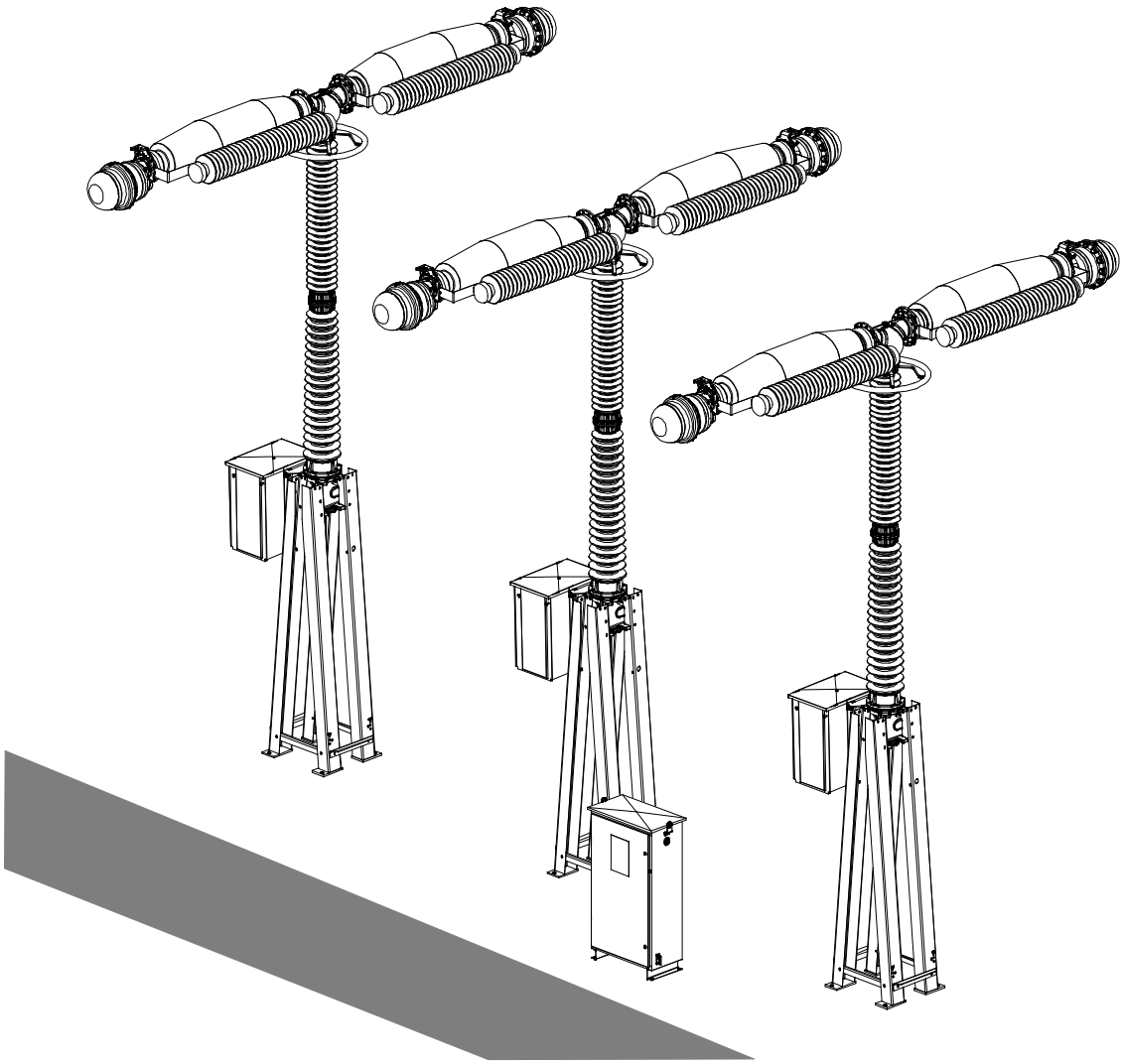
SF_6 circuit- breaker
GL317D
With spring operating mechanisms
FK3- 4



Administrator	First issue	Compiled by	Approved by
AHT	01- 06- 2017	F. Largeron	C. Catalano

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This equipment contains Fluorinated Greenhouse Gas (SF_6) covered by the Kyoto Protocol, which has a Global Warming Potential (GWP) of 22200. SF_6 should be recovered and not released into the atmosphere. For further information on the use and handling of SF_6, please refer to IEC 62271: High-Voltage Switchgear and Controlgear - Part 303: Use and Handling of Sulphur Hexafluoride (SF_6).

