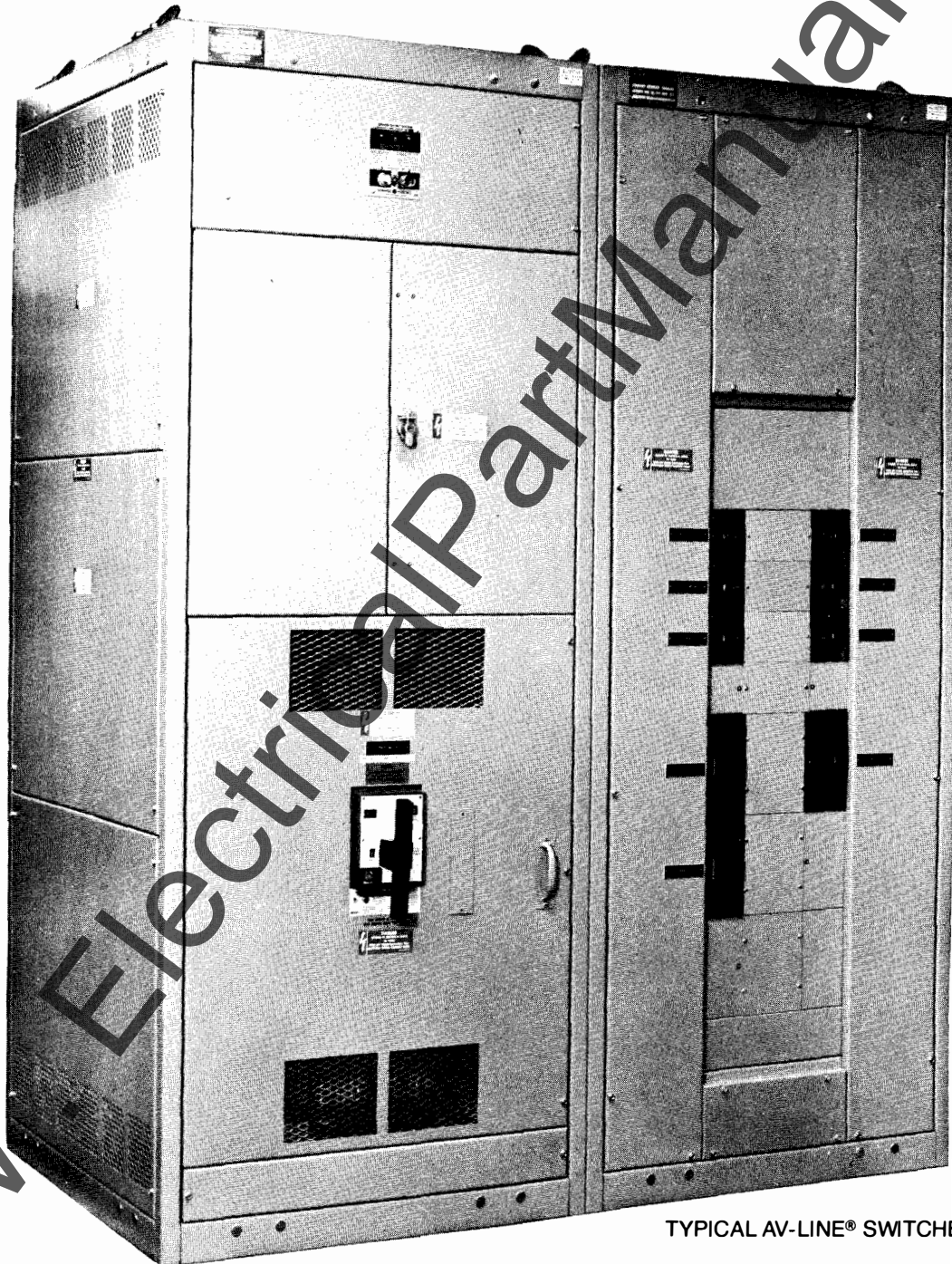




## AV/BV Line® Switchboards



TYPICAL AV-LINE® SWITCHBOARD

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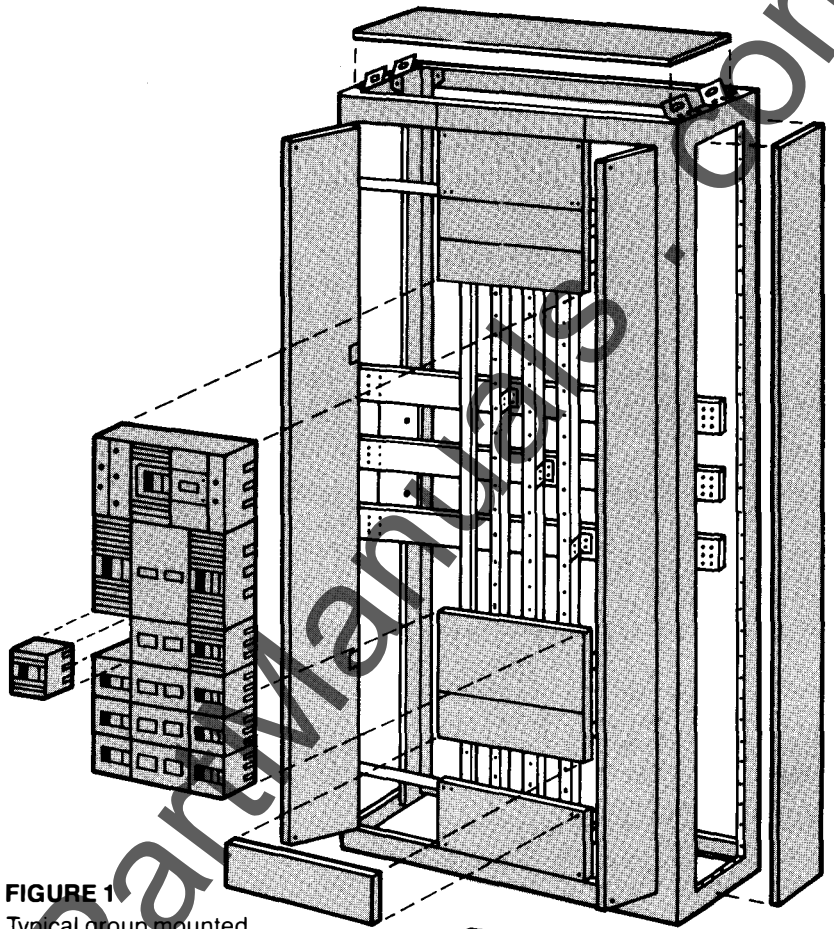
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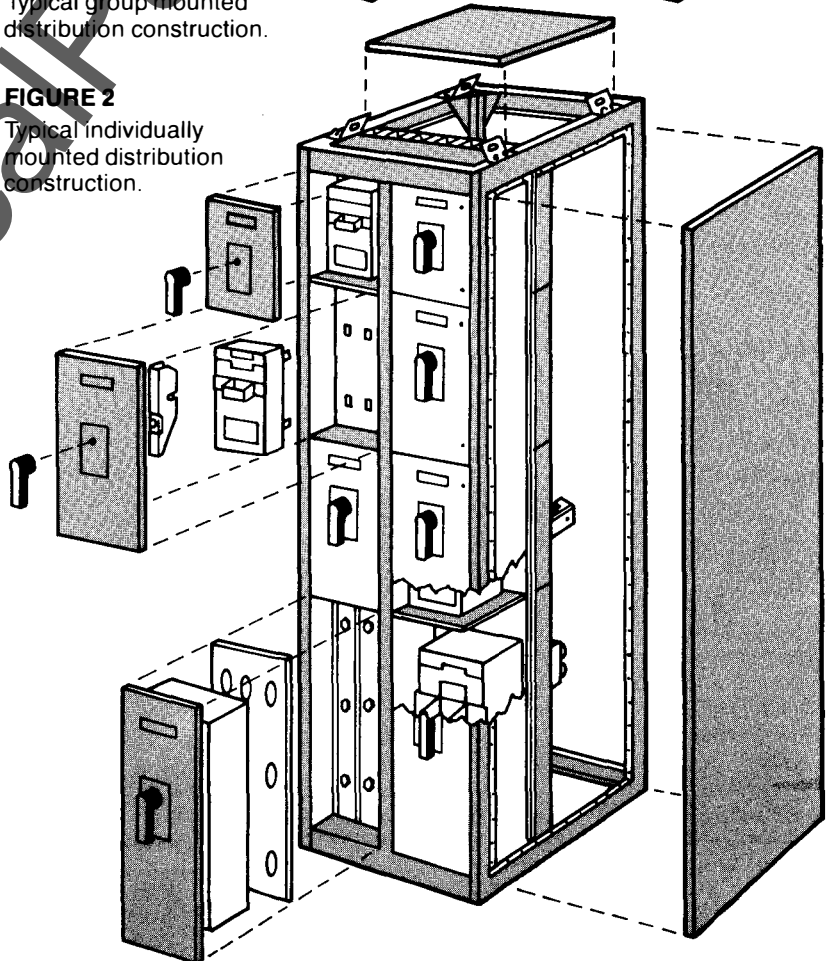
# Switchboard Construction

These instructions do not purport to cover all details or variations in equipment nor do they provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired, or should particular problems arise which are not covered sufficiently for the purchaser's purpose, the matter should be referred to your supplier.



**FIGURE 1**  
Typical group mounted distribution construction.

**FIGURE 2**  
Typical individually mounted distribution construction.



# Receiving, Handling and Storage

## RECEIVING

Before leaving the factory, the switchboard is given a final inspection and packed by workmen experienced in the proper handling and packing of electrical equipment. Upon receipt of any apparatus, an immediate inspection should be made for any damage sustained in transit. If damage is noted, or indication of rough handling is visible, a claim for damage should be filed with the carrier. Information as to damaged parts, part number, case number, requisition number, etc., should accompany the claim.

In regard to claims for damaged shipments, shortages and incorrect material, the following is an excerpt from the published Supplemental Terms and Conditions of Sale for products of the Company.

"Title and risk of loss shall pass upon delivery of the products to the carrier at the f.o.b. point and invoices shall be payable without deduction for losses in shipment. It is the Purchaser's responsibility to file claims with the carrier for loss or damage in transit."

"Claims for shortages or incorrect material must be made in writing within 30 days after receipt of the shipment by the Purchaser, and the failure to give the Company such written notice within the 30-day period shall be unqualified acceptance of the products and a waiver by the Purchaser of all claims for shortages or incorrect material."

