# *SWITCHBOARD MANUAL*

*META POWER SOLUTIONS®*

**Product information**

**Introduction**

This instruction manual will help guide competent technicians in installing, operating, and maintaining **Switchboards**.

This manual was made after anticipating most normal installation, operation, and servicing problems. However, the instructions do not cover all possible scenarios where equipment or application conditions may vary. In such cases, additional information can be obtained by contacting a factory representative at:

Meta Power Solutions (MPS)
500 S Australian Ave Suite 600, West Palm Beach, FL 33401

**Read this manual first!**

It is important that a technician reads this manual, understands its contents, and follows all locally approved practices and safety procedures before connecting or operating a switchboard.

**Additional information**

This instruction manual cannot cover every detail or variation in the equipment, process, or procedure described, nor can it provide directions for meeting all possible contingencies during the equipment installation, operation, or maintenance. Contact your Meta Power Solutions representative for additional information if the need arises.

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## Introduction

### Section 1.0 – Introduction

This instruction manual can be used by competent technicians to develop safe and efficient procedures and guidelines for installing, maintaining, and operating switchboard equipment. For additional information, refer to NEMA Standards Publication PB2.1, "General Instructions for Proper Handling, Installation, Operation, and Maintenance of Dead Front Distribution Switchboards rated 600 volts or less", which is available on the NEMA web site (www.nema.org).

MPS warrants that all the goods manufactured by MPS strictly conform to accepted industrial standards regarding materials and workmanship, which are verified until the day of product shipment from the MPS factory. However, if any non-conformity is observed in the manufactured goods by the purchaser within the first twelve months from the date of shipment and promptly notifies MPS in writing, MPS will rectify the identified defect through adjustment, repair, or replacement of the item and any affected part of the goods. Purchasers may refer to "Standard Terms and Conditions of Sale" for the complete warranty terms and contact the MPS representative if additional information is required.

### 1.1 Qualified Person

The instructions in this manual are not meant to be used as substitutes for proper training and experience in safely operating the described equipment. Only "competent technicians" should be allowed to install, operate, and service the equipment. A competent technician should have the following qualifications:

- They are thoroughly familiar with the instructions given here.
- They are properly trained in industry-accepted low-voltage and high-voltage safe operating procedures and practices.
- They are adequately trained and fully authorized to energize, de-energize, ground, and clear power distribution equipment.
- They are properly trained in the care and use of protective equipment such as rubber gloves, face shields, safety glasses, hard hats, clamp-sticks, arc flash clothing, hot-stick, etc.

### 1.2 Signal Words

Switchboard installation, operation, and maintenance procedures can give rise to various hazardous situations. Signal words like **"Danger" "Warning"** and **"Caution"** are used to indicate the degree of danger associated with these different hazards that the user may encounter. These signal words are defined as follows:

- **DANGER** indicates an imminently hazardous situation that **will** result in serious injury or even death.
- **WARNING** indicates a potentially hazardous situation that **could** result in serious injury or even death.
- **CAUTION** indicates a potentially hazardous situation that **may** result in minor or moderate injury but not death.

### 1.3 Dangerous Procedures

In addition to the specific precautions that must be followed to ensure safety against various hazards and dangers associated with switchboard installation, operation, and maintenance procedures, user personnel must also always adhere to the following warnings:

**DANGER**

Hazardous voltage. Contact with hazardous voltage can cause severe injuries and even death. Personnel working around low-voltage and high-voltage lines and equipment should follow all locally approved safety procedures and practices, and only Qualified personnel should be allowed to work on or near high-voltage equipment.

**WARNING**

Ensure the switchboard equipment is completely de-energized and disconnected from the rest of the system to prevent accidental re-energization. Otherwise, possible shocks from an energized switchboard component could lead to equipment damage, severe physical injuries, and even death.

**CAUTION**

Always allow the interlock device or safety mechanism to function completely without forcing the device.

**CAUTION**

Hydrocarbon compounds and spray propellants can cause the degradation of certain types of plastics used within the switchboard equipment. Contact MPS representatives before applying these products for cleaning and lubricating switchboard components.

### 1.4 Field Service

MPS provides its customers with the following support services for switchboards:

- Start-up Commissioning of Switchboard Equipment.
- Switchboard Component and System Testing.
- Switchboard Maintenance (Preventative and Scheduled).
- Switchboard Component Repair and Refurbishing.
- On-Site Operational Training for Switchboard Technicians.

Contact MPS to obtain additional information about the aforementioned services and to schedule an appointment.

### 1.5 General Description

MPS switchboards are designed and manufactured to perform efficiently within standard operating conditions. The instructions provided in this manual aim to assist purchasers in deriving prolonged and economical switchboard functionality. This manual and its guidelines should be shared with operators and engineers associated with the owner/purchaser to ensure that the switchboards are operated and maintained in the best possible conditions.

This manual covers the standard construction details of MPS switchboard assemblies, as defined in NFPA70 (NEC), UL891, and NEMA PB2, including the necessary accessories and auxiliary equipment. Any special or additional equipment furnished with the standard product, in accordance with the purchaser's order requirements, is covered separately in supplementary instruction books. All switchboard parts, conductors, and insulation materials are designed and constructed to meet the voltage class requirements of the system. Additionally, all switchboard components are enclosed within a grounded metal enclosure for added protection.

MPS designs the switchboard equipment to cater to the specifications provided by the purchaser at the time of purchase. The final product, therefore, has the circuit capacity to meet the operating conditions of the purchaser's specified power system. However, the momentary rating of the switchboard and the interrupting capacity of the switchboard protective devices must be rechecked when installing the switchboard equipment in a different system or when the short-circuit capacity of the target system is increased. If the service is changed, the equipment's short circuit capacity, amperage, and voltage class should

be checked to ensure they meet or exceed the new system's requirements.

Switchboards are free-standing units rated at 1000 volts AC or less and 4000 amperes or less. A typical switchboard contains distribution sections with branch devices and service entrance sections with main devices. These sections contain auxiliary equipment, protective devices, disconnect devices, and current transformers for control, metering, or ground fault protection.

**Safety Precautions and Switchboard Preparation**

Switchboards are constructed in various sizes and mounting arrangements, depending on the purchaser's unique requirements. Outdoor switchboards are typically made by enclosing the equipment inside a weatherproof housing and fixing a door over the inner front panels.

**Section 2.0 - Safety Precautions**

**⚠ DANGER**

Care should be taken when energizing a switchboard for the first time after initial installation or maintenance due to the potential danger posed by any undetected exposed parts. Contact with hazardous voltage through these parts can cause severe injuries and even death. The following safety precautions must be strictly followed while working on switchboard preparation:

- Only qualified persons familiar with the operation and construction of the switchboard equipment should be allowed to perform the procedures described in this set of instructions.
- Qualified persons should be allowed to work on the switchboard equipment only after reading this complete set of instructions.
- The qualified persons should ensure they strictly follow the safety-related work practices, as described in NFPA 70E.
- Switchboard inspection and maintenance should only be performed after cutting off, disconnecting, and electrically isolating the switchboard so it cannot be accidentally re-energized.
- Some electrical equipment can introduce harmonics in the electrical system and cause it to overheat. This condition should be considered when determining the switchboard loading. The equipment rating may need to be derated in case of excessive heating.

**Section 3.0 - Switchboard Preparation**

**3.1 Receiving**

MPS inspects each switchboard before being shipped to the purchaser-designated site to ensure that the electrical and structural construction of the switchboard equipment complies with the applicable specifications, codes, and standards. Depending on the number of sections and the size of each section, the switchboard may be divided into one or more vertical pieces and placed onto wooden skids for easy shipping. Each piece is packaged, securely blocked, and braced for shipment.

Regardless of the shipping method, every precaution is taken to minimize the possibility of damage to the equipment and to ensure its safe arrival. The packages are carefully loaded to prevent damage to the relatively delicate instruments or devices, and similar care must be exercised upon arrival at the required site. Once the switchboard equipment arrives at the required destination, the marking tag(s) or packing list(s) should be checked very carefully by the purchasing party against the equipment received to ensure the correct and complete list of equipment has been shipped. In case of any shortages or deficiencies, the purchasing party must claim in writing within the first 30 days of receipt of shipment. Failure to give such a notice would constitute an unqualified acceptance of the shipped goods and a waiver of any future claims.

Marking tags are attached to every shipped package or crate for identification on shipments with more than one shipping group. In lieu of the marking tags, the section marking can be found on the rating label on each section, and the location of each unit within the group lineup can be found on the general arrangement drawing.

