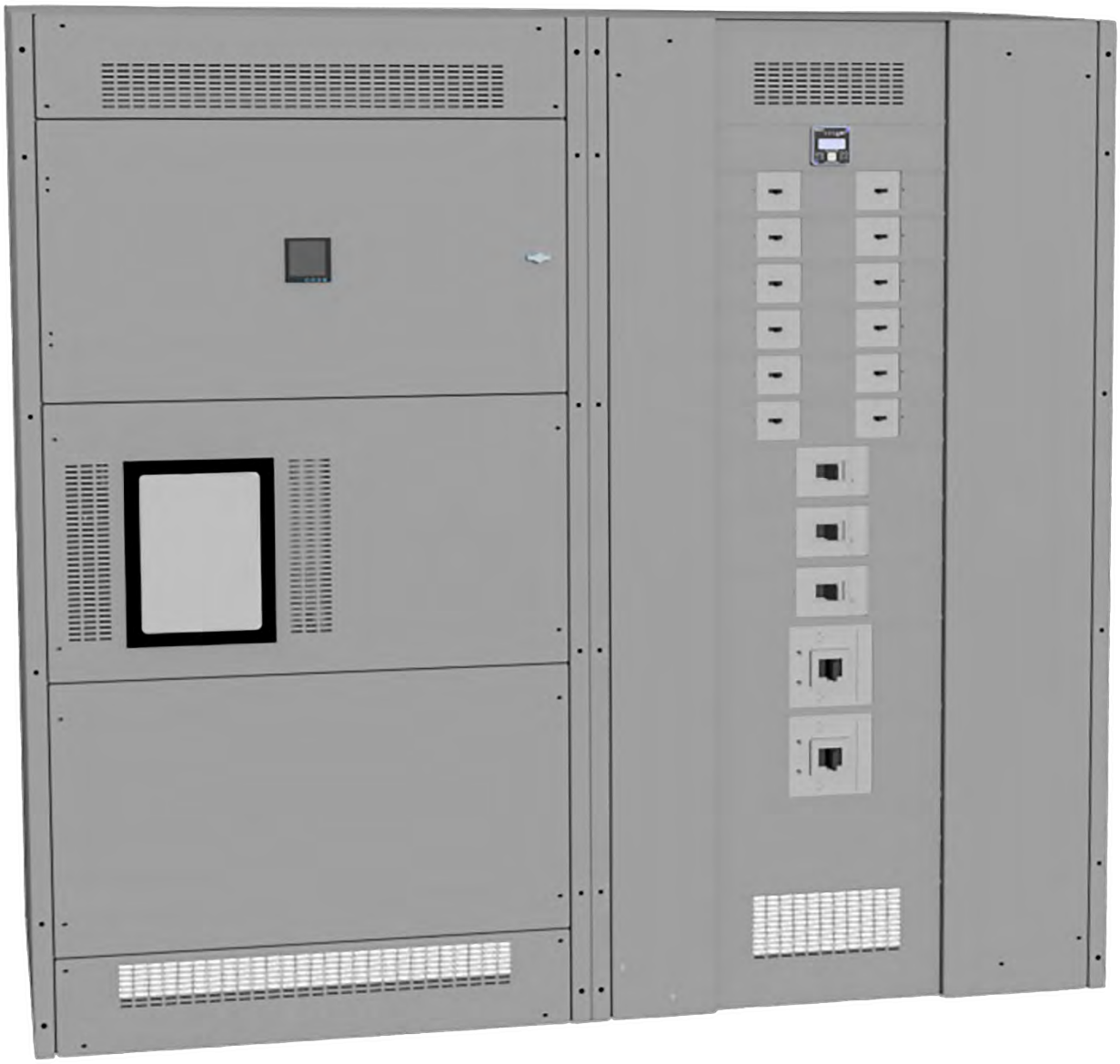
LAKESHORE
ELECTRIC CORPORATION



DISTRIBUTE: LOW VOLTAGE SWITCHBOARD UL 891

Lake Shore Electric Corporation's Operation and Maintenance Manual

TABLE OF CONTENTS

Lake Shore Electric Corporation Documentation 2

Warning 2

Notes 2

Warranty 2

Terms and Conditions 2

Troubleshooting Guide 2

Sales Rep Locator 2

Introduction 3

Lake Shore Electric UL 891 Switchboard 3

Purpose 3

Lake Shore Electric Standards 3

General Descriptions 3

Safety 3

Receiving 4

Handling 5

Storage 6

Installation 7

LSE Outdoor Installation Instructions 8

Attaching Switchboard Sections 8

Positioning 9

Circuit Breakers and Accessories 10

Cabling 10

Wiring 12

Bus Splice Connections 13

Grounding and Bonding 14

Pre-energizing Procedures, Inspections and Testing 14

Energizing and Operation 16

Lake Shore Electric Testing 17

Replacement Parts 17

Addendums 18

Eaton 18

ABB 21

LAKE SHORE ELECTRIC CORPORATION DOCUMENTATION

WARNING

WHEN WORKING ON EQUIPMENT OF THIS TYPE, EXTREME DANGER OF ELECTROCUTION EXISTS THAT MAY RESULT IN INJURY OR DEATH. DO NOT ATTEMPT ANY REPAIRS OR ADJUSTMENTS TO THIS EQUIPMENT WITHOUT FIRST TAKING THE APPROPRIATE PRECAUTIONS TO PREVENT PERSONAL INJURY AND EQUIPMENT DAMAGE. DURING INSTALLATION AND USE OF THIS PRODUCT, COMPLY WITH THE NATIONAL ELECTRICAL CODE (NEC), FEDERAL, STATE AND LOCAL CODES, AND ALL OTHER APPLICABLE SAFETY CODES. MAIN UTILITY POWER MUST BE OFF DURING INSTALLATION, WHEN PERFORMING EQUIPMENT MAINTENANCE OUTSIDE THE EQUIPMENT'S NORMAL MAINTENANCE SCOPE AND WHEN PERFORMING REQUIRED MAINTENANCE ON ANY POWER CABLE(S) CONNECTED TO THE EQUIPMENT.

LAKE SHORE ELECTRIC IS NOT RESPONSIBLE FOR DAMAGE TO ITS EQUIPMENT THROUGH IMPROPER INSTALLATION OR USE, UNAUTHORIZED REPAIR, OR MODIFICATIONS, OR ATTEMPTS TO OPERATE IT ABOVE ITS RATED CAPACITIES OR IN ABNORMAL ENVIRONMENTS. IN NO EVENT, WHETHER AS A FAILURE TO MEET CONDITIONS OF THE WARRANTY OR OTHERWISE, SHALL LAKE SHORE BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, INCLUDING, BUT NOT LIMITED TO, LOSS OF PROFIT OR REVENUES, LOSS OF GOODWILL, DAMAGES TO ASSOCIATED EQUIPMENT, COST OF CAPITAL, COST OF SUBSTITUTE PRODUCTS, FACILITIES, SERVICE OR REPLACEMENT POWER, COSTS OF DOWNTIME OR CLAIMS OF THIRD PARTIES FOR SUCH DAMAGES.

NOTES

Engineering changes may have been made after the publication date. Any departure from this manual should be checked with Lake Shore Electric Corporation. LSE reserves the right to change specifications without prior notice.

WARRANTY

Seller warrants equipment (and its components parts) of its own manufacture against defects in materials and workmanship under normal use and service for one (1) year from the date of installation or start-up, or for eighteen (18) months after the date of shipment, whichever occurs first.

Please visit our website for Lake Shore Electric Corporation's Standard Warranty Policy.

TERMS AND CONDITIONS

Unless otherwise mutually agreed in writing, prices quotes by the Seller shall be firm for a period of 30 days after quotation, or, after receipt of an acceptable purchase order from the Buyer, for the duration of the contract, not to exceed one year after the Seller's receipt of the purchase order.

Please visit our website for Lake Shore Electric Corporation's Terms and Conditions of Sales.

TROUBLESHOOTING GUIDE

For questions relating to the use of this manual, please contact our Technical Support Team. To help technical support, please have a serial number and/or a model code readily available. This information can be found on the inside of the equipment door.

Please visit our website for Lake Shore Electric Corporation's Technical Support Form.

SALES REP LOCATOR

Lake Shore Electric offers available representatives all across the U.S. ready and available to help with any other information needed.

Please visit website for Lake Shore Electric Corporation's Rep Locator.

INTRODUCTION

LAKE SHORE ELECTRIC UL 891 SWITCHBOARD

Lake Shore Electric Corporation's UL 891 Switchboard is a reliable solution that integrates molded case and insulated case circuit breakers into a single assembly. LSE's design is component agnostic allowing the use of industry-recognized breaker and switch manufacturers to meet the customers' requirements. This operation and maintenance manual contains important procedures and information pertinent to receiving, handling, storage, and installation of Lake Shore Electric's Low Voltage UL 891 Switchboard. Information provided in this instruction manual and by other supplied documentation and/or drawings should be read and understood by all personnel responsible for supervision, operation, or maintenance. Familiarization should always include the characteristics of each piece of equipment contained in or mounted on the assembly.

PURPOSE

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

LAKE SHORE ELECTRIC STANDARDS

LSE enclosures and bus fabrication are completed in-house to provide a true custom experience. The fully rated bus per density ratings that we use lower operating temperatures compared to the heat rise test. Our switchboards are UL Listed 891 Construction, we use UL 489 and 1066 breakers with standard 100kAIC rated bus bracing. Lake Shore Electric system options include, but are not limited to, voltage up to 10,000A*, ampacity up to 10,000A* and 100% rated neutral. Our enclosure options are NEMA Type 1 or 3R, as well as front, rear, and side accessibility. We offer texture ANSI 61 powder coat, aluminum, and stainless-steel options.

GENERAL DESCRIPTIONS

Lake Shore Electric UL 891 Switchboards are designed and manufactured to perform efficiently under normal operating conditions. This information should be distributed to the owner's operators and engineers for proper operation and maintenance. Any special equipment furnished in accordance with purchase order requirements are covered by supplementary instruction books. The switchboards described in this manual are the deadfront type as defined in NFPA70 (NEC) and UL891. The equipment furnished has been designed to operate in a system having the circuit capacity specified by the purchaser.

If, for any reason, the equipment is later used in a different system, or if the short-circuit capacity of the system is increased, the momentary rating of the switchboards, the interrupting capacity of the protective devices and the bus capacity must be checked. Should the service be changed, the equipment must be checked to ensure that the short circuit capacity, amperage, and voltage class of the equipment meets or exceeds the requirements of the new system. A typical switchboard will contain the service entrance section with main devices and distribution sections with branch devices. The sections contain disconnect devices, protective devices, auxiliary equipment, and any current transformers for metering, control, or ground fault protection.

