, and tighten clamp to seal joint between cable and pothead body.

Siemens-Allis potheads are designed with base flange to match standard base size 4, so that standard fittings can be used on these potheads. Fitting flange is 5.37 inches (136.4 mm) outside diameter for base size 4.

## Insulating Pothead Bushings

Insulate the pothead bushings as follows:

1. Wrap approximately two feet (610 mm) of no-corona tape over bolt heads to form a smooth surface. See Figure 61.

2. Apply three layers of insulating cloth sheet (0.010-inch (.25 mm) thick), so that edges overlap adjoining insulation about three inches (76 mm) and end overlap by three inches (76 mm). Stagger the overlapping ends as much as possible and tie the layers firmly with bias-cut, yellow, cloth tape (0.010-inch thick by .75-inch (.25 x 19 mm) wide, approximately 30 feet (9 meters) long).

3. Perform this insulating operation twice for 5 KV class equipment and three times for 15 KV class equipment, using six sheets and nine sheets, respectively, of 0.010-inch (.25 mm) thick insulating cloth per joint.

4. Tape joints with one layer, half lapped, of electrical tape (one roll).

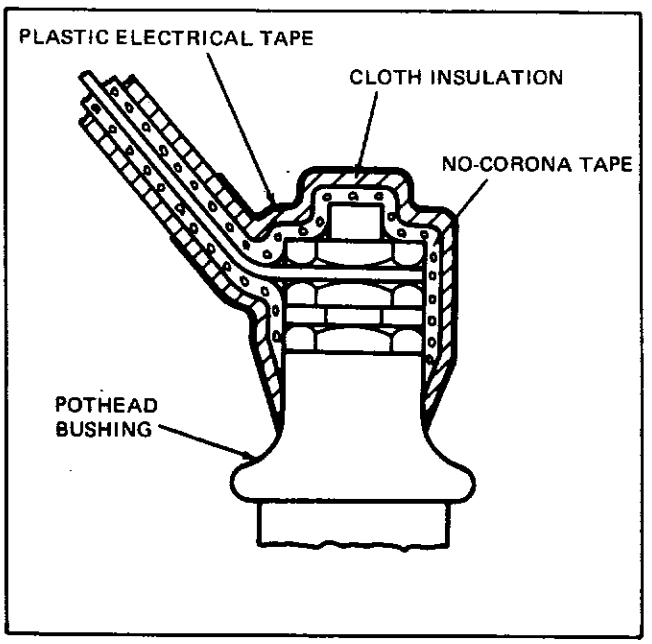



Figure 61. Insulating Pothead Bushing

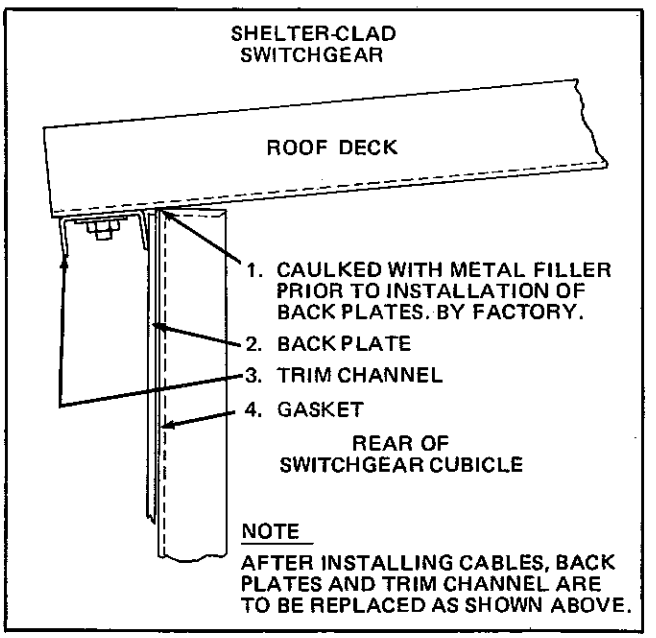



Figure 61A. Back Plate Mounting After Cable Installation

## 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 charts needed for installation are furnished in advance. These charts show both the changes originated by purchaser during manufacture and the changes made by the supplier to incorporate the purchaser's changes.

Wires can be easily traced on a wire chart similar to those shown in Figures 62 and 63. Each device is illustrated and identified with a letter. Each terminal on each device is identified by a number. The table on the chart indicates the device and terminal number to which each wire is connected and the next connection point. For example, the designations S4-T15 appear opposite wire No. 6 in the table in Figure 62. This indicates that wire No. 6 is connected to terminal 4 of S, the control power supply and to terminal 15 of T, the secondary disconnect block.

Wires may be connected to a series of devices. For example, wire No. CO is connected to terminal 9 on TB, the terminal block; then to terminal X2 on L, phase 1 current transformer; then to terminal X2 on M, phase 2 current transformer; and then to terminal X2 on N, phase 3 current transformer.

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 64 shows a typical secondary control cable installation. Figure 64A shows the physical location of maximum number of terminal blocks, located above secondary cable entrance, is shown to guide customer in designing conduit entrance layouts or control cable locations.