**3.2 Inspection**

The equipment should be inspected as soon as possible after the arrival of the shipment for any damage that may have occurred in transit. The packing of the switchboard components should be carefully removed to allow for inspections for possible damage. However, the packing material must not be discarded in the process, as the material itself can be used to store the equipment at the designated site until installation or to repackage the equipment for a return shipment if necessary. When moving or handling the switchboard, it should be kept upright and secured to the shipping skid to prevent distortion or damage to the bottom frame.

**3.3 Shipping Damage Claims**

If the goods get lost or damaged in transit, the purchaser must handle all claims directly with the carrier. The carrier must be notified about any concealed damage within 15 days after receipt of goods. The following procedures must be followed to ensure that the goods are received in accordance with the purchase order:

- Upon arrival of the shipment, the purchasing party should note:
  - ❖ The blocking condition of the equipment.
  - ❖ The condition of the equipment upon arrival and whether it was properly protected from environmental factors like humidity, heat, wind, etc.
  - ❖ The trailer number on which the equipment arrived.
  - ❖ Whether the equipment count during unloading agrees with the delivery receipt.
- An inspection should be made to detect any visible damage to the equipment as soon as possible upon arrival of the goods. If possible, such inspection should be finished on the shipping vehicle before the unloading process. However, if it is impossible, a close inspection of the goods should be maintained during the unloading process, and any signs of visible damage should be noted. Pictures may also be taken for evidence if possible.
- Any visible damage on the equipment must be noted on the delivery receipt and signed by the driver to acknowledge the detected deformity. A detailed description of the damage should be added whenever possible, and the notation "Possible internal damage, subject to inspection" should be included on the delivery receipt. If the driver does not provide acknowledgment through a sign on the delivery receipt, the shipment should not be signed for or received by the consignee or their approved agent.
- Any detected damage should be reported to the MPS Sales Office immediately.
- If any damage is observed on the shipped equipment, the consignee or their agent must arrange a carrier inspection immediately. The equipment must not be removed from the place it was set by the carrier when unloading. This location should be properly protected to ensure further damage does not occur before an inspection from the carrier. This eliminates loss to the consignee arising from carrier claims that the equipment was damaged or the damage aggravated on-site after unloading.
- The equipment should be covered properly to protect it from any further damage after unloading. The equipment should be stored

in a dry, clean place at a uniform temperature to prevent condensation and damage.

- If practical, further equipment inspections for possible concealed damage should be done in the presence of the carrier inspector. If not possible while the carrier is on-site, the consignee or an affiliated party must inspect the equipment within 15 days of receipt. If the concealed damage is found, the consignee party must notify the carrier and a carrier inspection must be made before any corrective action or repair to remove the observed defects is made. Notify the MPS Sales Office immediately of any detected signs of damage.
- After the carrier inspection, the consignee party must obtain the original carrier inspection report and send it to the MPS Sales Office along with a copy of the noted delivery receipt. Upon receiving these two documents, MPS shall obtain approval from the carrier to initiate the repair work on the equipment.

### 3.4 Handling

**⚠ CAUTION**

First, verify the weight of each switchboard shipping section by contacting the MPS Sales Office. Then, check the lifting capacity of all available hoisting and lifting equipment, and only use the cranes and forklifts if their load capacity exceeds the weight of each section. Do not use damaged hooks, slings, or cables. Only lift the switchboard from the provided lifting provisions, like lifting points and lifting bars, on the equipment. The sections can be moved by attaching the lifting bars at the top of the switchboard to a crane with at least four lift cables. If crane facilities are unavailable due to space or budget constraints, rollers can be fitted beneath the skids to facilitate movement. Take care when lifting the unit and removing it from the truck so it does not get damaged.

#### A. Lifting By Means of an Overhead Crane

Lifting brackets are installed at the top and rear positions of the switchboard section, as depicted in **Figure 3-1**. These brackets are used to lift the section using overhead cranes. There are two methods for lifting the switchboard sections when using an overhead crane, depending on the number of sections of the switchboard equipment.

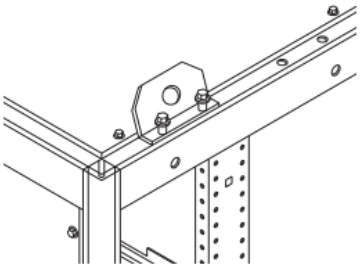

**Figure 3-1** Lifting Brackets on Top of Switchboard Sections.

- **Single Section Lifting –** In this method, the lifting cables are first connected to the lifting brackets, as shown in Figure **3-2**. A crane of sufficient height must be used to ensure that the load angle between the horizontal surface of the switchboard section and the lifting cables is at least 45 degrees or more when viewed from the side of the section.
- **Multi-Section Lifting –** A multi-section switchboard unit can be lifted in the same manner as a single section. However, in this method, the lifting cables must be connected to all lifting brackets, as shown in **Figure 3-3**. A crane of sufficient height must be used to ensure that the load angle between the horizontal surface of the switchboard section and the lifting cables is at least 45 degrees or more when viewed from the side of the section.

**NOTE**

Spreaders may be employed with the lifting cables to prevent the brackets from twisting. **Figures 3-4** and **3-5** illustrate the use of spreader beams for single-section and multi-section lifting, respectively.

**Figure 3-2** Single Section Lifting

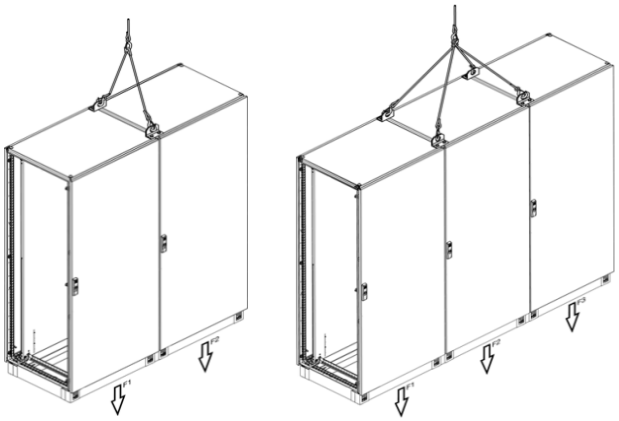

**Figure 3-3** Multi-Section Lifting

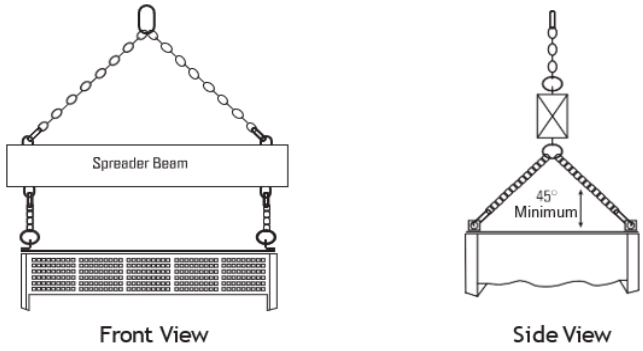


**Figure 3-4** Single Section Lifting Using Spreader Beams.

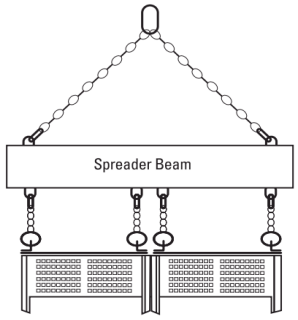

**Figure 3-5** Multi-Section Lifting Using Spreader Beams

**B. Lifting by Means of a Forklift**

Forklift trucks can easily lift and move switchboard equipment in an upright position over short distances. However, they must be used with a lot of care, as any improper lift points can cause damage to the equipment. Balance the load carefully and use safety straps when handling the switchboard equipment with a forklift. Switchboard sections properly supported by sturdy timbers can be lifted using jacks. Multiple rollers may be used to ensure the unit's weight is distributed uniformly throughout the moving process. The path to the installation place should be level and free of debris and obstructions. **Figure 3-3** shows the standard procedure for lifting an indoor switchboard using a forklift.

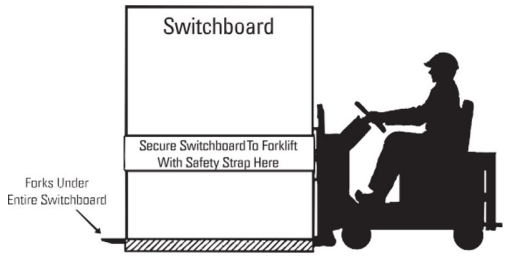


**Figure 3-3** Lifting by Means of a Forklift.

Please refer to the NEMA Standards Publication PB 2.1 for information on alternate handling means.

**3.5. Storage**

**A. Indoor Switchboards**

If the equipment must be stored for some time prior to installation, the equipment should be stored in a dry, clean place with a uniform temperature and adequate air circulation to prevent condensation and damage. When storing a switchboard for prolonged periods, it should be kept upright to avoid distortion or damage to the bottom frame. The packing of the switchboard components should be carefully removed when performing inspections for possible damage so that the packing material can be used to store the equipment until installation. If the packing material is damaged, an appropriate cover should be placed over the switchboard to protect it from moisture, dust, and debris.

