Installation, Operation and
Maintenance Instructions

Uniflex

ABB PTMV

SAFETY FIRST!

For safe and correct usage note the following recommendations:

- Only install switchgear and switchboards in enclosed rooms suitable for electrical equipment.
- Ensure that only suitably qualified personnel carry out the installation, operation and maintenance of switchgear.
- Comply in full with the legally recognised standards (BS, DIN VDE, IEC, SABS, etc.), the connection conditions of the local electrical utility and the applicable safety at work regulations.
- Local / site operating procedures take precedence over the operating instructions given in this manual
- Observe the relevant information in the instruction manual for all actions involving switchgear and switchboards.
- Keep the instruction manual accessible to all persons concerned with installation, operation and maintenance.
- Personnel are to act responsibly in all matters affecting safety at work and the correct handling of the Switchgear.
- When in doubt ask! Our service technicians will be willing to assist you and provide any information required.

Pay special attention to cautionary / explanatory notes given.

ABB PTMV

3,6 – 17,5 kV
Uniflex Metalclad Switchgear

ESQF1910

CONTENTS

1. TECHNICAL DESCRIPTION

1.1 INTRODUCTION

This publication contains the information required for installation, commissioning, operation and maintenance of Uniflex switchboards.

For correct operation of the product, please read this manual carefully.

As with all switchboards which we manufacture, Uniflex switchboards are also designed for a large number of standardised requirements. They do however also allow for further technical/ constructional variations (at the customers request) to adapt to special installation requirements. For this reason the information given below will not always contain instructions applicable to special layouts. It is therefore necessary to consult both this manual and the latest technical documentation applicable to the switchboard (circuit diagrams, general arrangement drawings, assembly instructions etc.), especially in the case where variations to the standard are requested.

In all cases it is advisable that correctly trained personnel carry out installation, commissioning, operation, and maintenance.

Uniflex switchboards comprise individual switch cubicles, connected together via a common main horizontal single or double busbar. The following equipment can be supplied with the switchboard, and we recommend that you consult the applicable documentation when operating this product.

ABB VD4 circuit-breakers

ABB VM1 circuit-breakers

ABB HD4 circuit-breakers

ABB V contact contactors

ABB NAL/NALF switch disconnector/fuse switch disconnector

1.2 SPECIFICATIONS

Uniflex switchgear complies with the standards and specifications for factory-assembled, type tested and metal clad high voltage switchgear as follows:

IEC 60129 (1984-01)	Alternating current disconnectors and earthing-switches.
IEC 60298 (1990-12)	AC Metal enclosed switchgear and controlgear for rated voltages above 7kV and up to 52 kV.
IEC 60529 (1989-11)	Degrees of protection provided by enclosures (IP Code).
IEC 60694 (1996-05)	Common specifications for high-voltage switchgear and control gear standards.

All relevant specifications, BS/IEC/SABS publications, the national or local safety at work regulations and the safety regulations for production materials are to be followed during erection and operation of these systems.

1.3 OPERATING CONDITIONS

1.3.1 Normal operating conditions

The switchgear is designed for normal operating conditions for indoor switchgear and control gear to IEC Publication 60694, (Part 1000). The following limit values (among others) apply:

Ambient temperature:

- Maximum + 40° C
- Maximum 24 h average + 35° C
- Minimum (according to "minus 5 indoor class") - 5° C

Humidity:

- Highest mean value measured over 24 hours 55 %
- Highest mean value measured over 1 month 90 %

The maximum site altitude is up to 1000m above sea level.

1.3.2 Special operating conditions

Special operating conditions that deviate from the normal operating conditions are to be agreed by the manufacturer and user. The manufacturer must be consulted in advance about each special operating condition. The following are examples of special conditions:

- Site altitudes above 1000m were the reduction in dielectric strength of the air on the insulation level must be taken into account.
- Increased ambient temperatures can be compensated for in the design of the busbars and tee-off conductors. i.e. fitting additional ventilation can assist heat dissipation in the switchgear cubicle.
- When switchgear is operated in areas with high humidity and/or major rapid temperature fluctuations, there is a risk of dew deposits for indoor switchgear. Preventative action (e.g. fitting electric heaters) must be taken in consultation with the manufacturer to avoid such condensation phenomena and possible corrosion or other adverse effects.

1.4 DIMENSIONS AND WEIGHTS

1.4.1 Dimensions

The dimensions of standard cubicles are given in Table 1-1, 1-2 and 1-3. Cubicle sizes may vary depending on special contractual requirements. In such cases, please consult contract specific documentation.

Cubicle Function and Rating	Number of Figure	Cubicle Width (mm) (a)	Power-cable Compartment Depth (mm) (b)	LV Control Compartment Height (mm) (c)	Control Cable Termination Box Height (mm) (d)
... 1250A Tee off	1.1	650	500 or 775	450 or 750 or 1050	820 or 1170
... 1600A Tee off	1.2	1000			
... 2000/2500A Tee off	1.3	1000			
... 3150A Tee off	1.4	1000			
... 1250A Bus section	1.5	650			
... 1250A Bus riser	1.6	650			
... 3150A Bus section	1.7	1000			
... 3150A Bus riser	1.8	650			
... 31.5kA Busbar earth + VT	1.9	650			
... 315A Tee off disconnector fuse & contactor	1.10	800	500 or 775	300 or 600	820 or 1170
... 630A Tee off disconnector and fuse	1.11	800			
... 31.5kA Busbar earth end cubicle	1.12	400	-	-	-

Table 1-1 Typical dimensions for single tier, single busbar cubicles

Cubicle Function and Rating	Number of Figure	Cubicle Width (mm) (a)	Power-cable Compartment Depth (mm) (b)	LV Control Compartment Height (mm) (c)	Control Cable Termination Box Height (mm) (d)
... 1250A Tee off	1.13	650	500 or 775	450 or 750	820 or 1170
... 1250A Bus section	1.14				
... 1250A Bus riser	1.15				

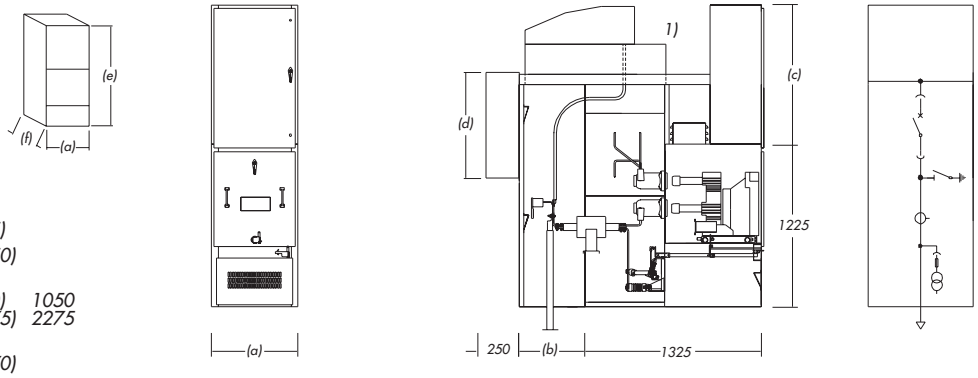
Table 1-2 Typical dimensions for double tier, single busbar cubicles

Cubicle Function and Rating	Number of Figure	Cubicle Width (mm) (a)	Power-cable Compartment Depth (mm) (b)	LV Control Compartment Height (mm) (c)	Control Cable Termination Box Height (mm) (d)
... 1250A Tee off	1.16	650	500 or 775	450 or 750	820 or 11750
... 1250A Top busbar bus section	1.17	650			
... 1250A Bus riser	1.18	650			
... 1250A Buscoupler	1.19	650			

Table 1-3 Typical dimensions for double busbar cubicles

1.4.2 Weights

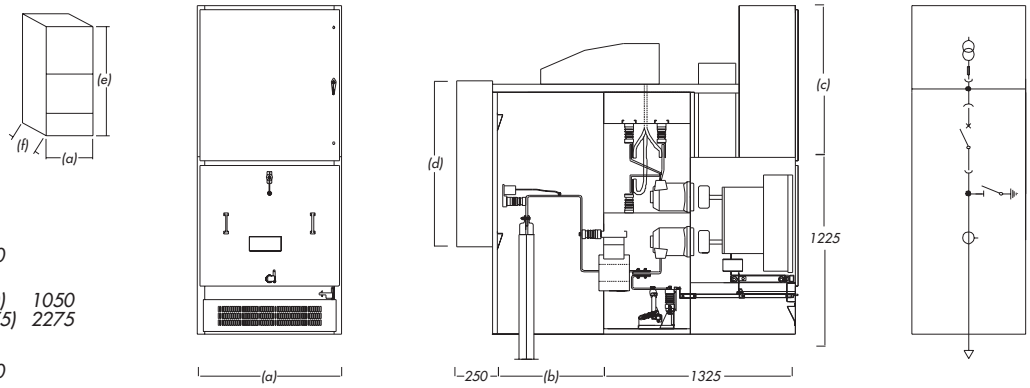
A cubicle weighs from 610kg to 1300kg, depending on the equipment installed.



Width
a = 650
Depth
b = 500 (775)
f = 2075 (2350)
Heights
c = (450) (750) 1050
e = (1675) (1975) 2275
Other
d = 820 (1170)

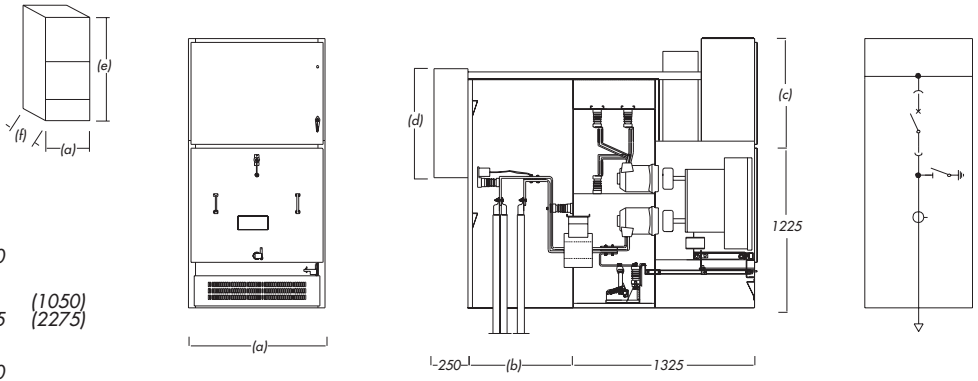
1) VT raised to provide blow out path for 500 mm deep power cable box

Figure 1.1 ...1250A Tee off circuit with cable connected voltage transformer



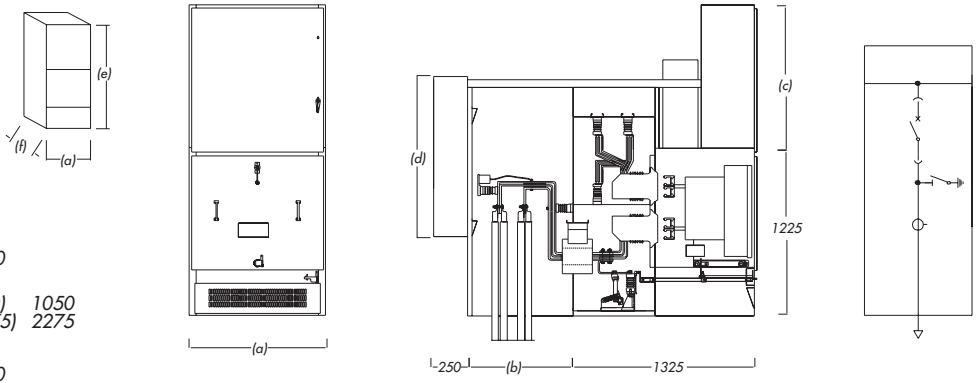
Width
a = 1000
Depth
b = (500) 775
f = (2075) 2350
Heights
c = (450) (750) 1050
e = (1675) (1975) 2275
Other
d = (820) 1170

Figure 1.2 ...1600A Tee off circuit with busbar connected voltage transformer



Width
a = 1000
Depth
b = (500) 775
f = (2075) 2350
Heights
c = (450) 750 (1050)
e = (1675) 1975 (2275)
Other
d = (820) 1170

Figure 1.3 ...2000/2500A Tee off circuit



Width
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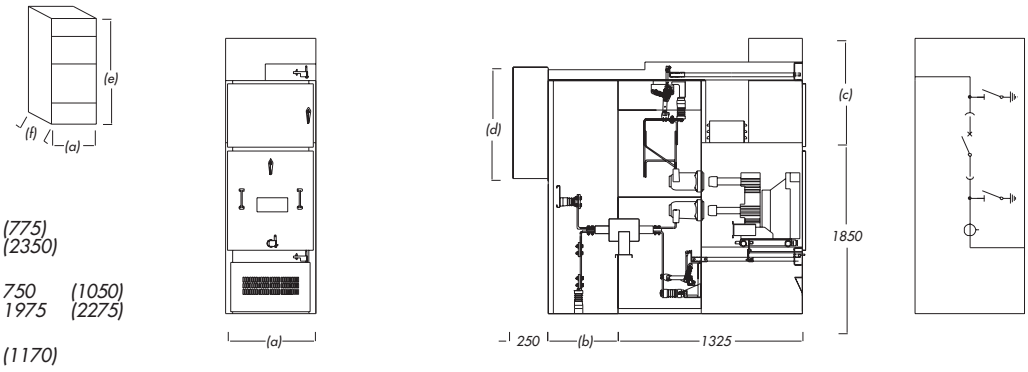
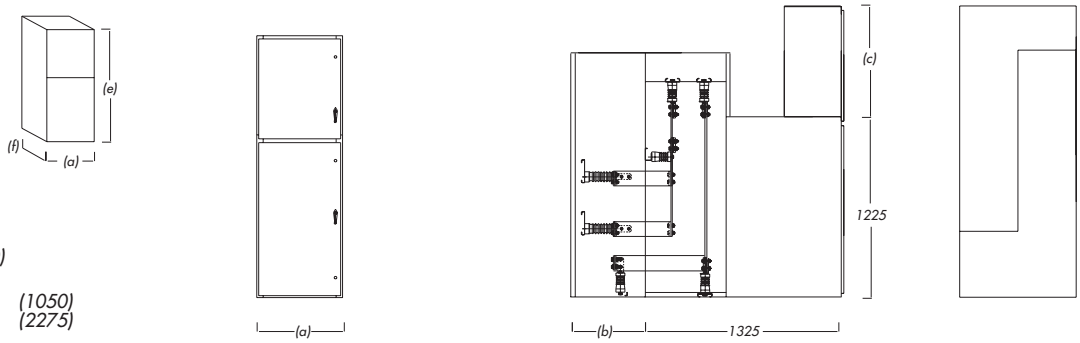
Depth
b = (500) 775
f = (2075) 2350
Heights
c = (450) (750) 1050
e = (1675) (1975) 2275
Other
d = (820) 1170

Figure 1.4 ...3150A Tee off circuit



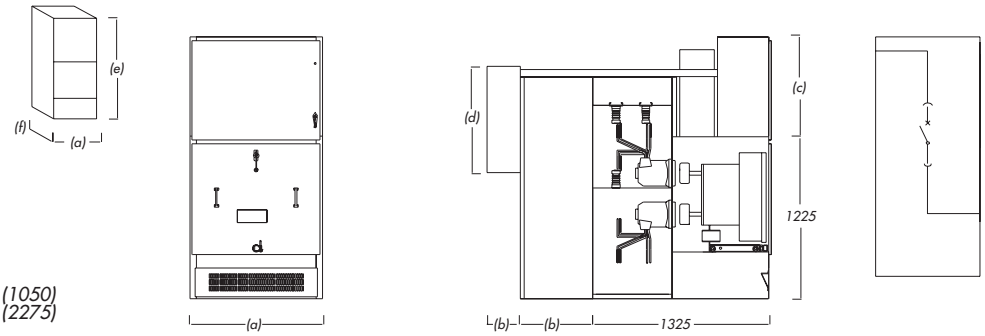
Width
a = 650
Depth
b = 500 (775)
f = 2075 (2350)
Heights
c = (450) 750 (1050)
e = (1675) 1975 (2275)
Other
d = 820 (1170)

Figure 1.5 ...1250A Bus section cubicle with LHS & RHS busbar earthing and current trasnformers



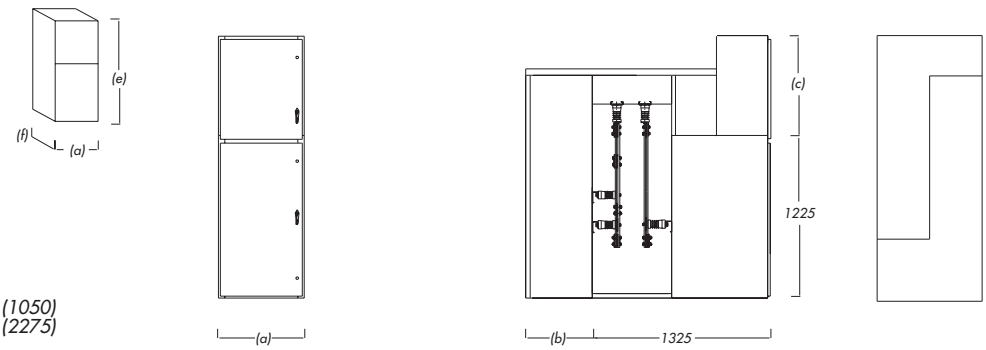
Width
a = 650
Depth
b = 500 (775)
f = 1825 (2100)
Heights
c = (450) 750 (1050)
e = (1675) 1975 (2275)

Figure 1.6 ...1250A Bus riser cubicle, when current transformers are fitted to bus section



Width
a = 650
Depth
b = 500 (775)
f = 2075 (2350)
Heights
c = (450) 750 (1050)
e = (1675) 1975 (2275)

Figure 1.7 ...3150A Bus section cubicle, without busbar earthing and current transformers.