## HANDLING

Equipment may be moved into position by means of construction rollers under the shipping skids. Remove all outer packaging. Lifting by crane or other hoisting methods done as shown in Figures 3 and 4.

To remove the switchboard from the skids after taking out the shipping bolts, carefully slide the equipment so that the rear side is off the skids, resting on the floor (see Fig. 5). Tilt the entire equipment slightly to the rear to release the skids. Caution is advised in sliding and tilting this equipment due to its height and weight. It can become top heavy if tilted too far. Slide the switchboard into place by pushing on the frame. Blow out any dust or loose particles of packing material which may have collected on the device parts. Remove all protective blocking on relays, devices or breakers.

## STORAGE

If it is necessary to store the equipment for any length of time, the following precautions should be taken to prevent corrosion or breakage:

1. Uncrate equipment.
2. Store in a clean, dry, rodent-free area in moderate temperature. Cover with a suitable canvas to prevent deposits of dirt or other foreign material on movable parts and electrical contact surfaces. (Heavy duty plastic covers are recommended.)
3. If stored in cool or damp areas, heat should be provided to keep the equipment dry. On outdoor switchboards this may be accomplished by making a temporary power connection to the heaters installed in the equipment. On indoor switchboards, two standard 120 volt lamps rated at 100 watts can be used inside each vertical section.

**CAUTION:** Remove all cartons and other miscellaneous packing material from inside the units before energizing any heaters.

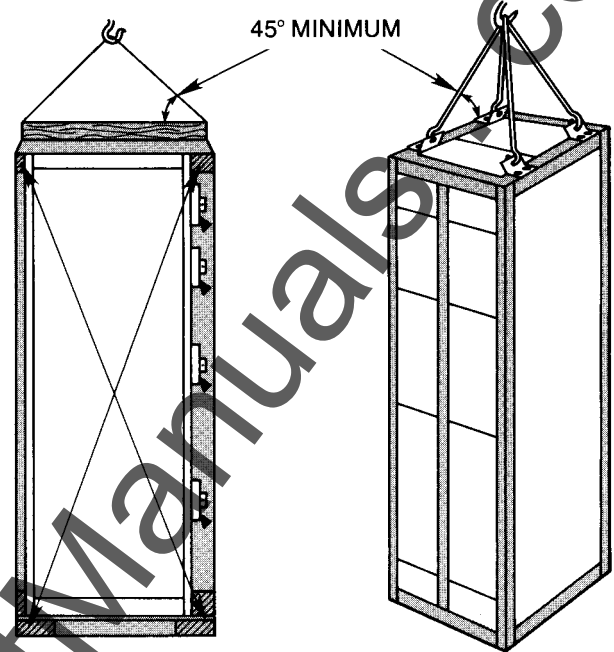


FIGURE 3

Using lifting slings, spreader and blocking are not furnished with equipment.