Introduction

Your decision to use GE high voltage switchgear means that you have chosen a product that is very advanced technically and has proven effective and reliable in the field.

The entire development and production process for our high voltage switchgear is controlled by an ISO 9001 certificated quality management system, an ISO 14001 certified environmental management system, and the OHSAS 18001 occupational health and safety management system. Regular audits guarantee that our products and services meet high quality standard.

In order to ensure optimum operation (and take advantage of all product benefits), please follow the instructions in this manual when installing, commissioning and operating the equipment. In the event of problems or equipment malfunction, please contact your local GE representative.

This manual describes installation, commissioning, operation, inspection, maintenance and reconditioning. Additional copies of this manual can be obtained from your local GE representative by specifying the OI- number.

GE's high voltage switchgear units are specifically designed to allow for long maintenance intervals. The operational reliability of the equipment is guaranteed by proper servicing and by following the instructions given in this manual. GE assumes no liability for damage due to failure to follow the manual instructions.

The information contained within this document is to be considered for information only. GE issues no guarantee as to its accuracy, integrity or the fact that this information may be suitable for any particular product, in so far as this information may vary as a function of technical and commercial circumstances.

This document and the equipment described herein are subject to change without notice in the interest of further development. No claims of any kind may be derived from the specifications, figures or descriptions.

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Safety

Technical data

Description and operation

Packaging - Shipping and storage

Installation

Continued on next page.

Installation, continued

Commissioning

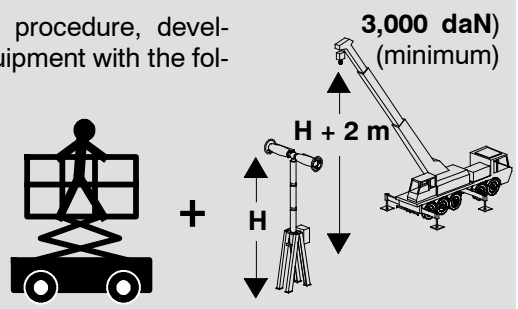
Maintenance

Annexes

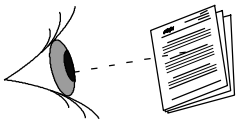
End of equipment service life

Complementary installation procedure

The complementary installation procedure, developed below, imposes a lifting equipment with the following characteristics :



Support- frame assembly	**L31-140EN/02**
Lifting and positionning the pole	**L31-200EN/06**
Installing terminals with preparation of contact surfaces	**L31-508EN/03**
Installing the capacitors	**L31-603EN/02**
Column - chambers coupling	**L31-7143EN/01**
Installing the operating device	**L31-7902EN/01**