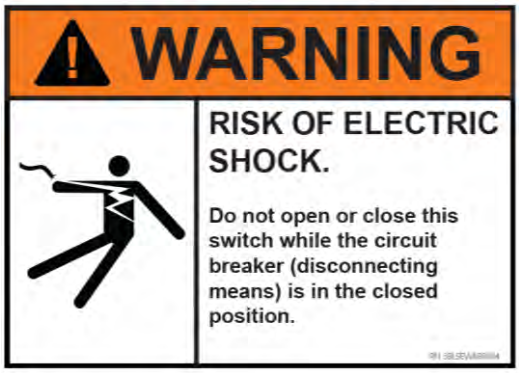
SAFETY

Due to the weight and size of the switchboards and the dangers from electrical hazards, every precaution should be taken to maintain safe working conditions when handling this equipment. Due to the custom nature of switchboards and the site variables, every potential situation cannot be anticipated. Safety must always be the overriding factor. Always follow all instructions and all safety guidelines published by OSHA and other industry and local, state, and federal agencies. Follow safety-related work practices, as described in NFPA 70E, at all times.

For the purpose of this manual, a qualified person has the following qualifications:

- Training and authorization to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety practices.

- Training in the proper care and use of protective equipment such as rubber gloves, hard hats, safety glasses, face shields, flash clothing, etc., in accordance with established safety procedures – NEC and NFPA requirements.
- Training in first aid.



The signal words "Danger," "Warning," and "Caution" used in this manual indicate the degree of hazard that may be encountered by the user. Danger indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury. Warning indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury. Caution indicated a potentially hazardous situation that, if not avoided, may result in minor or moderate injury.

RECEIVING

Upon delivery, use the packing list to confirm the number of items against what was received to ensure that the shipment is complete. Any discrepancies should be noted on the freight bill before signing. Report any shortages or damage to the freight carrier immediately. Immediately upon receipt of the switchboard, the plastic covering should be carefully removed, and a thorough inspection of each section should be made to detect any damage incurred during shipment. Any damage should be noted on the bill of lading and the consignee receiving the equipment should notify the freight carrier. After inspection, it is recommended that a plastic covering be used to protect the equipment from dust, dirt, moisture, and damage until ready for installation. The switchboard should remain attached to its shipping skid until it has been moved into its final installation position.

FAILURE TO NOTIFY THE FREIGHT CARRIER OF DAMAGE IN A TIMELY MANNER MAY RESULT IN THE CONSIGNEE ASSUMING THE COSTS ASSOCIATED WITH THE REPAIR OR REPLACEMENT OF DAMAGED EQUIPMENT.

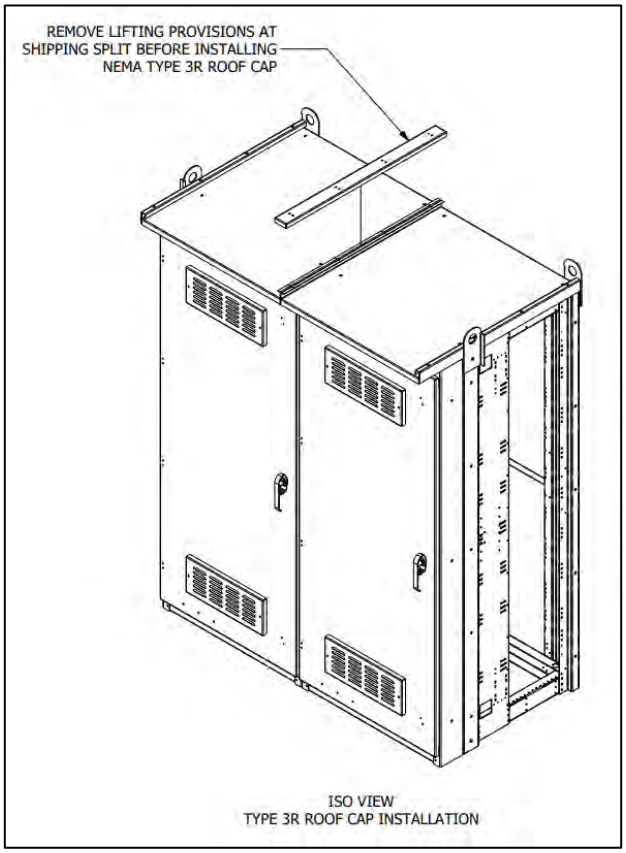
Except as otherwise mutually agreed, domestic shipment will be EXW, Seller's point of shipment, international shipments will be FCA Seller's point of shipment. Buyer will pay all transportation charges. Seller's quoted prices are based on shipment immediately upon readiness, with no delays or storage. Work which has been suspended or stored for the Buyer's convenience may be billed in place, and applicable storage charges shall accrue. If Buyer does not furnish exact shipping instructions, Seller will select, at its discretion, the means of shipment. Seller will not be liable for any loss resulting from such selection. The time of delivery is an estimate only, and Seller may change such time if Seller does not receive the information and approvals necessary to proceed with the manufacture of the equipment. Buyer agrees to inspect all deliveries immediately. Any claim for shortages or damage must be made in writing within twenty-four (24) hours after Buyer receives a shipment, and if not made, shall be deemed waived. Any other claim by Buyer, other than claims under the WARRANTY stated below, shall be made within fifteen (15) days after Buyer receives shipment, and if not made shall be deemed waived. Seller is not responsible for loss or damage in transit after having received an "In Good Order" receipt from the carrier. Buyer will make all claims for loss or damage in transit against the carrier.

Seller's quoted prices are based on shipment immediately upon readiness, with no delays or storage. Work that has been suspended or stored for the Buyer's convenience shall be billed in place, and applicable storage charges shall accrue. Promise date, shipment date or completion of manufacture date of the equipment may be changed only with Seller's written consent. If the shipment is delayed at Buyer's request, Buyer will make any payments due under the Order as if the equipment has been shipped on the date when it was ready for shipment. If completion of manufacture is delayed at Buyer's request, Seller may require payment according to the percentage of completion. Buyer shall have the risk of loss with respect to equipment held for Buyer, and Seller may charge Buyer for storage.

Any loose components and installation parts will be shipped loose in a container that will be marked in the drawing package.

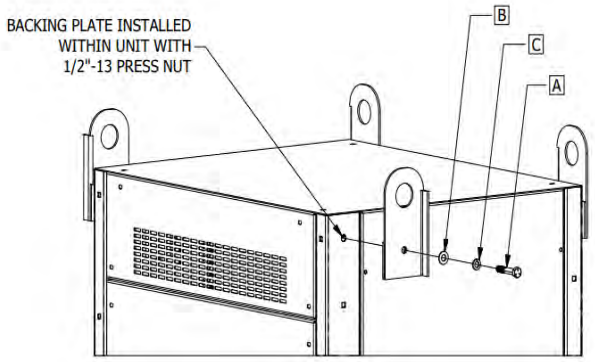
HANDLING

Switchboards are top-heavy. Switchboard sections may weigh more than two thousand pounds. Before moving or lifting, verify that the equipment used to handle the switchboard is within safe limits of its lifting capacity. Switchboard shipping lengths will vary. Each shipping section is bolted with lag bolts to heavy wooden skids that extend beyond all sides of the switchboard.

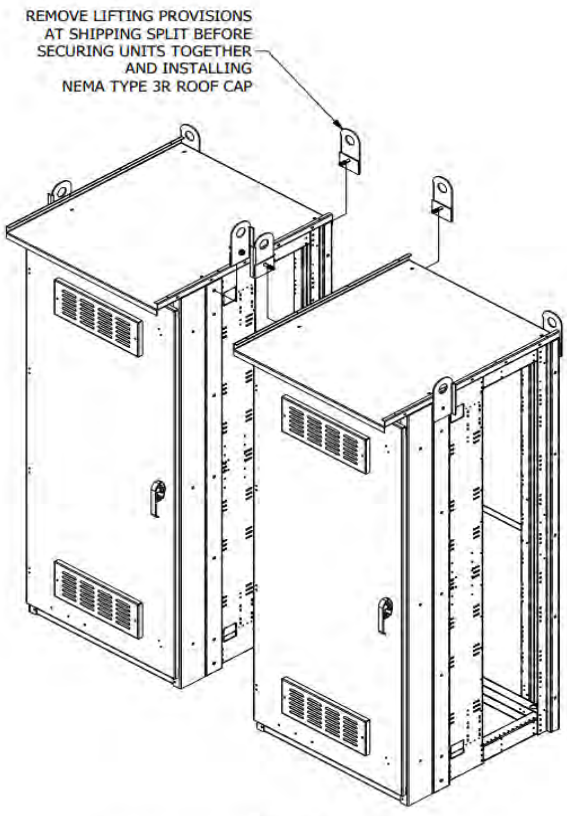


ISO VIEW
TYPE 3R ROOF CAP INSTALLATION

FASTENER TABLE		
ITEM	LSE PART NUMBER	DESCRIPTION
A	63XXXSC2120250	1/2"-13x2-1/2" SCRW,HH,GR5,ZN
B	63XXXFW0000051	1/2" FLAT WASHER, GR8
C	63XXXLW0000051	1/2" LOCK WASHER, GR5



ISO VIEW
LIFTING PROVISION INSTALLATION HARDWARE

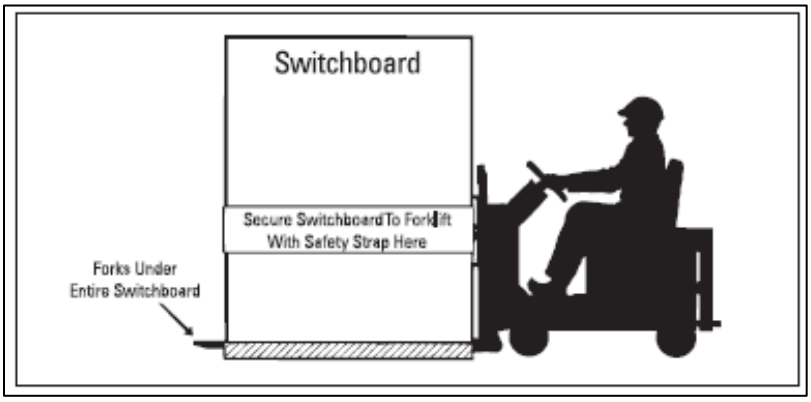


ISO VIEW
LIFTING PROVISIONS AT SHIPPING SPLITS TYPE 3R

Lifting provisions can be loosened and rotated 180° for storage. Before lifting return lifting provisions to their original position and ensure the hardware is installed properly. Side and rear lifting provisions at the shipping split must be removed before securing units together. If the switchboard has an IR heat shield, lifting provisions at the rear must be removed or rotated 180° for installation. LSE Units are designed to be picked up from the top only. All covers and doors are to be installed and closed during rigging. All four lifting tabs are required for proper lifting. See the drawing below for each elevation. Splice plates are to be installed using 3/8" hardware that is provided by LSE. For NEMA Type 3R, the rear and side lifting provisions at the shipping split must be removed before securing units together. Once units are secured together the roof cap should be installed ¼-20 self-tapping screws. Refer to job-specific drawings for more detail.