Width
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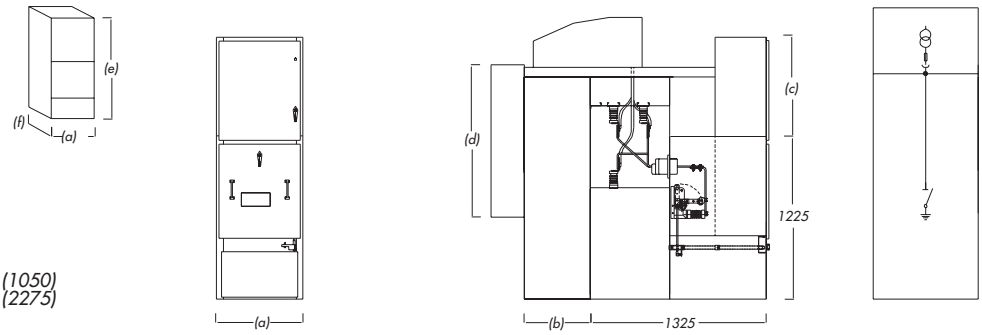
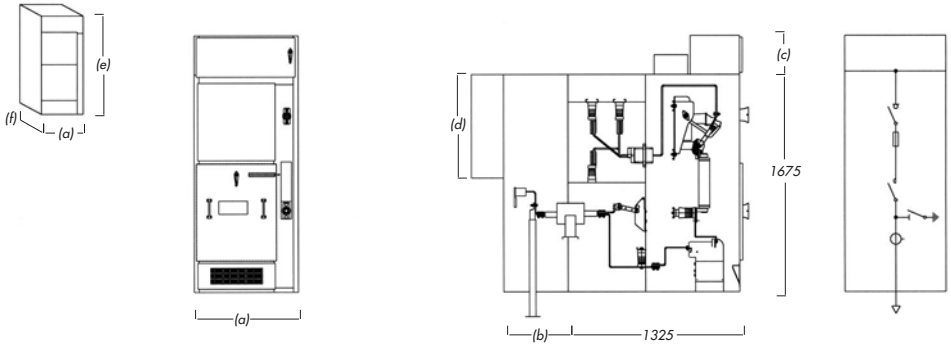
Depth
b = 500 (775)
f = 1825 (2100)
Heights
c = (450) 750 (1050)
e = (1675) 1975 (2275)

Figure 1.8 ...3150A Bus riser cubicle, when no current transformers are fitted



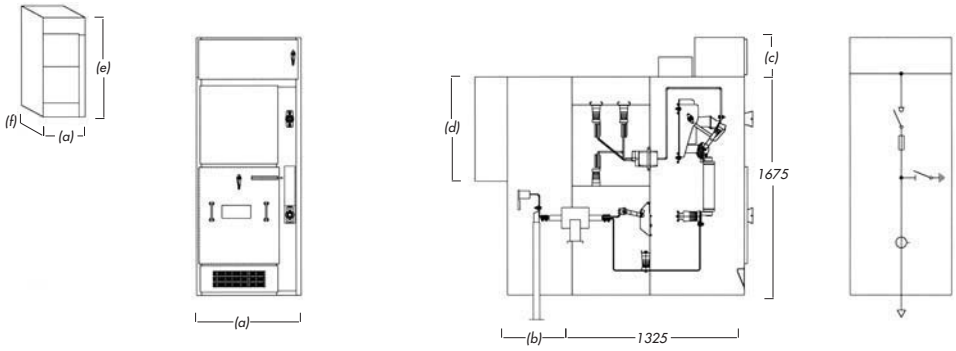
Width
a = 650
Depth
b = 500 (775)
f = 2075 (2350)
Heights
c = (450) 750 (1050)
e = (1675) 1975 (2275)
Other
d = (820) 1170

Figure 1.9 ...Busbar earth with voltage transformers.



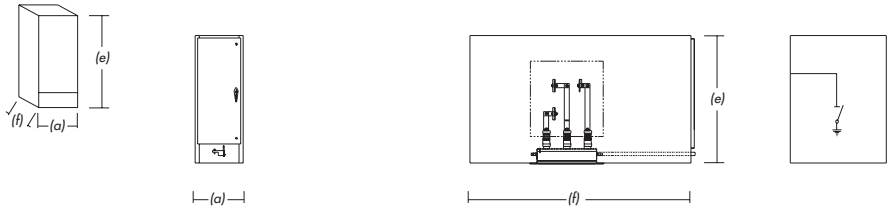
Width
a = 800
Depth
b = 500 (775)
f = 2075 (2350)
Heights
c = 300 (600)
e = 1975 (2275)
Other
d = 820 (1170)

Figure 1.10 ...315A Tee off circuit, switch disconnector, fuse and contactor



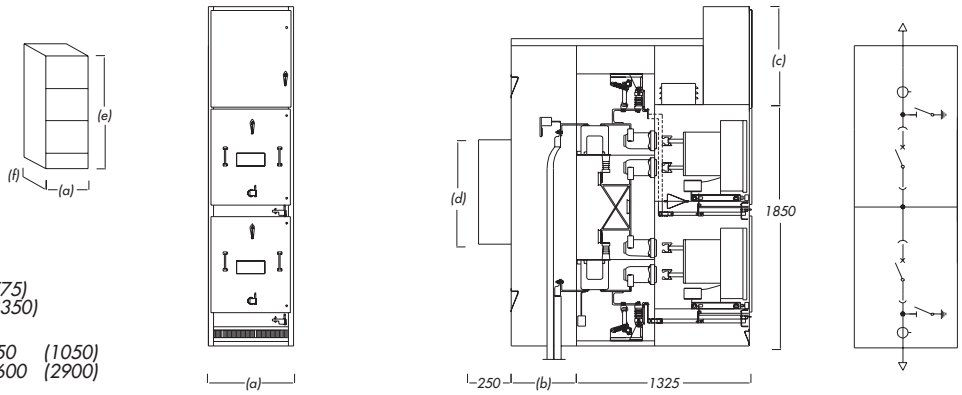
Width
a = 800
Depth
b = 500 (775)
f = 2075 (2350)
Heights
c = 300 (600)
e = 1975 (2275)
Other
d = 820 (1170)

Figure 1.11 ...630A Tee off circuit, switch disconnector and fuse



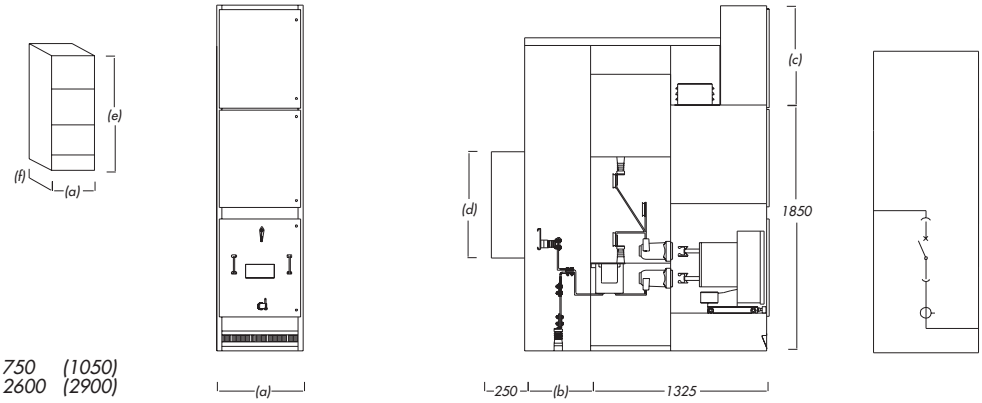
Width
a = 400
Depth
f = 1825
Heights
e = 1055

Figure 1.12 Busbar earthing in busbar end cubicle



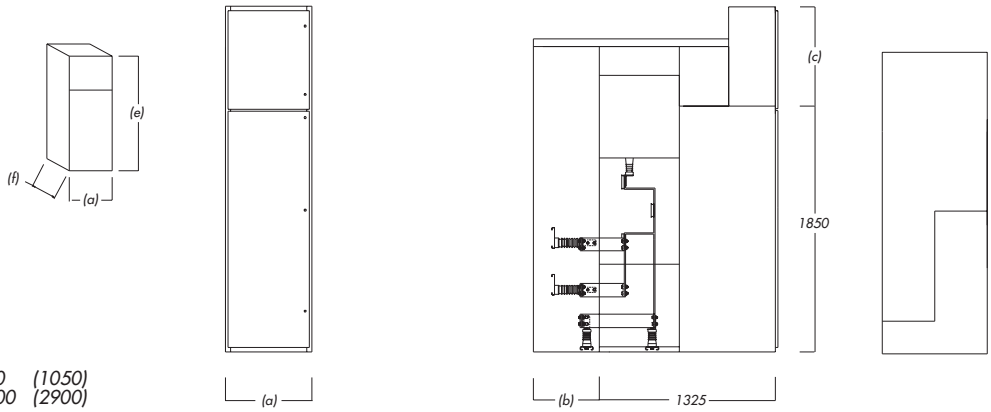
Width
a = 650
Depth
b = 500 (775)
f = 2075 (2350)
Heights
c = (450) 750 (1050)
e = (2300) 2600 (2900)
Other
d = 820 (1170)

Figure 1.13 ...1250A Tee off circuits, double tier cubicle.



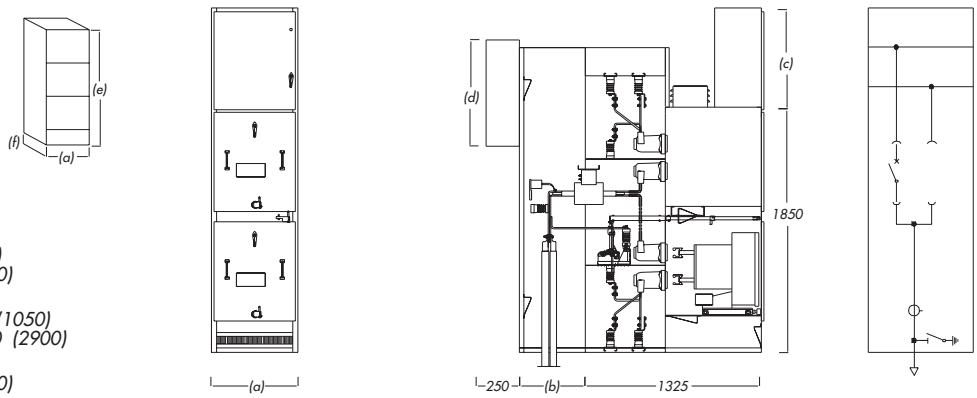
Width
a = 650
Depth
b = 500
f = 2075
Heights
c = (450) 750 (1050)
e = (2300) 2600 (2900)
Other
d = 820 (1170)

Figure 1.14 ...1250A Bus section, double tier cubicle.



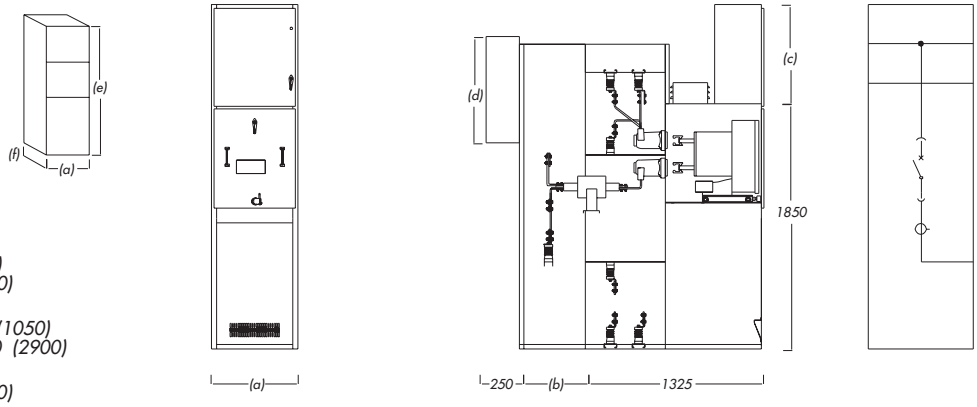
Width
a = 650
Depth
b = 500
f = 1825
Heights
c = (450) 750 (1050)
e = (2300) 2600 (2900)

Figure 1.15 ...1250A Bus riser, double tier cubicle.



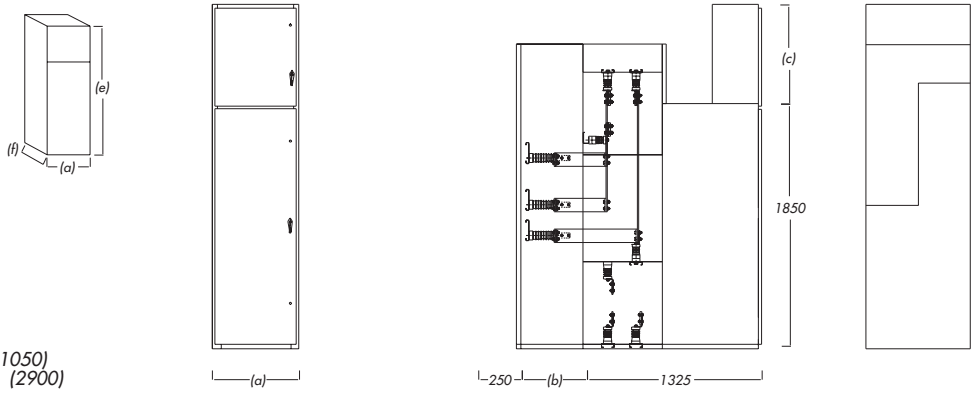
Width
a = 650
Depth
b = 500 (775)
f = 2075 (2350)
Heights
c = (450) 750 (1050)
e = (2300) 2600 (2900)
Other
d = 820 (1170)

Figure 1.16 ...1250A Tee off circuit, double busbar cubicle.



Width
a = 650
Depth
b = 500 (775)
f = 2075 (2350)
Heights
c = (450) 750 (1050)
e = (2300) 2600 (2900)
Other
d = 820 (1170)

Figure 1.17 ...1250A Top busbar bus section with current transformers, double busbar cubicle.



Width
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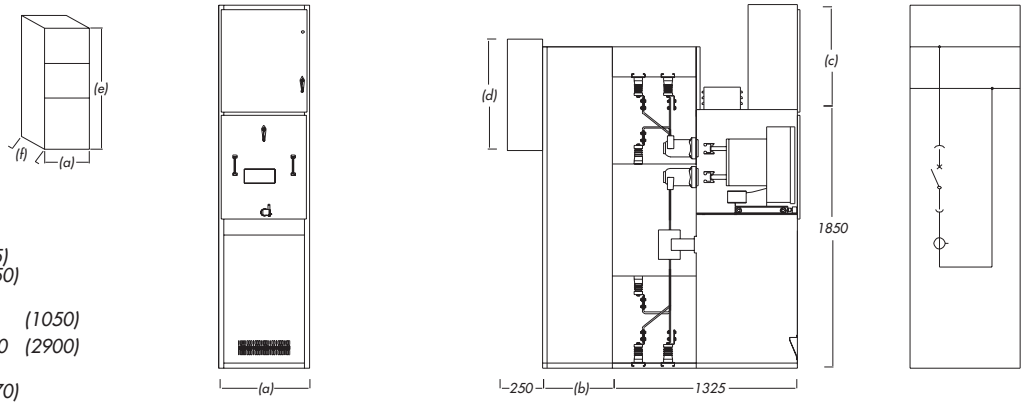
Depth
b = 500
f = 2075
Heights
c = (450) 750 (1050)
e = (2300) 2600 (2900)

Figure 1.18 ...1250 Top busbar bus riser with current transformers on the bus section, double busbar cubicle.



