

**GI-E**

MV Distribution

-  
-

---

**outdoor SF6  
circuit-breaker GI-E  
type**

**instructions for  
installation, operation  
and maintenance**



<b>1 foreword,</b>		<b>1</b>
	1.1 introduction,	1
	1.2 general warnings,	1
<b>2 description,</b>		<b>3</b>
	2.1 general characteristics,	3
	2.2 circuit breaker,	4
	2.3 the operating mechanism,	7
	2.4 external linkage,	11
	2.5 supporting structure,	11
<b>3 technical characteristic</b>		<b>13</b>
	3.1 technical data,	13
	3.2 overall dimension,	16
	3.3 electrical life,	17
	3.4 mechanical stress,	18
	3.5 standard wiring diagram,	19
	3.6 filling gas pressure,	20
	3.7 lubricants,	22
<b>4 installation</b>		<b>23</b>
	4.1 receiving,	23
	4.2 storage,	24
	4.3 unpacking,	24
	4.4 handling,	24
	4.5 assembling,	25
	4.6 grounding the structure,	31
	4.7 main circuit connection,	31
	4.8 filling the poles with SF <sub>6</sub> gas,	33
	4.9 transmission adjustment,	35
	4.10 control and auxiliary circuits connection,	36
	4.11 final checks before commissioning,	37
<b>5 use,</b>		<b>39</b>
	5.1 warnings for the user,	39
	5.2 operations,	39
<b>6 maintenance,</b>		<b>43</b>
	6.1 recommendations for the user,	43
	6.2 general,	43
	6.3 maintenance and checks,	44
	6.4 measuring the gas pressure of the poles,	46
	6.5 topping up the poles with gas,	46
	6.6 checking the wear of arcing contacts,	46
	6.7 pole replacing,	47
<b>7 app. A: SF<sub>6</sub> gas information,</b>		<b>49</b>
	A.1 general,	49
	A.2 circumstances where handling of SF <sub>6</sub> is necessary,	49
	A.3 safety,	52
	A.4 references,	54



---

## 1.1. Introduction

The purpose of this instruction manual is to provide all the information required for the correct handling, installation, operation and maintenance of the SF6 circuit breaker for outdoor use, model GI-E.

Careful observance of these instructions is essential for the safety of personnel and the reliability of this equipment. If you have any doubts or come across problems that are not covered in this manual, please contact Schneider Electric.

Schneider Electric cannot be held liable for any damage or injury arising from the non-observance of these instructions or the performance of operations not specifically described in this manual.

All the obligations assumed by Schneider Electric are specified in the sales contract.

No statement appearing in this manual can affect the warranty conditions established in the sales contract.

The personnel using this equipment must be made fully familiar with the contents of this manual as soon as possible, to obtain all necessary clarifications or additional information before actually handling the equipment. This manual must be displayed or kept close at hand for immediate consultation by the personnel involved.

This instruction manual does not include information concerning corrective maintenance: if required, contact Schneider Electric for an examination and overhaul of the equipment.

---

## 1.2. General warnings

The following points must always be borne in mind when working on the equipment:

- the conductors and power cables could be live
- the control and auxiliary circuits could be live
- the circuit breaker poles could be pressurized
- the mechanical parts could move suddenly after an automatic or remote control
- the operating mechanism high-energy springs could be charged and accidentally released.



**ANY NEGLIGENCE COULD CAUSE SERIOUS PERSONAL INJURY OR DEATH**

**Only qualified and trained personnel should be allowed to work on the equipment.**



## 2.1. General characteristics

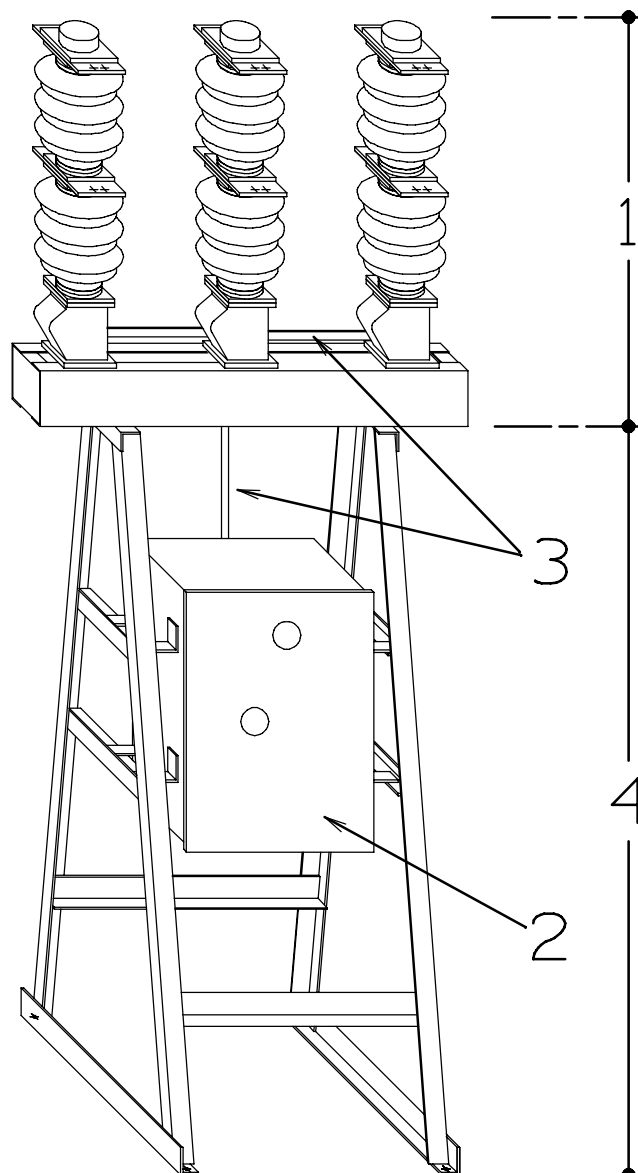
- The GI-E circuit breaker is a SF<sub>6</sub> gas circuit breaker suitable for outdoor installation in electricity distribution networks with rated voltage up to 40.5 kV.

- The circuit breaker uses the "puffer" technique (self-compression) for self-generating and self-regulating of the flow of SF<sub>6</sub> gas required to extinguish the electrical arc during opening.

- It has a GMh spring electro-mechanical operating mechanism, suitable for rapid re-closing cycles.

- The circuit breaker basically consists of:

- (1) three poles fixed to a frame
- (2) an operating mechanism housed within an enclosure
- (3) an operation linkage between the operating mechanism and the poles.
- (4) the supporting structure



## 2.2. Circuit breaker poles

25 kA  
1600 A

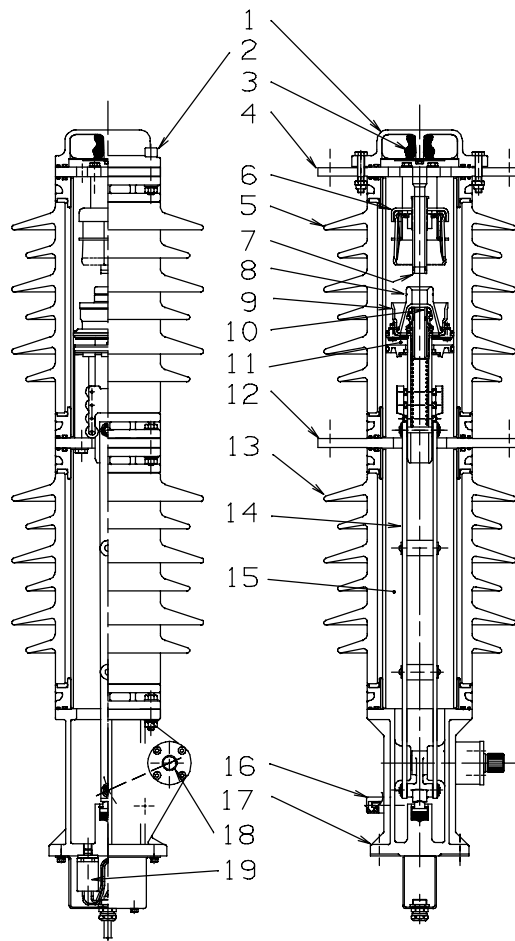
### 2.2.1 Description

- circuit breaker pole version (1)  
In=up to 1600A I<sub>sc</sub>=up to 25kA

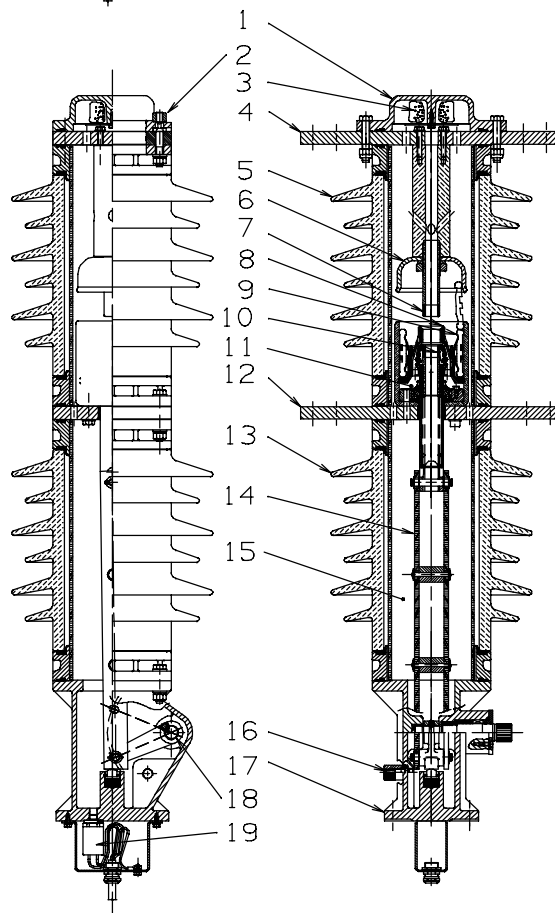
- circuit breaker version (2)  
In=up to 3150A I<sub>sc</sub>=up to 31.5kA

#### -Key

- 1 Cover
- 2 Overpressure safety device
- 3 Molecular sieves
- 4 Upper terminal
- 5 Upper insulator
- 6 Main fixed contact
- 7 Moving arcing contact
- 8 Nozzle
- 9 Main moving contact
- 10 Moving arcing contact
- 11 Compression chamber
- 12 Lower terminal
- 13 Lower insulator
- 14 Insulating rod
- 15 SF<sub>6</sub> gas
- 16 Inlet valve
- 17 Crank gear box
- 18 Operating shaft
- 19 Pressure switch



31,5 kA  
3150 A





## 2.2.2 Interruption process

### Key

- 1 Main contact
- 2 Arcing contact
- 3 Compression chamber
- 4 Valves
- 5 Nozzle

### Description

Initial status: Circuit breaker closed (Figure A).

The main contacts (1) and the arcing contacts (2) are closed and the main and auxiliary opening springs are charged.

On opening, the moving contacts are violently moved by the opening springs to the open position.

During this movement, the following events take place in quick succession:

- The gas compression phase starts in the compression chamber (3) as the piston attached to the moving contacts moves down; the compression chamber valves (4) are kept closed by the pressure itself.
- The main contacts separate with the total transfer of the current in the arcing contacts circuit (Figure B).
- The arcing contacts come away and the electrical arc starts burning between them (Figure C).
- The arc cools down after a flow of the gas is generated by the pressure created in the compression chamber, directed towards the arc zone by means of suitable insulating nozzle (5).
- The arc disappears as the current passes through the zero.
- The moving contacts complete the opening stroke (Figure D).

Figure A

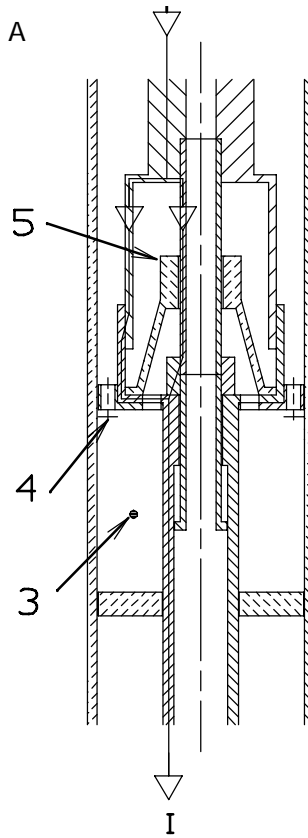


Figure B

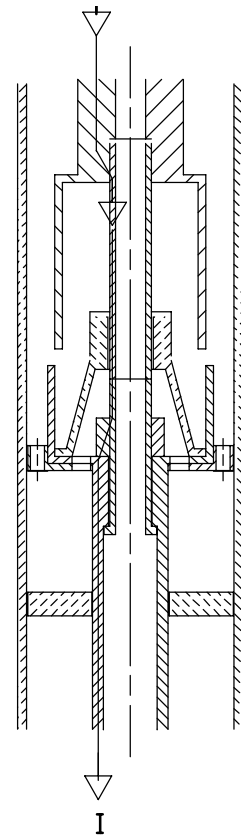


Figure C

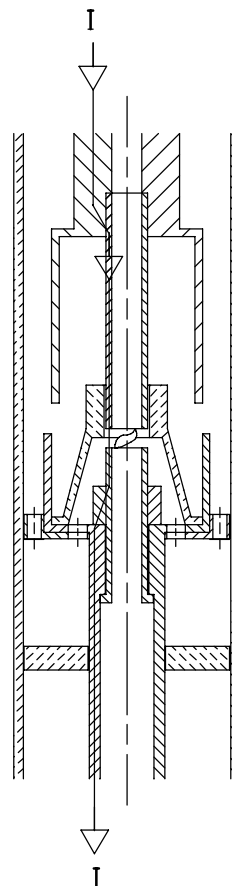
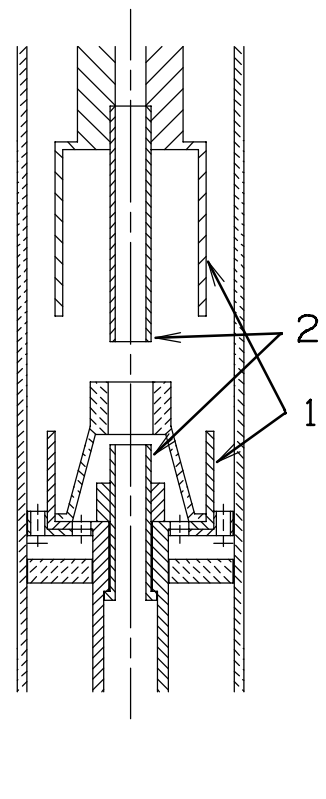


Figure D



---

The gas decomposed by the electrical arc quickly recombines, restoring the stable molecules. The remaining decomposition by-products are absorbed by suitable absorbent materials (molecular sieves).

When the circuit breaker is closed again, the depression produced by the upward movement of the piston allows the valves to open and the gas to enter the compression chamber.

When very high currents are interrupted, the electrical arc occupies the entire available space between the arcing contacts and the nozzle.

The flow of gas is therefore obstructed: this is the so-called "clogging" effect, which has several positive effects:

- The storing, when the current does not pass by the zero, of almost all the gas compressed by the piston in the compression chamber.
- The limitation of the energy of the electrical arc as the slowing down created in the movement of the moving contacts unit as a result of the "clogging" effect limiting the length of the arc.

### 2.2.3 Controlling the status of the SF6 gas in the poles

---

The three poles, separate from each other, make up three pressurized SF6 gas systems that are fully independent.

Each pole is controlled by a pressure switch with two independent electrical contacts, activated with two different pressure levels.

When the pressure of the gas drops, the following events happen in sequence:

- Remote alarm by means of the pressure switch contacts at the highest intervention level.

The contacts are each connected to the terminal board in the operating mechanism box.

The pole in failure can therefore be identified without having to make a direct measurement with the pressure gauge.

- Remote and local locking of the circuit breaker electrical operation, leaving the mechanical operation enabled for emergency only via the mechanical opening and closing push buttons on the front of the operating mechanism.

This lock is effected by means of one of the two function combinations below, depending on whether there is a bridge on the terminal board in the operating mechanism box (see standard wiring diagram at par. 3.5: bridge between terminals 24 and 25):

a) instantaneous tripping and prevention of a subsequent electrical closing (bridge present)

b) prevention of both electrical opening and closing (no bridge).

The intervention levels of the contacts in the pressure switch when there is a drop in the pressure are indicated at par. 3.1.2, point i).