June 2023
LSE Control Document Number: LSEE-050-020

Chains/cables must be securely attached to hooks, eyes, shackles, and the spanner/spreader. Use the crane to bring the assembly tout without raising the switchboard from the floor. Make any necessary adjustments before moving the equipment. Slowly lift equipment to the minimum height from the floor required to safely relocate it. Move the equipment to approximately two inches above its resting place. Safely make a visual inspection of the rigging. If necessary, return the switchboard to its original resting place to make any modifications necessary to the rigging.



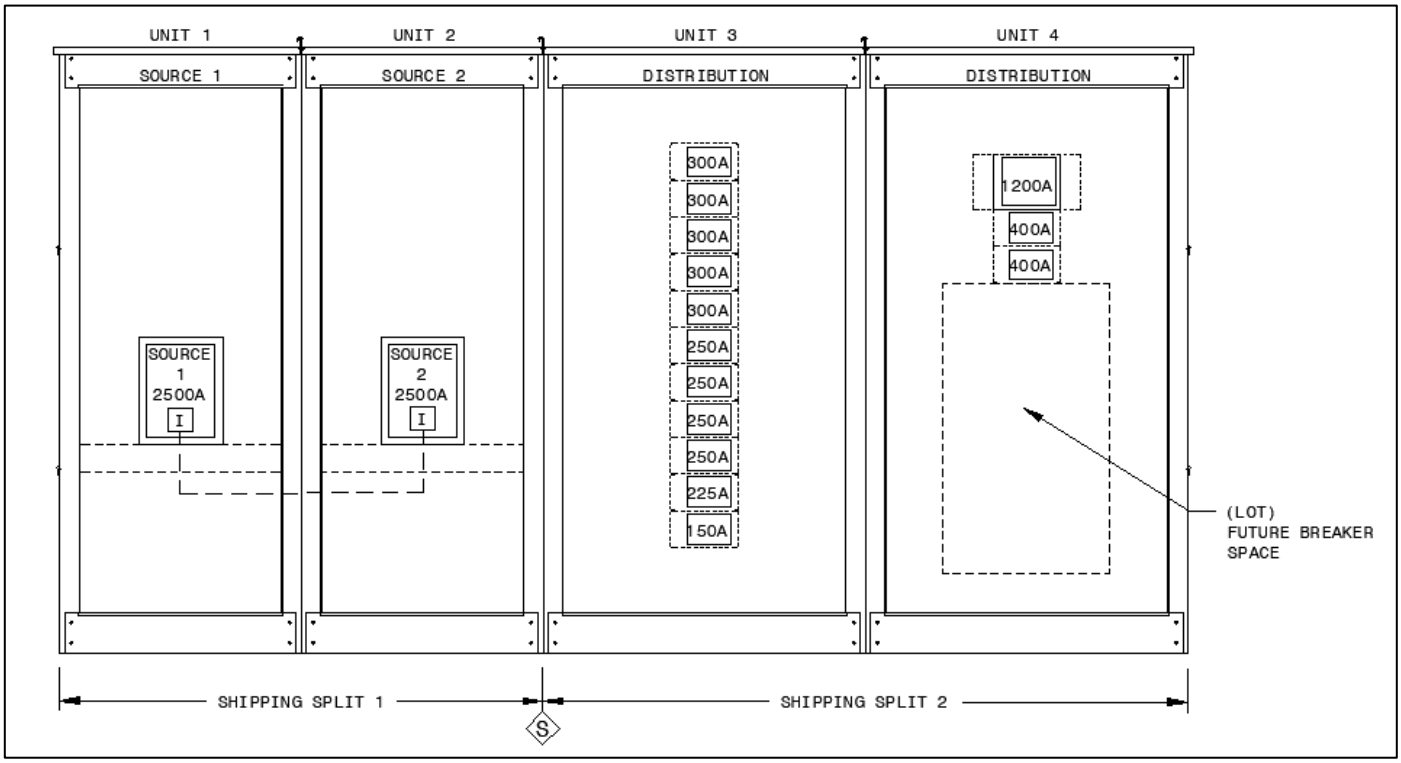
A forklift may be used for handling switchboards. Only personnel trained for that equipment should operate forklifts. Be sure that the ground surface is solid and follow all safety recommendations for operating the forklift. Be aware of wet or slick floors and surfaces that can affect stopping and turning. Check the labeling on the switchboard packaging material for additional information. Verify that the forklift load and lifting ratings are within safe limits of the weight of the switchboard being lifted. Do not lift the switchboard from the front. Damage to components, such as breakers, fusible switches, and metering, can result. Forklift trucks should be used with care as improper lift points could cause damage to equipment. Balance the load carefully and use safety straps when handling a forklift. Jacks may be used to lift switchboard sections which are properly supported by sturdy timbers. To prevent distortion of the enclosures, rollers and cribbing of equal height must be used in sufficient numbers to evenly distribute the load. **Note**: Always use caution when moving switchboards, which are top-heavy equipment.

STORAGE

Switchboards that cannot be immediately installed and energized should be stored in an indoor dry, clean, and heated environment. Do not store in areas where conditions such as dampness, changes in temperature, cement dust, or a corrosive atmosphere are present. Should the storage area be prone to moisture condensation, take precautions by making sure that the switchboard is covered, and install temporary heating equipment. Approximately 250 watts per vertical section are required for average conditions. Switchboards should be placed on solid, level surfaces for storage. Switchboard sections must remain in an upright position at all times. Laying switchboard sections on their back or side can result in permanent damage to components and the switchboard structure.

Outdoor switchboards are not weather resistant until completely and professionally installed and energized. Additionally, using temporary heating as described above should keep an unenergized outdoor switchboard dry internally. When the switchboard is not to be installed immediately, it should be unpacked, inspected, and stored in a clean dry location having adequate air circulation and uniform temperature to prevent condensation. If the switchboard is to be stored for any length of time prior to installation, restore the packaging for protection. If the packing material is removed, cover the switchboard to protect from dust, debris, and moisture. Indoor switchboards are neither weatherproof nor drip-proof. Therefore, it should be stored indoors. If it is to be kept either outdoors or in a humid, unheated area, provide an adequate covering to protect against weather and dirt, and place a heat source of approximately 250 watts output within each vertical section to prevent condensation. Space heaters are not standard equipment on indoor switchboards. Remove any loose packaging or flammable materials inside the switchboard before energizing the heat source. Lubricate any moving parts such as hinges, shutters, etc., if equipment is stored for an extended period.

It is important that outdoor switchboards are stored exactly as described for indoor switchboards. When it is necessary to store outdoor switchboards in an area exposed to the weather or under humid conditions, they should be kept clean and dry as described above. Energize the self-contained space heaters (if provided) and make certain that louvers and vents are uncovered to allow air to circulate and cover shipping splits to protect from the elements. Refer to the wiring diagram drawing for space heater circuit connections. Lubricate hinges, shutters, and other moving parts. Every custom switchboard is different, consult Submittal, Record or As Built Drawing Package for specific shipping split locations and weights.



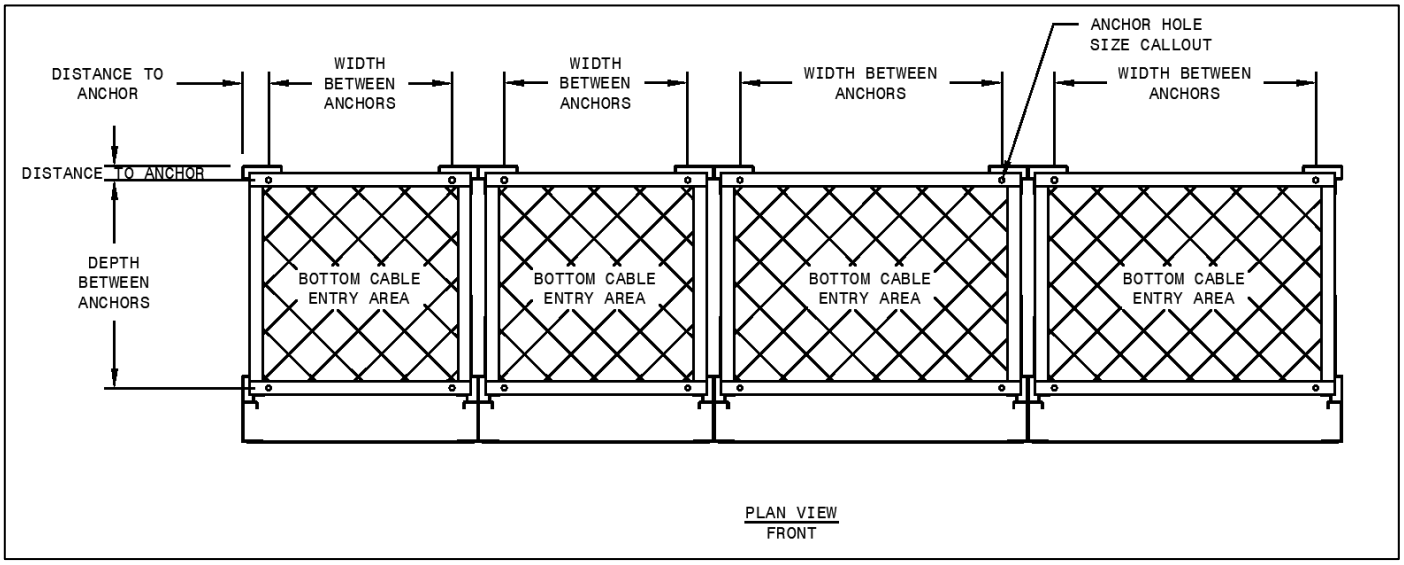
INSTALLATION

The permanent location of switchboards must be on a smooth, solid, and level (no more than ±0.125 inches per every 3 feet) foundation. Alignment is verified in the factory prior to shipment. An uneven foundation can cause misalignment of sections, units, doors, and other parts. If a housekeeping pad is used, check factory drawings and verify handle height rules relative to the National Electrical Code (NEC) and utility meter heights where applicable. When embedded anchors or channel sills are used, materials and attachments must be adequate to support the structure(s). Switchboard sections must be aligned and level over the length of the installation. From the manufacturer's drawings, determine the layout of the electrical distribution equipment for each location. Verify and confirm that the available equipment space and equipment location(s) comply with the minimum working space clearances per the NEC. Refer to the manufacturer's switchboard drawings for available conduit area in each section before installing the finished grade flooring. Conduits must be installed in conduit area shown to ensure compliance with NEC wire bending space requirements. **Note**: Conduit areas may vary in each section of a multi-section switchboard lineup.

The preferred method of anchoring the switchboard is by fastening the switchboard to steel channels that are properly and permanently embedded in a concrete floor or by using anchors designed for this purpose. Conduits, floors, and/or wall openings, such as busway or other penetrations, should be located relative to the space shown on the manufacturer's drawings. Refer to the NEC for installations in damp locations for additional requirements. The entire area around the switchboard should be thoroughly cleaned of all debris. The proper switchboard installation method depends on whether the units are shipped as one complete group (maximum of 84.0") or in two or more shipping sections. The general arrangement drawing supplied by the factory will indicate the shipping groups and their respective location within the lineup. Units must be assembled in accordance with the general arrangement drawing.