Width
a = 650
Depth
b = 500 (775)
f = 2075 (2350)
Heights
c = (450) 750 (1050)
e = (2300) 2600 (2900)
Other
d = 820 (1170)

Figure 1.19 ...1250A Buscoupler, double busbar cubicle.

1.5 CONSTRUCTION

1.5.1 Enclosure

The enclosure of the switchgear cubicles is manufactured from Aluzinc and mild steet sheel. Doors and/or removable covers seal the front and rear of the cubicles. The enclosure can be fully painted or partially panted as required by the contractal requirements. Doors / edges are adequately sealed to maintain degree of protection requirements. Where visual inspection is required, viewing windows manufactured from Polycarbonate are fitted. Cubicles adjacent to each other are segregated by the sidewalls of each cubicle.

Where ventilation is required air vents (refer to figure 1.20) constructed of Teflon and stainless steel wire mesh are fitted to the switchgear, allowing air to flow through the switchgear. These vents close when there is a sudden overpressure in the switchgear, preventing gases from exhausting to the front, sides or rear of the switchgear. Gases are exhausted to the top of the switchgear, through the explosion vents provided. The explosion vents are manufactured from Zinc passivated sheet steel.

Figure 1.20 Airvent

Once fully assembled, Uniflex switchgear has a degree of protection IP4X.

1.5.2 Internal segregation and fixings

The internal fixing brackets and covers of the switchgear are manufactured of Aluzinc, Zinc passivated mild steel sheet and stainless sheet steel as required.

In certain cases where insufficient air clearance is encountered between phases and/or phase earth parts, additional insulation is provided by means of flash barriers (refer to figure 1.21) manufactured from Polycarbonate / Perspex. They are fitted between parts and/or heatshrink fitted onto copper bars. In addition, barriers similar to the above may be fitted to prevent access to live parts.

Figure 1.21 Flash barriers

When ventilation is required between compartments air vents are fitted as described above. These vents close when there is a sudden overpressure in a chamber, preventing further contamination or faults to adjacent compartments.

The compartments are fully segregated by earthed metal parts designed for a degree of protection between compartments of IP2X.

1.6 SWITCHGEAR COMPARTMENTS

The switchgear cubicles are of modular construction (refer to figure1.22), comprising of the following compartments:

- busbar compartment (A)
- switching compartment (B)
- power-cable compartment (C)
- voltage transformer compartment (D)-(on request)
- instrument compartment (E)
- auxiliary control cabling compartment (F).

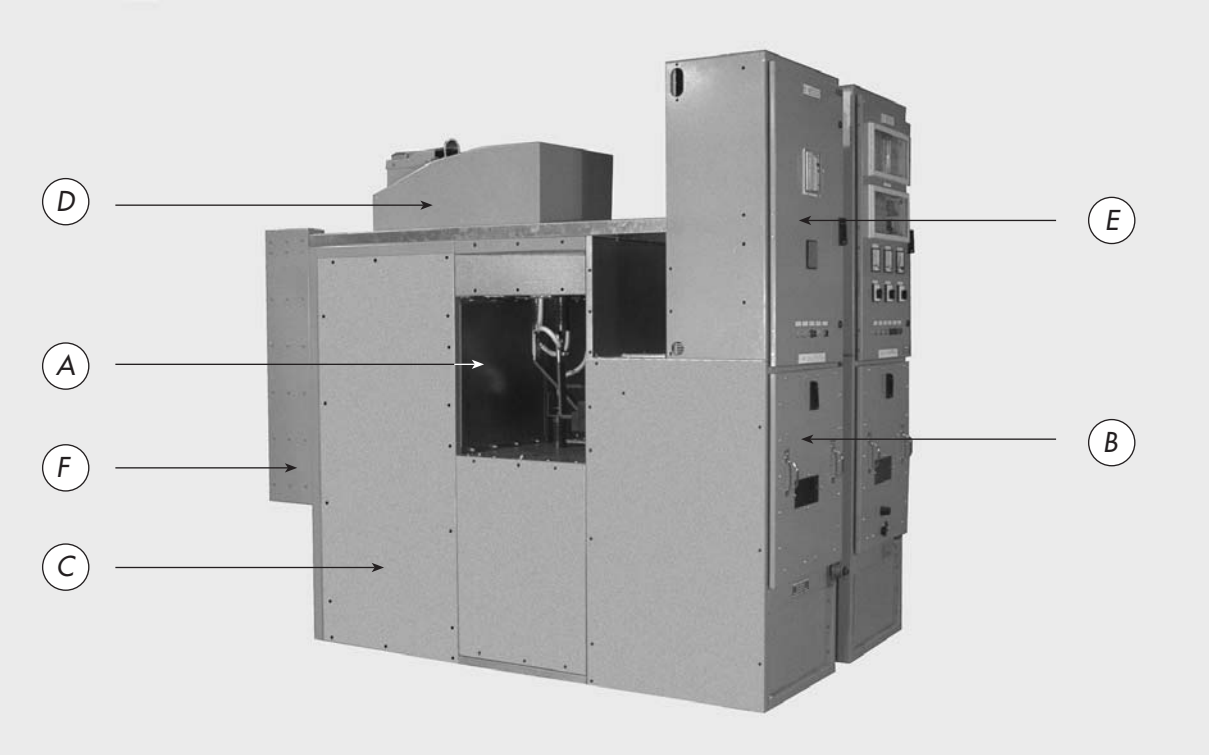


Figure 1.22 Switchgear compartments

A. Busbar compartment

The busbar compartment (refer to figure 1.23) houses the main horizontal busbar system, mounted on the terminals connected to the upper contacts and/or insulator supports depending on the current and fault level rating. Support insulators are provided for current ratings >1250A or for fault ratings >25kA. The busbars are accessible from the rear, though the power-cable compartments.

The conductor material used is rectangular copper bar with air insulation, in single, double or triple configuration depending on the current rating. The connection to the flat tee-off conductors is made without any special connecting clamps or insulation.

Figure 1.23 Busbar compartment

B. Switching compartment

The switching compartment (Refer to figure 1.24) is designed to hold the circuit-breaker or contactor.

The switching compartment door is designed to suit the circuit breaker or contactor i.e. position of inspection window, and manual operation (on request). The switching device is earthed through its rollers. An earthing contact may be provided on request.

The following components are housed in this compartment:

- insulating spouts, i.e. the bushings, which contain the primary connections between the switching device, the busbar compartment and the power-cable compartment
- segregation shutters, which provide automatic segregation of the medium voltage circuit when the switching device is in the test or removed position
- anticondensation heater (on request)
- standard interlocks
- other interlocks (on request)
- metal wiring ducts
- multiple plug connector, for connecting the secondary circuits of the switching device.

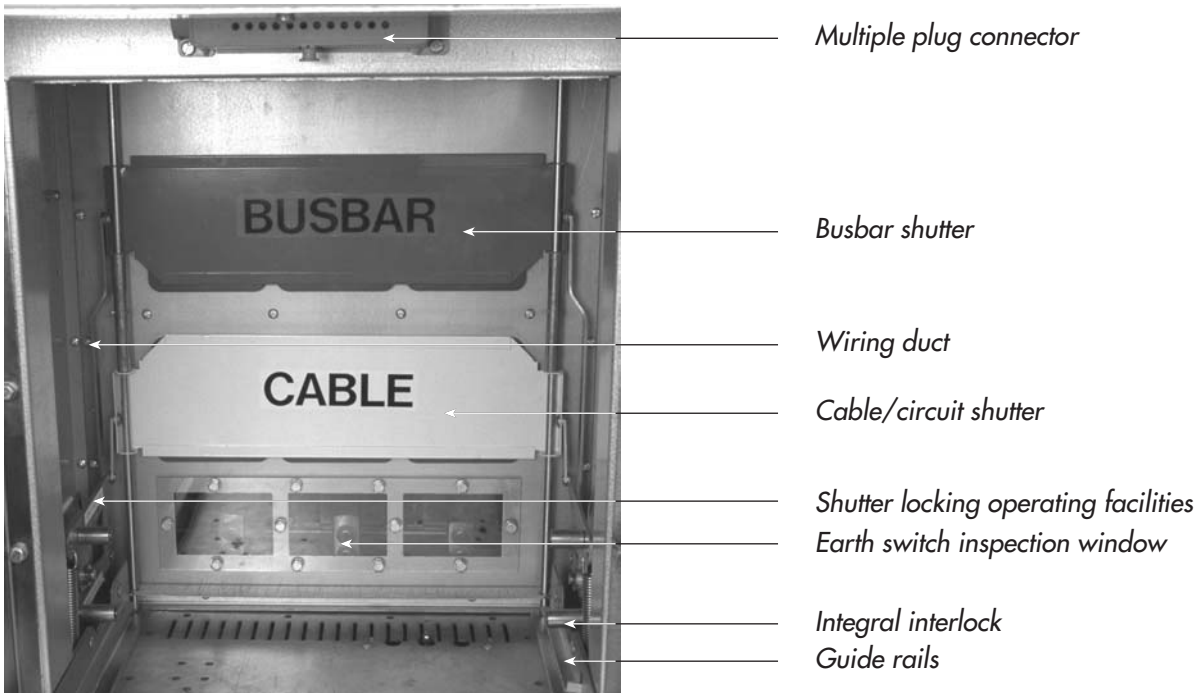


Figure 1.24 Switching compartment

C. Power-cable compartment

The power-cable compartment (Refer to Figure 1.25) is accessible from the rear of the cubicle.

Depending on contract requirements the power-cable entry may be from the bottom or top of this compartment. The cables are secured using glands, cable blocks, clamps etc. to the gland plates provided.

The power-cable compartment can contain the following components:

- cable earthing-switch and associated components
- current transformers (CT's)
- toroidal current transformers around cable
- cable terminals
- voltage transformer connectors
- capacitor dividers (on request)
- surge suppression devices (on request)
- flash barriers (when required)
- metal wiring ducts
- removable gland plate

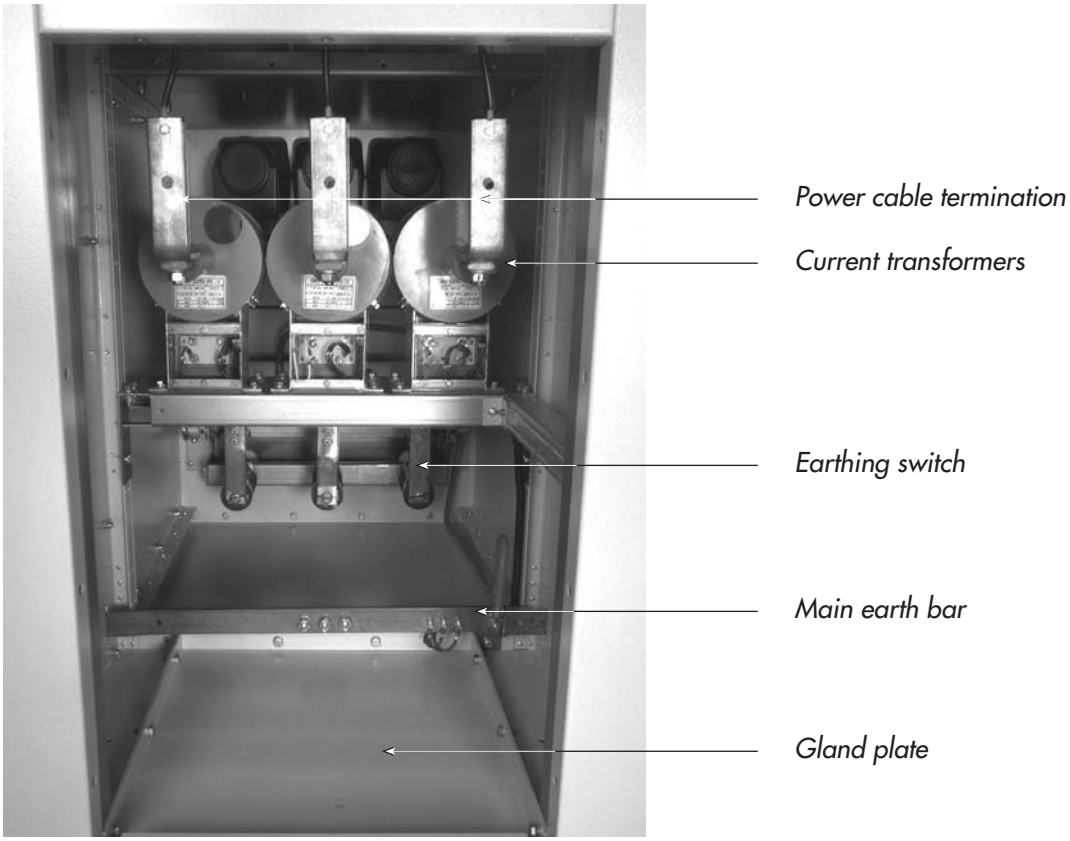


Figure 1.25 Power cable compartment

D. Voltage transformer compartment (on request)

The voltage transformer (VT) and associated fuses are mounted in this compartment (refer to figure 1.26), and can be withdrawn to facilitate replacement and isolation. The VT compartment is mounted on top of the busbar and power cable compartments. The primary connection is connected between the VT and the main busbar or cable termination, depending on the voltage being monitored. The main characteristics of the equipment are:

- VT mounted on withdrawable truck
- isolation of the VT and its secondary circuits
- segregation of the power circuits by means of automatic shutters
- replacement of high voltage fuses in the withdrawn position
- replacement of secondary fuses in the connected, isolated, or withdrawn positions

VT's are provided for measurement and power supply. They have performance and class of precision as specified in the contract document or as provided by the manufacturer.

Figure 1.26 Voltage transformer

E. Instrument compartment

The instrument compartment (refer to figure 1.27) is located on top of the switching compartment and is accessible from the front of the cubicle. The compartment is fitted with a lockable (on request) door. All the low voltage apparatus required is mounted in this compartment. In particular:

- terminals for interconnection/buswiring between cubicles
- terminals for cubicle circuits
- auxiliary circuit-breaker and cubicle accessories (measuring instruments, protection relays, control and signalling devices, fuses, etc.)
- identification markers i.e. current transformer rating plates, cubicle rating plate

Figure 1.27 Instrument compartment

F. Auxiliary control cable compartment

The auxiliary control cable compartment (refer to figure 1.28) is located at the rear of the cubicle and houses terminals for connection of secondary cables. Cable entry is typically from the bottom of the compartment. The cables are secured using glands to the gland plate provided. The compartment is fitted with a lockable (on request) door.

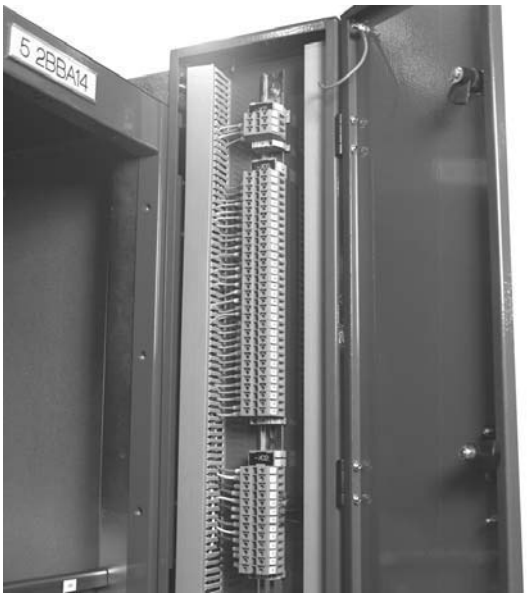


Figure 1.28 Auxiliary control cable compartment

1.7 INTERLOCK PROTECTION

Switchboards are provided with a number of interlocks to ensure safe operation.

1.7.1 Integral interlocks

The following integral interlock functions are provided by the switching device in conjunction with the switchgear cubicle:

- The switching device can only be moved from the test/isolated position into the service position (and back) with the switching device open, the earthing-switch open, and earthing-switch drive mechanism access disabled.
- The circuit-breaker can only be closed when the switching device is precisely in the defined test position or defined service position, and the switching device is ready for closing (i.e. springs are fully charged).
- The earthing-switch can only be closed when the switching device is in the test/isolated position or the removed position.
- The switching device cannot be moved from the test/isolated position into the service position when the earthing-switch is closed or when access to the earthing-switch drive is enabled.
- In the case of a switch disconnector, the cable earth switch cannot be closed when the switch disconnector is in the closed position, and visa versa.

