

INSTALLATION, OPERATIONS AND MAINTENANCE MANUAL

ReliaGear® LV SG

Low voltage switchgear



These instructions convey information that pertains to ReliaGear® LV SG low voltage switchgear.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the Purchaser's purposes, the matter should be referred to an ABB sales representative. These instructions are intended for use by qualified personnel only.

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Warranty and general information

Read the following hazard classifications carefully, and fully inspect the equipment for any identifiable hazards prior to installation, operation, or maintenance. The following classifications listed below will appear throughout this document or on labels located on the equipment. These are standard symbols defined by ANSI Z535.4-2011 which were established for recognition of potential hazards which pose risk to life and property. The classification is based on the probability and severity of injury if the hazard is not avoided. Please follow instructions, warnings, labels, and codes for proper installation, operation, and maintenance of equipment and devices. Only Qualified Persons, as defined by NFPA 70, should provide installation, operation, and maintenance on this equipment and devices.



This is safety alert symbol. It is used to alert you to potential physical injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.



Danger: Indicates a hazardous situation which, if not avoided, will result in death or serious injury.



Warning: Indicates a hazardous situation that, if not avoided, could result in death or serious injury.



Caution: Indicates that if the hazard is not avoided could result in minor or moderate injury.



Notice: Is used to notify of practices not related to personal injury.

Trademarks

Emax 2®
Emax 2 Ekip®
ReliaGear® LV SG
SACE®

All third-party trademarks are the property of their respective owners.

Warranty

This document is based on information available at the time of publication. While efforts have been made to ensure accuracy, the information contained herein does not cover all details or variations in hardware and software, nor does it provide for every possible contingency in connection with installation, operation, and maintenance. Features may be described herein that are not present in all hardware and software systems.

ABB assumes no obligation of notice to holders of this document with respect to changes subsequently made. ABB makes no representation or warranty, expressed, implied, or statutory, with respect to, and assumes no responsibility for the accuracy, completeness, sufficiency, or usefulness of the information contained herein.

No warranties of merchantability or fitness for purpose shall apply. Contact your local sales office if further information is required concerning any aspect of ReliaGear LV SG switchgear and SACE Emax 2 breaker operation or maintenance.

Introduction

General information

This manual contains procedures for receiving, handling, storage, equipment installation, operation, and maintenance and service of ReliaGear LV SG low voltage switchgear.

NOTICE

Notice: The personnel responsible for installing, operating, and servicing this equipment should be thoroughly familiar with the contents of this manual.

Before any installation work is performed, thoroughly read and understand the material in this instruction manual and the drawings furnished with the equipment. The As-built documentation shipped with the equipment includes the Summary, Front View, Elementary Diagram, and Connection Diagram. This material is located in a forward compartment tagged "INSTRUCTIONS IN THIS COMPARTMENT." The documentation provides all of the information necessary for installation of the switchgear. When requesting information from ABB, include the complete data appearing on the equipment nameplate, requisition number, summary number, and elementary diagram number. The nameplate is located in the lower left, front corner of the lineup.

When requesting information concerning any specific item furnished with the switchgear, refer to that item by description, part number, its location within this manual, and any applicable drawing number. Any material external to the equipment, which may be required to meet local codes (such as mats, screens, railings, etc.), is not furnished by ABB.

If there are any questions or requirements not covered in this manual or in the accompanying drawings, please contact your ABB sales representative.

Instruction book arrangement

Information and procedures in this instruction book are divided as follows:

Introduction: gives a brief account of the equipment's function and provides for general information, and applicable data for the equipment and its components.

Receiving, handling and storage: describes procedures required for receiving and handling the equipment and how to prepare it for short-or long-term storage.

Switchgear description: describes the ReliaGear LV SG low voltage switchgear and its various components. Included are the section enclosure, breaker compartment, circuit breakers, instrument panels and instrument compartments, bus bar arrangement, incoming cable and busway, ground and neutral bus, outdoor equipment, and auxiliary section. This section also explains how the electrical and mechanical components perform their assigned functions.

Equipment installation: provides the information needed prior to installation, site location and foundation requirements, and how to anchor the equipment properly and safely. It also covers installation of peripheral equipment and includes information on electrical connections and mechanical construction.

Installing and removing circuit breakers: gives a step-by-step procedure for lifting the breaker from the floor, installing the circuit breaker into the cradle, and moving it into the connected position.

A further procedure is given to withdraw a breaker, remove it from the cradle, and lower it to the floor. Also included is a description of the rejection system provided to avoid the inadvertent use of an incorrect breaker in a breaker compartment.

Testing and Inspection: reviews items which should be tested or inspected prior to energizing and operating the switchgear.

Cooling fan control module: describes the components, setup, test and maintenance procedures for the optional cooling fan compartment.

Operating the switchgear: covers how to operate the breakers, and contains information concerning draw-out provisions, doors, and various accessories.

Energizing the switchgear: outlines the steps to be taken before and during the electrical energization of the equipment.

Maintaining the switchgear: provides instructions for all preventive maintenance, servicing, and lubrication information for the switchgear equipment. Included is service and maintenance data for the circuit breakers, instrument compartments, instruments, bus bar joints, and cable and busway connections.

Appendices A, B, C and D contain information concerning screw and bolt torque values, circuit breaker rejection features, circuit breaker information and spare parts.

Related publications

Addenda to this instruction book are the available service and maintenance publications supplied separately for circuit breakers, relays and other devices not described in this instruction book.

In addition to instruction books, the following As-built documentation will be supplied as required for each order of ReliaGear LV SG switchgear equipment:

1. General arrangement drawings, including front view and floor plan.
2. Elementary and connection drawings (or wiring routing tables) which indicate and identify test and connection points including terminal blocks, device studs, switch contact developments, and remote connections.
3. Summary of switchgear equipment which is a list of all the components furnished with the switchgear, including the breakers, identified by catalog number.

These are all the documents necessary to install, operate, and maintain the equipment. One complete set of drawings and this instruction book is shipped with the equipment. An electronic copy of this documentation package is also sent to the customer after shipment.



Receiving, handling and storage

Receiving

Equipment packages

Every package leaving the factory is plainly marked with the case number and customer's order number. If the equipment has been split for shipment, the section numbers of the equipment enclosed in each shipping package are identified.

NOTICE

Notice: To avoid the loss of any parts when unpacking, the contents of each container should be carefully checked against the packing list before discarding the packing material.

The contents of each shipping package are listed on the Master Packing List. In addition, this list includes the number of the shipping crate in which miscellaneous parts needed to install and operate the equipment (such as hardware, contact lubricant, touch-up paint, breaker closing devices, etc.) are located. Normally, such devices are packed in a cardboard carton and the carton secured in an empty switchgear compartment. See Figure 02. If such items are packed in a switchgear section instead of a separate crate, the list will indicate the appropriate section number in which they are stored. Large items (such as breaker lifting devices and dollies used with indoor equipment) will always be shipped in separate crates or cartons. See Figure 03.

Inspecting for damage

All equipment leaving the factory is carefully inspected and packed by personnel experienced in the proper handling and packing of electrical equipment. Upon receipt of any equipment, immediately perform a visual inspection to ascertain if any damage has been sustained in shipping or if there are any loose parts. Circuit breakers may be shipped separately in individual containers with the breaker in the open position.

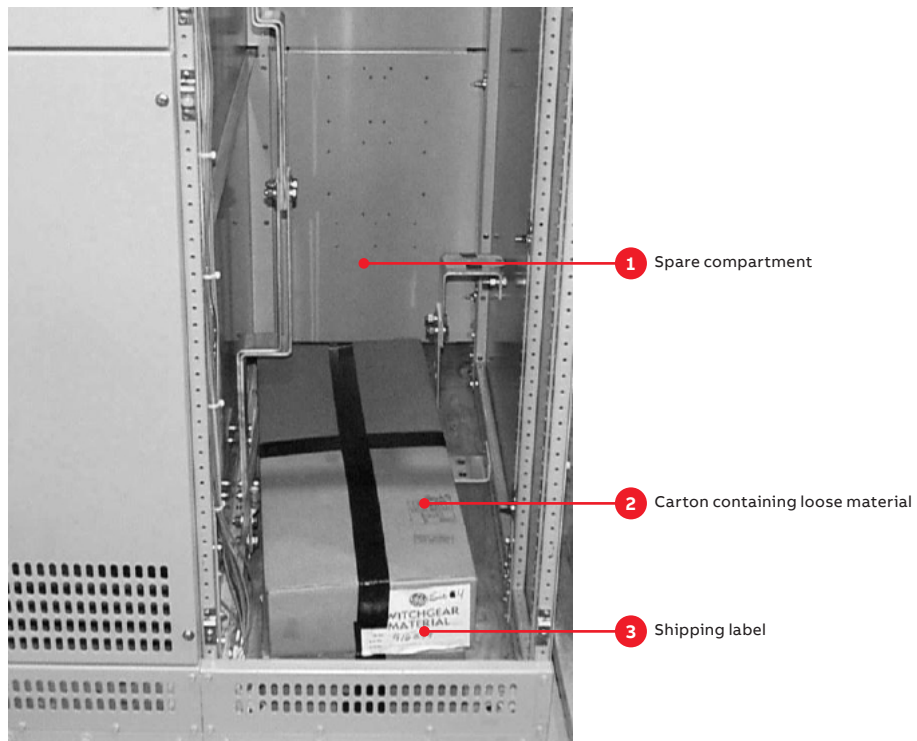
Circuit breakers should be unpacked and visually inspected for damage or loose parts as soon as possible after they have been received.

Be sure to inspect all devices mounted or packed inside compartments of each section to see if any have been dislodged or damaged.

Filing a claim

If any damage is evident, or indication of rough handling is visible, file a claim for damage at once with the transportation company and notify your ABB sales representative immediately. Information on damaged parts, part number, case number, requisition number, etc., should accompany the claim.

—
02
Packaging of loose
material for shipment



—
03
Carton containing
breaker lifting device



—
04
Recommended method of
lifting indoor enclosure

—
05
Warning label is located
on each corner by
the lifting plate

Handling

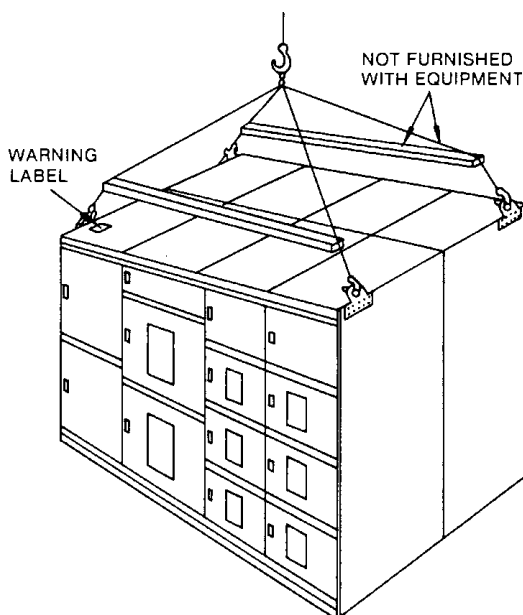
NOTICE

Notice: It is preferable to leave the shipping skids in place under the switchgear until it reaches its final location. The equipment should be installed in its final location prior to installing the circuit breakers.

Indoor enclosure lifting

The indoor switchgear sections are best handled by lifting with a crane as shown in Fig. 04. Removable lifting plates are provided, as standard equipment, on the top of each switchgear section. To preserve the external appearance of the equipment, it is suggested that the lifting plates be left in place except where adjacent equipment must be bolted together, i.e. shipping splits, etc.

Utilize four equal length cables and an overhead crane, each with a minimum load rating of twice the weight of the switchgear. Estimated weights for shipping splits appear on the Front View drawings.



—
04

Example: Switchgear section weight = 5,000 pounds. The crane and the four lift cables must have a minimum load lifting capacity of 10,000 pounds.

WARNING

Warning: The angle between the cables and the top of the equipment must be at least 45 degrees. If this is not possible because of lack of headspace, spreader bars must be used. Also, lift cables with greater load capability may be necessary, depending upon the angle between the cables and the crane hook.

Connect a cable from the crane to the four lifting plates located on the top-front and rear of the switchgear (Figure 04).

WARNING

When lifting this equipment, use lifting holes provided.

Angle of sling must not be less than 45 degrees.

If head space is insufficient, use a spreader bar.

Refer to Instructions and Operations Manual.

AVERTISSEMENT

Lorsque vous soulevez cet équipement, utilisez les trous de levage fournis.

L'angle de l'élingue ne doit pas être inférieur à 45 degrés.

Si l'espace de tête est insuffisant, utilisez une barre d'écartement.

Reportez-vous au Manuel d'Instructions et Opérations.

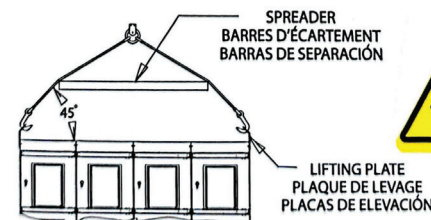
ADVERTENCIA

Cuando levante el equipo, utilice los agujeros de transporte proveídos.

El ángulo de la eslinga no debe ser inferior a 45 grados.

Si el espacio de cabeza es insuficiente, utilice una barra separadora.

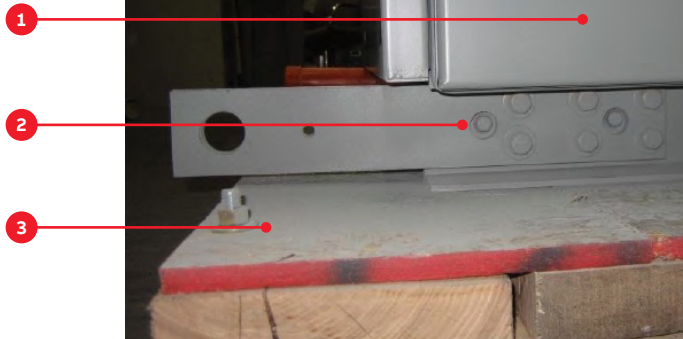
Consulte el Manual de Instrucciones y Operaciones.



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05

06
Location of lifting plates
of outdoor enclosure



1. Lifting plate
2. Lifting plate mounting bolts
3. Shipping skid

07
Warning label is
located on each side
by the lifting plate

Take up the slack in the lifting device very carefully and manually stabilize the switchgear to prevent it from rotating.



WARNING

Warning: Do not stand under switchgear while it is being moved. Serious injury may occur if the cables or lifting device fail.



CAUTION

Caution: Gently lower the switchgear section onto the level site location. If the switchgear is roughly handled or jarred, it is possible to damage or misalign internal components.

Outdoor enclosure lifting

Methods of lifting outdoor switchgear sections are much the same as for indoor equipment except the lifting plates are provided at the base of the structure. See Figure 06.

If lifting outdoor switchgear sections, side support timbers must be placed along the sides to prevent any damage that could be caused by the lifting cables.

WARNING

When lifting outdoor equipment, use lifting plates provided along with spreader bars and timber (which are not furnished with switchgear). Refer to Instructions and Operations Manual.

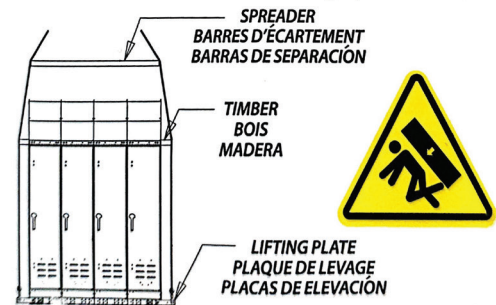
AVERTISSEMENT

Lorsque vous soulevez l'équipement extérieur, utilisez les plaques de levage fournies avec les barres d'écartement et le bois (qui ne sont pas fournis avec l'appareillage de commutation.) Reportez-vous au Manuel d'Instructions et Opérations.

ADVERTENCIA

Cuando levante el equipo al aire libre utilice placas de elevación junto con barras de separación y madera (que no están equipadas con aparamento).

Consulte el Manual de Instrucciones y Operaciones.



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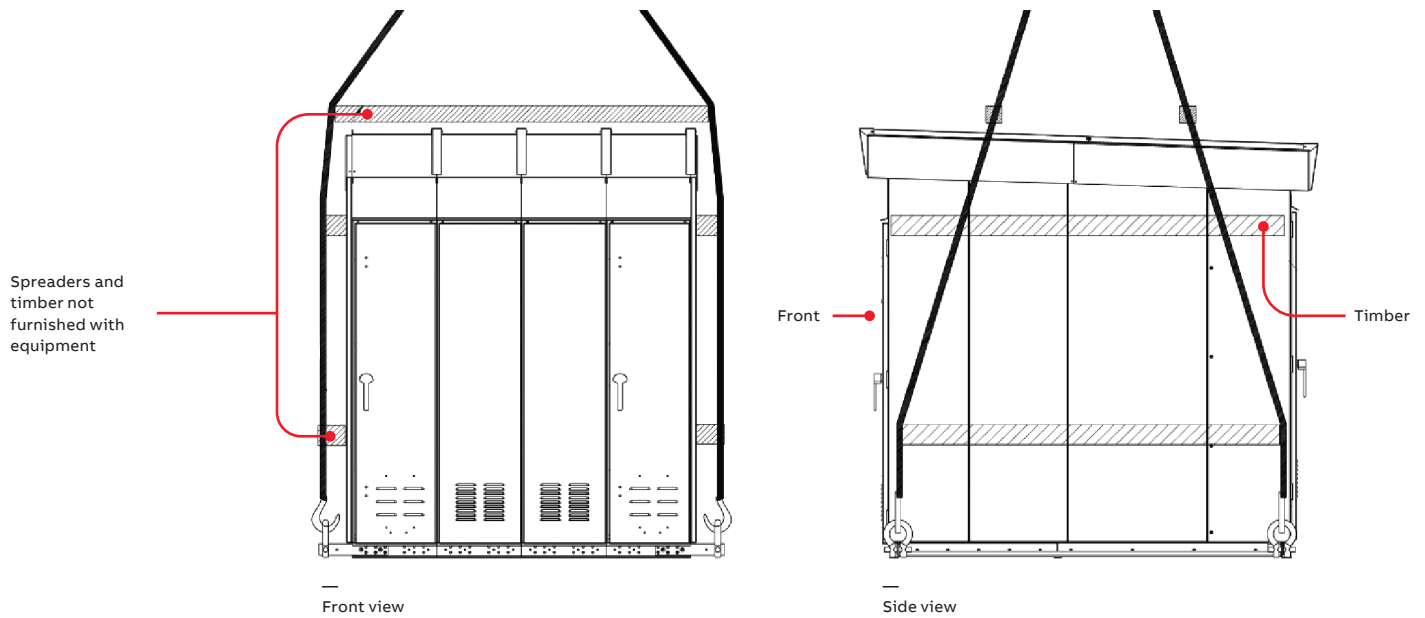
07

In addition, spreader bars must be inserted between each lift cable, both front and rear. Spreader bar locations must be on the sides and above the switchgear equipment as shown in Fig. 07. Proceed to lift and place the outdoor switchgear utilizing all the precautions and requirements that apply to lifting the indoor switchgear. The lifting plates, Figure 05, should be removed after the equipment is permanently anchored so passageways at the ends of the equipment will not be obstructed.

Rollers

If crane facilities are not available, the equipment may be moved into position by means of construction rollers placed under the shipping skids. The switchgear may be raised enough for the placement of rollers by means of a fork lift or jack.

There should never be less than four rollers under the equipment unless the line-up is less than five feet long. Use one roller for each 18 inches of equipment length.



08

08
Recommended method of lifting outdoor enclosure (using cable spreaders)

09
Placing forklift tines under equipment shipping skid

10
Placement of rollers under shipping skid

Forklifts

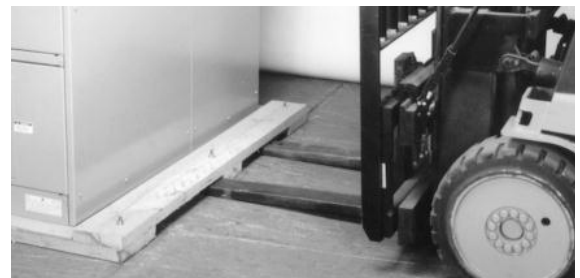
When using a forklift to raise the line-up to position rollers underneath, proceed as follows:

1. Expand forklift tines to their maximum (widest) extension.
2. Carefully insert tines of forklift below one side of the switchgear line-up at the approximate center of the panel as shown in Figure 09.

NOTICE

Notice: Do not attempt to lift or move the equipment with a forklift positioned in the front or rear of the equipment.

3. Raise equipment and position one roller under the skids close to the raised end of the line-up.
4. Carefully lower the gear until it rests on the roller as shown in Figure 10.
5. Repeat the lifting process at the other end and place the appropriate number of rollers under the skids spacing them evenly across the width of the line-up.

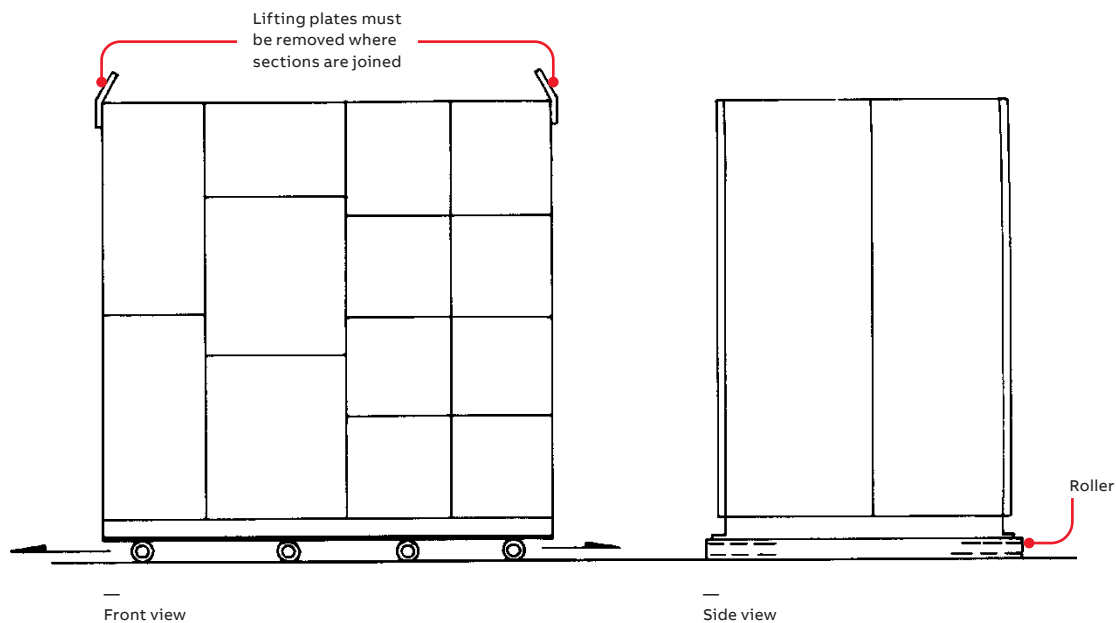


09



10

—
11
Method of rolling
equipment into place



—
11

NOTICE

Notice: If shipping skids are removed prior to final placement of equipment, rollers may only be used to move the equipment in a direction parallel to the front.

6. Carefully lower the gear until it rests on the rollers (Figure 10).
7. While carefully pushing the switchgear to its final site position, the rollers that are freed from the rear of the switchgear are then repositioned at the forward end. This procedure should be continued until the switchgear is in its final location (Figure 11).

8. When the switchgear is in its final position, remove all lug bolts holding the shipping skids to the switchgear line-up.
9. Insert the tines of the forklift at one end of the line-up, raise slightly, and remove the loose rollers.
10. Lower the end of the gear carefully to the floor.
11. Raise the other end of the line-up slightly and remove the remaining roller at that end.

—
12
Recommended
method of jacking
outdoor equipment

—
13
Recommended
method of jacking
outdoor enclosure

Jacks

Jacks may be used in place of forklifts to raise and lower switchgear.

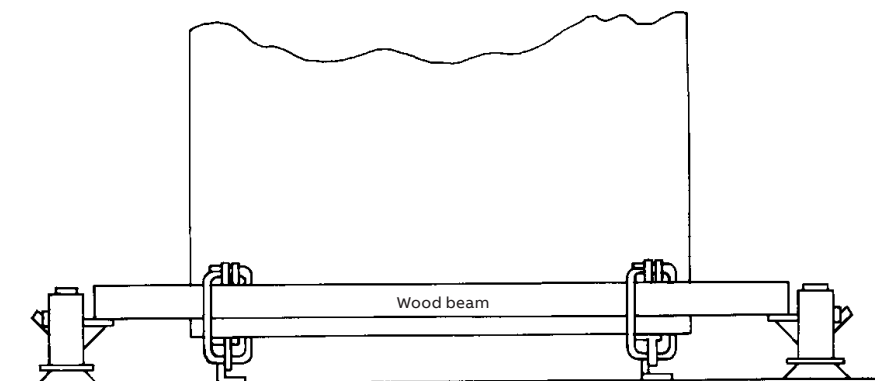
1. Place a jack under the front and rear corners of one end of the line-up. Figure 12 and 13 illustrate the use of jacks with outdoor equipment.



Caution: Do not place jacks in any other location other than the front and rear corners of the switchgear. Doing so may result in serious damage to the switchgear equipment.

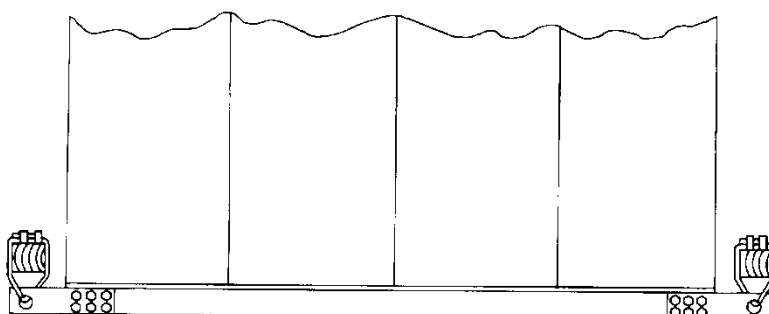
2. Raise the switchgear evenly and just enough to position a roller beneath the equipment. Gently lower the switchgear onto the rollers. Repeat the procedure at the opposite end of the switchgear, raising the gear far enough to place the appropriate number of rollers under the skids, spacing them evenly across the width of the line-up. Gently lower the gear onto the rollers.

3. While carefully pushing the switchgear to its final site position, the rollers that are freed from the rear of the switchgear are then repositioned at the forward end. This procedure should be continued until the switchgear is in its final location.
4. When the switchgear is in its final position, remove all lag bolts holding the shipping skids to the switchgear line-up.
5. Place one jack at each corner, front and rear of the switchgear. Carefully raise the line-up evenly and remove the rollers and the shipping skids. Evenly lower the line-up to the floor and remove the jacks.



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Side view

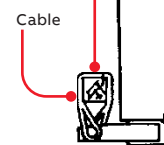
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12



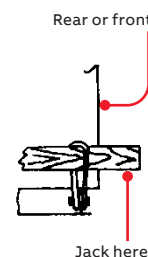
—
Front view

—
13

Jacking timber
not furnished
with switchgear



—
Partial front or rear
view of jacking



—
Partial side view
of jacking

Storage

Switchgear

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

1. Remove protective covering. Check thoroughly for damage.
2. Store in a clean, dry, rodent-free location with moderate temperature and provide protective coverings to prevent dirt, water, or other foreign substances from entering the switchgear.



Caution: Remove all cartons, containers and any other miscellaneous packaging and packing material from inside the switchgear sections before energizing any internal heaters. To prevent fire, remove any plastic or polyethylene shrouding from the switchgear sections before energizing any internal heaters.

3. If dampness or condensation may be encountered in the storage location, heaters must be placed inside the switchgear sections to prevent moisture damage. Approximately 250 watts of heat in each section is required. On outdoor switchgear equipment, this may be accomplished by making a temporary power supply connection to the heaters already installed in the equipment.