## 2.3. The operating mechanism

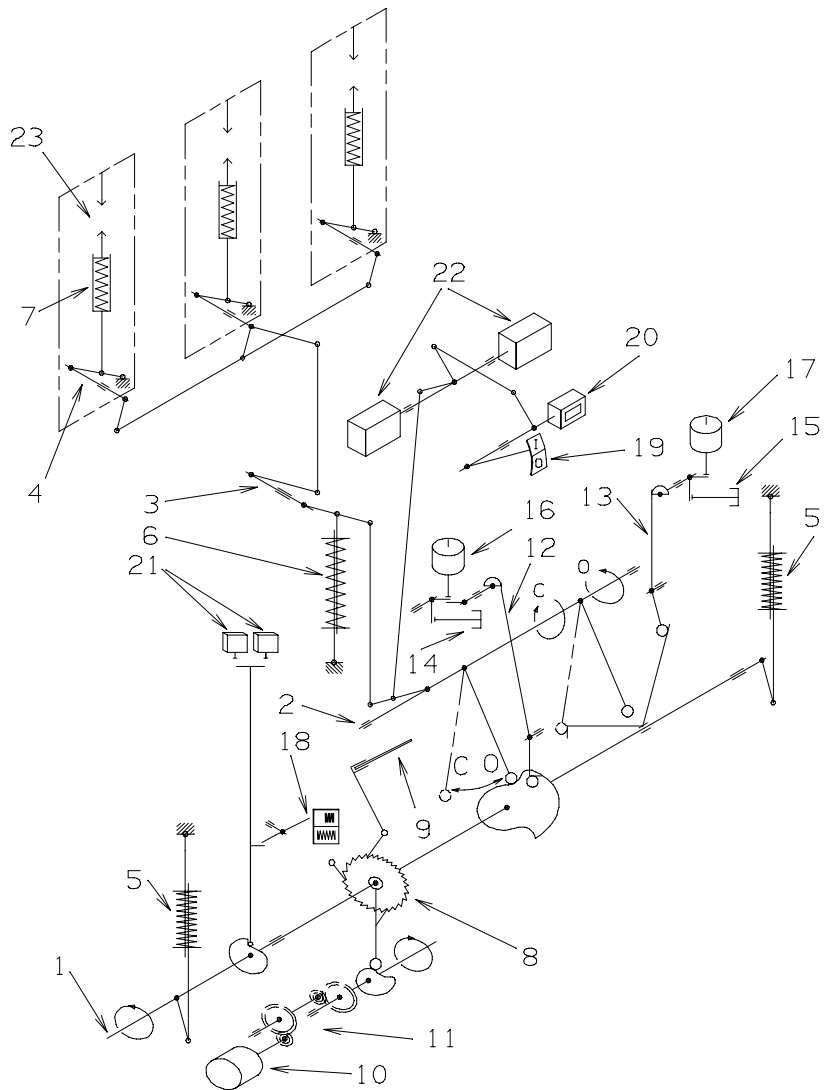
### 2.3.1 Operating principle

#### Principle diagram

The diagram shows the circuit breaker in the open position with the closing springs charged.

#### Key

- 1 Main shaft
- 2 Auxiliary shaft
- 3 Operating mechanism box output shaft
- 4 Pole shaft
- 5 Closing spring
- 6 Opening spring
- 7 Auxiliary opening spring
- 8 Spring charging mechanism
- 9 Charging lever
- 10 Electrical charging motor
- 11 Reducer
- 12 Closing latch
- 13 Opening latch
- 14 Manual closing push button
- 15 Manual opening push button
- 16 Closing release
- 17 Opening release
- 18 Closing springs status indicator
- 19 Circuit breaker status indicator
- 20 Operation counter
- 21 Closing springs position switches
- 22 Circuit breaker auxiliary contacts
- 23 Pole contacts



### 2.3.2 Description of operations

#### 1 Manual charging of the closing springs

By using the charging lever (9) with alternating movement, the main shaft (1) starts to rotate by means of the charging mechanism (8), which consists of a geared wheel and a drive and check ratchet gear.

The rotation of the main shaft provokes the compression of the closing springs (5) directly connected to the shaft by means of levers and the operation of the springs status indicator (18). The ratchet gear drive stops when the springs are fully charged. The springs remain compressed thanks to the closing latch (12).

#### 2 Electrical charging of the closing springs

The charging principle is similar to manual charging. The rotation of the main shaft (1) is actuated by the charging motor (10), instead of by the manual lever, by means of the reducer (11) and the charging mechanism (8). Two position switches (21) cut the motor supply when the closing springs are fully charged.

---

### 3 Closing

By pressing the manual closing push button (14) or energizing the closing release (16), the closing latch (12) is released and so the main shaft is disengaged.

The torque developed by the closing spring (5) provokes the rotation of the main shaft, which drives the circuit breaker mechanical linkage and the connected auxiliary devices to the circuit breaker closed position.

The following functions are thus carried out:

- closing of the pole contacts (23)
- charging of the main (6) and auxiliary (7) opening springs. The latter are mounted inside the poles
- operation of the auxiliary contacts (22)
- operation of the circuit breaker status indicator (19)

The closed position is held by means of the opening latch (13).

### 4 Opening

By pressing the manual opening push button (15) or energizing the opening release (17), the opening latch is released (13) and so the auxiliary shaft (2) is disengaged.

As a result, the torque developed by the main (6) and auxiliary (7) opening springs drives the mechanical circuit breaker linkage and the connected auxiliary devices to the circuit breaker open position.

The following functions are thus carried out:

- opening of the pole contacts (23)
- operation of the auxiliary contacts (22)
- operation of the circuit breaker status indicator (19)
- operation of the operation counter (20).

The main shaft (1) and the devices directly connected to this (closing springs, geared wheel, charging mechanism and closing springs position indicator) do not move during the opening operation.

## 2.3.3 Operating mechanism safety devices

The circuit breaker is always supplied with the following safety devices:

- Anti-pumping: the electrical or manual reclosing is prevented if the command which has provoked the previous closing is permanent.
- Anti-spring discharging in closed circuit breaker position: the closing springs can only be discharged when the circuit breaker is open by means of a closing/opening operation.
- Remote/Local selector switch with key trapped in the Local position (standard version).
- Low SF6 gas pressure lock: see SF6 gas status check at par. 2.2.3.

The following safety devices can be supplied on request:

- Set break screws on poles: they stop an increase in the pole pressure from reaching danger levels (after excessive filling, for example) by breaking and allowing the gas exhaust.
- 1 to 3 closing latches on the operating mechanism box door arranged for padlock application or other locks to prevent unauthorized opening of the door.
- 1 to 3 padlocks for the above latches.
- Key lock for the circuit breaker in the open position:
  - electrical and manual closing is not possible when the key is extracted.

This key can only be extracted when the circuit breaker is open and the mechanical opening push button is pressed.

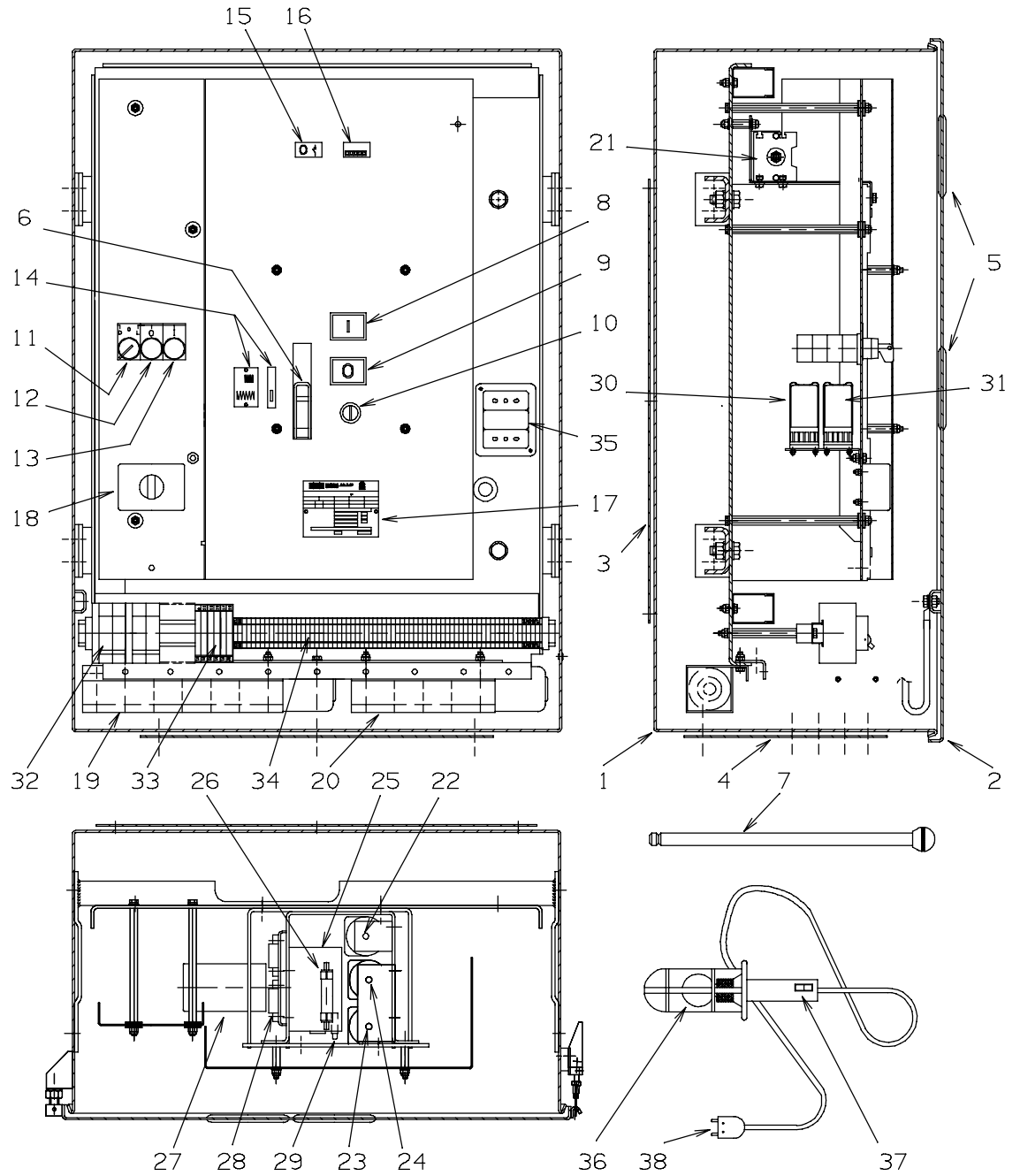
- Low voltage release: it opens the circuit breaker when there is low or no voltage on the breaker.

Manual and electrical closing of the circuit breaker is impossible when the release trips (de-energized).

- Moulded case thermal-magnetic circuit breakers protecting each auxiliary circuit. Each breaker has an auxiliary contact for remote indication of the position.

### 2.3.4 Operating mechanism box with electrical equipment

Layout



---

- The layout above includes all the possible electrical accessories. Check, therefore, the version actually supplied by referring to the order and the specific wiring diagram attached to the circuit breaker.

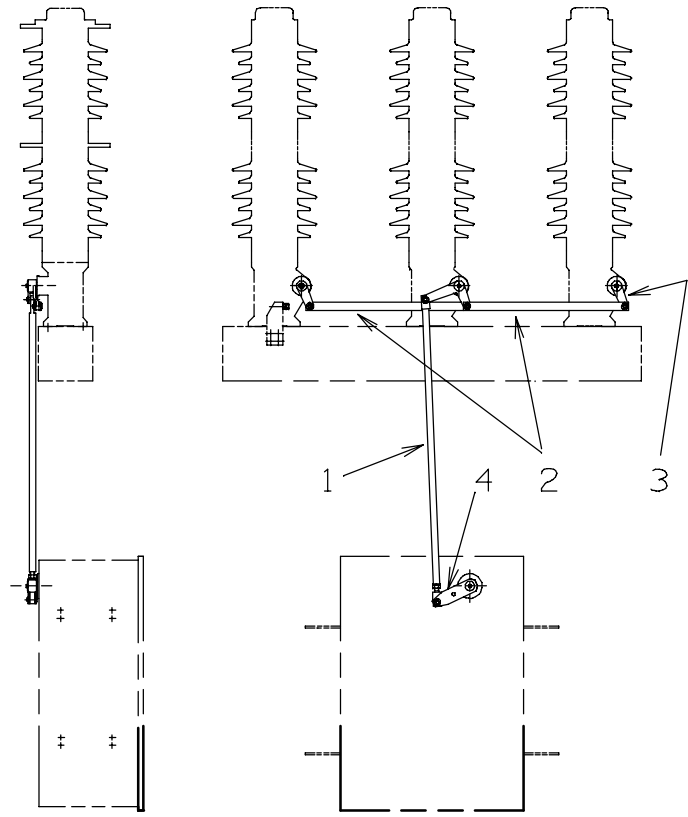
**Key**

- |    |  |    |  |
|----|--|----|--|
| 1  | Box  | 21 | Sets of circuit breaker auxiliary contacts<br>(driven mechanically by the operating mechanism) |
| 2  | Door   | 22 | Closing release  |
| 3  | Rear closing plate                                 | 23 | 1st. shunt opening release   |
| 4  | Bottom closing plate                               | 24 | 2nd shunt opening release  |
| 5  | Windows  | 25 | Under-voltage opening release  |
| 6  | Charging lever seat                                | 26 | Economy resistor for release item 25 if DC   |
| 7  | Springs charging lever                             | 27 | Electrical charging motor  |
| 8  | Mechanical closing push button                     | 28 | Closing springs charging position switch   |
| 9  | Mechanical opening push button                     | 29 | Opening release position switch  |
| 10 | Closing key lock                                   | 30 | Auxiliary relay for low SF <sub>6</sub> gas pressure lock-out                                  |
| 11 | Local/Remote operation key switch                  | 31 | Anti-pumping relay   |
| 12 | Electrical closing push button                     | 32 | Moulded case circuit breakers  |
| 13 | Electrical opening push button                     | 33 | Terminals to isolate electrical supplies   |
| 14 | Closing springs status indicator                   | 34 | Terminals for control and auxiliary circuits   |
| 15 | Circuit breaker status indicator                   | 35 | Double socket  |
| 16 | Operation counter                                  | 36 | Moving lamp for lighting   |
| 17 | Circuit breaker nameplate                          | 37 | Switch for lamp item 36  |
| 18 | Thermostat   | 38 | Plug for lamp item 36  |
| 19 | Thermostat-controlled heating element              |    |  |
| 20 | Continuous heating element (for anti-condensation) |    |  |
-

## 2.4. External linkage

### Key

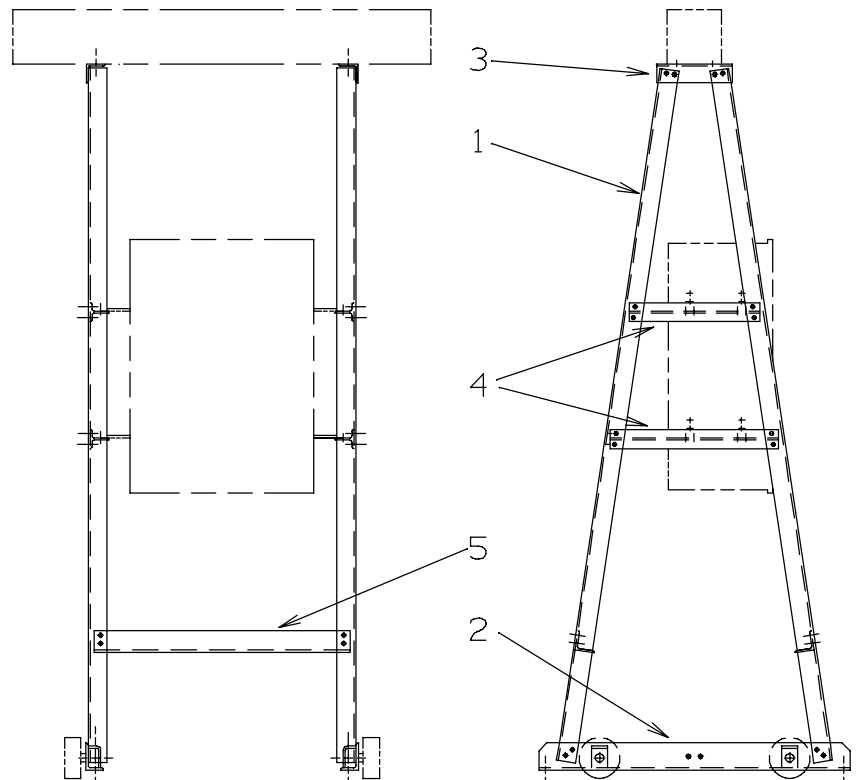
- 1 Operating mechanism/poles transmission rod
- 2 Central pole/lateral poles transmission rod
- 3 Pole operation lever
- 4 External lever on the operating mechanism box



## 2.5. Supporting structure

### Key

- 1 4 uprights
- 2 2 base cross beams
- 3 2 upper cross beams
- 4 4 operating mechanism box cross beams
- 5 2 side cross beams
- 6 4 wheels (optional)







## 3.1. Technical data

### 3.1.1 Foreword

The data given at par. 3.1.2 are standard values. Refer to the values marked on the circuit breaker nameplate or in the specific documentation supplied with the circuit breaker for possible deviations.