FIGURE 4

Using lifting plates, angles or beams which are furnished with equipment.

## LIFTING INSTRUCTIONS

1. Do not pass cables or ropes through support holes.
2. Always use load rated shackles or safety hooks in support holes.
3. Rig so that legs of sling (Figs. 3 and 4) are no less than 45° from horizontal.

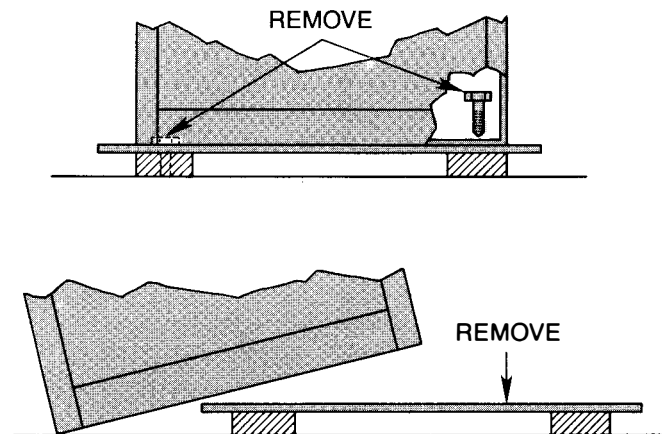
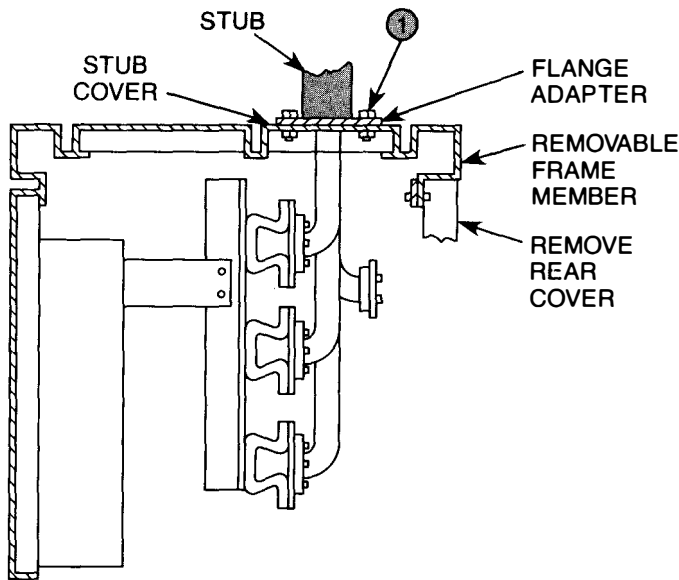


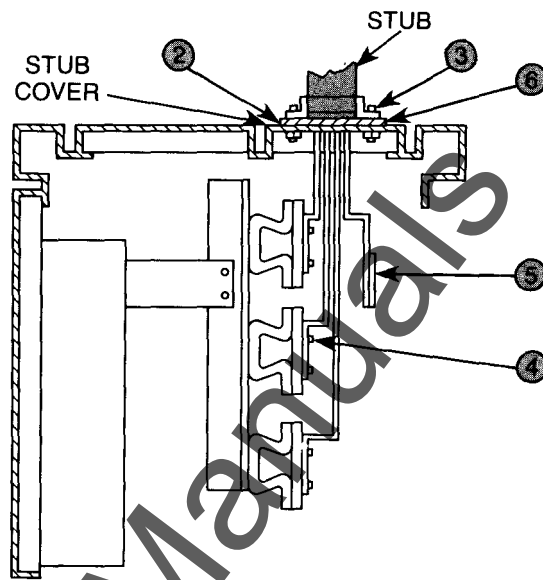
FIGURE 5

Remove lag bolts. Slide unit off skid and remove skid.

# Installing The Bus Stub



**FIGURE 6**  
For GE LVD busway stubs.



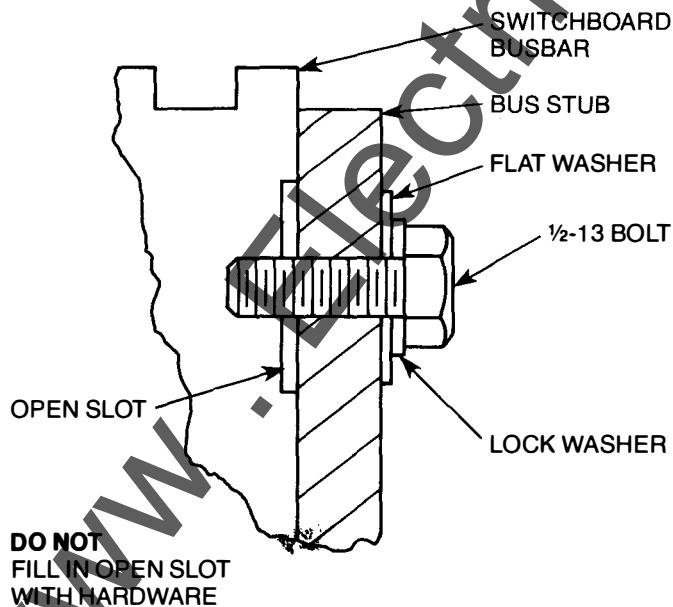
**FIGURE 7**  
For GE Armor-Clad® busway stubs.

## INSTALLATION PROCEDURES

If access to switchboard bus at point of connection to busway stub is limited by wall or other obstruction, stub must be installed before board is placed in final location.

- 1 Remove shipping screws holding bus stub flange adapter to stub cover. Slide adapter apart to allow stub to enter through slot in cover. When space is limited, the top rear frame member may be removed so that the stub with stub cover may be installed horizontally instead of vertically.