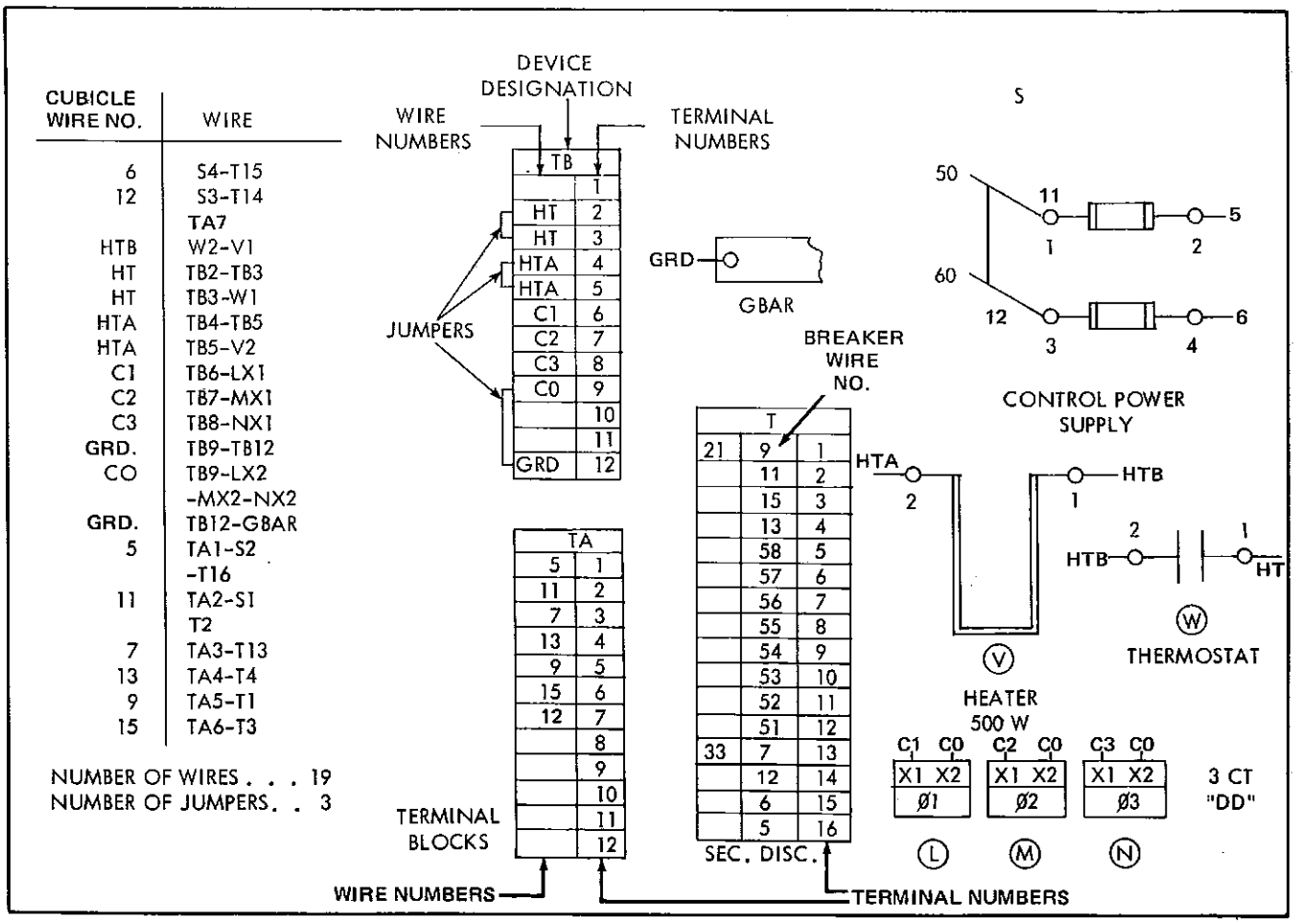



**Figure 62. Typical Structure Wiring Chart**

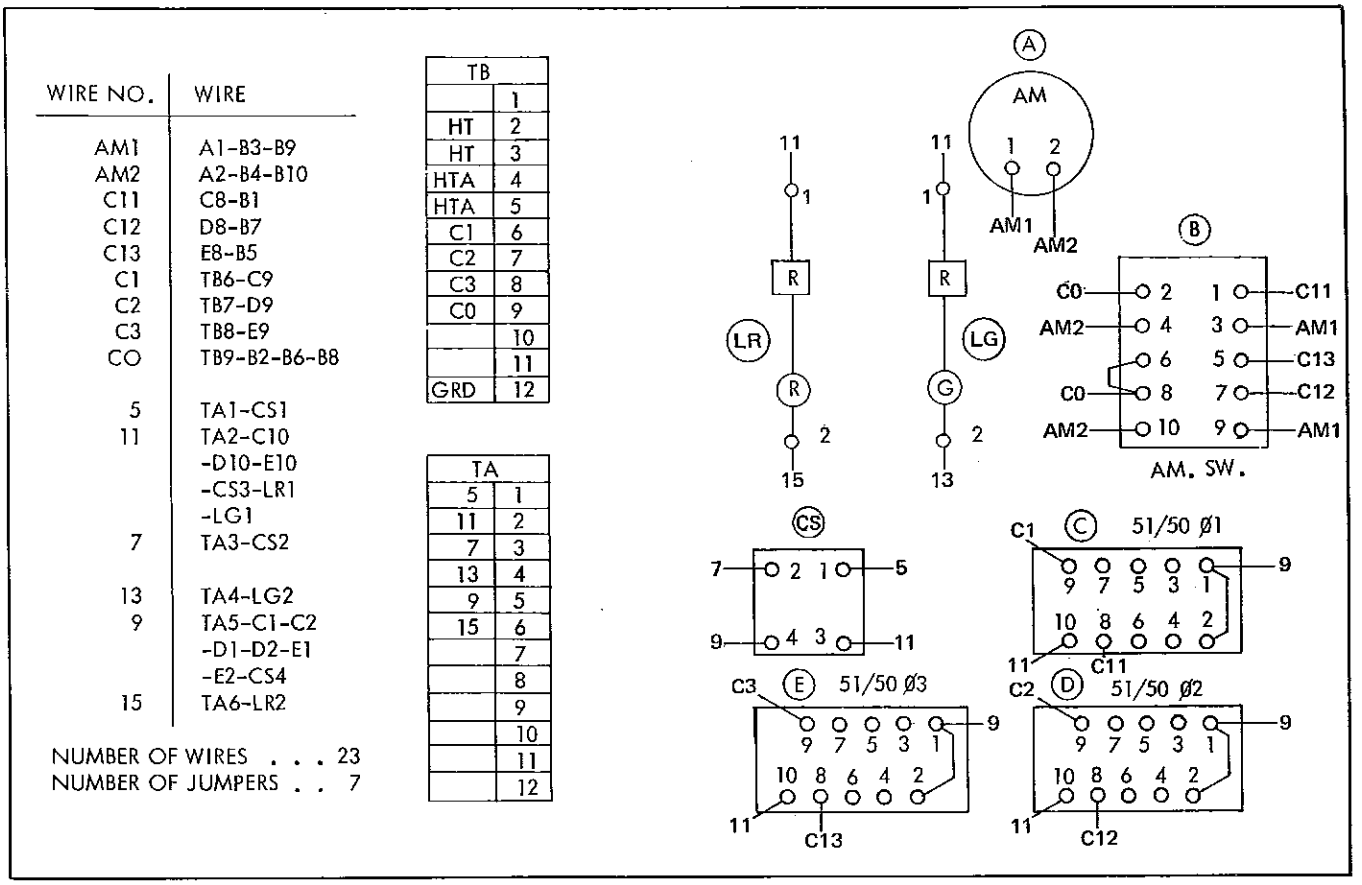



Figure 63. Typical Hinged Panel Wiring Chart

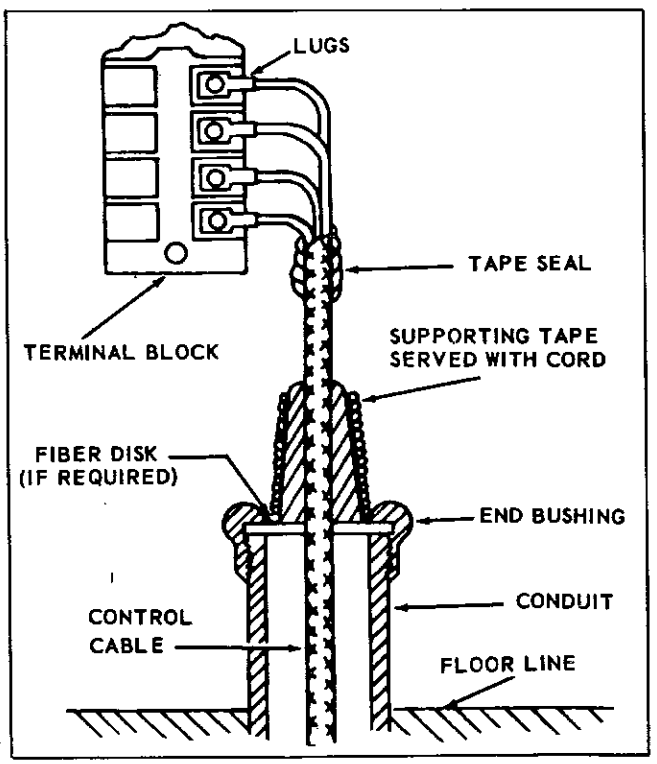



Figure 64. Secondary Control Cable Connections

## GROUND CONNECTION

A common ground bus is incorporated in all units for properly grounding the equipment after installation.

The ground bus extending through the switchgear is accessible in the primary cable area of the left-hand end unit.

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.

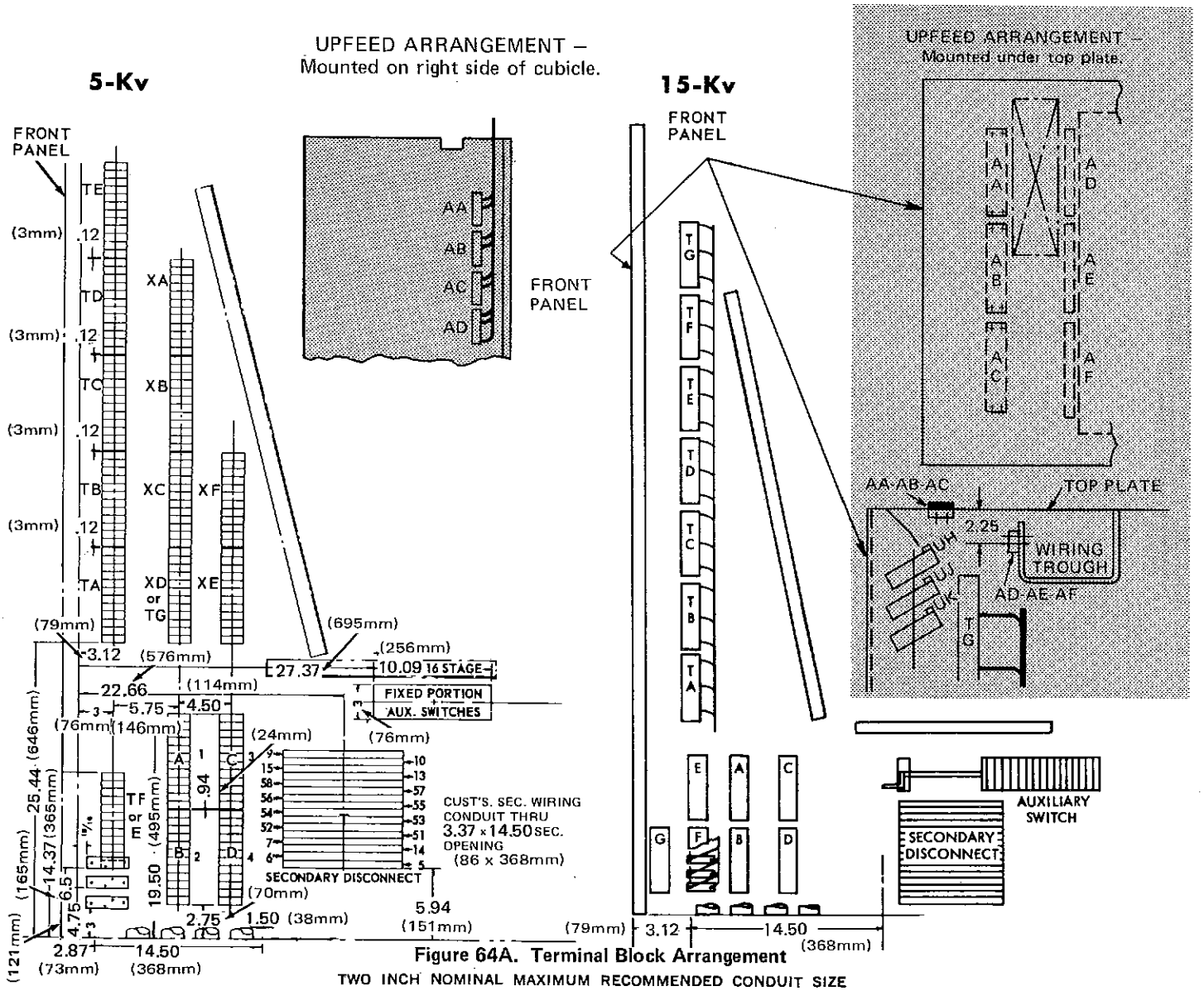



**Figure 64A. Terminal Block Arrangement**

TWO INCH NOMINAL MAXIMUM RECOMMENDED CONDUIT SIZE

## POTENTIAL TRANSFORMERS

Potential transformers are mounted on a base which rotates on trunnions to provide the convenience of automatic disconnection when withdrawing the potential transformers for test or inspection.