Please contact Schneider Electric technical service for special applications. Some of the characteristics listed here differ depending on the circuit breaker version (1) or version (2) (see par. 3.2 for overall dimensions).

### 3.1.2 Data

a) Standards	IEC 62271-100
b) Service conditions	
- Installation	outdoor
- Ambient air temperature	-25 +40°C
- Altitude above sea level	≤1000 m
- Ice coating	≤10 mm
- Wind pressure	≤700 Pa
corresponding wind speed (approx.)	≤125 km/h
c) Temperature rise of the main terminals at rated normal current	≤50 K
d) Main circuit resistance (circuit breaker in new conditions)	
- version ( 1 )	≤50μ
- version ( 2 )	≤25μ
e) Maximum number of C-O operations as a function of the interrupted current without pole overhauling	see par. 3.3
f) Maximum number of C-O operations without circuit breaker overhauling	10.000
g) Maximum life of the circuit breaker without overhauling	20 years
h) Distances in air	
- Minimum clearance	
- between poles	
- version (1)	410 mm
- version (2)	380 mm
- between terminals of a pole	400 mm
- to earth	400 mm
- Minimum distance between the lowest live part and ground level:	
- version (1)	3460 mm
- version (2)	3480 mm
- Creepage distance:	
- between terminals of a pole	1025 mm
- to earth	1025 mm

---

i) SF<sub>6</sub> gas quantity in the poles

NOTE: All pressure values indicated are intended to be read on the pressure gauge (relative pressure) and referred to standard atmospheric air condition of 101.3 kPa and 20°C

- SF <sub>6</sub> gas mass per 3 pole circuit breaker at rated filling pressure	
-version (1)	1.2 kg
-version (2)	1.6 kg
- Rated filling pressure	400kPa
- Operating pressure of the pressure switches (with decreasing pressure):	
-first level (alarm)	300 kPa
-second level (lock-out)	250 kPa
-Minimum functional pressure	250 kPa
-Maximum leakage per year for each pole	1%
-Specifications for SF <sub>6</sub> gas	IEC 60376 IEC 60480

l) Maximum dynamic load on foundation during closing or opening operations

see par. 3.4

m) Maximum allowable static load on main terminals

see par. 3.4

n) Mass

-overall circuit breaker(without wheels)	
- version (1)	540 kg
- version (2)	610 kg
-frame with poles	
- version (1)	234 kg
- version (2)	306 kg
-pole	
- version (1)	59 kg
- version (2)	83 kg
-operating mechanism box	150 kg
-GMh operating mechanism	38 kg
-supporting structure	150 kg
-wheels	25 kg

o) Operating times at rated gas pressure and rated control voltage

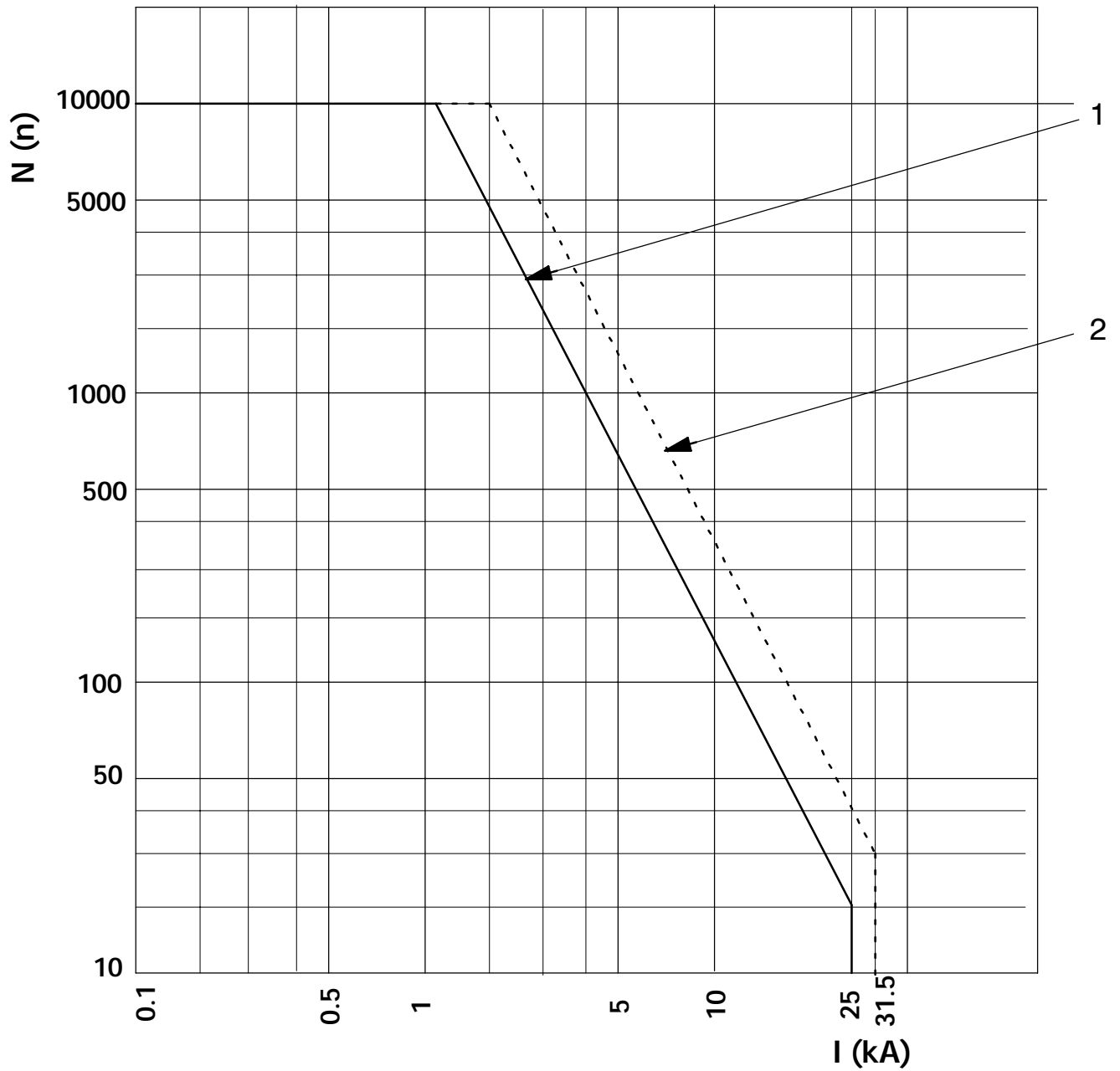
-Closing time	
-a.c. supply	
- version (1)	60 ÷ 70 ms
- version (2)	57 ÷ 67 ms
-d.c. supply	
- version (1)	73 ÷ 83 ms
- version (2)	70 ÷ 80 ms
-Opening time	
-a.c. supply	
- version (1)	33 ÷ 43 ms
- version (2)	30 ÷ 40 ms
-d.c. supply.	
- version (1)	40 ÷ 50 ms
- version (2)	33 ÷ 43 ms

---

-Pre-arcing time	4 ms
-Arcing time	15 ms
-Opening and closing contact simultaneity	3 ms
p) Power consumption	
-Closing spring charging motor	
- a.c. supply	500 VA
- d.c. supply	400 W
-closing shunt release	
- a.c. supply	150 VA
- d.c. supply	100 W
-opening shunt release	
- a.c. supply	200 VA
- d.c. supply:	150 W
-opening under voltage release	
- a.c. supply	75 VA
- d.c. supply:	15 W
-continuous heating elements	60 W
-thermostat controlled heating elements	150 W
-lightning lamp	60 W
q) Motor charging time	15 s
r) Auxiliary contacts ratings (contacts driven by the operating mechanism)	
-rated voltage:	250 V
-rated normal current:	10 A
-breaking current:	
-a 220 V d.c. - L/R 40 ms	0.5 A
-a 220 V d.c. - L/R 10 ms	3 A
-a 220 V a.c. - power factor 0,3	10 A



### 3.3. Electrical life



Maximum allowable number (N) of CO operations without pole overhauling as a function of the interrupted current (I)

– Curve 1:  
Circuit breaker version (1)  
– Curve 2:  
Circuit breaker version (2).

### 3.4. Mechanical stress

#### 3.4.1 Maximum allowable static load each main terminal

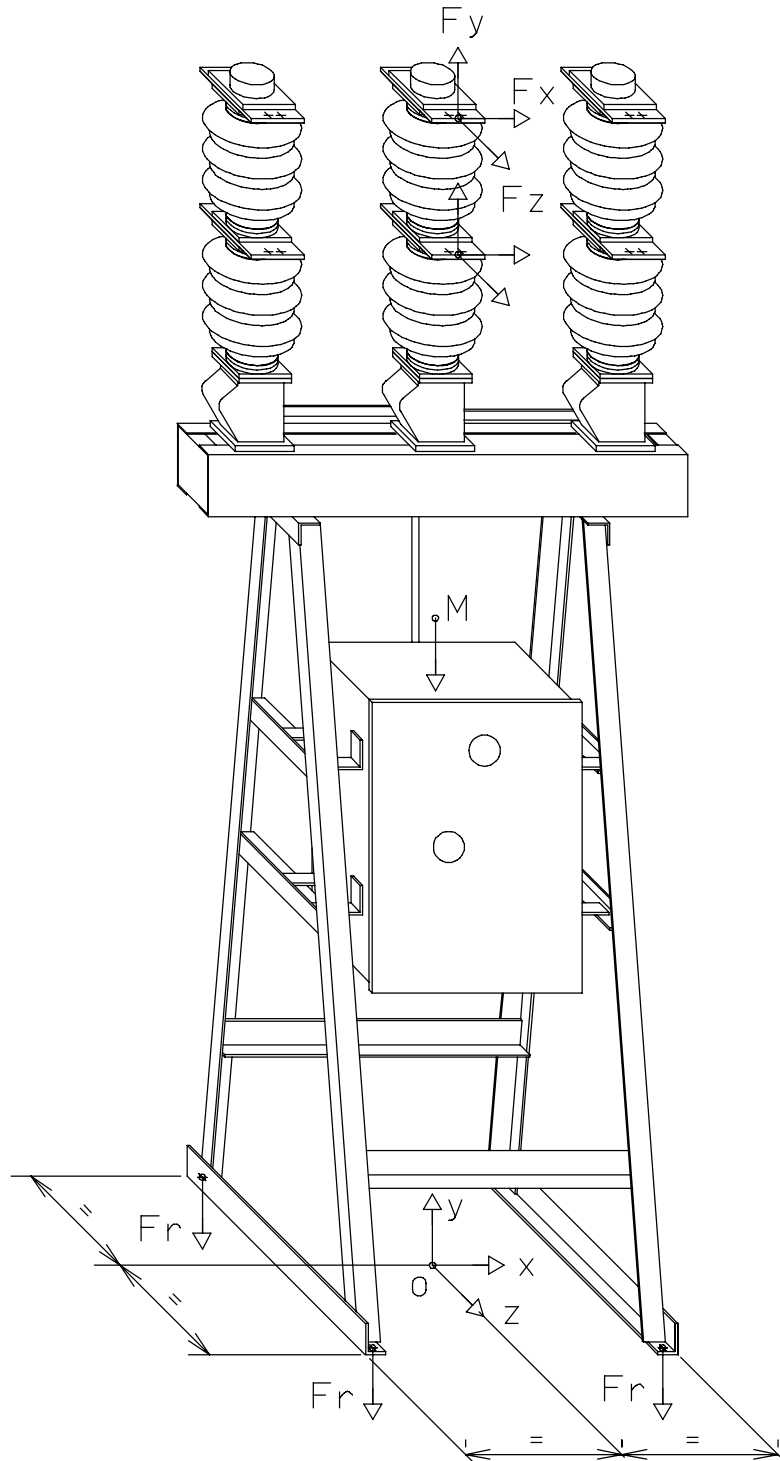
Version (1)	Version (2)
$F_x = \pm 400 \text{ N}$	$F_x = \pm 500 \text{ N}$
$F_y = \pm 500 \text{ N}$	$F_y = \pm 750 \text{ N}$
$F_z = \pm 500 \text{ N}$	$F_z = \pm 750 \text{ N}$

#### 3.4.2 Circuit breaker mass and center of gravity

Version (1)	Version (2)
Mass $M = 540 \text{ Kg}$	Mass $M = 610 \text{ Kg}$
Center of gravity M	Center of gravity M
Coordinates referred to point 0	Coordinates referred to point 0
$x = 0 \text{ mm}$	$x = 0 \text{ mm}$
$y = 2050 \text{ mm}$	$y = 2240 \text{ mm}$
$z = 18 \text{ mm}$	$z = 16 \text{ mm}$

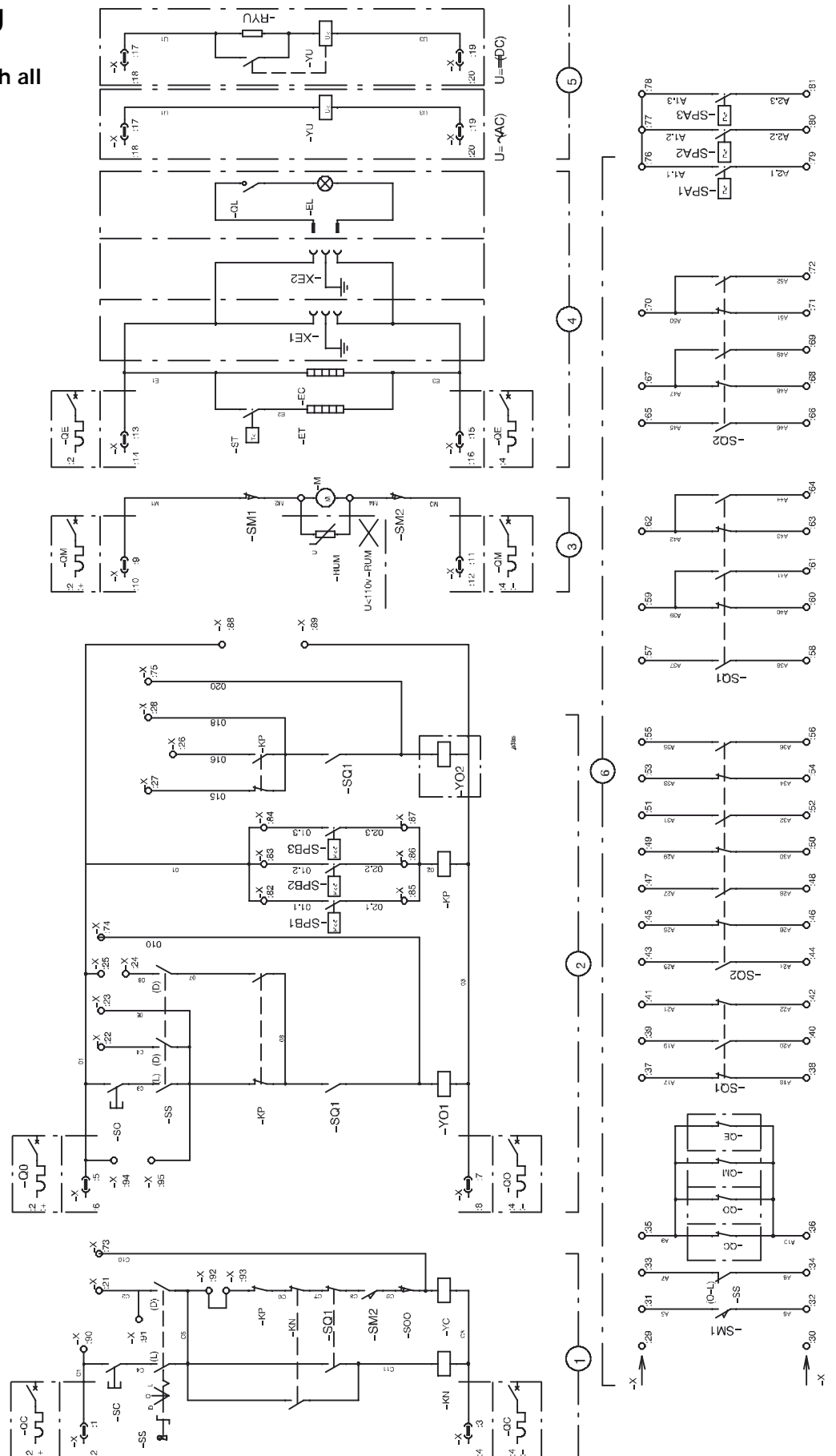
#### 3.4.3 Maximum dynamic load on foundation at each anchoring point during operation (circuit breaker weight included)

Version (1)	Version (2)
Closing	Closing
$F_r = + 8000 \text{ N}$	$F_r = + 9000 \text{ N}$
$F_r = - 4000 \text{ N}$	$F_r = - 5000 \text{ N}$
Opening	Opening
$F_r = + 5000 \text{ N}$	$F_r = + 9000 \text{ N}$
$F_r = - 3000 \text{ N}$	$F_r = - 4000 \text{ N}$



### 3.5. Standard wiring diagram

Basic diagram: version with all the available accessories.