- 2 Slide flange adapters together to close up slot.
- 3 Loosely fasten bus stub flange to stub cover with hardware furnished with stub.
- 4 Bolt stub bus to switchboard bus (see Fig. 7A).
- 5 Bolt neutral splice bus (if required) to stub neutral with hardware furnished with the neutral splice bus.
- 6 After stub and switchboard bus is properly aligned and bolted, tighten down flange screws.



**FIGURE 7A**  
For GE Armor-Clad® busway stubs.

# WARNING: Short Circuit Cable Bracing Required

## MAIN CABLE BRACING

Main cable bracing is required when five cables per phase or less feed a switchboard at available short circuit currents of 100,000 and 150,000 rms symmetrical amperes, and eight cables per phase or less at an available short circuit current of 200,000 rms symmetrical amperes.

Assembly, purchasing and maintenance instructions for main cable short circuit bracing can be found on pages 6 and 7.

## LOAD CABLE BRACING

Load cable short circuit bracing is required for each component installed in a class 3 or 4 switchboard section with available short circuit currents of 65,000 rms symmetrical amperes and above.

Assembly, purchasing and maintenance instructions for load cable short circuit bracing can be found on page 8.

## Installing The Main Cable

### CLASS 1, 2, AND 5 SWITCHBOARDS UTILIZING CORD FOR SHORT CIRCUIT PROTECTION

#### PRIOR TO INSTALLATION

Before any installation work is performed, study all drawings furnished by the supplier for the particular installation. These include arrangement drawings (front, end and plan view), connection diagrams and schedule of equipment. Any material external to the equipment which may be required to meet any local codes (railings, etc.) is not furnished.

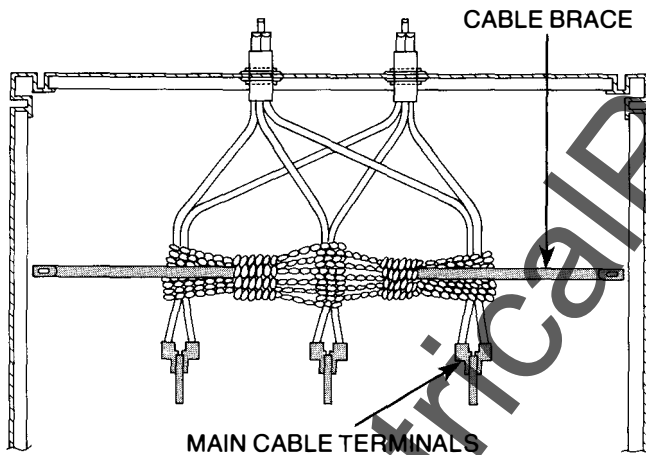


FIGURE 7B

#### INSTALLATION PROCEDURES FOR MAIN CABLE WITH SHORT CIRCUIT PROTECTION

Align conduit holes in a linear orientation directly over or as close as possible to the braces. Consideration should be given to installing conduits or sleeves which might be required for future connections.

Run and bend the main cable in a most convenient orientation, making sure the main cable has been located directly up against the cable braces before it connects to the main cable terminals. Lash the main cable according to Figure 7B above, using a  $\frac{3}{8}$ " nominal nylon rope, or a polyester braided rope having a tensile strength of 2000 lbs. minimum, making 6 revolutions around the

"A" and "B" phase main cables and 6 revolutions around the "B" and "C" phase main cables. Now, with the remaining cord, wrap the main cable lashing to the cable braces in between phases with 4 to 5 revolutions, tying a knot to the cable braces as you complete your last revolution. All revolutions should be made as tight as possible so as to prevent whipping during short circuits.

#### INSPECTION AFTER MAIN CABLE INSTALLATION

To prevent heating, there should be no closed loop of steel around a single conductor or group of conductors which does not include all the conductors (including the neutral) of the circuit. If the conductors must pass through separate holes in a piece of steel, slots should be cut between the holes. Do not allow cables carrying heavy current to come near instruments or meters as this may affect their accuracy. Use the minimum amount of cable necessary to accomplish the connections. The increased resistance of longer cables generates unnecessary heat. Main cable lashing should be checked annually.

#### REAR ACCESS

Some switchboards may require access to field wiring terminals from the rear. Do not install these switchboards against the back wall.

# Installing The Main Cable (Cont'd)

CLASS 3, 4 SWITCHBOARDS UTILIZING CORD FOR SHORT CIRCUIT PROTECTION

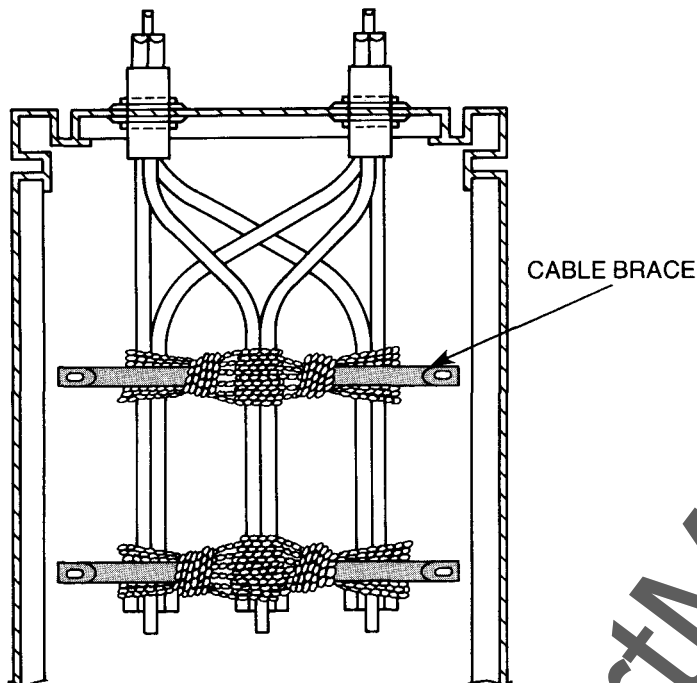


FIGURE 7C

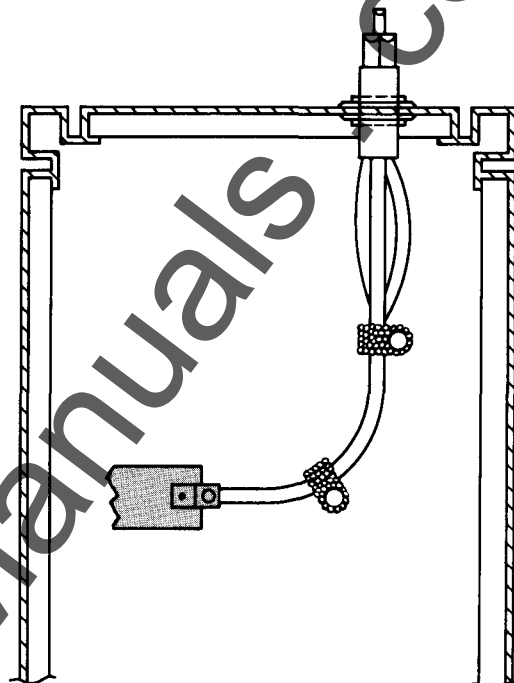


FIGURE 7D

## PRIOR TO INSTALLATION

Before any installation work is performed, study all drawings furnished by the supplier for the particular installation. These include arrangement drawings (front, end and plan view), connection diagrams and schedule of equipment. Any material external to the equipment which may be required to meet any local codes (railings, etc.) is not furnished.