The drawout base for the potential transformer is located in the top rear compartment of a standard cubicle at shoulder height or in an auxiliary unit. The base, which is mounted on a pair of trunnions, is rotated 135 degrees to the test or disconnect position.

While rotating the potential transformers from the connected to the disconnected position, the primary windings and transformer-mounted, current-limiting fuses are automatically grounded to remove any charge from the transformers. When the transformers are in the test or disconnect position, the base acts as the protective barrier between the stationary primary contacts and the operator. The weight is so distributed that a minimum amount of effort is needed to rotate the carriage.

Potential transformers are mounted in the cubicle and in the connected position when shipped.

To open or close potential transformer trunnion, proceed as follows (see Figure 65):

### 5-kV Class

Opening Trunnion:

1. Turn knurled screws holding the door and swing hinged door open.

2. While holding trunnion firmly in closed position, turn latches - one at each side - to release

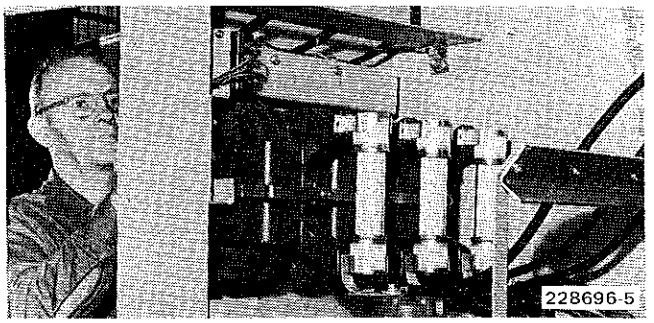
and using handle, pull to rotate trunnion in one continuous motion 135 degrees. This disconnects transformers and grounds the fuses. Fuses are now accessible for removal or replacement.

Closing Trunnion:

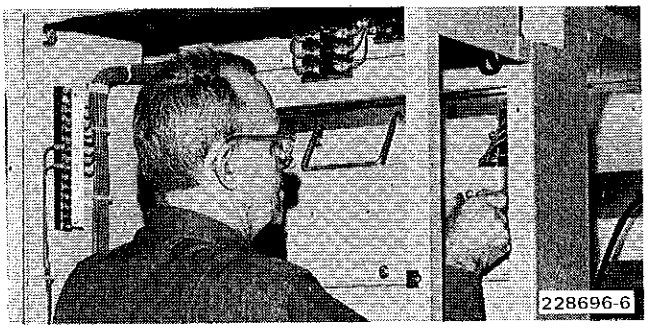
1. Using handle, rotate trunnion 135 degrees to closed position in one continuous motion and hold trunnion firmly in closed position.

2. While holding trunnion firmly in closed position, turn latches - one at each side - to latch closed.

3. Close hinged door and turn knurled screws to secure door in closed position.




TRANSFORMERS IN CONNECTED POSITION




TURN LATCHES

### 15-kV Class

Opening Trunnion:

1. Same as 5-kV No. 2

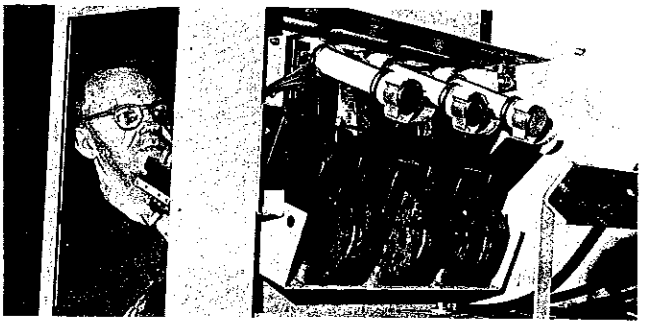
Closing Trunnion:

1. Same as 5-kV No. 1

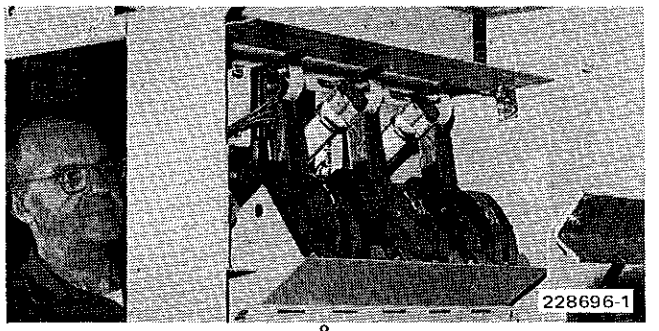
2. Same as 5-kV No. 2

**CAUTION**

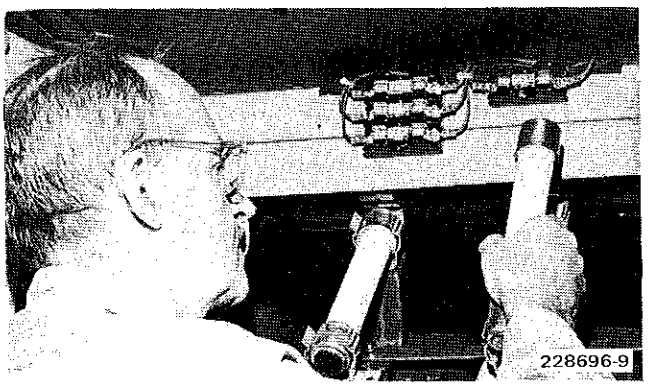
When opening or closing any type of disconnect always perform the action in one complete, continuous motion.



PULL BASE




ROTATE BASE 135°, FUSES GROUNDED




REMOVE FUSES

**Figure 65. Removing Potential Transformer Fuses**

## CONTROL POWER TRANSFORMERS

With the exception of small control power transformers (up to 15-kVA, single phase) in 15kV switchgear which may be mounted on a trunnion type barrier, all control power transformers are mounted in a fixed position with trunnion-mounted primary fuses in a separate compartment. Control power transformers and their associated primary fuses are mounted in auxiliary cubicles.

An interlocked circuit breaker is furnished on the secondary side of the control power transformer to prevent disconnecting the transformer unless the circuit breaker is open. Only when the circuit breaker is opened (disconnecting the load from the transformer) can the fuse carriage be rotated from the connected position.

Figure 66 illustrates the circuit breaker interlocks for the 15kV CPT fuse trunnion and trunnion mounted control power transformer.

To open or close control power transformer trunnions, proceed as follows:

### 5-kV CPT Fuse Trunnion:

Opening Trunnion:

1. Turn knurled screws holding the door and swing hinged door open.

2. While holding trunnion firmly in closed position, operate circuit breaker interlock to release and using handle, pull to rotate trunnion in one continuous motion 135 degrees. This disconnects CPT transformer and grounds the fuses. Fuses are now accessible for removal or replacement.

Closing Trunnion:

1. Using handle, rotate trunnion 135 degrees to closed position in one continuous motion and hold trunnion firmly in closed position.

2. While holding trunnion firmly in closed position, operate circuit breaker interlock to latch trunnion closed.

3. Close hinged door and turn knurled screws to secure door in closed position.

### 15-kV CPT Fuse Trunnion:

Opening Trunnion:

1. Place circuit breaker handle in "OFF" position,

2. While holding trunnion firmly in closed position, turn latches - one at each side - to release and using handle, pull to rotate trunnion in one continuous motion 135 degrees. This disconnects CPT transformer and grounds the fuses. Fuses are now accessible for removal or replacement.

Closing Trunnion:

1. Using handle, rotate trunnion 135 degrees to closed position in one continuous motion and hold trunnion firmly in closed position.

2. While holding trunnion firmly in closed position, turn latches - one at each side - to latch closed.

3. Place circuit breaker handle in "ON" position.

### 15-kV Trunnion Mounted Control Power Transformer

Opening Trunnion:

1. Place the circuit breaker handle in the "OFF" position which will simultaneously move the interlock link to the right unlatching interlock.