Caution: If the space heaters are to be temporarily energized from external source, it is important to remove the fuses on the secondary side of the control power transformer. This precaution is to prevent a feedback of higher voltage to other portions of the equipment through the CPT primary.

Circuit breakers

If circuit breakers are not to be placed into service at once, remove them from their shipping cartons and thoroughly inspect them for damage. If the breakers are in satisfactory condition, replace the breakers in their shipping cartons for storage. Do not remove the circuit breaker shipping members at this time.

Store the circuit breakers in a clean, dry location in an upright position. They must be properly supported to prevent bending of the stud or damage to any of the breaker parts. Do not remove any protective grease until the circuit breakers are ready to be installed. A plastic or canvas-type cover should be provided to reduce the possibility of damage to the breakers due to dust and water. For more details, please see 1SDH001330R1002.

Switchgear description

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14
Side-view section of
low voltage switchgear

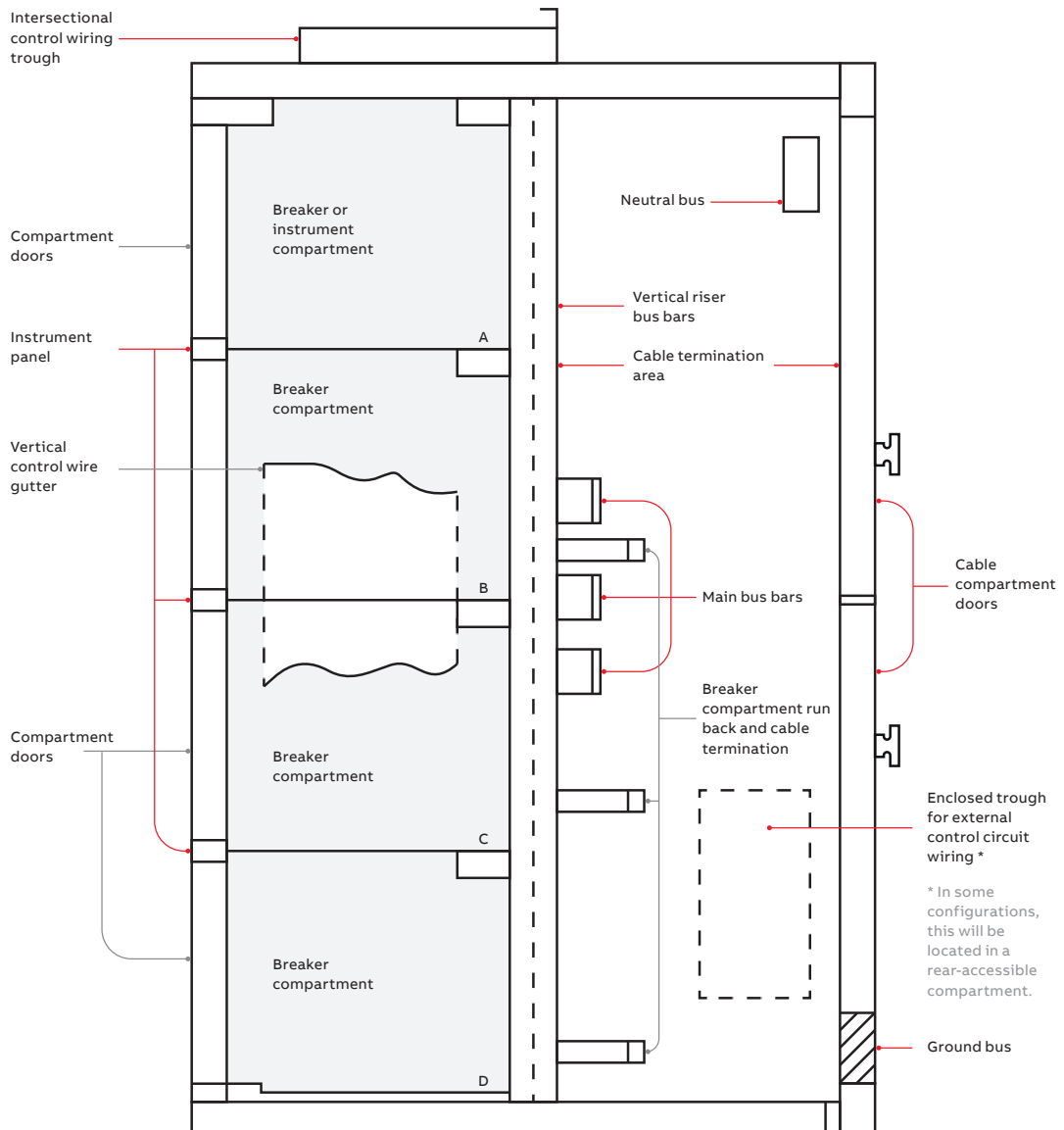
General

This section contains a description of the ABB low voltage switchgear. It also describes the functions of the electrical and mechanical systems.

Figure 14 is a side view of a typical section showing compartmentation.

Summary description

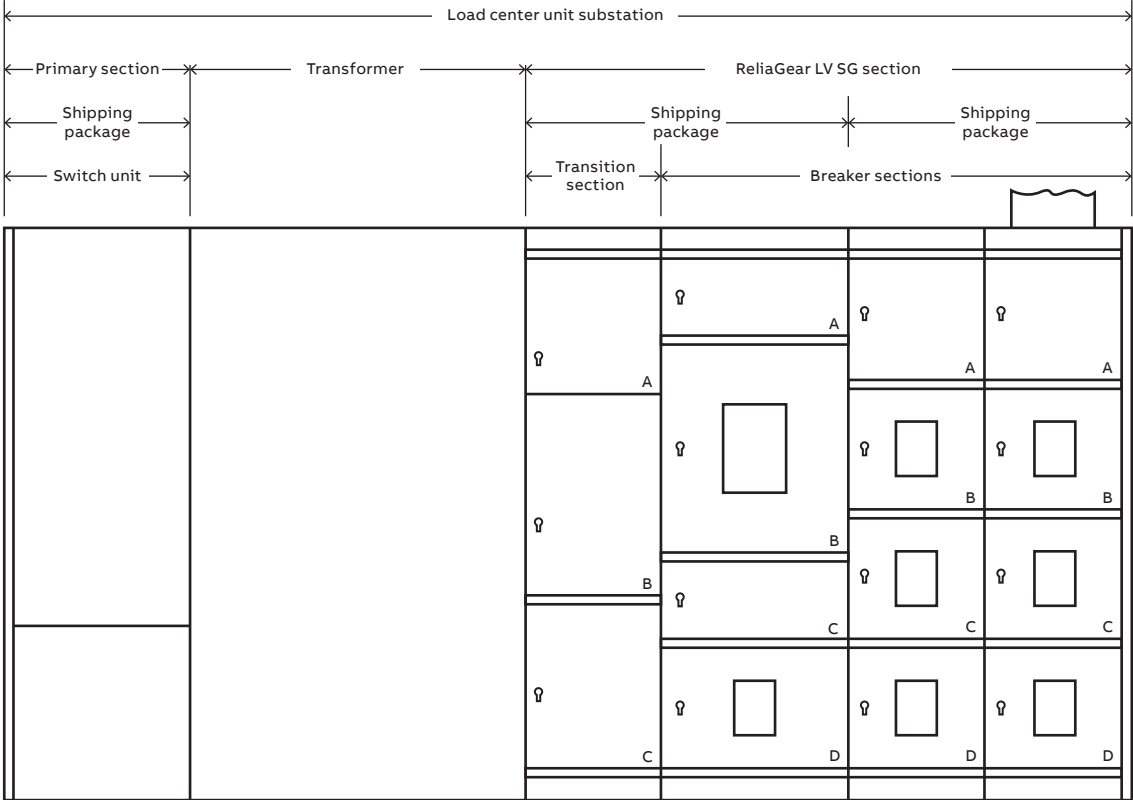
ABB low voltage switchgear is a freestanding assembly of metal-enclosed sections containing low voltage power circuit breakers, bus bars, cable termination provisions, auxiliary power circuit protective devices, controls, and instrumentation. It may also be an integral part of a load center unit substation, either single-ended or double-ended.



—
15
Outline of a typical load
center unit substation

All of the primary circuit switching and protective devices, secondary control and metering devices, control fuses and instrument transformers, are mounted in the enclosure. The breaker compartments include stationary breaker contacts, interlocks and necessary control and indicating devices.

The breakers are provided with self-aligning primary and secondary disconnecting contacts, breaker locking mechanism, and integral trip unit. The individual sections, compartments, and devices are described in the following paragraphs. Figure 15 is an outline of a typical single-ended load center unit substation illustrating the nomenclature used for all equipment.



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15

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16
ReliaGear LV SG
instrument panel

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17
Instrument/auxiliary
compartment

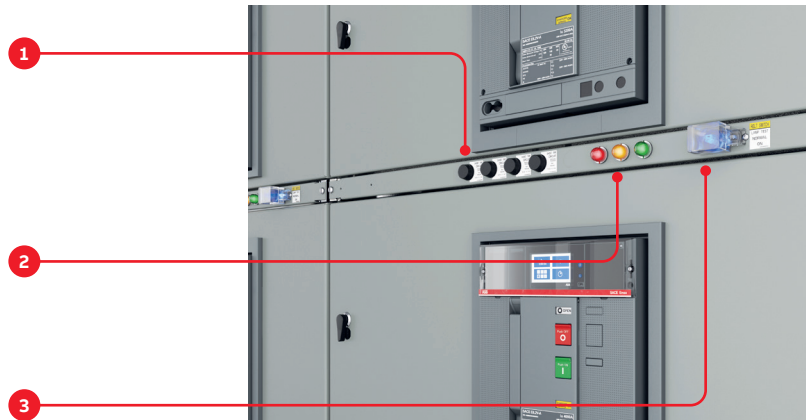
Compartment area

The front enclosure of each section is divided into individual compartments. These compartments house either a low voltage power circuit breaker or are used to mount instruments, control components and other ancillary devices.

Instrument panel

A standard instrument panel, Figure 16, is located above each breaker compartment eliminating cross-hinge wiring. When required, optional devices may be included and mounted on the front face of the panel such as breaker control circuit fuses, pilot lights, and a RELT switch.

Fuses for the charge, close, and trip circuits of the electrically operated SACE Emax 2 breakers are mounted on the panel. Routine wiring inspections and fuse checks or fuse replacements can be performed with the breaker compartment door in the closed position so that operators are protected from the energized primary circuits.

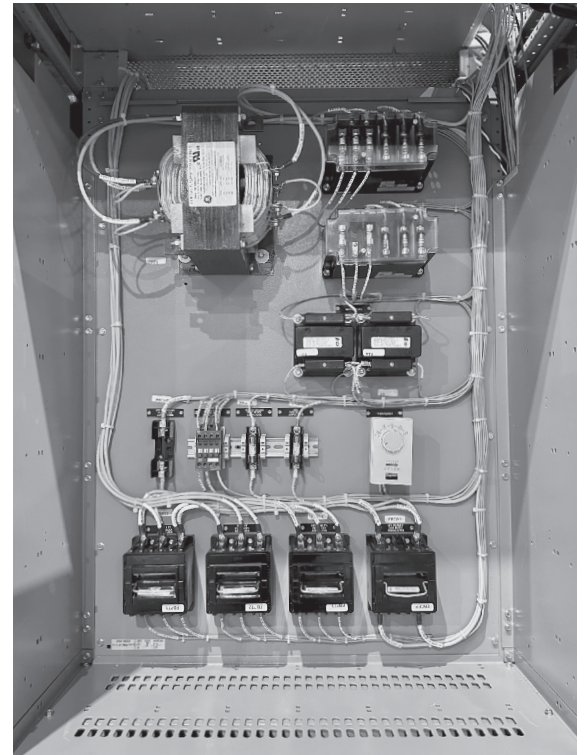


1. Control circuit fuses
2. Pilot lights
3. RELT switch and indication

—
16

Instrument/auxiliary compartment

An instrument/auxiliary compartment, Figure 17, is available as a standard feature. Relays, fuse cutouts, and similar devices may be installed in the instrument compartment or in adjacent compartments.



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17

—
18A
SACE Emax 2 E2.2, E4.2,
E6.2 circuit breaker
racking mechanism
components

—
18B
SACE Emax 2 E1.2
circuit breaker racking
mechanism components

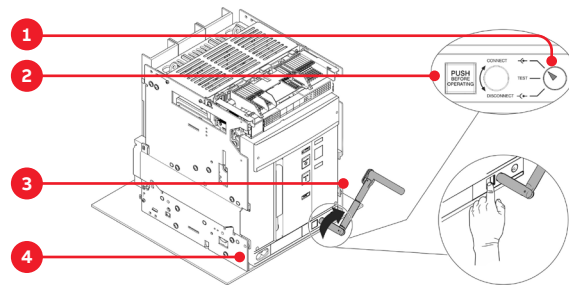
—
19A
Circuit breaker
compartment for SACE
Emax 2 E2.2, E4.2, E6.2
circuit breakers

—
19B
Circuit breaker
compartment for
SACE Emax 2 E1.2

—
20
Front view of the circuit
breaker compartment for
SACE Emax 2 E2.2, E4.2,
and E6.2 circuit breakers

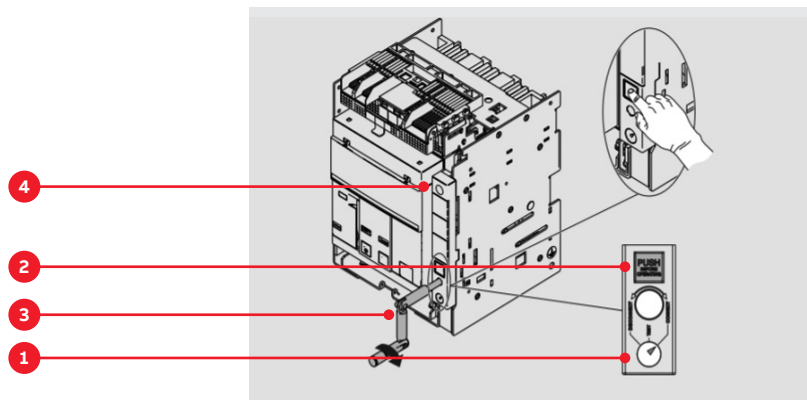
Breaker compartment

Closed-door draw-out circuit breaker compartments are standard construction with all switchgear equipment. The circuit breaker compartment doors remain closed and latched while the breaker is racked out from the CONNECTED position, through TEST, to the DISCONNECTED position. Breaker compartment doors do not have any ventilation slots, thus protecting operators from gases which may be vented by the breaker during circuit interruption. Additionally, the breaker compartment, Figures 19A, 19B, and 20, are enclosed by grounded steel barriers on the top, sides, bottom, and front. A flame-retardant, track resistant, glass-filled polyester base may be provided to separate the front compartment and the rear bus.



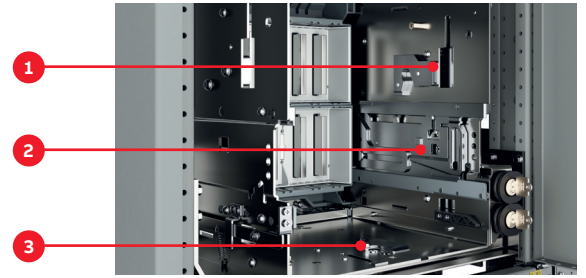
1. Breaker position indicator
2. "Push to operate" racking mechanism button (shown engaged)
3. Racking handle
4. Racking handle storage

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18A



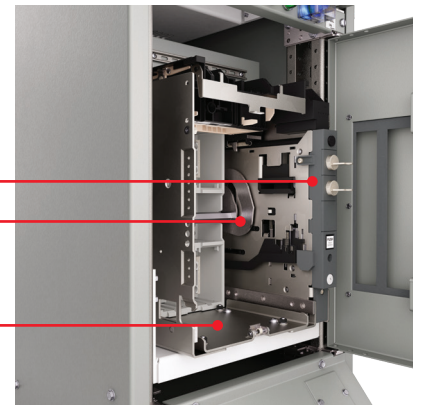
1. Breaker position indicator
2. "Push to operate" racking mechanism button (shown engaged)
3. Racking handle
4. Racking handle storage

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18B



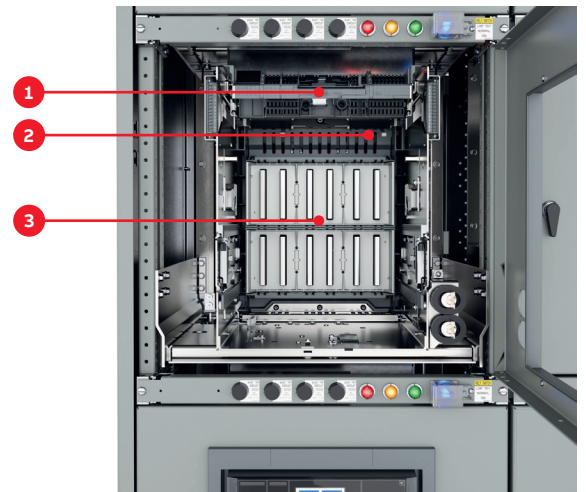
1. Cradle side barrier
2. Draw-out rails
3. Cradle pan

—
19A



1. Cradle side barrier and racking box
2. Racking arm
3. Cradle pan

—
19B



1. Secondary disconnects
2. Position switch location (not shown)
3. Primary disconnect stab tip (typical)

—
20

—
21A
SACE Emax 2 E2.2, E4.2,
E6.2 circuit breaker's
racking mechanism

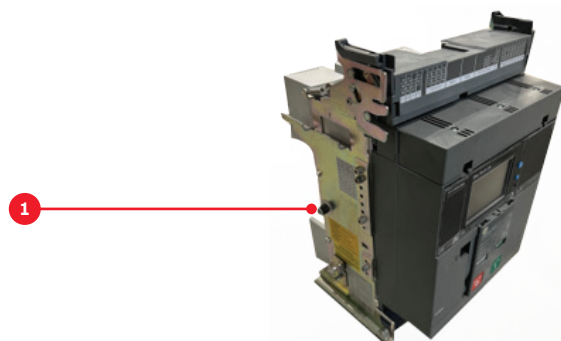
—
21B
Circuit breaker racking
mechanism feature for
SACE Emax 2 E1.2

—
22
Racking handle for
movement of SACE
Emax 2 circuit breakers



1. Circuit breaker mounted racking mechanism

—
21A



1. Circuit breaker racking mechanism feature

—
21B

For E2.2, E4.2 and E6.2, the cradle draw-out rails, item 2 in Figure 19A, engage the racking mechanism, item 1 in Figure 21A, on the sides of the breaker. The breaker is pulled into the compartment and locked in its final connected position through the operation of the racking handle. For E1.2, the cradle racking arm slots, item 2 in Figure 19B, engage with the fixed racking anchor pins on the sides of the breaker, item 1 in Figure 21B. As the racking arms are rotated by operation of the racking handle, the breaker is pulled into the compartment and locked in its final connected position.

The breaker should always be OPEN when it is moved into or out of the CONNECTED position. As a safeguard, a draw-out interlock will prevent operation of the racking mechanism unless the breaker is OPEN.

All SACE Emax 2 circuit breakers are provided with a mechanical rejection feature. See section 5 of this instruction book for additional details.

Each circuit breaker compartment has four positions as described in the Table 1.

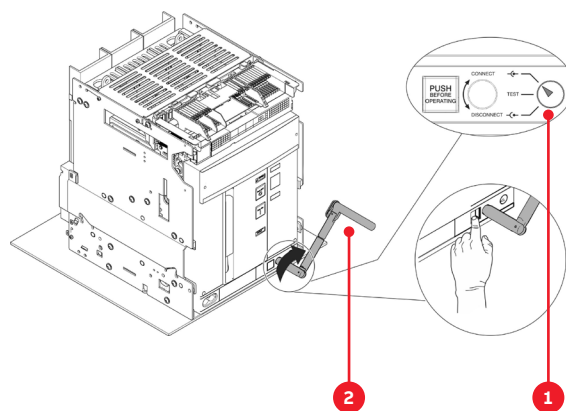
Movement of the breaker between the CONNECTED, TEST, and DISCONNECTED positions is performed by the use of a racking handle, see Figure 22, which engages the racking mechanism mounted on the circuit breaker. An optional remote racking device is also available.

Movement to the WITHDRAWN position is manually performed after opening the compartment door. These positions are illustrated and described more fully in Section 5 of this instruction book.



Warning: The door should NOT be opened when the circuit breaker is closed and in the CONNECTED position. Although the breaker compartment door may be opened in any position, it is recommended that the door only be opened when the breaker is in the DISCONNECTED or WITHDRAWN position.

The dedicated front-mounted auxiliary ventilated compartment is constructed with grounded metal barriers on all sides resulting in a segregated compartment thus protecting operators from gases which may be vented by the breaker during circuit interruption.



1. Breaker position indicator
2. Racking handle

—
22

—
23
Primary disconnect
shutter assembly (shown
in closed position)

—
24
Primary disconnect
shutter assembly (shown
in open position)

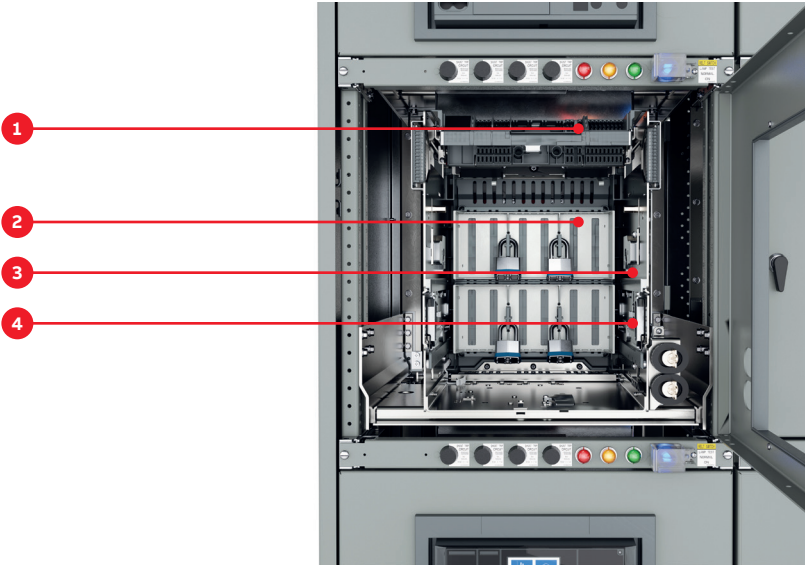
Table 1 - Description of the circuit breaker positions

Circuit breaker position in the cradle	Primary disconnects	Secondary disconnects	Shutter assembly	Circuit breaker functionality	Circuit breaker door position
Connect	Engaged	Engaged	Opened	• Breaker can be operated mechanically or electrically • Breaker ready for service	Closed
Test	Disengaged	Engaged	Closed	• Breaker can be operated mechanically or electrically • Breaker and control circuits operations can be tested and verified	Closed
Disconnect	Disengaged	Disengaged	Closed	• Breaker can be operated only mechanically. • Breaker cannot be removed from the circuit breaker compartment.	Closed
Withdrawn	Disengaged	Disengaged	Closed	• Breaker can be operated only mechanically. • Breaker can be removed from the compartment.	Open

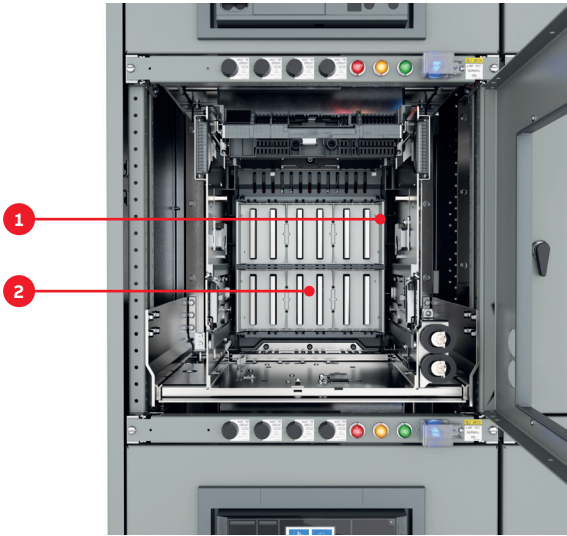
Primary disconnect shutters

Primary disconnect shutters, Figure 23, are equipped as a standard to provide protection against contact with the energized stationary primary disconnects when the breaker is removed from its compartment.

The shutters are constructed from UL approved flame retardant materials carrying a V0 flammability classification per UL 94.



- 1. Secondary disconnect
- 2. Shutter assembly (closed with padlock in place)
- 3. Cradle side barrier
- 4. Draw-out rails



- 1. Shutter assembly (open)
- 2. Primary disconnect stab tip (typical)

The shutters are closed when the breaker is in the DISCONNECT Position. As the circuit breaker is racked from the DISCONNECT Position to the TEST Position the shutters remain fully closed. As the breaker is racked from the TEST Position to the CONNECT Position, the shutters open allowing the breaker to connect to the primary disconnects.

Figure 24 shows the shutter assembly with the shutter in the open position.

⚠ DANGER **Danger:** Hazard of electrical shock or burn. Turn off power to this equipment before working inside.

—
25
SACE Emax 2
circuit breaker

—
26
SACE Emax 2 circuit
breaker (shown with
draw-out rails extended)

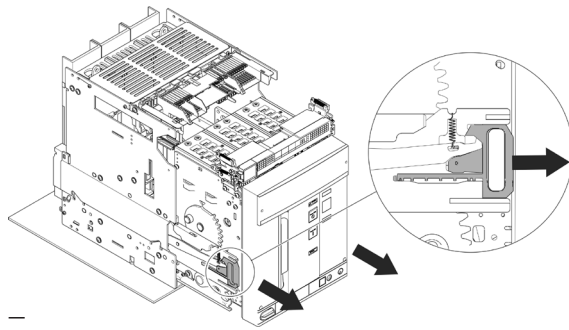
Circuit breakers

The SACE Emax 2 low voltage power circuit breaker includes spring-operated, stored energy, close and trip mechanisms for either manual or electrical operation.

SACE Emax 2 circuit breakers form the complete family of breakers used in ReliaGear LV SG. Each type of breaker listed in Table 2 describes the breaker interrupting rating which corresponds to the 3rd digit of the breaker catalog number. These circuit breakers, in a compartment, range from 800 to 6000 A.