1.7.2 Safety locks for operator's use

- Access to the earthing-switch drive and the switching device racking mechanism is provided with padlocking facilities (on request) to prevent unwarranted operation of the switchgear when safety locks (refer to figure 1.29) are fitted.

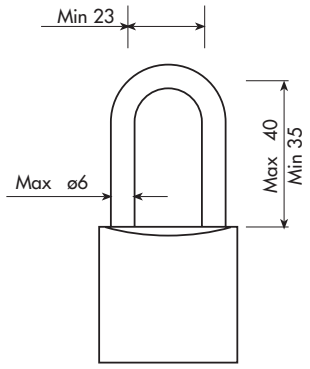


Figure 1.29 Safety lock dimension drawing

- The shutters can be secured in the open or closed position independently of each other with safety locks (refer to figure 1.30) when the switching device has been removed.

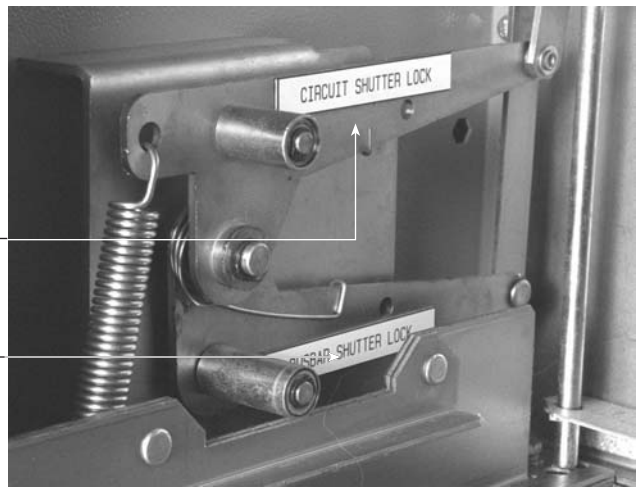


Figure 1.30 Shutter locking

1.7.3 Other interlocks (on request)

Other interlocks as follows can be provided:

- Key interlocks to prevent operation when remote circuits are not ready i.e. busbar earthing-switches can not be closed until all incoming circuits are isolated.
- Electro-mechanical interlocks preventing operation under incorrect conditions.

1.8 ELECTRICAL DATA

The standard switchgear cubicles available are shown in Table 1-4 and the standard busbar ratings are given in Table 1-5. Each switchboard is marked with a nameplate (Refer to Figure 1.31) and each cubicle is marked with a rating plate (Refer to Figure 1.32) giving particular information about the cubicle and switchboard.

Rated Voltage	kV	3.6	7.2	12	17.5
Rated power frequency withstand voltage	kV	10	20	28	38
Rated lightning impulse withstand voltage	kV	40	60	75	95
Rated frequency	Hz	50/60	50/60	50/60	50/60
Rated current of Busbars (up to)	A	...3150	...3150	... 3150	...3150
Rated current of tee-off (up to)	A	...3150	...3150	... 3150	...3150
Rated peak withstand current 1)	kA	...78.75	...78.75	... 78.75	...78.75
Internal Arc 200 ms	kA	...31.5	...31.5	... 31.5	...31.5
Rated short-time current (1 sec) 2)	kA	...31.5	...31.5	... 31.5	...31.5
Auxiliary voltage 3)	V	DC 30, 110, 220; AC 110, 220			

1) Take the short circuit withstand capability of the instrument transformers into account separately.
2) 3 second ratings (on request)
3) Special DC and AC voltages (on request)

Table 1-4 Electrical data of Uniflex cubicles up to 17.5kV

COPPER SIZE AND SPECIFICATION		
RATING	BUSBARS	TERMINAL CONNETIONS
...630 A	1 x 80 x 10 mm Cu bars per phase	1 x 40 x 10 Cu bars per phase
...800 A	1 x 80 x 10 mm Cu bars per phase	1 x 40 x 10 Cu bars per phase
...1250 A	1 x 100 x 10 mm Cu bars per phase	2 x 40 x 10 Cu bars per phase
...1600 A	1 x 100 x 12.5 mm Cu bars per phase	1 x 125 x 10 Cu bars per phase
...2000 A	2 x 100 x 12.5 mm Cu bars per phase	2 x 125 x 10 Cu bars per phase
...2500 A	2 x 100 x 12.5 mm Cu bars per phase	2 x 125 x 10 Cu bars per phase
...3150 A	3 x 100 x 12.5 mm Cu bars per phase	3 x 125 x 10 Cu bars per phase

Table 1-5 Busbar and terminal connection ratings

ABB Electrical Systems
P O Box 15006 westmead 3608 SOUTH AFRICA
TEL +27 31 700 5916 FAX +27 31 700 4393

PANEL TYPE	UNIFLEX
DATE OF MANUFACTURE	DEC-97
ABB SERIAL No	74347132
CUSTOMER ORDER No	T70719
RATED OPERATIONAL VOLTAGE @ 50Hz	12kV
60 SEC DIELECTRIC WITHSTAND VOLTAGE	28kV
RATED LIGHTENING WITHSTAND VOLTAGE	95kV BIL
RATED BUSBAR CURRENT	1600A
RATED SHORT TIME WITHSTAND CURRENT	25kA (3SEC)
RATED PEAK WITHSTAND CURRENT	63kA
DEGREE OF PROTECTION	IP 2X, IP 4X
CONTROL CIRCUIT SUPPLY VOLTAGE	110VDC
TRIP CIRCUIT SUPPLY VOLTAGE	110VDC
SPRING CHARGE MOTOR SUPPLY VOLTAGE	240VAC

Figure 1.3.1 Example of switchboard nameplate

ABB Electrical Systems
P O Box 15006 westmead 3608 SOUTH AFRICA
TEL +27 31 700 5916 FAX +27 31 700 4393

PANEL TYPE	UNIFLEX
DATE OF MANUFACTURE	DEC-97
ABB SERIAL No	74347132
SWITCHING DEVICE	SF6 CIRCUIT BREAKER
SWITCHING DEVICE TYPE	HA1 12. 12.25
RATING OPERATIONAL VOLTAGE @ 50Hz	11kV
RATED PANEL CURRENT	1250A
RATED SHORT TIME WITHSTAND CURRENT	25kA (3SEC)

Figure 1.3.2 Example of cubicle rating plate

2. INSTALLATION PROCEDURES

2.1 DELIVERY AND STORAGE

2.1.1 Condition on delivery

To facilitate transportation the switchboard is divided into sections usually not longer than 3000-mm. The switchboard is packed in accordance with the clients shipping and storage requirements. Unless otherwise requested switchboard cubicles are individually secured on suitable pallets and are covered to prevent damage. The cubicles must be shipped, loaded and stored upright at all times.

The cubicles are normally shipped with the apparatus (voltage transformers and circuit-breakers) inserted into the relevant cubicles, unless otherwise agreed with the customer.

In certain cases where the circuit-breakers are to heavy to be shipped with the cubicle they will be packed separately. The busbars, fasteners and other accessories that are not assembled at the factory are packed separately.

On receipt the switchboard and accessories must be unpacked and checked according to the instructions on the relative order documentation. Any irregularities or damage should be noted, and reported to ABB as soon as possible, and in any case within 5-days. Notification of any irregularities, even after receipt must contain the year of manufacture and the serial number listed on the rating plate.

2.1.2 Loading and positioning

The cubicles must be preferably loaded using a crane of suitable capacity (A), a forklift truck (B), or a pallet-jack (C). If necessary the cubicle may be positioned using rollers (D). In all cases, care must be taken not to damage the cubicle base.

A. Loading by crane

- fit lifting slings with shackles (of suitable capacity) under the cubicle through the pallet opening (refer to figure 2.1)
- secure the lifting slings to the to the lifting crane catch
- lift the cubicle to the required position
- remove the lifting slings from the cubicle

The crane operator must be trained and authorised to use the selected crane.

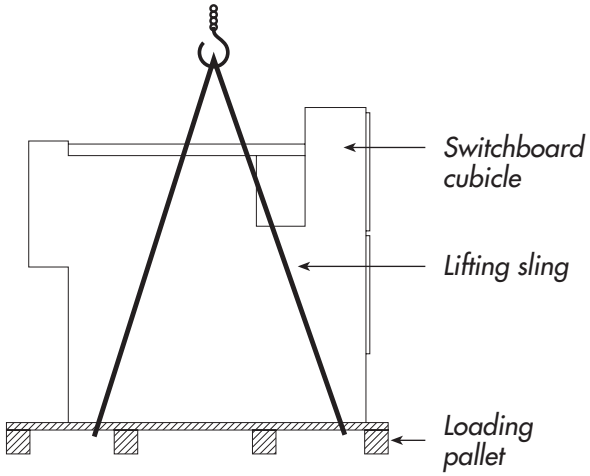


Figure 2.1 Lifting by crane

B. Loading by forklift truck

- position the forklift truck forks through the sides of the cubicle pallet, ensuring the forks reach through the pallet (refer to figure 2.2)
- lift the cubicle evenly and move to the required position
- remove the forklift truck forks from the pallet once the pallet is placed securely in position

The forklift operator must be trained and authorised to use the selected forklift.

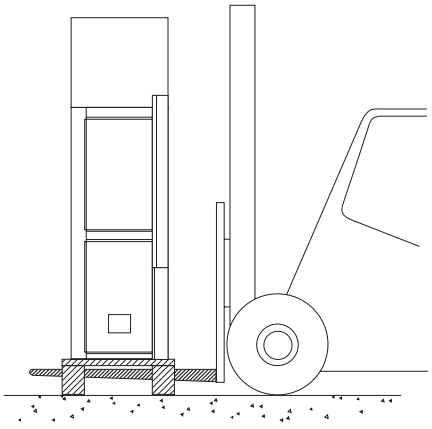


Figure 2.2 Loading by forklift truck

C. Positioning by pallet-jack

- position the pallet-jack forks through the front of the cubicle pallet, ensuring the forks reach to at least half way through the depth of the cubicle (refer to figure2.3)
- lift the cubicle evenly and move to the required position
- remove the pallet-jack forks from the pallet once the pallet is placed securely in position

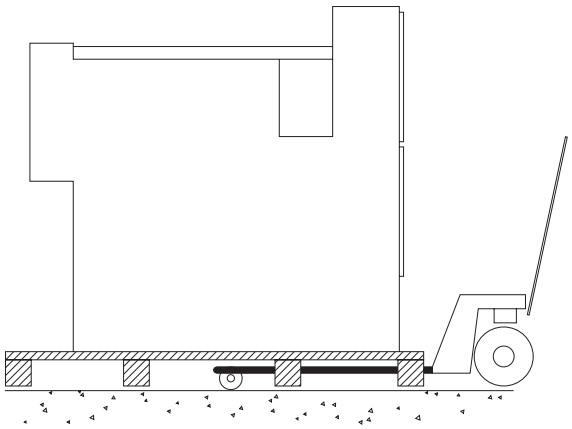


Figure 2.3 Positioning by pallet jack

Care must be taken to ensure that the cubicle does not tip over during this operation

D. Positioning using rollers

- care must be taken not to damage the cubicle base
- position the cubicle on the rollers placed under a strong metal sheet
- move the cubicle to the required position
- remove the rollers and metal sheet once the cubicle is in position

Cubicles are secured to the pallets through the floor fixing holes (refer to figure 2.5). The securing bolts must be removed before attempting to remove the cubicle from the pallet.

2.1.3 Intermediate storage conditions

If the switchgear and its components have to be stored after manufacture and before installation observe the following conditions:

- the switchgear must be stored in a dry, well-ventilated, dust free, non-corrosive environment
- there should be no notable change in temperature
- the switchgear must not be stored outside
- store the switchgear cubicles standing upright
- do not stack switchgear cubicles
- do not remove or damage the packaging
- for storage periods longer than six months, hygroscopic substances must be placed inside each cubicle, with at least one standard bag per switching device. The bags must be replaced about every six months. If cubicles are to be stored for a specified period, ABB will supply (on request) packaging for the specified period and conditions.

2.2 INSTALLATION OF THE SWITCHGEAR

2.2.1 General

Correct installation of switchgear is of great importance. The manufacturer's instructions and drawings must be studied and followed carefully. The drawings include overall views, front and cross sectional views and other order related data i.e. floor plans, drilling requirements, substation layout etc.

2.2.2 General site requirements

Maximum ambient air temperature	+40 °C
Minimum ambient air temperature	-5 °C
Maximum relative air humidity	95 %

For other conditions please consult ABB's engineering department.

The site and installation room must be complete prior to installation of the switchboard. In particular:

- the site must have electricity supply
- the site must be accessible via road
- the installation room as given below must be complete, and lockable
- preparation for laying of cables must be in place
- the foundations and fixing surface must be prepared as given below

2.2.3 Installation room

The switchboard must be situated in a room according to the scale and layout as given in the contract specific documentation.

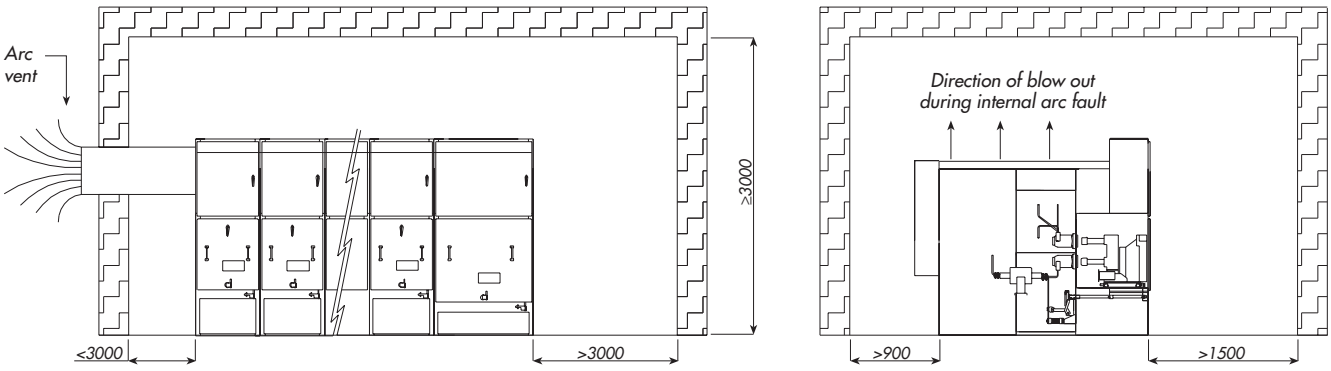


Figure 2.4. Minimum distance to walls and minimum ceiling height for internal arc proofing

When designing the switchboard-room, account must be taken of the exhaust gas that may be emitted during internal faults. Figure 2.4 shows the minimum distances to the walls and the minimum height to the ceiling, for installing switchboards with internal arc proofing, in accordance with IEC 60298, access type "A". The distance from both ends of the switchboard to the walls must be equal to or greater than 3000-mm. In all cases, special attention must be paid to the overpressure which can be produced inside the switch-room during conditions of an internal arc fault.

For smaller distances a duct must be installed to conduct gases away from operators to outside the switchroom. Please consult ABB's engineering department in these special circumstances.

2.2.4 Foundations and fixing surface

The floor or foundations must be strong enough to support the weight of the switchboard. The foundations must be made in good time before the installation to allow for correct curing as given in the technical documentation.

The switchboard must be installed on floors or foundations that are smooth and have a level surface. A level tolerance of approximately 1-mm per 1- m measured length is required.

Figure 2.5 shows the standard floor fixing dimensions.