**Note:**  
For commissioning and operation of the circuit breaker refer only to the wiring diagram enclosed in the accompanying documents.

Key			
EC	Continuous anticondensation heating element	SO1	Set 1 of main circuit breaker auxiliary contacts
EL	Light bulb	SO2	Set 2 of main circuit breaker auxiliary contacts
ET	Thermostat-controlled heating element	SPA1	Pressure switch contact in phase L1 for low SF6 pressure alarm
KN	Anti-pumping relay	SPA2	Pressure switch contact in phase L2 for low SF6 pressure alarm
KP	Low SF6 pressure lock-out relay	SPA3	Pressure switch contact in phase L3 for low SF6 pressure alarm
M	Closing springs charging motor	SPB1	Pressure switch contact in phase L1 for low SF6 pressure lock-out
Q	Main circuit breaker	SPB2	Pressure switch contact in phase L2 for low SF6 pressure lock-out
QC	Moulded case circuit breaker for closing circuit	SPB3	Pressure switch contact in phase L3 for low SF6 pressure lock-out
QE	Moulded case circuit breaker for heating circuit	SS	Control selector switch "D - 0 - L" (Remote - zero - local)
QL	Lamp switch	ST	Thermostat
QM	Moulded case circuit breaker for closing springs charging motor	X	Terminal block for external connections
QO	Moulded circuit breaker for opening circuit	XE1	Socket 1
RUM	Varistor (temperature dependant resistor)	XE2	Socket 2
RYU	Economy resistor for YU with d.c. supply	YC	Closing shunt release
SC	Electrical closing push button	YU	Under-voltage opening release
SO	Electrical opening push button	YO1	Shunt opening release 1
SOO	Opening release position switch	YO2	Shunt opening release 2
SM1	Set 1 of closing springs charging position switches		
SM2	Set 2 of closing springs charging position switches		

## 3.6. Filling gas pressure

### 3.6.1 Foreword

The circuit breaker rated filling pressure is 400 kPa (pressure gauge reading) and refers to standard (temperature-pressure) atmospheric conditions of 20°C and 101.3 kPa. When filling or topping up with gas at temperatures or atmospheric pressures different from standard, the effect of the actual temperature and atmospheric pressure on the filling pressure value shall be taken into consideration.

As a rule however, the effect of the atmospheric pressure is negligible, given the high value of the filling pressure compared with the possible variations of atmospheric pressure.

Only in extreme atmospheric conditions it is necessary to make a correction to the filling pressure value (see SF6 gas information at par. A.2.1.6.)

The pressure-temperature graph at para 3.6.2 that reports the constant gas density curve is therefore generally sufficient for establishing the actual filling pressure.

If topping up is necessary, after putting the circuit-breaker out of service, wait for the gas in the pole to reach the ambient air temperature; otherwise, the temperature of the gas shall be estimated in order to establish the actual filling pressure.



---

All gas pressure values given in this manual unless otherwise specified, refer to atmospheric pressure and are therefore relative values (or pressure gauge readings).

CONVERSION UNITS OF PRESSURE MEASUREMENT  
100 kPa = 0.1 MPa = 1 bar

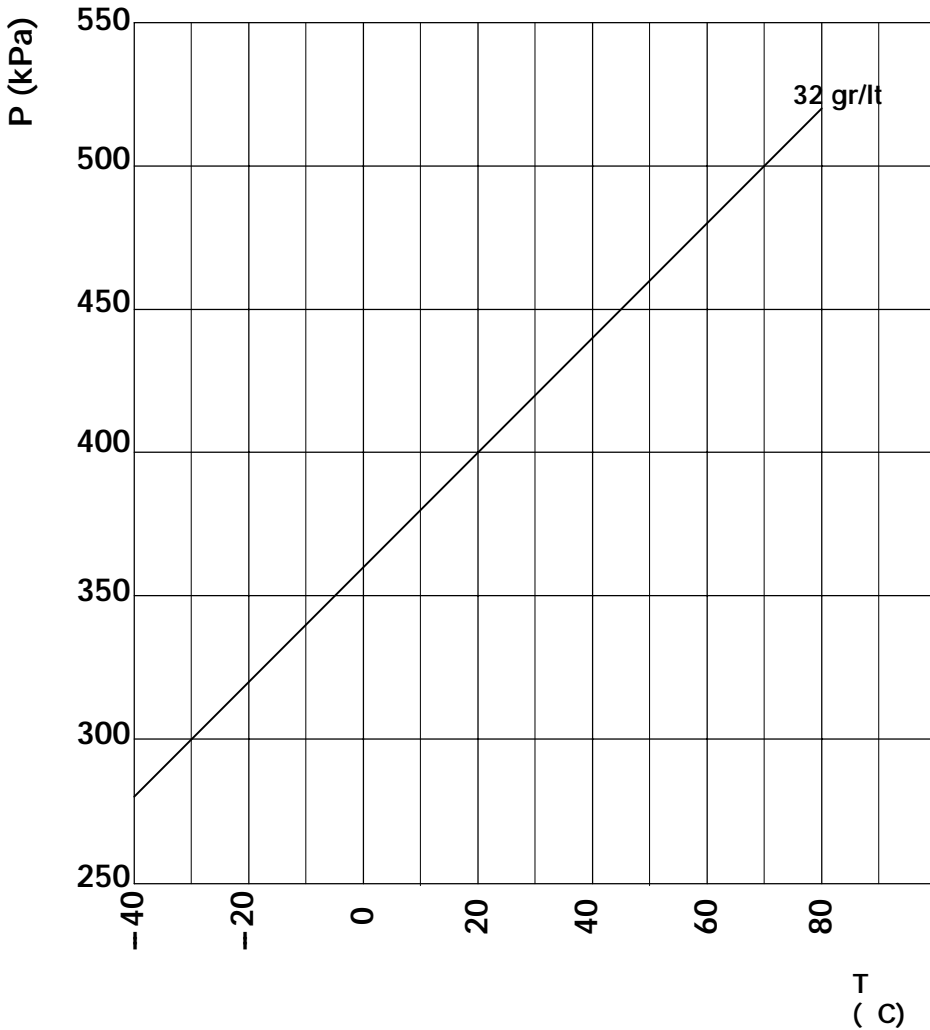
For more information and clarifications, see: SF6 gas information at par. A.2.1

If pressure gauges with temperature compensation are used, the effect of the gas temperature shall not be taken into consideration.

---

### 3.6.2 Filling pressure/gas temperature graph

Entering diagram on abscissa at the actual temperature (T) of the gas you read the corresponding value of the actual filling pressure (P) on ordinate.



---

### 3.7. Lubricants

Guide for selecting greases to be used for commissioning and maintenance of the circuit breaker.

#### **Lithium soap grease**

Application: lubricating grease for all metal parts subject to friction (pins, bushes, bearings, wheels, etc...) also operating outdoors under hard environmental conditions

(-50 +150°C).

Supplier: KLÜBER

Brand name: ISOFLEX TOPAS L 152

#### **Silicon grease**

Application: rust-protecting grease for metal parts, for lubricating gaskets and preventing the same from sticking under severe temperature conditions

(-40 +200°C).

Excellent resistance to humidity, salinity and general atmospheric conditions.

NOTE: not suitable for contact with SF<sub>6</sub> gas of circuit breakers.

Supplier: RHONE POULENC

Brand name: SILICOMPOUND 4

#### **Fluorinated grease**

Application: inert grease for lubricating electrical contacts and gaskets in contact with SF<sub>6</sub> gas of circuit breakers.

Contains rust-retarding additives.

Properties unchanged even in a

wide range temperature

(-30 +250°C).

Supplier: MONTEFLUOS

Brand name: FOMBLIN YUH-2

#### **Vaseline**

Application: neutral grease for treating electrical connection contact surfaces.

Can also be used for lubricating the gaskets (if silicon grease is unavailable)

Supplier: ..... (Several)

Brand name: VASELINE

## 4.1. Receiving

### 4.1.1 General

The circuit breaker is shipped disassembled into the following parts (see description at par. 2.1):

- frame with three poles
- operating mechanism box
- supporting structure
- transmission rod

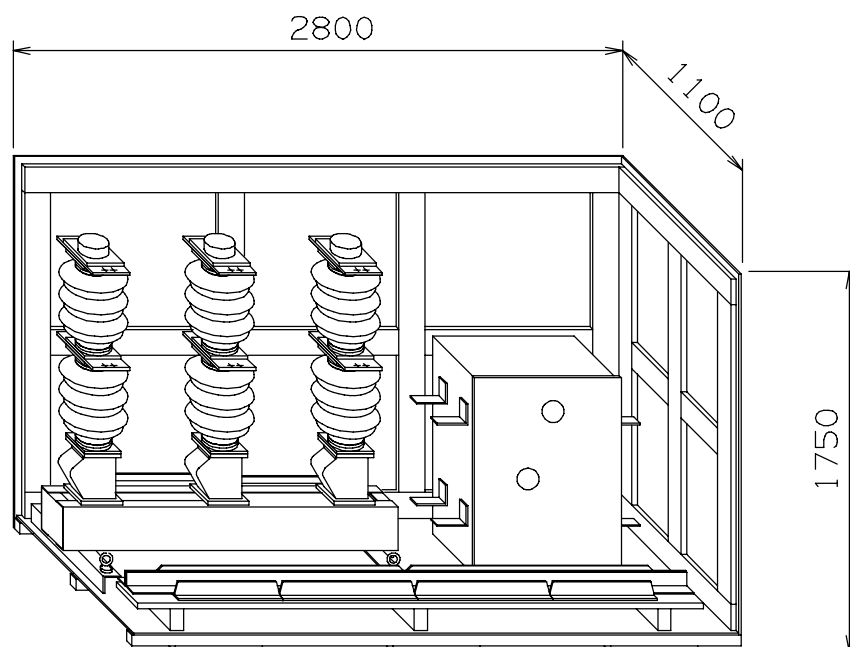
The supporting structure is generally shipped disassembled with all the nuts and bolts required for the assembling. The structure can also be provided by the customer according to the instructions of SCHNEIDER ELECTRIC.

Packaging can vary.

Depending on the transport means used for shipping and the final destination, the number, contents and weight of the cases are given in the shipping list that accompanies the equipment.

The cases shall be handled with care and kept in the position indicated by the conventional symbols on the packaging to avoid any damage to the equipment.

A standard packing layout is shown in the next figure as example.



### 4.1.2 Checks

On receiving the equipment, check that all the cases have arrived (see shipping list) and that no damage or tampering has occurred during shipment.

In particular, check that the insulators (porcelain) are not damaged.

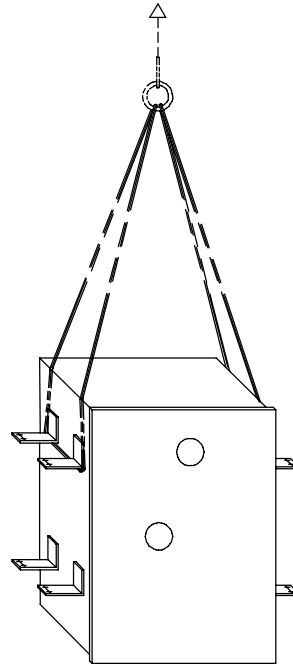
If there is any damage or irregularity, immediately notify the nearest SCHNEIDER ELECTRIC representative of the fact and, if you think it is appropriate, file a claim against the shipping company.



---

### 4.4.3 Lifting the operating mechanism box

- anchor the cables to the proper supports provided on the sides of the box.



---

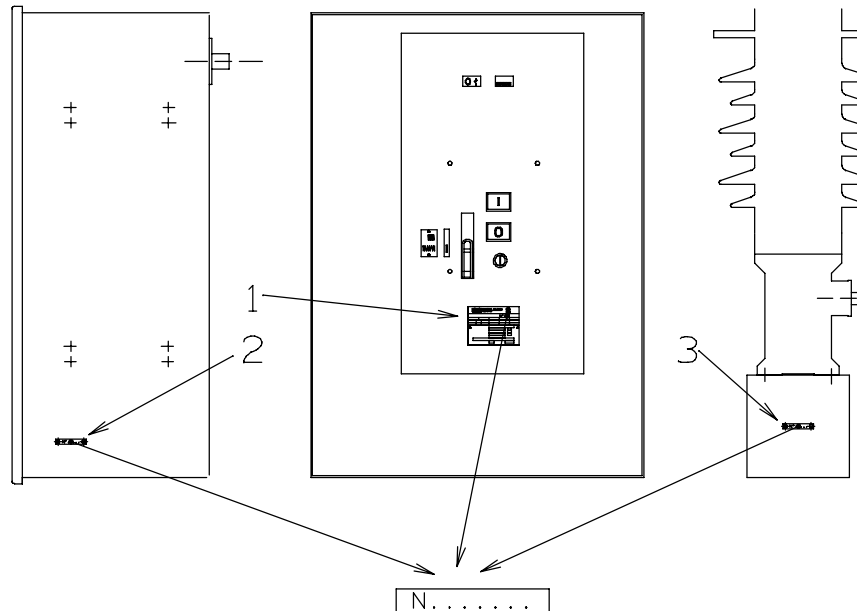
## 4.5. Assembling

### 4.5.1 Identification checks

Check that the characteristics of the circuit breaker displayed on the nameplate (1) inside the operating mechanism box correspond to those of the order confirmation.

Check that the same serial numbers are read on the following components:

- nameplate inside the operating mechanism box (1)
- external plate (2) on the right-hand side of the operating mechanism box
- external plate (3) on the right-hand side of the pole frame



Check that the gas inside the pole is at the shipping pressure of about 50 kPa (see par. 6.4 for details of how to read the pressure).  
If there is no gas pressure (pressure gauge reading = 0 kPa) the pole shall not be used:

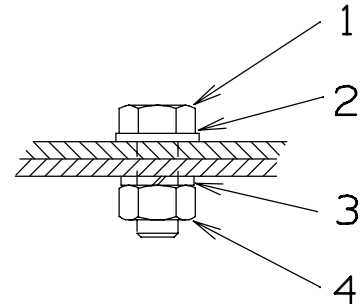
- contact your nearest Schneider Electric representative to get the pole sent back to the Schneider Electric factory; the pole shall be re-checked and possibly dismantled.
- for pole replacement, see par. 6.7.

### 4.5.2 Warnings

The circuit breaker has been completely assembled and tested in the factory. Make sure that each operating mechanism box is coupled with the proper set of poles (see par. 4.5.1 identification checks).

**CARRY OUT THE INSTALLATION OF THE CIRCUIT BREAKER FOLLOWING THE STEPS DESCRIBED IN THIS MANUAL CAREFULLY**

The circuit breaker shall be assembled using only the stainless steel nuts and bolts provided with the circuit breaker.



Every bolted connection of the various structure elements shall include a screw (1), a flat washer (2), an elastic washer (3) and a nut (4).