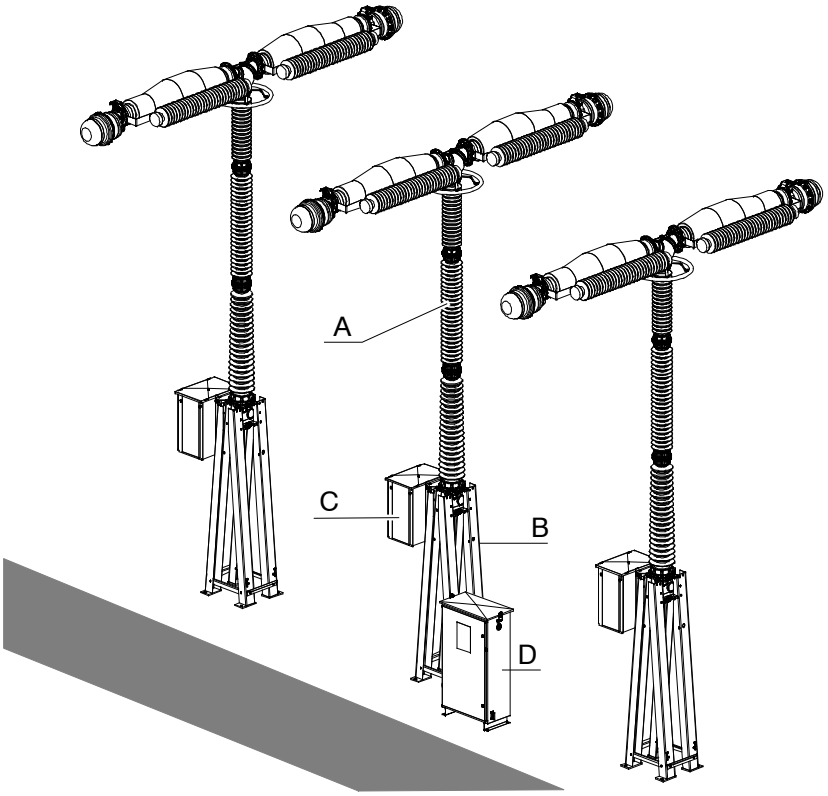
Installation, continued

Circuit- breaker GL317D with spring operating mechanism FK3- 4

Description

The circuit- breaker is made up of three poles, each activated by a spring operating mechanism.

Diagram



Parts table

The table below gives the main parts of the circuit- breaker :

Mark	Component	Page
A	Pole of the circuit- breaker	2
B	Bearing structure	3
C	Operating device	4
D	Marshalling cubicle	5

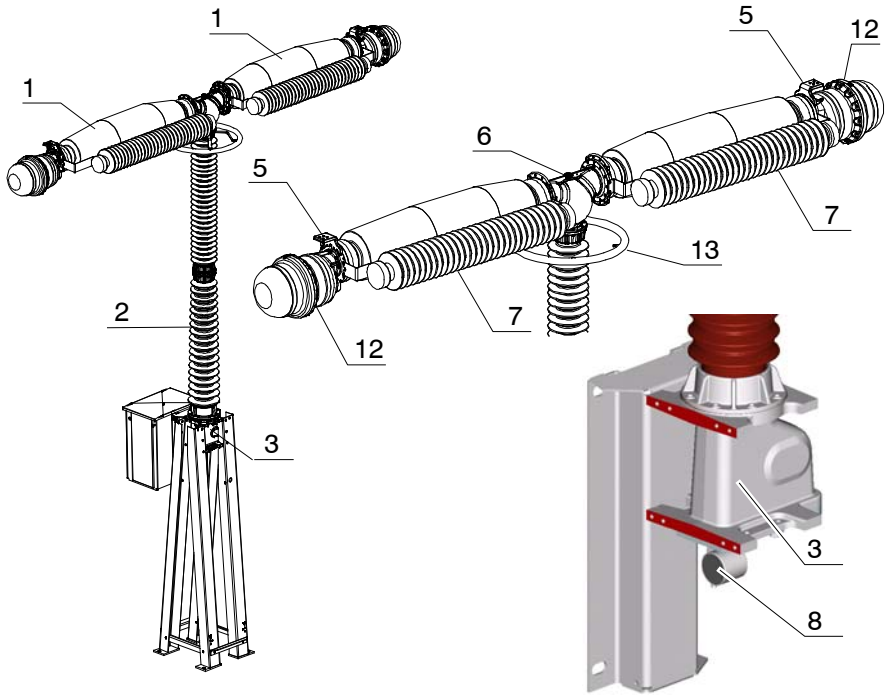
Pole of the circuit- breaker

Description

The pole of the circuit- breaker is made up with three main components :

- The interrupting chambers (1).
- The support column (2).
- The housing of the mechanism (3).

Diagram



Interrupting chambers

The pole is comprised of two interrupting chambers (1) - in a ceramic envelope - equipped at each end with a resistor (12) and an HV terminal (5).
The interrupting chambers are laid out horizontally and attached, at their base, to a common housing (6). This housing contains the mechanism used to transfer the operating movement to the mobile contacts of both chambers.
The interrupting can also be equipped with capacitors (7).