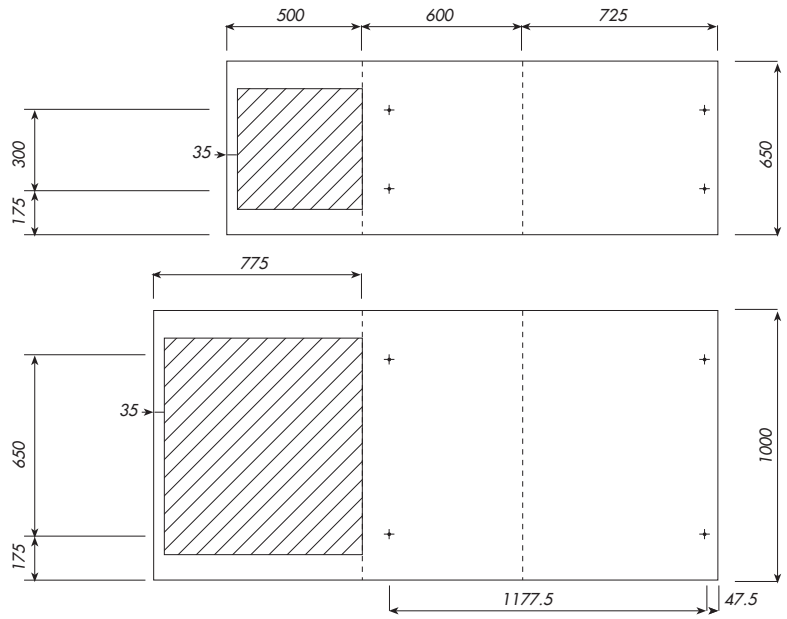


Figure 2.5 Floor fixing dimensions

Depending on the foundations provided it is also necessary to follow these instructions

a) Fixing without floor channels: Level the floor both longitudinally and transversely.

b) Fixing with floor channels eg. Unistrut: Construct the floor channels as shown in the drawings, ensuring the channels are level and straight.

2.2.5 Installing switchboard sections

For correct installation, the switchboard must be installed according to the following instructions:

A) positioning, alignment and leveling of the cubicles
B) coupling of cubicles
C) securing of the cubicles to the floor
D) connection of the power circuits and the auxiliary control cables
E) completing the installation

A. Positioning, alignment and leveling of the cubicles

To facilitate positioning it is advisable to remove all the withdrawable parts (circuit-breakers, and voltage transformers) from the cubicles.

To obtain correct alignment of the cubicles it is advisable to trace a straight line a few centimeters from the front, parallel to the final position of the switchboard. When positioning and fixing make sure the distance from this line to each cubicle is constant. Care must be taken with regards to cubicle alignment as final installation of the earth bar could be difficult in the case of misaligned cubicles.

To level the cubicles, it is advisable to start positioning the cubicles from the highest floor point. Position the first cubicle making sure it is level. Position the adjacent cubicles making sure they are level to the first cubicle, and so on. Shims as required can be placed under the cubicles to level them.

THREAD	WITH OIL OR GREASE (N.m)
M6	4.5
M8	10
M10	20
M12	40
M14	60
M16	80
M20	160

Tolerance –0% +20%

Table 2-1 Recommended nominal torque settings

The tightening torque's for fixings and couplings are as given in table 2-1. Note that oil or grease must be applied to the fastening surface, prior to fitting of the bolts and nuts.

B. Coupling of cubicles

Cubicles are coupled together to form the complete switchboard by a) fastening the cubicles, b) installing the main busbars, c) connecting the earthing bar, d) connecting the auxiliary interconnections between cubicles

a) Fastening of cubicles. Access to the cubicle coupling holes is obtained by removing the rear cover plates, front cover plates and switching device door. Proceed as follows:

- remove front and rear cover plates
- remove switching device compartment door
- fasten cubicles using M8 x 25 mm nuts and bolts through the fixing holes as shown in figure 2.6. Fixing holes may vary depending on construction, i.e. single busbar, double busbar etc. The fixing holes for cubicles supplied in a suite will be matched
- end panels may be fitted with covers (on request) as shown in figure 2.7.
- all holes must be closed with fixing bolts on the end panels to achieve the required IP rating.

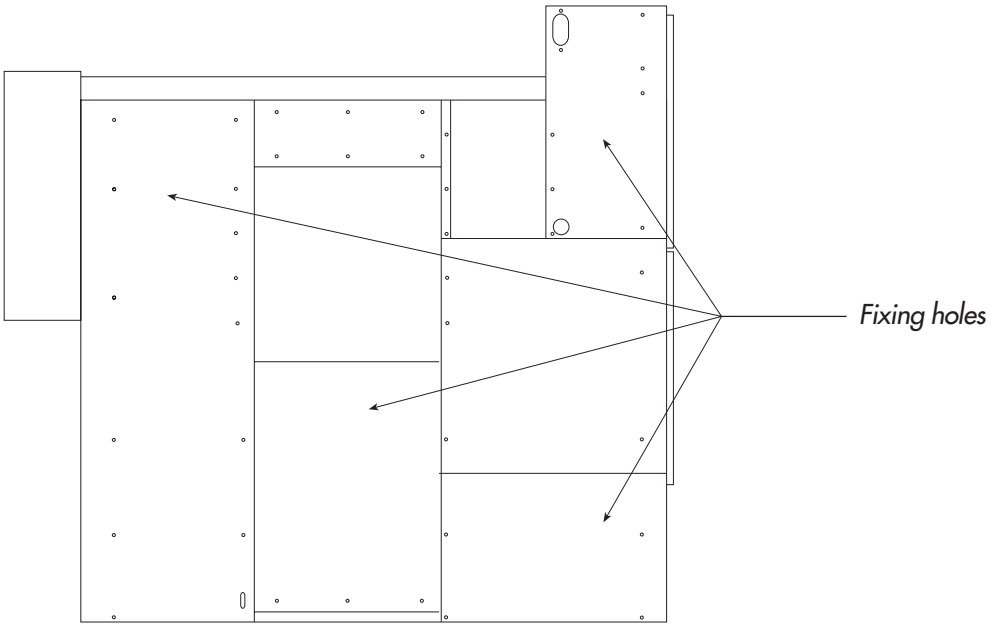


Figure 2.6 Fixings for coupling of cubicles

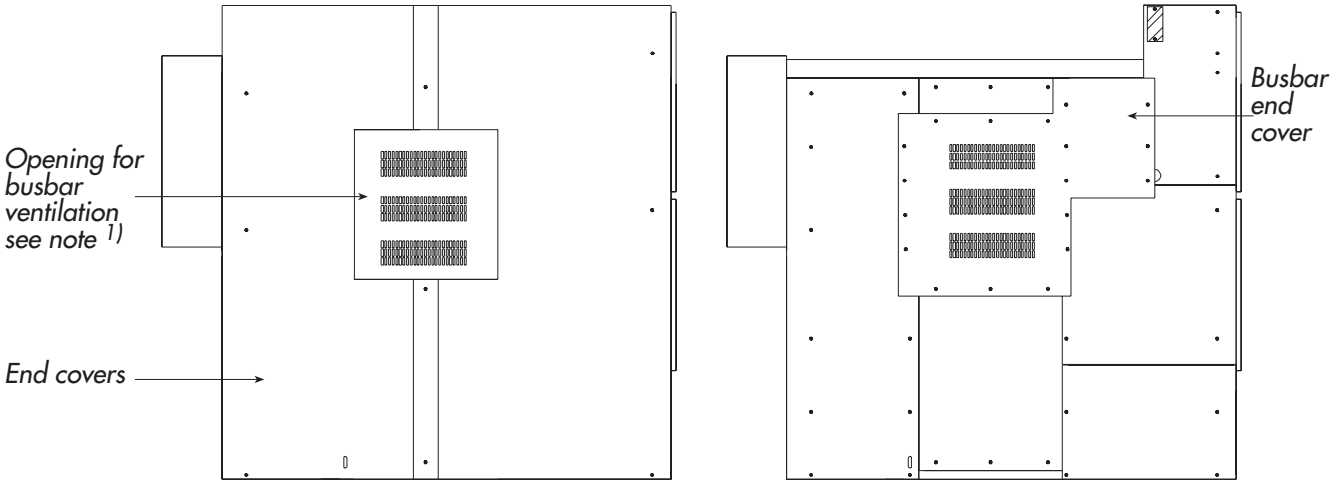
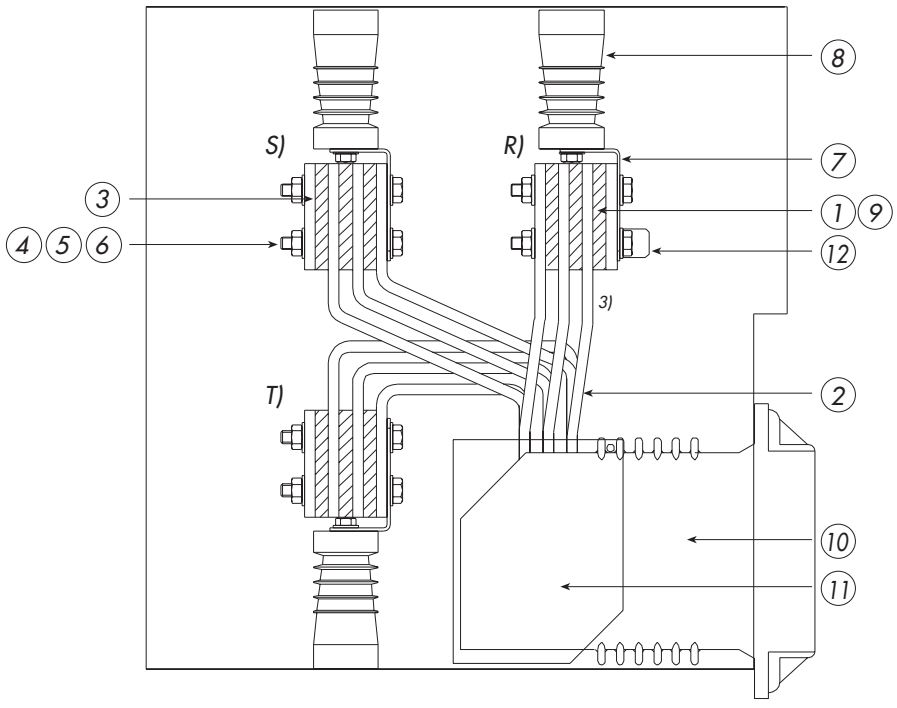


Figure 2.7 Cubicle end panels

b) Installing main busbars. Busbars are shipped in sections, and packed with all the parts required for coupling. Access to the busbar compartment is from the rear through the cable compartment. Proceed as follows:

- remove rear covers
- remove inner busbar compartment access plates
- clean the busbar contact area with a clean cloth soaked in alcohol or a suitable solvent
- grease the contact area with neutral grease
- couple the busbars to the tee off connections as shown in figures 2.8 through to figure 2.14
- tighten the busbar connections to the required torque as given in table 2-1



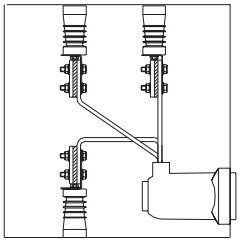
1. *Main busbar*
2. *Terminal connection coppers*
3. *Fish plates*
4. *M12 bolts, see note 2)*
5. *M12 dome washer*
6. *M12 nut*
7. *Support bracket*
8. *Support insulator*
9. *End plate*
10. *Terminal insulating spout*
11. *Flash barrier cover*
12. *Bolt cap*

2) 800 ...1600A bolt length = 55mm
2000 ...2500A bolt length = 80mm
3150A bolt length = 100mm

3) Terminal connection coppers insulated using heat shrink

Figure 2.8 Legend for busbar compartment

630 A ...1600 A Tee-off cubicle with
800 A ...1600 A Busbars



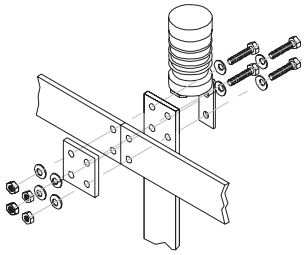
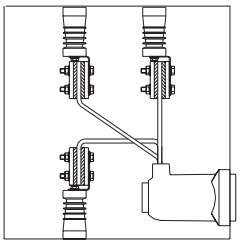


Figure 2.9

630 A ...1600 A Tee-off cubicle with
2000 A ...2500 A Busbars



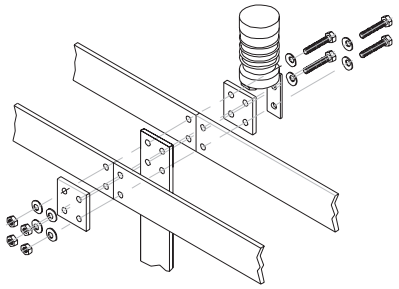
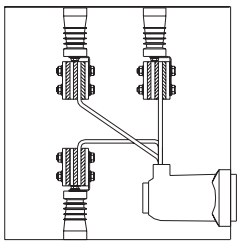


Figure 2.10

630 A ...1600 A Tee-off cubicle with
3150 A Busbars



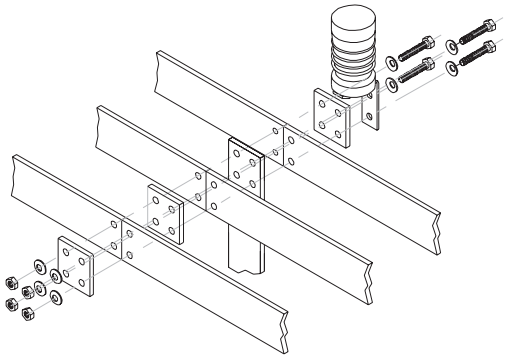
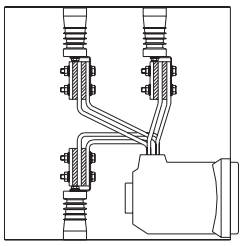


Figure 2.11

2000 A ...2500 A Tee-off cubicle with
2000 A ...2500 A Busbars



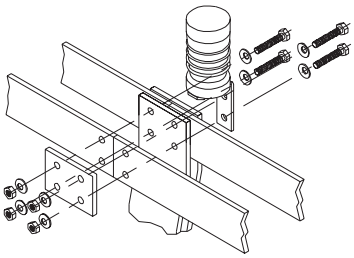
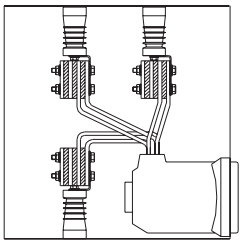


Figure 2.12

2000 A ...2500 A Tee-off cubicle with
3150 A Busbars



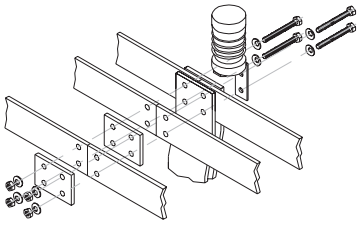
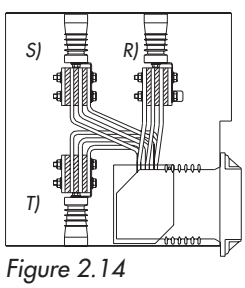


Figure 2.13

3150 A Tee-off cubicle with
3150 A Busbars



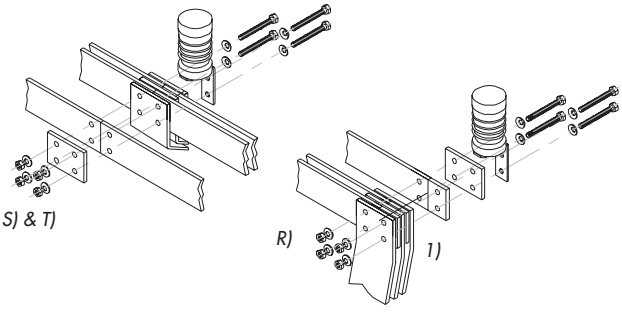


Figure 2.14

1) A half finish plate is provided for end cubicle busbars.

c) Earthing bar connection. All cubicles are normally shipped with earthing bars fitted. Proceed as follows:

- remove the rear cover plates
- clean the earthing bar contact area with an emery cloth
- fasten the earthing bar by means of a M8 x 35 mm bolt with flat and spring washers and nut, to the required torque (refer to figure 2.15)
- both ends of the switchboard earthing bar must be connected to the main earth network