Use caution as well as appropriate equipment and practices when moving the switchboard into its final position. Determine the switchboard orientation with the use of the manufacturer's drawings and markings on the switchboard sections. Switchboards may be shipped either in individual sections or in two or more sections joined by the manufacturer.

The drawing supplied with the switchboard will indicate the correct orientation of sections by section number. Each section will have a label with the ULT listing mark designating "Deadfront Distribution Switchboard Section ___ of ___." The manufacturer will fill in the blanks prior to shipment.



LSE OUTDOOR INSTALLATION INSTRUCTIONS

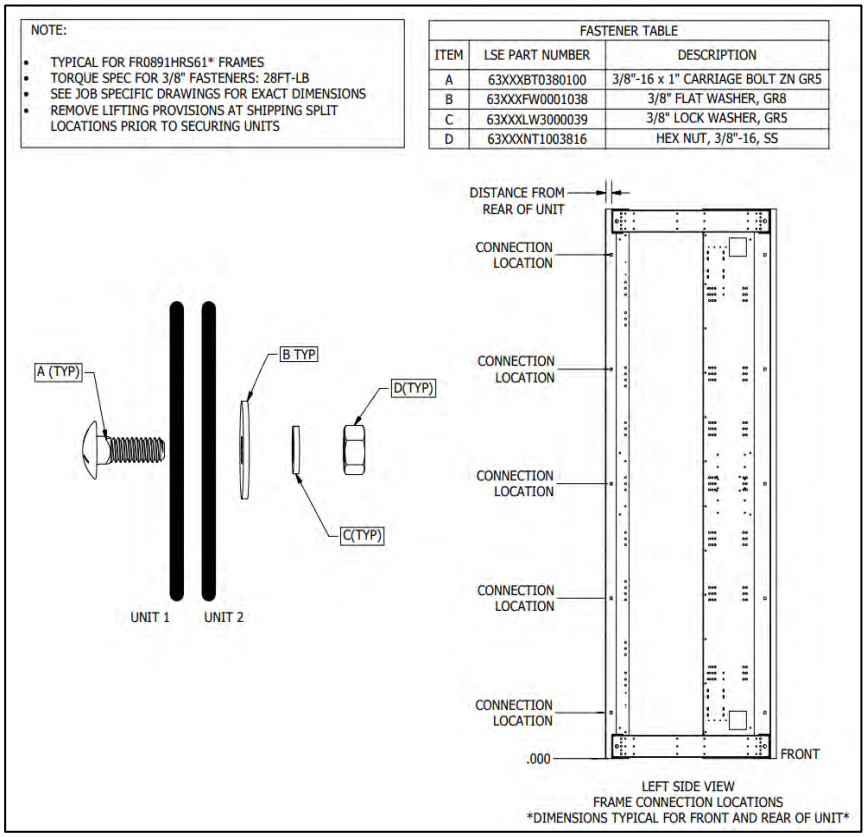
Proper installation of outdoor switchgear will prevent moisture from entering the equipment. The installation of the housekeeping pad and the conduits need to follow a few extra rules for outdoor installation as noted below: HOUSEKEEPING PAD NOTES: Outdoor units should be on a "housekeeping pad" that sits higher than any water around it. Typically, four inches above the ground, but may need to be higher in wet areas.

Housekeeping pads next to buildings are sloped away from the building. Typically, ½ inch per ten feet but may need to be more in areas with heavy rains or poor drainage. Housekeeping pads away from the building are typically level and crowned in the middle so that any heavy rain will run off the edge of the pad and not puddle down to the middle of it, i.e., under the equipment. CONDUITS: All conduits should be sealed with duct seal. This keeps moisture from wicking into the enclosure and turning into condensation and then forming corrosion. This is also important on many NEMA 1 enclosures mounted in an air-conditioned environment. The air conditioning keeps the unit cool on the outside, however hot moist air can pour into the enclosure through unsealed conduits that travel outside, up walls and over roofs. This hot moist air condensates on the inside of the enclosure creating condensation and then tracking issues on electronics.

WARNING
Failure to properly seal outdoor equipment can result in moisture entering which can cause VOID OF WARRANTY.

ATTACHING SWITCHBOARD SECTIONS

The manufacturer has provided hardware with the equipment to join switchboard sections. The hardware includes (10) 3/8˝ - 16x1” carriage bolt, (10) 3/8” lock washer, (10) 3/8” flat washer and (10) 3/8”-16 hex nut. Holes are provided on the side of each switchboard section for this purpose. Five holes each on the front upright and on the rear upright of the frame at each shipping split, so a total of ten connections per shipping split.



Join sections by using the carriage bolts and hex nuts with lock and flat washers through the holes provided. While maintaining the level and alignment of the structures, torque each connection for 3/8” fasteners; 28 ft-lb. If switchboard sections are outdoor type, reinstall roof cap(s). Visually inspect the roof cap to ensure a reliable, permanent watertight fit prior to energizing the switchboard. Once the switchboard structures are attached, visually inspect the board for foreign objects and visually inspect the structure for proper clearances of live parts.

UL 891 Standard Fastener Information				
Connection Type	**Number of Connection Points**	**Hardware Size**	**Torque**	**Hardware Used**
Unit to Unit	10 Per Shipping Split	3/8”	28 ft-lb	3/8’-16x1” Carriage Bolt, FW, LW, Hex Nut
Neutral/Main Phase Bus Splice Plates	8 Per Phase Per Shipping Split	3/8”	28 ft-lb	3/8” Bolt (Length Dependent on Application), FW, LW, Press Nut (Installed in Last Lamination of Splice Plates)
Ground Splice Plate	4 Per Shipping Split	1/4"	68 in-lb.	1/4"-20x1” Bolt, LW, FW, Press Nut (Installed in Ground Spice Plate)

POSITIONING

Positioning and connection of the switchboard sections at the installation site are done in the following manner. Space to the front and rear should be sufficient for the opening of doors, insertion and withdrawal of removable breakers, inspection, and maintenance. Service entrance equipment should be located as close as possible to the incoming service of the building. Clean the mounting surface to remove all dirt and debris. Start with the left end shipping group and continue in sequence. Maneuver the section into the desired position using procedures described under “Handling.”

Use care in locating sections over conduit areas and beware of any conduits which stub-up above floor level as these may block sliding the section in either direction. Prepare for the connections across shipping splits before the equipment is moved into the final position. Bus supports and bus joints should be removed using side, rear, and front access options as required. Note the mounting position and orientation and save hardware for use in reinstallation. Remove the shipping skid and stand the section in an upright position. Remove all packing material and the bottom floor plate if one is installed in the section. To protect the bottom channel, any sliding force must be carefully applied across the bottom 4 inches (100mm) of the side to fully distribute the sliding force. All shipping sections must be leveled and aligned to each other in order to maintain proper alignment of the horizontal main through bus and splice bus

connections. Bolt all section frames together and connect all through bus and ground bus at shipping breaks using the splice plate bus and hardware supplied. Tighten bolted connections in accordance with torque specifications indicated on the instruction label supplied.

Anchoring, leveling and assembly Indoor switchboard shipping groups are held in alignment by bolts holding the vertical sections to each other. The entire shipping group is to be anchored and leveled as a single element without loosening any hardware until the entire shipping group is leveled and anchored. Supporting surfaces for the switchboard at each anchoring bolt location must be level and in the same plane. There must not be any projection above this plane within the area covered by the switchboard cubicles.

CIRCUIT BREAKERS AND ACCESSORIES

Visually inspect circuit breakers for signs of discoloration, cracking, scorching, overheating, or broken parts. Exercise the breaker operating mechanism, making sure it is opening and closing. A breaker showing signs of any one of these issues should be replaced. Some circuit breaker types provide the ability to adjust trip settings. When shipped, settings are typically at the minimum rating. There are two types of trip units included in this group: adjustable thermal magnetic and electronic trip units.

Some circuit breaker types provide the ability to adjust trip settings. When shipped, settings are typically at the minimum rating. There are two types of trip units included in this group: adjustable thermal magnetic and electronic trip units. Thermal-magnetic trip units may have an adjustable magnetic setting. Use the engineering study recommendations, if available, to adjust to the proper setting. Low magnetic settings feeding high inrush loads, such as motors, could nuisance trip on startup. For specifics on breaker types, consult the circuit breaker instruction leaflets shipped with the switchboard.

Electronic trip units have several settings depending on the breaker ordered. Electronic trip units may include long-time (L), short-time (S), instantaneous (I), and ground fault (G) settings. These trip units are available in combinations of LS, LSI, LSG, and LSIG. Check the electrical drawings, engineering study, or the engineer's recommendations for these trip unit settings. **See below for the Eaton and ABB Addendum sections.*

CABLING

Some switchboards use cable/wire for some connections in lieu of bus. Cabling is typical in Integrated Facility System E (IFSE) type switchboards that incorporate lighting and appliance branch circuit panelboards and dry-type distribution transformers within a switchboard lineup. Eaton's selection of wire and cable follows UL 891 switchboard procedures, National Electrical Manufacturers Association (NEMA), Federal Specification standards, and the National Electrical Code standards for IFS switchboards. The manufacturer identifies each phase conductor by means of color-coded tape with markings "Factory Installed" in IFS switchboards. Markings are affixed to both the line and the load ends of the conductors.

Conductors installed by the manufacturer have been cut and stripped to predetermined lengths for connection between components. When conductors are intended to run between components in two different sections that are joined by the manufacturer, the manufacturer will connect both the line and the load ends of the conductors. **Note**: The National Electrical Code restricts the field installation of conductors that run horizontally through switchboard vertical sections. Refer to the NEC for specifics.