—
25



—
26

SACE Emax 2 circuit breakers

• E1.2 SACE Emax 2 circuit breaker

- 1200 A frame size
- Up to 65 kAIC interrupting rating
- Available in 15, 22, and 30-inch wide sections

• E2.2 SACE Emax 2 circuit breaker

- 2000 A frame size
- Up to 100 kAIC interrupting rating
- Four high stacking; 22-inch wide sections

• E4.2 SACE Emax 2 circuit breaker

- 2000 A frame size
- Up to 100 kAIC interrupting rating
- Four high stacking; 22-inch wide sections

• E4.2 SACE Emax 2 circuit breaker

- 3200 A frame size
- Up to 100 kAIC interrupting rating
- Available in 22-inch wide sections

• E6.2 SACE Emax 2 circuit breaker

- 5000 A frame size
- Up to 100 kAIC interrupting rating
- Available in 38-inch wide sections

• E6.2 SACE Emax 2 circuit breaker

- 6000 A frame size
- Up to 100 kAIC interrupting rating
- Available in 49-inch wide sections

Table 2 - SACE Emax 2 short time and short circuit interruption ratings

Interrupting Rating Tiers ANSI/ UL1066 Devices, LVPCB					E1.2		E2.2		E4.2		E6.2		E6.2 ¹	
Type	254 Vac	508 Vac	635 Vac	1/2 Withstand	800, 1200	250, 800, 1200	800, 1200, 1600, 2000	250, 800, 1200, 1600, 2000	800, 1600, 2000, 3200	3200	3200, 4000, 5000	5000	5000	6000
B-A	42	42	42	42	X									
N-A	50	50	42	50	X									
S-A	65	65	42	50		X								
S-A	65	65	65	65			X		X					
H-A	85	85	85	85			X		X		X			X
V-A	100	100	85	85				X						
V-A	100	100	100	100					X	X	X	X	X	X

1. 49W switchgear sections only

—

27A
Inside of future breaker
compartment door for
SACE Emax 2 E2.2, E4.2,
and E6.2 circuit breakers

—

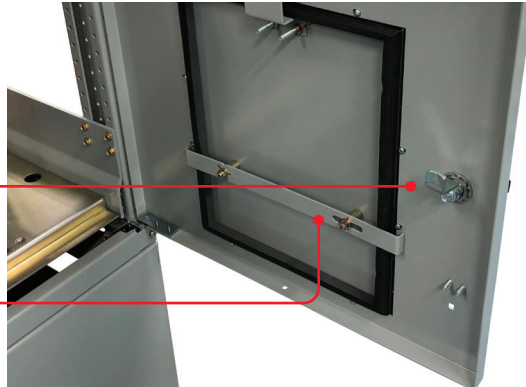
27B
Inside of future breaker
compartment door for
SACE Emax E1.2
circuit breaker

—

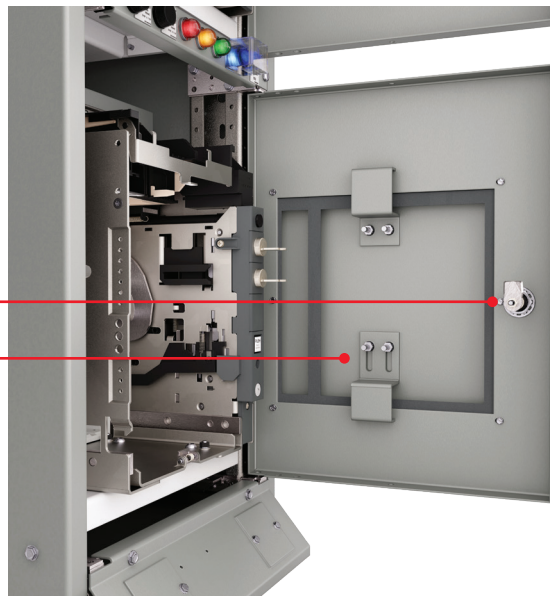
28
Future breaker door cover
(pad-lockable ¼-turn
latch may be provided on
future breaker cubicles)

Compartments for future breakers

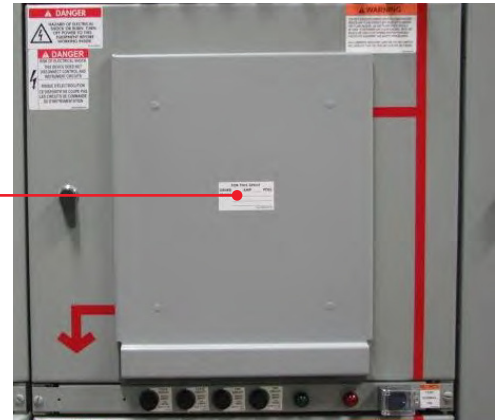
When specified, compartments may be supplied for future addition of circuit breaker elements. These compartments are fully equipped with cradles, primary disconnects, and ancillary devices as required (i.e. secondary disconnects, accessory devices, etc.). The opening in the breaker compartment door is closed with a bolted-on steel plate to deter accidental contact with energized electrical circuits (i.e. primary disconnect stab tips). See Figure 27A, 27B and 28.



1. Quarter-turn latch
2. Steel plate (future cubicle door cover)

—
27A

1. Quarter-turn latch
2. Steel plate (future cubicle door cover)

—
27B

1. Future cubicle door cover

—
28

Auxiliary/transition sections

Sections may be provided for any one or more of several reasons including:

- Transition to a close-coupled transformer
- Transition to "match and line-up" with existing AKD-8/AKD-10/AKD-20 switchgear
- Incoming cable or busway when a main breaker section is not provided
- Mounting and wiring of additional metering, relaying, and control devices requiring more space than available in a standard instrument panel or instrumentation compartment (transition or auxiliary)
- Mounting and wiring of purchaser specified and/or furnished devices (i.e. utility revenue metering equipment, etc.)

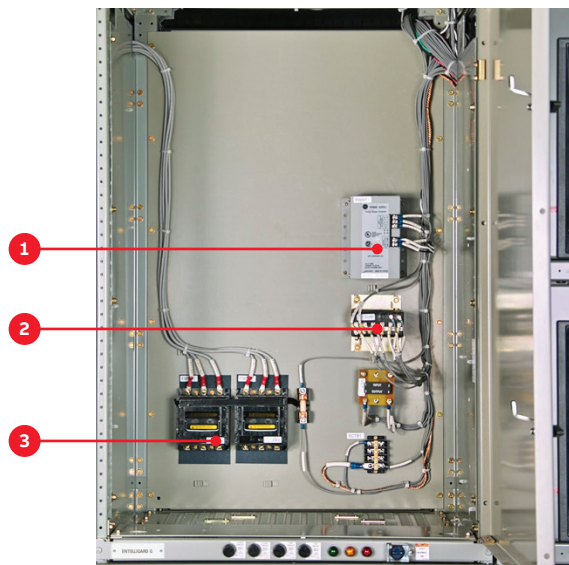
Auxiliary sections may be 15-inch, 22-inch, 30-inch, or 38-inch wide as required to accommodate the space requirements. The compartment doors on the front of the sections are hinged and latched in the same manner as breaker compartment doors.

Generally, transition sections will be 22-inches wide for close-coupling to transformers and "match and line-up" to non-ABB equipment.

Power company metering requirements generally require either a 38-inch or 49-inch wide auxiliary section to accommodate the current transformers, kilowatt-hour meters, demand meters, etc. as required by their individual practices, tariff schedules, and/or regulatory commissions.

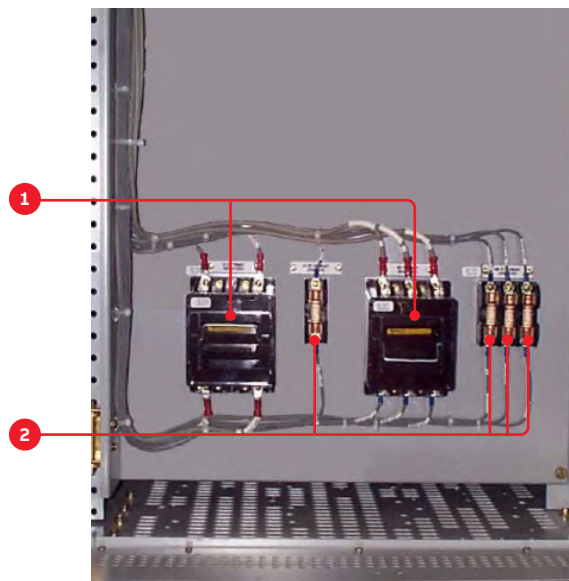
Figure 29 is a front view of a typical instrumentation compartment. Examples of primary and secondary control protection in the instrument compartment are shown in Figure 30.

- 29
Auxiliary/transition
section (partial
front view)
- 30
Auxiliary/transition
compartment
(primary and secondary
circuit fusing)
- 31
Auxiliary/transition
compartment
- 32A
Bus construction
with molded bases



- 1. 24V power supply
- 2. Auxiliary summing ct
- 3. Enclosed fuse block

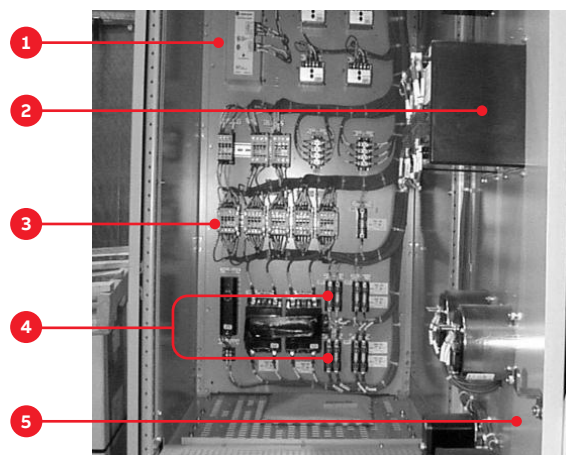
—
29



- 1. Enclosed fuse block
- 2. Open fuse block

—
30

Figure 31 illustrates an auxiliary/transition compartment with switchgear-type relays mounted in semi-flush draw-out cases installed on the compartment door. Space in the compartment has been used for power management components and other control devices.

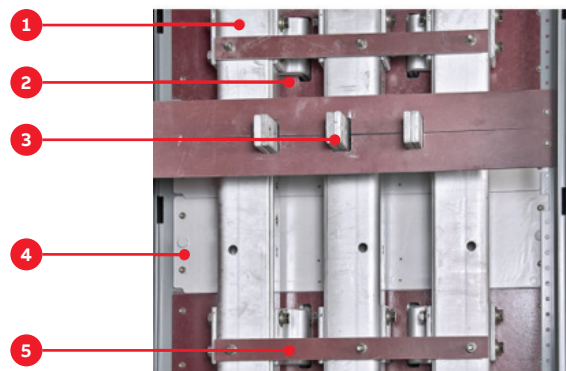


- 1. Power supply
- 2. Relays in draw-out cases
- 3. Auxiliary relays
- 4. Fuse blocks
- 5. Compartment door

—
31

Bus area

The bus area contains the main horizontal bus and vertical riser bus bars for the particular section. The vertical bus bars are supported at the breaker run-ins which may be bolted to the molded bases (Figure 32A) that form the rear wall of the breaker compartment or steel c-channels (Figure 32B) located in the rear compartment. The horizontal bus bars are supported by the power connectors which are bolted to the vertical bus bars. All bolted supports and connections are accessible from the rear for maintenance. The bus area may be fully isolated from the breaker, instrument and auxiliary compartments by the molded bases or glass polyester sheet.

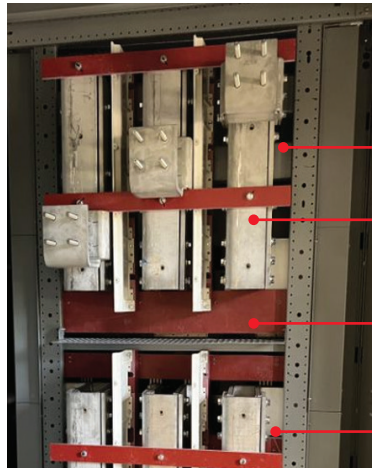


- 1. Vertical riser bus
- 2. Run-ins to breaker compartment
- 3. Molded case
- 4. Run-backs from breaker compartment
- 5. Short-circuit brace

—
32A

—
32B
Bus construction with
steel c-channels

—
33
Main breaker
arrangement



1. Steel c-channel supports
2. Vertical riser bus
3. Line-load barrier
4. Short-circuit brace

—
32B

Busing system

Bus bars are fully tin-plated copper with bolted joints and silver plating is optional. The standard construction is open bus. A barrier system (Bus Compartmentation) that isolates the main and vertical bus bars from the cable area is available as an option. All run-backs (load-side power conductors) from the breaker compartment to the cable termination area are covered with non-PVC insulated tubing.

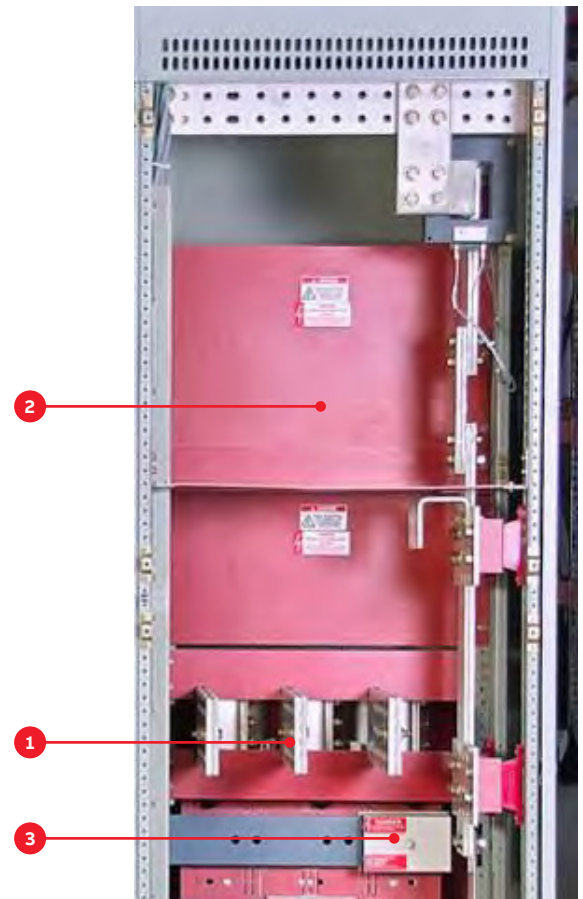
The typical arrangement for a Service Entrance with insulated / isolated bus is shown in Figure 33.

The standard bracing is 65 kA, RMS symmetrical. Bracing for 100 kA, 150 kA and 200 kA, RMS symmetrical is available as an option.

In general, when the switchgear equipment has no more than four sections or does not exceed 10 feet in length, it will be shipped as one complete lineup. In such cases, the only field assembly would be to a close-coupled transformer if the switchgear were part of a Load Center Unit Substation. If, because of shipping and/or handling considerations, the equipment cannot be handled in one piece, it can be split into two or more shipping sections at the factory. The individual shipping splits require both mechanical and electrical connections between sections to be made in the field.

At these shipping splits, provisions are made for bolting all buses and making the necessary electrical and mechanical connections. These are described in Section 4 of this publication.

On main and tie breakers, the bus area is divided into an upper and lower section by a barrier. For typical unit substation main circuit breakers, the upper section contains the incoming line bus. The lower section of the bus area contains the load side main bus (protected by the main breaker) which feeds all sections of the switchgear equipment. Similarly, barriers at tie breakers isolate the two main bus sections from each other.



1. Incoming cable connection
2. Isolation barriers
3. Main horizontal bus connections

—
33

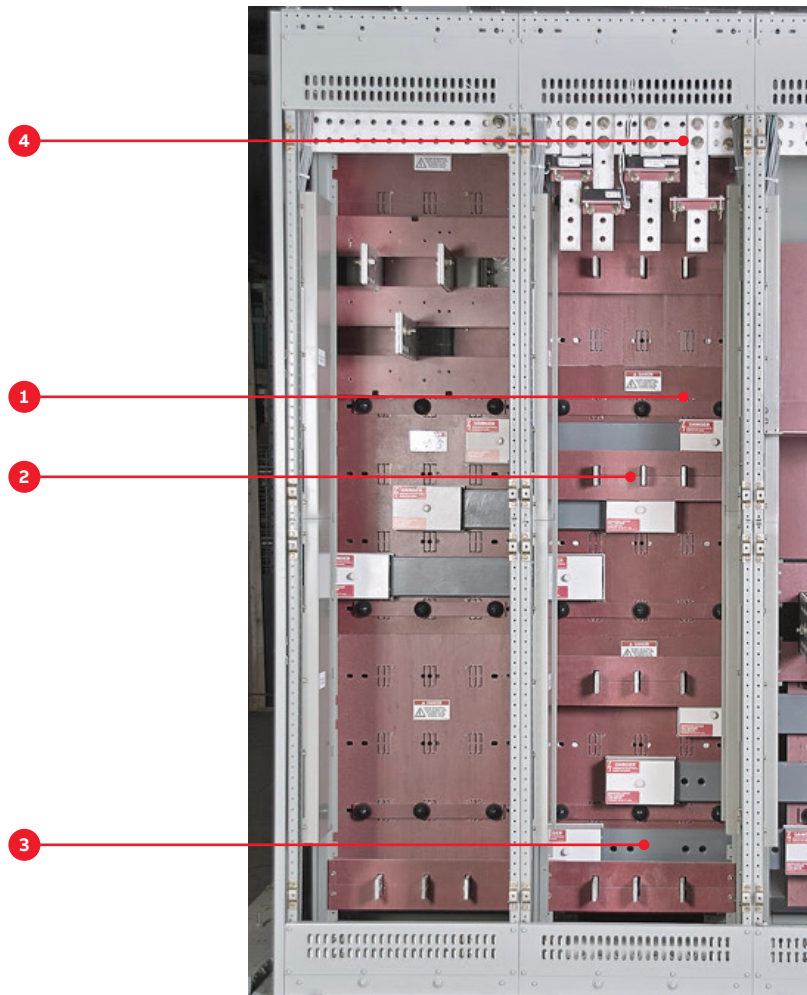
—
34
Insulated/isolated-
bus system

—
35
Bus system

Insulated/isolated bus system

A bus insulation system, Figure 34, that fully insulates and isolates each phase of the horizontal main bus and isolates each phase of the vertical bus, is optionally available for ReliaGear LV SG when specified. With the insulated/isolated bus system, there are no live connections accessible in the rear of each section except the cable lugs.

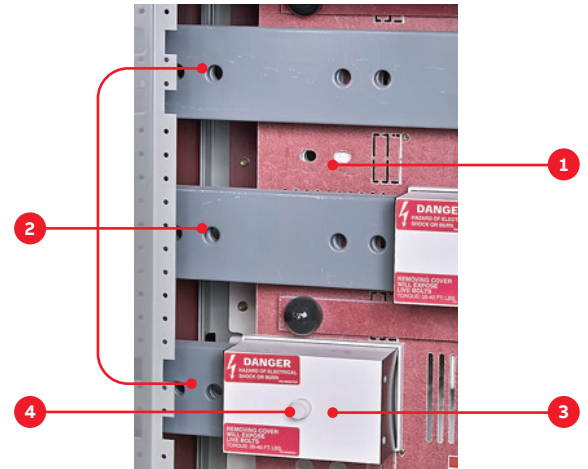
Insulation and isolation of the vertical riser bus bars, Figure 34, is provided by installing phase isolation barriers (not shown) between the bus bars and by the vertical bus barrier which covers over the bus bars. The phase isolation barriers and riser bus covers are constructed from insulating material. Insulation of the horizontal main bus bars is achieved by an oven-cured coating of epoxy.



1. Vertical riser bus covers
2. Run-backs to feeder cables
3. Horizontal main bus
4. Upper neutral bus with 4th wire sensors

The vertical/horizontal bus bar joints may be covered with collars and joint caps (Figure 35A) or with an isolation barrier assembly (Figure 35B). All materials are constructed from insulating material. The Joint Cap is held in place with nylon thumb screws.

When using the isolation barrier assembly, an additional glastic barrier is required. This barrier is to be installed on the side wall of the assembly with nylon thumb screws.



1. Vertical bus barrier
2. Insulated bus bar (epoxy coated)
3. Joint cap
4. Nylon thumb screw

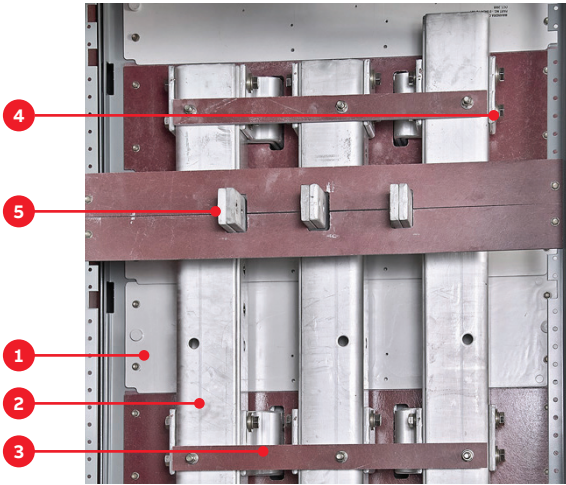


1. Short-circuit brace
2. Vertical bus barrier
3. Isolation barrier assembly
4. Insulated bus bar (epoxy coated)
5. Nylon thumb screws (not shown)

—
36
Insulated horizontal
bus system

—
37
Transition section

—
38
Cable termination
provisions

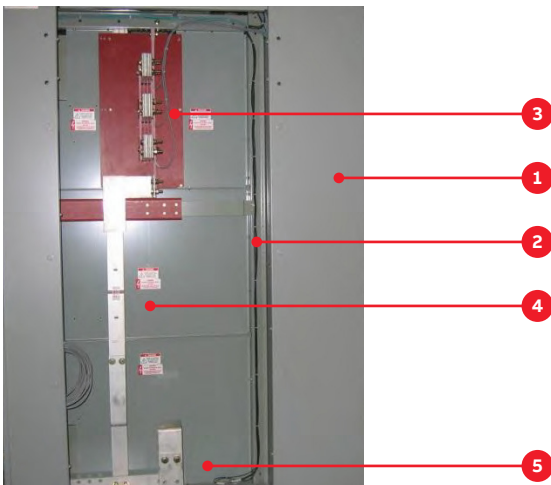


- 1. Molded base
- 2. Vertical riser buses (cover removed to show bus location)
- 3. Vertical bus bracing
- 4. Run in conductors
- 5. Insulated run backs

—
36

Figure 36 illustrates the various components comprising the vertical bus bars. Bus bars can be supported by either molded, machined, or steel c-channel barriers. Vertical bus can be braced depending on the interrupting rating of the switchgear. Conductors that provide current to the breaker compartments are called run in bars and are bolted to the riser bus bars. Insulated run back bars are for connecting load conductor cabling.

A vertical barrier, Figure 37, between the transition section and the first breaker section is always furnished. The buswork in the device/auxiliary/ transition sections is not insulated at the termination points to the other connected equipment such as transformers, busway, or existing equipment.



- 1. Transition compartment
- 2. Barrier
- 3. Main incoming bus
- 4. Neutral bus
- 5. Ground bus

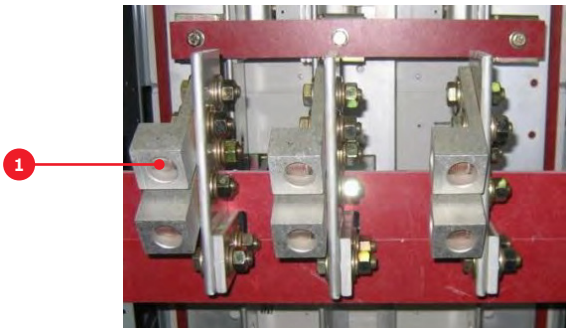
—
37

Feeder cable and busway

The rear cable and terminal compartment, Figure 38 provides for cable installation and terminations. The cable bending space meets the requirements of the National Electric Code. Various arrangements of single or double cable terminals are provided, depending upon the purchaser's requirements.

When specified, racks for the support of feeder cables are located in the cable compartment. The actual support of the cables is provided by lashing them to these racks.

Also located in the cable compartments are provisions for terminating control wires between external devices and control circuits within the switchgear equipment. Figure 39 shows this typical arrangement.



- 1. Cable lugs (mechanical type)

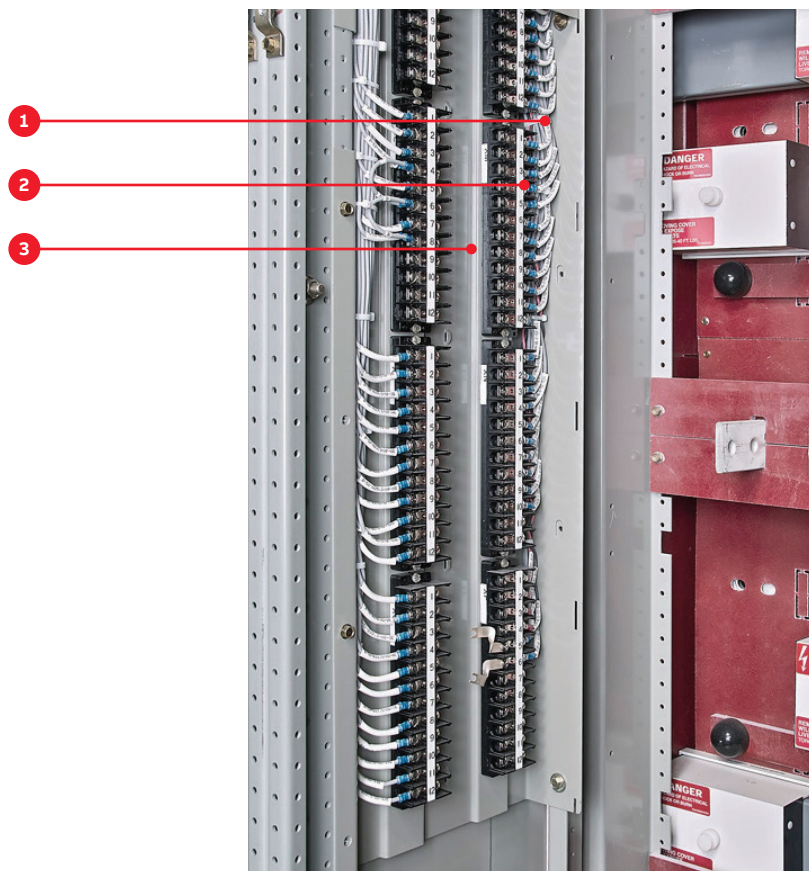
—
38

—
39
Control wiring
termination trough

—
40
Cable termination
compartment

When selected, terminal blocks are located in a steel wiring trough, mounted to the side or the rear of the cable compartment (Figure 39). The trough, when mounted on the side, is of steel construction with bolted covers to provide an isolation barrier between the control wiring and the adjacent power cables.

A neutral bus, insulated from ground, is provided in the bus area on switchgear designed for four-wire systems. The neutral bus is located either near the top or near the bottom of the cable compartment. It includes provisions for terminating the neutral conductor of four-wire feeder cables and also direct mounting of the neutral sensor as required for those feeder system circuit breakers having a ground fault trip function.

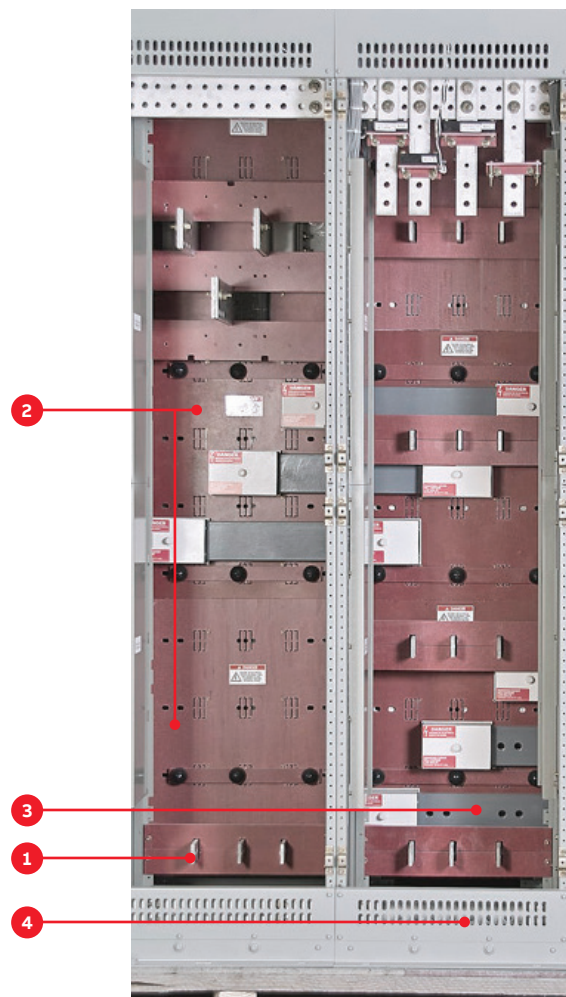


1. Internal equipment control wiring
2. Terminal boards
3. Space for purchaser's field control wiring

—
39

Ground bus

All ReliaGear LV SG sections are grounded to the internal equipment ground bus, Figure 40, located at the bottom or the top of the cable compartment.