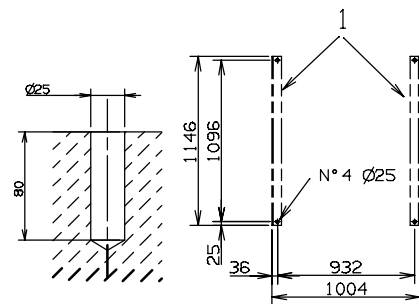
### 4.5.3 Preparing the base

The concrete base on which the circuit breaker stands, shall be as level as possible and of suitable consistency so that the circuit breaker anchor screws and the base itself can withstand the foreseeable stress (see mechanical stress at par. 3.4):

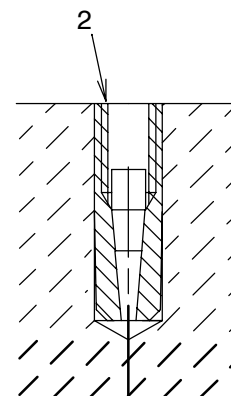
- concrete strength = > 2500 N/cm<sup>2</sup> (BN 25 according to DIN 1045 standards)

Drill 4 holes of 25 mm dia. and 80 mm deep in the base, as indicated in figure, with reference to the theoretical base of the circuit breaker (1).

- see par. 3.2 for overall circuit breaker dimensions.

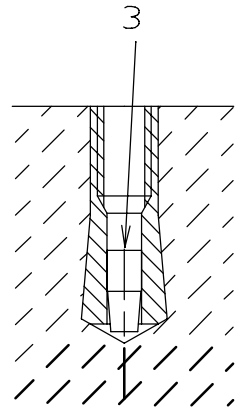


Insert the four expansion anchor inserts (2) provided by hammering them in slightly.



---

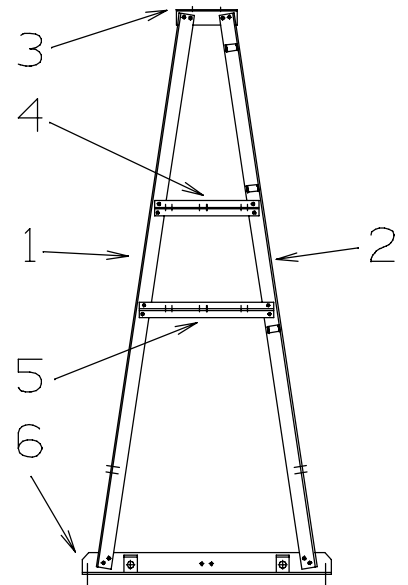
Using a proper tool, make the insert expand by forcing tapered pin (3) inside the insert until it reaches the bottom.



#### 4.5.4 Assembling the supporting structure

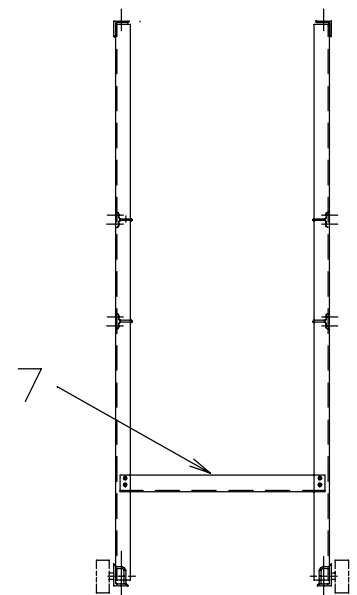
##### Uprights

To make the operation easier, lay the uprights on the floor. Connect legs (1) and (2) with cross members (3) (4) (5) and (6). Do not fully tighten the bolts.



##### Structure

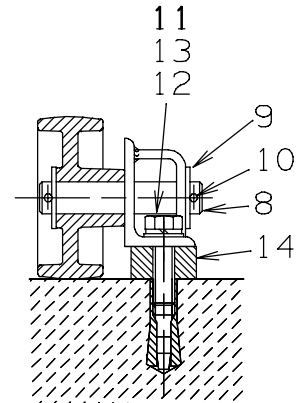
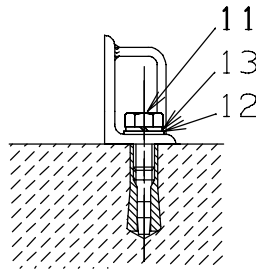
Connect the two uprights, previously assembled, with cross members (7) (front and rear). Do not fully tighten the bolts.



If provided, fit the wheels to the cross member (6) by using pin (8) with washer (9) and cotter pin (10).

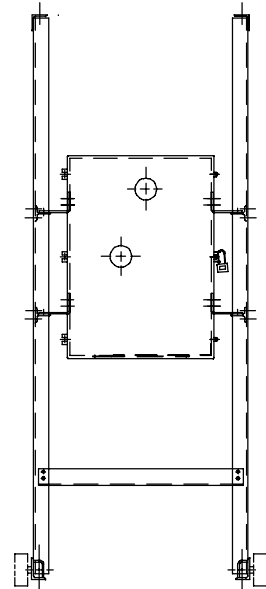
Fix the structure to the base by tightening screws (11) with flat washer (12) and elastic washer (13) to the four inserts previously fitted in the base.

If wheels are provided, place spacer (14) between the base and the base cross member.



#### 4.5.5 Fitting the operating mechanism box to the structure

Set into position the operating mechanism box on the structure (see par. 4.4.3 for lifting instructions) and fix. Do not fully tighten the bolts.



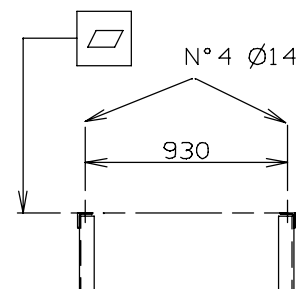
#### 4.5.6 Checking the structure and tightening the bolts

Before fully tightening the bolts, check that the following conditions are met:

- the distance between the four holes in the upper part of the structure is correct (930 mm)
- the upper part of the structure is perfectly level.

Tighten all the bolts (M12 thread), starting from those fixing the operating mechanism box to the structure with the following torque:

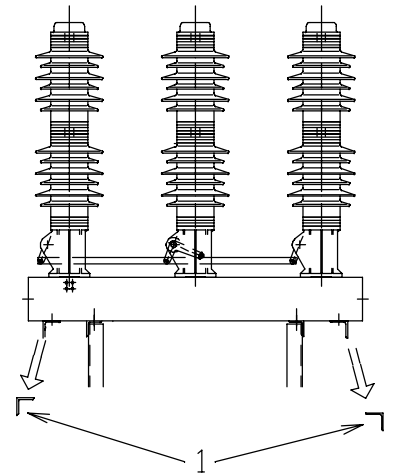
**tightening torque**  
= 85 Nm = 8.6 kgm = 62 Ftlb





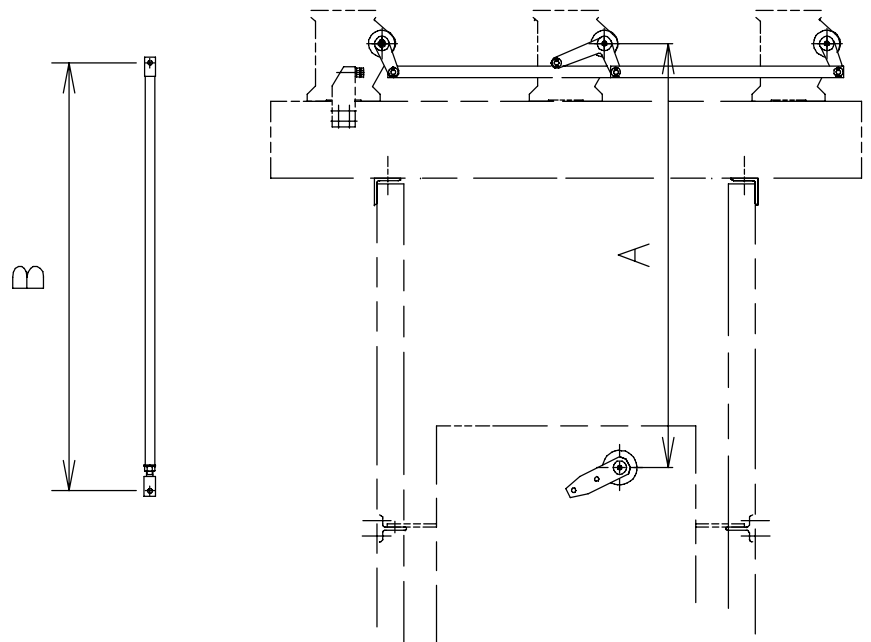
#### 4.5.7 Installing the pole frame on the supporting structure

Clean the insulators with a clean dry cloth.  
 Set into position the frame with the poles on the supporting structure (see par. 4.4.2 for lifting instructions).  
 Tighten the bolts with the torque indicated at par. 4.5.6.  
 - both the operating shafts of the poles and that of the operating mechanism box shall project on the same side.  
 Remove the two angle sections (1) used for lifting the pole frame and store them for possible future use.  
**IMPORTANT:  
 DO NOT REMOVE THE PROTECTIVE BARRIERS OF THE POLES.**

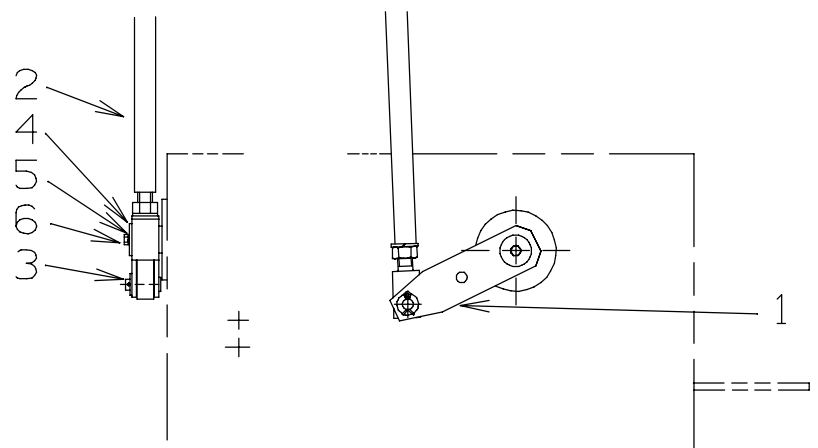


#### 4.5.8 Connecting the transmission rod

Measure the distance A between the axes of the central pole shaft and of the shaft project from the operating mechanism box.  
 Adjust the length of the transmission rod using the adjustable coupling so that the distance B between the axes of the holes in the attachments are the same as distance A previously measured :  $A = B$   
 (theoretical distance = 1105 mm)  
 - the two rod coupling shall be parallel.  
 Check that all moving parts are properly greased.



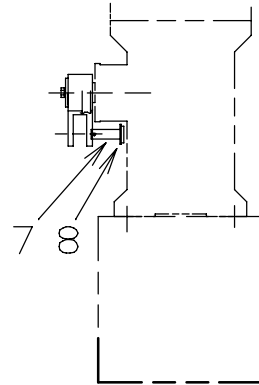
Connect lever (1) and transmission rod (2) to the operating mechanism box shaft.  
 - The pin (3) shall have its head facing the operating mechanism box.  
 - The lever shall be secured on the shaft with flat washer (4), elastic washer (5) and screw (6).



---

Connect the other end of the transmission rod to the double lever of the central pole in the following way:

- insert partially pin (7) with flat washer (8) in the central pole lever. The head of the pin shall face the pole.

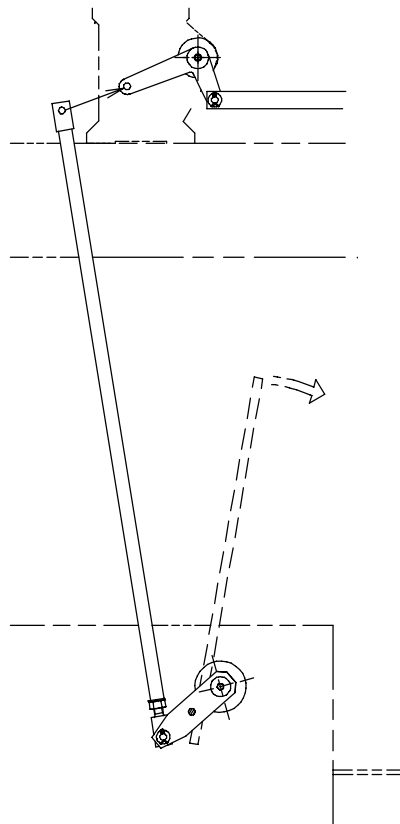


- 
- Move the rod upwards until the hole in the rod coupling end is aligned with the hole in the pole lever.

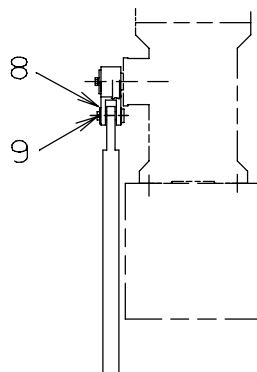
In order to attain this, the force of the opening springs in the operating mechanism box shall be overcome.

To this purpose, insert a rod and a 12 dia. pin in the lever on operating mechanism box shaft and exert leverage as shown in the figure.

The same lever for charging the closing springs (see par. 2.3.4 item 7) can be used.



- 
- Complete the insertion of pin (7) and secure it with flat washer (8) and cotter pin (9).



**DO NOT OPERATE THE CIRCUIT BREAKER BEFORE ADJUSTMENT OF TRANSMISSION (SEE par. 4.9.)**

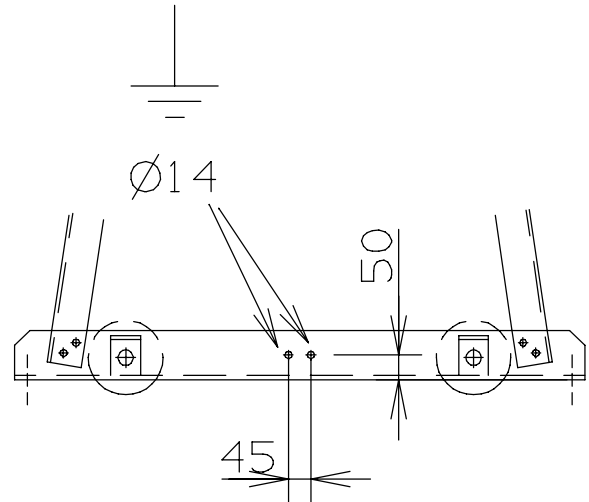
---

## 4.6. Grounding the structure

Connect the earth conductor to the 14 dia. holes in the bottom cross members of the supporting structure uprights.

The conductor (bar or cord) must have a cross section suitable for carrying the maximum earth current during a fault.

The contact areas shall be clean, scratched with a fine emery cloth without removing the finish, and coated with a thin and even layer of neutral grease (e.g. Vaseline). Tighten the bolts and cover the joint with abundant neutral grease around the joint in order to prevent corrosion.



---

## 4.7. Main circuit connection

### 4.7.1 Warning



**THE CONDUCTORS SHALL BE ISOLATED FROM THE SUPPLY AND EARTHED IN COMPLIANCE WITH CURRENT SAFETY REGULATIONS**

### 4.7.2 Preparing the contact surfaces

Check that the contact surfaces have not been damaged (dents, scratches etc.). Treat the contact surfaces of the conductor connections and of the pole terminals as follows, depending on the contact materials:

#### **Bare aluminium surfaces**

Scratch the contact surface vigorously with fine-grain emery cloth.

Immediately after scratching, clean the surface with a clean dry cloth and apply a very thin and even layer of neutral grease (e.g. Vaseline).

Joint to the other contact surface as soon as possible.

#### **IMPORTANT:**

- Never use emery cloth that has already been used for other types of material
- Successful jointing depends on the speed with which the above operations are carried out as the aluminium surface starts to re-oxidise extremely quickly immediately after scratching (aluminium oxide is an excellent insulation).

#### **Bare copper or bronze surfaces**

Scratch all the contact surface with fine-grain emery cloth.

Clean with a clean and dry cloth. Coat all the contact surface with a very thin and even layer of neutral grease as soon as possible.

#### **IMPORTANT:**

- Never use emery cloth previously used on other types of material.

#### **Tin-coated surfaces**

Do not use electroplated materials.

Rub vigorously the contact surface with a clean dry cloth.