## INSTALLATION PROCEDURES FOR MAIN CABLE WITH SHORT CIRCUIT PROTECTION

Align conduit holes in a linear orientation a distance equal to the radius bend of the cable. Consideration should be given to installing conduits or sleeves which might be required for future connections (see Figure 7D). Run and bend the main cable in a most convenient orientation, making sure the main cable has been located directly up against cable braces before it connects to the main cable terminals (see Figure 7C). Lash the main cable according to Figure 7C above, using a  $\frac{3}{8}$ " nominal nylon rope, or a polyester braided rope having a tensile strength of 2000 lbs. minimum, making 6 revolutions around the "A" and "B" phase main cables and 6 revolutions around the "B" and "C" phase main cables. Now with the remaining cord, wrap the main cable lashing to the cable brace in between phases with 4 to 5 revolutions, and tie a knot to the cable brace as you complete your last revolution. All revolutions should be made as tight as possible so as to prevent whipping during short circuits.

## INSPECTION AFTER MAIN CABLE INSTALLATION

To prevent heating, there should be no closed loop of steel around a single conductor or group of conductors which does not include all the conductors (including the neutral) of the circuit. If the conductors must pass through separate holes in a piece of steel, slots should be cut between the holes. Do not allow cables carrying heavy current to come near instruments or meters as this may affect their accuracy. Use the minimum amount of cable necessary to accomplish the connections. The increased resistance of longer cables generates unnecessary heat. Main cable lashing should be checked annually.

## REAR ACCESS

Do not install these switchboards against the back wall. Rear access is required for field wiring and maintenance.

# Installing The Load Cable

CLASS 3, 4 SWITCHBOARDS UTILIZING CORD FOR SHORT CIRCUIT PROTECTION

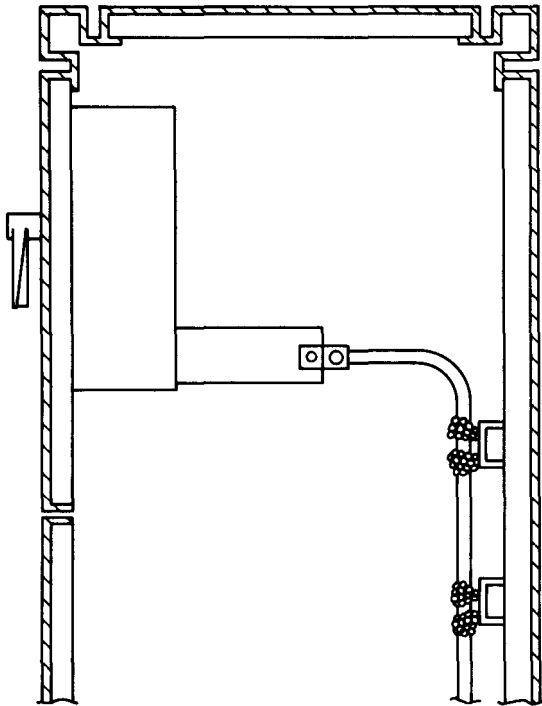


FIGURE 7E

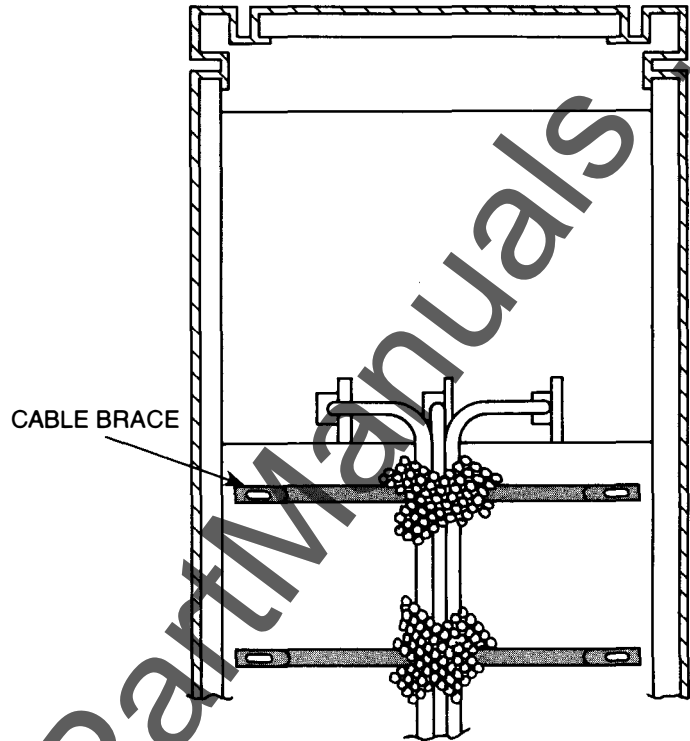


FIGURE 7F

## PRIOR TO INSTALLATION

Before any installation work is performed, study all drawings furnished by the supplier for the particular installation. These include arrangement drawings (front, end and plan view), connection diagrams and schedule of equipment. Any material external to the equipment which may be required to meet any local codes (railings, etc.) is not furnished.

## INSTALLATION PROCEDURES FOR LOAD CABLE WITH SHORT CIRCUIT PROTECTION

Locate the load cable braces which can be found every 18" on the back of the switchboard. Run and bend the load cable in the most convenient manner, making sure that the load cable is up against the load cable brace closest to the component's load terminals (see Figure 7E) and to every load cable brace above or below, depending if the load cable will exit the switchboard on top or bottom (see Figure 7F).