1. Feeder run backs
2. Vertical riser bus covers
3. Horizontal main bus
4. Ground bus (behind steel cover)

—
40

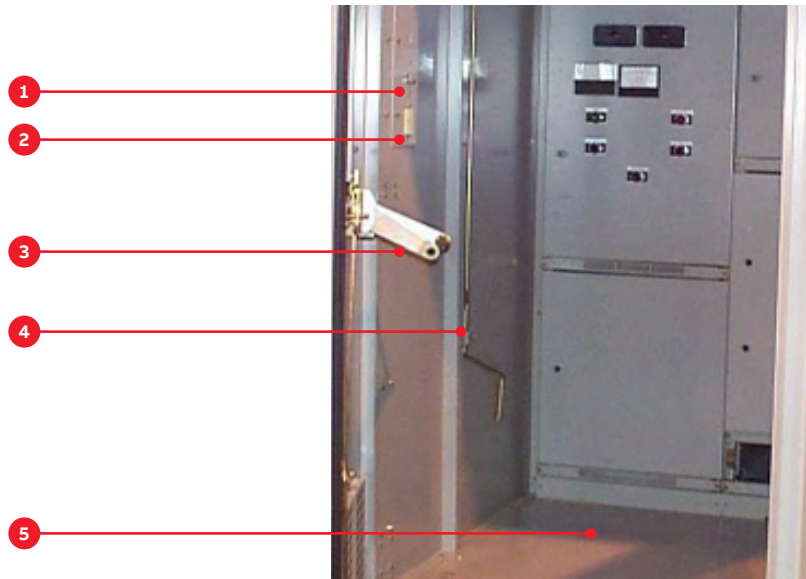
—
41
Switchgear outdoor
enclosure

—
42
Location of space heater
(indoor enclosure)

Outdoor switchgear

Switchgear designed for outdoor installations is fully weatherproofed. See Figure 41. A weatherproof housing completely encloses the switchgear and may be provided with a walk-in front aisle for easy access to all controls and instruments.

Aisle lighting with wall switch, Figure 41, and a 115-volt GFCI convenience outlet are standard devices supplied with front aisle outdoor switchgear equipment. Also included in the walk-in front aisle area are the breaker-lifting device and storage provision for the breaker-lifting device operating crank as shown in Figure 41. A double-wide door with panic latch is provided for breaker loading.



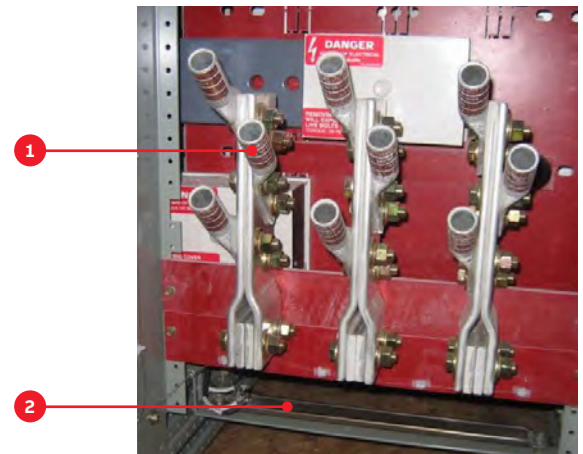
1. Interior lighting switch
2. GFCI convenience outlet
3. Panic latch
4. Breaker lifting device crank
5. Walk-in aisle - 46 inches deep (approx.)

—
41

Space heaters, Figure 42 are provided as standard equipment. They provide protection against condensation of moisture that could, in combination with air-borne contaminants, deteriorate insulation or cause corrosion.

One 1000-watt, 240-volt, operating at 120V (250-watts) AC heater is located on the floor of the bus compartment of each outdoor switchgear section. The heaters should be energized at all times to prevent condensation within the switchgear.

Heaters are fed by the control power transformer. The on-off control switch is located in the walk-in front aisle.



1. Run backs and cable lugs (compression type)
2. Space heater

—
42

Outdoor switchgear may also be provided without the walk-in front aisle. Non-walk-in outdoor equipment is not equipped with an overhead breaker lifting device. A portable breaker lifting device, available as an optional accessory, is used for lifting the SACE Emax 2 breakers.

Equipment installation

—
43
Definition of flat
and level

General

This section contains complete instructions for installing ReliaGear LV SG voltage switchgear.

CAUTION

Caution: Personnel installing this equipment must be thoroughly familiar with this instruction manual and all articles of the National Electrical Code applicable to the installation of this switchgear. In addition, all drawings, both mechanical installation and electrical, must be understood and strictly followed to prevent damage to the switchgear or equipment being protected by the switchgear.

NOTICE

Notice: Before installation work is started, it is important to review all of the drawings provided, including the equipment arrangement drawings, site installation drawings, elementary and remote connection drawings, mechanical connection drawings, and the summary of equipment list.

All expendable hardware for shipping purposes only, is painted yellow or tagged with yellow adhesive tape and may be discarded at completion of the installation phase.

Site location

In general, the location of the switchgear equipment will have been predetermined during the specification and/or procurement of equipment phases. Indoor locations within buildings impose certain requirements which must be met so that the switchgear may operate efficiently with a minimum of maintenance.

In locating the switchgear, adequate aisle space must be provided at the front and rear of the equipment to ensure proper ventilation of the equipment and to allow service and maintenance of the equipment with the front and rear doors open. The recommended aisle space is shown on the floor plan supplied with the equipment drawings.

The switchgear equipment should be placed in an area where clean, dry air is free to circulate around and above it. Since air is taken into the equipment at the bottom of each section and exhausted at the top, a location with good airflow must be provided for efficient operation. A minimum of 30 inches of clear space above the equipment is recommended.

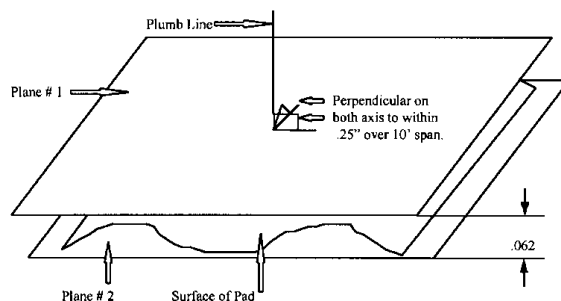
Foundation requirements

For optimum performance of your switchgear equipment, the foundation requirements expressed in this section should be strictly adhered to.

NOTICE

Notice: The foundation for the outdoor switchgear must provide proper drainage of ground and/or surface water accumulations away from the equipment.

The foundation must be strong enough to prevent sagging due to the weight of the switchgear structure and to withstand the shock stress caused by the opening of the breakers under fault conditions. The shock loading is approximately 1-1/2 times the static load. The foundation must be flat and level in all planes. Refer to Figure 43 for definition of flat and level.



—
43

Foundation preparation - indoor equipment

Refer to Figure 44 along with the owner's foundation construction drawings and the supplemental installation drawings. Although the indoor switchgear equipment can be mounted directly on a smooth, level floor, it is recommended that recessed steel channels be installed for supporting the equipment. Anchor bolts and channels are to be provided by the purchaser.

NOTICE

Notice: When the equipment is installed on a surface subject to impact (shock) loads due to operating conditions or environmental seismic (earthquake) conditions, the anchor bolts should be fabricated of medium carbon steel (grade 5 load rating).

The floor channels under the front and rear switchgear anchor points (see Figure 42) should be embedded in a level concrete slab with their top surfaces flush with the finished floor. It is essential that these steel channels be level and aligned with each other prior to final anchoring, to prevent distortion of the switchgear structure, to assure proper mechanical and electrical connections between shipping splits, and to assure proper interfacing to other close-coupled equipment.

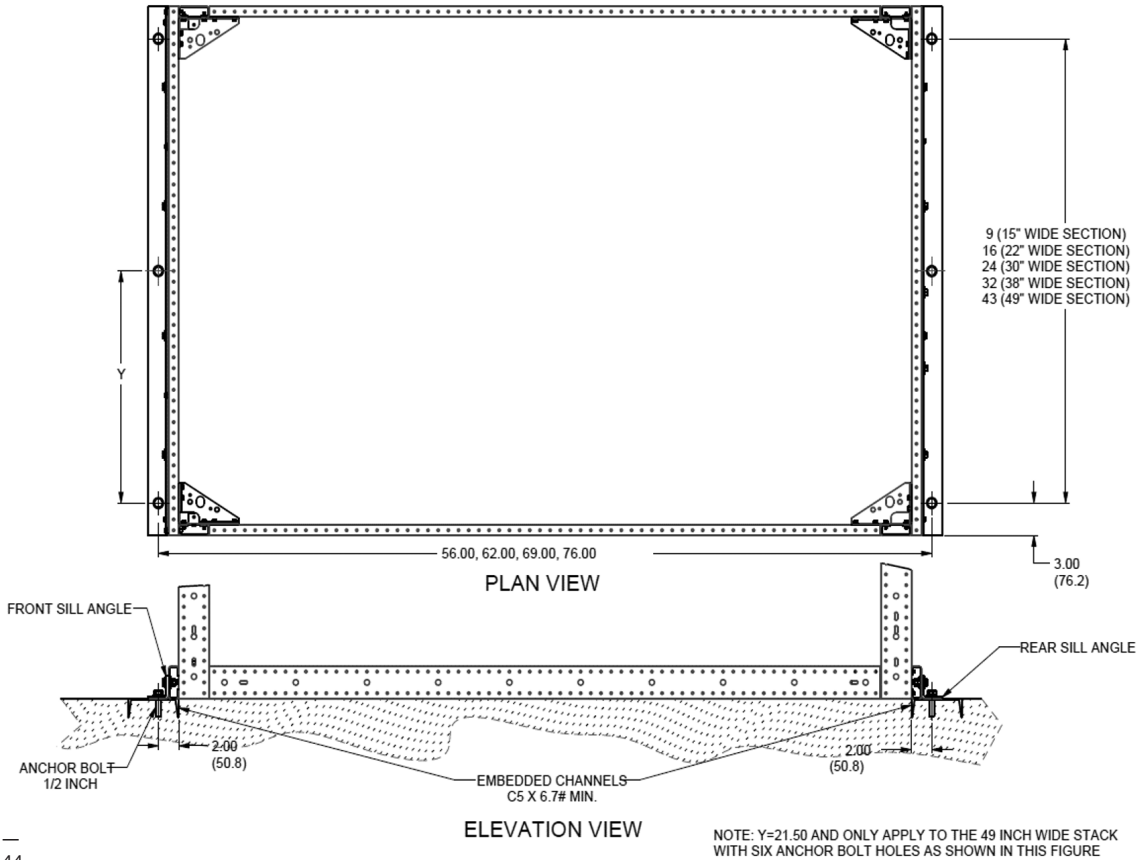
ABB switchgear and load center substations are frequently mounted on steel floors and/or structural steel in industrial installations (such as a mezzanine) to minimize usage of production floor space.

Regardless of the type of mounting surface, the requirement for a smooth level surface remains.

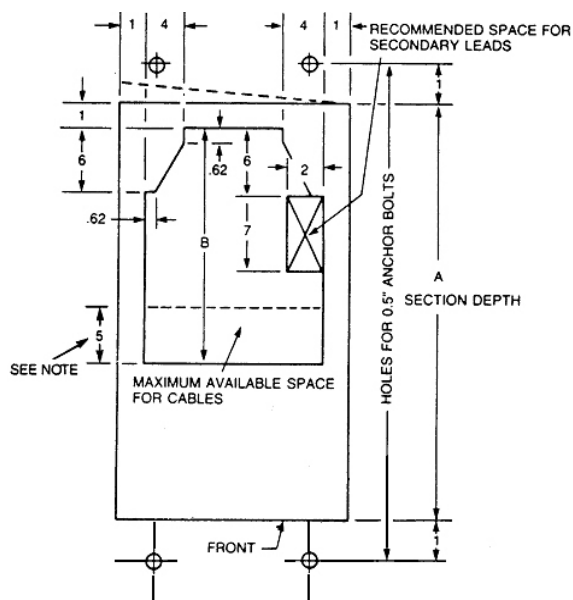
If studs or anchor bolts are to be used, they should be installed in the foundation as it is poured. It is important that the studs or bolts are spaced to agree with dimensions given on the job drawings. The dimensions between anchor bolts for a particular installation are dependent upon the configuration of equipment ordered. The dimensions shown on Figure 44 cover the entire standard enclosures available for ReliaGear LV SG switchgear.

Figure 45 illustrates the space available for conduit and/or cable entrance through the bottom or top of each equipment section. The space required for control wiring entry to the optional wiring trough is also shown.

44
Indoor enclosure
anchor locations



45
Floor plan and cable
entry space (indoor
enclosure)



45

NOTICE

Notice: Bus compartment barrier location. When this optional feature is provided, it will reduce the available cable entry space by (5) inches.

NOTICE

Notice: On 49W sections, recommended space for secondary leads is located 6" closer to rear and oriented towards the rear.

Table 3 - Maximum available cable space

Stack Width	Equipment Depth "A" (inches)	Direction of Leads	"B" (inches)
15, 22, 30, 38"	54"	Below	19
		Above	24
	60"	Below	25
		Above	30
	67"	Below	32
		Above	37
49"	74"	Below	39
		Above	44
	67"	Below	19
		Above	24
	74"	Below	26
		Above	31

All dimensions are in inches.

Outdoor equipment

Refer to Figure 46 along with the owner's foundation construction drawings and the supplemental installation drawings. The outdoor switchgear equipment is supplied with three built-in structural support channels in the base of the switchgear as shown in Figure 46. The front and rear structural support channels are designed to be clamped to the foundation.

The center channel is a structural stabilization channel. Although the equipment can be mounted directly on a smooth, level surface, it is recommended that recessed steel channels be installed to support the switchgear. The floor channel sills under the front, center, and rear of the switchgear base should be embedded in a level concrete slab with their top surfaces flush with the finished floor.

NOTICE

Notice: Four (4) clamp plates (see Figure 47) are required for each outdoor lineup. One clamp plate located at each corner of the equipment.

While the equipment base center channel is not anchored to the foundation, it is still required that the center channel sill (see Figure 46) be level with the foundation and also with the front and rear channel sills to prevent structural distortion of the switchgear equipment. Only four anchor bolts are normally used for outdoor enclosures.

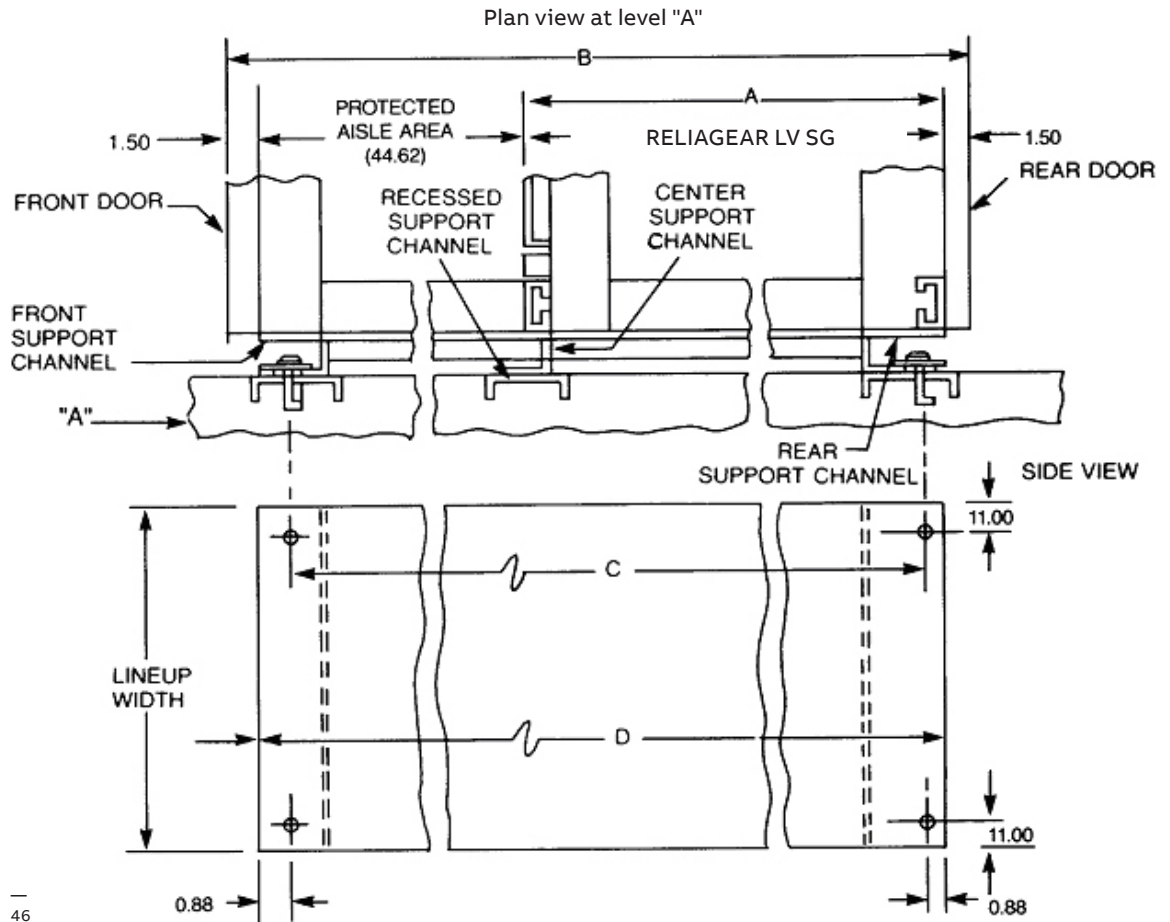
Table 4 - Outdoor equipment mounting dimensions

Depth of indoor switchgear "A"	Depth of outdoor switchgear "B"	Anchor bolt spacing "C"	Sub base depth "D"
60	107.62	106.00	104.62
74	121.62	120.00	118.62

All dimensions are in inches.

—
46
Outdoor walk-in
enclosure anchor
locations

—
47
Outdoor enclosure
clamp plate

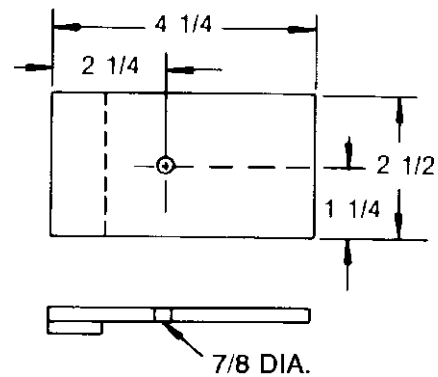


NOTICE

Notice: The factory must be consulted for anchoring recommendations for equipment subject to operational and/or environmental (seismic) shock loading.

Anchor bolts and channels are to be provided by the purchaser; the clamp plates (Figure 45) are not supplied with the equipment.

It is recommended that the anchor bolts be 5/8-inch diameter.



—
47 Dimension in inches

—

48

Lifting plate location

Assembly and installation of switchgear equipment

General requirements

Before assembling or installing the switchgear equipment, all components should be available at the site location. This will facilitate switchgear component identification as well as installation. The foundation should be prepared in accordance with the instructions in the previous sub-sections, and all embedded conduits installed and capped.

NOTICE

Notice: If rollers are to be used for movement of the equipment to its permanent installation, it is recommended that the shipping skid not be removed until the equipment is placed in position over the anchor bolts.

If a transformer is not part of the installation, and/or the equipment has been split for shipment, place the center section on the foundation first. Assemble the remaining sections outward from the center section, in each direction. If the switchgear equipment is part of a load center unit substation, the transformer section should be set on its pad first in accordance with the instructions furnished with the transformer. All remaining sections of the switchgear should then be installed.

NOTICE

Notice: Before assembling and installing the switchgear equipment, the foundation must be absolutely level and clear of debris to prevent damage and possible misoperation of the switchgear equipment.

Detailed assembly and installation instructions indoor equipment

The recommended procedure for installation of an indoor switchgear or load center unit substation is as follows:

1. Position the equipment - Position the equipment or sections of the complete equipment in their final location.



1. Indoor lifting plates

—

48

NOTICE

Notice: If the equipment line-up was split into shipping sections, the lifting plates on corners of adjacent sections shown in Figure 48 must be removed. Failure to remove these plates will interfere with mating adjacent sections and prevent installation of bus splice plates, structure tie plates, etc.

Once the lifting plates have been removed, they may be discarded.

NOTICE

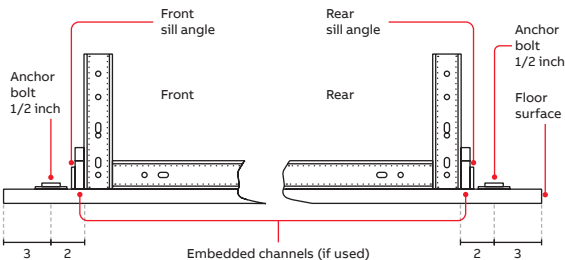
Notice: In the event the lifting plates must be reassembled on the equipment for lifting purposes, they must be moved to locations where unused screw holes are available, generally achieved by shifting the plate horizontally on the mounting surface one bolthole from its previous location. When remounting the lifting plates, torque the mounting bolts to 7-9 ft-lbs.

NOTICE

Notice: All mating sections of the equipment line-up (including transformer, if applicable) must be securely fastened together prior to tightening anchor bolts fastening the equipment to the mounting surface.

- 49 View showing method of attaching equipment to shipping skids
- 50 Location of through-bolts (dimension in inches)
- 51 Through-bolt installation
- 52 Typical location of buses at shipping split

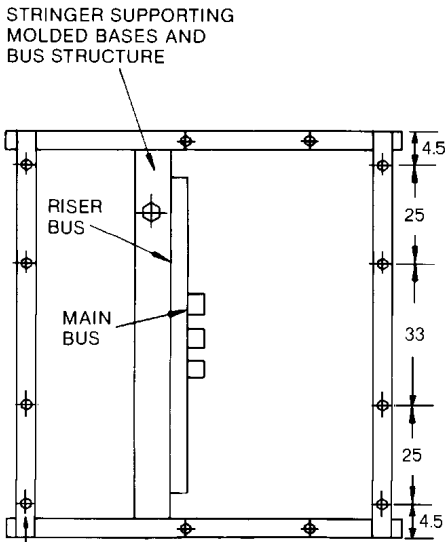
2. Remove the shipping skids - The equipment is fastened to the shipping skids with ½ inch lag screws through the equipment anchoring holes. See Figure 49.



49

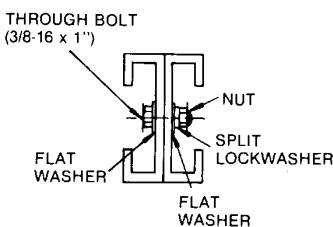
Equipment shipping sections up to 10 feet long will be fastened to the skids with four lag screws, one in each corner. The shipping skid and lag screws are expendable material and may be disposed of at the purchaser's discretion.

3. Fasten section together - After placement of the equipment and installing the anchor bolts loosely, the various shipping sections must be rigidly fastened together. Throughbolts fasten each section of the switchgear equipment to the adjacent section. Figure 50 shows the location of the throughbolts.



50

Figure 51 illustrates the installation of the throughbolts. The throughbolts are in the front and rear compartments. The nut and bolt assembly should be tightened with a torque of 25–30 ft-lbs.



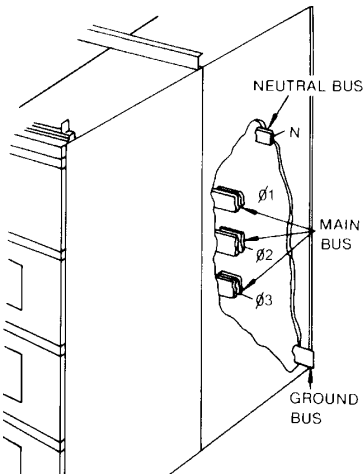
51

All of the hardware required for assembling the equipment across the shipping splits is furnished with the equipment. If a transformer is included in the line-up of equipment, the transformer flange should be aligned with the opening in the side of the transition section and fastened together using the 3/8-16 bolts, nuts and washers supplied with switchgear. The fastener assembly should be tightened with a torque of 25-30 ft-lbs.

4. Complete the electrical interconnections - After completing the mechanical connections between the several sections of equipment, the electrical interconnections should be completed. This includes the installation of splice plates for the main bus bars, the neutral bus, and the ground bus in addition to the control and metering circuits.

WARNING All switchgear equipment must be adequately grounded for safety. Failure to ground equipment properly may result in serious injury.

Figure 52 illustrates the general location of the buses that must be spliced across the shipping splits.



52

—
53
Plan view of ground
bus splice installation

—
54
Flange opening on
a transition section
to a transformer

Ground bus

The ground bus is mounted directly on the rear upright channels in each individual section.

NOTICE

Notice: It is particularly important that the ground bus be connected first since it provides an integral ground for all the equipment. It must also be connected to the station ground prior to proceeding with the installation.

A 4/0 AWG cable connector is located in the bottom of the transition section (or in the incoming line compartment if a transition section is not included) for terminating the purchaser's cable connection to ground. The specific location of the station ground connection is shown on the site floor plan drawing and in the electrical drawings supplied with the equipment. All grounding of the switchgear should be in accordance with National Electrical Code.

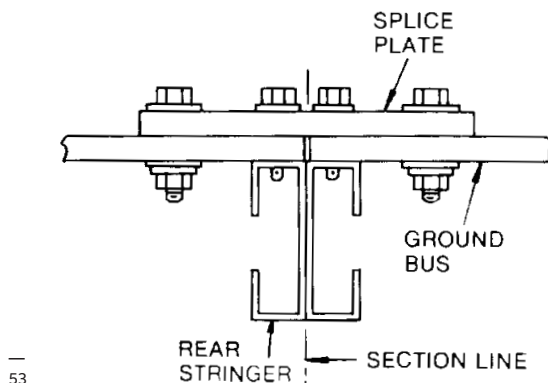
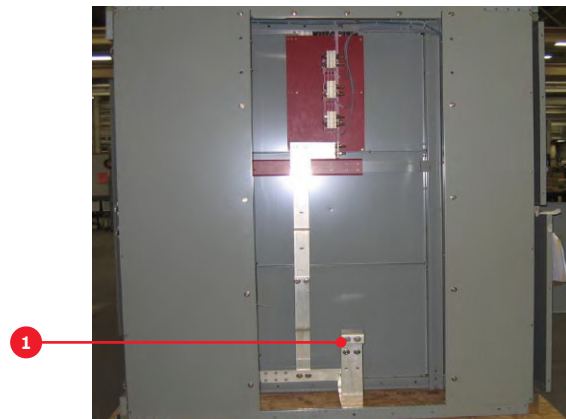


Figure 53 illustrates the installation of the ground bus splice plate across a shipping split. In addition to the bolted fastening of the splice plate to the two ends of the ground bus, self-tapping 1/4-20 bolts pass through the splice plate and ground bus stubs, and thread into the equipment frame. These bolts should be fastened with a torque of 7–9 ft-lbs.

If a transformer (rated above 750 kVA) is present in the line-up, a ground bar located in the transition compartment, Figure 54, is provided for connection of the transformer ground pad to the equipment ground termination point.



1. Ground bus

—
54

As shipped, the ground bar is mounted so it does not protrude beyond the outer surface of the equipment. When the equipment is installed in its final location, the ground bar must be reassembled using the outer bolt holes in the horizontal ground bus spanning the width of the transition compartment. In this mounting location, the offset portion of the ground bar will permit connection to the transformer ground pad with the 1/2-13 bolt assembly supplied with the switchgear equipment. If an optional floor plate is supplied for the transition compartment, it will be necessary to remove the floor plate to permit relocation of the ground connection bar.

All bolted bus joints should be made using the proper torque as shown in Table A.1 in Appendix A of this manual. Transformers not manufactured by ABB may require special mounting and bus connection hardware.

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55
Plan view of neutral
bus splice installation

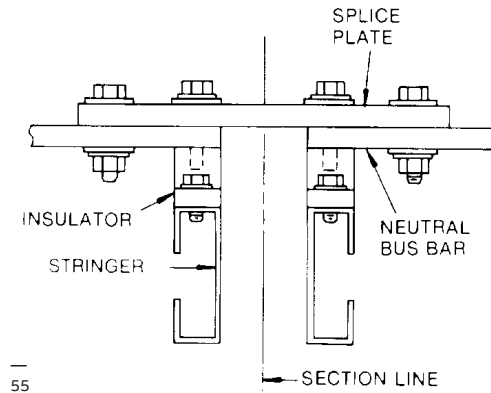
—
56
Rear view of main bus
at a shipping split

—
57
Plan view of a three bar
main bus connection

Neutral bus

The neutral bus may be insulated from the grounded frame of the switchgear equipment; thus, it is mounted on insulators throughout the equipment.