When there is a shipping split between sections that are cabled, the factory connects one end of the conductors. The remainder of the conductors are coiled and secured in the section with the connection. Factory drawings included in the switchboard clearly indicate the required field connections for the coiled conductors. Inspect conductors/cables for damage. Any damaged conductors must be replaced. Contact manufacturer for replacement. Factory color-coded markings indicate phasing/neutral and are marked on both the line and the load ends of the conductors. Using the factory drawings, the installer connects conductors to the component(s) indicated on the drawings, keeping phases correctly oriented. Care should be taken in forming insulated cables to ensure that no insulation is forced permanently

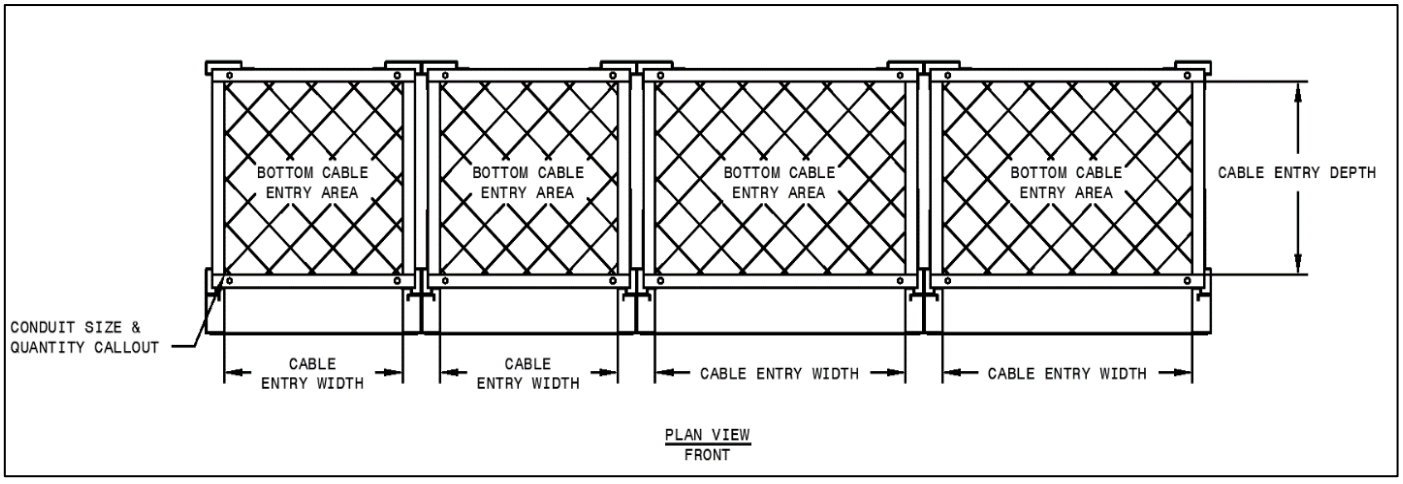
against the edges of any metal parts. Torque both line and load connections to values indicated on the switchboard labeling.

DO NOT work on electrical equipment while it is energized. Verify that power entering the equipment is de-energized at the source. Power is normally brought into a switchboard either by cable or by busway (bus duct). Remove structure covers as needed to access the switchboard chassis and components. Retain all cover mounting hardware and covers for reassembly. Protect hardware and parts from moisture, debris, and damage. **Note**: As a minimum, all switchboard connections are rated for use with 75 °C or higher rated conductors. When wire is used with temperature ratings above 75 °C, it shall be sized based on the ampacity of wire rated 75 °C.

When cable connections are used, either mechanical set screw or compression lugs are typically supplied. See the factory drawing for specific lug terminations and wire ranges. Some utilities make their own service entrance connections. In these cases, the manufacturer typically supplies lug landing provisions, or a landing pad in lieu of lugs. These are designed to the specific utility's requirements. Refer to the manufacturer's drawings for specifics covering this connection. Unless a switchboard specifically restricts entry to a single means or area, cables may enter through the top, bottom, side, or back of the main incoming section. These restrictions are typically required to conform to wire bending space requirements of the NEC. Consult the manufacturer's drawings for conduit entry data.

Once the conductors are pulled inside the main section, the cables should be formed in the space provided. Clearly identify and segregate conductors by phase and neutral. Care should be taken in forming insulated cables to ensure that no insulation is forced permanently against the edges of any metal parts. Using appropriate tools, the installer must strip the conductor insulation sufficiently to fill the entire barrel of the connector with bare, uninsulated conductor. The conductor must be stripped without damage to the conductor strands. Bare strands should be of equal length (flush) on the end cut.

Do not strip off more insulation than needed. Exposure of bare conductors outside the lug can compromise clearances. The connector and conductor should be free of all foreign debris. Never clip cable/wire strands in order to fit within connectors. If the cable/wire does not match the rating of the connector, contact the manufacturer. Mechanical set screw lugs are the most common. Use an antioxidant compound, if required. Insert bare conductor into lug so the bare conductor fills the full length of the lug body. Tighten the lug, and then torque to levels indicated on the switchboard label. If compression lugs are used and supplied with the switchboard, the lugs will be mounted on the incoming lug pad. Remove lugs from the pad. Use an antioxidant compound, if required. Use a crimping tool approved for that specific lug manufacturer and lug size. Follow the instructions provided by the manufacturer of the crimp tool. Once the lug is affixed to the conductor, reinstall the lug on the lug pad using the existing hardware. Torque hardware using information provided on the switchboard labeling.



Lake Shore Electric Switchboards are constructed according to NEMA standards for cable arrangements. All cables must enter the switchboard in the conduit area shown on the plan view on the -M001 drawing and per the instructions

shown below: Use only cable sizes suitable for a proper fit with the corresponding lugs. Pull the proper number of line side and load side cables as per the load served. Position the cables inside the switchboard so that they are not subject to physical damage. Maintain the maximum possible bending radii and proper clearance to bus bars and grounded parts. If any cables are lying or bearing on structural members, support them to relieve this condition or place suitable protective material at the bearing point to protect the cable insulation. Where cables enter or leave the switchboard, or pass through any metal which has magnetic properties, be certain to run all phases and the neutral conductors through the same opening. See 300.20 (A) of the National Electrical Code.

Cables entering or exiting the switchboard should be in the same section in which they are terminated, except as noted in 408.3 of the National Electrical Code. See Article 300 of the National Electrical Code for proper wiring methods. For Class 2 and Class 3 remote control, signaling and power-limited circuits separation requirements, see 725.136 of the National Electrical Code. Conductors of size 1/0 AWG and larger may be run in parallel. When these conductors are run in parallel, they should be of the same size, length, and material to assure an equal division of current, as required by 310.4 of the National Electrical Code.

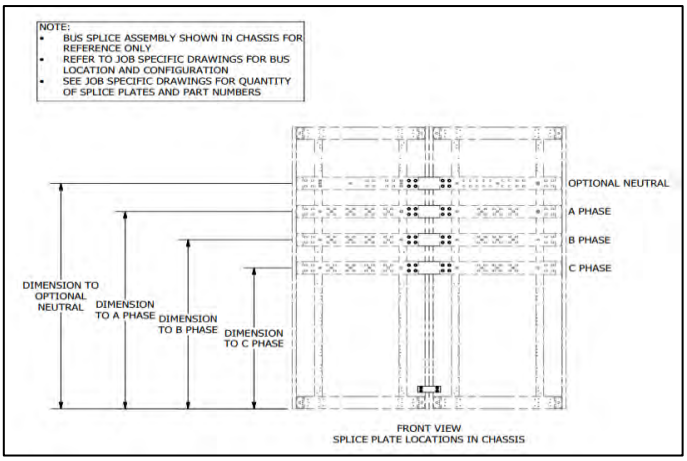
Strip a length of insulation from the end of the cable sufficient to fit into the full length of the lug barrel, being careful not to nick or ring the strands. Use a proper insulation stripping tool. Thoroughly clean aluminum cable contact surfaces with a wire brush. Apply an acceptable joint compound to the bare aluminum. If compression-type lugs are furnished on any switch or circuit breaker, or as the main incoming power lugs, unbolt and remove them. Insert the cable into the lug barrel and, using the recommended crimping tool, make the specified number of crimps. Wipe excess sealant from the connector and insulation. With the cables connected, remount the lugs onto the bus bars, switches, or circuit breakers. Set screw-type lugs may be furnished as main incoming lugs and are standard on all devices supplied by Lake Shore Electric. Torque values for these lugs are marked on these units. Torque values for other switchboard lugs are marked on the switchboard. For conductor lashing instructions on switchboards marked 65kA, 100kA or 200kA short circuit current ratings, refer to the following instructions: Switchboards with a single fusible main switch rated 4000A or less do not require lashing. Switchboards with a single main molded case circuit breaker rated 4000A or less do not require lashing. When using a WL Circuit Breaker, lashing is required. Switchboards with a single main fused circuit breaker rated 4000A and less do not require lashing. Switchboards of single-section construction with fusible disconnects, circuit breakers, or fusible circuit breakers do not require lashing.

WIRING

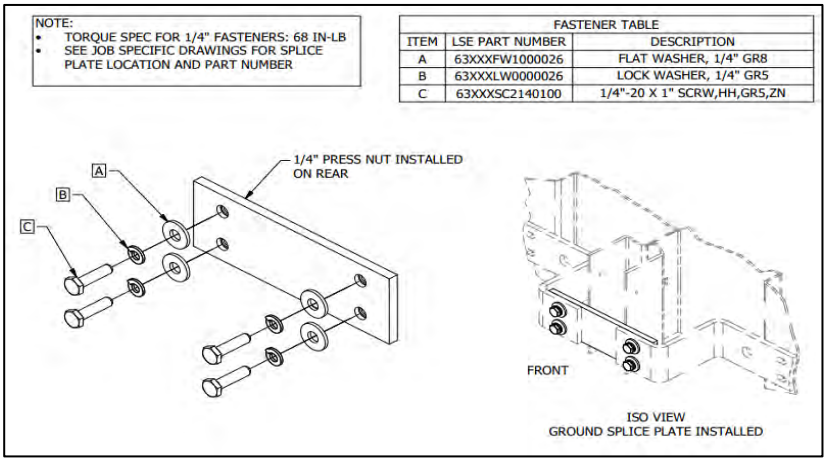
All incoming and outgoing control connections should be made in accordance with the switchboard schematic and wiring diagrams. After wiring is completed, all connections should be carefully checked against the diagrams to ensure that all connections are correct and proper. A set of “as built” prints and instructions manuals covering the switchboards are furnished with the equipment. The prints should be consulted before connecting any external wiring to the switchboards. If aluminum cables are used, it is recommended that the following procedure be followed to guard against overheating: Check all lugs to ascertain that they are suitable for use with aluminum cable. Strip the wire of its insulation to the desired length without ringing or nicking the wire. Wire brush the stripped portion of the conductor thoroughly. Thoroughly coat stripped conductor with oxide inhibiting compound. Insert the conductor into the connector making certain all strands are contained and tightening the connector screws securely. This operation should result in the compound oozing out from between the individual strands of the conductor. If this does not happen, this is an indication an insufficient quantity of compound was used. Wipe excess compound from the area adjacent to the connection because some compounds contain metallic particles and could reduce the dielectric strength of the insulating materials employed. All wiring drawings from Lake Shore Electric Engineering will be labeled -E###.