Unlike outdoor switchboards, indoor switchboards are not expected to suffer extreme outdoor weather conditions and are, therefore, not equipped with similar weatherproof or drip-proof protections. If possible, indoor switchboards should only be stored indoors where the building walls and roof can provide the required insulation from harmful weather conditions.

If there is a lack of indoor space for storage, the indoor switchboard can be stored outdoors if given adequate protection against humidity, heat, weather, dirt, and other weather conditions. Indoor switchboards are not equipped with space heaters, so heat sources of approximately 250 watts output must be placed within each vertical switchboard section to prevent condensation and damage. However, the heat source should only be energized after ensuring no loose packaging or flammable materials are inside the switchboard. If the equipment must be stored for an extensive period, all moving parts, such as shutters, hinges, etc., must be adequately lubricated to prevent rusting.

**B. Outdoor Switchboards**

Outdoor switchboards must be stored exactly in the same manner as described above for indoor switchboards. If possible, the switchboard must be stored indoors for added protection. However, if there is a lack of indoor space for storage, the outdoor switchboard can be stored outdoors by keeping it dry and clean. The outdoor switchboards are equipped to handle outdoor conditions, but additional protection should be provided, if possible, to extend their service life. If self-contained space heaters are provided with a switchboard unit, they must be energized to prevent condensation and damage. The vents and louvers on the switchboard must be uncovered to allow air to circulate, and the shipping splits must be covered to protect them from outdoor environmental elements like humidity and dust. Refer to the wiring drawing to find the connections needed for the space heater circuit. If the equipment must be stored for an extensive period, all moving parts, such as shutters, hinges, etc., must be adequately lubricated to prevent rusting.

**Installation**

**Section 4.0 – Installation**

The proper installation method depends on whether the switchboard units are shipped as a single complete group (84.0" or less) or in two or more shipping sections. The MPS factory that manufactures a product for the consignee also ships a general arrangement drawing to indicate the shipping groups and the location of each unit within the group lineup. The general arrangement drawing also provides instructions for assembling the switchboard units after receiving all sections/ shipping group components at the installation site.

**4.1. Location**

The switchboard installation area should be designated on the building plan prior to the arrival of the unit. The chosen location must provide working clearances in accordance with NEC Article 110.26. The equipment drawings provide the means to identify whether the switchboard is front-accessible or rear-accessible. If it is front-accessible, then adequate spacing must be provided on the front side of the installation site to allow access to field connections, e.g., the mains, ground, branches, and neutral connections. If the switchboard is rear accessible, the same spacing must be provided but on the rear side of the installation site.

**4.2. Foundation Requirements**

It is pivotal to ensure that the switchboard equipment is placed on a strong and sturdy foundation that can adequately support the switchboard weight in an upright position so that neither the foundation nor the equipment is damaged or deformed. The general arrangement drawing provides the exact spacing and location information needed to install the required anchor bolts and grouted sills (or bed plates) to the support and fix the switchboard on top of the foundation or floor. These drawings also provide information for designating an area for conduits, the associated limitations, and other general instructions. According to NEC 408.5, conduit couplings should be stubbed below or level with the finished horizontal floor. After lowering the equipment and setting it in place on top of the prepared foundation, the conduit extension sleeves may be screwed into these couplings.

The foundation and grouted sills (or bed plates) should be properly aligned and have a smooth horizontal level throughout their lengths so that the floor and sills are on the same plane at each point of contact with the switchboard equipment. The foundation surface must not protrude above the grouted sills or bed plates at any point.

Usually, outdoor equipment is installed on a concrete pad with a flat and even surface. The outdoor equipment must be supported at each section if assembled on formed base plates. While preparing the foundation, it must be ensured that adjacent units at each shipping split are supported by a single support.

**4.3. Positioning of Sections**

Adequate space should be provided in the front and rear of the installation site to allow for door opening, installation, and removal of breakers, as well as inspection and maintenance activities. The service entrance equipment should be positioned near the incoming service of

the building. The process of positioning and connecting the switchboard sections at the installation site should follow the below instructions:

- Before the process can begin, the mounting surface should be thoroughly cleaned of any dirt or debris.
- Refer to this manual's "Handling" section for instructions on maneuvering the switchboard sections into the desired positions. Start this process from the left-end shipping group and proceed in sequence until the right-end group is also in position. Exercise caution when moving the switchboard sections over conduit areas, as protruding conduits can obstruct the sliding movement of the section in either direction.
- Connections must be made across shipping splits before the final placement of the equipment. Remove the bus joints and supports using the front, rear, and side access options as necessary. Take note of the mounting orientation and position. Save the hardware for use in reinstallation.
- After removing the shipping skid, stand the switchboard section upright. Remove all packing material and any present bottom floor plates inside or near the section. To safeguard the bottom channel, carefully apply a sliding force across the bottom 4 inches (100mm) of the side to distribute the sliding force evenly.
- All shipping sections must be leveled and aligned to each other to maintain proper alignment of the horizontal main through bus and splice bus connections. Bolt all section frames together and connect all through the bus and ground bus at shipping breaks using the supplied splice plate bus and hardware. Tighten the bolted connections in accordance with the torque specifications indicated on the instruction label supplied.

### 4.4. Anchoring, Leveling, and Assembly

The vertical sections of the indoor switchboard shipping groups are held together using bolts. The entire shipping group must be leveled and anchored as a single structure without loose hardware. The supporting surfaces for the switchboard at each anchoring bolt location must be level and aligned within the same plane as one another. No projections above this plane must be allowed within the area covered by the switchboard cubicles. If the floor or ground sill channels do not meet this requirement, shims may be required to elevate the cubicle and mitigate the impact of protrusions.

All anchor bolt locations of a cubicle must rest freely over and in firm contact with the mounting support surface. There must be no projections or obstructions in other areas that could potentially distort the cubicle. Do not force a cubicle into firm contact by drastically tightening the anchoring bolts because such over-torquing would distort the cubicle. Instead, 4" (100mm) square shims may be added adjacent to anchor bolts until firm contact is achieved. Verify the location of each anchor bolt, as illustrated in **Figures 4-1(a), 4-1(b),** and **4-2**. The following steps must be implemented to complete the successful anchoring and leveling of the equipment:

- First, all side-mounted lifting bars on a shipping section must be removed unless the shipping sections also include top-mounted lifting brackets, in which case the removal becomes optional.
- Tighten the anchor bolts or weld them to the sills.
- If the lineup comprises multiple groups, place two groups into position, with the rear of one group aligned and tight against the adjacent group. The groups must not be bolted together at this stage. Ensure that the cubicles are in firm contact with the foundation at each corner and anchor point and that the bolt holes are aligned. If required, square shims may be added before the anchor bolts are tightened. Finally, bolt the groups together as outlined in this manual's "Joining Shipping Sections" section.
- Repeat the above step for the secure installation of all shipping groups in the correct order per the front elevation drawing supplied by the MPS factory.

**NOTE**

For seismic installations, see the installation instructions furnished with the purchased equipment.

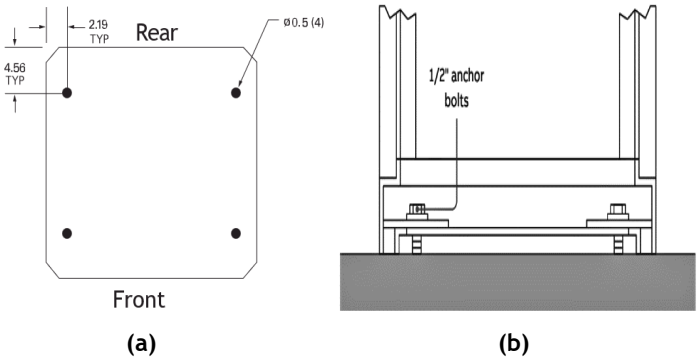


**Figure 4-1 (a)** Bolt-Down Hole Provision Locations on the Bottom of the Cubicles. **(b)** Switchboard Section Installed on a Foundation.

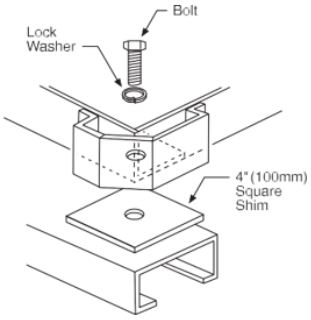


**Figure 4-2** Bolting and Shimming Diagram.

### 4.5. Joining Shipping Sections

Remove the front panels and, if feasible, the back plates for the secure bolting of adjacent shipping section frames. Insert 5/16-16 x 1.00-inch steel bolts through the holes in each front and rear corner post in accordance with the configuration shown in **Figure 4-3**. Apply a torque of 12 ft-lbs. to tighten the bolts.