Installation of the neutral bus splice plate across a shipping split is similar to the ground bar splice except that the splice plate is not bolted to the equipment frame. Figure 55 illustrates the installation of the neutral splice plate.



Horizontal main bus

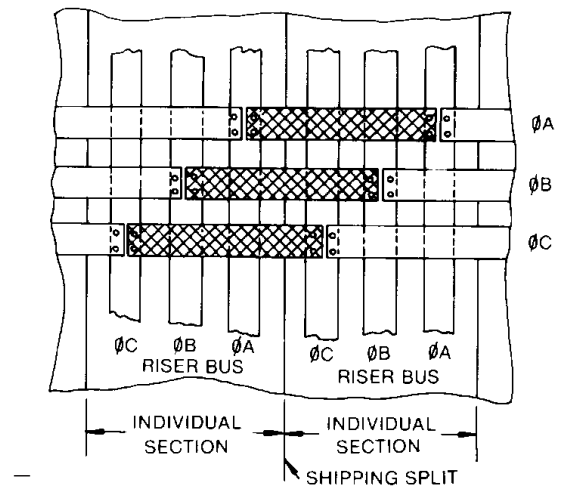
The installation of the horizontal bus splice bars is with bolted joints. Figures 56 and 57 illustrate the assembly of the main bus splice plates on the bolted bus system. Copper bus systems are normally supplied with flat washers and lock washers.

Figure 56 shows the rear view of the main bus area with the installed splice plates indicated with cross-hatching.

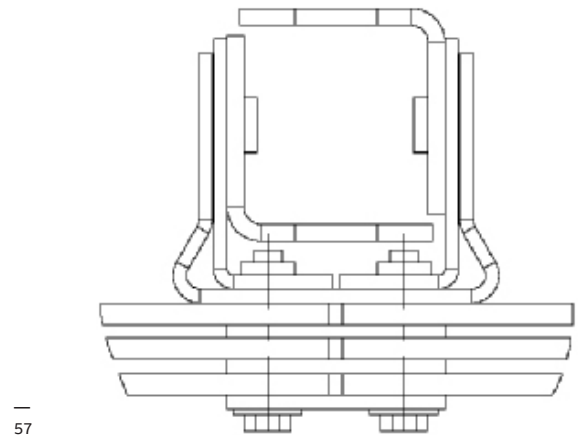
Figure 57 shows that a spacer is used both between the bus bars when more than one bar is used per phase (normally the 2000 A and larger main bus ratings).

After assembly of the splice bars and spacers, the 1/2-13 bolts should be tightened to a torque of 35-40 ft-lbs. After completing the installation of the main bus splice bars, the joint covers or the isolation barrier assembly may be mounted and secured by a 3/8-16 nylon bolt and polyester flat washer if the bus insulation option has been supplied with the equipment.

5. Connect the transformer secondary - The connection of the transformer secondary to the incoming bus bars in the transition is made using the flexible connection straps supplied with the transformer. These connections are always bolted joints.



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56



—
57

The recommended torque for tightening the 1/2-13 bolts fastening the transformer connection straps to the incoming bus bars is 35-40 ftlbs.

6. Interconnect control wiring - Interconnection of control wiring across shipping splits is accomplished by connecting to terminal blocks located in the cross-section wiring trough on top of the equipment shown in Figure 58.

If terminal blocks are provided, each wire must be attached to the correct point on the terminal block, following the circuit identification number attached to each wire.

Ethernet or other communication wiring is connected by similar methods.

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58
Interconnect
control wiring
—
59
Outdoor enclosure
shipping split assembly

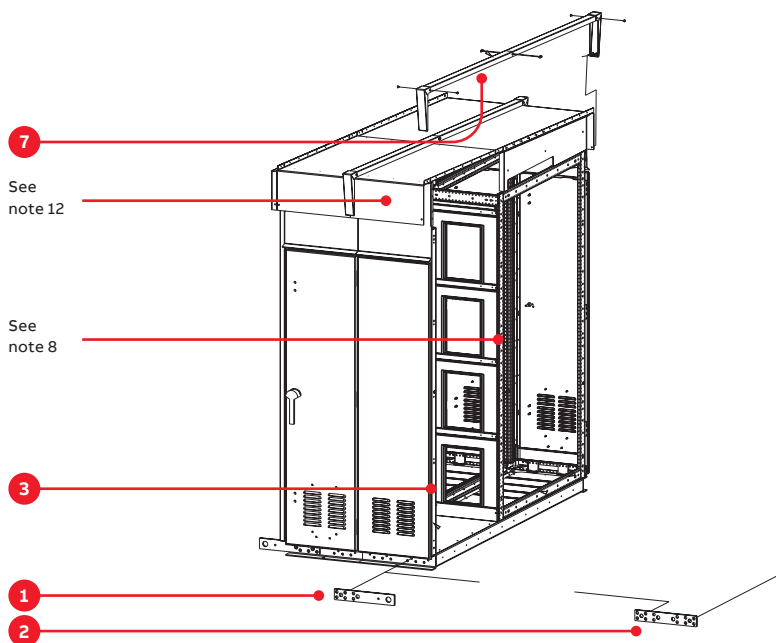


—
58

Outdoor equipment

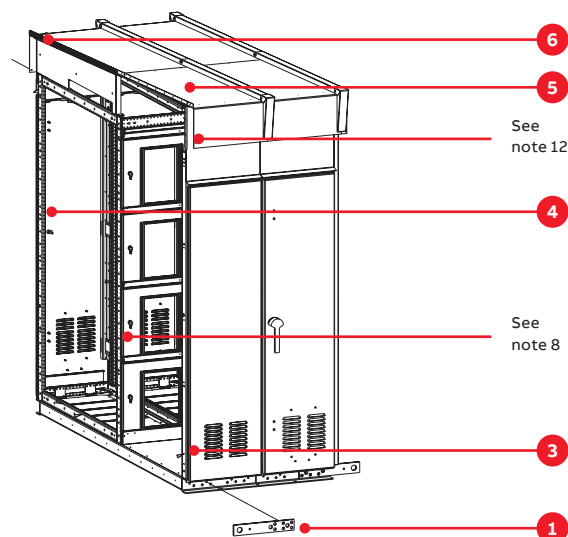
The recommended procedure for installing switchgear supplied in an outdoor enclosure is as follows:

1. Position the equipment - Position the equipment or sections of equipment in their final location. If the equipment line-up was split into two or more shipping sections, it is necessary to first match, line up, and reassemble the multiple sections into an integrated equipment assembly.
2. Apply gasket material - After removal of the lifting plates (see Figure 59), it is necessary to apply the presstite gasket material, Figures 59 and 60, to the mounting surface of the roof flange. The gasket material is supplied with the equipment.
3. Align sections - Align the two sections with the mating surfaces butted together.
4. Fasten sections together - Referring to Figure 50, the mating sections of the outdoor enclosure should be immediately bolted together including the front and rear vertical posts and the roof flange. Each vertical post will require ten 3/8-16 x 1-inch bolt assemblies, see Figure 59; the roof flange will require either eleven or twelve 1/4-20 x 1/2-inch thread forming bolts. The bolts should be tightened with a torque of 7-9 ft-lbs. Figure 60 is a cross-sectional view of the assembled roof joint.



1. Lifting plates (quantity of (4) per shipping split; rear plates not shown)
2. Splice plates
3. Front vertical post

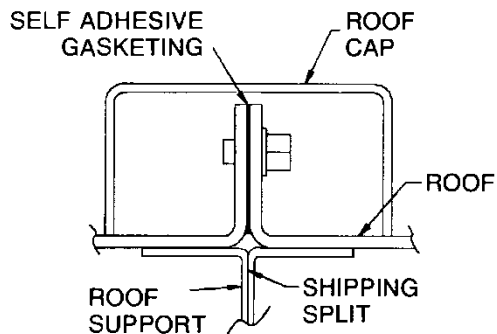
—
59



4. Rear vertical post
5. Roof flange
6. Gasket
7. Roof cap

—
60
Cross-section view of
assembled roof joint

—
61
Door seals

—
60

5. Tie housing bases together - Referring to Figure 59, tie the bases of the outdoor housing together using the splice plate supplied with the equipment and the bolts which previously secured the lifting plates removed after emplacement of the equipment. The nuts are welded to the rear surface of the base. The bolts should be tightened with a torque of 45 ft-lbs.

NOTICE

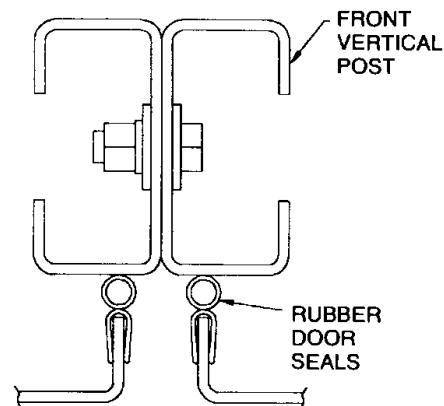
Notice: There are two splice plates required, front and rear of the assembly.

6. Install the roofcap - The roof cap, Figure 59, should be installed over the sealed and fastened roof flange assembly. The roof cap is secured in place with two 1/4-20 NC x 1/2-inch thread forming bolts, each at the front and the rear ends of the roof cap. These bolts should be tightened with a torque of 7-9 ft-lbs.

7. Connect transformer flange - If a transformer is included in the equipment line-up, the flange should be connected to the switchgear opening using the fastening material supplied with the switchgear equipment.
8. Join sections together - The switchgear equipment within the outdoor enclosure should be joined to its mating sections in the manner described for indoor equipment as described earlier in this instruction book.
9. Make electrical interconnections - The installation of bus splice plates for the main horizontal, neutral and ground buses should be done in accordance with the instructions for indoor equipment, as described earlier in this instruction book.

10. Connect the transformer secondary - The installation of the transformer connection straps to the incoming bus should be done in accordance with the instructions for indoor equipment, as described earlier in this instruction book.
11. Interconnect control wiring - The interconnection of control wiring across shipping splits should be done in accordance with the instructions for indoor equipment, as described earlier in this instruction book.

12. Seal small openings - After completion of the shipping split assembly, any small openings should be sealed with clear silicone caulking cement.

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61

Anchoring switchgear equipment

Correct anchoring of the switchgear equipment to the foundation is very important. After completion of re-assembly of the equipment at the shipping splits, the equipment anchoring procedure should be completed.

Indoor equipment

1. Anchoring by anchor bolts - Indoor equipment are normally secured to their final mounting surface by anchor bolts threaded into the embedded channel sills, Figure 62. The bolts were loosely threaded into place before reassembling the equipment shipping splits and connecting to the close-coupled transformer, if appropriate. The anchor bolts should now be tightened with a torque of 35-40 ft-lbs.

2. Anchoring by weld - An alternate method of anchoring the equipment to its foundation is to weld the equipment to floor sills (or the floor itself if constructed of steel). Several methods, shown on Figure 63, are available to the purchaser for welding the equipment to the channel sills.

- a. The front of the equipment is attached to the embedded channel sills, Figure 63, by two 3/16-inch fillet welds. It is recommended that two welds, each 2-1/2 inches long (min.), be used for each section to firmly tie the bottom width post to the channel sill.
- b. The rear of the equipment may be anchored by one of three procedures:

The first method is by plug welds, Figure 63, using the anchor bolt holes in the rear sill angle. The plug weld should receive a minimum 1/2-inch bead around the entire circumference of the anchor bolt hole.

A second method of securing the front and rear sill angles to the channel sill is the use of two linear fillet welds for each section. It is recommended that each weld be 2-1/2 inches long (min.) with a 3/16-inch fillet (min.).

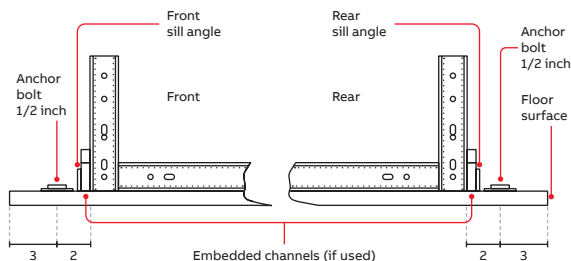
A third method for anchoring the rear of the equipment is to remove the rear sill angle from the switchgear and weld the rear bottom width post to the channel sill. These welds should, like the front welds, have a 3/16-inch (min.) fillet and each have a minimum length of 2- 1/2 inches.

Outdoor equipment

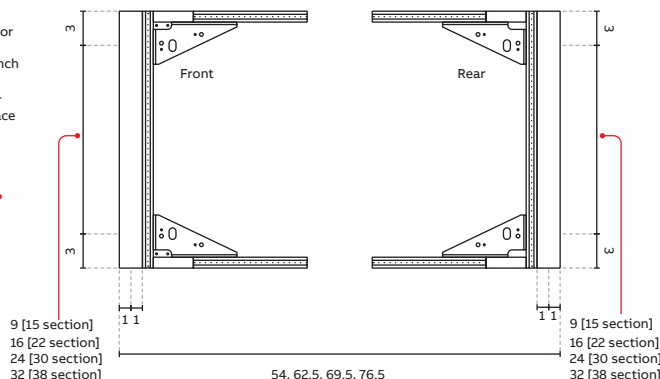
Outdoor equipment is anchored after re-assembly of the separately shipped sections. The four anchor bolts should be tightened with a torque of 45-55 ft-lbs.



Caution: If the equipment is to be subjected to operational or environmental (seismic) shock loading, the factory must be consulted for anchoring recommendations.



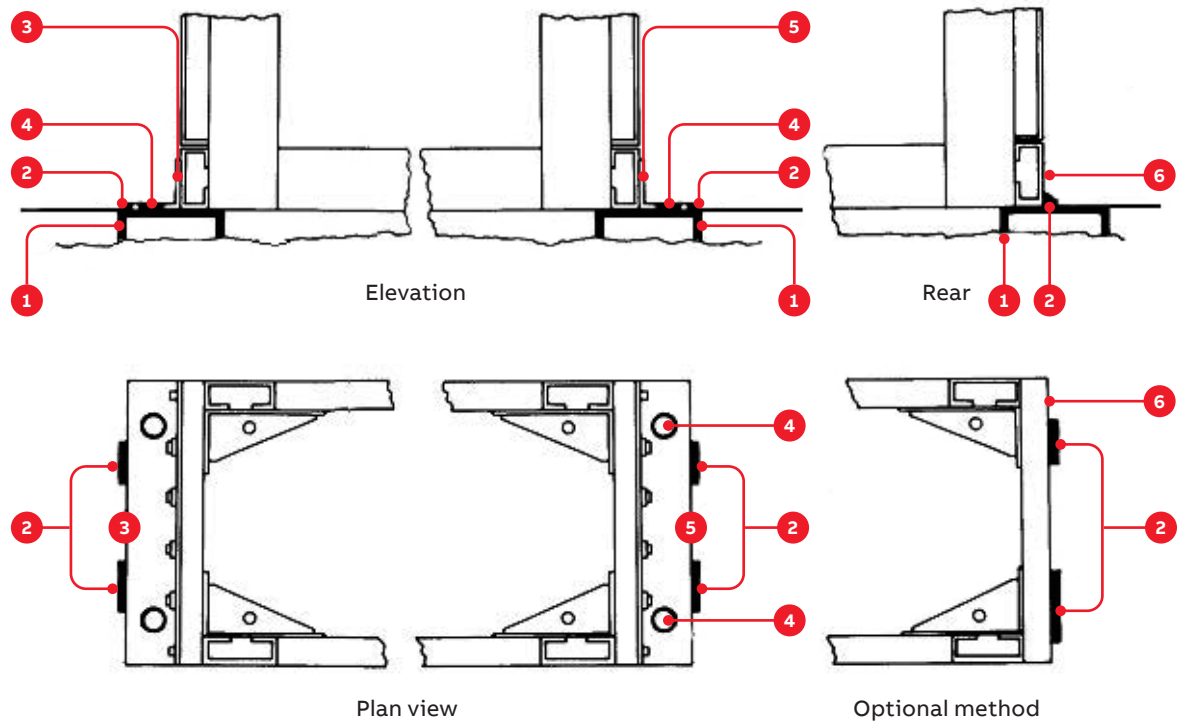
—
Mounting arrangement



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Plan view

—
63
Indoor equipment
weld anchoring

—
64
Spectra series® busway
mounting (front-entry)



1. Channel sills
2. 3/6 inch fillet weld
3. Front lag sill angle

4. Plug weld in anchor bolt hole
5. Rear sill angle
6. Rear width post

—
63

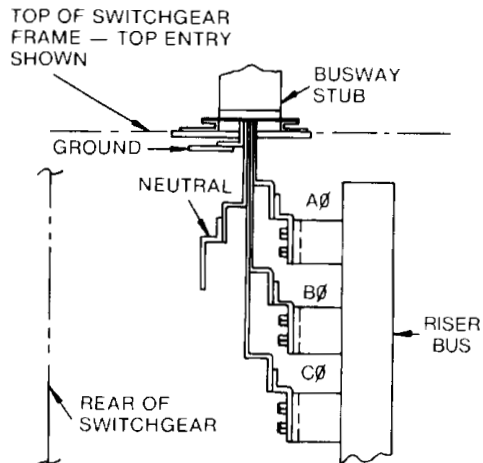
Busway connections

Busway runs must be aligned with openings in the equipment and connected to the mating components electrically and mechanically. A collar is mounted on the top of the equipment cable compartment to which is bolted the busway housing. See Figure 64. The 1/4-20 NC bolts, washers, and nuts for this mechanical connection are supplied with the busway stub. The bolts should be tightened with a torque of 7-9 ft-lbs.

The power conductors in the busway stub are designed to bolt directly to power connector blocks mounted on the switchgear riser bus bars. These connections are made with 1/2-13 NC bolts supplied with the switchgear equipment.

NOTICE

Notice: To maintain the minimum contact resistance across bolted bus joints, it is recommended that the joint contact surfaces be coated with a film of lubricating grease. A can of this grease is supplied with the equipment. Do not put grease on the bolt threads as this will affect the clamping force exerted by the bolt.



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64

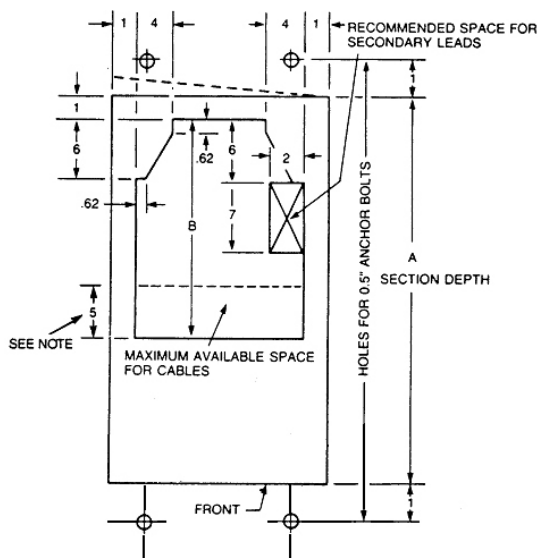
Control wire connections

For external control wiring, refer to Figure 65 for switchgear cable area dimensions, and connect the control wires to the switchgear sections as follows:

1. When control conduits enter the switchgear from below, they should not extend more than one inch above the floor. The control wires may be pulled through the conduits before or after the switchgear is installed.

65
Control wire entry space
(indoor enclosure)

2. Route the control wires from the conduits through the wiring trough (cross-hatched area - 2" x 7"-shown on Figure 65) at the side of the cable compartment. Connect the cables to the terminal blocks in accordance with the connection diagrams for the equipment.
3. If the control conduits enter from above, drill the top cover within the available space indicated. See Figure 65. Control wires should be routed to the wiring trough and connected to the terminal blocks as described previously.



65

NOTICE

Notice: On 49W sections, recommended space for secondary leads is located 6" closer to rear and oriented towards the rear.

Table 5 - Floor plan

Stack Width	Equipment Depth "A" (inches)	Direction of Leads	"B" (inches)
15, 22, 30, 38	54"	Below	19
		Above	24
	60"	Below	25
		Above	30
	67"	Below	32
		Above	37
	74"	Below	39
		Above	44
49	67"	Below	19
		Above	24
	74"	Below	26
		Above	31

Power cable connections

Connect the main cables to the main lugs. Before any main cable connections are made, the cables should be identified to indicate their phase relationship with the equipment. Adequate electrical and mechanical clearances must be provided between conduit, cables, and bus. Where the cables enter the section, they can be lashed to optional cable supports at the rear of the cable compartment as required.

Mechanical cable terminals are normally included with the switchgear (compression terminals are supplied when ordered) and are mounted at the ends of the breaker runbacks in the cable compartment. Carefully follow the cable manufacturer's recommendations for installation of cable.

Install the cables in the proper path to the terminals, using temporary lashing if required. Cut the cables to the proper length. Strip the insulation to the desired dimension, being careful not to damage any strands.

For copper cables, coat the wires with lubricating grease, insert the cables into the terminals, and tighten the set screws in accordance with torque values shown in the torque value table for cable terminals in the addendum of this manual. See Appendix A, Table A.2.

For aluminum cables, wire brush the wire strands thoroughly. Immediately after wire brushing, coat the cable strands with a quality oxide inhibiting compound such as Penetrox A. Insert exposed wires into the terminals and tighten the set screws in accordance with values shown in the torque Table A.2 in Appendix A of this Instruction Book.

CAUTION

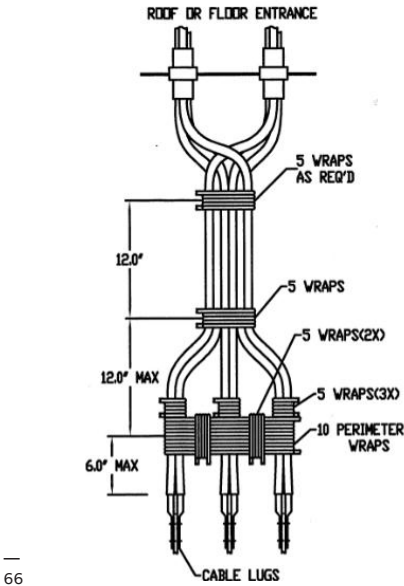
Caution: The torque values shown in the table are for dry threads only. Do not grease or otherwise lubricate the threads on the cable terminals as this will permit over-tightening of the screw and possible damage to the terminal or cable.

- 66
Typical cable lashing
- 67
Breaker lifting device assembly (indoor equipment)
- 68
Carton containing breaker lifting device

This should result in the oozing of compound material from between individual strands. Wipe off any excess compound.

Bolt the cable terminal connectors to the ends of the bars in the cable compartment. A non-oxidizing grease should be used at these connection surfaces. The bolts should be tightened in accordance with values shown in the torque Table A.2 in Appendix A of this instruction book.

Lash the cables securely to the cable support, if present, to take their weight off the runbacks and to brace them against short circuit forces in the event of a fault.



66

Cable supports can be optionally ordered from the factory. The following instructions for cable lashing should be used as a guide and Figure 66 details a typical cable lashing diagram. Run and bend the main cable in a most convenient orientation, making sure the main cable has been located directly up against any cable braces (if present) before it connects to the main cable terminals. Using a 3/8 inch diameter continuous nylon rope or equivalent (minimum 2000 pounds tensile strength) at 6 inches from the main cable terminals, make five revolutions around the "A" and "B" phase main cables, making sure the rope does not overlap.

Make five revolutions around the "B" and "C" phase main cables. With the remaining rope, wrap around the main cable lashing between the "B" and "C" phase and the cable brace (if present) with a minimum of 5 revolutions getting as much revolutions as possible between the phases. Continue wrapping between the "A" and "B" phase around the main cable lashing and the cable brace (if present) with a minimum of 5 revolutions getting as much revolutions as possible between the phases. Securely tie off the remaining rope. Repeat this lashing at every 6-inch interval.

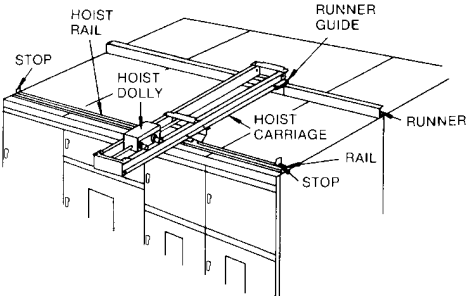
Relays and control devices

Remove all blocking on relays and devices as shown in the instructions accompanying the devices.

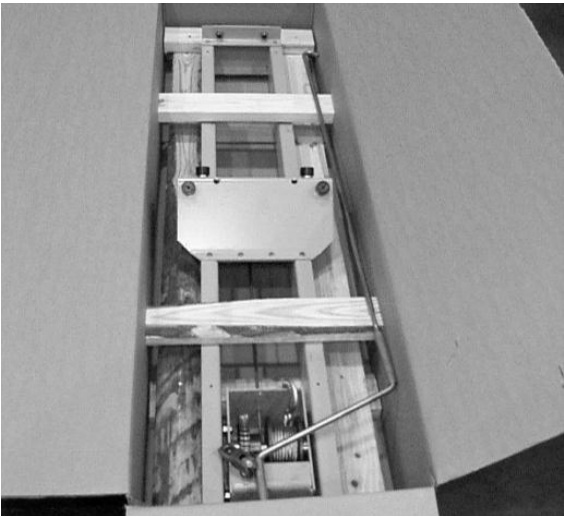
Breaker lifting device

Indoor equipment

Figure 67 shows the breaker lifting device assembled on indoor switchgear equipment. When supplied with indoor equipment, the breaker lifting device is shipped in a separate carton completely assembled, Figure 68.



67

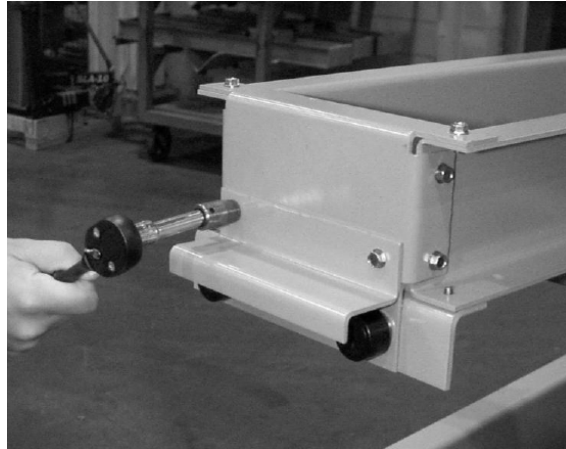


68

- 69 Removal of breaker lifting device runner guide
- 70 Location of breaker lifting device rear rollers
- 71 Front rollers positioned on front track
- 72 Replacing the runner guide after completion of breaker lifting device installation
- 73 Removing the bracket locking the dolly
- 74 Switchgear shipping split front splice plate

Before attempting to install the breaker lifting device assembly on the switchgear equipment, it is necessary to remove the runner guide from the breaker lifting device carriage as shown in Figure 69. Do not dispose of this guide since it must be reinstalled after mounting the breaker lifting device on the equipment.

NOTICE Notice: Maximum lifting capacity is 700 lbs.



69



71



72

The breaker lifting device should be lifted into position on top of the switchgear so that the end with two rollers is toward the rear of the



70

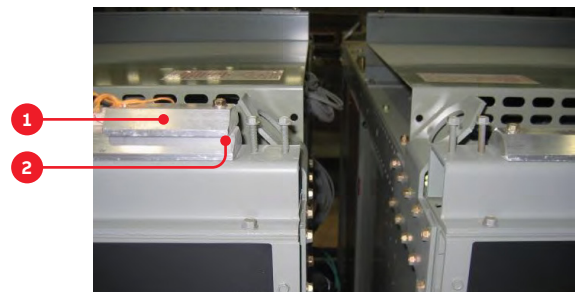
equipment, Figure 70.