Support column

Consisting of two, three or four ceramic insulators, the support column (2) allows the circuit- breaker to be ground- insulated and it also encloses the operating tie- rod which is attached to the interrupting chamber's moving contacts.
The support column can also be equipped with a corona ring (13).

Housing of the mechanism

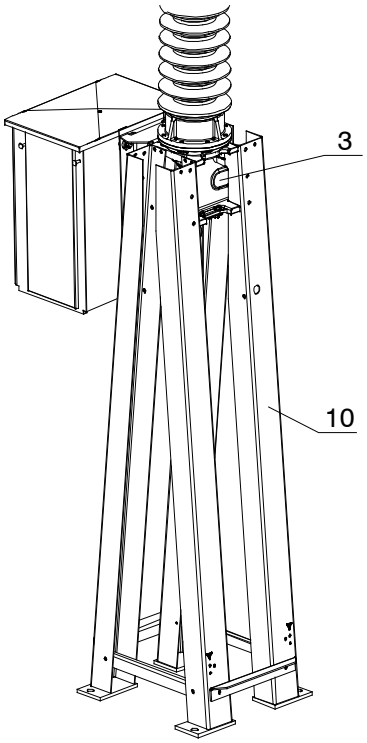
A housing (3) - situated at the base of the column - contains the lever and crank assembly and which operates the moving contact.
The SF_6 filling and monitoring device (8) is also situated on the housing.

Bearing structure

Description

The support- frame (10) - made up with four supports fastened to the housing (3) - supports all the circuit- breaker components.
The support- frame may be supplied by either Grid Solutions or the customers.

Diagram

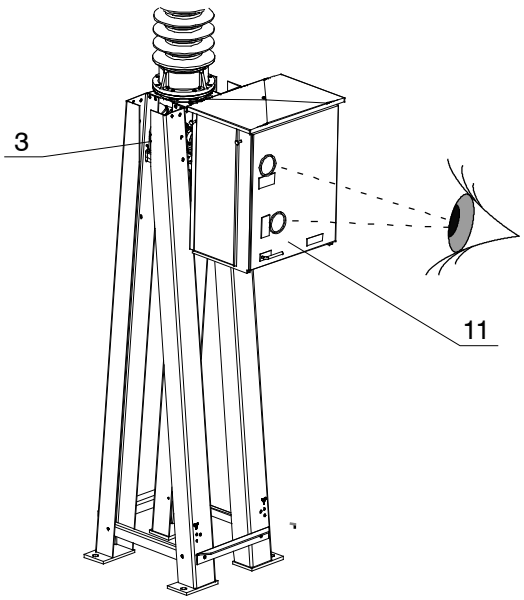


Operating device

Description

The operating device (11) is a spring operating mechanism of the FK3- 4 type. The door of the operating device (11) is equipped with two windows. These windows permit to display the optical signalization of the circuit- breaker state and closing spring state.

Diagram



Fastening

The operating device is fastened on the housing (3).

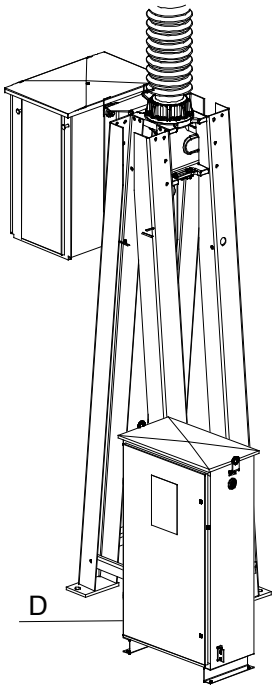
Marshalling cubicle

Description

The marshalling cubicle (D) is fastened on the ground near the central pole. Included with :

- The relays required to operate the circuit- breaker.
- The interconnection terminals boards.
- The terminals boards.