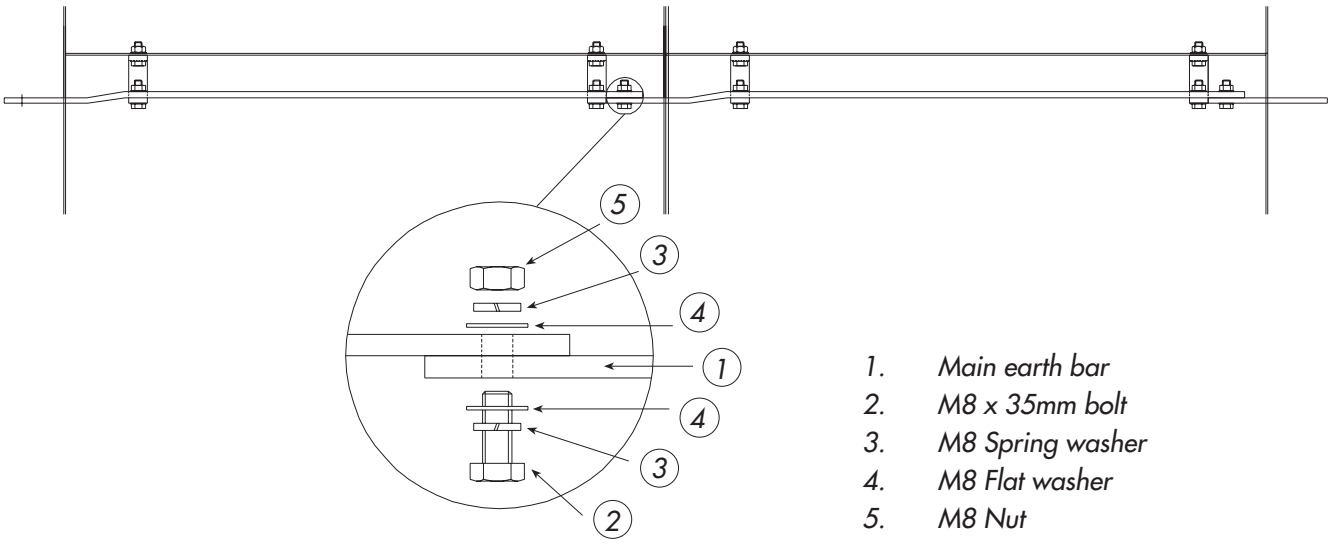


Figure 2.15 Earth bar connection

d) Auxiliary interconnections. Switchboards normally require auxiliary interconnections (buswiring) between cubicles. The buswiring should be done in accordance with the termination schedules/drawings provided in the technical contract documentation. The interconnecting wires are not connected but are temporarily coiled up, placed in the instrumentation compartment. Proceed as follows:

- uncoil the interconnecting wires
- connect the wires in accordance with the termination schedules/drawings supplied
- securely fasten all terminals after interconnections are complete

C. Securing of cubicles

The fixing holes are located in the cubicle base plate. Access to the fixing points for securing of cubicles requires removal of the rear and front cover plates.

a) Fixing without floor channels:

- drill the fixing holes, 4 x Ø11 mm holes per cubicle are required.
- Secure the cubicles to the floor using M8 fixing bolts (sleeve anchor type) trough the cubicle base plate into the fixing holes, refer to figure 2.17

1. *M8 x 50 Sleeve Anchor bolt*
2. *M8 Nut*
3. *M8 Flat washer*
4. *Sleeve anchor*
5. *Cubicle base*

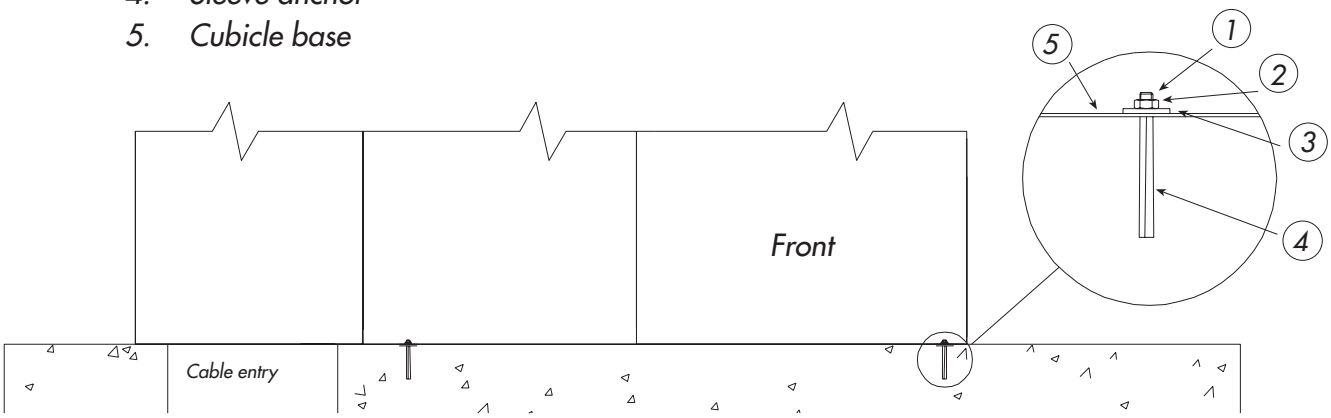


Figure 2.16 Fixing to floor without floor channels

b) Fixing with floor channels i.e. Unistrut:

- Secure the cubicles to the floor channels with M8 fixing bolts trough the base plate into channel fixing nuts, refer to figure 2.17

1. *M8 Bolt*
2. *M8 Flatwasher*
3. *M8 Spring nut*
4. *Floor channel*
5. *Cubicle base*

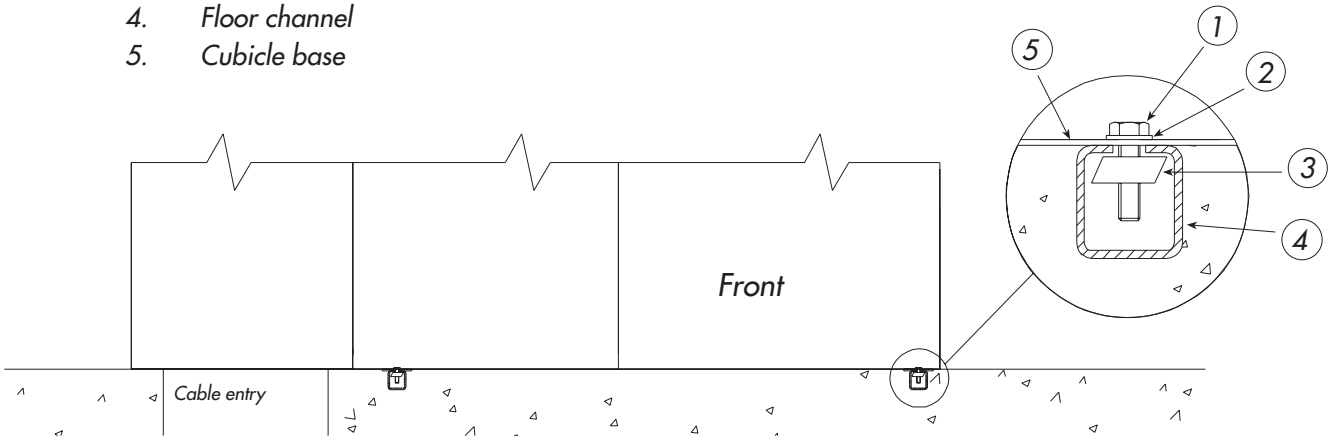


Figure 2.17 Fixing to floor with floor channels

D. Connection of the power and control cables

a) Power-cable connections. The power-cable connections are accessible from the rear of the cubicle and located in the power-cable compartment. When connecting the power-cables special attention must be given to the phase sequence to ensure safe paralleling of two systems, correct direction of rotation of motors supplied and the correct operation of the metering and protection systems. When cable terminations are made in the switchboard, suitable measures must be taken to prevent sharp bends, which might damage or destroy insulation. Also pay attention to the manufacturers instructions regarding bending radius of cables, termination instructions, and recommended clearances. Each cable must be anchored separately and fixed to the cubicle using an acceptable method of termination. When required the cables may have a separate earth to be connected to the main earthing bar. Proceed as follows:

- remove the rear cover plates
- check the contact surface is flat and clean the terminals
- if necessary eliminate burrs, dents and traces of oxidation with a file or emery cloth, carry out surface treatment again
- remove the gland plates and prepare holes in these for the cables
- prepare the cable termination by following the manufacturers instructions for the cable and terminations
- fix the cable to the gland plate and fasten the gland plate to the cubicle
- connect the cable using bolts and nuts, refer to figure 2.18
- if required complete the installation using insulation tape
- close the compartment

Flash barriers provided should not be removed. Where these have been removed to facilitate cable termination, ensure that the barriers are reinstalled as shown on the drawings.

b) Auxiliary cable connections. The auxiliary cable terminations are normally located in the auxilary control cable compartment. To connect the auxiliary cables refer to the termination schedules for each cubicle. Refer to figure 2.19

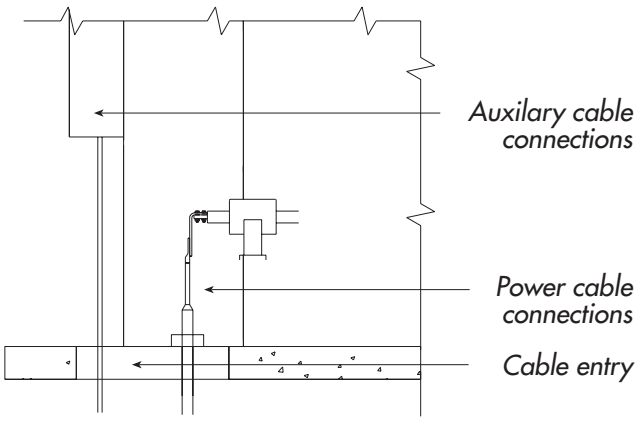


Fig 2.18 Cable connection

E. Completing the installation

- Insert all withdrawable parts removed during installation, into the cubicles i.e. circuit-breakers, contactors and voltage transformers.
- In certain cases delicate auxiliary equipment may be dismantled and shipped separately. This equipment must be carefully checked on receipt and fitted into its original position or stored until final installation.
- Any damage to painting i.e. scratches and scrapes made during installation, can be repaired using the paint supplied with the switchboard. Refer to the instructions given in section 5.3.
- Ensure all withdrawable parts are in the test position

Refit all removable covers. To ensure the integrity of the cubicles under conditions of internal arc, it is vital that all bolts and fixings associated with removable covers are correctly replaced.

3. COMMISSIONING

Before commissioning carry out the checks below. As a minimum requirement these tests must be made. In addition, for special requirements other tests as required by the contract may also have to be performed before the power circuit is energised.

3.1 CUBICLES

- Visually check the inside and outside of all the cubicle compartments, making sure there is no evident of damage. Remove any foreign bodies (such as tools or test connections), which might have been forgotten during installation.
- Carefully clean insulating parts, removing any traces of humidity, dust, and grease etc.
- Remove dust or dirt from the air intake grids and from the vents. Ensure the air vents (when fitted) are open, allowing air to flow through the switchgear.
- Ensure all power connections have been tightened to the torque as given in table 2.1.
- Ensure all necessary flash barriers are fitted.
- Ensure all the internal and external covers are fitted with all required fixings.
- Ensure correct operation of interlocks.

3.2 PRIMARY CIRCUIT CONNECTIONS

- Check tightness and continuity of the primary circuits as given in table 2-1

3.3 MAIN AND EARTHING BUSBARS

- Check tightness and continuity of the busbars as given in table 2-1.
- Check earthing efficiency according to the safety standards.

3.4 INSULATION

- Check the insulation resistance of the power circuits (between phase-phase and phase - ground) using a 2500 V or 5000 V Megger. The switchboard must not be put into service if the measured value is very low, for example below 5MΩ. The insulation resistance can be influenced by humidity. If the low insulation resistance is caused by humidity, use temporary heaters.
- The insulation resistance must remain constant after any voltage tests.

3.5 CIRCUIT-BREAKERS AND CONTACTORS

- Carry out the operations as prescribed in the relevant instruction manuals before commissioning.
- Check the operating mechanism and accessories for normal operation.
- Check the racking operation of the switching device.
- Insert the equipment into their correct compartments and connect the auxilliary plugs
- Close the compartment door and rack the equipment into the “service” position
- Close and open the circuit-breakers and/or contactors a few times.

3.6 EARTHING-SWITCHES

- Check the earthing-switch opens and closes as described in section 4.1.2
- Close the earthing-switch

Do not connect an earthing-switch to cables that have been powered up i.e. incoming cables.

3.7 PROTECTION, METERING AND CONTROL AUXILIARY CIRCUITS

- Carry out all necessary current/voltage injection tests and functional tests in accordance with the switchboard drawings, to ensure circuits are correct.
- Check required protection co-ordination has been completed and settings of all the various relays installed have been applied.
- Check the insulation resistance of auxiliary circuits using a 1000V Megger. The measured value must be at least a few tenths of MΩ for the auxiliary circuits. During this test ensure that all instruments that could be damaged by the high voltage are disconnected.

3.8 CURRENT TRANSFORMER SECONDARY CIRCUITS

Special attention must be paid to secondary circuits of the current transformer circuits. Check that the circuits are earthed and connected to the relative protection circuit and/or measuring circuit, then eliminate (if provided) any short circuit connection. It is important to note that current transformer secondary circuits must not be open circuited in service as this could lead to damage of CT's and subsequent failure.

3.9 VOLTAGE TRANSFORMER SECONDARY CIRCUITS

In case the secondary wiring of the voltage transformer has to be connected to equipment outside the switchboard, the following conditions must be determined, to prevent overloads or short circuits:

- Check that the total load connected to the voltage transformer does not exceed the rating of the voltage transformer
- Check that there are no incorrect connections in the circuit (even temporary ones) and, are in compliance with the schematic diagram of the switchboard, and of other installation units.
- Check that only one phase of the secondary wiring is earthed. This is particularly important on the supply side of equipment interconnected by means of a bus-tie (bus-section).

3.10 FINAL CHECKS

On completion of the preliminary tests carry out the following general checks:

- Check that various mechanical and electrical interlocks (which may have been disconnected to carry out tests) are reconnected and functional.
- Open and isolate all circuit-breaker and/or contactor trucks.
- Eliminate all test connections.
- Make sure all internal compartments and external cover plates are fitted and secured.
- Make sure all compartment doors are closed.

3.11 ENERGISING THE SWITCHBOARD

- Clear all isolations or plant lock-outs.
- Open all earthing-switches (compatible to installation requirements) to ensure no live circuits will be short-circuited via an earthing-switch.
- Energise the auxiliary circuits and the power circuit.
- Close the circuit-breakers and/or contactors (compatible with installation requirements) making sure that each operation is carried out correctly.
- Lock the compartments with control locks (if required).
- Check correct operation of the measuring instruments.

It is advisable to charge all the circuit-breaker-closing springs manually before supplying the auxiliary circuits to avoid any excessive current absorption due to simultaneous start up of the spring wind motors.

All operations (switching and isolation) must be carried out with the switching device door closed and firmly secured.

4. OPERATING PROCEDURES

4.1 MECHANICAL OPERATIONS

4.1.1 Switching device (circuit-breaker / contactor)

On request a special truck is available to transfer the circuit-breakers.

Refer to the manufacturers operating instructions as listed under section 1.1 for the applicable switching device.