2. Same as 15-kV CPT fuse trunnion.

Closing Trunnion:

1. Same as 15-kV CPT fuse trunnion.

2. Same as 15-kV CPT fuse trunnion.

3. Place the circuit breaker handle in the "ON" position which will simultaneously move the interlock link to the left interlocking with the frame to prevent opening of the trunnion.

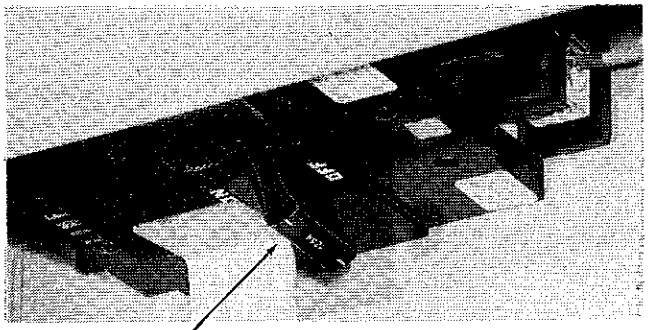
**CAUTION**

When opening or closing any type of disconnect always perform the action in one complete, continuous motion.

## CURRENT TRANSFORMERS

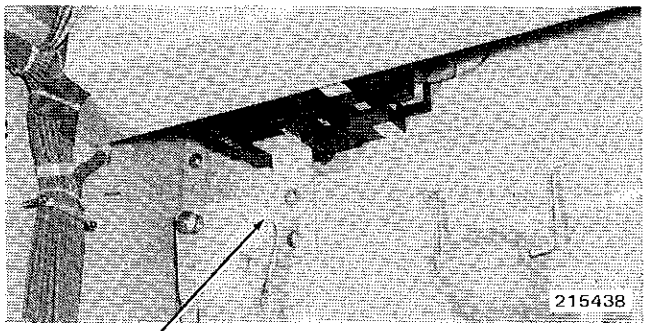
Current transformers, with high ratio, are of the torroidal type mounted in the circuit breaker compartment in front of the plate which supports the high voltage disconnects. See Figure 67.

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. It is possible to test the current transformers without removing them from the unit while maintaining maximum operator safety. Because the shutters are located behind the current transformers, testing of transformers located on the bus side can be accomplished without de-energizing the bus.



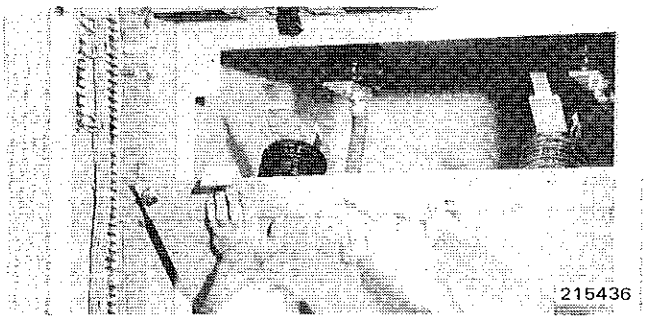
CIRCUIT BREAKER TOGGLE

CIRCUIT BREAKER "ON". FUSE CARRIAGE CANNOT BE ROTATED



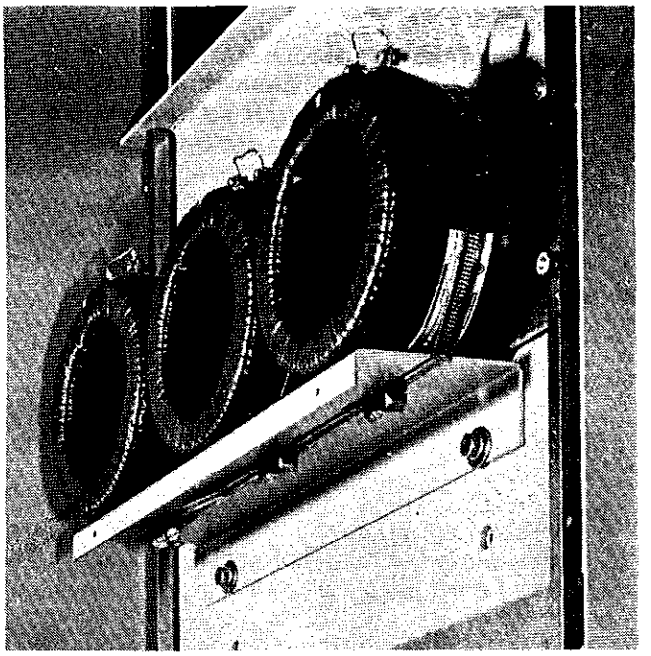

FUSE CARRIAGE BRACKET

CIRCUIT BREAKER "OFF". FUSE CARRIAGE FREE TO ROTATE




FUSE CARRIAGE OPEN

**Figure 66. Circuit Breaker Interlock**



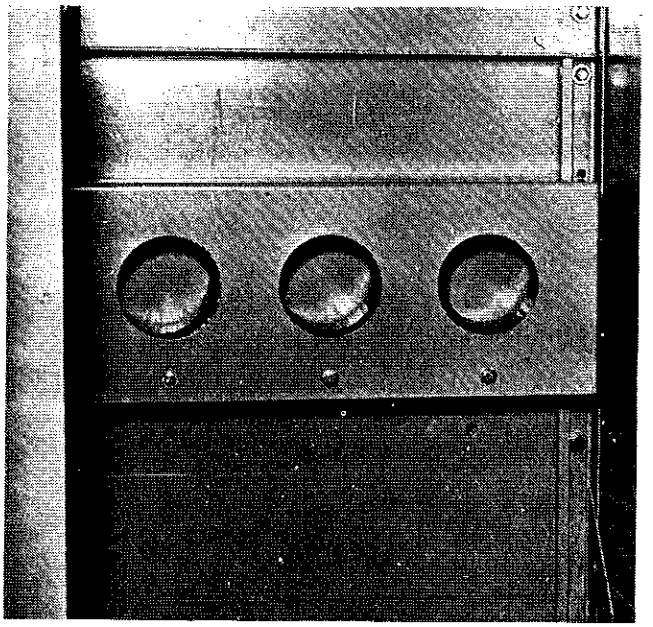
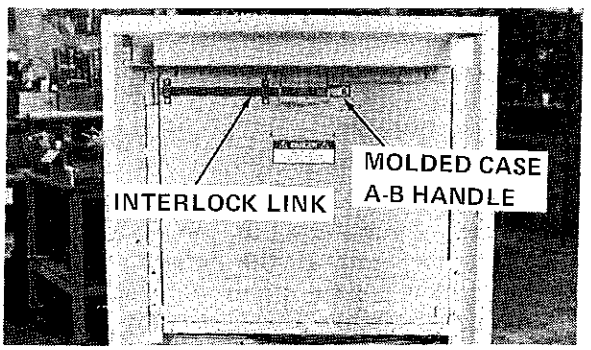
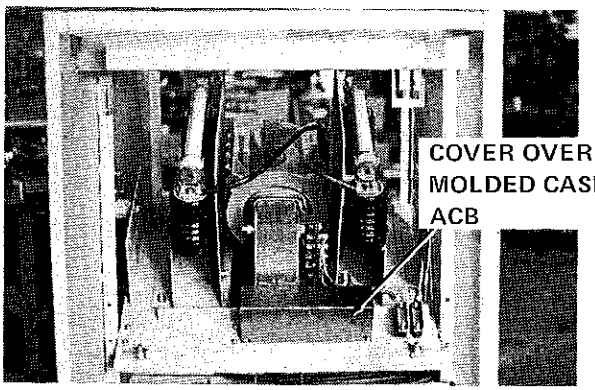


**Figure 67. Location and Mounting of Current Transformers**




TRUNNION MOUNTED 15 KVA (MAX.)
15 kV CLASS SINGLE PHASE
CONTROL POWER TRANSFORMER
SHOWN IS "CONNECTED" POSITION.




TRUNNION MOUNTED 15 KVA (MAX.) 15 KV CLASS
SINGLE PHASE CONTROL POWER TRANSFORMER
SHOWN IN THE DISCONNECTED POSITION.

Removal of the current transformer covers is accomplished by removing cover bolts accessible from the circuit breaker compartment.

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.

**CAUTION**

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

The torroidal current transformers shown in Figure 68 are the type extensively used in switchgear equipment. The circuit breaker primary bushings pass through the high-ratio transformers when in the connected position. Name plates are located in the inner diameter of the transformer for ready accessibility.

Wound or bar type current transformers, Figure 69, are used when additional transformers are required (beyond two per phase maximum of torroidal type), when location is a critical factor and where low ratios are required. See Figure 70. An elliptical shaped torroidal current transformer, Figure 71, is furnished for ground sensing circuits. This transformer is mounted in the primary cable area at a convenient height for receiving customer's cables.