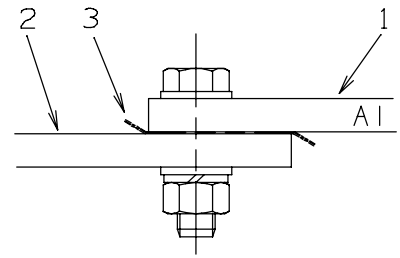
Only in case of persistent oxidation, scratch lightly the surface with fine-grain emery cloth, taking care not to remove a portion of the plating.

Coat the contact surface with a very thin and even layer of neutral grease.

### 4.7.3 Jointing

Joint the contact surfaces of the connection (2) and of the pole terminal (1), previously treated, by means of appropriate bolts with an elastic washer and two flat washers (one against the connection and the other on the terminal).

If possible, place the connection (2) under the pole terminal (1), keeping the nut as shown in the figure .



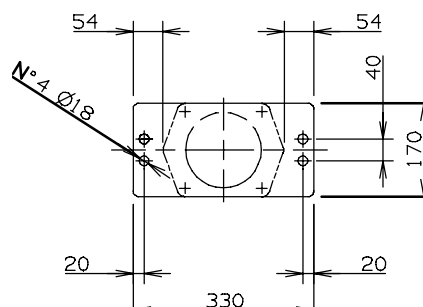
For jointing bare copper (or bronze) to bare aluminium, insert a bi-metallic copper-aluminium plate (3). The bi-metallic plate shall be treated as described at par. 4.7.2. The bi-metallic plate shall stick out slightly from the full perimeter of the contact area and be bended as indicated in the figure.

#### IMPORTANT:

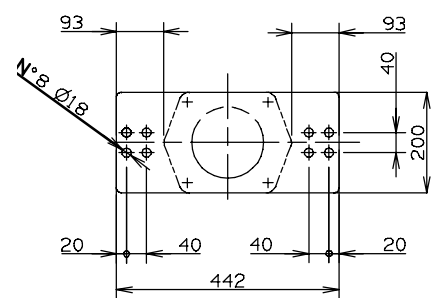
- The bi-metallic plate shall be inserted correctly so that surfaces of the same material touch each other.

Pole terminal dimensions:  
(see also the overall dimensions at par. 3.6)

- circuit breaker version (1)



- circuit breaker version (2)



The cross section of the conductors and the contact area of the joint shall be selected with a safety margin to suit the maximum operating current in order to avoid any overheating that could damage the poles:

- maximum overtemperature when carrying the load current: 50 K.

The poles shall not be used as a mooring point for the line conductors.

- see maximum allowable load on terminals at par. 3.4;

- if necessary, provide near the circuit breaker terminals suitable support insulators of the right size to cope with the electro-dynamic forces arising during a short circuit. Recommended tightening torque C for bolted connections:

- C = 150Nm for stainless steel A2-70, M16 threaded bolts



**DO NOT STRESS THE POLE WHEN TIGHTENING THE BOLTS ALWAYS USE TWO WRENCHES.** After completion of the joint, cover it with abundant neutral grease.

---

## 4.8. Filling the poles with SF6 gas

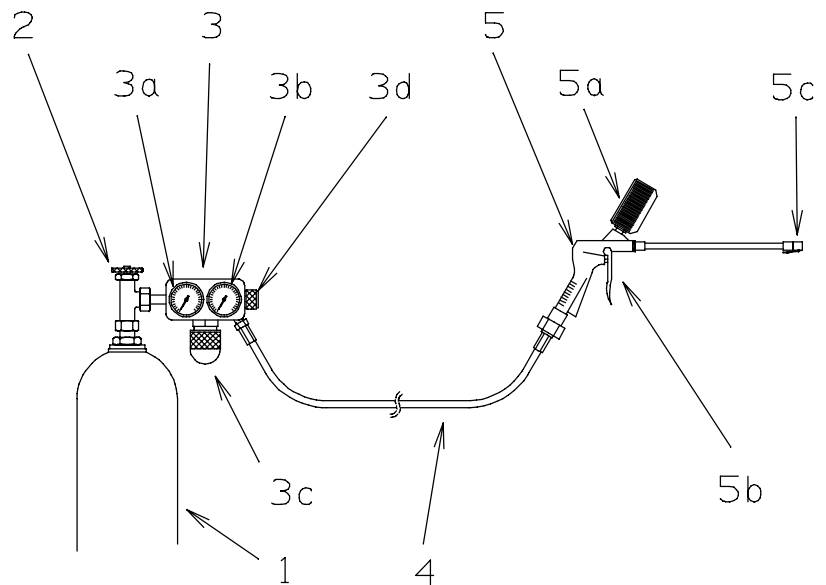
### 4.8.1 NOTE:

If the poles have been delivered at the gas pressure of 50 kPa (as highlighted on the bill applied to the barriers), it is necessary to complete the filling of the poles up to the nominal pressure of 400 kPa.

To pressurize the poles, it is required a filling device consisting of:

#### Key

- 1 gas cylinder
- 2 cylinder tap
- 3 pressure-reducing regulator with:
  - 3a cylinder pressure gauge (high pressure)
  - 3b output line pressure gauge (low pressure)
  - 3c output line pressure adjusting knob
  - 3d regulator tap
- 4 teflon hose
- 5 control pressure gauge with:
  - 5a pressure gauge
  - 5b lever valve
  - 5c coupling



### 4.8.2 Preparing the filling device

Fit the pressure reducing regulator to the gas cylinder, making sure that tap (3d) is closed and that knob (3c) for adjusting the pressure is fully unscrewed.

Check that the hose (4) does not contain any water or condensation before connecting.

If this is the case, dry thoroughly with compressed air.

Connect hose (4) to the pressure reducing regulator and then control pressure gauge (5) to the house.

Set the output line pressure from the regulator to the appropriate pole filling value as a function of the ambient air temperature - see the filling pressure curve at par. 3.6.

- open cylinder tap (2) and check the gas pressure inside the cylinder on the pressure gauge (3a);

- slowly tighten adjustment knob (3c) until the required filling pressure is indicated on the output line pressure gauge.

---

### 4.8.3 Filling the poles

Open pressure reducing regulator tap (3d);

Check very carefully the poles in order to make sure that they have not been damaged during transport or handling. In particular, check the porcelain insulators for any possible cracks.

Unscrew and remove the protective cap on the pole gas inlet valve (see pole description at par. 2.2.1 item 16).

Let the gas escape for about 10 seconds by the pressing valve lever (5b) on the control pressure gauge.

This operation evacuates any air inside the filling device.

While the gas is escaping, connect the coupling (5c) to the pole valve.

After about 2 or 3 minutes, the pole gas pressure will reach the filling value set on the outputline pressure gauge (see para. 4.8.2). After releasing the lever of the valve (5b), check on the control pressure gauge that the pole gas pressure is correct.

Remove the coupling (5c) from the pole valve and replace the protective cap on the valve, having previously checked that the two seals on the cap are in place, intact and lubricated (if necessary, lubricate these with fluorinated grease or Vaseline).

---

## 4.9. Transmission adjustment

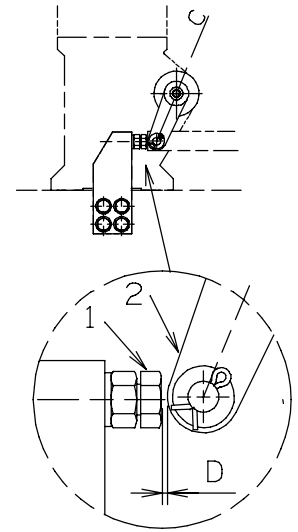
The transmission shall be adjusted with the circuit breaker poles filled at the rated pressure.

Charge manually the circuit breaker closing springs:  
- see manual charging at par. 5.2.3.

Close manually the circuit breaker:  
- see manual closing at par. 5.2.6.

**ATTENTION :**  
**THE CIRCUIT BREAKER IS CLOSED**

Measure and record the airgap D between the left-hand pole lever (2), as viewed from the back of the circuit breaker, and the head of reference screw (1) on the pole frame.



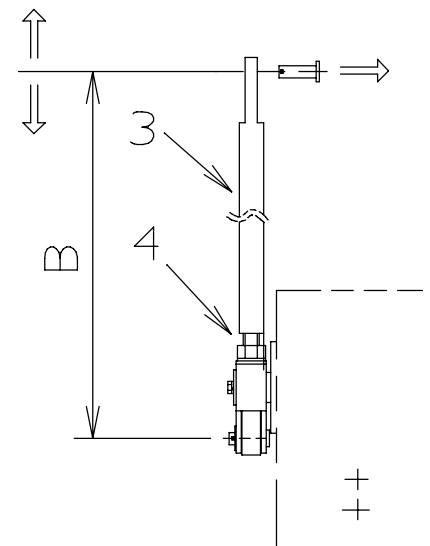
Open the circuit breaker:  
- see manual opening at par. 5.2.6.

**THE ROD ADJUSTMENT SHALL BE CARRIED OUT ON THE CIRCUIT BREAKER IN OPEN POSITION AND WITH CLOSING SPRING DISCHARGED**

Adjust the length (B) of the transmission rod (3) in order to get an air gap D = 2mm when the circuit breaker is closed.

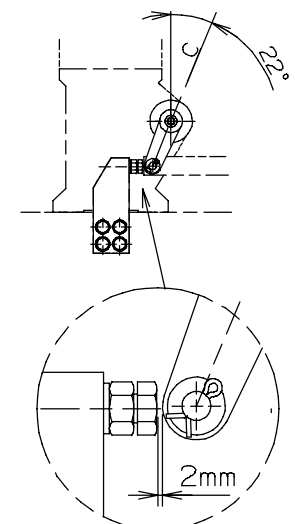
To adjust the length of the rod, remove the upper pin by carrying out the operations described for mounting the rod in the reverse order and then turn the adjustable coupling (4), bearing in mind that:

- if  $D > 2$  : lengthen the rod
- if  $D < 2$  : shorten the rod
- 1/2 turn of the coupling decreases or increases the airgap D of about 0.6 mm.



Do not tamper the reference screw (1) on the pole frame since this is set in the factory.

With the pole lever at 2 mm from the head of the position screw, the circuit breaker reaches the correct closing position of the circuit breaker, i.e., the pole lever is at 22° from the vertical.



---

## 4.10. Control and auxiliary circuits connection

### 4.10.1 General

A terminal block for connecting external cables and, on request, one or more molded-case circuit breakers are provided at the bottom of the operating mechanism box (see description of the operating mechanism box at par. 2.3.4).

### 4.10.2 Preparing the closing plate at the bottom of the operating mechanism box

Remove the closing plate at the bottom of the operating mechanism box.  
Make holes in the closure plate for the appropriate glands for the external cables.  
Fit the glands in the holes.  
Note:  
3 glands are supplied already fitted for the cables coming from the pressure switches under the poles.

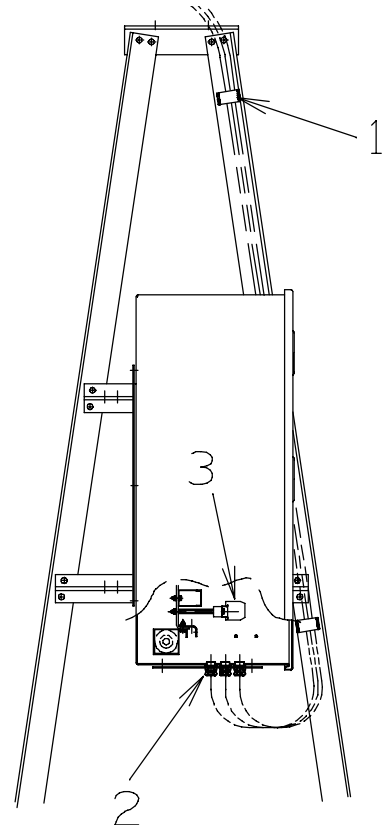
The cable clamps used must guarantee the operating mechanism box degree of protection IP55.

Set the plate into position and tighten the screws evenly with a slight torque (2 - 3 Nm) so that the seal is pressed.

### 4.10.3 Connecting the cables

Connecting the cables from the pressure switches

Run the cables through the guides (1) welded to the front upright on the structure.  
Insert the cables in the glands (2) on the closing plate at the bottom of the operating mechanism box.  
Connect the cables to the terminal board (3), following the specific circuit breaker wiring diagram included with the circuit breaker documents.  
(The diagram shown at par. 3.5 is a standard diagram.)  
Tighten the glands until the cables are securely fixed.  
Using the wiring diagram supplied with the circuit breaker, check the connections for the electrical lock required in the event of a drop in the gas pressure below the minimum functional value (see SF6 status check at par. 2.2.3).





---

## Connecting supply, control and signal cables

Insert the external cables in the glands previously applied to the closing plate at the bottom of the operating mechanism box (see par. 4.10.2).

Connect the cables to the terminal board and, if provided, to the moulded case circuit breakers, always referring to the specific circuit breaker diagram.

The cross section of the supply cables for the electrical devices shall be selected not only on the basis of the current carrying capacity but also considering the allowable voltage drop.

- The voltage measured at the circuit breaker terminal block shall always be within the limits indicated on the circuit breaker nameplate.

- See par. 3.1.2, point p) for details concerning the consumption of the electrical devices.

When all connections have been made, close the moulded-case circuit breakers protecting the circuits.

---

## 4.11. Final checks before commissioning

Check that all the installation operations have been correctly made by reviewing, point by point, the entire installation chapter.

Check that the gas pressure of SF<sub>6</sub> inside each pole is 400kPa

Carry out the following operations:

- Supply control and auxiliary circuits.
- Check that the motor charges the closing springs within 15 s.
- Close and open the circuit breaker manually and electrically (see circuit breaker operations at par. 5.2) and check that the operations are performed without delays or unusual sounds.

- Check that the continuous heating element works correctly (see par. 2.3.4, item. 20). This heating element reduces condensation on the equipment inside the operating mechanism box.

- Check that the thermostat-controlled heating element works properly (see par. 2.3.4, pos. 19) by using the thermostat knob. This heating element prevents the formation of ice on the equipment inside the operating mechanism box when the outside temperature drops below freezing point and further reduces condensation.

- Calibrate the thermostat: Set the thermostat knob to the temperature value at which the thermostat shall operate.

We recommend at first, to set this value at the average outside temperature expected for the wettest season, and in any case at a temperature not lower than 5°C. If, during later regular checks (see maintenance at par. 6.3), signs of condensation within the operating mechanism box are noticed, the thermostat setting shall be increased.

Otherwise, the temperature setting can be gradually reduced, but always remaining above 5°C.

- Close the operating mechanism door and check that the waterproof seal is evenly pressed.



**IMPORTANT:**

**BEFORE PUTTING UNDER VOLTAGE THE POLES, CUT AND REMOVE THE PROTECTIVE BARRIERS OF THE POLES.**



**5.1. Warnings for the user**

**5.1.1 Prohibited operations**



**ATTENTION :**

The following operations are strictly prohibited as they may damage the circuit breaker:

- Opening and closing of the operating mechanism when the mechanical transmission between the operating mechanism and the poles is disconnected.

- Manual opening and closing of the circuit breaker when electrically locked-out due to a drop in the SF6 gas pressure in the poles (see SF6 gas status check at par. 2.2.3).

**THE MANUAL OPERATION BY-PASSES ALL ELECTRICAL INTERLOCKS AND THEN IT SHALL BE CONSIDERED AS AN EMERGENCY OPERATION.**

**5.2. Operations**

**5.2.1 General**

See par. 2.3.2 for a description of the operating principles.

Closing the circuit breaker is only possible when the closing springs are charged.

The closing springs can be charged:

- electrically via the motor
- manually by using the charging lever.

Opening the circuit breaker is nearly always possible since the closing operation automatically charges the opening springs.

Closing and opening operations can be carried out:

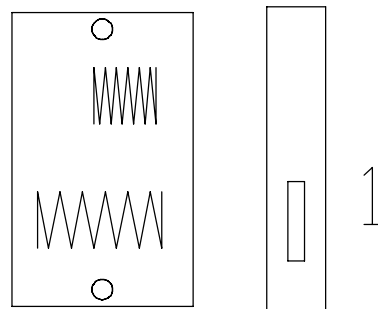
- electrically by means of the electro-mechanical shunt releases that are controlled:
  - remotely, via an electrical command
  - locally via the electrical push buttons
- manually and locally by means of mechanical push buttons.

The circuit breaker is equipped with all the safety devices necessary to ensure its correct use (see safety devices at par. 2.3.3).