After running the load cable up against the load cable braces and using a  $\frac{3}{8}$ " nominal nylon rope, or a polyester braided rope having a tensile strength of 2000 lbs. minimum, lash the load cable to the load cable brace, making 4 revolutions around the cable and the brace. Tie a knot to the cable brace after completion of the last revolution. All revolutions should be made as tight as possible so as to prevent whipping during short circuits.

## INSPECTION AFTER LOAD CABLE INSTALLATION

To prevent heating, there should be no closed loop of steel around a single conductor or group of conductors which does not include all the conductors (including the neutral) of the circuit. If the conductors must pass through separate holes in a piece of steel, slots should be cut between the holes. Do not allow cables carrying heavy current to come near instruments or meters as this may affect their accuracy. Use the minimum amount of cable necessary to accomplish the connections. The increased resistance of longer cables generates unnecessary heat. Load cable lashing should be checked annually.

## REAR ACCESS

Do not install these switchboards against the back wall. Rear access is required for field wiring and maintenance.



# Installing The Switchboard

## PRIOR TO INSTALLATION

Before any installation work is performed, study all drawings furnished by the supplier for the particular installation. These include arrangement drawings (front, end, and plan view), connection diagrams and schedule of equipment. Any material external to the equipment which may be required to meet any local codes, (mats, screens, railings, etc.), is not furnished.

## LOCATION

In locating the switchboard, consideration should be given to the aisle space required. The space at the front must be sufficient to permit the opening of doors, and the insertion and withdrawal of removable breakers. The space at the rear must be sufficient for opening of doors as well as the cables, inspection, and maintenance. Check local codes for special aisle space requirements.

## FOUNDATION REQUIREMENTS

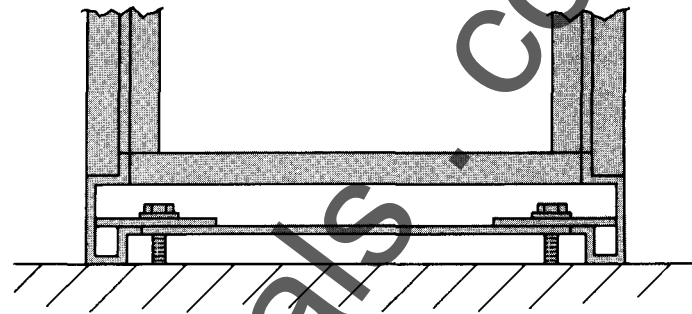
**Indoor Equipment**—The floor or foundation must be strong enough to prevent sagging from the weight of the switchboard structure. If the foundation is subject to vibrations, special mounting must be provided to prevent the transmittal of vibrations to the equipment.

Because of its high structural strength, the switchboard may be bolted directly to the floor (see Fig. 8). The floor must be entirely level without any high spots which might cause misalignment. If the floor is not level it is recommended that floor channels be used.

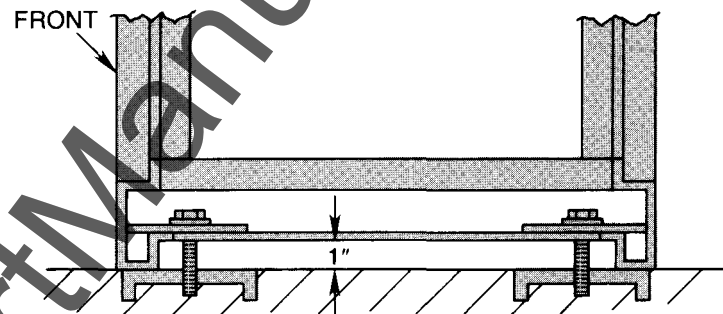
The steel floor channels when used should be embedded in a level concrete slab with the top surface of the channels flush with the finished floor. To avoid distortion of the structure, it is essential that the steel channels be level and aligned with each other prior to the final anchoring. The recommended foundation construction and method of mounting the switchboard to the foundation is shown in Fig. 9. Channels should be grouted after installation.

**Outdoor Equipment**—Outdoor equipment is usually installed on a concrete pad with a level and smooth surface. When optional channel sills are supplied with the switchboard (three), they should set on the pad and be filled with grout. See Figs. 10 and 11. Tamper-proof rodent guards are provided with sills.

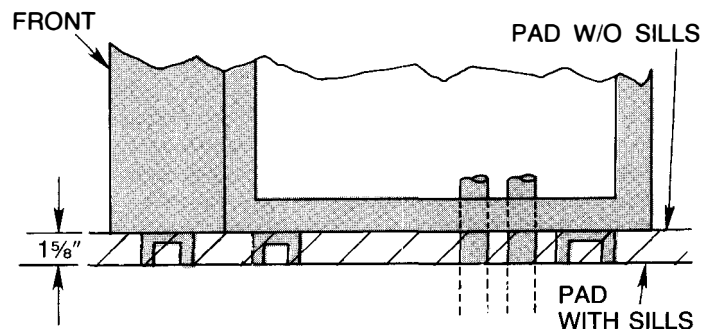
**Conduits**—At the time the foundation channels are being installed, any conduits or sleeves required for power and control cables that are to enter the equipment from underneath should be located and installed within the available space shown on the floor plan drawings. Consideration should be given to installing conduits or sleeves which might be required for future connections. Conduit stubs should extend above the floor just enough to prevent the entrance of water. Consideration should be given to the location of components in the switchboard and space should be allowed for swinging cables after they leave the conduit. The lowest live metal part in the switchboard will be approximately 8" minimum above the bottom of the switchboard (not including floor sills). It should be noted that the switchboard must be lifted over the conduit stubs. The conduits should terminate at the switchboard with the appropriate conduit connectors. Conduits may require grounding or electrical connection to the switchboard enclosure.



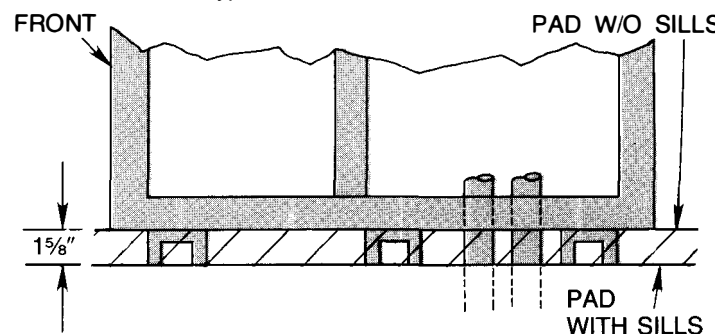
**FIGURE 8**  
Bolting the switchboard directly to the floor—  
indoor construction.