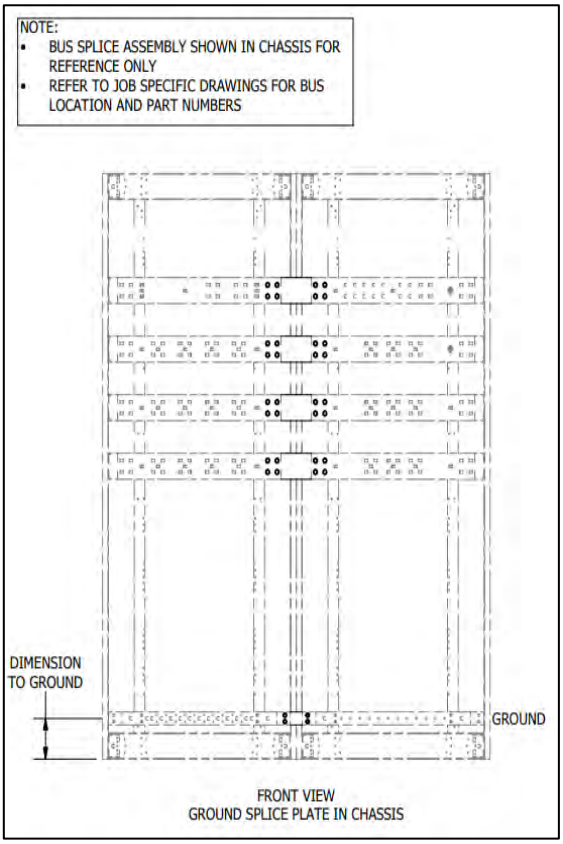
BUS SPLICE CONNECTIONS

When a switchboard group is split for shipping purposes, the cross bus and ground bus connections must be made when installing the equipment. Access to the main bus from the cable termination area varies depending on the unit type, some units only need the outer covers removed. For some arrangements, it may be necessary to remove items between the main bus barriers and the rear of the unit in order to gain full access. After completion of the bus assembly and installation, these items should be reassembled in reverse sequence. All surfaces must be free of dust, dirt, or other foreign material.



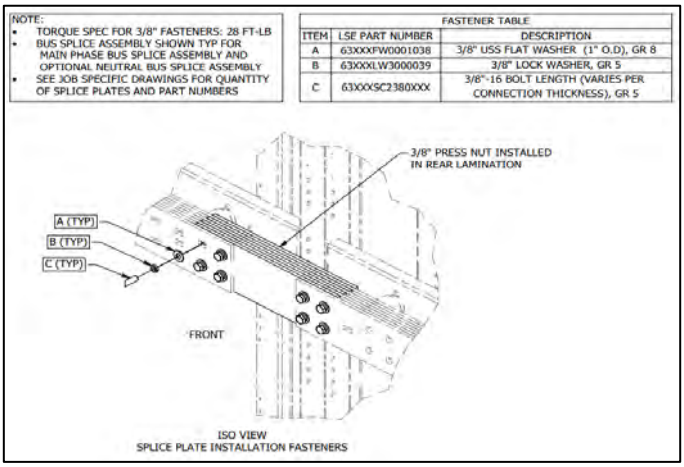
Do not use any abrasive cleaner on plated contact surfaces. Cleaning is normally not necessary and should not be done unless parts are badly tarnished. If cleaning is necessary, use a mild cleaner and thoroughly remove all residue. Keep the cleaning agent off the insulation. Before assembling any bus bar joint, check that the bar is inserted through bus supports (when required).



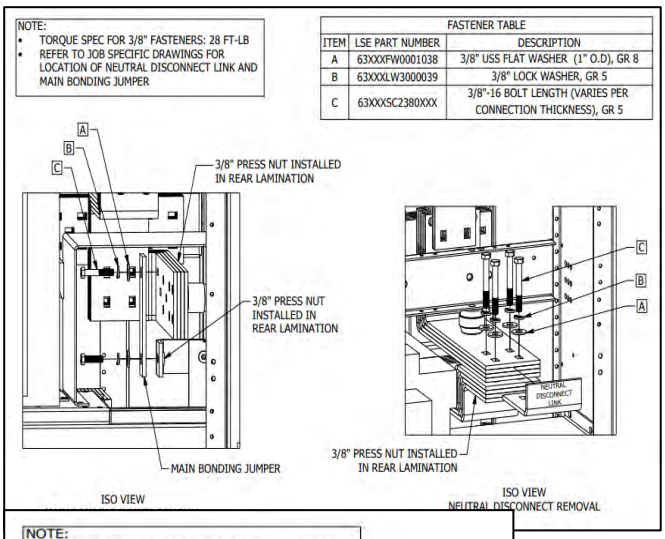


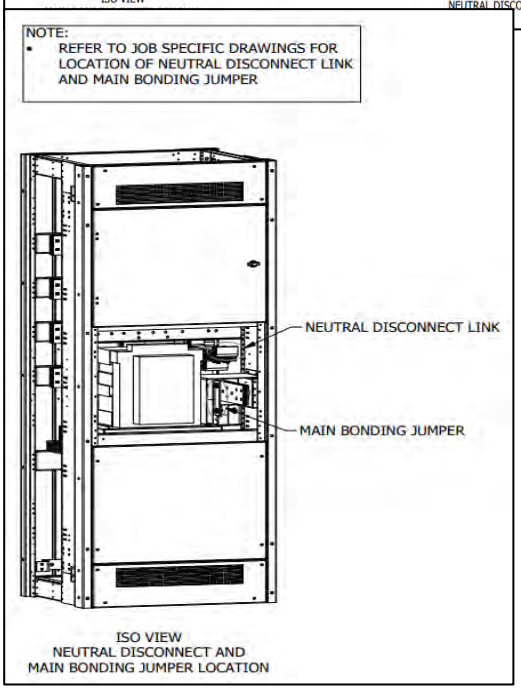
Observe the relationship of the bus bar and maintain this relationship when connecting bus bars. Spacers may be required in some bus joint connections. Assemble all joints with the parts dry. Do not use grease or "no-oxide" product. Use the hardware provided with the Splice Plate Kit. Using smaller or different grade hardware may result in the overheating of the connection. For bus splice connections, we changed to multiple bolt connections. The main bonding jumper should be the only place that should encounter single bolt connections. **Note**: Proper installation is essential for the safe and proper operation of the ground fault protection system (when provided).

Where indicated Splice Plate Kits may include bus splice plates that use captive hardware secured by the manufacturer in the rear lamination of each Splice Plate Kit. When installing follow the drawing shown here for



June 2023
LSE Control Document Number: LSEE-050-020





reference as well as job-specific drawings to ensure the Splice Plate Kits are installed properly. When used properly this hardware shall limit the need to access the unit from the rear while installing splice plates.

GROUNDING AND BONDING

For grounded systems used as service equipment or as a main switchboard on a separately derived system, follow the steps below: Run a grounding electrode conductor from the grounding electrode at the installation site to the switchboard grounding electrode conductor terminal. Select the proper material and size for the grounding conductor to comply with sections 250.62, 250.66, and 250.166 of the National Electric Code (NEC). Install the grounding electrode conductor as specified in section 250.64(B) of the National Electric Code (NEC). No ground conductors are allowed on the load side of the neutral disconnect link or ground fault sensor. 4.9.1.2. If required, the main bonding jumper between the neutral bus and the ground bus will be installed at the factory. Ensure that the bonding jumper is in place and properly labeled. It is important that none of the grounding conductors are connected to the load side of any neutral disconnecting link, or any sensor used for ground fault protection.

For ungrounded systems used as service equipment, or as a main switchboard on a separately derived system, follow the steps below: Run a grounding electrode as described in part above. If the system is grounded at any point ahead of the switchboard, the grounded conductor must be run from that point and connected to the ground bus as described in paragraph 250.24(C) of the National Electric Code (NEC). This conductor is required even if the switchboard supplies only phase-to-phase loads. For a switchboard not used as service equipment or as a main switchboard on a separately derived system: Use equipment grounding conductors sized according to Table 250.122 of the National Electric Code to ground the switchboard frame and ground bus to the service ground, or by bonding to the raceway enclosing the main supply conductors in accordance with sections 250.118 and 250.120 of the National Electrical Code.

PRE-ENERGIZING PROCEDURES, INSPECTIONS AND TESTING

Before the equipment is energized, it must be thoroughly inspected and tested. Correct any deviations and re-inspect equipment before energizing.

Visually inspect the switchboard for any damage that may have affected bus bar supports, device mountings or reduced electrical clearances within the switchboard. Electrical disconnecting contacts, machine parts, shutter, etc., checked for lubrication and operation. Blocking, supports and other temporary ties removed from breakers, instruments, relays, etc. Check the torque of all accessible bus bar connections, including factory and field-installed connections. Access to connections may require the temporary removal of certain barriers. Proper fuses are correctly installed. Manually operate all devices (circuit breakers, switches, etc.) Check for alignment and proper operation. Operate all electrically operated devices (circuit breakers, switches, meters, relays, etc.). An auxiliary power source may be required. Temporary wiring jumpers (used on the secondaries of current transformers tied to external devices, as shown on wiring diagrams) were removed. Check the current transformer shorting terminal block screw position. All protective devices and relays are shipped from the factory with all adjustable settings configured at the lowest possible values. Adjustments based on the required system coordination study must be done by the end user.

Make sure ground connections are properly made. Make sure incoming primary and secondary connections are properly made and checked for shorts or undesired grounds. Make sure all equipment that has been removed during assembly has been replaced. Confirm that interlocks perform properly. Disconnect devices checked per instruction books. Make sure any filters in the vent areas are clean and free of foreign material. Inspect and remove any tools or objects left inside the equipment. Make sure all covers are installed. Close doors and ensure that all conductors are not pinched or nicked.

A dielectric test, if possible, should be made on the high voltage (power) circuit for one minute at the appropriate test voltage. Voltage transformers, control power transformers, surge arresters, surge protective devices and surge capacitors must be disconnected during these tests. **Note**: The dielectric test voltage is given as a reference only for those using dielectric tests to verify the integrity of connected cable installations without disconnecting the cables from the switchboard. It represents values believed to be appropriate and equivalent to the corresponding power frequency withstand test values specified for each voltage rating of the switchboard. When performing dielectric tests, the voltage should be raised to the test value in discrete steps and held for a period of one minute.

In accordance with ANSI C37.20.02 Clause 5.5, Field Dielectric Tests are also recommended when new units are added to an existing installation, or after major field modifications. It is not expected that equipment shall be subjected to these tests after it has been stored for long periods of time or has accumulated a large amount of dust, moisture, or other contaminants without being first restored to good condition.

Before energizing any switchboard, perform a comprehensive inspection to make certain that the switchboard is ready to be energized. This includes the following steps: Verify that the switchboard is not energized. Visually inspect the switchboard and remove all foreign materials, such as tools, scraps of wire, and other debris from all switchboard sections. Remove and discard all packing materials and temporary shipping braces from the switchboard. Any accumulation of dust and dirt should be removed with a vacuum cleaner. Use a lint-free cloth to remove dust and dirt on other surfaces. Never use compressed air, as this may blow contaminants into electrical and/or electronic components. Never use solvents or other chemicals to clean surfaces or components. Visually inspect all ventilation points to ensure that there is no blockage or debris. Remove any debris that is present. Verify that all field bus and wire connections have the proper torque per instructions on the switchboard and on components. All factory connections are made using calibrated power tools. However, vibrations do occur in transit and handling. Verify factory connections by checking at least 10% of the total factory connections for tightness. If this spot check reveals loose connections, proceed to check all factory connections. These connections include bus hardware connections, circuit breaker and switch terminals, contactors, metering, and other connections, including the incoming terminals. Visually inspect switchboard insulators, bus bars, and conductors for damage. DO NOT ENERGIZE IF DAMAGE IS FOUND.