Diagram



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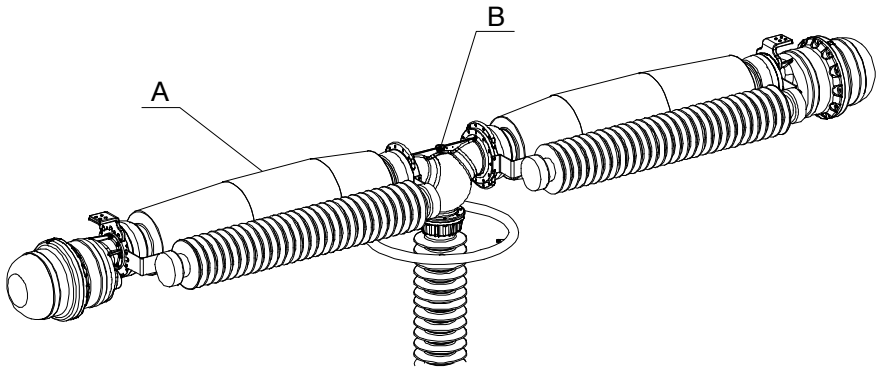
Presentation

Diagram



Parts table

The table below gives the main parts of the interrupting chambers :

Mark	Component	Page
A	Interrupting chamber	2
B	Upper housing	3

Interrupting chamber

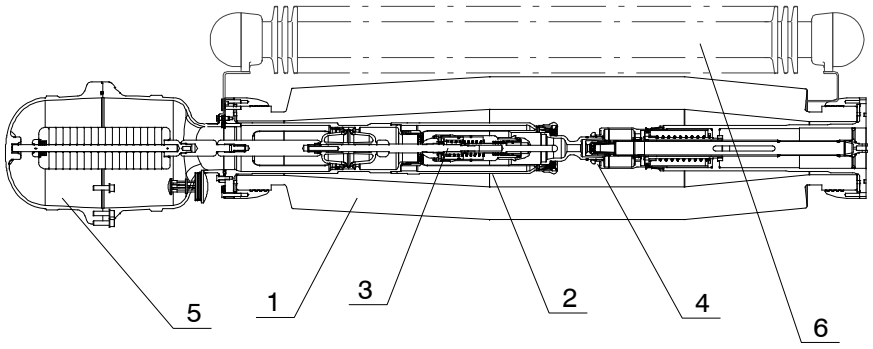
Quenching medium

The quenching medium is pressurized SF_6 gas or - in particular instances - pressurized SF_6+CF_4 gas mixture.

Interrupting principle

The interrupting chamber is of thermal blasting type, using the energy from the arc, with an auxiliary autopneumatic effect.

Diagram



Description

The interrupting chamber has been designed in such a way as to increase the mechanical resistance of the working part and take advantage of the low wear rate of the contacts subjected to the arc in SF_6. The working part is enclosed in a leak tight ceramic envelope, providing insulation between the circuit-breaker input and output.
The chamber is made up of the following elements :

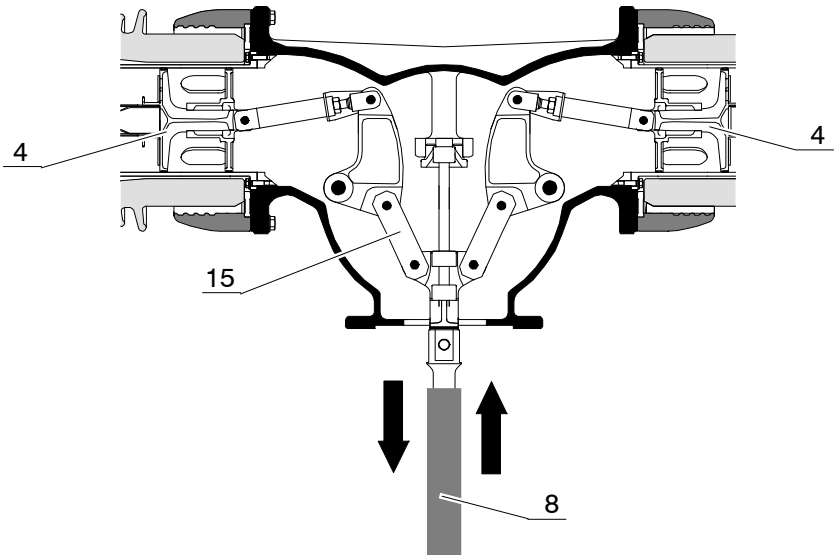
Mark	Component	Information
1	Envelope	Can have a long creepage distance, depending on the pollution level.
2	Fixed contact support	Supports the main contacts.
3	Resistor insertion device	By- pass the resistor.
4	Moving contact	It is worked by the operating mechanism and contains the blasting device.
5	Resistor	Used for operation of lines, capacitor banks or reactors...
6	Capacitor	(depending on the apparatus)