**FIGURE 9**  
Switchboard mounted on floor channels—indoor construction.



**FIGURE 10**  
Non-walk in type switchboard—outdoor construction.



**FIGURE 11**  
Walk-in type switchboard—outdoor construction.

# Installing the Switchboard (Cont'd)

## FIELD CONNECTIONS AND TESTING OF GROUND-FAULT PROTECTION SYSTEMS

1. In the service-entrance section, the neutral conductor shall be bonded to the switchboard ground bus by a "main bonding jumper" (ground strap) (NEC 250-5). This grounding point on the neutral conductor shall be located on the **supply** side of any ground-fault sensors involving the neutral conductor. Grounding connections shall not be made to the neutral conductor on the load side of the service disconnecting means (NEC 250-23a).
2. On load feeders, run all phase conductors (and neutral if used) through the sensor window(s), with all in the same direction with respect to sensor polarity.
3. Do not run equipment ground conductors through ground-fault sensors. Connect them directly to the switchboard ground bus (**not** to the neutral bus).
4. Connect the service grounding electrode (water pipe, etc.) to the lug provided on the switchboard ground bus for this purpose (NEC 250-26c).
5. Whenever a service is derived from a grounded neutral supply, the grounded neutral conductor must be brought into the service-entrance equipment, even if the grounded conductor is not needed for the load supplied by the service (NEC 250-23b). This is required to provide a low-impedance ground-fault current return path to the neutral to assure operation of the overcurrent device, for safety to personnel and property.
6. Refer to GE publication GE1-48907 for instructions for conducting performance tests of new installations of ground-fault protection systems, as required by NEC 230-95(c).

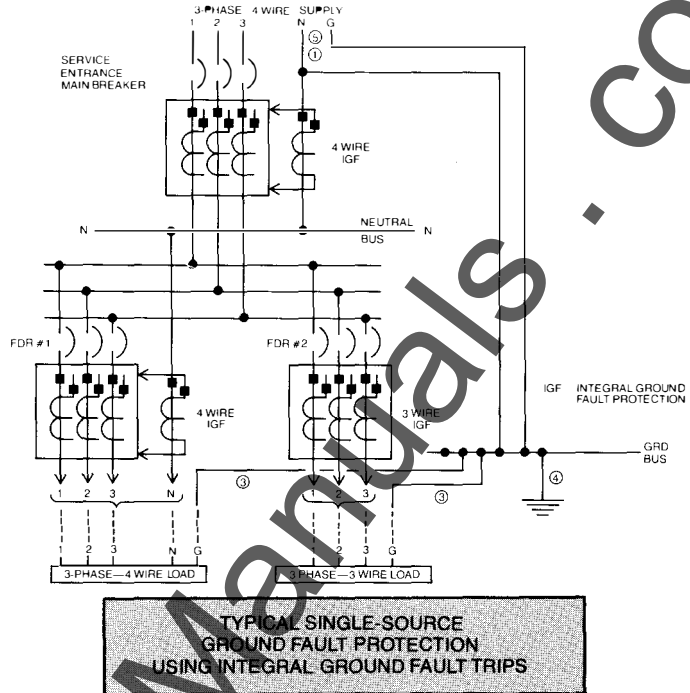


FIGURE 13

## FUSE SELECTION

The proper fuses for each circuit should be selected based on load characteristics (see Ambient Temperatures and Circuit Loading) and available short-circuit current at the line terminals of the switchboard. Select a fuse for which the rating of the combination fuse and switch equals or exceeds the available short-circuit current. Removable link-type fuses are not recommended.

## TESTING AND INSPECTION

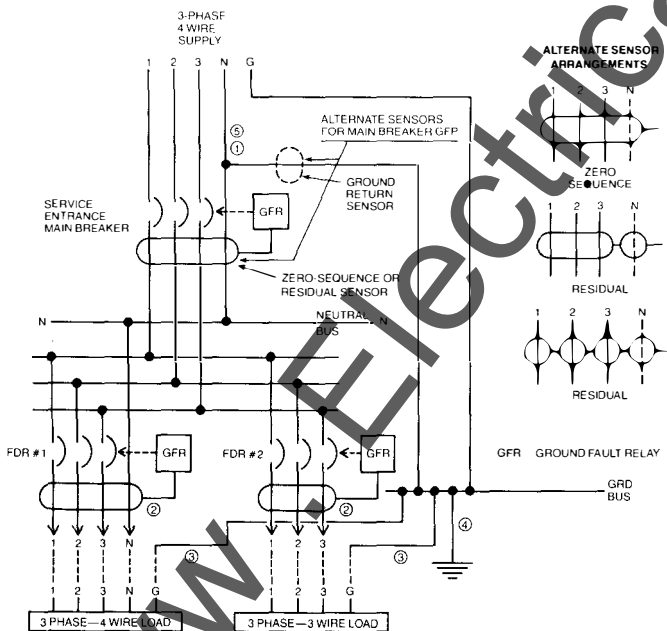
After the equipment has been installed and all connections made, it should be tested and inspected **BEFORE ENERGIZING**. Although the equipment and devices have been inspected at the factory, a final field test should be made to be certain that the equipment has been properly installed and that all connections are correct and have not become loose in transportation. It is recommended that the switchboard be completely wire checked, and all bolts and terminals double checked for tightness. Check all Kirk key interlocking schemes to insure desired performance. The incoming line should be completely de-energized while the tests are in progress.

In addition to these mechanical checks the switchboard should be meggered. Meggering should be performed with all switchboard devices in the open position and all instrumentation and control fuses removed. A megger (megohmmeter) developing 500 volts should be used. As a guide, switchboards tested when leaving the factory have shown typical minimum values of 100 megohms. Any switchboards job tested under the above conditions showing values considerably below this should be inspected for possible tracking on insulation or insulation breakdown.

All scraps of wire, plaster, dust and other foreign material must be removed. Vacuum cleaning is the recommended method of removal.

After thorough cleaning and inspection, if the megger reading is still low, it may still be safe to energize the equipment. When restoring flooded or wet equipment to service, for example, it is accepted maintenance practice to require a minimum of **one megohm** before energizing. Under damp or humid conditions it is considered good practice to operate the equipment at lower-than-rated voltage for a short time, if possible, to improve the low megger reading.