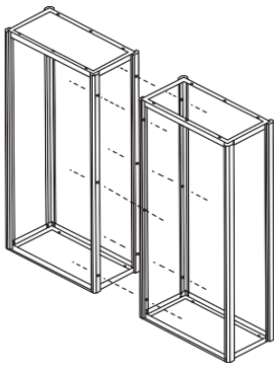

**Figure 4-3** Joining Adjacent Shipping Section Frames.

### 4.6. Electrical Connections

All electrical connections within switchboards are made using cables or bus bars. Bus bars are furnished for connecting the main bus, pads for cable terminations, and circuit breakers fusible devices. MPS Switchboards are designed to comply with accepted industrial standards for electrical clearances between energized components. However, some cable and bus connections must be made in the field, and in such cases, the technicians making the connections must ensure that all minimum clearances are maintained according to the

provisions provided in **Table 4-1**.

**Table 4-1** Minimum Clearances Between Energized Components

| **Between Live Parts of Opposite Polarity** | **0-125V** | **126-250V** | **251-600V** |
|---|---|---|---|
| Through Air | 1/2" | 3/4" | 1" |
| Over Surface | 3/4" | 1 1/4” | 2" |
| **Between Live Parts and Grounded Metal** | **0-125V** | **126-250V** | **251-600V** |
| Through Air | 1/2" | 1/2" | 1" |
| Over Surface | 1/2" | 1/2" | 1" |

### 4.7. Through Bus Splice Connections

When the switchboard group is divided into parts for shipping purposes, cross-bus and ground-bus connections must be established in the field during the equipment installation process. Follow the provided instructions for making the necessary bolted connections:

- The main bus can be made accessible from the cable termination area by removing the main bus compartment barrier, which separates the main bus from the cable area. Depending on the arrangement, it may be necessary to remove additional items between the main bus barriers and the rear of the unit to gain full access. Upon the completion of bus assembly and installation, these items should be reassembled in reverse sequence.
- Ensure that all surfaces are free of dust, dirt, or any other foreign material. Avoid the use of abrasive cleaners on plated contact surfaces. Cleaning is unnecessary and should only be done if parts are significantly tarnished. If necessary, cleaning should be done using a mild cleaner to thoroughly remove all residue. The cleaning agent must be kept away from the insulation.
- Before assembling a bus bar joint, confirm that the bar is correctly inserted through bus supports whenever required. Observe and maintain the relationship of a bus bar when making connections to other bus bars. Spacers may be necessary in some bus joint connections.
- Assemble all joints while keeping the parts in a dry state. Do not apply grease or "no-oxide" products.
- Utilize the hardware provided with the Splice Plate Kit to make the necessary connections. The use of smaller or different-grade hardware may cause the connections to overheat.
- The next step can vary depending on the type of bolt connection. These two types of connection are:
  - ❖ **Single Bolt Connections:** For this connection, the bolt must be inserted through the hole on the tie plate and the bus. Subsequently, the large-diameter Belleville washer must be placed on the 1⁄2 -13 bolt. The nut must be tightened by hand and then a torque of 50 ft-lbs. This process is repeated for each set.
  - ❖ **Four Bolt Connections:** For this connection, the four 3⁄8 - 16 carriage bolts must be positioned in the slotted holes in the splice plate and through the bus. The 3⁄8 -16 Belleville washer nut must be tightened by hand and then a torque of 20 ft-lbs. This process is repeated for each set.
- If more than one splice plate is provided per phase, install a splice plate on each side of the through bus, as shown in **Figure 4-4**. **Figures 4-5** through **4-11** illustrate various types of bus coupling plates and connections for joining different switchboard sections.

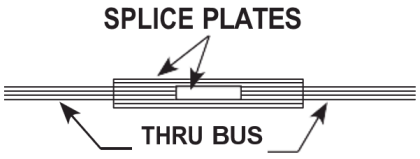


**Figure 4-4** Installing Splice Plates over Thru Busses.

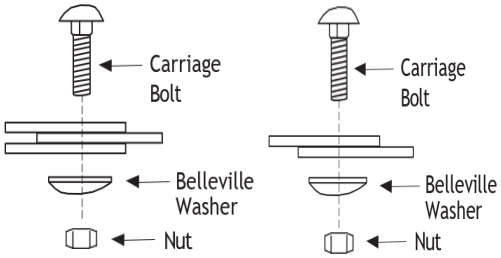


**Figure 4-5** Typical Bolt Alignment for Tie Plates

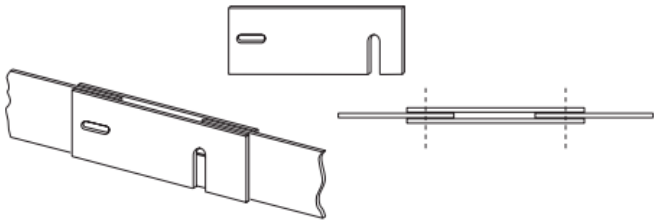

**Figure 4-6** Splice Plate – Single Hole

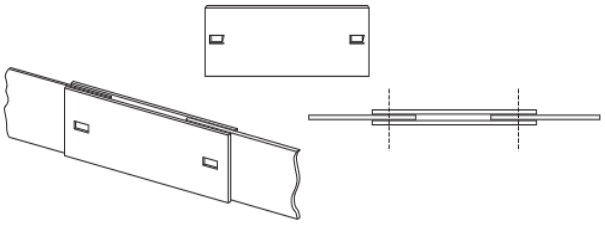

**Figure 4-7** Straight Tie Plate – Single Hole

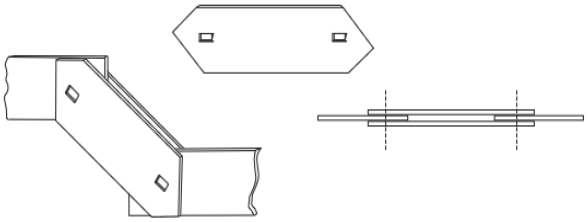

**Figure 4-8** Angle Tie Plate – Single Hole

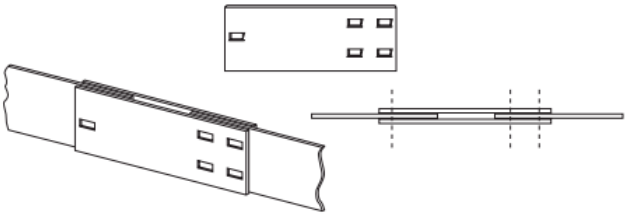

**Figure 4-9** Straight Tie Plate – Four Hole to Single Hole

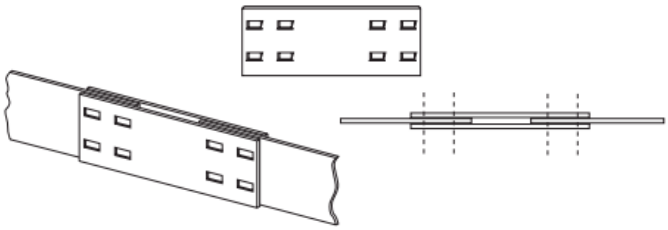

**Figure 4-10** Straight Tie Plate – Four Hole

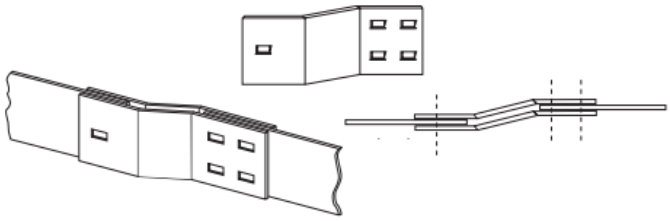

**Figure 4-11** Offset Tie Plate – Four Hole to Single Hole.

**Table 4-2** Maximum Allowed Torque for Different Hardware Specifications.

| HARDWARE | GRADE | MAXIMUM TORQUE |
|---|---|---|
| $^3/_8 - 16$ | 5 | 20 FT/LBS |
| $^1/_2 - 13$ | 5 | 50 FT/LBS |
| $^1/_2 - 13$ | 2(1) | 22 FT/LBS |

Older switchboards used Grade 2 hardware. Refer to the Hardware Grade Determination Detail to determine the type of bolt installed in the gear. Refer to the torque table to find the appropriate tightening force for each gear.

### 4.8 Ground Bus Splice Connections

Rotate the bar into place after removing the ground bus splice plate. The ground bus splice connections must be aligned and secured between shipping sections. Refer to **Figure 4-11** for the correct connections. Torque these connections by 6 ft-lbs.