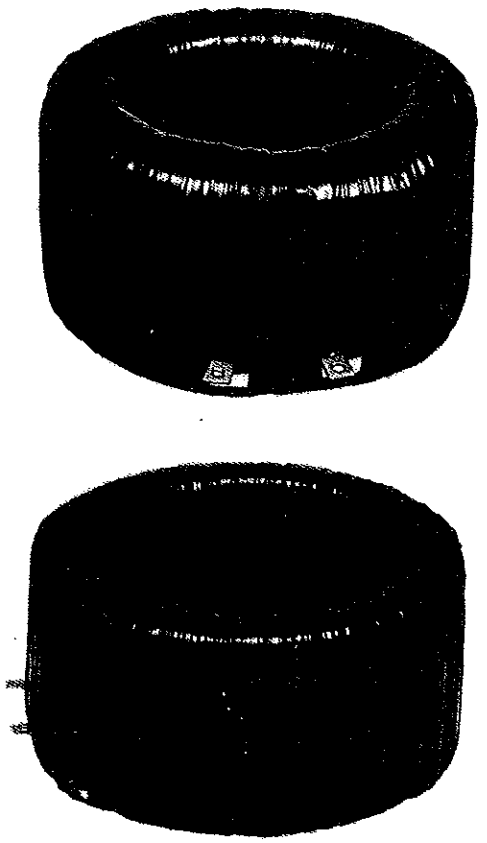



**Figure 68. Torroidal Current Transformers**

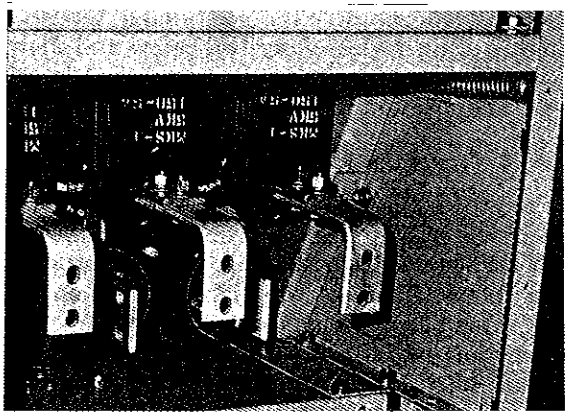


**Figure 69. Wound or Bar Type Current Transformers**

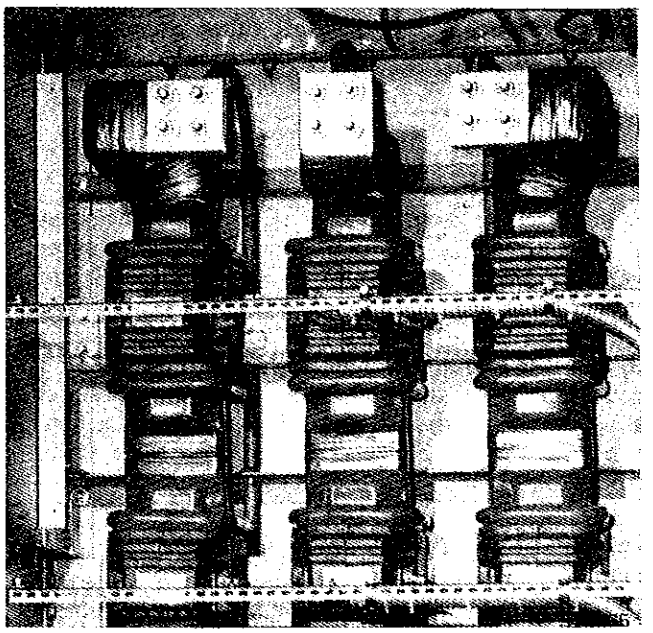


**Figure 70. Bar-Type Current Transformer Application**

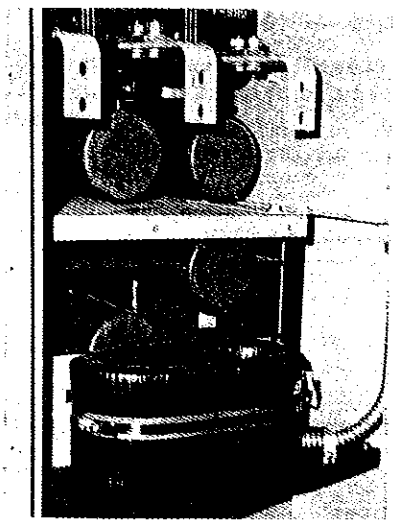


**Figure 71. Elliptical Torroidal Current Transformer (Ground Sensor)**

# CIRCUIT BREAKER INSTALLATION

## CUBICLE PREPARATION

The cubicle contains the positioning, interlocking and operating devices described below and shown in Figure 72. These devices must be checked for placement and freedom of operation.

### Guide Track and Main Interlock Bar

The guide track aligns the circuit breaker with the cubicle and guides the primary disconnects into proper engagement with the primary studs. The main interlock bar is the right wall of the guide track. This bar contains three depressions which, in conjunction with the interlock plunger on the circuit breaker, latch the circuit breaker in a definite position. The three positions (see Figure 73) are disconnect, test and operate. The circuit breaker is made trip-free (main contacts cannot be held closed, electrically or mechanically) at all times except when interlock plunger on the circuit breaker engages either the test or operate position as shown in Figure 73.

### Interlock Stop Angle

This angle is mounted on the cubicle floor so as to allow only a 1200-ampere circuit breaker to enter a 1200-ampere cubicle and a 2000-ampere circuit breaker to enter a 2000-ampere cubicle. When other special devices restrict a circuit breaker to a specific cubicle, it will be indicated on the circuit breaker rating plate. Normally cubicle and circuit breaker rating plates will be identical. Figure 72 illustrates the placement of the interlock stop angle for a 1200-ampere breaker.

### Fulcrum Angle — 5-kV Class Only

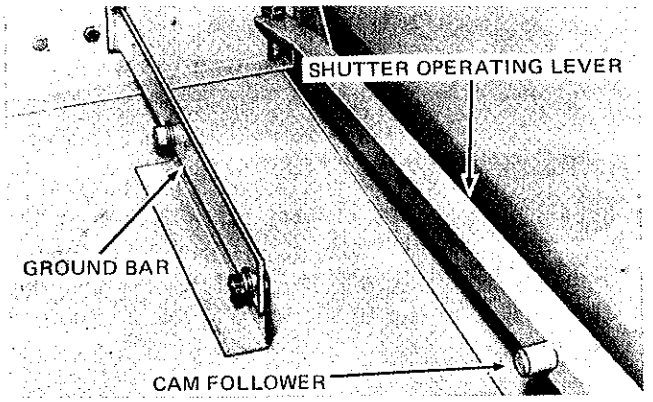
This angle is used in conjunction with the lever bar to insert the circuit breaker into and withdraw it from the connected (operate) position. Refer to Racking Instructions for 5-kv class circuit breakers.

### Racking Strip — 15-kV Class Only

This strip engages the pawl on the racking lever for inserting the circuit breaker into and removing it from the cubicle. Refer to racking instructions for 15-kv class circuit breakers.

### 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 sliding fingers of the secondary disconnect block on the circuit breaker engage the contact strips on the secondary disconnect in both in the test and connected (operate) positions.