The rear wheels can then be hooked under the channel and the front wheels can be positioned on the front track. See Figure 71. The runner guide at the rear should then be reassembled, Figure 72. Stop blocks are provided at each end of the front track to prevent the breaker lifting device from rolling off the ends of the track.



73

If the equipment has been shipped in sections, Figure 74, there are splice plates for the runner guide and breaker lifting device rail attached to each respective part.



- 1. Breaker lifting device rail splice plate
- 2. Splice plate mounting hardware

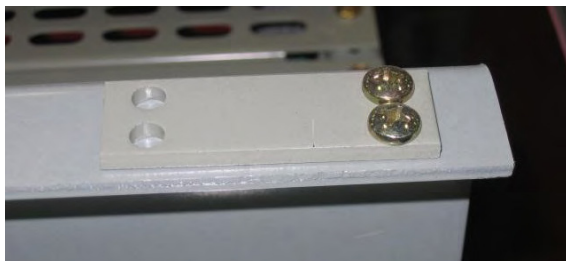
74

—
75
Switchgear shipping
split rear splice plate

—
76
Switchgear shipping
breaker lifting device
rail splice plate

—
77
Retaining clips used
for shipment

After the sections have been aligned and bolted together, on each shipping split section remove the bolt holding the splice plate to the breaker lifting device runner. Retain the splice plate and remove the remaining bolts, Figure 74, and reinstall bolts with splice plates in place. Figure 76 shows a typical breaker lifting device rail splice installed.



—
75

On the runner, there is also a splice plate held in place with two screws, Figure 75 shows a typical example. After the breaker lifting device rail splices have been installed, remove and retain the two screws holding the runner splice.

Remove the two screws that are on the other side of the shipping split. Place the runner splice over both sections of the shipping split and align the four mounting holes. Install the four screws that were previously removed.

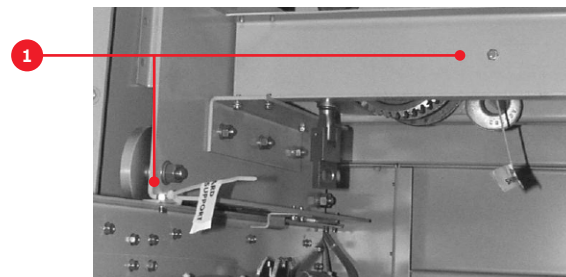


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76

After the splice plates have been installed, run the breaker lifting device over the assembled shipping split to check the alignment of the rail and runner. If necessary, adjust the rail and/or runner for smooth operation of the rollers on the breaker lifting device. On seismic rated equipment, it is necessary to remove the bracket locking the dolly on the breaker lifting device before the device can be used, Figure 73. Replace the bracket after breaker installation or removal is complete.

Outdoor equipment

When the breaker lifting device is provided with outdoor equipment, it is shipped mounted and secured in place. The shipping supports at either end of the breaker lifting device movable track must be removed. To free the dolly, remove the retaining clip used to keep it in place during shipment, as shown in Figure 77.



1. Retaining clips

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77

Final Inspection

Make a final inspection to see that no tools, construction materials, or other foreign matter have been left in the switchgear equipment.

Installing and removing circuit breakers

—
78
Rejection pin mounting
used in cradle

—
79
Rejection pin mounting
used on SACE Emax
2 circuit breaker

General

Inspection and preparation of circuit breakers

Before installing, operating, or removing a circuit breaker, refer to the applicable circuit breaker Installation, Operations and Maintenance Manual as listed in Appendix C for preparation, inspection, and test. Check thoroughly for damaged or loose parts and for any dirt or foreign matter which may be in the breaker.

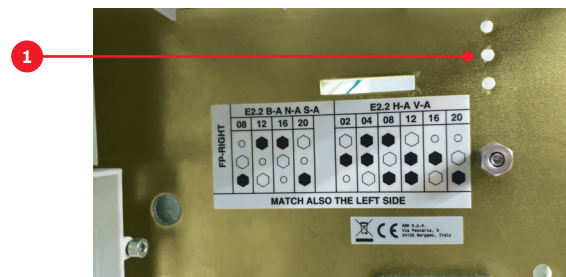
Circuit breaker installation

To install a circuit breaker, proceed as follows:

1. Before installing check the contact areas on each primary disconnect bar or cluster of fingers for foreign matter that may have accumulated. Clean these areas if necessary. Be sure that a thin film of lubricating grease (Reference 1SDH000999R0002 and 1SDH001000R0002 for lubricating grease details) covers the contact areas before putting a breaker in the compartment.
2. Check to see that the breakers match their respective compartments. Each breaker is assigned a part or mark number. This number is shown on the breaker sheets of the summary, the front view drawings, and on the identification card on the breaker shipping carton. The breaker may also be identified using the 20 digit catalog number.
3. To locate the breaker in the proper compartment, refer to the breaker location list on the front view drawing. Find the proper breaker by the identification card on the breaker carton. All identical breakers will have the same mark and catalog number.

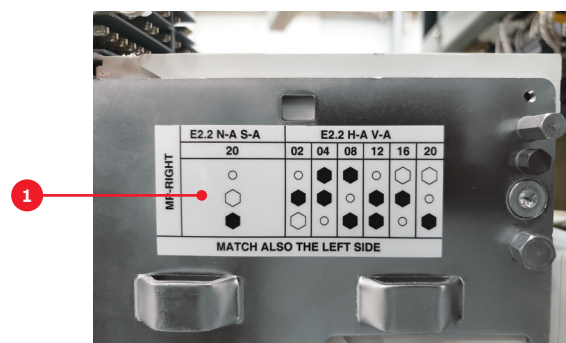
Rejection feature

Draw-out breakers of the same type and ratings are interchangeable in their equipment compartments. Draw-out breakers of different type or short-circuit rating are intentionally made noninterchangeable to prevent inserting the wrong type breaker into a draw-out compartment. Unique "rejection hardware" is affixed to each breaker and its cradle. When the wrong type breaker is inserted into a compartment, the pins on the breaker and in the cradle interfere, thus preventing the wrong breaker from being racked onto the primary stabs.



1. Example of cradle pins (not shown)

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78



1. Example of breaker pins (shown)

—
79

NOTICE

Notice: If a breaker is rejected by the rejection pins, check the breaker type and rating against the job drawing.

In addition to the rejection pins previously described, ReliaGear LV SG cradles will reject SACE Emax 2 E2.2, E4.2, and E6.2 circuit breakers which are not configured for cradle mounted kirklock interlocks if so equipped.

A non-kirklock ready E2.2, E4.2 or E6.2, SACE Emax 2 breaker will be equipped with a bracket on the lower right hand corner which will interfere with the cradle kirklock lever.

An E2.2, E4.2 or E6.2, SACE Emax 2 circuit breaker can be modified in the field such that it can be made cradle mounted kirklock ready thus removing the interference.

Please see 1SDH001000R0748 for guidance. A kirklock ready circuit breaker can be applied in a cradle that has no cradle mounted kirklock interlock equipped without issue.

Installing the circuit breakers

Prior to installation

Prior to lifting a breaker to its intended compartment location, observe the following precautions:

1. Check the compartment to ensure that it is free of foreign objects.
2. Verify that the breaker is the correct type for that compartment.
3. Ensure that the breaker is OPEN.
4. Apply a thin fresh coat of lubricating grease (Reference 1SDH000999R0002 and 1SDH001000R0002 for lubricating grease details) to the breaker's primary disconnects.
5. Ensure that the position indicator on the circuit breaker is in the DISCONNECTED position and is correctly positioned for initial engagement. To do this, open the racking handle door and insert the racking handle and rotate it fully counter-clockwise.

Installation procedures

To install the SACE Emax 2, E1.2 circuit breaker, proceed as follows:

1. Carefully place the circuit breaker in front of the section in which it is to be installed.
2. Open the breaker compartment door by rotating the door latch assembly ¼ turn clockwise.
3. Slide the circuit breaker onto the lifting tray.
4. Pull the locking pin back and insert the safety interlock bar through the square opening on the left side of the tray and circuit breaker, as shown in Figure 80 . Release the locking pin into the interlock bar groove, as shown in Figure 81.

⚠ CAUTION

Caution: Ensure the interlock bar is fully inserted through the tray and the circuit breaker, locking the two subsystems together for a safe lifting means.

5. Open the breaker compartment door by rotating the door latch assembly ¼ turn clockwise.
6. On the cradle, turn the plate 90 degrees before inserting the moving part. Check the signaling device on the cradle indicates the DISCONNECT position.
7. Attach lifting beam, catalog number 31026599250A001, to the side of the lifting tray as shown in Figure 82 .

⚠ CAUTION

Caution: When using the switchgear breaker lifting device, do not unwind the cable completely from the drum. To lift the breaker, turn the device operating crank clockwise. To lower the breaker, turn the device crank counterclockwise.

8. Using the switchgear breaker lifting device or a suitable lifting mechanism and the appropriate lifting beam, raise the circuit breaker to the desired compartment location and push the circuit breaker into the cradle until the safety interlock, located on the left side as shown in Figure 82, is engaged with the circuit breaker.
9. Pull the locking pin back and extract the safety interlock bar from the lifting tray and circuit breaker. Remove the lifting beam and lifting tray.

—
80
Emax E1.2 safety
interlock bar assembly
components

—
81
Emax E1.2 safety
interlock bar assembled

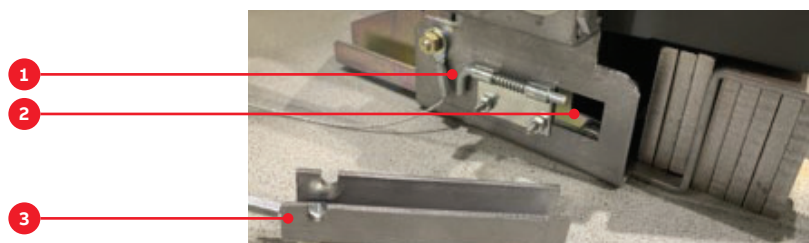
—
82
Attaching lifting beam
to SACE Emax 2 E1.2
circuit breaker

10. Move the circuit breaker into the compartment to the DISCONNECT position. If an incorrect breaker has been installed, the interference pins on the breaker will interfere with the rejection pins in the cradle prior to reaching the disconnect position.

11. Close the compartment door and rotate latch $\frac{1}{4}$ turn counterclockwise.

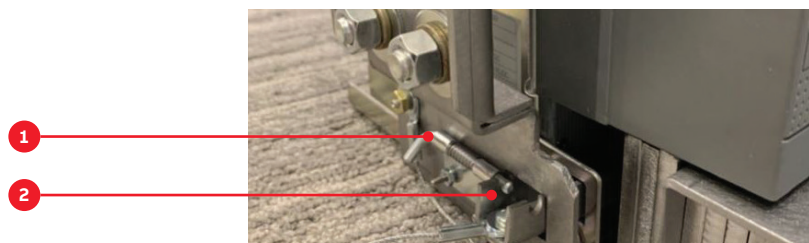
12. Engage the racking handle by pressing the “Push to operate” button to open the racking shaft door, then insert the manual racking handle.

13. Rotate the handle clockwise as far as it will go. As you rotate the handle clockwise, the breaker will travel from the DISCONNECT position to the TEST position. The SACE Emax 2 racking mechanism provides a positive position interlock which disables the racking mechanism at each of the positions (CONNECT, TEST and DISCONNECT). Therefore, once reaching the TEST position, the racking mechanism will be locked out; to proceed to CONNECT, again press the “Push to operate” button and resume turning the racking handle as far as it will go. The breaker position can be seen on the indicator, located on the cradle escutcheon.



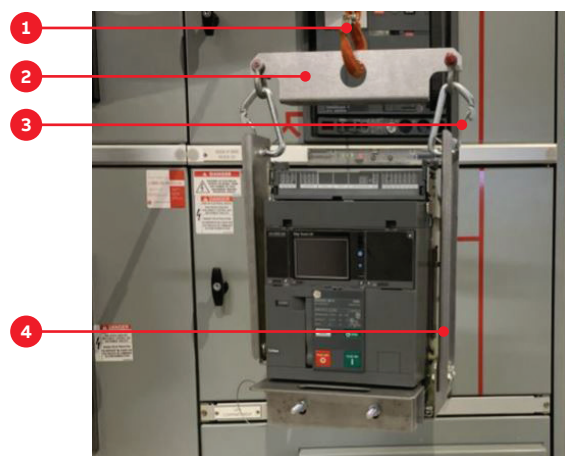
1. Locking pin
2. Safety interlock bar
3. Square opening in lifting tray

—
80



1. Locking pin
2. Interlock bar groove

—
81



1. Breaker lifting device hook
2. Lifting beam
3. Carabineer
4. Circuit breaker lifting tray

—
82

Removing the circuit breakers



WARNING

Warning: Do not stand under the circuit breaker during the lowering operation.



CAUTION

Caution: When using the switchgear breaker lifting device, do not unwind the cable completely from the drum. To lift the breaker, turn the device operating crank clockwise. To lower the breaker, turn the device operating crank counterclockwise.

To remove the SACE Emax 2, E1.2, circuit breaker, proceed as follows:

1. Open the breaker by pressing the OFF/OPEN button.
2. Press the “Push to operate” button to enable the racking mechanism and insert the racking handle. Rotate the handle counterclockwise until the breaker travels from CONNECT to TEST, as shown by the position indicator. Upon reaching TEST, again press the “Push to operate” button to enable the racking mechanism and resume turning the handle counterclockwise until reaching DISCONNECT. This operation should be performed with the door closed. If the breaker closing spring is fully charged, press the “Discharge” button to discharge the energy.

83
Attaching lifting
beam to SACE Emax
2 E2.2, E4.2, and E6.2
circuit breakers

3. Open the compartment door and move the breaker out until the cradle safety interlock prevents further movement. This is the WITHDRAWN position. The SACE Emax 2 circuit breaker has an interlock which prevents the breaker from being able to move to the WITHDRAWN position if the breaker’s mechanism spring is in the Charged state.
4. Insert the lifting tray and lifting beam into place, as shown in Figure 82.
5. Pull the locking pin back and insert the safety interlock bar through the square opening on the left side of the tray and circuit breaker, as shown in Figure 80. Release the locking pin into the interlock bar groove, as shown in Figure 81.

CAUTION

Caution: Ensure the interlock bar is fully inserted through the tray and the circuit breaker, locking the two subsystems together for a safe lifting means.

6. Unlock the cradle safety interlock and pull the circuit breaker forward until the primary disconnects clear the compartment.
7. Lower the circuit breaker onto a flat surface.
8. Close the breaker compartment door. If the circuit breaker will be removed from the compartment for an extended period of time, an optional dead front cover, catalog number 3100323960A001, may be ordered and installed to prevent access to live conductor parts.

To install the E2.2, E4.2 or E6.2, SACE Emax 2 circuit breaker, proceed as follows:

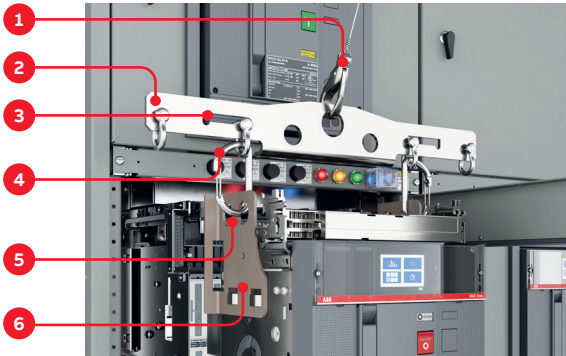
1. Carefully place the breaker in front of the section in which it is to be installed.
2. Open the breaker compartment door by rotating the door latch assembly ¼ turn clockwise.
3. Attach the appropriate lifting beam, Table 6, to the circuit breaker's lifting plates as shown in Figure 80. The carabineers of the lifting beam should be securely closed on the circuit breaker's lifting plates. See 1SDH001000R0002 for guidance on proper use of the circuit breaker's lifting plates.

CAUTION

Caution: When using the switchgear breaker lifting device, do not unwind the cable completely from the drum. To lift the breaker, turn the device operating crank clockwise. To lower the breaker, turn the device operating crank counter-clockwise.

NOTICE

Notice: E2.2 and E4.2 circuit breakers share a common lifting beam. The lifting beam has two unique positions for the carabineers to properly lift each of these circuit breakers as detailed in Figure 83.



1. Breaker lifting device hook
2. Lifting beam
3. E2.2 carabineer position (shown)
4. E4.2 carabineer position
5. Carabineers
6. Circuit breaker lifting plates

Table 6 - SACE Emax 2 lifting beams

Catalog number	Poles	Stack Width	Description
31017251275A001	3	Any	E2.2/E4.2 lifting beam
31017252934A001	3	38	E6.2 Lifting Beam
31017252934A002	3	49	E6.2 ¹ Lifting Beam

1. 49W switchgear sections only

4. Using the switchgear breaker lifting device or a suitable lifting mechanism and the appropriate lifting beam, raise the breaker above the elevation of the cradle draw-out rails.

WARNING

Warning: Do not stand under the circuit breaker during the lifting or lowering operation.

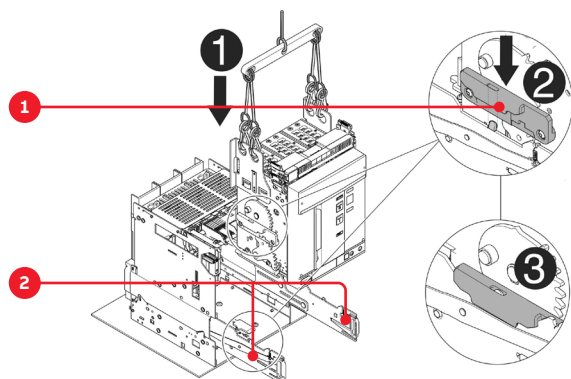
5. Engage the cradle rail release levers and withdraw the rails to their stop.
6. Slowly lower and guide the circuit breaker to align with the breaker compartment. Prior to lowering the circuit breaker onto the rails, be sure the breaker racking plate (see Figure 81), are aligned with the cradle draw-out rails.

—
84
Alignment of SACE
Emax 2 circuit breaker
with cradle

—
85
Using breaker lifting
device and lifting
beam to raise or lower
circuit breaker

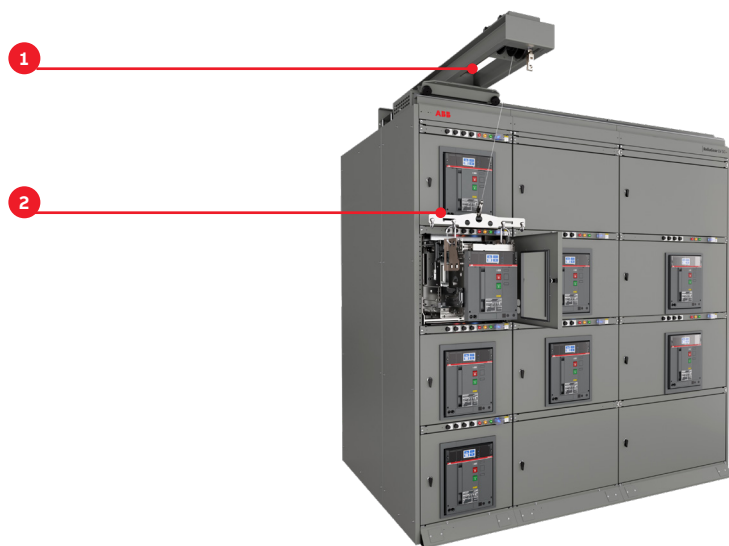
—
86
Engage the racking shaft
with the racking handle

7. With both sides of the circuit breaker aligned with the grooves in the cradle, slowly lower and guide the breaker to allow the racking plates on both sides to align with the rails. See Figure 84 and 85. Remove the lifting beam and the breaker lifting plates. The breaker is now positioned on the draw-out rails.



1. Breaker racking plate
2. Cradle draw-out rails

—
84



1. Switchgear breaker lifting device
2. Lifting beam

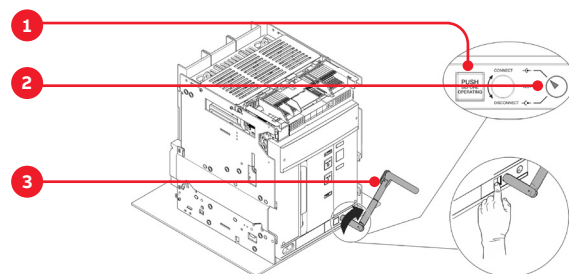
—
85

8. Move the breaker into the compartment to the DISCONNECT position. If an incorrect breaker has been installed, the interference pins on the breaker will interfere with the rejection pins in the compartment prior to reaching the disconnect position.

9. Slide rails back into compartment. Close the compartment door and rotate latch ¼ turn counter-clockwise.

10. Engage the racking handle by pressing the "Push to operate" button to open the racking shaft door, then insert the manual racking handle. See Figure 86.

11. Rotate the handle clockwise as far as it will go. As you rotate the handle clockwise, the breaker will travel from the DISCONNECT position to the TEST position. The SACE Emax 2 racking mechanism provides a positive position interlock which disables the racking mechanism at each of the positions (CONNECT, TEST and DISCONNECT). Therefore, once reaching the TEST position, the racking mechanism will be locked out; to proceed to CONNECT, again press the "Push to operate" button and resume turning the racking handle as far as it will go. The breaker position can be seen on the indicator, located on the circuit breaker front cover.



1. "Push to operate" racking mechanism button
2. Breaker position indicator
3. Racking handle

—
86

Removing the circuit breakers



WARNING

Warning: Do not stand under the circuit breaker during the lowering operation.



CAUTION

Caution: When using the switchgear breaker lifting device, do not unwind the cable completely from the drum. To lift the breaker, turn the device operating crank clockwise. To lower the breaker, turn the device operating crank counter-clockwise.

To remove the SACE Emax 2 circuit breaker, proceed as follows:

1. Open the breaker by pressing the OFF/OPEN button.
2. Press the "Push to operate" button to enable the racking mechanism and insert the racking handle. Rotate the handle counterclockwise until the breaker travels from CONNECT to TEST, as shown by the position indicator. Upon reaching TEST, again press the "Push to operate" button to enable the racking mechanism and resume turning the handle counterclockwise until reaching DISCONNECT. This operation should be performed with the door closed. If the breaker closing spring is fully charged, press the "Discharge" button to discharge the energy.

3. Open the compartment door and fully extend the draw-out rails. Move the breaker out until the rail stops. This is the WITHDRAWN position. The SACE Emax 2 circuit breaker has an interlock which prevents the breaker from being able to move to the DISCONNECT position if the breaker's mechanism's spring is in the Charged state.
4. Attach the breaker lifting plates, the lifting beam and lifting device securely and raise breaker off draw-out rails.
5. Push the draw-out rails back into the compartment.
6. Pull the breaker forward until the primary disconnects clear the compartment.
7. Lower the breaker onto a flat surface free of protrusions that could damage the breaker's internal parts.
8. Close the breaker compartment door. If the circuit breaker will be removed from the compartment for an extended period of time.

An optional dead front cover may be ordered and installed to prevent access to live conductor parts. Refer to Appendix D for ordering information.

Testing and inspecting

General

After the equipment has been installed and all connections made, it must be tested and inspected before it is put in service. Although the equipment and devices have been tested at the factory, a final field test must be made to be sure that the equipment has been properly installed and that all connections are correct.



WARNING

Warning: The equipment must be completely de-energized while the tests are in progress.

Directions for testing relays, instruments, and meters are given in the instruction book furnished for each device. The proper settings of the protective relays and circuit breaker trip units are normally determined from a complete power system coordination study performed by the purchaser or their consultant; therefore, the settings of these devices must be made by the purchaser. When the equipment is shipped from the factory, the time dial of all inverse-time induction disc relays (i.e., IFC types) is set to zero to prevent contact bounce during transportation.

NOTICE

Notice: The trip setting adjustments of the trip unit for each circuit breaker may be at any setting when shipped from the factory and must be correctly set prior to energization of the equipment.

General instructions for setting the relays are given in the applicable Relay or Trip Unit Instruction Book. The extent of the tests on the equipment as a whole will depend on the type and function of the equipment. Tests which should be performed, however, include circuit breaker operation, and switchgear meggering, phasing, and grounding checks.

High-potential tests to check the integrity of the insulation are not necessary if the installation instructions are carefully followed. If local codes demand this test, or the purchaser wishes to make high-potential tests, the voltage should not exceed 75 percent of the IEEE factory test voltage. For the power circuit, the IEEE factory test voltage is two times switchgear rating plus 1,000 volts. See Table 7. Potential and control power transformers must be disconnected during highvoltage testing.

Table 7 - Factory high potential test values

Switchgear voltage rating	ANSI test voltage, ac RMS	Field test voltage, ac RMS
600V	2200V	1650V
480V	1960V	1470V
240V	1480V	1110V

Key interlocks

After initial installation of the switchgear equipment, all necessary interlock keys should be inserted into the appropriate locks and all spare keys should be stored in a location in accordance with the owner's established procedures.

Caution: Refer to the key interlock schematic included in the summary furnished with the equipment to determine the sequence of operation and the correct number of operating keys required. This precaution is necessary since the improper use of spare keys will defeat the interlocking scheme.

Breaker operation test

All compartments housing SACE Emax 2 circuit breakers have a TEST position in which the breaker primary contacts are disconnected while the secondary contacts are still engaged. This TEST position permits complete testing of the electrical control circuit without energizing the primary power circuit. When the breaker is first put into service, its control circuit must be thoroughly tested while in this position to make sure that all closing and tripping circuits are complete and functioning properly. The TEST position is not suitable for inspection and maintenance of the breaker and should therefore be used only for testing breaker operation. Refer to the appropriate breaker instruction manual for other preoperational checks on the breakers. See 1SDH001000R0002.

SACE Emax 2 trip units

The complete trip system is comprised of the following components:

1. Solid-state Trip Unit with rating plug
2. Phase Current Sensors
3. Flux Shift Magnetic Trip Device
4. When applicable, a Neutral Sensor for units containing a Ground Fault Trip element.

All components, except the Neutral Sensor, are integrally mounted in the circuit breaker. When used, the Neutral Sensor is separately mounted in the bus or cable compartment of the switchgear. In draw-out construction, it is automatically connected to the trip unit in the breaker via a draw-out secondary disconnect terminal.



Caution: Never disengage the trip unit on a breaker that is energized and carrying load current. This will open-circuit the current sensors, allowing dangerous and damaging voltages to develop.

Complete instructions for testing the trip units are included with the test set. The trip unit user manuals are 1SDH001330R1002.

Advanced Applications for SACE Emax 2 Protections (ReliaGear LV SG only)

Reduced energy let through (RELT) -The RELT functionality is achieved by leveraging the 2I protection of the SACE Emax 2 circuit breaker. The 2I tripping curve is designed to mitigate against arc flashes. This protection can be adjusted from 1.5 to 15 x I_n , with a maximum setting of 18kA. The clearing time of the 2I protection is between 25 and 42ms at 60Hz (+5ms for 50Hz). Easy activation and I/O assignment, including positive feedback, can be implemented using the RELT Ekip Signalling 2K-3 module.

To learn more about the feature, please see 9AKK107991A1097.

Prior to operation the 2I setting must be activated and NEC 240.87 requires field testing be completed for arc mitigation protections. Please see 9AKK107991A2520 for setup and test instruction.

For field testing of the RELT function:

- Step 1: Test position
Turn the RELT switch to the "TEST" position.
Observations to be made:
 1. Pilot lamp will glow
 2. Switch will return to the "NORMAL" state and the Pilot lamp will turn off
- Step 2: ON position
Turn the RELT switch to "ON" position.
Observations to be made:
 1. Pilot lamp will glow
 2. Switch will remain in "ON" position
 3. At the same time, the breaker trip unit will keep flashing "2I Protection Active"
- Step 3: Normal position
Turn the RELT switch back to "NORMAL" position.
Observations to be made:
 1. Pilot lamp will turn off and at that point there will not be any indication on the breaker trip unit

For general wiring diagrams please see 1SDM000019A1002.