NOTE

Proper ground bus splice connection installation is critical for safe ground fault protection system operations.

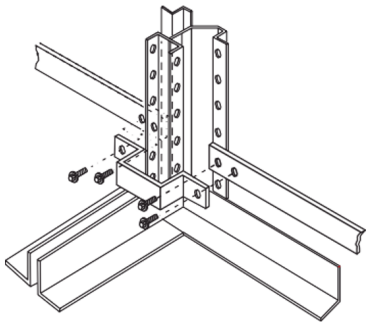

**Figure 4-11** Ground Bus Splice Connections

### 4.9 Grounding and Bonding

- Implement the following guidelines for grounded systems employed as service equipment or as the main switchboard on a separately derived system:
  - ❖ A grounding electrode conductor must be run between the grounding electrode conductor terminal of the switchboard and the global grounding electrode at the installation site. The appropriate material and size for the grounding conductor must be chosen in accordance with provisions in NEC Sections 250.62, 250.66, and 250.166. NEC Section 250.64(B) provides the guidelines for installing the grounding electrode conductor. It is crucial to note that no ground conductors must be permitted on the load side of the neutral disconnect link or ground fault sensor.
  - ❖ The main bonding jumper between the neutral and ground buses may be installed at the factory if necessary. The bonding jumper must be properly placed inside the equipment and properly labeled.
  - ❖ It is crucial to note that no ground conductors must be permitted on the load side of the neutral disconnect link or ground fault sensor.
  - ❖ Refer to the switchboard front elevation drawing for properly grounding and handling dual-fed (double-ended) systems with ground fault protections.
- Run a grounding electrode as described above for ungrounded systems employed as service equipment or as the main switchboard on a separately derived system.
- If the system is grounded at a point ahead of the switchboard, the grounded conductor must be run from that point and connected to the ground bus as specified in NEC Section 250.24(C). This conductor must be provided even if the switchboard supplies only phase-to-phase loads.
- If a switchboard is not utilized as the main switchboard on a separately derived system or as service equipment, equipment grounding conductors sized according to NEC Table 250.122 must be used to ground the ground bus and switchboard frame to the service ground, or it may be bonded to the raceway enclosing the main supply conductors in accordance with the provisions in NEC Sections 250.118 and 250.120.

### 4.10 Conduit Area

All stubs and conduits must be positioned to avoid cable interference with live buses and nearby structural members. According to NEC Section 408.5, conduits shall not be permitted to protrude more than 3 inches above the bottom of the enclosure.

The side-to-side frame supports on a deep switchboard frame may need to be removed to install the conduit properly. An appropriate number of hubs or sleeves and ring connectors must be used while installing a conduit to protect cables and prevent water from entering and accumulating in the switchboard. All metallic conduits and stubs should be bonded to the switchboard with electrical connections sized in accordance with the provisions given in NEC Section 250.122. According to NEC Section 110.14(C), the cable should only be pulled after verifying the cable's compliance with the required size, temperature rating, and conductor insulation, as highlighted by the switchboard markings.

NOTE

If the switchboard comes furnished with bottom plates, the required bottom conduit entrance must be holed by the customer.
The bottom plate must be reinstalled after a sufficient hole is made. The top plate is not designed to support the weight of the conduit and will buckle if under such weight for extensive periods of time. Therefore, conduits must be supported by other, more proper, means.

### 4.11 Cable Pulling

All MPS switchboards are constructed in accordance with NEMA standards for cable arrangements. The front elevation drawing and the following instructions should be followed when entering the cables into the switchboard in the conduit area:

- Only utilize cable sizes appropriate for a secure fit with the corresponding lugs.
- Pull the proper number of line and load side cables based on the served load.
- Arrange the cables within the switchboard in a way that helps

prevent physical damage.

- Maintain the maximum cable bending radii and ensure proper clearance between cables, bus bars, and grounded parts. If any cables rest on structural members, either provide a different support structure to relieve the stress from the current member or place the necessary protective material at the bearing point to safeguard cable insulation.
- When cables enter or exit the switchboard or pass through metals with magnetic properties, all phase and neutral conductors should be run through the same opening as per the guidelines in NEC 300.20 (A).
- Cables entering or leaving the switchboard should be in the same section where they are terminated unless exempted under the guidelines of NEC Article 408.3. Refer to NEC Article 300 for information on the appropriate wiring methods.
- Refer to NEC Article 725.136 for information on the separation requirements in Class 2 and Class 3 remote control, signaling, and power-limited circuits.
- According to NEC Article 310.4, conductors sized 1/0 AWG or larger can be run parallel in the same size, length, and material to ensure uniform current distribution.

### 4.12 Cable Termination

- Use an appropriate insulation stripping tool to strip a sufficient length of insulation from the end of the cable that can be used to fit into the entire length of the lug barrel. Be careful not to ring or nick the strands during this process.
- Use a wire brush to clean the contact surfaces of aluminum cables thoroughly.
- Apply an approved joint compound to the exposed aluminum.
- Remove any compression-type lugs that are furnished on circuit breakers and switches or if they serve as the main incoming power lugs by following these steps:
  - ❖ Unbolt and remove the compression-type lugs.
  - ❖ Insert the cable into the lug barrel.
  - ❖ Utilize the recommended crimping tool to make the specified number of crimps.
  - ❖ Wipe off any excess sealant from the connector and insulation.
  - ❖ With the cables securely connected, reattach the lugs onto the bus bars, switches, or circuit breakers.
  - ❖ Torque the bolts according to the values in the charts in this manual's "Torque Value" section.
- Set screw-type lugs may be provided as main incoming lugs and are standard on all devices supplied by MPS. The torque values for these lugs are indicated on the units. For other switchboard lugs, refer to the markings on the switchboard for the respective torque values.

### 4.13 Cable Lashing Requirements

Consult the following guidelines for conductor lashing instructions on switchboards marked with 65kA, 100kA, or 200kA short circuit current ratings:

- Lashing is not required for switchboards with a single fusible main switch rated 4000A or less.
- Lashing is not required for switchboards featuring a single main molded case circuit breaker rated at 4000A or less unless the circuit breaker is of the WL type, in which case lashing becomes mandatory.
- Lashing is not required for switchboards outfitted with a single main fused circuit breaker rated 4000A or less.
- Lashing is not required for switchboards constructed as a single section with fusible circuit breakers, disconnects, or fusible circuit breakers.

For switchboard sections that require lashing, refer to the instructions below:

**A. Lashing Instructions to 65kA Short-Circuit Rated Switchboards:**
To comply with the UL short-circuit withstand rating requirements, the adjacent N & Ø connections shall be lashed per the following instructions:

- The line cables must be wrapped with a nominal 3/8" nylon rope or a rope with a minimum tensile strength of 2000 lbs.
- From the switchboard entrance to the point where the cables are laced together, each cable run must be wrapped with 1 turn every 3 inches. Support must be provided to the cables at points where they lace into terminals, as shown in **Figure 4-12**. They should be installed 6" from the terminals and every **12"** beyond that point.
- Refer to the provided instructions on connectors to find the proper crimping tool and quantity of required crimps.

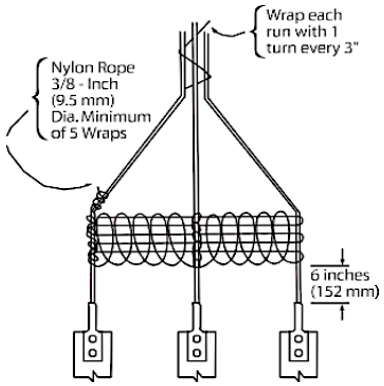


**Figure 4-12** Lashing Diagram for 65kA Short-Circuit Rated Switchboards.

**B. Lashing Instructions to 100kA Short-Circuit Rated Switchboards:**
To comply with the UL short-circuit withstand rating requirements, the adjacent N & Ø connections shall be lashed per the following instructions:

- The line cables must be wrapped with a nominal 3/8" nylon rope or a rope with a minimum tensile strength of 2000 lbs.
- From the switchboard entrance to the point where the cables are laced together, each cable run must be wrapped with 1 turn every 3 inches. Support must be provided to the cables at points where they lace into terminals, as shown in **Figure 4-12**. They should be installed 6" from the terminals and every **9"** beyond that point.
- Refer to the provided instructions on connectors to find the proper crimping tool and quantity of required crimps.