Upper housing

Description

The upper housing encloses the movement transfer mechanism (15) from the operating tie- rod (8) to the moving contact (4) of the two chambers.

Diagram



Parts table

The table below gives the housing internal and peripheral components :

Mark	Component	Function
4	Moving contact	It is worked by the operating mechanism and contains the blasting device.
8	Operating tie- rod	Transmits the movement to the moving contact of the two chambers.
15	Mechanism	Transfer of the movement.

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Presentation

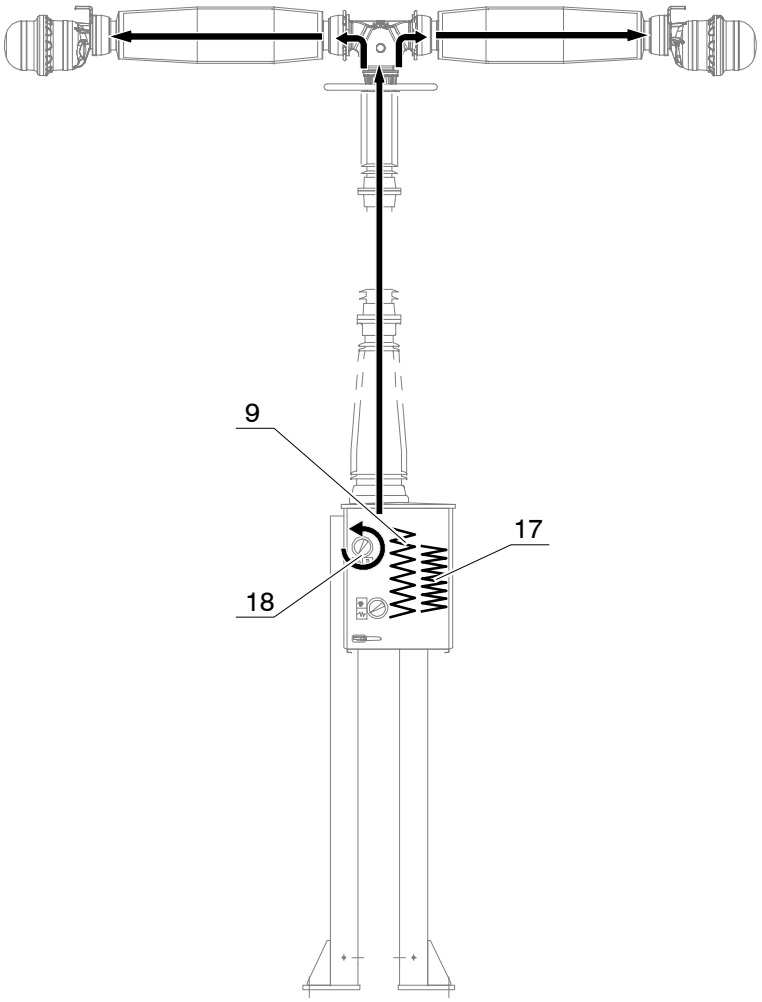
In this module

This module contains the following topics :

Closing

Description

When an electrical or manual closing order is given, the energy accumulated in the closing spring (17) - situated inside the operating device - is released. This energy is transmitted directly to the pole operating shaft (18), to ensure closing by way of the transfer mechanism inside the housing (11).
The release of the energy stored up in the closing spring (17) causes displacement of the moving parts - and so the closing of the interrupting chambers - and also reloads the opening spring (9).