For further wiring guidelines, please see 1SDH001330R100.

For specific wiring diagrams related to your order, please review the As-Built documentation.

Zone selective interlocking (ZSI) - ZSI to be used to minimize circuit-breaker trip times closer to the fault. The protection is provided by connecting all the zone selectivity outputs of the trip units belonging to the same zone and taking this signal to the trip unit input that is immediately upstream. Each circuit breaker that detects a fault reports it to the circuit breaker upstream; the circuit-breaker thus detects the fault but does not receive any communication from those downstream and opens without waiting for the set delay to elapse. It is possible to enable zone selectivity if the fixed-time curve has been selected and the auxiliary supply is present.

Prior to operation ensure that breakers utilizing ZSI protection are properly configured and NEC 240.87 requires field testing be completed for arc mitigation protections. Please see [9AKK107991A2521](#) for setup and test instructions.

For specific wiring diagrams related to your order, please review the As-Built documentation.

Modified Differential Ground Fault (MDGF) - For each breaker in a MDGF protection scheme the equipment is fashioned with corresponding compartment mounted phase current transformers, neutral mounted current transformer, a compartment mounted summing current transformer and a secondary disconnect terminal block. The summing current transformers are interconnected to form a loop with an output connected to the secondary disconnect terminal block of the circuit breakers.

For generic wiring diagram, please see [1SDM000019A1001](#).

To ensure proper functionality the following wiring limitation are adhered to:

- Phase and neutral current transformers to primary side of auxiliary current transformer wire to be 14 AWG, twisted pair with a maximum one-way length of 30 ft.
- Summing to summing current transformer wiring to be 14 AWG, twisted pair with a maximum loop length of 31,000 ft.
- Summing current transformer to secondary disconnect terminal wiring to be 16 AWG, twisted pair with a maximum one-way length of 49 ft.

CAUTION

Caution: To ensure intended functionality of a given breaker within the MDGF scheme, the breaker rated current, rating plug and phase & neutral current transformers shall have matching primary current ratings. The summing current transformer's primary current rating is to match the secondary current rating of the phase & neutral current transformers.

NEC 240.95 requires that all ground fault protection schemes be performance tested prior to going into service. For field testing procedures please see [1VAL006401-HT](#).

For specific wiring diagrams related to your order, please review the As-Built documentation.



Cooling fan control module

General

ReliaGear LV SG may be provided with a front-mounted auxiliary ventilation compartment for 5000 A and 6000 A applications, Figure 87. A system with five fans is shown. Other configurations may utilize three fans.

The SACE EMAX 2 circuit breaker compartment is provided with an integrally mounted cooling fan system. The cooling fan system, when provided, is contained within a dedicated front-mounted auxiliary ventilation compartment below the circuit breaker. The dedicated front-mounted auxiliary ventilated compartment is constructed with grounded metal barriers on all sides resulting in a segregated compartment thus protecting operators from gases which may be vented by the breaker during circuit interruption. When a front-mounted auxiliary ventilation compartment contains a fan cooling system, the instrument tray directly above the front-mounted ventilation compartment will be provided with the components shown in Figure 88.

In ReliaGear LV SG 5000 A and 6000 A applications, the fan control is initiated by the "Alarm Warning lw1" feature of the trip unit which signals a fan control circuit to turn the fans on or off. Refer to Figure 89 for a typical fan cooling circuit diagram.

The fan control circuit requires 120Vac control power, which is normally provided by the switchgear control power transformer, and a 24Vdc power supply. The power requirements for each fan is 0.7 amps @ 24Vdc. For 5000 A applications, five fans may be installed. For 6000 A applications, three fans will be installed.

Remote monitoring of the fan control circuit is optionally available.

NOTICE

Notice: Variations of the fan control circuit may be provided. Operators should review and understand the As-built documents provided with the equipment from the factory to confirm final fan control circuitry.

Table 8 provides the current threshold values that EKIP Touch or Hi-Touch trip unit's "Alarm Warning lw1" function should be programmed to initiate the fan cooling system.

Refer to the Cooling Fan Installation and Trip Unit Programming Guide 1VAL106902-MB for more information. Load reduction contacts are provided within the equipment section. These contacts are provided for customer connections as required by CSA C22.2 No 31-18 in the event of a cooling fan failure.

Operation of the switchgear, for an extended period, above the threshold limits shown in Table 8 without a properly working fan cooling system will not create an unsafe condition but is not recommended.

Table 8 - Current alarm 1 settings for cooling fan system

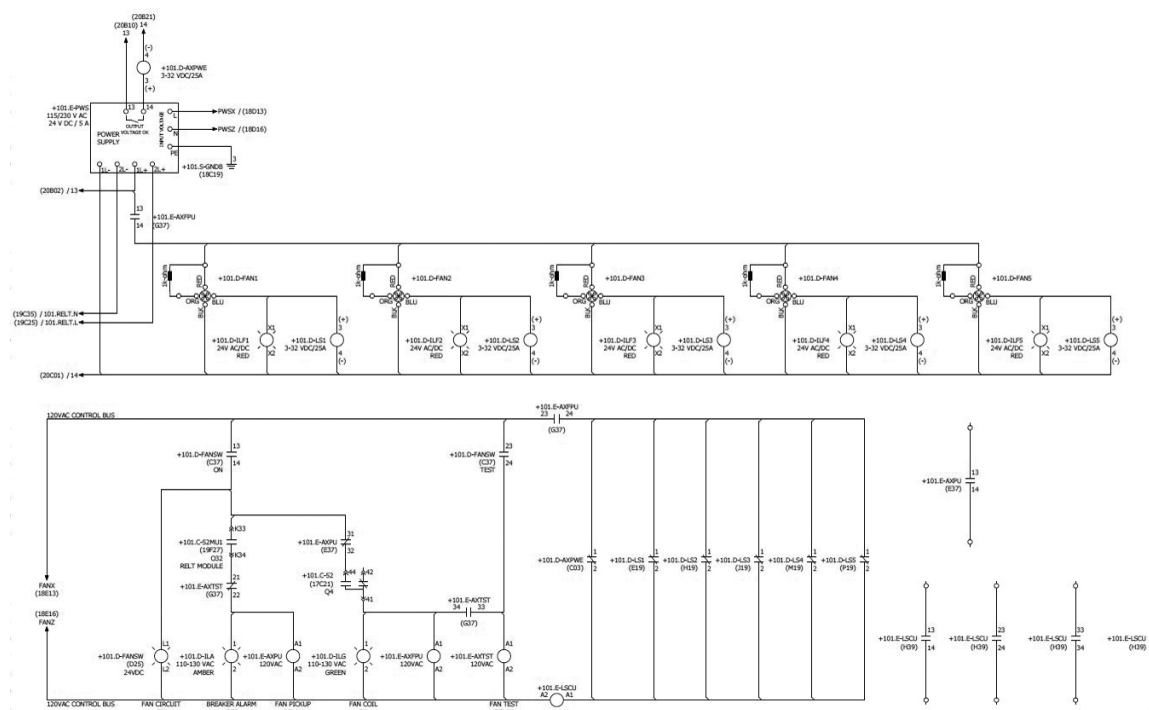
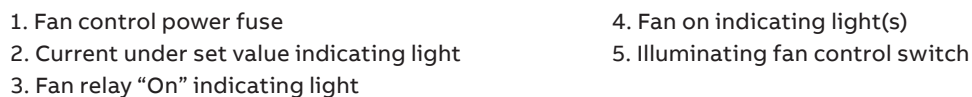
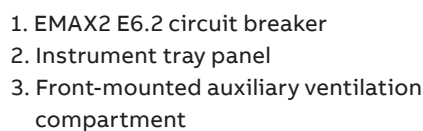
Circuit breaker	Section width	Current threshold (A)	Alarm warning lw1
			Up set point
E6.2	38	4400	0.88
E6.2 ¹	49	5200	0.86

1. 49W switchgear sections only.

NOTICE

Notice: The circuit breaker(s) referenced in Table 8 must be configured with the "Alarm Warning lw1" trip unit option and this function must be set per Table 8 for proper operation of the fan cooling system.

89
ReliaGear Low-voltage
Switchgear cooling
fan control circuit



Operation

A three position Illuminated Fan Control Switch, Figure 88, is provided to allow an operator to select the mode of operation for the cooling fan system. The fan control switch is provided with a pad-lockable hasp to allow an operator to lock-out/tag-out the fan control switch. The three positions of the fan control switch are “OFF”, “ON” and “TEST”. The “TEST” position of the fan control switch is a momentary position.

OFF operating mode

This operating mode may assist with an operator trouble-shoot or perform maintenance on the fan cooling system.

With the Illuminated Fan Control Switch in the “OFF” position, the 120Vac control power to the fan cooling system is not available except for the line side of the Fan Control Power Fuse and the Illuminated Fan Control Switch. All indicating lights will be off.

ON operating mode

With the Illuminated Fan Control Switch in the “ON” position, the 120Vac control power to the fan cooling system is available. The fan control switch itself will be illuminated and the fan cooling system is ready to respond as necessary. This is the normal operating mode for the fan cooling system.

If the current exceeds the values shown in Table 8 for 60 seconds, the amber Current Under Set Value Light will not be illuminated. The red Fan Relay On Indicating Light will be illuminated. If the fans are operating normally, each white Fan On Indicating Light will be illuminated. If a fan is rotating below its nominal value, then a failure has occurred and the white Fan On Indicating Light corresponding to that fan will not be illuminated. When a fan failure is detected, load shedding will occur.

If the current drops below the values shown in Table 8 for 60 seconds, the amber Current Under Set Value Light will be illuminated. The red Fan Relay On Indicating Light and all white Fan On Indicating Lights will be off.

Test operating mode

With the Illuminated Fan Control Switch held in the “TEST” position, an operator can perform a functional test on the fan cooling system without having to exceed the values shown in Table 8. While the Illuminated Fan Control Switch is held in the “TEST” position, the following events will indicate a healthy fan cooling system.

- Amber current under set value indicating light is not illuminated
- Red fan relay on indicating light is illuminated
- Each white fan on indicating light is illuminated

If the amber Current Under Set Value Indicating Light is illuminated, check to see if there is a problem with the fan control switch or with the EKIP signaling module or the AXTST relay. If the red Fan Relay On Indicating Lamp did not illuminate, check to see if the Fan Relay is operating properly.

If any of the white Fan On Indicating Lamps are not illuminated, check to see if the fan itself has failed. Refer to 1VAL106902-MB for instructions on how to replace a cooling fan.

NOTICE

Notice: Each cooling fan has a built-in alarm that indicates if the fan's speed has dropped to 40% of its maximum speed. The white Fan On Indicating Light will turn off if the fan's speed drops below this value.

Load shedding event

For a fan failure event, load shedding will occur. Two possible causes include:

1. Fan Speed Failure (Ex: Rotor is stuck, debris on blades hindering fan operation, etc.)
2. DC Power Supply Failure

If load shedding has occurred and one or more of the white Fan On indicating lamps are not illuminated, replace the corresponding fans. If load shedding has occurred and all the white Fan On indicating lamps are not illuminated, check to see if the green LED on the DC power supply is illuminated. If the green LED is not illuminated, there is a problem with the power supply, and it needs to be replaced.

If load shedding had not occurred but either a fan speed failure or DC power supply failure has occurred, check to see if the load shed relays are properly engaging.

Maintenance

Cooling fans have a lifetime of ~40,000 hours. It is recommended to inspect and test the fans once per year. To test the fans refer to the Test Operating Mode and Load Shedding Event sections above.

Operating the switchgear

Circuit breaker operation

General

Included below are abbreviated operating instructions for SACE Emax 2 circuit breakers. Before activation of the circuit breakers or operation of the switchgear equipment, thoroughly read and be familiar with the circuit breaker manuals which will be supplied as supplementary information to this manual. Publication references are listed in Appendix C.

Manually operated circuit breakers

Closing operation

Manually operated SACE Emax 2 circuit breakers are equipped with an integral charging handle and a push button marked "I" on the front of the cover. The spring must be charged first.

- A complete charge is accomplished by pulling the handle down about 90° (until it stops) ten times to fully charge the closing springs. This will not close the breaker contacts. The charge indicator will show CHARGED on a yellow background

Opening Operation

A mechanically operated open button marked "O" is mounted on the breaker front cover, operates the trip shaft to open the breaker.

Electrically operated circuit breakers closing operation

Electrically operated breakers may be closed by ac control power, or dc (normally station or standby battery) control power. Refer to the provided elementary diagrams for information on control circuitry.

Opening operation

A shunt trip device is used for electrical tripping and each breaker can have up to two shunt trip accessories installed.

Circuit breaker draw-out operation

Breaker positions

Refer to Figs. 90, 91, and 92. The draw-out operation features four positions:

1. Connected - In the CONNECTED position, the primary and secondary disconnects are fully engaged. The breaker must be opened before it can be racked out of this position.
2. Test - When in the TEST position, the primary contacts are disconnected, but the secondary contacts remain engaged. This allows complete breaker operation without energizing the primary circuit.
3. Disconnected - In the DISCONNECTED position, neither primary nor secondary contacts are made. Breakers may be racked between these three positions with the compartment door closed and latched.
4. Withdrawn - With the door open, the breaker can be rolled out manually from the DISCONNECTED to the WITHDRAWN position. Here, the breaker is completely out of its compartment, ready for removal.

- 90
Breaker shown in
CONNECT position
- 91
Breaker shown in
TEST position
- 92
Breaker shown in
DISCONNECTED position

Draw-out operation

E1.2 circuit breakers rest within the floor of the cradle.

Motion is provided by a mechanism mounted on the right-hand side of the cradle. This mechanism drives racking cams which engage pins anchored to each side of the breaker. The cams are driven by a removable racking handle which engages the mechanism. The handle is inserted through an opening in the cradle escutcheon to the right of the breaker.

E2.2, E4.2 and E6.2 circuit breakers are supported on the draw-out rails mounted on the side walls of the cradle. On SACE Emax 2 breakers, a racking plate on each side of the breaker rest on each draw-out rail.

Motion is provided by a mechanism mounted on the bottom of the breaker. This mechanism drives racking gears which engage components anchored to each side of the cradle. The racking mechanism is driven by a removable racking handle or remote racking device (see 1SXU200040C0201 for RDD ordering details), which engages the mechanism. The handle is inserted through an opening in the cradle escutcheon.

Turning the handle in a clockwise direction drives the breaker into the compartment. As the breaker disconnect fingers engage the stab tips, a high force will be felt. Turn the racking handle until the position indicator clearly shows CONNECTED.



— 90



— 91



— 92

Front doors

Operation

The front access doors on all standard switchgear are hinged and equipped with a ¼-turn latch, Figure 93. To open the door, rotate the knob clockwise ¼ turn.

Removal and installation

Refer to Figure 94 and remove/install switchgear front doors.

—	93	Switchgear front access doors
—	94	Front access door details
—	95	Future circuit breaker compartment

Door removal

To remove the switchgear door, proceed as follows:

1. Open door. See Figure 93 for overall switchgear front doors.
2. Loosen the two screws holding the top hinge pin plate and allow the pin to drop out of the hinge block. See Figure 94.
3. Move the top of the door away from the switchgear, avoiding the door stop and lift the door out of the lower hinge pin socket. Retain the washers.

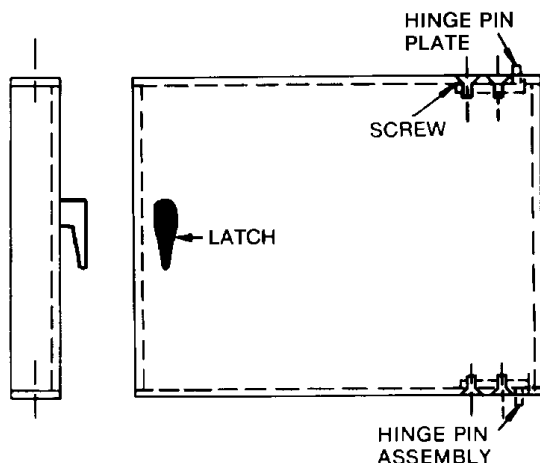
Door installation

To install the switchgear door, proceed as follows:

1. Insert washer, then place lower hinge pin into hinge pin socket on switchgear. See Figure 94.
2. Swing door open, position behind door stop and align hinge pin socket.
3. Insert the hinge pin into the hinge block and tighten two screws.
4. Close door.



—
93



—
94

Switchgear accessories

Future circuit breaker compartments

Breaker compartments designed for future use are complete and ready to use. These breaker compartments have a steel panel to cover the door cutout, Figure 95. To prepare the circuit breaker compartment for use, remove the steel outer cover.



Warning: Terminals behind the steel barrier may be electrically hot.



—
95

Circuit breaker key interlock

General

A circuit breaker key interlock is available to provide protection against unauthorized operation. E1.2, SACE Emax 2 circuit breakers may be equipped with a 1 key, circuit breaker installed solution, to prevent a circuit breaker closing operation and/or a 2 key, cradle installed, solution to prevent a circuit breakers racking operation.

E2.2, E4.2 and E6.2, SACE Emax 2 circuit breakers may be equipped with a 2 key, cradle installed, solution to prevent a circuit breaker closing operation and/or a 2 key, breaker installed solution, to prevent a circuit breakers racking operation. The cradle installed solution is mounted on the right-hand side sheet of the cradle as seen in Figure 96. A third option is available, providing a 1 key, circuit breaker installed solution, preventing a circuit breakers closing operation. For a summary of these details, refer to Table 9.

The typical interlock system is designed so that they key may be removed for the lock only when the breaker is tripped.

A cradle equipped with a key interlock system will reject a breaker that has not been properly configured for cradle mounted key interlock interaction. Said breaker will require modification, see instruction manual 1SDH001000R0748.

Table 9 - Breaker key interlock ordering details

Size	Key Quantity Supported	Function	Installed Location	Global code	
				Circuit Breaker Components	Cradle Components
E1.2	2	To prevent racking operation	Cradle	NA	1 st key, 1SDA073834R1 2 nd key, 1SDA073835R1
E2.2	2	To prevent racking operation	Cradle	1SDA114350R1	1SDA114353R1 1SDA114349R1
E4.2	2	To prevent racking operation	Cradle	1SDA114351R1	1SDA114353R1 1SDA114349R1
E6.2	2	To prevent racking operation	Cradle	1SDA114352R1	1SDA114353R1 1SDA114349R1
E6.2 ¹	2	To prevent racking operation	Cradle	1SDA122916R1	1SDA114353R1 1SDA114349R1
E1.2	1	To prevent racking operation	Circuit Breaker	1SDA073789R1	NA
E2.2, E4.2 or E6.2	2	To prevent racking operation	Circuit Breaker	1 st key, 1SDA073818R1 2 nd key, 1SDA073819R1	NA
E2.2, E4.2 or E6.2	1	To prevent racking operation	Circuit Breaker	1SDA073798R1	NA

1. 49W switchgear sections only.

—
96
Key interlocks shown
in cradle mounted
accessory



—
96

Key interlock operation check

The operation of the key interlock should be checked as follows:

1. With the breaker in the CONNECT position, manually trip the breaker. This then allows the key interlock to activate a trip free status of the breaker. While the breaker is in the trip free state the key can be removed. The breaker will remain trip free until the key is returned and the lock rotated.
2. If desired, the breaker may be moved to either the TEST or DISCONNECT position while its held in a trip free position. In these positions, the breaker cannot be operated for checking or maintenance.

Please contact the factory for guidance on modifying the factory installed cradle mounted key interlocks.

Padlocking in CONNECT, TEST or DISCONNECT

The circuit breaker's racking mechanism can be padlocked to prevent access. The racking mechanism can be padlocked with the breaker in any position or without the breaker installed. Up to three padlocks of a diameter of 8mm can be used.

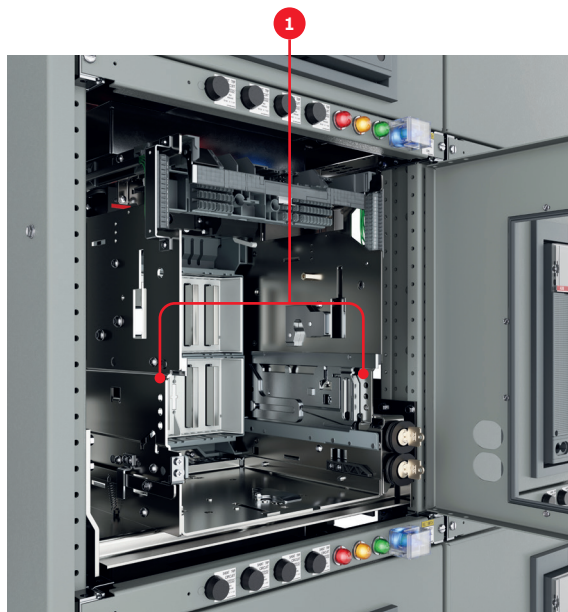
Padlocking the cradle

The circuit breaker compartment door must be opened to put the padlock on; however, there is no interference with the door after the padlock has been placed in position. Padlocks will prevent the acceptance of breakers in the cradle. The padlock device on the cradle will accept up to three padlocks on both the left and right sides of the cradle for E2.2, E4.2 and E6.2 SACE Emax 2 cubicles. See Figure 97.

For the E1.2 SACE Emax cubicle however, the padlock device on the cradle will accept up to three padlocks only on the left side of the cradle.

—
97
Compartment
padlock device for
E2.2, E4.2, and E6.2
circuit breakers

—
98
Shutter padlocking



1. Provisions for padlocks (not shown)

—
97

Padlocking the shutter

The shutter on each cubicle can be padlocked to prevent access to the live primary conductors. The breaker must be removed from the compartment to padlock the shutter. For E1.2, E2.2 and E4.2 cradles, a minimum of 2 padlocks are required (one for the top shutter assembly and one for the bottom shutter assembly).

For E6.2, a minimum of 4 padlocks are required (2 for the 2 top shutter assemblies and 2 for the 2 bottom shutter assemblies). See Figure 98 for reference on how to install a padlock on the shutter.

Removing the shutter unit

Refer to 1SDH001399R0717 for the E1.2 circuit breaker removal of the shutter units. Refer to 1SDH001400R0831 for full instructions on the removal of the shutter unit for E2.2, E4.2, and E6.2 circuit breakers.



WARNING

Warning: Unless the proper precautions are taken, the removal of a shutter unit presents the hazard of electrical shock and burn. Do not remove the shutter unit unless the equipment has been deenergized. Failure to do this can result in serious injury.



—
98

Installing the shutter unit

Refer to 1SDH001399R0717 for E1.2 shutter units. Refer to 1SDH001400R0831 for full instructions on installation of E2.2, E4.2 and E6.2 shutter units. Available shutter units are listed below in Table 10.

Table 10 - SACE Emax 2 shutter catalog numbers

Size	Type	Global ordering code
E1.2	shutter top or bottom, E1.2 FP 3p ReliaGear LV SG	1SDA114341R1
E2.2	shutter top or bottom, E2.2 FP 3p ReliaGear LV SG	1SDA114343R1
E4.2	shutter top. E4.2 FP 3p ReliaGear LV SG	1SDA114345R1
	shutter bottom. E4.2 FP 3p ReliaGear LV SG	1SDA114346R1
E6.2	shutter top. E6.2 FP 3p ReliaGear LV SG	1SDA114347R1
	shutter bottom. E6.2 FP 3p ReliaGear LV SG	1SDA114348R1
E6.2 ¹	shutter top and bottom, E6.2 ReliaGear LV SG	1SDA115930R1

1. 49W switchgear sections only



WARNING

Warning: Unless the proper precautions are taken, the installation of a shutter unit presents the hazard of electrical shock and burn. Do not install the shutter unit unless the equipment has been de-energized. Failure to do this can result in serious injury.

Energizing the switchgear

Before energizing

Before switchgear is energized, a thorough final check should be made using the following checklist.

Refer to section 6 for additional information.

- Breakers and other operating mechanisms exercised
 - Electrical insulation resistance tested phase-to-phase and phase-to-ground
 - Relays, meters and instruments properly connected
 - Electrically operated breakers and operating mechanisms exercised
 - Ground fault protection system tested
 - Adjustable trips properly set
 - Field wiring secured and free of live bus
 - Grounding connections made
 - All debris, scrap wire, etc. removed
 - All covers installed, doors closed and latched.
- Advanced application of SACE Emax 2 protections tested

Energizing procedures



Caution: Energizing switchgear for the first time is potentially dangerous. Therefore, qualified electrical personnel should be present when the equipment is energized. If problems caused by damage or poor installation practices have not been detected in the checkout procedure described previously, serious damage can result when power is turned on. There should be no load on the switchgear when it is energized.

Turn off all of the downstream loads, including those such as motor control centers and other devices which are remote from the switchgear. The equipment should be energized in sequence by starting at the source end of the system and working toward the load end. In other words, energize the main devices, then the feeder devices, and then the branch-circuit devices. Turn the devices on with a firm positive motion.

Maintaining the switchgear

Maintenance requirements

General

A periodic maintenance schedule must be established to obtain the best service from the switchgear. An annual check of the switchgear devices and all connections should be made as a minimum requirement. Equipment subject to highly repetitive operation may require more frequent maintenance. A permanent record of all maintenance work should be kept. The record should include a list of periodic checks and tests made, the date they were made, the condition of the equipment, and any repairs or adjustments that were performed. Maintenance employees must follow all recognized safety practices, such as those contained in NFPA 70B: Electrical Equipment Maintenance, and NFPA 70E: Standard for Electrical Safety in the Workplace and in company or other safety regulations.



WARNING

Warning: Solid insulation surrounding an energized conductor and power apparatus must never be relied upon to provide protection to personnel.

For specific information regarding the maintenance of devices, such as circuit breakers, relays, meters, etc., refer to the separate instruction book furnished for each device. Please see the applicable circuit breaker Installation, Operations and Maintenance Manual as listed in Appendix C.

Breaker and instrument compartments

Periodic inspection of the circuit breaker is recommended at least once a year. More frequent inspections are recommended where severe load conditions, dust, moisture or other unfavorable conditions exist, or if the vital nature of the load warrants it. Always inspect the breaker after a short-circuit current has been interrupted.

Wetted equipment

Electrical equipment exposed to water or other liquids can be extremely hazardous if re-energized without performing a proper evaluation and taking necessary actions. Reductions in the integrity of electrical equipment due to moisture can affect the ability of the equipment to perform its intended function. Damage to electrical equipment can also result from flood waters contaminated with chemicals, sewage, oil, and other debris, which will affect the integrity and performance of the equipment.

Ocean water and salt spray can be particularly damaging due to the corrosive and conductive nature of the saltwater residue. Do not energize equipment that is exposed to flood or other contaminated water or liquids. Consult ABB Field Services for guidance.

When equipment has become exposed to non-contaminated water observe the following points during maintenance:

- Completely de-energize the switchgear
- Carefully clean and wipe dry all parts of the switchgear
- Use of moving air and heaters is recommended to facilitate the drying process. When using heaters, make sure that temperature does not exceed 180° F
- Replace all fuses
- Inspect all individual devices for the entrance of water, dirt, or foreign matter. Consult device manufacture concerning cleaning, refurbishment and testing requirements
- Replace all wetted or flooded sealed devices and circuit breakers
- Before re-energizing the switchgear, perform all inspections defined in this document

In addition to these checks, use a megohm-meter to test the switchgear. Open all switchgear devices, remove all instrumentation and control fuses, and isolate the neutral from ground. All scraps of wire, plaster, dust, and other foreign material must be removed. Vacuuming is recommended. Use a megohm-meter developing 500 volts.

Conduct electrical insulation resistance tests from phase to phase, phase to ground, phase to neutral, and neutral to ground. If any switchgear tested under the above conditions shows resistance values less than 1 megohm, inspect it for possible tracking on insulation or insulation breakdown. If assistance or guidance is required, contact your local service engineer.

Your supplier's service shop may have facilities for reconditioning equipment and devices. Water soaked and wetted equipment will void the factory warranty.