Instructions for inspection and testing of low voltage power circuit breakers are given in the applicable individual instruction book. Directions for testing devices such as relays, instruments and meters are given in the instruction book furnished for each device. Protective relays must be coordinated with other relays in the system, therefore these relays are to be set by the purchaser. General instructions on setting the relays are given in the relay instruction books.



TYPICAL SINGLE-SOURCE GROUND FAULT PROTECTION USING GROUND FAULT RELAYS

FIGURE 12

## GROUND FAULT PROTECTION

When ground fault protection is furnished, it is important that all field connections shall be made correctly so that the ground fault protection system will function properly. Observe the following rules, illustrated in Figs. 12, 13.

### BOLTING

Switchboards are furnished with medium carbon steel hardware having a high tensile strength. 1/4" to 1/8" bolts have a tensile strength of 120,000 psi, and 1/2" to 5/8" bolts have a strength of 60,000 psi. Similar hardware should be used for any additional bolting. The use of a torque wrench is recommended to assure the following torques. These torques apply to aluminum or copper connections. When torquing bolts the following values are nominal:

1/4"	— 20 bolts . . . . .	8-10 lb. ft.
5/16"	— 18 bolts . . . . .	16-19 lb. ft.
3/8"	— 16 bolts . . . . .	23-27 lb. ft.
1/2"	— 13 bolts . . . . .	35-40 lb. ft.
5/8"	— 16 bolts . . . . .	45-50 lb. ft.

Flat washers and spring washers should be used for all connections. Washers should not be included under the heads of carriage bolts.

### ELECTRICAL CLEARANCES

The following minimum clearances should be maintained except at terminals of circuit breakers and switches:

	0-125V	126-250V	251-600V
Between live parts of opposite polarity:			
Through air	1/2"	3/4"	1"
Over surface	3/4"	1 1/4"	2"
Between live parts and grounded metal through air or over surface	1/2"	1/2"	1"

### GROUNDING

The ground bus is bolted to the uprights of the rear frame structure. It is arranged so that connections to the station ground can be made in any unit. A ground lug is included in each complete equipment for tying the switchboard to the station ground. IT IS VERY IMPORTANT THAT THE EQUIPMENT BE ADEQUATELY GROUNDED, TO INSURE THAT ALL PARTS OF THE EQUIPMENT, OTHER THAN LIVE PARTS, ARE AT GROUND POTENTIAL. Ground sensor relays are recommended for protection of the switchboard.

## Switchboard Maintenance

**CAUTION! De-energize this equipment before performing any work.**

A periodic maintenance schedule should be established to obtain the best service from the switchboard. An annual check and overall maintenance procedure for the switchboard devices and all connections, should be followed as a minimum requirement. Equipment subject to highly repetitive operation may require more frequent maintenance.

A permanent record of all maintenance work should be kept. The record should include a list of periodic checks and tests made, the date they were made, the condition of the equipment, and any repairs or adjustments that were performed. Maintenance employees should follow all recognized safety practices, such as those contained in the National Electrical Code, OSHA and in company or other safety regulations during maintenance.

For specific information regarding the maintenance of devices, such as circuit breakers, relays, meters, etc., refer to the separate instruction book furnished for each device.

1. Periodically inspect switchboard while under load to determine if there is any indication of overheating. If overheating or any other unsatisfactory condition is found, completely de-energize switchboard and investigate. Particularly look for loose bolts and connections, or overloading. Remove any accumulation of dirt or other foreign matter in enclosure. Do not touch live parts while switchboard is energized.
2. Plated parts may become dark over a period of time due to oxidation. Do NOT remove this discoloration, as it will reduce the thickness of the plating.
3. Retighten lugs and joints to eliminate possible heating points. Transmittal of vibration through building structure and conduit to switchboard may loosen lugs and joints. Turning load off and on causes expansion and contraction between lug and cable tending to loosen lug.
4. Do not open sealed breaker or trip units as calibration may be disturbed. Return to factory for any replacement.

### AMBIENT TEMPERATURES AND CIRCUIT LOADING

Switchboards are designed for installation where average ambient temperature will not exceed 40°C (104°F). For higher temperatures, derating may be required. The conductor temperatures within the enclosure may be as high as 80°C (176°F). Some parts of breakers, switches and fuses may run hotter. In accordance with NEC Art. 384-16(c) it is recommended that thermal-magnetic molded-case breakers in switchboards not be loaded in excess of 80% of rating where load will continue for three hours or more, even with ambient-compensated breakers.

### SHORT CIRCUITS

Normally, the overcurrent protective device on the circuit will prevent any electrical damage except at the actual point of short-circuit. A thorough inspection of the entire system after any large fault current should be made to insure that there has been no mechanical damage to conductors, insulation or equipment.

In addition, the individual overcurrent protective device or devices which performed the short-circuit interruption must be inspected for possible arcing damage to contacts, arc chutes and/or insulation. Do not open sealed devices such as breaker trip units or 150A frame breakers. If there is any possibility that sealed units may have been damaged, they should be replaced. For additional details on the particular device involved, refer to the applicable individual instruction book.

### ARCING DAMAGE TO INSULATION

Some organic insulating materials carbonize when subjected to the heat of an electrical arc and lose their insulating qualities. Any insulation found to be carbon-tracked must be replaced before applying power.

(Continued on Page 12)

# Switchboard Maintenance (Cont'd)

## WATER-SOAKED EQUIPMENT

1. Completely de-energize switchboard.
2. Carefully clean and dry all parts of the switchboard. When using heaters, do not exceed 180 degrees F.
3. Replace all fuses.
4. Individual devices should be inspected for the possible entrance of water, dirt or foreign matter.
5. Do not open sealed devices such as breaker trip units or 150A. frame breaker. Replace them.
6. Prior to re-energizing the switchboard it should be meggered. Refer to testing and inspection section on page 7.
7. If assistance or guidance is required contact your local service engineer. Your supplier's service shops have facilities for reconditioning.

## SPARE PARTS

A spare parts stock for the components of the switchboard, such as bus, insulators, etc. is not recommended. When components need to be reordered, please refer to the nameplate marking, shop drawing number, and order by description. A spare parts stock of devices such as circuit breakers, meters, switches, etc. will vary due to the variety of installations. Your supplier sales engineer will be glad to assist you in the proper selection for a device stock list.



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