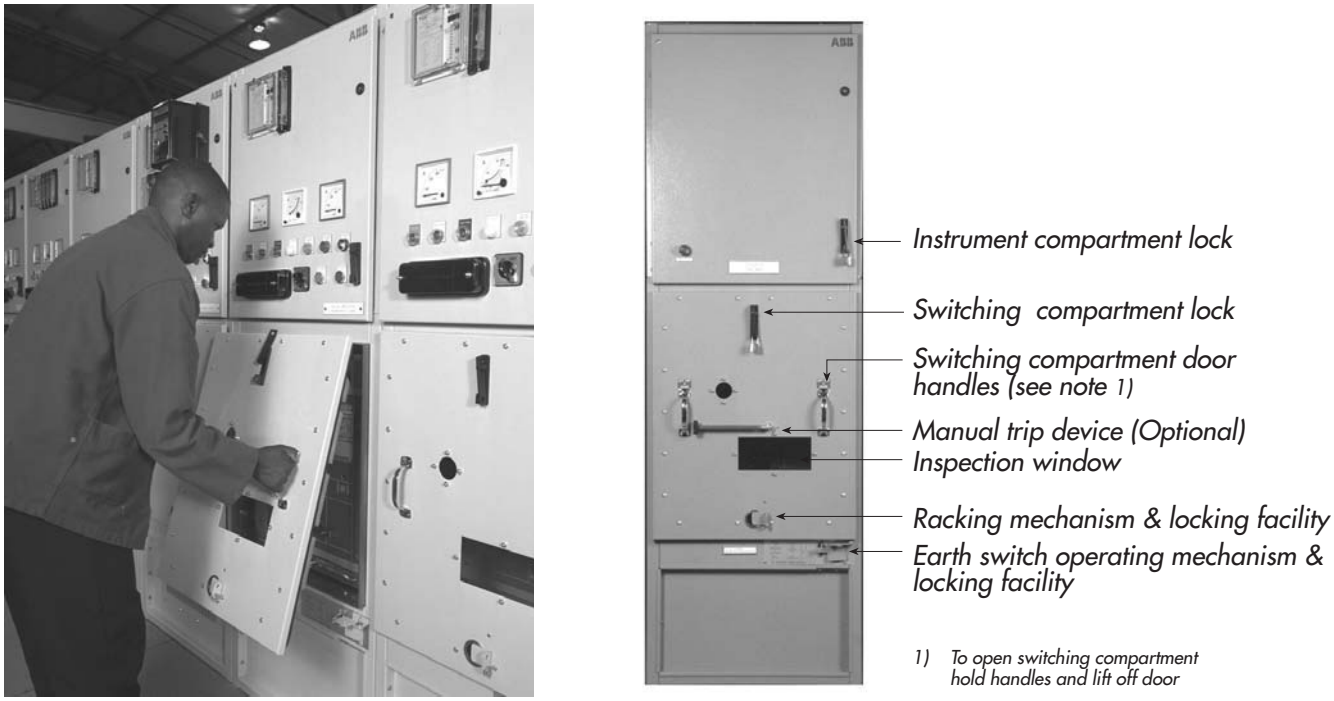
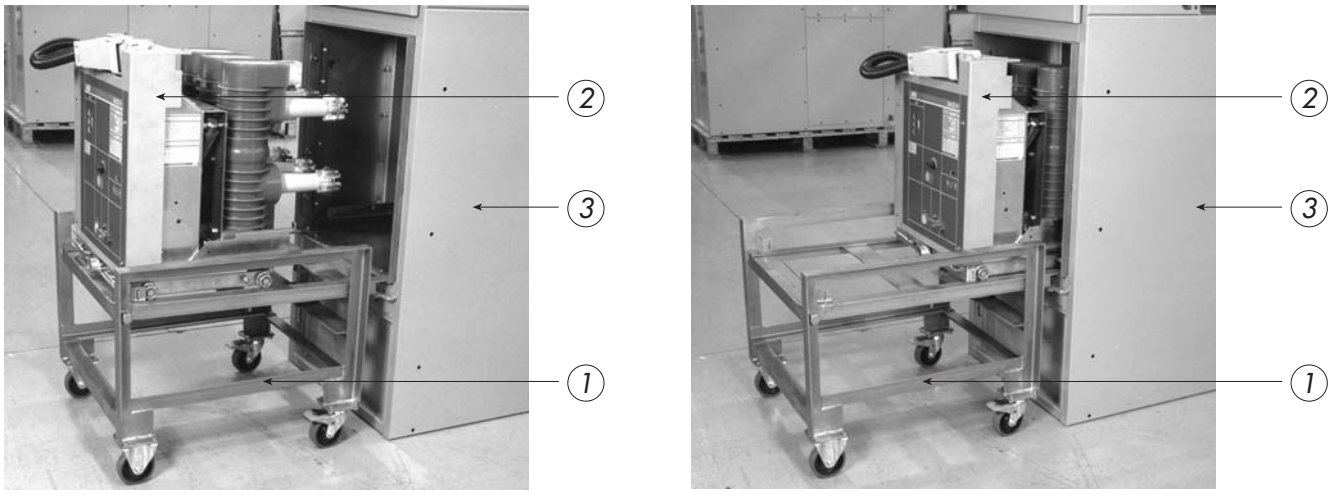


Figure 4.1 Front of cubicle

To ensure protection against internal arc faults, the operator must ensure the switching compartment door is properly secured before any switching operations are performed.



1. Switching device truck 2. Switching device 3. Cubicle

Figure 4.2 Inserting/removing the switching device

a) Lift the switching device using a special hoist/crane. Place it on the transfer truck and hook it into the appropriate position.

b) Insertion of the switching device into the switching compartment, and racking the switching device from the test to the service position is achieved as follows:

- Open the compartment door, if present (figure 4.1), by releasing the door lock and lifting the door up to remove.
- Bring the truck (1) with the switching device (2) close to the compartment (3).
- Position the switching device rollers in line with the guide rails in the compartment.
- Release the switching device and move it into the compartment (figure 4.2).
- Secure the switching device into the compartment (figure 4.3), ensure that side locking bars locate correctly in the guide rails.
- Connect the auxiliary wiring multiple plug connector, (figure 4.4).

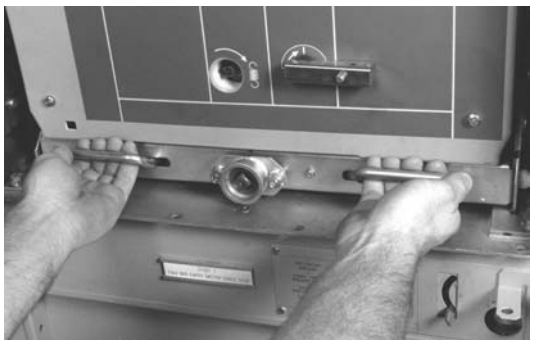


Figure 4.3 Securing/removing the switching device

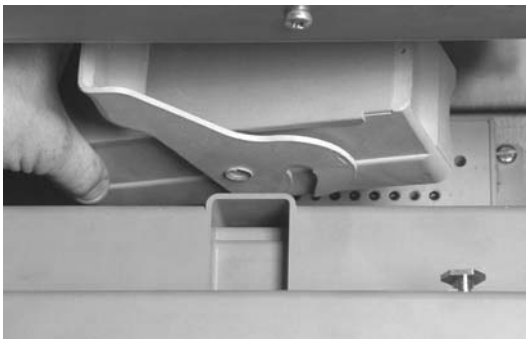


Figure 4.4 Inserting/removing multiple plug connector

- Fit the switching compartment door by placing the door in the correct position and pushing down. When secure, the door lock should be moved into the locked position.
- The switching device is now in the test position.
- Unlock the racking mechanism, insert the crank handle into the switching device racking mechanism (figure 4.5) and rotate the handle clockwise for approximately 20 turns until a dead stop is reached.
- If required, lock the racking mechanism (figure 4.6)
- The switching device is now in the service position, ready for operation.

Figure 4.5 Switching device racking

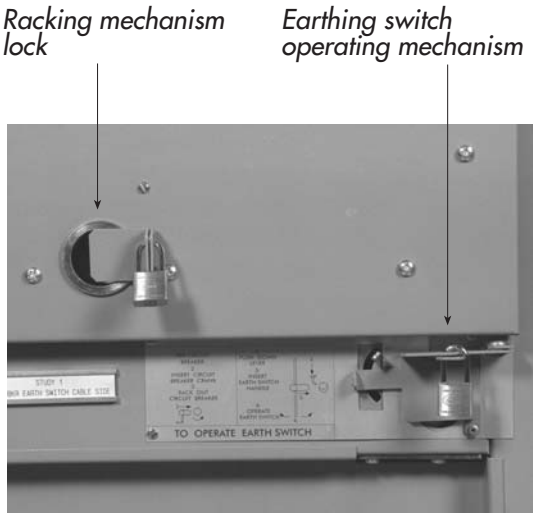


Figure 4.6 Racking mechanism and earth switch mechanism

c) Withdrawal of the switching device from the switching compartment, and racking the switching device from the service to the test position.
   - Open the switching device
   - Proceed in reverse order to the instructions given in points b).

All operations (racking, switching and isolation) must be carried out with the switching device compartment door closed and firmly secured.

The power contacts contained in the insulating spouts behind the segregation may be live. To prevent unwarranted access to the power contacts when the power contacts are live, the operator must lock the segregation shutters.

4.1.2 Earthing switch

The feeder cubicles are fitted (on request) with medium voltage cable earthing-switches. Earthing-switches are fitted (on request) to separate cubicles designed for busbar earthing. Refer to figure 4.7 for the earthing switch.

The earthing switch is a snap action type, enabling fast closure of the main contacts. Once the earthing switch handle is rotated the main contacts will close completely before opening is allowed.

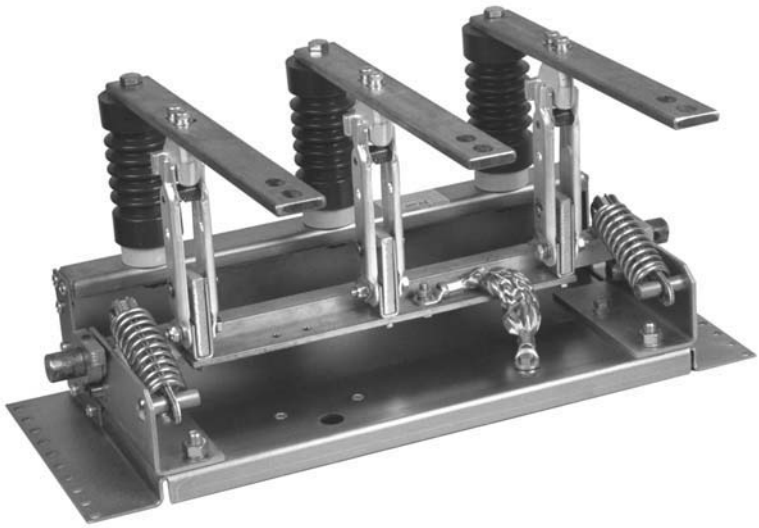


Figure 4.7 Earthing switch

Cable earthing

The procedure below refers to the cable earthing switch, refer to figure 4.8 and 4.9.

a) Closing the earthing switch
- Withdraw the switching device
- Unlock the interlock lever cover (figure 4.8)
- Move the interlock lever (figure 4.8) down to enable access to the earthing switch drive hexagonal shaft.
- Insert the operating handle onto the hexagonal shaft (4.9).
- Close the earthing switch by rotating the operating handle.
- Lock the interlock lever (figure 4.6)
- Confirm the earthing switch is closed by inspection through the viewing windows provided, see figure 1.24
- The earthing switch is now closed.

b) Opening the earthing switch
- Proceed in reverse order to the instructions given in points a).

Interlock lever up earth switch drive mechanism not accessible

Interlock lever down earth switch drive mechanism accessible

Figure 4.8 Earthing switch drive mechanism

The operator must ensure all live electrical connections to the circuit being earthed are disconnected before closing the earthing switch.

Busbar earthing

The procedure below refers to busbar earthing.

a) Closing the earthing switch
- Disconnect all circuits connected to the busbar
- Unlock the drive mechanism
- Insert the operating handle onto the drive shaft
- Close the earthing switch
- Lock the interlock lever
- Confirm the earthing switch is closed by inspection through the viewing windows provided.
- The earthing switch is now closed.

b) Opening the earthing switch
- Proceed in reverse order to the instructions given in points a).

Figure 4.9 Operating the earthing switch

4.1.3 Switch disconnector and fuse cubicle

Switch disconnector operation

a) Closing the switch disconnector
- Remove the lock from the drive mechanism.
- Insert the operating handle onto the disconnector drive splined shaft (figure 4.10).
- Release the locking facility by pulling the arrestor ring (figure 4.11) away from the bearing.
- Close the switch disconnector by rotating the operating handle.
- Lock the drive shaft (figure 4.12).
- The switch disconnector is now closed.

b) Opening the switch disconnector
- Proceed in reverse order to the instructions given in points a).

Figure 4.10 Switch disconnector / earthing switch drive

Earthing switch operation

a) Closing the earthing switch
- Remove the lock from the drive mechanism.
- Insert the operating handle onto the earthing switch drive splined shaft (figure 4.10).
- Release the locking facility by pulling the arrestor ring (figure 4.11) away from the bearing.
- Close the earthing switch by rotating the operating handle.
- Lock the drive shaft (figure 4.12).
- The earthing switch is now closed.

b) Opening the earthing switch
- Proceed in reverse order to the instructions given in points a).

Figure 4.11 Switch disconnector / earthing switch drive locking ring

Figure 4.12 Locking the switch disconnector /earthing switch drive mechanism

In the case of busbar earthing disconnect all circuits connected to the busbar, ensuring the busbar is not energised i.e. circuit-breakers, contactors, disconnectors, feed cables etc. before closing the busbar earthing switch.

A mechnical interlock is provided between the disconnector and cable earthing switch. Do not force interlock.

4.1.4 Testing the interlocks

The mechanical operations must be carried out using normal strength, without forcing the interlocks, and thereby preventing permanent damage. Excessive force may damage interlocks permanently allowing unsafe operation. Test the standard interlocking provided as follows:

4.1.4.1 The switching device can only be moved from the test/disconnected position into the service position (and back) with the switching device open, the earthing switch open, and earthing-switch drive mechanism access closed

a) Test when the switching device is in the test position.

- Close the switching device
- The switching device cannot be moved to the service position, as the racking handle will lock within approximately 3 turns. Return the switching device to the test position.
- Open the switching device
- Gain access to the earthing switch drive mechanism, by moving the interlock lever down.
- Close the earthing switch.
- The interlock lever is locked in the down position.
- The switching device cannot be moved to the service position, as the racking handle will lock within approximately 3 turns.

b) Test when the switching device is in the service position.

- The interlock lever is locked in the up position preventing access to the earthing switch drive mechanism.
- Close the switching device
- The switching device cannot be moved to the test position, as the racking handle will lock within approximately 3 turns.

4.1.4.2 The switching device can only be closed when the switching device is precisely in the defined test position or defined service position, and the switching device is ready for closing (i.e. circuit-breaker springs are fully charged)

a) Test when the switching device is in the traverse position between the test and service position.

- In the case of a circuit-breaker ensure the springs are charged.
- Move the switching device from the test position to the traverse position, by rotating the handle clockwise for approximately 4 turns.
- The switching device cannot be closed.

b) Test when the circuit-breaker is in the test or service position and the springs are discharged.

- Discharging the springs by closing and then opening the circuit-breaker after ensuring the motor supply is disconnected.
- The circuit-breaker cannot be closed

4.1.4.3 The earthing switch can only be closed when the switching device is in the test/disconnected position or the removed position

a) Test when the switching device is in the service position

- Access to the earthing switch drive is inhibited. The interlock lever cannot be moved down.

b) Test when the switching device is in the traverse position

- Move the switching device from the test position to the traverse position, by rotating the handle clockwise for approximately 4 turns.
- Access to the earthing switch drive is inhibited. The interlock lever cannot be moved down.

c) Test when the switching device is in the test/isolated position

- Access to the earthing switch drive is enabled. The interlock lever can be moved down.

4.1.4.4 The switching device cannot be moved from the test/isolated position into the service position when the earthing switch is closed or when access to the earthing switch drive is enabled

a) Test when access to the earthing switch drive is enabled, the interlock lever is in the down position and the earthing switch is closed.

- The switching device cannot be moved to the service position as the racking handle will lock within approximately 3 turns.

b) Test when access to the earthing switch drive is disabled, the interlock lever is in the up position.

- The switching device can be moved to the service position.

4.1.4.5 The switch disconnector cannot be closed when the earthing switch is closed and visa versa. (Switch disconnector cubicle)

a) Test when the earthing switch is closed.

- The disconnector cannot be closed.

b) Test when the earthing switch is open.

- The disconnector can be closed.

c) Test when the switch disconnector is closed.

- The earthing switch cannot be closed.

d) Test when the switch disconnector is open.

- The earthing switch can be closed.

4.1.4.6 The cubicle door cannot be removed when the earth switch is open (switch disconnector cubicle).

a) Test when the earthing switch is open.

- The cubicle door cannot be opened as the door bolt is trapped in the latched/locked position.

b) Test when the earthing switch is closed.

- The cubicle door can be opened as the door bolt is free to be unlatched.

Circuit/cable shutter safety Lock

Busbar shutter safety Lock

Figure 4.13 Shutter safety locks

4.1.5 Operator Locks

The switching compartment doors, operating/racking mechanisms and shutters provide for operator safety padlocks (not supplied) to be fitted thereby preventing unwarranted access. The user is responsible for fitting of safety padlocks and for control of the keys to the safety padlocks. Refer to figure 1.29.

To ensure that the switching device cannot be moved from the test position to the service position safety locks must be applied to both the racking locking device and the compartment door lock.

The following safety locks are available :

- Compartment door locks (figure 4.1), preventing access to the compartment.
- Racking lock (figure 4. 6) preventing access to the racking switching device racking mechanism.
- Earthing switch lock preventing access to the earthing switch, (figures 4.6 and 4.12).
- Shutter locks, preventing access to the medium voltage fixed contacts (figure 4.13).

4.1.6 Other Interlocks

Refer to contract technical documentation for other interlocks, which may be fitted.

4.2 ELECTRICAL OPERATIONS

Only trained personnel must carry out electrical operations, after the switchboard has been fully tested in accordance with the applicable schematic diagrams, wiring schedules, etc. and the switchboard is ready to be put into service.