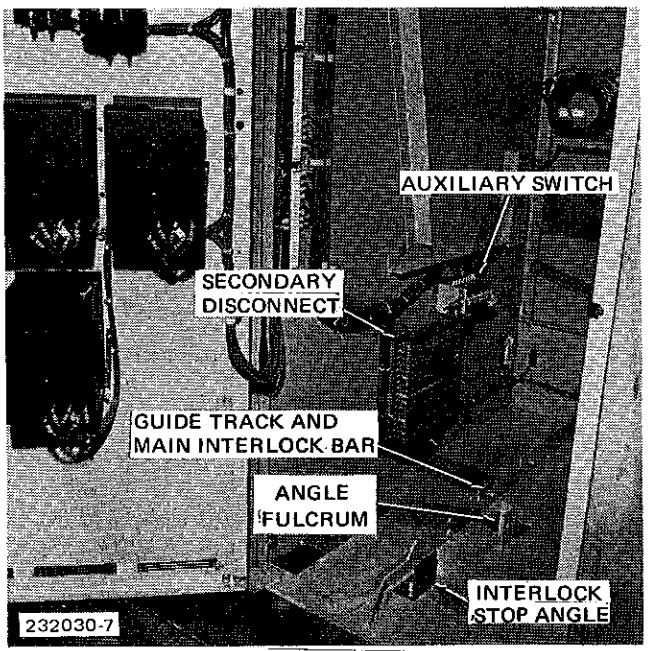




**Figure 72. Positioning Interlocking and Operating Devices**

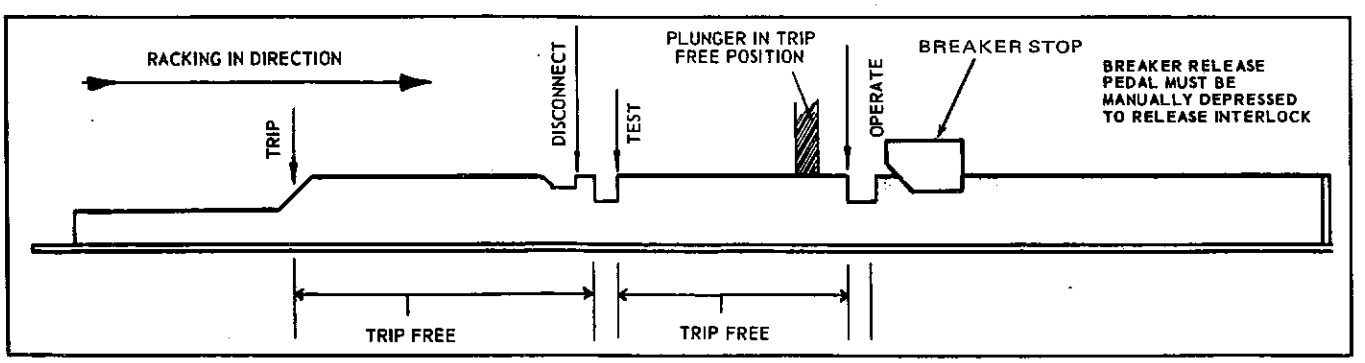



**Figure 73. Guide Track and Interlock Mechanism**

### Auxiliary Switch

This switch is operated by a fork on the circuit breaker. The breaker engages the 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.

### Circuit Breaker Ground Connection

A pair of sliding contact fingers for grounding the circuit breaker frame is mounted underneath the breaker. These fingers engage a ground blade mounted in the cubicle and maintain a solid ground contact with a continuous wipe through the test and connected positions. The contact is broken when the breaker passes the test position while being removed from the cubicle.

### Shutter Operating Lever

This lever, through the engagement of a cam on the circuit breaker with a cam follower on the lever, opens the shutters as the circuit breaker is moved into the connected (operate) position and closes the shutters when the circuit breaker is withdrawn. The shutters are fully closed with the breaker at the test position and are opened when the breaker is just forward of the test position.

## CIRCUIT BREAKER PREPARATION

**CAUTION**

Remove Packaging. Note: *Breakers are shipped in closed position with the trip rod and foot lever enclosed by packaging to prevent opening during shipment.*

Refer to the appropriate circuit breaker manual for instructions on handling and preparing the circuit breaker.

## CIRCUIT BREAKER INSERTION

After the circuit breaker has been prepared in accord with instructions in the appropriate manual, check to see that control power is off and primary system is de-energized. Visually inspect the cubicles and remove any foreign material that might hinder or prevent smooth insertion of the breaker. Proceed as follows:

1. Line up the circuit breakers in front of their respective cubicles.

2. Check that circuit breaker interlock will pass interlock stop angle on floor of cubicle.

3. Apply a .03 to .06 (1 to 2 mm) layer of electrical contact grease inside primary finger clusters at contact point area. Siemens-Allis electrical contact lubricant, No. 15-171-370-002).

**NOTE**

The finger clusters are lubricated in preparation for the check of the primary contact engagement which is made when circuit breaker is removed, (see step 7) and also to protect contact surfaces (see step 8).

4. Move breaker into disconnect position. See Racking Instruction (page 54). The funnel-shaped guide rails on the cubicle floor and a mating guide bar on the underside of the breaker will align the breaker with the cubicle on entry. When the disconnect position is reached, the interlock plunger on the circuit breaker will drop into the guide rail notch and the lower right hand edge of the breaker panel will be in line with the word DISC. on the position indicating label, Figure 74. The disconnect position notch in the guide rail is shallow, holding the breaker trip-free and preventing it from accidentally rolling into the secondary disconnect contacts of the test position. In this position, check the following items:

a) That secondary contacts have good contact alignment.

b) That ground contact (under breaker) has good contact alignment.

c) That breaker panel has engaged lock hooks (top of panel) properly and sides of panel are parallel to cubicle side plates.

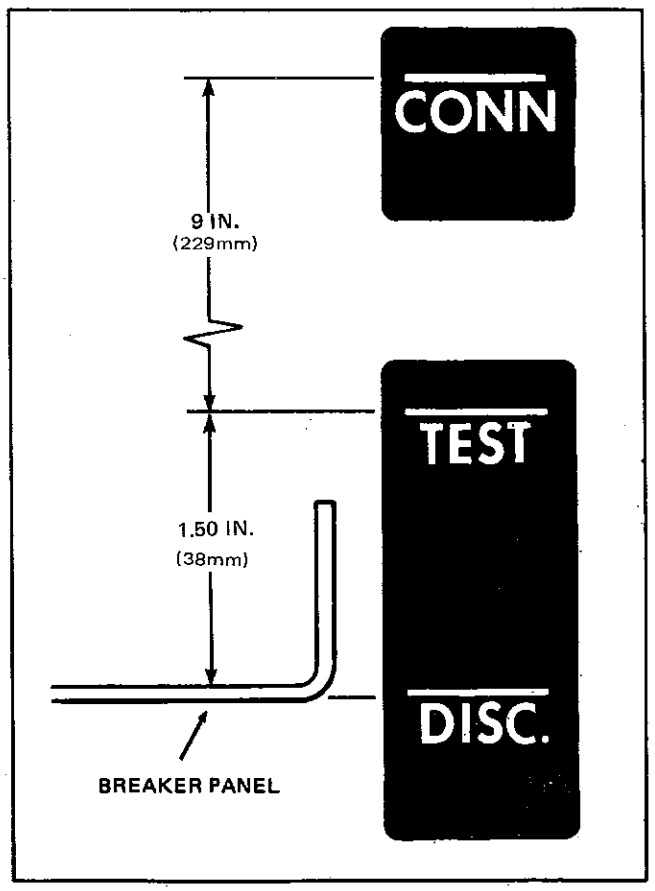



**Figure 74. Circuit Breaker Position Indicator**

d) If auxiliary switch is provided, that the operating fork on the breaker is in line with the auxiliary switch operating arm.

e) That breaker shutter cam is in line with and will engage shutter cam follower.

5. Move the breaker to the test position. At this point the interlock plunger will drop into the test position notch and the lower right edge of the breaker panel will be in line with TEST on the position indicator label. Also the breaker release pedal will return to its forward position indicating that the interlock plunger has dropped into the notch in the rail. In this position check the following items:

a) That secondary contacts have made with good contact pressure.

b) That ground contact is made.

c) If cubicle has an auxiliary switch with test position pickup, check to see that it has properly engaged breaker operating fork.

d) If manual charging crank has been used, remove it. Then energize control power and proceed with the checks outlined in steps e, f and g.

**NOTE**

Spring-charging motor will start immediately. Wait until springs are completely charged (motor stops) before proceeding.

e) Close and trip breaker electrically two or three times using panel-mounted control switch.

f) Close breaker mechanically by pulling lanyard ring and tripping mechanically by pushing trip rod.

g) Close breaker and trip mechanically by depressing breaker release pedal.

**NOTE**

Allow time for the charging motor to complete its charging cycle before moving breaker to the connected position. The breaker spring will remain charged between positions.

6. Move the breaker to the connected position. (See Racking Instructions, page 54). The breaker will travel nine inches to reach this location at which time the interlock plunger will drop into the connected position notch. In this nine inches of travel the shutters will open and there will be increased resistance on the racking lever as the primary contacts are made. The lower right hand edge of the breaker panel will rest in line with the position indicator label marked CONN and the breaker release pedal will have snapped to its forward position. If the breaker is of the stored-energy type and the springs are discharged, the charging motor will start immediately upon reaching this position. However, with control power on, if breaker stopped in test position, the mechanism would have charged and retained its charge between positions. Perform the following checks in this position:

a) Electrically close and trip breaker to check operation in the connected position.

b) Check ground contact.

7. Remove breaker from cubicle and check the length of engagement of the primary contact fingers over the straight portion of the contact surface on the stationary contact. The contact point of the fingers must have a minimum wipe of .12 inch (3 mm) over the straight portion of the stationary contacts (Figure 75). This can be observed by opening shutters and with a flashlight note the polish marks on the stationary contacts. Remove excess grease from contact fingers.

**WARNING**

STATIONARY CONTACTS MUST NOT BE ENERGIZED WHEN OPENING SHUTTERS.