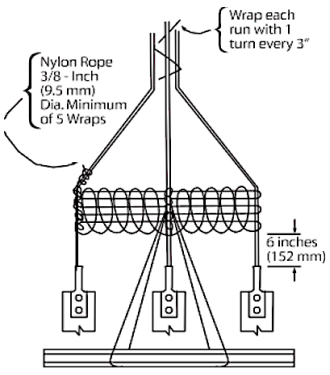


**Figure 4-12** Lashing Diagram for 100kA Short-Circuit Rated Switchboards.

**C. Lashing Instructions to 200kA Short-Circuit Rated Switchboards:**

To comply with the UL short-circuit withstand rating requirements, the adjacent N & Ø connections shall be lashed per the following instructions:

- The line cables must be wrapped with a nominal 1/2" nylon rope or a rope with a minimum tensile strength of 3000 lbs.
- From the switchboard entrance to the point where the cables are laced together, each cable run must be wrapped with 1 turn every 3 inches. Support must be provided to the cables at points where they lace into terminals, as shown in **Figure 4-12**. They should be installed 6" from the terminals and every **6"** beyond that point.
- Refer to the provided instructions on connectors to find the proper crimping tool and quantity of required crimps.
- The cable support must be reinstalled over lug barrels after the cable termination.

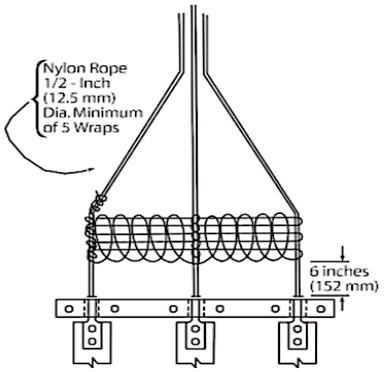


**Figure 4-12** Lashing Diagram for 200kA Short-Circuit Rated Switchboards.

**4.14 Control Wiring**

The control wiring undergoes meticulous installation and verification processes at the MPS factory before shipment. Inter-group wiring at shipping splits can be easily connected by referencing wire markings. These wires are designed with sufficient length to facilitate the on-field routing to their termination points after the cubicles are securely bolted together. Terminals for these leads can be readily obtained from other sources to accommodate the available crimping tools. However, the terminal block hardware may also be included with the switchboard when required. All requisite wiring diagrams for installation are provided in advance.

Wires can be effortlessly traced on the wiring diagram furnished with the switchboard. Each device is clearly depicted, and each terminal of every device is precisely identified. The wire list is also provided adjacent to each device on the diagram to specify the device and terminal number to which each wire is connected at the subsequent connection point.

All control wiring is installed at the MPS factory. It is meticulously bundled and secured to the cubicle wiring pan or side plate. It is recommended to make all field connections in a similarly organized manner for ease of use in the future. All parts and components must be verified to clear any additional wiring installed. Furthermore, all field wiring must be routed behind the removable cable retainer, specifically designed for such installation purposes. Plastic or nylon ties may be used to secure all field-installed wires to the cubicle structure.

**Pre-Energizing, Inspection, and Testing**

**SECTION 5.0 – Pre-Energizing, Inspection and Testing**

Prior to energizing the equipment, conduct a comprehensive inspection and testing. Address any deviations and reinspect the equipment before proceeding with energization. MPS provides its customers with the following support services for switchboards:

- Start-up Commissioning of Switchboard Equipment.
- Switchboard Component and System Testing.
- Switchboard Maintenance (Preventative and Scheduled).
- Switchboard Component Repair and Refurbishing.
- On-Site Operational Training for Switchboard Technicians.

Contact MPS to obtain additional information about the aforementioned services and to schedule an appointment.

**5.1 Inspection**

When inspecting the switchboard equipment, check the following carefully:

- Inspect the switchboards for any visual signs of damage that could negatively affect bus bar supports and device mountings or reduce the electrical clearances within the switchboards. **Table 4-1** of this manual lists the minimum clearance values.
- Check the electrical disconnecting contacts, shutters, machine parts, etc., for operation and lubrication conditions.
- Check the supports, blockings, and other temporary ties removed from relays, instruments, breakers, etc.
- Check the applied torque on all accessible busbar connections, including the factory and field-installed connections. If the connections are inaccessible, temporarily remove the barriers to the inspection process.
- Ensure that the proper fuses are installed correctly.
- Manually operate devices like switches, circuit breakers, etc., to check their alignment and operation.
- Operate all electrically operated devices like switches, circuit breakers, relays, meters, etc., to ensure their alignment and operations. Use an auxiliary power source to provide the necessary signals and power, if needed.
- Ensure all temporary wiring jumpers are removed from the equipment.
- Check the screw position of the current transformer shorting terminal block.
- MPS configures the adjustable settings of all its switchboard protective devices and relays to their lowest possible values prior to shipping. These settings must be adjusted in the field by the end users depending on the required system coordination study. Contact MPS Technical Services to perform the system coordination study and system commissioning.
- Ensure that the equipment is properly grounded.
- Check the incoming primary and secondary connections to ensure they are properly made and free of undesired shorts and grounds.
- Ensure that the equipment removed during assembly has been replaced.
- Confirm that the interlocks perform correctly.
- Check the disconnect devices and ensure they conform to the provided instruction books.
- Confirm the condition of the filters located in the vent areas. Make sure they are clean and free of undesired foreign material.
- Make sure no tool or object is left inside the equipment.
- Confirm the covers and doors are properly installed. Close the

doors and ensure no cable or conductor is nicked or pinched.

### 5.2 Testing

A **megger test** must be performed to verify the insulation of all connections made in the field. According to guidelines in NEMA PB2.1, Section 7.6., the test must be performed between phase to phase, phase to neutral, phase to ground, and neutral to ground connections, with the neutral isolated overcurrent devices in the open position. A healthy switchboard should give a resistance reading of 1 Megohm or greater. If lower resistance readings are observed, the issue should be investigated, and the required corrective measures should be applied. If the issue persists, contact the MPS Sales Office for further assistance.

If possible, a **dielectric test** should be applied on the high-voltage and high-power circuit for one minute at the appropriate test voltage, as given in **Table 5-1**.

**Table 5-1** Test voltages for Dielectric Testing

| Rated Voltage of Circuit | Test Voltage |
|---|---|
| 480 or 600 | 75% of 2200 = 1650 VAC |
| 208 or 240 | 75% of 1500 = 1125 VAC |
| Secondary and Control Circuits | 75% of 1500 = 1125 VAC |

Various equipment like control transformers, voltage transformers, surge protective devices, surge arresters, and surge capacitors must be disconnected before performing these tests.

NOTE

The above dielectric test voltages are provided as a reference. They can be used to verify the integrity of the connected cable installations without disconnecting them from the switchboard. During the dielectric test, the voltage should be incrementally raised to the test value in discrete steps and maintained at that level for one minute.

According to ANSI C37.20.02 Clause 5.5, Field Dielectric Tests must be performed after significant field modifications and when new units are introduced to an existing installation. These tests must not be performed on equipment stored for extended periods because such equipment accumulates a significant amount of moisture, dust, and other contaminants during the storage period and does not give accurate results. If dielectric tests must be performed on such units, the equipment must be restored to a satisfactory condition through comprehensive cleaning and maintenance. This precaution is crucial to ensure the reliability and accuracy of the field dielectric tests.

### 5.3 Ground Fault Protection System

NEC Section 230.95 mandates the inclusion of ground fault protection on all service disconnects in the switchboard rated 1000 amperes or greater, particularly when fed by a solidly grounded Wye system with more than 150 V line-to-ground voltage. To ensure compliance with relevant standards, all ground fault protection equipment for the switchboard is thoroughly tested before shipment from the factory. When provided, the ground fault protection system must undergo testing upon its initial installation, adhering to the specifications outlined in NEC Section 230.95 paragraph C. However, there are exceptions to this rule, and ground fault protection is not obligatory for fire pumps or continuous industrial loads where a non-orderly shutdown could pose an additional hazard.

NEC Article 517 outlines the specific requirements for installing the mandated additional levels of ground fault protection inside healthcare facilities, such as hospitals.

NEC Sections 215.10 and 240.13 require that ground fault protection be provided on devices, switches, and breakers rated 1000 amp or greater and applied in a system as described above unless the necessary ground fault protection is already provided upstream.

Utilities commonly use grounded Wye secondary transformers and connect the grounded mid-point to the service section ground bar. In such cases, the switchboard equipment must be provided with the necessary ground fault protection.

## Ground Fault Inspection and Testing

### SECTION 6.0 Ground Fault Inspection and Testing

For a 480-volt, 1000-ampere (or larger), three-phase, three-wire service section, an inquiry should be made to determine whether the utility uses a three-wire delta secondary transformer. If confirmed to be the case, ground fault protection is not required for the switchboard equipment.

⚠ WARNING

Only qualified personnel should be allowed to perform the following procedures defined in NEC article 100. The ground fault relay (GFR) and ground fault sensor (GFS) must be installed as in **Figure 5-2**.