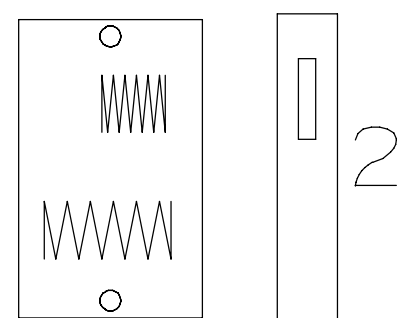
**5.2.2 Electrical charging of the closing springs**

At the instant in which the motor is energized, the closing springs start to be charged. This charging phase lasts less than 15 seconds. During this phase, the mechanical indicator showing the closing springs status on the front of the operating mechanism goes from:

-springs discharged (1)



to -springs charged (2)



**Note :**  
During a closing operation, the closing springs are discharged, but the motor is immediately energized in order to recharge the springs automatically.

---

### 5.2.3 Manual charging of the closing springs

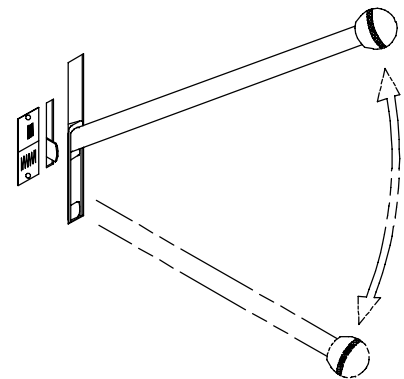
In the event of an emergency, the charging of the closing springs can be carried out using the proper removable lever supplied with the circuit breaker.

Insert the lever in the special slot on the front of the operating mechanism and, moving the lever up and down, charge the springs. Charging requires about 14-15 complete stroke up and down.

**IMPORTANT:**

Stop as soon as the lever moves idle.

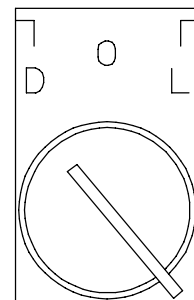
During manual charging, the closing springs status indicator goes from springs discharged to springs charged (see par. 5.2.2).



---

### 5.2.4 Remote electrical operation

For remote operation, the D-O-L key selector switch inside the operating mechanism box shall be turned to the D position (Distance). In this position the locking key can be withdrawn.

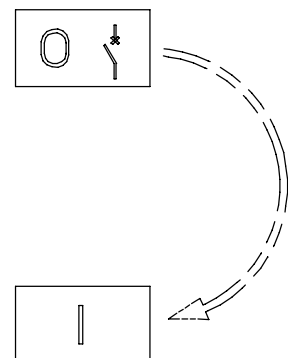


---

### Remote electrical closing

The closing release is energized by a remote electrical command. During closing, the mechanical indicator showing the circuit breaker position on the front of the operating mechanism goes from:

- "O" for circuit breaker open
- to:
- "I" for circuit breaker closed.



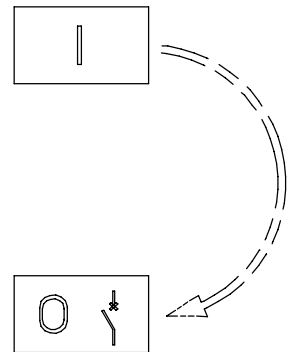
---

## Remote electrical opening

The opening release is energized by a remote electrical command. During opening, the mechanical indicator showing the circuit breaker position on the front of the operating mechanism goes from:

- "I" for circuit breaker closed
- to:
- "O" for circuit breaker open.

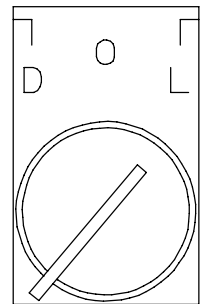
The 2nd opening release, if provided, is for remote opening like the 1st. release above. However, its remote control is not depending upon the position of the D-O-L selector switch. Use this release only for EMERGENCY REMOTE OPENING



---

## 5.2.5 Local electrical operation

For local electrical operation, the D-O-L key selector switch inside the operating mechanism box shall be turned to the L position (Local). In this position the locking key is trapped.

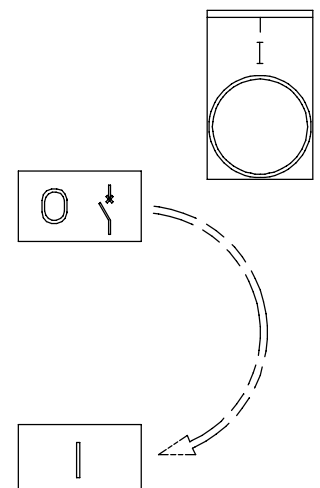


---

## Local electrical closing

By pressing the electrical closing push button "I" near the D-O-L selector switch, the closing release will be energized. During closing, the mechanical indicator showing the circuit breaker position on the front of the operating mechanism goes from:

- "O" for circuit breaker open
- to:
- "I" for circuit breaker closed.

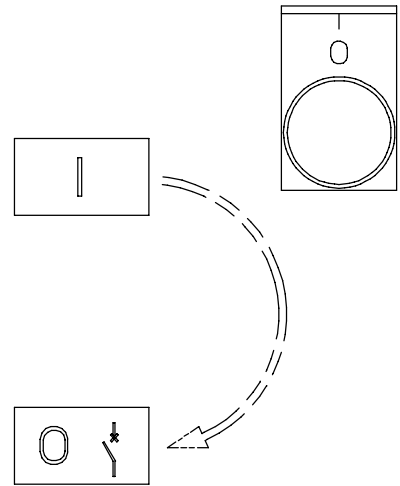


---

### Local electrical opening

By pressing the electrical opening push button "O" near the D-O-L selector switch, the opening release will be energized. During opening, the mechanical indicator showing the circuit breaker position located on the front of the operating mechanism goes from:

- "I" for circuit breaker closed
- to:
- "O" for circuit breaker open.



---

### 5.2.6 Local manual operation



**ATTENTION**

Use only for EMERGENCY LOCAL OPERATION  
See prohibited operations at par. 5.1.1

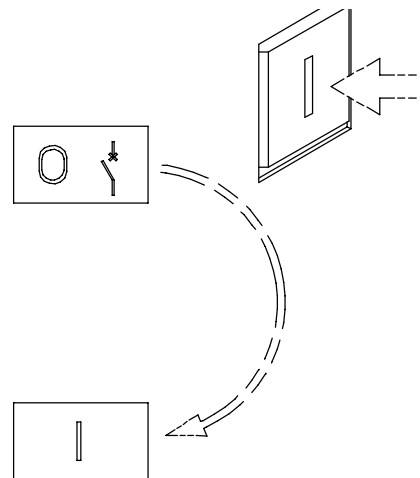
Manual operation by-passes all electrical interlocks.

---

### Local manual closing

Press the mechanical closing push button "I" on the front of the operating mechanism. During closing, the mechanical indicator showing the circuit breaker position on the front of the operating mechanism goes from:

- "O" for circuit breaker open
- to:
- "I" for circuit breaker closed.

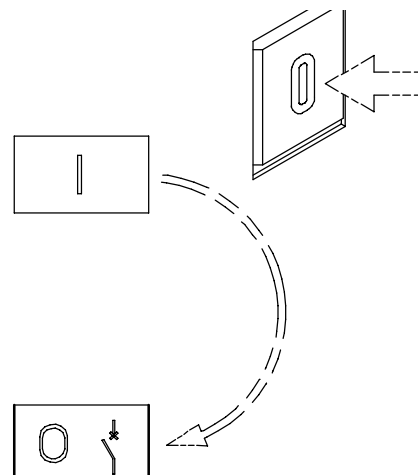


---

### Local manual opening

Press the mechanical opening push button "O" on the front of the operating mechanism. During opening, the mechanical indicator showing the circuit breaker position on the front of the operating mechanism goes from:

- "I" for circuit breaker closed
- to:
- "O" for circuit breaker open.



---

## 6.1. Recommendations for the user

If the user intends to carry out maintenance, he must make sure that his staff are properly trained and fully familiar with the equipment concerned.

On receiving the circuit breaker, the user must create a file containing:

- the serial number and model of the circuit breaker
- the date the circuit breaker was commissioned
- the results of all actions and tests, including diagnostics during the working life of the circuit breaker
- the dates and description of all maintenance work carried out

- regular records of all operations carried out by the circuit breaker and other operating indications (e.g. operations in short circuit)
- findings of every malfunction report.

In the event of a malfunction or defect, the user should draw up a malfunction report (see IEC 62271-1 Failure report) and inform the manufacturer, specifying the particular circumstances and measures adopted.

Depending on the type of malfunction, analysis should be carried out in collaboration with the manufacturer.

---

## 6.2. General

Circuit breakers require very low maintenance during normal operating conditions.

Maintenance operations and their frequency are linked to the actual operating conditions, which are determined by the following factors:

- frequency of operations
- total number of operations
- value of the interrupted current
- operating times
- environmental conditions.

The maintenance table at par. 6.3 should be adopted initially and then improved to suit the results obtained during the regular checks carried out on the equipment.

In particular, extreme environmental conditions imply a reduction in the recommended time intervals.

The circuit breaker should be put out of service as follows when carrying out maintenance work:

- open the circuit breaker remotely
- disconnect the main circuit breaker circuit from the network
- earth both sides of the main circuit close to the circuit breaker terminals
- de-energize the supply circuit of the closing springs charging motor
- discharge the closing springs by means of a closing and opening operation
- de-energize the control and auxiliary circuits
- check locally that the circuit breaker is open and the springs discharged.

In addition to the recommended maintenance operations, remember to perform the following during service :

- operate the circuit breaker at least once every year to prevent abnormal friction arising due to a long inactivity
- inspect the circuit breaker externally to check for any abnormalities or damages of any kind that could affect correct operation of the circuit breaker.

## 6.3. Maintenance and checks

### 6.3.1 Table of recommended maintenance

Part to be inspected	What to check for	Remedies if problems exist	Frequency
Pole	Gas pressure at rated value (see par. 6.4 for measuring)	Restore to rated value by topping up (see par. 6.5 for topping up)	1 year after commissioning and then every 3 years
Pole insulators	No dirt on surfaces	Clean with a dry cloth or a water dampened cloth	Depending upon environmental conditions at site
Connections to pole terminals	No corrosion at joints Bolts correctly tightened	Disassembled the joint Clean the corroded area with fine-grain emery cloth Restore the joint following in all respects the required procedure (see par. 4.7 for jointing)	1 year after commissioning and then every 3 years
	Presence of grease on joints	Clean the joint of any dirt with a dry cloth or ethyl alcohol Cover the joint with neutral grease (Vaseline) (see par. 3.7 for grease types)	As above
Grounding of structure	No corrosion at joints and bolts correctly tightened	Disassembled the joint Clean the corroded area with fine-grain emery cloth Restore the joint following in all respects the required procedure (see par. 4.6 for jointing)	1 year after commissioning and then every 3 years
	Presence of grease on joints	Clean the joint of any dirt with a dry cloth or ethyl alcohol Cover the joint with neutral grease (Vaseline) (see par. 3.7 for grease types)	As above
External mechanical transmission	No dirt, foreign bodies or corrosion in areas subjected to friction	Disconnect the transmission (see transmission connection at par. 4.5.8 and repeat steps in reverse order) Eliminate any dirt and signs of corrosion with suitable means (brush, emery cloth, cloth soaked in ethyl alcohol or trichloro-ethane)	As above
	Presence of grease in areas subject to friction	Lubricate the pins generously and completely with heavy-duty lithium grease (see para. 3.7 for grease types) Lubricate all shafts generously with silicon grease up to the seals (see para. 3.7 for grease types) <b>IMPORTANT:</b> Never use solvents in the shaft area Risk: deterioration of the seals against penetration of water	As above



External metal structure	No corrosion	Remove any sign of corrosion by suitable means (brush or emery cloth) Retouch the treated area with suitable paint	1 year after commissioning and then every 3 years
	No loose bolts	Tighten any loose bolts (see par. 4.5.6 for tighten torque)	As above and after every 3000 operations
Devices inside the operating mechanism box	No dust or dirt from outside No signs of condensation	Clean with clean cloth or cloth soaked in ethyl alcohol Check that all box closures guarantee the required safety factor (IP55) In particular, check that the door seals, closing panel seals and cable clamps are pressed evenly Lubricate, if necessary, with neutral grease (silicon or vaseline) If there are signs of condensation and previous checks resulted in no defects, follow these steps: – check that the heating elements work correctly (see para. 4.11) – if there are still no defects, increase the thermostat temperature	1 year after commissioning and then every 3 years
	Presence of grease on mechanisms subject to friction Securing device correctly positioned and tightened	Lubricate with lithium heavy-duty grease (see par. 3.7 for grease types) Tighten loose screws Replace safety rings correctly	As above and after every 3000 operations As above

### 6.3.2 Complete overhaul

**Operating mechanism:** every 10.000 operations

**Poles:** Every 10.000 mechanical operations  
or after 20 years of service  
or after the maximum allowable number of interruptions (see electrical life curve at para. 3.3)  
or when the arcing contacts are worn out (see contact wear check at par. 6.6).



#### ATTENTION

Overhaul of the operating mechanism and the poles shall be carried out by Schneider Electric staff or the user's staff after training at Schneider Electric.

Since special procedures are required when overhauling the poles (gas recovering, cleaning of parts, handling of gas sealing systems, air evacuation, gas humidity checks, tests), the pole shall be sent to the Schneider Electric factory.  
– for replacement of the pole, see par. 6.7.

---

### 6.3.3 Control tests after maintenance

Check that the various electrical and mechanical devices work properly by carrying out some operation sequences.

---

### 6.4. Measuring the gas pressure of the poles

Make sure that the circuit breaker has been put out of service (see para. 6.2).

Wait until the pole is at ambient air temperature.

Remove the protective cap on the gas inlet valve by unscrewing it.

Connect the control pressure gauge to the valve.

Read the pressure.

Bear in mind the effect of the ambient air temperature on the pressure value obtained (see filling pressure/temperature curve at par. 3.6.2).

Restore the protective cap on the gas inlet valve and after checking that the two seals are in place, intact and lubricated.

---

### 6.5. Topping up the poles with gas

If a pole needs to be topped up with gas, after the alarm has been activated by the pressure switch (see gas status control at par. 2.2.3) or after direct check of the pressure with a pressure gauge (see measuring the pressure at par. 6.4), follow the same steps given for pressurizing the pole during installation of the circuit breaker (see pressurizing the poles at par 4.8.3).

If the gas needs to be topped up with abnormal frequency, find the leakage point by using a leak detector for halogen gas.

If the pole is involved in repair operations, the same recommendations given for the complete overhaul of the pole are apply. (see pole overhaul at par. 6.3.2)

---

### 6.6. Checking the wear of arcing contacts

Check that the circuit breaker is out of service (see relevant operations at par. 6.2).

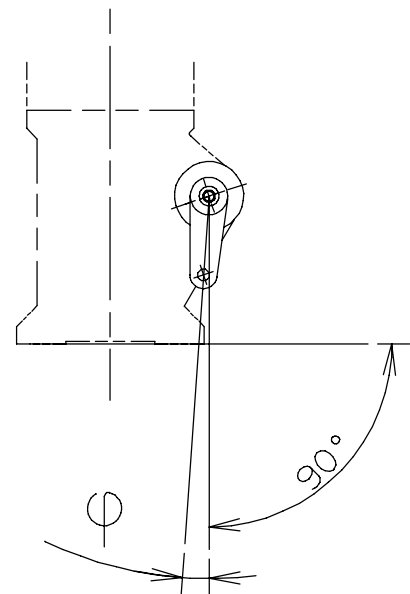
Disconnect the vertical transmission rod from the central pole lever by removing the connection pin (see transmission connection at par. 4.5.8 and repeat the steps in the reverse order).

Disconnect the horizontal linkage from the lever of the pole you need to check by removing the connection pin.

Slowly move the pole lever towards the closed position by hand.

Stop when the arcing contacts touch each other, that is when electrical continuity is established between the upper and lower terminals of the pole.

The position of the lever (see figure) when touching the arcing contacts, indirectly indicates wear conditions of the arcing contacts within the pole, according the table below:



	pole version (1)	pole version (2)
New arcing contacts	= 3.2 °	= 4.4 °
Arcing contacts with maximum allowable wear	= 6.4 °	= 8.9 °

NOTE:  
The pole shall be overhauled when the arcing contacts reach the maximum allowable wear (see pole overhaul at par. 6.3.2.)