If fusible switch type overcurrent devices are used, verify that proper fusing has been selected and installed. Eaton does not typically supply switchboards with these fuses. Overcurrent devices are typically shipped in either the open (OFF) or “tripped” position. Manually close, and then open these devices to ensure that they are functioning properly. At the completion of this process, be sure that the overcurrent device is in the OFF or “tripped” position. Inspect overcurrent devices for any visible damage. If damage is found, DO NOT ENERGIZE the switchboard.

This switchboard may contain overcurrent devices with ground fault protection (GFP). The National Electrical Code may require ground fault protection for this installation. Other GFP applications may be used, including multi-level. Refer to the switchboard drawings and electrical construction drawings for usage and placement within the switchboard. GFP may be installed integral to overcurrent device(s) or as a separate system. Separate systems typically are connected to a shunt-tripping mechanism on an overcurrent device. Visibly inspect connections on GFP systems, neutral sensors, and ground connections. Refer to the manufacturer’s instructions for details. Prior to shipment, the manufacturer has preset the GFP at minimum set points. Adjust settings per engineered electrical plan drawings. If this information is not readily available, contact the design engineer or other qualified persons responsible for the specifics

of the installation and system design. Prior to testing the GFP system, remove the neutral disconnect link(s) on the switchboard to isolate the neutral of the system from the supply and ground.

Confirm that the neutral connection has been run from the supply to the service equipment per the National Electrical Code. All GFP systems shall be performance tested when first installed on site. The test shall be conducted in accordance with instructions outlined in NEC Article 230.95. A qualified person(s) shall conduct this testing.

The interconnected system shall be investigated in accordance with the following instructions. Determine the location of the sensors around the bus of the circuit protected by the GFP system. This can be accomplished visually with knowledge of which bus is involved. Identify all grounding points of the system to verify that ground paths do not exist that would bypass the ground fault sensors. The installed system is to be tested for correct response by application of full-scale current into the equipment to duplicate a ground fault condition, or by equivalent means. It is recommended that this be performed by a qualified testing organization. Record the test date and results on the form provided in Appendix C of this instruction manual. Those in charge of the site's electrical installation should retain the completed form and make it available to the AHJ. Due to the varied types of devices and GFP systems available, detailed testing instructions can vary. For detailed instructions, identify the specific type of device and GFP system provided. Then refer to the separate instructions for that specific type of device.

WARNING
Qualified personnel should only perform the following as defined in NEC article 100. The ground fault sensor (GFS), and ground fault relay (GFR), must be installed.

ENERGIZING AND OPERATION

Only qualified persons familiar with the construction and operation of switchboards should perform the work described in this set of instructions. Such work should be performed only after reading this complete set of instructions. Check all interrupting devices. Set all devices to open position. Check and open all control circuits. Energize primary incoming power source to equipment.

Close the control circuit to check all instruments, relays, meters, etc., during this time. Note: There should be no load on the switchboard when it is energized. Energize in sequence starting at the source and work towards the load. Close the main device, then feeder devices, then branch devices to source load. Observe instruments as the smallest branch load is added, observe instruments. Allow several minutes before connecting the additional load. Gradually connect more loads to equipment. Observe instruments and allow several minutes before adding additional load. Follow this procedure until the full load is connected. After all mains and branch devices have been closed, downstream loads such as lighting loads, contactors, heaters, and motors may be turned on. Check primary and secondary circuits for overheating. Also, check all instruments during the first week of operation.

Main Lug Switchboards, without the main, the total continuous load current through the supply bus should not exceed the current rating of the switchboard. For single Main Switchboards, the total continuous load current on the main device should not exceed 80 percent of the main device unless rated for 100 percent of its ampere rating. The same will apply to each main of a multi-main switchboard. A branch circuit breaker's total continuous load current should not exceed 80 percent of the devices rating unless the device is rated for 100 percent of its rating.

Some types of electrical equipment will cause harmonics in electrical systems. This may result in overheating. When determining the loading of the switchboard, this condition should be considered. Possible de-rating of equipment may be necessary. **Note**: The primary incoming power source should not exceed the normal rating of the equipment.

WARNING
Hazardous Voltages in Electrical Equipment can cause severe personal injury or death. Energizing a switchboard for the first time after initial installation or maintenance is potentially dangerous.

LAKE SHORE ELECTRIC TESTING

Lake Shore Electric Test Department will go through multiple test forms, the mechanical test form, the metering and controls test form, and the dielectric test form. All test forms intend to provide test personnel with the required resources to ensure that the equipment being tested will Pass all Lake Shore Electric testing and quality control requirements.

LSE verifies the following: Mechanical Dimension and Bus Torque. LSE performs the following: Mechanical Visual Inspection, Potential Transformer Ratio Test, Metering Test, Controls Sequence of Operations Test, and Calibrated Test. LSE tests the following: Open Contacts, Phase Separation, Neutral and Ground Separation, and Calibrations.

REPLACEMENT PARTS

When ordering renewal parts or when requesting information on the switchboard, it is essential to include as much information as possible. Each switchboard will have a nameplate and other identification marks with details that will help expedite information requests and orders. See Lake Shore Electric Corporation's Warranty above to see if the replacement parts are under warranty. Please contact Lake Shore Electric Sales Team for guidance. The following may be required to help identify parts and information requests: Sales Order Number/Serial Number, Stock Code, and Drawing Numbers.

System Information

Serial Number	# # # # # #
Voltage (V)	# # # / # # #
Frequency (HZ)	# # Hz
Phase (ϕ)	# Ph
Current Rating (A)	# # # # A
Short-Circuit Current Rating (kAIC)	# # kAIC
Enclosure Type	NEMA # #
Manufacture Date	# # / # # # #

ADDENDUMS

EATON

EATON – MAGNUM SB

The Magnum SB low voltage insulated case power circuit breaker is certified to UL 1066 but is specifically designed for the performance requirements of UL 891 switchboard class applications. UL and ANSI test certifications Magnum SB meets or exceeds all applicable ANSI, NEMA, UL and CSA standards, including: ANSI C37.13 (low voltage AC power circuit breakers used in enclosures), ANSI C37.16 (preferred ratings, related requirements, and application recommendations for low voltage power circuit breakers and AC power circuit breakers), ANSI C37.17 (trip devices for AC and general-purpose DC low voltage power circuit breakers), ANSI C37.50 (test procedures for low voltage AC power circuit breaker used in enclosures), and UL 1066 (standard for low voltage AC and DC power circuit breakers used in enclosures).

Magnum SB is a low-voltage insulated-case circuit breaker family designed for the performance requirements of UL 891 switchboards. These characteristics are Magnum SB breakers have short time current ratings and fixed internal instantaneous trip ratings, which is characteristic of UL 489 molded-case breakers commonly used in UL 891 switchboards. This provides for improved coordination and selectivity for most commercial switchboard applications. The instantaneous trip function facilitates feeder circuit breaker protection in UL 891 switchboards with 3-cycle bus bracing. This yields reduced energy let through to downstream circuits by eliminating the fault current above the fixed instantaneous trip point. Magnum SB insulated case circuit breakers have Interruption ratings up to 150 kA with continuous current ratings up to 5000A.

The non-automatic Magnum SB breaker (switch) shares the same frame and accessories as the circuit breaker. It does not, however, have the following: Trip unit, Sensors, and Overcurrent release. Like the Magnum SB breaker, the switch is available in both three-pole and four-pole, fixed and draw-out configurations. A non-automatic circuit breaker includes separable contacts for movement between a closed position and an open position, and an operating mechanism for moving the separable contacts between the two positions. It cannot be used for branch circuit protection. **See Eaton's Magnum DS, SB, and IEC Low Voltage Power Circuit Breakers Technical Product Guide for more details.*

EATON – MAGNUM DC

Eaton Magnum DC switches provide DC disconnect, isolation and switching technology in a Magnum power breaker platform. They feature load-switching capability and high withstand ratings in each voltage class. There are switch versions that can be applied in both grounded and ungrounded systems. Eaton Magnum DC switches are a comprehensive offering of third-party and globally certified DC switches that are designed to provide excellent safety with a high level of performance that meets the demands of a global market.

Magnum DC switches meet or exceed the applicable ANSI, NEMA, UL and CSA standards, including: ANSI C37.14 (low voltage DC power circuit breakers used in enclosures), ANSI C37.16 (preferred ratings, related requirements, and application recommendations for low-voltage power circuit breakers and AC and DC power circuit breakers), ANSI C37.17 (trip devices for AC and general purpose DC low voltage power circuit breakers), UL 1066 (standard for low-voltage AC and DC power circuit breakers used in enclosures), UL 489 molded case switches.

There are several versions available of Magnum DC switches, with defined voltage classes for each one, based on certifications. These are defined by the first 3 letters in their 25-digit catalog number: Standard Frame only, up to 3200A Continuous, 3-pole Draw-out Configuration, and 300 Vdc, 50 kA Withstand/Interruption or 600 Vdc, 50 kA withstand/interruption.

The Magnum DC switch is built with the same general frame construction as the other Magnum frames, therefore it mounts just as a size equivalent Magnum circuit breaker would mount. Draw-out switch – Used in combination with fixed draw out cassette which provides primary and secondary connections. Fixed Switch – supplied with horizontal, pre-drilled primary terminal pads with optional vertical primary adapters available. Utility companies incorporating DC facility power and control for emergency or redundant power. Backup UPS power systems require means to disconnect the battery for isolation and maintenance. SCR and drive isolation switches for maintenance and emergency disconnect. **See Eaton's Magnum DS, SB, and IEC Low Voltage Power Circuit Breakers Technical Product Guide for more details.*

EATON – ACCESSORY DEVICES AND CONNECTIONS FOR MAGNUM SB & DC

The shunt trip is an optional device on circuit breakers. It opens the circuit breaker instantaneously when its coil is energized by a voltage input. A total of two shunt trips can be mounted on a Magnum breaker. Two different shunt trip types are available: The continuous duty coil (or 100% rated) type can be continuously energized. It is useful in applications where it is desired to keep the breaker tripped open. The shunt trip type that has a cutoff switch removes voltage from the coil once the breaker contacts are opened.

The spring release is an optional device. It remotely closes the circuit breaker when the coil is energized by a voltage input. The closing spring must be fully charged, and the trip latch reset (not held in the tripped position) for the spring release to operate. If these two conditions are not met, the close signal will be ignored until it is removed and re-applied. An optional Latch Check Switch (LCS) can be installed to indicate when the breaker is "ready to close." The LCS wired to the spring release will not permit activation of the spring release until the breaker is fully charged and the trip latch is reset. If power is applied and maintained to the spring release, activation will occur when the breaker is "ready to close." The LCS for remote indication consists of one Form C contact wired to the circuit breaker secondary contacts for integration into external control schemes.