### 6.1 External Ground Fault

- Disconnect the main power source to ensure a secure work environment.
- Remove the neutral disconnect link and confirm that the neutral is grounded exclusively by the main bonding jumper. Ensure the main bonding jumper is positioned on the line side of the sensor.
- Close all branch devices to facilitate the measurement process.
- Use a "megger" type meter to measure the resistance of the load phase and neutral to ground. This step is essential to verify the absence of any ground connections in the system.
- A healthy insulated system should give a resistance reading of 1 Megohm or greater.
- Reinstall the neutral disconnect link once the resistance measurements have been obtained.
- Open all devices.
- Reconnect the main power source, ensuring a controlled and gradual restoration of power to the system.

Follow the below instructions to test the entire system, including the disconnect device:

- Check for control power and ensure that the LED is illuminated, indicating the presence of power.
- Press and hold the "shunt trip bypass" switch on the relay.
- Observe the trip indicator, which should move to the "trip" position, causing the disconnect device to open.
- Release the "push to test" switch on the relay.
- Reset the relay and the disconnect device to return the system to its normal state.


**Figure 5-1** Ground Fault Relay

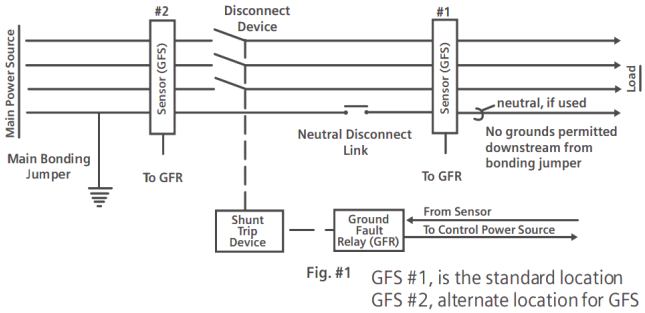


**Figure 5-2** Ground Fault Configuration

Follow the below instructions to test the ground fault relay and sensor only:

- Check for control power, ensuring that the "LED" is illuminated, indicating the presence of power.
- Press and hold the "shunt trip bypass" switch on the relay.
- While holding the "shunt trip bypass" switch, press the "push to test" switch. This action should cause the ground fault relay to trip.
- Reset the relay, and then release the "shunt trip bypass" switch to restore the system to its normal state.

NOTE

Make sure to document the results of the ground fault field testing. This record-keeping is valuable for maintaining an organized and comprehensive log of ground fault field testing activities.

## Energizing and Operation

### SECTION 7.0 - Energizing and Operation

WARNING

Care should be taken when energizing a switchboard for the first time after initial installation or maintenance due to the potential danger posed by any undetected exposed parts. Contact with hazardous voltage through these parts can cause severe injuries and even death.

**7.1 Placing Equipment into Service**
Only qualified persons familiar with the operation and construction of the switchboard equipment should be allowed to perform the procedures described in this set of instructions. Additionally, the qualified person should be allowed to work on the switchboard equipment only after reading this complete set of instructions.

- Verify the status of all interrupting devices and set them to the open position. Check and open all control circuits.
- Energize the primary incoming power source to the equipment, ensuring that the source's voltage does not exceed the normal rating of the equipment.
- Close the control circuit to check all instruments, meters, relays, etc. during this phase. It's essential to note that there must be no load on the switchboard when it is initially energized.
- Gradually energize the equipment in sequence, starting at the source and working towards the load. Close the main device first, followed by feeder devices, and then the branch devices to finally connect the source to the load. Observe instruments as the smallest branch load is added, allowing several minutes before connecting additional loads.
- Gradually increase the loads connected to the equipment while observing instruments and allowing several minutes before adding each additional load. Repeat the process, but add more and more loads until the full load is connected to the equipment.
- After all mains and branch devices are closed, downstream loads such as lighting, heaters, contactors, and motors may be turned on.
- Regularly check the primary and secondary circuits for signs of overheating. Additionally, monitor all instruments during the first week of operation to ensure proper functioning.

## Switchboard Loading and Maintenance

### SECTION 8.0 – Switchboard Loading

**8.1 Main Lug Switchboards Without Mains**
The total continuous load current flowing through the supply bus should not exceed the current rating of the switchboard.

**8.2 Single Main Switchboards**
For single main switchboards, maximum continuous loads must never exceed 80% of the overcurrent protective device rating, except in motor circuit applications or when the overcurrent protective devices are explicitly marked as suitable for continuous operation at a 100% rating. The same principle applies to each main in a multi-main switchboard. The feeders and branch circuits should also adhere to the 80 percent rule for the load applied to feeder and branch circuits, respectively.

**8.3 Harmonics Considerations**
Some electrical equipment can introduce harmonics in the electrical system and cause overheating. This condition should be considered when determining the switchboard loading. The equipment rating may need to be derated in case of excessive heating.

## Maintenance

### SECTION 9.0 – Maintenance

DANGER

Failure to properly maintain equipment can result in equipment failure, serious physical injuries, and even death. The instructions contained in this section should be reviewed, understood, and followed regularly when performing maintenance work on switchboard equipment.

**9.1 Inspection and Maintenance Intervals**
Periodic inspections and maintenance are crucial in ensuring equipment's safe and reliable operation. When the equipment is operated under "Usual Service Conditions", it is recommended to perform maintenance and lubrication at least once every year.

Generally, "Usual Service Conditions" refer to an environment where the equipment is not exposed to excessive acid fumes, dust, salt air, damaging chemicals, vibrations, rapid or frequent changes in temperature, and high humidity. More frequent maintenance would be required if the equipment were exposed to such conditions.
To prioritize the safety of maintenance personnel and others exposed to potential hazards during maintenance activities, it is essential to adhere to safety-related work practices outlined in NFPA 70E and other notable safety practice guidelines. Maintenance personnel should receive training in safety practices, procedures, and job-specific requirements. This manual should be reviewed thoroughly and kept in a readily accessible location for reference during equipment maintenance activities.

The user is responsible for establishing a periodic maintenance program to ensure safe and reliable equipment operations. The frequency of inspections, periodic cleaning, and preventative maintenance depends on specific operating conditions. NFPA Publication 70B, "Electrical Equipment Maintenance," can serve as a guide for establishing such a program.

It is crucial to note that a preventative maintenance program is not intended to cover reconditioning or major repairs. Instead, it should be designed to identify the need to perform such actions in a timely manner to prevent malfunctions during operation.

**9.2 Recommended Maintenance**

Routine maintenance of switchboards involves cleaning, lubricating, and exercising its different components. The frequency of maintenance checks depends on the extent of switchboard usage and the environmental conditions of the installation site. However, the interval between two inspection checks should not exceed one year. All the tests detailed in the "Maintenance Tasks" section of this manual must be performed at the date of the inspection check.

A comprehensive and permanent record of all maintenance work should be maintained. This record should include a list of periodic checks and tests conducted, the date of their execution, the equipment's condition, and details of any repairs or adjustments made.

**9.3 Maintenance Tasks**
Before conducting maintenance on a switchboard that has been energized for a minimum of three hours, a simple hand test should be performed just before the inspection. This test involves putting a hand on the front and side of the equipment enclosure and the dead-front surfaces of interior trims, switches, circuit breakers, and doors for at least three seconds.
If maintaining contact with these surfaces is challenging due to extreme temperatures, it could signal a potential issue in the equipment, thus necessitating immediate investigation.

**⚠ DANGER**
Switchboards contain hazardous voltages. Contact with these hazardous voltages can cause severe injuries, property damage, and even death. Only qualified persons must be allowed to perform maintenance work on switchboard equipment, and they should follow all safety procedures and practices of working near switchboards and associated equipment. These practices include powering off, disconnecting, electrically isolating, and grounding the switchboard to prevent accidental energization while personnel work around the equipment. The workers should not come into contact with energized parts of the equipment during the inspection and maintenance procedures unless specified otherwise.

Before starting any maintenance work on the equipment, complete the following steps on any component that affects the area of the work:

- Disable the automatic transfer schemes and remote control.
- Turn off the power from all direct and back-feed power and control sources, test, and ground.
- Disconnect all voltage and control power transformers.
- Open all disconnects.