4.3 VOLTAGE TRANSFORMER

4.3.1 Description

The voltage transformer compartment consists of an enclosure in which the voltage transformer is mounted, complete with relative protection fuses. The voltage transformer is completely withdrawable. The voltage transformer enclosure is fitted with:

- Shutters preventing contact with the medium voltage terminals when the voltage transformer is isolated.
- Provision for shutter safety locks, preventing access to the medium voltage contacts.
- Provision for safety locks preventing withdrawal and insertion of the voltage transformer

4.3.2 Testing of voltage transformer interlocks

a) With the voltage transformer in the withdrawn position and the shutter interlock locked:

- The shutter mechanism is closed.
- Access to the medium voltage terminals is inhibited.
- The voltage transformer can not be inserted into the service position

b) With the voltage transformer in the service position:

- Access to the voltage transformer medium voltage circuits/fuses is inhibited.

4.3.3 Voltage transformer mechanical and electrical checks

Prior to putting into service check the following.

- Check mechanical operation and interlocks.
- Check the voltage insulation of the main circuit with a 2500V Megger. The measured result should be not less than a few dozen MΩ.
- Check the voltage insulation of the secondary circuit with a 500V Megger. The measured result should be not less than a few MΩ.

4.3.4 Operating procedure for racking the voltage transformer into service

After carrying out the tests above, the operation described below must be carried out for putting into service. Considering the shutters are closed and the Voltage Transformer is withdrawn:

- Unlock the shutter interlock.
- Insert the voltage transformer.
- Lock the voltage transformer in place.

4.3.5 Maintenance of voltage transformers

Trained personnel must carry out maintenance. Before starting any maintenance work the personnel must carry out safety operations so that all live parts are without voltage and/or earthed.

4.3.5.1 Inspection frequency

To prevent deterioration of the insulation to dangerous levels, it is advisable to inspect the Voltage Transformer 6 months after putting into service. Thereafter the Voltage Transformer should be inspected each time the switchboard is maintained, as determined by the switchboard maintenance program.

4.3.5.2 Maintenance operations

a) Remove any dust from the insulating parts, using a clean dry cloth.

b) Check correct operation of levers and if necessary grease moving parts.

c) Inspect the main contacts, eliminating any blackness and if necessary clean with alcohol, protect them again with a layer of Vaseline grease.

d) When maintenance operations have been completed put the voltage transformer back into service.

5. MAINTENANCE PROCEDURES

The operations described in this chapter are only intended for normal maintenance and should eliminate wear on the apparatus due to usage.

Expert and qualified personnel must carry out the normal maintenance operations in order that the original safety and operation of the equipment be guaranteed. The owner of the installation is responsible for the maintenance operations.

It is good practice to keep a maintenance log book and record all the operations carried out in detail, together with the date, description of activity and reference to identify the apparatus, etc.

In case of necessity and for further details please refer to what is stipulated in art.10 of the IEC 60694 standard. In any case, should any problems occur please do not hesitate to contact ABB.

5.1 SAFETY REGULATIONS

Before carrying out any maintenance on the switchboard or the equipment installed it is compulsory to:

- turn off the power
- carry out all earthing required for the work

These operations must refer to the cubicle or section of the switchboard to be maintained and includes the power circuit of the auxiliary circuits. Only in case of dire necessity can some parts of the switchboard or cubicle remain in service.

In any case do not remove any partition of the switchboard before checking that the circuit has been de-energised, and safely earthed.

- Use safe well-insulated tools for low voltage operation.
- Use voltage detectors
- Use barriers and monitors for signalling danger
- Maintenance work must always be carried out in the presence of at least two other people.

5.2 GENERAL

Electrical equipment is sensitive to ambient environmental conditions and is easily damaged by abnormal conditions.

Dust, heat, cold, humidity, a corrosive atmosphere, chemical residues, fumes, vibrations, and other conditions can affect the performance and life of the electrical equipment. These conditions, especially when combined are certain to cause premature faults and damage. Repair costs can be avoided by following the recommendations of the manufacturer for application and maintenance. The most important rules in this respect are the following:

- Keep clean
- Keep dry
- Tighten bolts and connections
- Prevent excessive friction of mechanical parts

Instructions regarding maintenance of the various switchboard parts, excluding the equipment which is referred to in the specific instruction booklets, are given below, complete with tables regarding the maintenance program, operation checks and remedies for operating anomalies.

5.3 MAINTENANCE OPERATIONS

5.3.1 Metal Structure

The overall structure, including removable parts, vertical segregation sheets, hinges, doors, and locks are normally protected against corrosion by means of galvanising/plating, except for some parts, which are painted.

Painted parts

The switchboard doors and covers are painted with epoxy polyester resin, with a minimum thickness of 40-50 μm

Touching up

On request, sufficient paint for any touching up required after installation is provided with the switchboard.

Where possible follow the paint supplier's instructions. When these are not available carry out the following:

- with damp emery paper, clean the part to be touched up and smooth the edges around the damaged area
- prepare the amount of paint required for the repair, adding 30% catalyst by weight of the paint
- carry out the final touch up repair on a piece of sheet to check the appearance. Any brush stroke marks can be minimised by adding solvent. The product prepared in this way must be kept for in a refrigerator for 24 hours, after this period it solidifies.

Cleaning

For any cleaning of painted surfaces, a cloth with soap water or, in more difficult areas, common paint thinner can be used. However in the later case it is always advisable to test on a surface which is not in view, and check the thinner does not remove the paint.

Galvanised / plated components

All galvanised parts can be cleaned using a dry cloth. Any oil or grease can be removed using a cloth soaked in alcohol. Repeat the previous operation to make the surface shiny again.

Hinges

These are lubricated in our workshop during assembly. If necessary lubricate periodically, with oil or grease.

5.3.2 Mechanical movements

Al the moving parts are lubricated during factory assembly and testing. For any problems with switchboards already installed, please seek assistance from ABB.

The mechanical interlocks must not be ignored but correctly used to prevent dangerous situations from arising.

Knowledge of the interlock procedure is important so that correct operation in all situations can be completely checked.

When operation is prevented, test the mechanical operating sequence before forcing the mechanical interlock.

Mechanical interlocks must be positioned in the final locked and unlocked positions without stopping in the intermediate positions. The mechanical interlocks must be tested several times to ensure that their movement is free, also checking the force required to carry out the operations.

In all cases, correct interferance of the mechanical interlock operating part and with the interlocked equipment must be checked. If excessive force is needed it means that the device is prevented from moving by alteration of the adjustment of the mechanism itself. To test the device proceed as follows:

- when provided remove the switching device, clean it and, if necessary, clean and lubricate the parts subject to movement or friction
- test free movement of all devices which make up the mechanism; pins, levers, plugs, screws, nuts and washers, etc, and if necessary clean and lubricate them
- adjust the device, checking the force required for movement

If a defective component is noticed during tests and cannot be replaced, note this down in the maintenance logbook, indicate the anomaly with a tag on the cubicle, and inform the operating personnel. For interlock operation and safety locks of the circuit breaker trucks, see the relative installation, service, and maintenance instructions, referred to in section 1.1.

5.4 MAINTENANCE PROGRAM

The time intervals shown in the table 5.4.1 refers to normal ambient environmental conditions (atmosphere, vibrations...) and is the minimum required for safe operation and long life.

For more severe conditions (which must, however, be declared at the time of order and allowed for during the construction stage), these intervals must be reduced.

During the initial period of operation, it is always necessary to make more frequent checks to establish a correct preventative maintenance program. Equipment supplied with the switchgear must be maintained as per instructions laid out in the manuals listed in Section 1.1

5.4.1. General Inspections

PART SUBJECT TO INSPECTION	TIME INTERVAL	INSPECT FOR	REMEDIES
Metal structure	12 Months	• Presence of dirt or scratches	• Clean or touch up
Painted parts Hinges	24 months	• Presence of dirt grease or rust • Presence of dirt	• Clean or remove rust, touch up • Clean and oil
Mechanical activating elements Forced locks Prevention locks Safety locks	12 months	• Presence of dust or rust • Higher than normal operating force • Alteration to the adjustments	• Clean and remove the rust • Check the locking sequence • Adjust the mechanism
Isolating contacts	12 Months	• Blackening of silver-plated surfaces	• Clean and remove with alcohol and protect the surfaces with Vaseline grease
Fixed contacts	24 Months	• Blackening of silver-plated contact surfaces in ambients with H_2S or SO_2 present and in saline ambients	• Clean and remove with alcohol and protect the surfaces with silicone grease spray
Circuit breaker trucks Special trucks	12 months	• See relative installation, service and maintenance instructions	• Carry out recommendations
Busbars Main Busbars Branches Connections	12 months	• Traces of discharges or traces of lampblack • Loose screws	• Clean with solvent • Tighten screws
Earthing Earthing bus-ties Compartment earthing connections Connections to earthing network	12 Months	• Traces of discharges or traces of lampblack • Loose screws	• Clean with solvent • Tighten screws
Auxiliary connections	12 Months	• Loose connections	• Tighten connections
External connections Power circuits Auxiliary circuits	12 Months	• Traces or presence of lampblack	• Clean with solvent • Remove any traces of oxidation with an emery cloth
Insulation resistance check Power circuits Auxiliary circuits	12 Months	• Insufficient resistance see note 1)	• Look for weak point

1) Measure the insulation resistance using the same methods given for commissioning. The values obtained must not differ greatly from those taken at the time of commissioning. Should the insulation have notably decreased, carry out the voltage tests. It is advisable to measure the insulation resistance before and after the voltage tests to facilitate localization of the fault .

5.4.2. Operational Checks

PART SUBJECT TO INSPECTION	TIME INTERVAL	INSPECT FOR	REMEDIES
Control circuit Power supplies Local controls Remote controls	12 Months	• No power supply • No contactor opening or closing	• Check the power supply circuit • Using the schematic diagrams, check operation of the control devices (pushbuttons, circuit-breakers, auxiliary relay contacts, terminals, cables, etc.).
Controls Signalling devices	12 months	• No working sequence of one or more of the foreseen functions • Do not light up	• Using the schematic diagrams check the circuits and intervene as necessary. • Check the power supply circuit. • Check the necessary lamps are working and if necessary replace them
Measuring devices	12 months	• Irregular or missing indications	• Check the measuring circuit operation including current and/or voltage transformers and any measuring transducers • Check the operation of the measuring instruments using testing equipment.
Protection	12 Months	• Unwarranted or no intervention	• Check the measuring circuit efficiency including current and/or voltage transformers and any measuring transducers • Check the efficiency of the protection relays using testing equipment. • Check the protection relay functions as well as the protection settings • Check the power supply relays as well as the tripping circuits.
Service circuits Socket outlets	12 Months	• Not working	• Check the power supply circuit • Check the socket functionality
Mechanical interlocking devices	12 months	• Incorrect operation of the mechanical interlocking devices	• Check adjustments

6. CORRECTIVE ACTION IN CASE OF OPERATING DEFECTS

If programmed maintenance is efficient and installation is correct, intervention for operating anomalies should not be necessary, except in cases of electrical or mechanical parts wearing out (e.g. signalling lamps).

DEFECT	PROBABLE CAUSE	CORRECTIVE ACTION
Metal structure buzz	Incorrect tightening of: • Segregation sheets • External closing panels	• Check sheet and closing panel fixing
Compartment heating	Insufficient ventilation: • Blocked ducts • Blocked louvers • Ventilation flap closed	• Unblock • Open flap
	Incorrect tightening of: • Bus-ties • Branches • Power circuit connections	• Check bus-tie branch and terminal tightness
	Isolating contacts: • Bus-ties • Branches	• Check isolating contact pressure, cleanliness, and lubrication
	User overload:	• Reduce overload
Incorrect operation of equipment	• Circuit-breakers • Various components • Protection and control • Signalling devices	• See the relative service, installation the and maintenance instructions • Look for possible causes, consulting the schematic diagrams of the switchboard • Auxiliary supply beyond the permitted tolerance limits • Replace the faulty part or reset supply conditions
Unwarranted tripping of the circuit-breakers or opening	• No auxiliary supply • Overheating	• Restore the auxiliary supply • Check isolating contact pressure, cleanliness, and lubrication • On the basis of the installation selectivity diagrams, check the settings of the relative protection devices
	• Fault in the protection	• Replace or repair protection

7. ACCESSORIES AND SPARE PARTS

7.1 NORMAL COMPLETION ACCESSORIES

The switchboard is normally supplied complete with:

- Loading pallet
- Sleeve anchor bolts for fixing the panel to the floor
- Busbar side cover, for closing the busbar compartment
- Busbars, with fixings
- Handle for switch operations, see figure 7.1
- Handle and lever for switching device racking and charging springs (if applicable)
- Design drawings and schematics
- Installation, service and maintenance instructions

Standard earthing switch operating handle

Isolator and earthing switch operating handle (for locking type drive mechanism)

Figure 7.1 Operating Handles

7.2 OPTIONAL ACCESSORIES AND COMPLETION ITEMS

The switchboard can be supplied with the following items. Specific details will be contained in contract documentation.

Medium voltage components

- Voltage transformer compartment
- Current transformers
- Toroidal current transformers for cables
- Earthing switch
- Earthing truck
- Surge protection

Low voltage components

- Anticondensation heaters
- Protection relays, auxiliary relays, control knobs, position-signalling device's, flag relays, circuit-breakers, fuses, terminal boxes etc.
- Instrument compartment illumination lamp, plus 220v socket outlet.

Other components

- Side panels for closing the ends of the switchboard
- Rear covers for increased protection against internal arc faults
- Switching device transfer truck
- Switching device test truck or probes, for test and injection onto the medium voltage contacts
- Key and electromechanical interlocks
- Touch up paint

7.3 SPARE PARTS

- For circuit-breakers see the relative installation, service and maintenance instructions.
- For other equipment the quantity to be kept in stock must be evaluated on a case by case basis:
  - Protection relays
  - Auxiliary relays
  - Control knobs
  - Position indicators
  - Flag relays
  - Auxiliary switches
  - Sockets
- For consumable goods such as signalling lamps, fuses, and terminals for terminal boxes, a sufficient stock should be maintained.

When ordering spare parts, always specify the serial number of the switchboard on which the spare parts are to be installed. It is advisable to obtain as much detail as possible of the spare part and/or the replacement part being ordered.

The spare parts which can be supplied are as shown in the following table.

DESCRIPTION OF SPARE PART	ASSEMBLED BY CUSTOMER.
Complete earthing switch	No
Shutter with mechanism	No
Interlock device	No
Earthing switch contacts and fingers	No
Medium voltage isolating contacts	Yes

8 INSTALLATION AND COMMISSIONING CHECK LIST

1. NAME PLATE

Board Name _____

Date of manufacture _____ Serial number _____

Rated busbar current _____ A Rated voltage _____ kV

Short time current _____ kA _____ Sec Lightning impulse voltage _____ kV

Peak withstand current _____ kA Power frequency withstand voltage _____ kV

	CHECKED		CHECKED
2. SWITCHROOM		**4. GENERAL, VISUAL CHECKS AND SAFETY**	
2.1 Civil works and electrical installation complete		4.1 Installation complete	
2.2 Switchroom dust free and clean		4.2 Scratches on paint work touched up	
2.3 Switchroom ventilation in operation		4.3 Cleanliness ok.	
2.5 Auxiliary and control voltage available		4.4 Barriers, warning plates, lockouts available and fitted, no danger to personnel	
3 SWITCHGEAR INSTALLATION		4.7 Fire prevention equipment available	
3.1 Switchgear properly delivered and off loaded		**5. COMMISSIONING**	
3.2 Switchgear cubicles properly identified positioned, aligned and fixed to floor.		5.1 Mechanical operations of equipment checked eg. Opening, closing, racking, interlocks etc.	
3.3 Switchgear cubicles properly coupled i.e. busbars, buswiring, fastening etc.		5.2 Electrical operations, control, and metering circuits checked, for correct operation and functionality	
3.4 Main busbars, secondary busbars, and earth bar tightness checks completed		5.3 Current transformers checked eg. Magnetising curves, polarity, ratio etc	
3.5 Both ends of the switchgear main earth connected to earth network		5.4 Voltage transformers checked i.e. Interlocks, fuses, insulation resistance etc.	
3.6 Circuit and auxiliary cabling complete		5.5 Protection circuits checked i.e. Secondary and primary injection tests	
3.7 Switchgear is clean and all foreign material removed from switchgear.		5.6 Secondary circuit insulation resistance checked i.e. 1000V Megger test	
3.8 All equipment, CB's, VT's fitted in test position.		5.7 Primary circuit insulation resistance checked i.e. 2500/5000V Megger tests	
3.9 All covers, doors and barriers fitted and secured		5.8 High voltage test performed i.e. Power frequency test	
3.10 All ancilary equipment supplied and fitted, i.e. Operating tools etc.			

ACCEPTED	Erection Supervisor	Site Manager	Quality Control	Client
SIGNATURE				
PRINT NAME				
COMPANY				
DATE				

ESQF 1910 - 9/2002

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