An auxiliary switch is an optional device providing remote electrical indication if the circuit breaker is open or closed. Up to three auxiliary switches can be mounted in one breaker. Each switch has two normally open ("A") and two normally closed ("B") contacts for a total of 12 available contacts.

Other electrical accessories are mounted inside the circuit breaker. They can be factory or site installed. There are three different internally mounted accessories: Overcurrent Trip Switch (Bell Alarm), Mechanical Trip Flag Pop-out Indicator, and Motor Operator.

An overcurrent trip switch (bell alarm) is an optional device. It provides an electrical indication when a circuit breaker trips as a result of the trip unit reacting to an overcurrent condition. Opening as a result of a circuit breaker's manual open button, shunt trip, or under-voltage release does not cause the overcurrent trip switch to operate. The status of the contacts changes when the trip indicator pops out. This permits the switch to be used as an alarm or in conjunction with a spring release to block a subsequent remote electrical closing signal.

The mechanical trip flag pop-out indicator is an overcurrent indication feature that can be supplied as an option on Magnum breakers with integral trip units. This device is located just above the trip unit on the breaker's front faceplate. In the event the trip unit trips the breaker on an overcurrent condition, the red trip flag releases and pops out to give a local visual indication. This trip indication is in addition to any LED trip indication next to the protection feature. The red flag can be reset by manually pushing it back in. The breaker can be reclosed, even if the flag is not reset. An optional Overcurrent Trip Switch (OTS) is available should an electrical lockout be required on an overcurrent trip condition. If the trip unit trips the breaker on an overcurrent condition: A red mechanical trip flag indicator pops out and OTS contacts change state. The OTS Switch is reset by manually pushing in the red trip flag. When the trip flag is reset. A motor operator is an electric motor assembly internally mounted in the circuit breaker. It charges the closing springs electrically for remote or local operation. It can be factory or site installed. A UL-Listed motor operator kit is available to make the conversion from a manually operated breaker to an electrically operated breaker.

EATON – MAGNUM PXR

Magnum PXR circuit breakers are available in both draw out and fixed mounting configurations. A majority of features are common to all configurations and will be discussed in this section. The mounting features unique to the draw-out and fixed configurations will be covered individually in Sections 5 and 6, respectively. Controls and indicators for both draw-out and fixed circuit breakers are functionally grouped on the front of the circuit breaker. The front escutcheon (faceplate) is common for all Magnum frame sizes up to 6000A. Double frame PXR circuit breakers use six (or eight) sets of rear primary connections; these circuit breakers are available from the factory with several different phase sequences, distinguishable by the sixth character in the model number. The phase sequence is also labeled on the rear of the circuit breaker. For these PXR draw-out breakers, phase sequence labels are also supplied with the cassette and must be applied by the switchgear builder. Circuit breakers with different phase sequences are not interchangeable. PXR draw-out breakers with differing phase sequences are prevented from insertion into the cassette by properly assembled rejection key plates.

All Magnum circuit breakers use a rigid frame housing construction of engineered thermoset composite resins. This construction provides high-strength structural properties, excellent dielectric characteristics, and resistance to arc tracking.

A current-carrying pole unit is individually enclosed and rigidly supported by the case. The individual chambers provide for pole unit isolation and insulation from one another. Each pole unit has one primary contact assembly, which consists of a moving portion and a fixed portion. The exact design configuration depends upon the breaker's frame size. Double frame circuit breakers use two pole units and arc chute assemblies connected mechanically and electrically in parallel to form one phase. **See Eaton's Magnum PXR Low Voltage Power Circuit Breakers User Manual for more details.*

EATON – MAGNUM PXR ACCESSORIES

Shunt trip device (ST): Provides for remote electrically controlled breaker opening when energized by a rated voltage input.

Spring charge motor (MOT): Charges the breaker closing springs automatically, facilitating remote or local closing. The motor assembly includes a cut-off switch that changes state at the end of the charging cycle. This contact can be wired out for external indication.

Spring release device (SR): Provides remote electrically controlled breaker closing when its coils are energized by a rated voltage input.

Undervoltage release (UVR): This trips the breaker when an existing voltage signal is lost or falls below an established threshold. Auxiliary switch: Up to 6a/6b auxiliary individual dedicated contacts are available for customer use to indicate if the breaker is in the OPEN or CLOSE position. Mechanical trip indicator flag: The red trip indicator flag pops out to provide a local visual indication of when the PXR trip unit acts to trip the breaker in an overcurrent condition. Available in two options: an interlocked version that mechanically locks out the breaker until the indicator is manually reset and a non-interlocked version for indication only.

Overcurrent trip switch (OTS/bell alarm): Provides two Form C contacts that change state when the PXR trip unit acts to trip the breaker. The contacts are available for external indication or customer use and are manually reset by the mechanical trip indicator. Pad lockable pushbutton cover: Permits padlocking hinged cover plates to block access to the PUSH ON and PUSH OFF buttons on the breaker faceplate. Mechanical operations counter: Records mechanical operations of the breaker over its installed life.

Latch check switch: Provides one Form C contact that changes state when the breaker is ready to close. Can be wired to the spring release device for fast transfer applications or wired for external.

ABB

SACE EMAX 2

The SACE Emax 2 trip units are designed to be used in a wide range of applications. This complete, flexible protection trip unit can be adapted to the actual level of protection required, independently of the complexity of the system. The range is available for three levels of performance, to accommodate a wide variety of applications from basic to advanced.

The protection units for power distribution are available in the LI, LSI and LSIG versions, and are suited to all distribution systems. These trip units are designed for a vast range of applications, to be used with transformers, motors, and drives. Depending on the complexity of the system, voltage and energy measurements can also be included. The Ekip G range enables the protection of generators without the use of external devices that require dedicated relays and wiring. These trip units help increase efficiency from the design phase to installation, minimizing the time needed for the realization and commissioning of the system. They also help ensure high levels of accuracy and reliability of all protection devices required for running generators in applications such as naval, Genset or cogeneration.

The new Ekip Touch and Ekip Hi-Touch trip units help to provide maximum flexibility by offering a wide range of software solutions to always upgrade the circuit-breaker. These functions can be selected when ordering the circuit-

breaker or downloaded directly from the ABB Ability Marketplace™, even from a smart-phone or tablet, thus reducing installation time to zero.

The setting, testing, and downloading of reports can be carried out directly from a Smartphone, Tablet or PC. In addition, the commissioning stage can be further accelerated, minimizing the possibility of errors, by directly configuring the protection trip unit with the DOC design software settings. Cartridge-type modules that are easily installed onboard enable the units to be integrated into the most complex systems. Additional functions can be created, such as: Synchrocheck, to check the synchronization of the two half-busbars before enabling circuit breaker closing; Communication with all supervision systems available in the Modbus, Profibus and DeviceNet™ protocols as well as the modern Modbus TCP, Profinet, EtherNet/IP™ protocols; Integration into Smart Grids thanks to the possibility of communicating without the assistance of any external converter, according to standards (IEC 61850) already in use in the automation systems of high and medium voltage substations; Multi-voltage supply module, which enables the protection trip unit and modules to be supplied with any auxiliary voltage available in direct or alternating current; Programmable logic management with Ekip Signaling modules that provide a high number of electrical input and output contacts; Logical interlocks between circuit breakers, which can be achieved with the Ekip Link proprietary communication protocol, avoiding complex wiring due to the transmission of all signals via a bus. **See ABB's SACE Emax 2 Low Voltage Power Circuit Breakers ANSI C37 / UL 1066 / CSA Standards Technical Catalog for more details.*

SACE TMAX XT UL/CSA

Used in both AC and DC networks, these are a solution for protection against overloads and short circuits. Overload protection is ensured thanks to ABB thermal device based on a temperature-dependent bimetal heated by the current. Protection against short-circuiting is realized with a magnetic device.

The first level of the electronic trip units is used for the protection of AC networks: these are based on microprocessor technologies and guarantee high reliability and tripping precision. They protect against overloads, selective short circuits, short circuits, and ground faults. The power required for their operation is provided directly from the current sensors.

These represent the state of the art in terms of technology for AC network protection with advanced protection and system management functions. Diverse communication protocols enable the reading of measurement parameters and circuit- breaker control remotely. The integrated display makes interaction with the Ekip Touch/Hi-Touch an easy and intuitive experience for the user and the embedded Bluetooth functionality allows fast interaction via EPiC (Electrification Products intuitive Configurator), the new application to configure and check the status of the ABB low voltage circuit breakers. The Ekip Touch trip unit guarantees maximum flexibility. In fact, by selecting among the numerous software solutions available, it is possible to customize the functionality of the device at will. On the other side, the Ekip Hi-Touch trip unit includes all functions by default, representing the top-of-the-line in the SACE Tmax XT offer.

- With the new Ekip Touch and Hi-Touch trip units, it is always possible to select and install the desired functions on the device. The functions can be selected when ordering the circuit breaker or downloaded directly from the ABB Ability Marketplace™, even from a smartphone or tablet, thus reducing installation time to zero.
- Switchgear compartment: control of the main electrical values of the circuit breaker and set the protection functions, thanks to the embedded display of the trip units, Ekip Multimeter display connected to the trip unit, and smartphone connection via embedded Bluetooth.
- Electrical system: management of complex systems in which the devices must be integrated into automated industrial processes or in intelligent electrical networks, better known as smart grids. The system can be

supervised by: Ekip View software and the Internet with the ABB Ability™ Electrical Distribution Control System webapp

For all the possible supervision modes, connectivity modules are necessary. Two mounting solutions are possible, one excluding the other: Internally, it is possible to mount the Ekip Com modules in the circuit breaker. This solution can be used on XT2, XT4 and XT5 circuit breakers. The module is mounted directly inside the circuit breaker with no additional space needed in the switchboard. For this configuration, dedicated internal module codes are available.

Externally, through the Ekip Cartridge. The modules can be installed inside the cartridge, which is directly connected to the trip unit by a cable. Available in the XT2, XT4 and XT5 sizes. The Ekip cartridge is available in two versions depending on how many modules are needed. The solution with the external cartridge permits a double or even triple communication channel, as well as redundant communication. Besides, the cartridge solution makes it possible the use of advanced functions, such as Synchro Reclosing, embedded ATS and more. When an internal module is used, the Ekip Cartridge cannot be used and vice versa. It has to be highlighted that, for the XT7 and XT7 M sizes, the modules must be installed directly on the terminal box available on the upper part of the circuit breaker. The modules are the same as the Ekip Cartridge. On the upper part of the circuit breaker, it is possible to install one Ekip Supply plus a maximum of two additional modules. **See ABB's SACE Tmax XT UL/CSA Low Voltage Molded Case Circuit Breakers UL489 and CSA CS22.2 Standards for the NEMA Market Catalog for more details.*