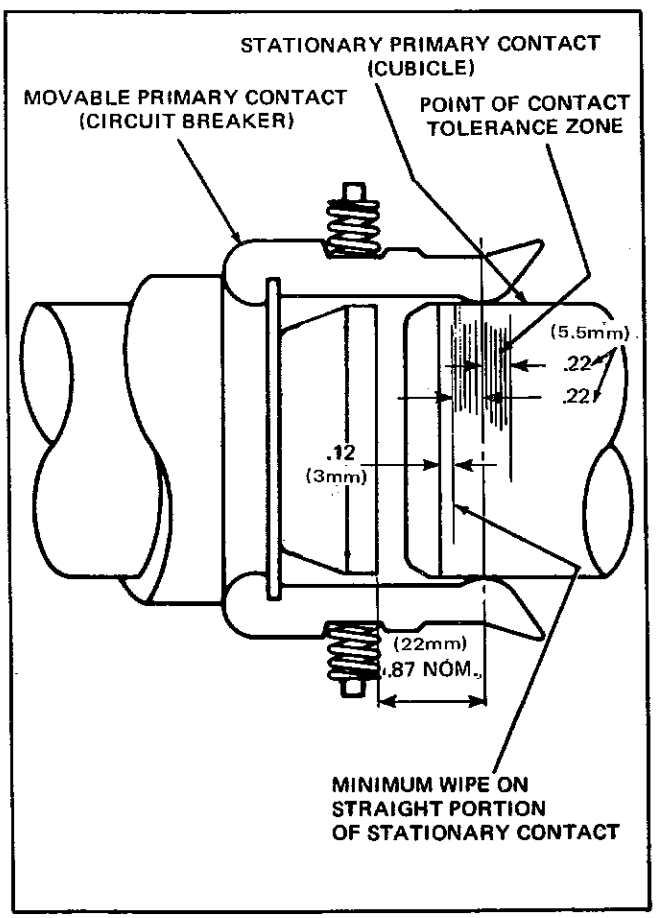



**Figure 75. Primary Contact Engagement.**

8. Before final installation of circuit breakers, check that all primary disconnect studs and contact fingers and secondary disconnect strips and fingers are lubricated with a film of the electrical lubricant provided. This lubricant will insure a long service life for the contacts and will protect them against corrosion. Lubricant Siemens-Allis No. 15-171-370-002.

## RACKING INSTRUCTION – 5-kV CLASS

Insertion of the circuit breaker into the cubicle to the disconnected position is accomplished simply by pushing the breaker into position. The breaker will come to a stop in the disconnected position when the interlock plunger engages the notch in the main interlock bar. The breaker release pedal must be manually depressed to raise the interlock plunger and permit movement of the breaker to test position. Here again, the breaker release pedal must be depressed to permit movement of breaker toward the connected position. The breaker will come to a stop when the primary fingers start to engage the primary stud mounted in the cubicle. To move the breaker to the fully connected position, use the racking lever.

**CAUTION**

The racking lever furnished with the accessories must be used to insure smooth, positive engagement of the contacts. Use of other means may damage the contact fingers and/or the stationary primary contact.

Insert the pivot point of the lever into its mating hole in the fulcrum angle on the cubicle floor (See Figure 76). A short upward stroke of the lever moves the breaker into the full operating position. The release pedal will snap to its forward-most position. Only when the breaker is in full operating position and the interlock plunger is in the corresponding notch of the main interlock bar can the breaker be closed and the stored energy springs charged.

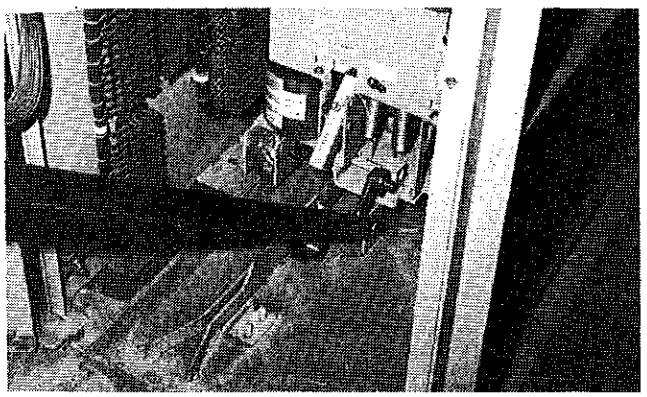


Figure 76. Racking Lever in Position to Move 5 kV Breaker to Fully Connected Position

To withdraw the breaker, insert the fulcrum pin of the lever into its mating hole in the breaker carriage (Figure 77).Depress the breaker release pedal. A short downward stroke of the lever will then withdraw the breaker from the operating position.

## RACKING INSTRUCTIONS – 15-kV CLASS

Visually center the breaker at the front of the cubicle. Most 15-kv class breakers can be manually pushed far enough into the cubicle to enable the racking lever pawl to engage the racking strip on the cubicle floor. A racking strip extension is used with the larger 15-kv class breakers. This strip is placed in position as shown in Figure 78. Insert the pin on the racking lever into the horizontal hole at the bottom of the breaker frame (Figure 79) with the racking lever pawl pointing toward operating personnel. By "pumping" the racking lever handle, the breaker will travel toward the disconnect, test and connected positions.

To remove the breaker, position the pawl to point away from operating personnel (Figure 80) and operate the racking lever as described above.

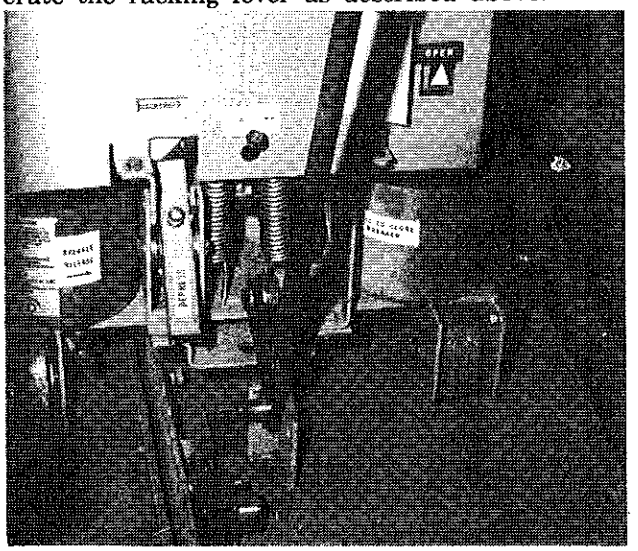


Figure 77. Racking Lever in Position to Withdraw 5 kV Breaker from Connected Position

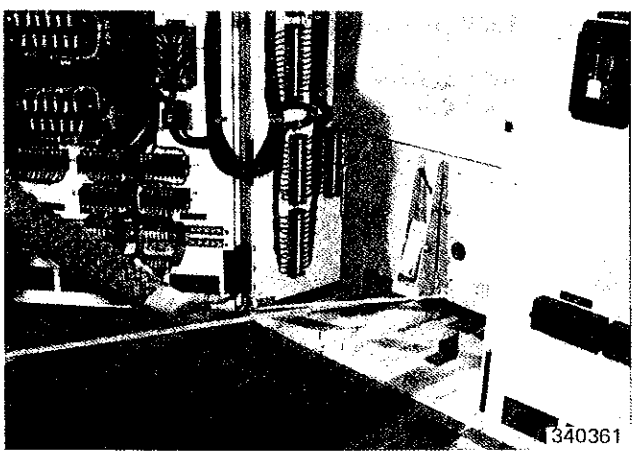



Figure 78. Placing Racking Strip Extension in Position – 15 kV Cubicle

## INSPECTION and TESTING

### INSTALLATION, INSPECTION AND TESTING

Before the equipment is put in service, it must be thoroughly inspected and tested. Correct any defects immediately

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.

### FINAL 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.

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. (Potential transformers, control transformers, lightning arresters, surge capacitors, are disconnected during this test.)

| Rated KV | Test KV | DC |
|---|---|---|
| 5.0 | 14.3 | 20.2 |
| 7.5 | 14.3 | 20.2 |
| 15.0 | 27.0 | 38.2 |

A dielectric test on secondary and control circuits should be made at 1200 volts. The above voltages are in accord with NEMA Standards.

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.

# OPERATION

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.

# MAINTENANCE

## SAFETY WARNING

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.

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.

1. Inspect switchgear interior for accumulation of dust, dirt or any foreign matter. Remove dust from all insulators.

2. Clean air filters by washing in any mild household detergent.

3. Check instrument and control switches and inspect their contacts.

4. Examine indicating lamps and replace as required.

5. Check terminal block contacts for loose connections.


Figure 79. Position of Racking Lever Pawl when Racking-in 15 kV Breaker

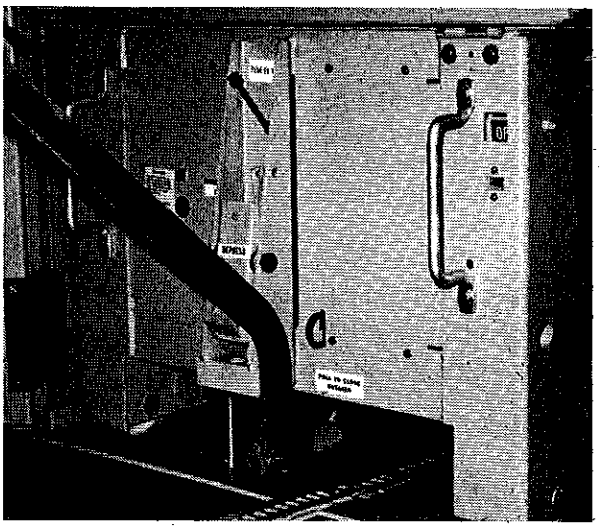


Figure 80. Position of Racking Lever Pawl when Racking-out 15 kV Breaker

6. Inspect bus bars and connections for proper condition. If bus bars are overheating, check for poor or loose connections or for overload.