Breakers

Test for proper operation

Test and inspect all circuit breakers for proper operation as follows:

1. Operate each breaker while in the TEST position and check all functions. This is particularly important for breakers that normally remain in either the opened or closed positions for long periods of time.



WARNING

Warning: Primary equipment must be completely de-energized while tests on control circuits, etc. are being conducted. Be sure that all areas of feedback from secondary circuits, as well as outside sources, are disconnected.

2. Remove the breakers from their compartments to a clean maintenance area. Close compartment door and cover the breaker cutout to prevent access to live parts.



WARNING

Warning: De-energize equipment completely before doing maintenance work on any devices, connections, bus work, breaker or feeder cable compartments. This includes de-energizing any connections to outside primary or secondary sources, such as transformers, tie lines, etc.

Checks after breaker is de-energized

At the time of inspection, the following checks should be made after the breaker has been de-energized.

1. Manually operate the breaker several times, checking for obstructions or excessive friction. Manual closing of an electrically operated breaker may be performed by the following two steps:
 - a. To charge the mechanism springs, pull the operating handle down until it stops (about 90°) ten times for the SACE Emax 2 breaker. The charge indicator will show CHARGED on a yellow background.
 - b. Depress the "I" button on the front of the breaker. The springs should discharge and, if the latch is properly reset, the breaker will close.
2. Electrically operate the breaker several times to check performance of the electrical accessories.
3. Refer to circuit breaker instruction manuals for detailed maintenance instructions and information for replacement of parts. See the applicable circuit breaker Installation, Operation and Maintenance Manual as listed in Appendix C.

Lubrication

In general, the circuit breaker requires moderate lubrication. For details on lubricating grease used for circuit breaker components please refer to the Installation, Operations and Maintenance Instructions for the Installer and the User: 1SDH000999R0002 and 1SDH001000R0002. Both of these cover E1.2, E2.2, E4.2 and E6.2 Emax circuit breakers. Bearing points and sliding surfaces should be lubricated at the regular inspection periods with a thin film of lubricant. Before lubricating, remove any hardened grease and dirt from latch and bearing surfaces with mineral spirits then wipe with a clean rag.



CAUTION

Caution: All excess lubricant should be removed with a clean cloth to avoid accumulation of dirt or dust.

On draw-out breakers, the contact surface of the disconnect fingers should be cleaned and greased with lubricant.

Instruments, instrument transformers, and relays

Check and inspect all devices to see that they are functioning properly. Check that all electrical connections are tight. Check mounting of the device.

Under normal conditions, the protective relays do not operate; therefore, it is important to check the operation of these devices regularly. Refer to Relay Instruction Books for detailed instructions.

Breaker compartment interiors



WARNING

Warning: De-energize equipment completely before doing maintenance work in compartments. This includes de-energizing any connections to outside primary or secondary sources, such as transformers, tie lines, etc.

Thoroughly clean the interior of the breaker and instrument compartments. Use a vacuum cleaner and clean rags only. Do not use steel wool or oxide papers. Blowing with compressed air is not recommended. Check indicating devices, mechanical and key interlocks. Check primary disconnecting device contacts for signs of abnormal wear or overheating. Discoloration of the silvered surfaces is not ordinarily harmful. These contacts should be cleaned only by wiping with a lint-free cloth. Clean the racking mechanism and lubricate with lubricant. Before replacing the breaker, wipe off the primary disconnecting device contacts. Apply a thin coat of lubricant to the stationary studs and to the primary disconnects on the breaker.

Bus area



WARNING

Warning: De-energize equipment completely before doing maintenance work on any devices, connections, bus work, breaker or feeder cable compartments. This includes de-energizing any connections to outside primary or secondary sources, such as transformers, tie lines, etc.

Inspect and check the bus area as follows:

1. Inspect the buses and connections carefully for evidence of overheating or weakening of the insulating supports. If bus insulation is present, remove the molded covers over the main bus connection to expose joints for inspection.
2. Check all connection bolts in the bus compartment and all bracing bolts for tightness. See the Torque Table A.1 in Appendix A.
3. Vacuum and, with a clean rag, wipe the buses and supports.
4. Visually inspect the insulation on the bars that run from the breaker studs through the bus structure to the cable area.

5. After cleaning, megger and record the resistance to ground and between phases of all insulated bars and all buses and connections. Disconnect all control circuits before checking resistance. Do not use over a 1500-volt megger. Since definite limits cannot be given for satisfactory insulation resistance values, a record must be kept of the readings.

Weakening of the insulation from one maintenance period to the next can be recognized from the recorded readings. The readings should be taken under similar conditions each time, if possible, and the record should include the ambient temperature and humidity.

Cable and busway compartment

Inspect and check the cable and busway compartment as follows:

1. Inspect all power cable connections for signs of overheating and tighten all connections. If severe discoloration or if damage is apparent, remove the damaged portion of the cable.



CAUTION

Caution: Be sure the condition which caused the over-heating has been corrected before energizing.

2. Check all bolts that hold cable terminals to the connection bars for tightness.
3. Check the neutral bus and ground bus connection and mounting bolts for tightness.
4. Check that all secondary control wiring connections are tight and that all control cabling is intact.

Overall switchgear

Make the following checks on the complete switchgear equipment.

- Clean and inspect all painted surfaces and retouch where necessary
- Check to see that all anchor bolts and other structural bolts are tight
- Check that all breaker and instrument compartment door latches operate properly
- If the switchgear is equipped with heaters, check to see that all heaters are energized and operating
- For exterior vent openings in equipment furnished with air filters, the foam filter elements should be removed and washed in warm soapy water, rinsed, and reassembled at least annually. Elements should be inspected before re-assembly and replaced if any signs of deterioration are evident

Circuit breaker lifting mechanism

Under normal conditions, no special maintenance procedures or lubrication is required for this device. If the cable is abraded under any condition, it should be inspected for broken strands or other damage and replaced if necessary.

Circuit breaker fan compartments

It is recommended that periodic checks be performed on the fan circuits to ensure proper functionality. Please see 1VAL106902-MB.

Appendix A - torque values

Table A.1 - Torque values for low voltage equipment electrical joint hardware other than cable terminals (copper, tin or silver plated)

Hardware Size	Torque ^{1,2} (ft/lbs)
1/4-20	7-10
3/8-16	25-30
1/2-13	35-40
5/8-11	45-55

1. These torque values are for non-lubricated threads

2. Standard nut with conical spring washer or lock washer

Table A.2 - Torque values for cable terminals

Wire Size	Torque ¹ (in/lbs)
6	100
5	
4	
3	
3	125
2	
1	
0	
00	150
000	
0000	
200	
250	250
300	
350	
400	
500	300
600	
700	
750	
800	400
900	
1.000	
1.250	
1.500	500
1.750	
2.000	
2.000	

1. These torque values are for non-lubricated threads.

Appendix B - circuit breaker rejection features

- 99
Circuit breaker
pin assembly
- 100
Cradle pin assembly

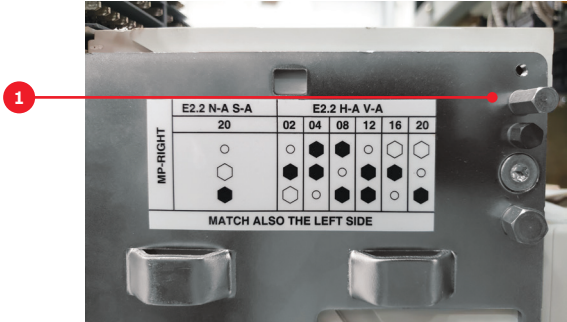
General

In general, draw-out breakers of the same type and rating are interchangeable in their equipment compartments; draw-out breakers of different types or short circuit ratings are intentionally made non-interchangeable. To prevent inserting the wrong breaker into a draw-out compartment, unique “rejection hardware” is affixed to each breaker and its cradle. The rejection is accomplished by pins on the sides of the breaker and on the sides of the cradle.

Rejection feature

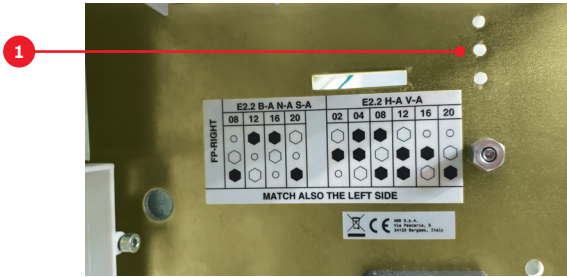
This factory-installed, pin and gate device prevents the insertion of a circuit breaker into a cradle if the nominal rating of the breaker is incompatible with that of the cradle and its ancillary equipment.

The information in the following appendices lists the available rejection scheme combinations for the rejection feature. Rejection combinations are in Appendix C.



1. Example of breaker pins (shown)

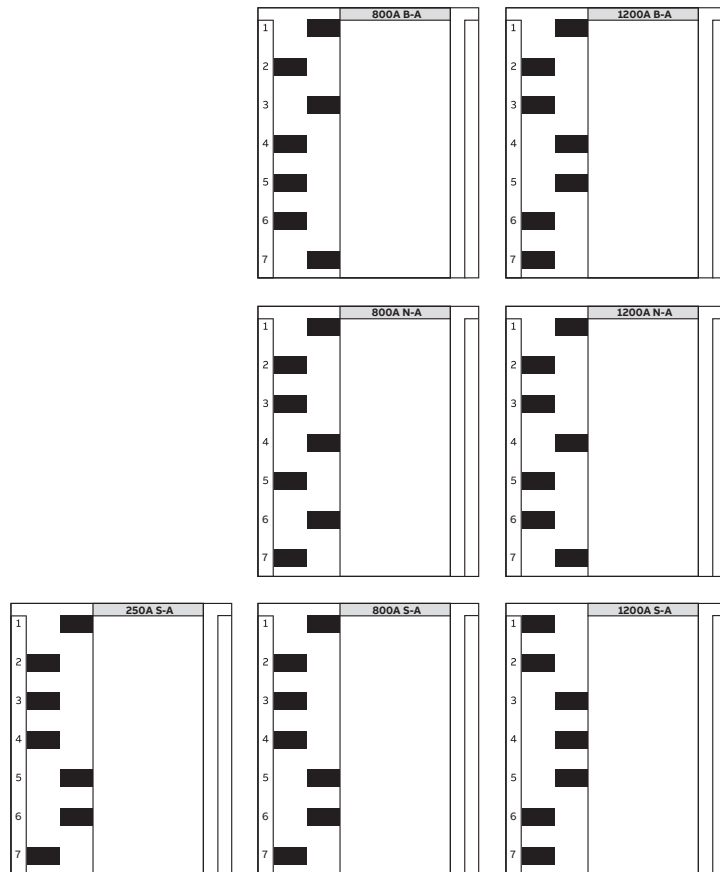
— 99



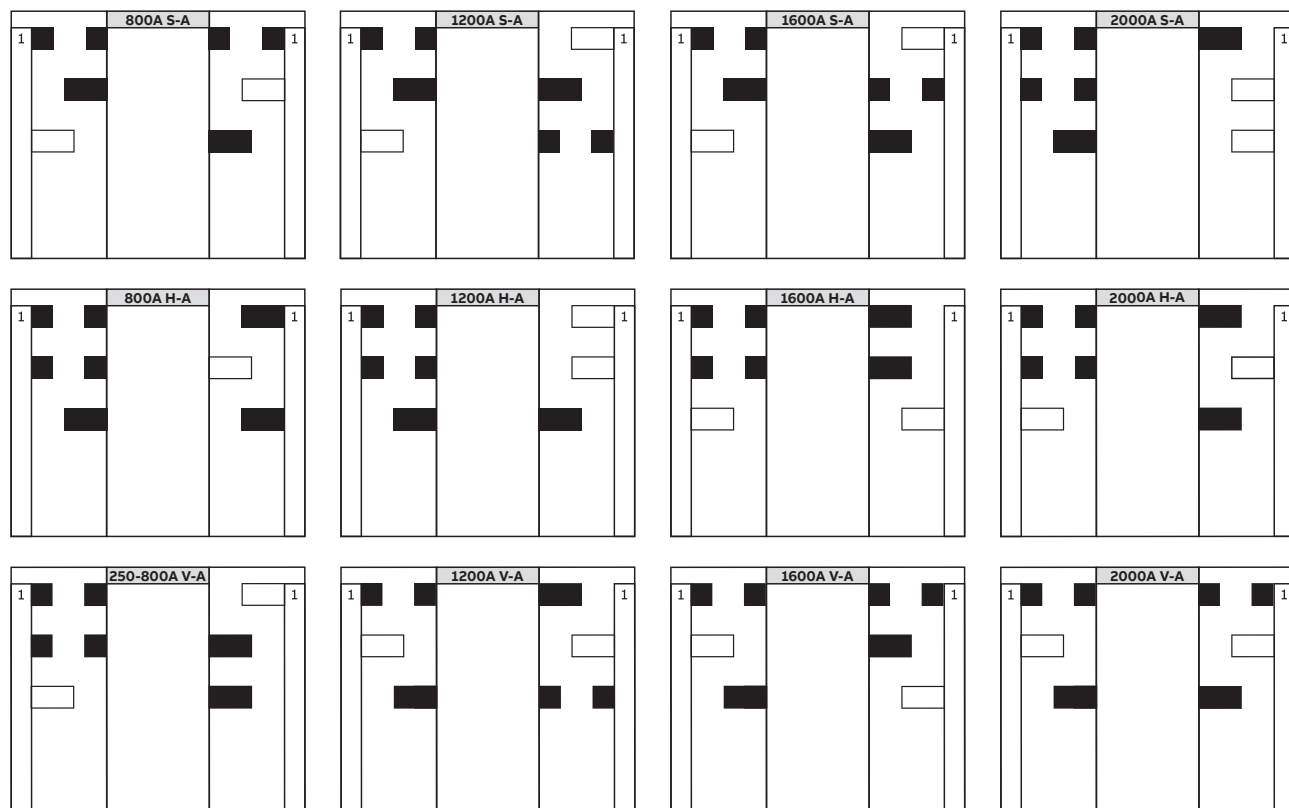
1. Example of cradle pins (not shown)

— 100

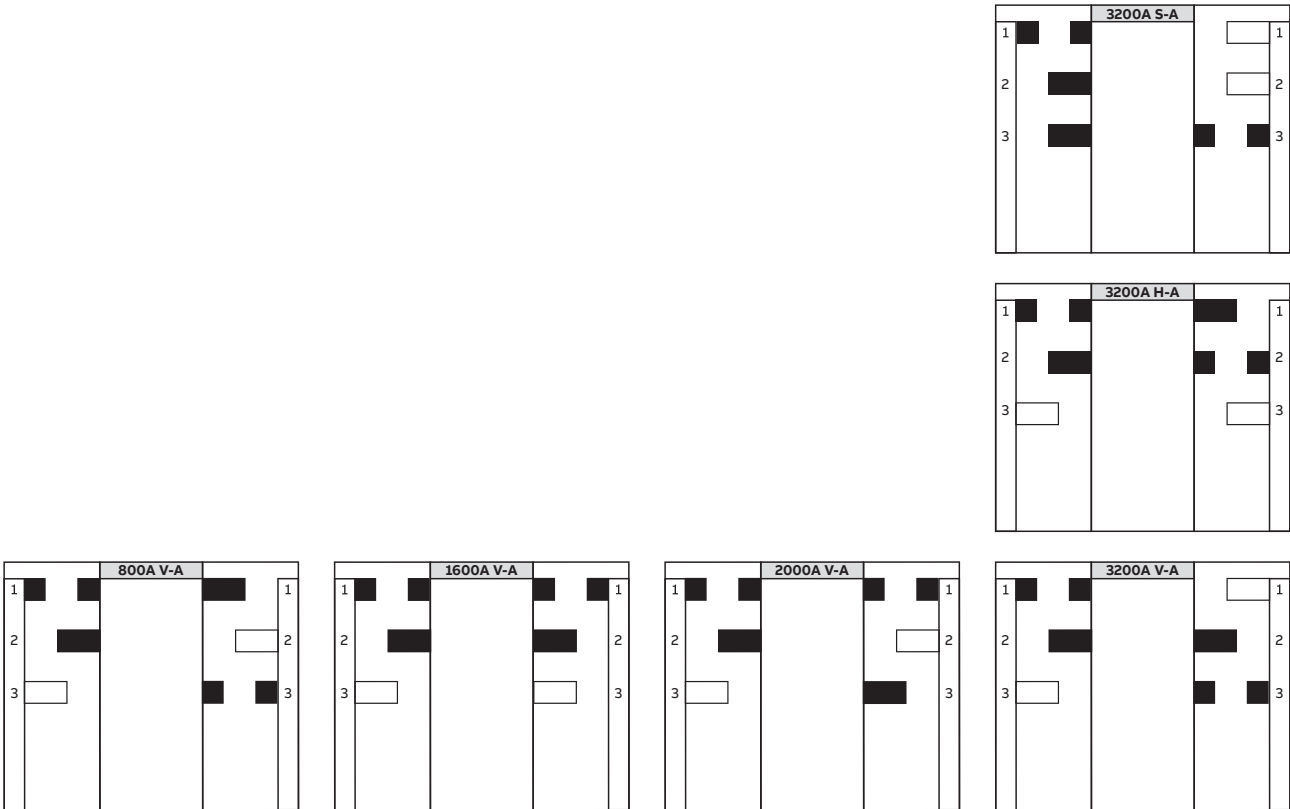
E1.2 UL 1066



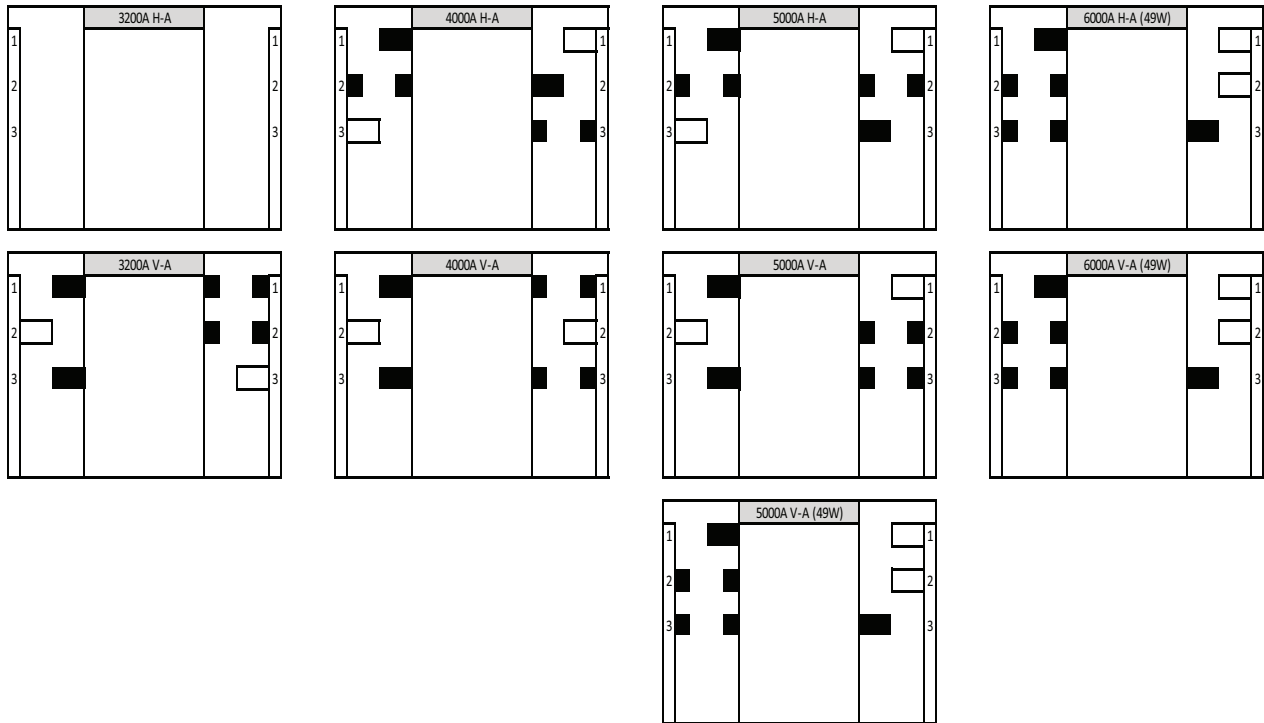
E2.2 UL 1066



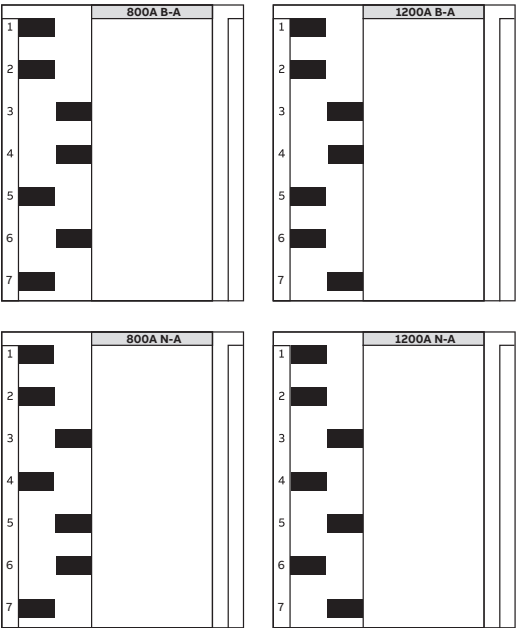
E4.2 UL1066



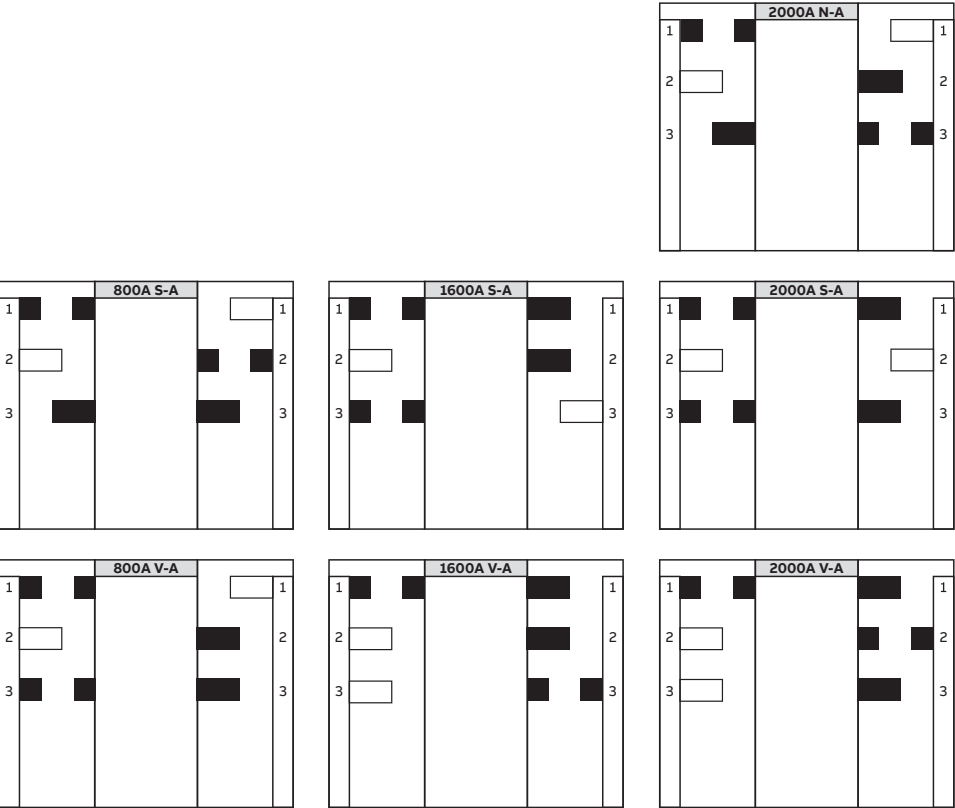
E6.2 UL 1066



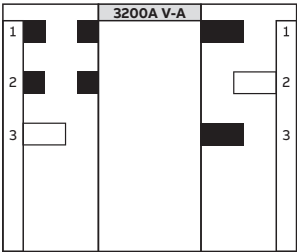
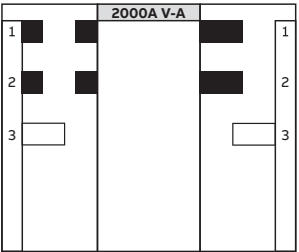
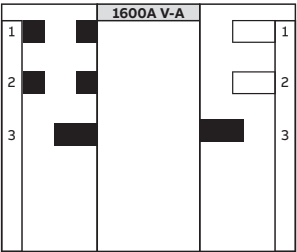
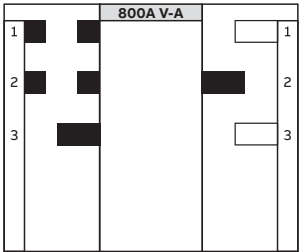
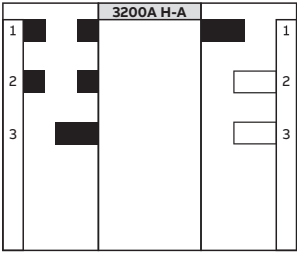
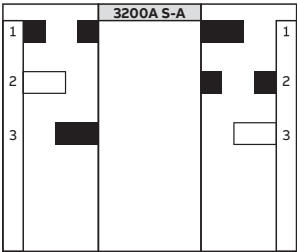
E1.2 Non-automatic



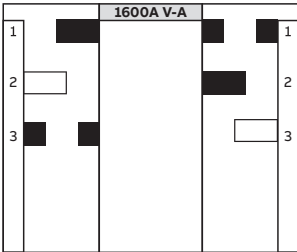
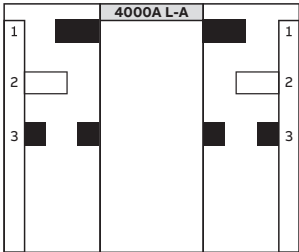
E2.2 Non-automatic



E4.2 Non-automatic



E6.2 Non-automatic



Appendix C - Circuit breaker information

For all circuit breaker information, including ratings, weights, accessories, etc., reference:

- 1SXU200040C0201 SACE Emax 2 UL Catalog
- 1SDH001330R1002 Operating instructions for the design engineer
- 1SDH001000R0002 Installation, operation & maintenance instruction, Emax E2.2, E4.2 and E6.2
- 1SDH000999R0002 Installation, operation & maintenance instruction, Emax E1.2.

Go to **library.abb.com**. In the search field, type the document number to find the necessary document.

Appendix D - Spare parts and field service guides

For all circuit breaker information please see
1SXU200040C0201.

Table D.1 - Switchgear items

Description	Order code
Circuit Breaker Lifting Cart	GE-1000
Circuit Breaker Transfer Truck	71-746-02
Future Door Cover (E1.2)	3100323960A001
Future Door Cover (E2.2, E4.2, E6.2)	31018103569A001
Lifting Beam and Tray, E1.2 3-Pole	31026599250A001
Lifting Beam, E2.2, E4.2 3-Pole	31017251275A001
Lifting Beam, E6.2 3-Pole	31017252934A001
Lifting Beam, E6.2 ¹ 3-Pole	31017252934A002
Overhead Circuit Breaker Lifting Device Crank	673D0500021505
Racking Handle - External to Breaker (E1.2)	310120088585A002
Red-Pigmented Bus Joint Grease for Switchgear	0282A2048P010
Racking Handle - External to Breaker (E2.2, E4.2, E6.2)	310120088585A001

1. 49W switchgear sections only

Below is a list of installation manuals to aid in field service activities:

- Emax E2.2, E4.2 and E6.2 shutter installation/removal / 1SDH001400R0831
- Emax E1.2 shutter installation/removal / 1SDH001399R0717
- Kirklock installation/removal / 1SDH001000R0748
- Emax E2.2, E4.2 and E6.2 cradle installed, cradle installation/removal / 1VAL106903-TG (inclusive of cradle, stab-tip and compartment current transformer instructions)
- 5000A and 6000 A Fan Installation & Trip Unit Programming: 1VAL106902-MB

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