## 6.7. Pole replacing

### 6.7.1 Preliminary steps

Put the circuit breaker out of service  
- see relevant at par. 6.2.

### 6.7.2 Removing the pole

Disconnect the vertical transmission rod from the central pole lever by removing the connection pin (see transmission connection at par. 4.5.8 and repeat the steps in the reverse order).

Remove the protective cap from the gas inlet valve by unscrewing it.

Connect the control pressure gauge and the hose to the valve and let the gas escape until there is a pressure of 50 kPa.

Remove the pressure gauge from the valve and replace the protective cap on the gas inlet valve.

Disconnect the horizontal linkage rod from the lever of the pole concerned by removing the connection pin.

Remove the lever from the pole shaft, having first removed the locking screw at the end of the shaft.

Remove the screws fixing the pressure switch protection box under the pole crank gear box.

Disconnect the pressure switch cables.

Securely hook the upper terminal of the pole on both sides to a suitable lifting device (see pole mass at par. 3.1.2, point n)).

Remove the 4 bolts fixing the pole to the main frame.

Remove the pole by lifting this slowly and without bumping the insulators and the pole top cover.

### 6.7.3 Remounting the poles

Check that the gas inside the pole is at the shipping level (for the measuring procedure, see par. 6.4).

If there is no gas pressure (pressure gauge reading: 0 kPa), the pole shall not be used (see checks at par. 4.5.1).

To mount the pole on the frame, follow the operations given for dismantling in the reverse order (see par. 6.6.2).

To fill the pole to the rated pressure for normal operation, follow the steps given for installation (see filling the poles at par. 4.8).



# APPENDIX A: SF<sub>6</sub> gas information

---

## A.1. General

### A.1.1 General characteristics of SF<sub>6</sub> gas

SF<sub>6</sub> gas is used for insulation and extinction of the electric arc in high and medium voltage apparatuses, for its outstanding characteristics that make it irreplaceable in these applications. There are in fact no currently known alternatives for this type of use which are on the whole preferable in technical, economic and ecological terms. In terms of environmental impact SF gas:

- does not participate in the reaction chain causing destruction of nitrogen in the atmosphere;
- does not contribute to acid rain;
- does not result in toxicity problems, and is neither carcinogenic nor bio-accumulating.

**It follows that the only specific problem remaining to be taken into consideration is the potential greenhouse effect. SF<sub>6</sub> gas is a highly stable gas.**

The general properties of new SF<sub>6</sub> are described in IEC 60376 section 2, while safety aspects, basic information and guidelines for working with SF<sub>6</sub> are covered by IEC TR 62271-303.

The contents of this section is fully in accordance with the above-mentioned publications.

---

### A.1.2 Standards of SF<sub>6</sub> gas

IEC 60376:  
Specification and acceptance of new sulphur hexafluoride.  
IEC 60480:  
Guide to the checking of sulphur hexafluoride (SF<sub>6</sub>) taken from electrical equipment.

IEC TR 62271-303:  
Use and handling of sulphur hexafluoride (SF<sub>6</sub>) in high-voltage switchgear and controlgear.

---

### A.1.3 Purchasing

SF<sub>6</sub> is commercially available as a liquid in containers of various sizes at a pressure of approximately 22 bar gauge at 20°C.  
All SF<sub>6</sub> purchased should meet the requirements of IEC 60376 and

consignments should be accompanied by a Certificate of Compliance.  
As with any pressurized gas, cylinders should be protected from heat and clearly labelled.

---

## A.2. Circumstances where handling of SF<sub>6</sub> is necessary

### A.2.1 Refilling

#### 10. Pressure/temperature diagram

The rated filling pressure (Pr) for an SF<sub>6</sub> insulated compartment is always referred to a gas temperature of 20°C, even if this is not expressly stated.

If the temperature changes, the gas pressure indicated by a gauge will change, but the density (mass of gas per unit volume) will remain constant.

Only a temperature compensated pressure gauge will read a constant gas pressure at different gas temperatures.

On a pressure/temperature diagram we can plot the curve of rated constant gas density corresponding to the rated filling pressure (Pr) :

- see filling pressure diagram at par. 3.6.

#### 20. Measuring the gas pressure

The current pressure manometers measure the pressure inside an enclosure taking the atmospheric pressure as a reference.

In other words they indicate the gauge or relative pressure. Unfortunately, atmospheric pressure is not constant but undergoes changes which depend on altitude and state of the atmosphere.

### 30. Effect of altitude

The standard atmospheric pressure at sea level is 101.3 kPa. In places above the sea level the atmospheric pressure will be lower and in places under the sea level (for instance in mines) it will be higher.

IEC Publication 60721-2-3 provides the following values for the standard atmospheric pressure (excerpts):

Altitude above sea level	Standard atmospheric pressure (kPa)
2000	79,5
1000	89,9
0 (sea level)	101,3
-- 400	106,2
-- 1000	113,9

### 40. Effect of atmosphere conditions

Depending upon the meteorological conditions, the atmospheric pressure at sea level can vary from about 91% to 107% of the above-mentioned value (IEC Publication 60721-2-3). The actual value can be measured by means of a barometer.

### 50. Measuring the gas temperature

Measuring the gas temperature It must be pointed out that the gas temperature within a switchgear does not necessarily coincide with the room temperature but it can be considerably higher due to the heat losses of the current carrying parts.

The best approximation is to assume the average gas temperature equal to the temperature of the crank gear box of the pole.

### 60. Determining the actual filling pressure

The actual filling pressure ( $P_g$ ) to be read on the pressure gauge is calculated as follows (all pressures are in kPa):

$$P_g = P_t - P_b + 101.3$$

where

$P_t$  = rated filling pressure corrected for the actual gas temperature;

it is obtain from the filling pressure / temperature diagram at par 3.6, entering the diagram on abscissa at the estimated average gas temperature.

$P_b$  = local atmospheric pressure, read on a barometer; if no barometer is available, at least the altitude effect should be taken into consideration and  $P_b$  should be selected on the standard atmospheric pressure table at par. A.2.1.3 as a function of the installation site altitude.

Obviously, the incidence of these corrections depends on the rated filling pressure and can result negligible in comparison with it.

### 70. Units of pressure

The unit of pressure in the International System of Units SI is the Pascal (Pa) with its multiples. Among these latter, the bar defined as 100 kPa is widely used. It may be helpful to users to recall some conversion factors regarding other pressure units still in use:

$$1 \text{ physical atmosphere} = 760 \text{ torr} \\ = 760 \text{ mmHg} = 1.013 \text{ bar} = 101.3 \text{ kPa}$$

$$1 \text{ technical atmosphere} = 1$$

$$\text{kgf/cm}^2 = 0.980 \text{ bar} = 98 \text{ kPa}$$

$$1 \text{ p.s.i.} = 0.069 \text{ bar} = 6.9 \text{ kPa}$$

---

#### **80. First filling**

When filling an enclosure for the first time or after any complete removal of SF<sub>6</sub> gas, it is necessary to evacuate the air inside the enclosure before filling. Suitable equipment must be used, including a vacuum pump and a vacuum gauge; the relevant instructions shall be carefully followed.

Particular attention shall be given to the following points, to be integrated with the manufacturer's instructions concerning the particular product :

- The specified quantities of molecular sieves shall be placed inside the compartment immediately before starting the vacuum pump.
- The residual pressure shall be achieved and maintained for the time stated for the particular equipment
- The effective gas pressure and the SF<sub>6</sub> humidity content shall be checked after a certain time from the completion of filling
- A leakage test shall be performed on seals and joints assembled at site. Even if it is widely recognized that SF<sub>6</sub> has a negligible impact on the global environment, it is recommended that losses of gas into the atmosphere are kept to a minimum.

#### **90. Removing used SF<sub>6</sub> from poles**

Where used SF<sub>6</sub> has to be removed, gas recovery equipment should be used to allow the gas to be stored under pressure. Precautions should be taken to prevent as far as possible the release of the gas into the work area and the atmosphere.

The final pressure to which a compartment should be evacuated should be as low as possible.

For gas-filled compartments not containing active parts of switching devices and where decomposition products are missing or are in very low concentration, no further action is required on opening the enclosure.

If some degree of decomposition is expected, when enclosures are first opened measures shall be taken in order to ensure that the criteria for SF<sub>6</sub> concentration mentioned at par. A.3.4 point 1) for maintenance is satisfied.

Solid SF<sub>6</sub> by-products shall be removed according to the instructions at par. A.3.4 point 5). Recovered used SF<sub>6</sub> gas should be returned to the supplier for re-processing to its new condition. In case of re-using, it shall be tested for impurities according to IEC 60480.

---

---

### A.3. Safety

#### A.3.1 General

The long service experience with SF<sub>6</sub> in electrical switchgear has shown an excellent statistical safety record. No major problem concerning its use does exist, provided that certain elementary precautions and procedures are established and observed.

Guidance for working with SF<sub>6</sub> used in switchgear during normal and abnormal service conditions is provided by IEC TR 62271-303; the following information and instructions are in accordance with the above-mentioned Publication.

---

#### A.3.2 Working with new SF<sub>6</sub> gas

SF<sub>6</sub> is not a toxic gas but obviously pure SF<sub>6</sub> does not support life. Since it is much heavier than air, SF<sub>6</sub> gas tends to accumulate initially in low-lying areas.

This could present a danger of asphyxiation due to oxygen deficiency if personnel are working, for example, below ground in ducts or trenches. In conclusion, adequate ventilation shall be provided as the only precaution when handling new SF<sub>6</sub>, particularly when operating indoors.

---

#### A.3.3 Handling used SF<sub>6</sub> gas

SF<sub>6</sub> decomposes at high temperatures (above about 500°C) and stable gaseous and solid decomposition products will be formed when arcing occurs during circuit-breaker switching and fault clearance operations; by-product concentration is directly proportional to the quantity of energy converted.

These products can cause irritation of the skin, eyes and mucous membranes, such as in the respiratory tract; in high concentrations they may have toxic properties.

In practice, however, there is a minimal risk due to the following reasons:

- SF<sub>6</sub> containing decomposition products has an unpleasant pungent smell that in itself is associated with an irritant effect.

Then even small quantities of gaseous products give rise to unmistakable warning indications within a matter of seconds, before any risk of poisoning can arise.

- Even in the most severe case (in the exceptional event of internal fault) it is unlikely that immediate exposure to SF<sub>6</sub> decomposition products would present a significant health risk for limited exposure times and other sources of toxic fumes (organic materials, metal vapors) could pose a greater threat than that from SF<sub>6</sub> by-products.

- SF<sub>6</sub> decomposition products (and moisture) inside equipment in service can be effectively and practically irreversibly removed by adsorption.

Material such as alumina, molecular sieves, etc. are suitable for this purpose.

- In normal service conditions in switchgear (including routine maintenance), the SF<sub>6</sub> and its decomposition products are contained within a well-controlled and enclosed environment. Personnel is never involved in handling arced gas during the operating life of the equipment. In particular, it must be pointed out that topping up of an enclosure with SF<sub>6</sub> does not normally require specific safety precautions.

The only events which might exceptionally require contact of workers with used SF<sub>6</sub> are the following :

- Removal of gas to allow repair or extension to be carried out.
- Abnormal release of gas due to a severe fault as an internal fault. For safety provisions in these circumstances refer to par A.3.4.



---

### A.3.4 General safety recommendations when working on SF<sub>6</sub>-filled equipment

1) Premises housing SF<sub>6</sub>-filled equipment shall be effectively ventilated during operations involving the handling of SF<sub>6</sub> gas both new and used. Special attention shall be paid to ventilation of lower level areas. In those situations where ventilation is restricted, an SF<sub>6</sub> leak detector should be used to test for the presence of gas which can then be dispersed by using forced air movement if necessary.

Approximate concentration limit values are given in the following for different situations:

- filling:

1000 ppmv of SF<sub>6</sub>

(This value is not related to toxicity but is an established limit for all harmless gases not normally present in the atmosphere)

- maintenance-extension:

200 ppmv of SF<sub>6</sub>

- internal fault:

20 ppmv of SF<sub>6</sub>

(This value refers only to SF<sub>6</sub> related arc products; it must be underlined that, in internal arc fault situations, metal and plastic vapours are the dominant contributors to overall toxicity).

The two last values are based on a mixture of the ambient air in the switchgear room with a restricted volume of differently polluted SF<sub>6</sub> and represent a high security factor.

2) If a disagreeable smell is detected on opening the door of the premises or near the place where the plant is installed, the area should be thoroughly ventilated and entering the premises should be avoided until the ventilation has dispersed the nauseous products or SF<sub>6</sub> concentration below the above-mentioned limit values have been measured.

3) Should irritation of the upper respiratory tract and eyes become apparent, personnel shall immediately get into fresh air even if no equipment failure is evident.

4) Emergency work involving contact with SF<sub>6</sub> decomposition products require the use of protecting clothes. Contact with the solid decomposition products should be avoided as far as possible.

Particular attention should be given to protecting the eyes and the respiratory tract.

Goggles, gloves and a mask shall be used; respirators are required for concentration values exceeding the limits specified at point 1).

(Light duty disposal rubber gloves are appropriate, preferably nitrile or neoprene. The mask should comply with European Standard EN140, and the filter with EN141 and 143 Type A2/B2/E2/K2/P/3 or equivalent.)

5) Solid SF<sub>6</sub> by-products shall be handled with certain precautions. They shall be removed by means of a vacuum cleaner fitted with a dust filter and reserved for "SF<sub>6</sub> use only". Blowing them around shall be avoided and compressed air shall be strictly ruled out. Solid products shall be removed quickly after an enclosure is opened in order to minimize acid formation due to ambient humidity. (It is recommended to use a vacuum cleaner with a filter capable of trapping particles in the micron range.

A Type H machine in accordance with BS5415 : Supplement No.1 1986 or equivalent is suitable).

6) Adsorbent or molecular sieves shall not be subjected to high temperatures or disposed of by incineration, as toxic vapours are likely to be released.

7) Personnel working on equipment which has contained SF<sub>6</sub> decomposition products shall:

- Observe high standards of personal hygiene.

- Not eat, drink or smoke.

- Clean themselves and their equipment using disposable materials, before leaving the work area.

- Remove protective clothing and wash themselves thoroughly after leaving the work area.

---

**8)** First aid equipment shall include an eye-wash kit containing a saline solution. In case of irritation of the eyes, irrigation shall be carried out immediately. If signs of skin irritation occur, the affected part shall be washed in cool running water. Adequate washing facilities shall be made available for workers whenever handling of used SF<sub>6</sub> is foreseeable.

**9)** Powder deposits and adsorbent materials can be neutralised by immersion for a time period of 48 hours in a solution of 10–14 kg sodium carbonate (Na<sub>2</sub>CO<sub>3</sub> : washing soda) per 100 litres of water; clothing should be immersed in the same kind of solution for about one hour and then rinsed in clean water, before laundering or disposal. Due to the high concentration of this alkaline solution, care should be taken to avoid contact with the skin, eyes, etc. Neutralized solid decomposition products, vacuum-cleaner bags and adsorbents may be disposed of as normal waste. Used neutralizing solution should be disposed of according to local regulations.

---

## A.4. References

- 1 Mauthe, G. and Pettersson, K. et al (1991): “*Handling of SF<sub>6</sub> and its Decomposition Products in Gas Insulated Switchgear (GIS) ELECTRA*” No.136, June 1991, pp 69–89 and No.137, August 1991, pp 81–108
  - 2 IEC 60376: *Specification and acceptance of new sulphur hexafluoride (SF<sub>6</sub>)*
  - 3 IEC 60480: *Guide to the checking of sulphur hexafluoride (SF<sub>6</sub>) taken from electrical equipment*
  - 4 IEC TR 62271 -- 303: *Use and handling of sulphur hexafluoride (SF<sub>6</sub>) in high-voltage switchgear and controlgear*
-

---

**group Schneider Electric  
service centers are there for:**

engineering and technical  
assistance  
start-up  
training  
preventive and corrective  
maintenance  
adaptation work and spare parts

**Call your sales representative  
who will put you in touch  
with your nearest group  
Schneider Electric service  
centers.**

---

**Schneider Electric SpA**

Via Circonvallazione Est, 1  
24040 Stezzano-BG  
Tel : (39) 035 4151111

[www.schneiderelectric.it](http://www.schneiderelectric.it)

**03804257ZA revision : E0**

As standards, specifications and designs change from time to time, please ask for confirmation of the information given in this publication.

Conception, rédaction: Service Documentation  
Technique T&D

Edition of: june 2009