The following steps should be performed during a switchboard maintenance procedure:

- Assess the overall condition of the switchboard installation.
- Inspect the interior of the switchboard for signs of accumulation of dust, dirt, or any foreign material. If any are found, vacuum the interior to remove the accumulated dust or dirt deposits; avoid using an air hose for the cleaning, as it can blow the dust into critical electrical contact areas.
- Carefully examine the interior of the switchboard for signs of moisture, condensation buildup, and prior wetness. Inspect conduit entrances and cracks. Seal off any leaks to eliminate moisture. Use a mild household detergent to wash and clean the air filters.
- Examine the condition of the indicating lamps and replace them if required.
- Inspect the connections on the terminal block contacts for looseness.
- Check the control and instrument switches and the condition of their contacts.
- Ensure the instrument transformers are in proper condition. Check both primary and secondary connections. Replace any burned-out fuses, if present.
- Examine the de-energized insulators for signs of dust accumulation and clean any observed buildup.
- Inspect the condition of bus bars and connections. If bus bars have overheating issues, check the bus bar connections and loading conditions to find the cause.
- Inspect the fuse clip contact pressure and contact means. If any signs of looseness or overheating are observed, contact the MPS Sales Office for replacements.
- Inspect and replace deteriorated insulated material where the sealing compound has melted.
- Inspect the condition of all safety interlocks to ensure they function properly.
- Carefully examine all devices inside the switchboard for worn, broken, or missing parts. Manually operate all devices several times to ensure proper functionality. Follow the maintenance procedures for interrupting devices outlined in the device instruction manual. Avoid opening sealed breakers or trip units, as such actions may disrupt their calibrations. Contact the MPS factory for any necessary replacements. Refer to NEMA AB4 for further guidance.
- Make sure the space heaters and thermostat (if equipped) operate properly.
- Maintain other auxiliary equipment according to the requirements in their respective instruction books.
- Lubricate contacts, mechanisms, and other moving components, excluding parts of molded case circuit breakers.
- Inspect painted surfaces of the switchboard and perform touch-ups as required.
- Check the interior of the switchboard for signs of insect or rodent nesting.
- Replace, re-insulate, reassemble, and return all switchboard items to their proper operating condition. Remove grounds before energization.
- Ensure the instruments and relays operate satisfactorily in accordance with the requirements outlined in the separately furnished instruction books. Avoid leaving the device covers off for

an extended period. If a cover is damaged, temporarily cover the device and promptly replace the broken glass.

- Verify the functionality of the ground fault protection system (if provided).
- Perform the electrical insulation resistance test on the switchboard to verify that it is free of short circuits and grounds.

This checklist is not a comprehensive examination of all the maintenance steps needed to guarantee the safe and reliable operations of the equipment. Specific applications might demand additional procedures. If further procedures are needed or if specific issues arise that are not adequately addressed for the purchaser's requirements, consult the MPS Sales Office for guidance.

### 9.4 Cleaning Insulation

The majority of plastics and synthetic materials utilized in insulation systems are susceptible to damage from solvents containing aromatics or halogenated hydrocarbons. Exposure to such solvents can lead to crazing and deformation of the material, thereby diminishing its dielectric strength. Isopropyl alcohol is the only solvent cleaner recommended for use with MPS insulation systems.

## Adverse Conditions and Informational Charts

## Section 10.0 – Adverse Conditions

### 10.1 Ambient Temperatures

Switchboards are typically designed for installation in areas where the average ambient temperature never exceeds 40ºC (104ºF). In installations at higher temperatures, the switchboard operation may need to be derated. Contact the nearest MPS representative for assistance before relocating a purchased switchboard unit.

### 10.2 Short Circuits

Overcurrent protective devices effectively limit the damage to the precise location where the short circuit or fault occurs. However, the short circuit currents can generate intense mechanical stresses in the system that can travel physically (rather than electrically) and potentially inflict harm on nearby conductors, insulation, and other switchboard equipment despite the function of protective devices. Therefore, a comprehensive inspection of the entire system must be made after the occurrence of any fault to confirm the absence of damage to all conductors, insulations, and equipment.

Furthermore, the overcurrent protective device(s) should also undergo inspection for potential arcing damage to contacts, arc chutes, and insulation. However, sealed devices and breaker trip units should not be opened, as doing so would result in a loss of functionality and require replacement. A hi-pot test should be conducted on the equipment to detect any traces of current leakages. For the necessary inspection and correction procedures, consult this manual's inspection and maintenance sections. If a device is damaged, it should be promptly replaced.

### 10.3 Arcing Damage

In the event of a fault, the intense heat from an electrical arc can cause certain organic insulation materials to lose some of their insulation properties due to carbonization. Therefore, any signs of carbon deposits or tracking should be removed using a dry, lint-free cloth. Additionally, the affected material may be replaced entirely before the switchboard re-energization. Contact the MPS sales representative before undertaking any cleanup or corrective actions.

### 10.4 Water Damage

The switchboard must be completely de-energized if any signs of moisture or water are observed on the equipment. Refer to the NEMA publication, "Guidelines for Handling Water Damaged Electrical Equipment" for detailed instructions for dealing with water damage and moisture issues inside switchboards and other electrical equipment. In case of extensive damage or prolonged exposure to moisture, contact the MPS sales representative for assistance.

### 10.5 Corrosive Atmospheres

Special precautions must be followed when switchboards are installed and operated in corrosive environments to minimize their impact on switchboard performance. Non-insulated bus bars, disconnect switches, exposed metallic surfaces, wire ends, primary and secondary disconnecting contacts, instrument terminals, etc., must all be protected from the corrosive environment.

During each maintenance inspection, the old grease must be removed from contacts, and a new lubricant must be applied to sliding surfaces. A coat of a corrosion-resistant material, like glyptal, can be applied to secure other exposed components.

## Section 11.0 - Informational charts

### 11.1 Torque Values

The equipment connections are inspected, tested, and properly applied prior to shipment. However, transit conditions may result in some connections becoming loose. Hence, it is advisable to recheck the tightness of all connections before energizing the equipment at its intended destination.

**Table 11-1** Torque Values for Machine Thread Bolts and Nuts and Thread Forming Screws

| | MACHINE THREAD BOLTS & NUTS (1) | | THREAD FORMING SCREWS | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Torque in lb-in (2) | | | | | | |
| | Torque | | 0.125 | | 0.188 | | 0.25 | | >0.25 |
| Size | lb-in | lb-ft | AL | CU | AL | CU | AL | CU | AL /CU |
| 8-32 | - | - | 20 | 25 | 30 | 35 | 30 | 35 | |
| 10-24 | - | - | 20 | 25 | 30 | 50 | 30 | 50 | |
| 1/4-20 | 72 | 6 | 30 | 50 | 30 | 72 | 50 | 72 | |
| 5/16-18 | 144 | 12 | - | - | 108 | 144 | 108 | 144 | 144 |
| 3/8-16 | 240 | 20 | - | - | - | - | - | - | 240 |
| 1/2-13 | 600 | 50 | - | - | - | - | - | - | - |

**(1)** For use with all washer types

**(2)** Based on material thickness

**Table 11-2** Torque Values for Breaker Connecting Machine Screws

| BREAKER CONNECTING MACHINE SCREWS | |
|---|---|
| Screws | Torque in lb-in |
| #10 | 20 |
| 1/4" | 72 |

### 11.2. Branch Load Conductors-Panel Mounted Devices

The switchboard is designed in accordance with the standards specified in NEC 312.6 to ensure the secure installation of conductors. The branch circuit devices determine cable size and the required securing torque. At a minimum, this product incorporates wire bending space standards from NEC Tables 312.6(A) and 312.6(B), aligning with the standard wire and cable sizes outlined in NEC Table 310.16. Circuits rated at 110 amps or less utilize standard wire and cable sizing ratings from the 60°C aluminum columns, while circuits rated above 110 amps follow conditions specified in the 75°C aluminum columns for sizing. The 400-amp circuits are designed with either two 250 kcmil cables per phase or a single 500 kcmil cable per phase. Circuits rated at 600 amps or greater are designed with multiple 500 kcmil cables per phase.

### 11.3. Tightening Torque for Field Wired Connectors

When the required tightening torque is not marked on the component,

the connectors should be torqued in accordance with the values indicated in **Table 11-3**.

**Table 11-3** Torque Values for Hex Socket Head Set Screws and Slotted Head Screws

| **Hex Socket Head Set Screw** | | **Slotted Head Screws** | | |
|---|---|---|---|---|
| Allen Wrench Size | Torque lb-in | AWG Wire Size | Torque lb-in | |
| | | | Small Hole #6-Max. | Large Hole 1/0 Max. |
| 7/32" | 150 | | | |
| 1/4" | 200 | #14-#10 | 20 | 35 |
| 5/16" | 275 | #8 | 25 | 40 |
| 3/8" | 375 | #6 | 35 | 45 |
| 1/2" | 500 | #4 | - | 45 |
| 9/16 | 600 | #3-1/0 | - | 50 |

Connectors terminating field-made connections are suitable for use with either 60°C or 75°C rated CU or AL conductors unless otherwise specified on the devices. Maximum continuous loads must never exceed 80% of the overcurrent protective device rating, except in motor circuit applications or when the overcurrent protective devices are explicitly marked as suitable for continuous operation at a 100% rating.