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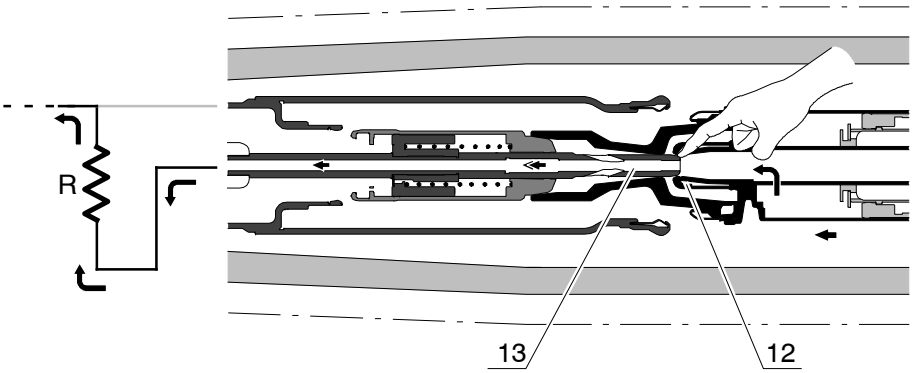
Closing, continued

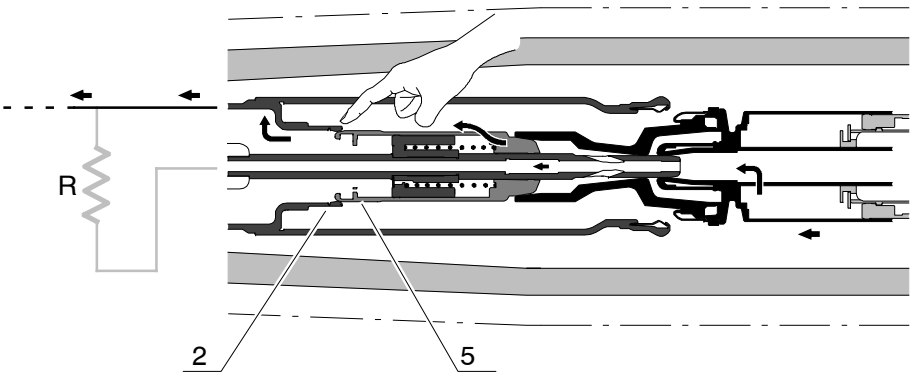
Start of insertion of resistor

The arcing fingers (12) of the moving contact comes in contact with the fixed contact rod (13), the resistor (R) is inserted.



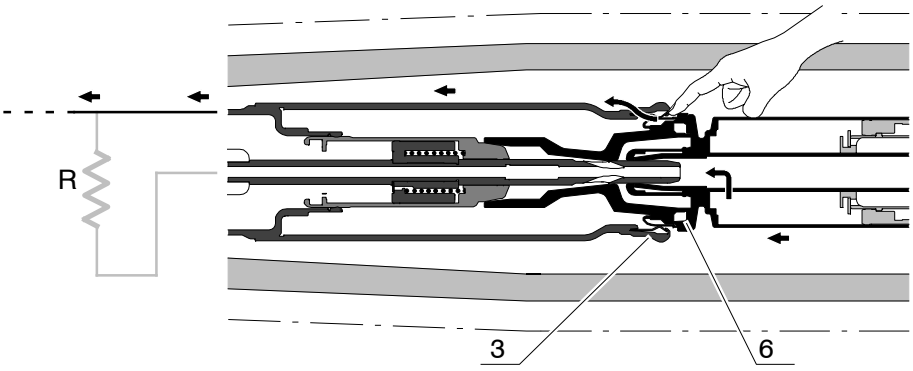
End of insertion of resistor

As the closing stroke continues, the moving part of the resistor insertion device (5) come into contact with the fixed contact (2) and by- pass the previous electric circuit.



Closing of main contacts

As the closing stroke continues, the moving contact (6) come into contact with the main fingers (3) of the fixed contact. The C.B. is then in “CLOSED” position.