7. Check for proper condition of instrument transformers. Replace burned out fuses, if any. Check primary and secondary connections.

8. Examine automatic shutters for proper operation.

9. Examine all safety interlocks.

10. Perform maintenance of circuit breakers as outlined in circuit breaker instruction manual.

11. Check space heaters and thermostat (if equipped) for proper operation.

## CUBICLE 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 of lubricant is furnished by Siemens-Allis, packed with accessories, for this purpose. Old grease should be removed annually and parts relubricated. Relubricate at more frequent intervals if required. Lubricant Part No. 15-171-370-002.

## MOVING PARTS

Lubricate shutter guides, bearings, tilt-out transformer trunnions, etc. with dry spray lubricant Siemens-Allis Part No. 15-171-270-001.

**NOTE**

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

## ELECTRICAL CONTACTS

Lubricate stationary silver-surfaced contacts with contact lubricant furnished by Siemens-Allis, prior to use, as follows:

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

**CAUTION**

Avoid getting lubricant on insulation.

**CAUTION**

**CLEANING INSULATION**

Most of the plastics and synthetics used in insulation systems are attacked by solvents 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.

## 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 - 2 mm) thick. Use only Siemens-Allis Electrical Contact Lubricant, part no. 15-171-370-002, available in 8 oz. (.23 kg) tubes. Other exposed members can be protected with a cost of glyptol lacquer or any other corrosion-resisting paint.

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

Matching paint, one pint per three units, thinned and ready for use, is supplied with each order for touching up any scratches, etc., made during installation. Inspect the surface and retouch where necessary. Paint is furnished in spray-on one pint cans.

Inspect the cubicle surfaces and touch up scratches as necessary. Use the paint furnished with the unit. This paint matches the cubicle, is thinned and ready for use in spray-on pint (473 $mm^3$) cans.

# ACCESSORIES

## KEY INTERLOCK

When specified, a key interlock can be supplied to prohibit closing a breaker. The interlock bar is attached to the guide bar. In the locked position, the lock bolt is extended, raising the cam follower bar, locking the breaker in the trip-free position. Then the key can be removed to release disconnects or associated equipment for operation.

This interlock is cleared for normal breaker operation by returning disconnects, etc., to normal operating position and inserting the key into its lock, permitting withdrawal of the bolt and lowering of the cam follower bar.

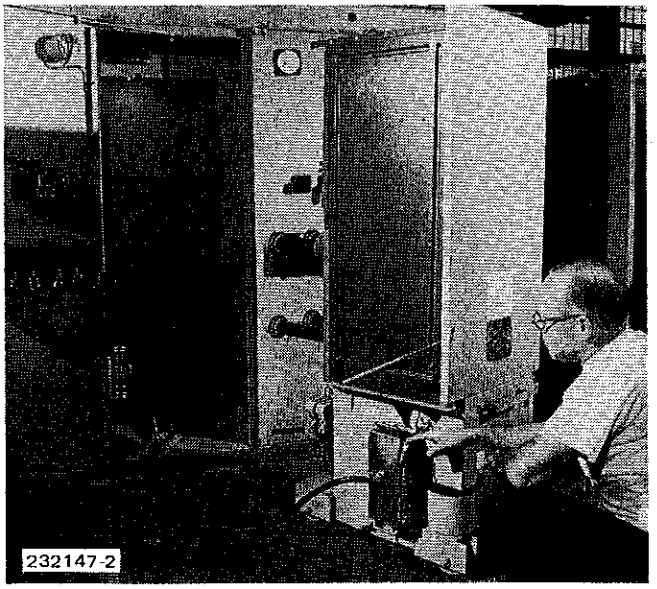



**Figure 81. Test Device for Testing Breaker Outside Unit with Switchgear Control Power.**

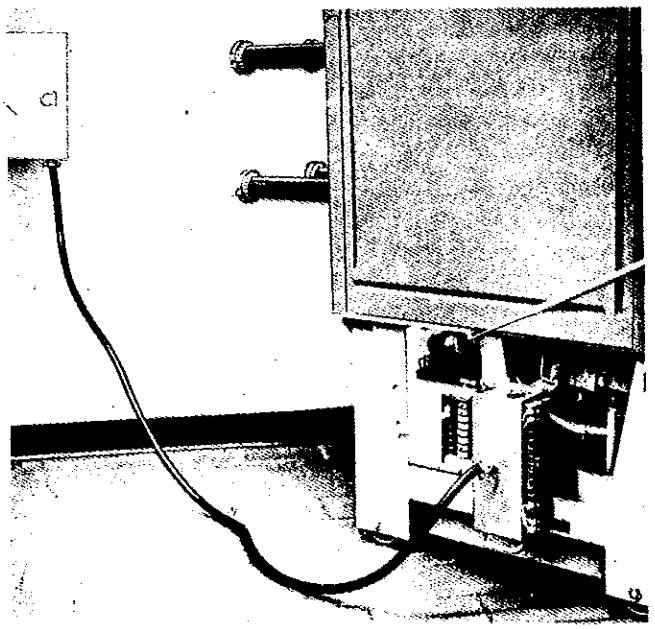


**Figure 82. Testing Breaker Outside Unit with Test Cabinet.**

## TESTING DEVICE

When specified, a plug jumper is supplied so that a breaker can be operated (tested) outside its compartment with the control switches on the instrument panel. This plug jumper is used to bridge — with a flexible cable — the secondary disconnects so that the breaker can be electrically closed and tripped, see Figures 81 and 82. Refer to Figures 83 and 84 for plug jumper connection instructions.

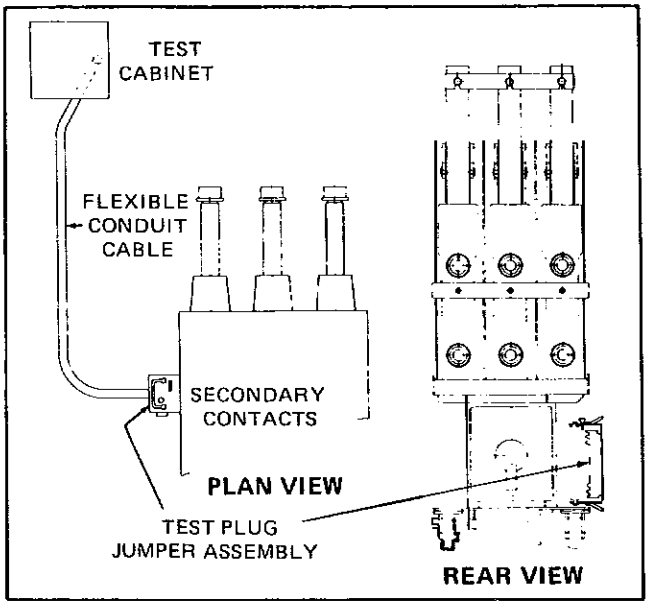



**Figure 83. Connecting Breaker Secondary to Test Control Cabinet**

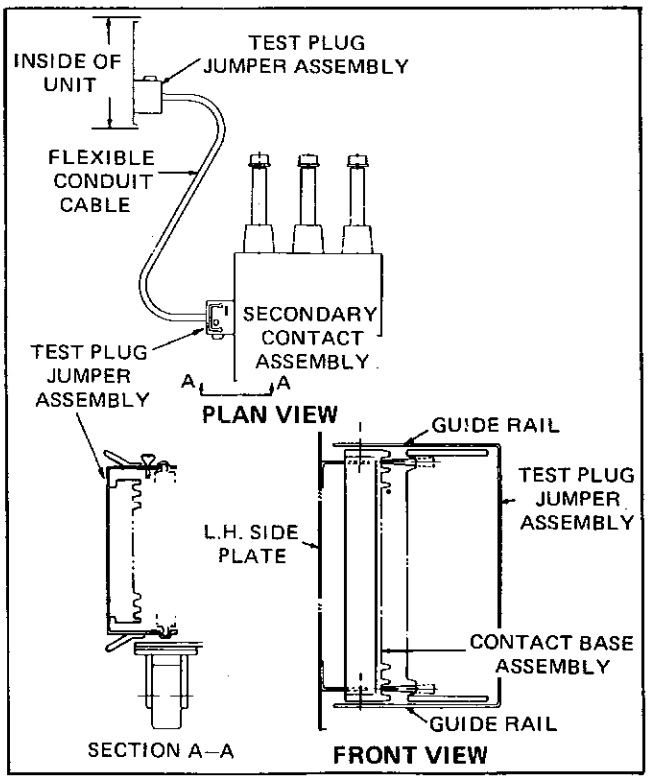



**Figure 84. Connecting Breaker Secondary to Cubicle.**

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