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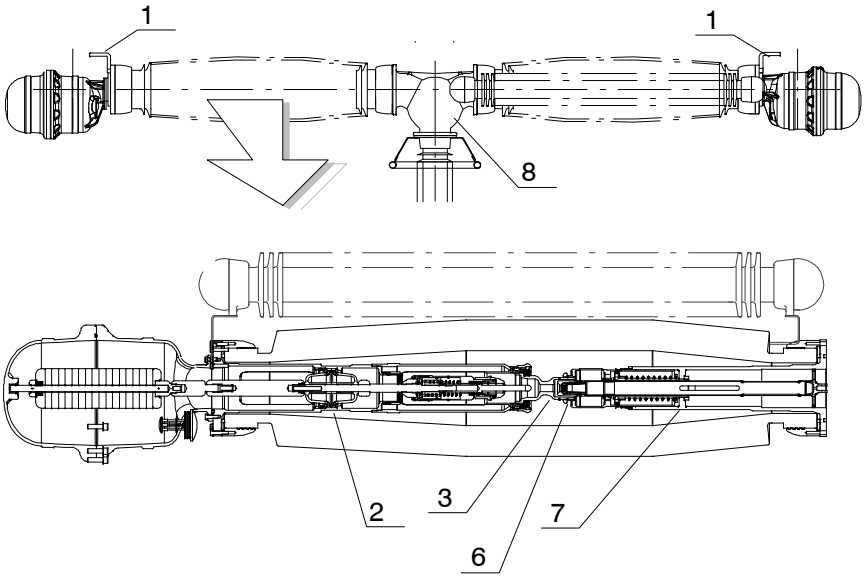
Closing, continued

“CLOSED” position

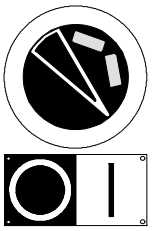
In “CLOSED” position the current passes through :

- the terminal (1),
- the fixed contact support (2),
- the main contacts (3),
- the moving contact (6),
- the moving contact support (7),
- the common housing (8),

and follows the opposite chain on the other chamber and the terminal (1).



Circuit- breaker
Closed

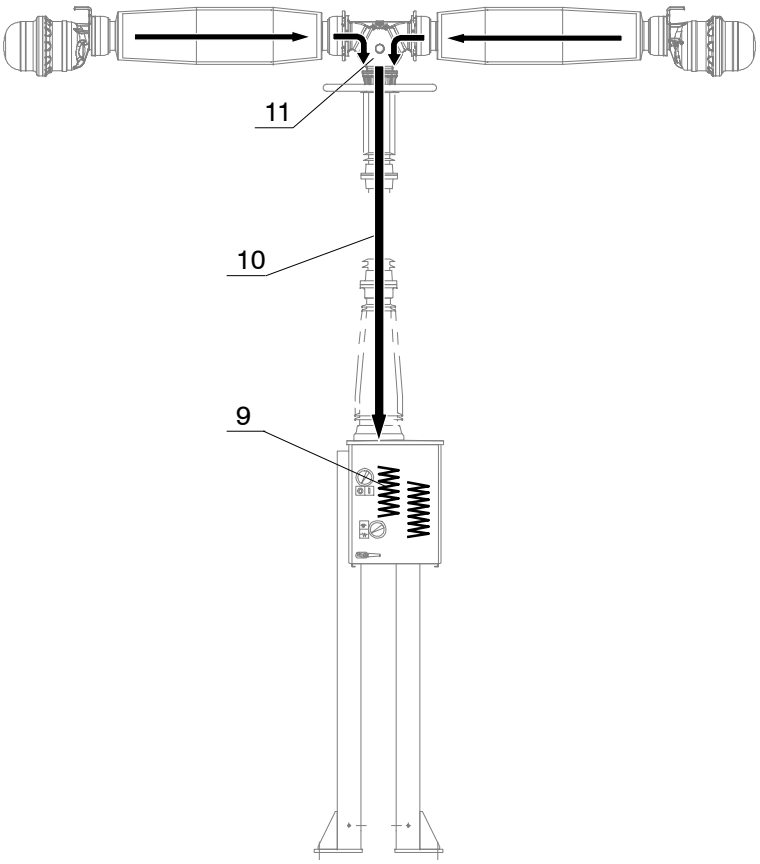


Opening

Opening

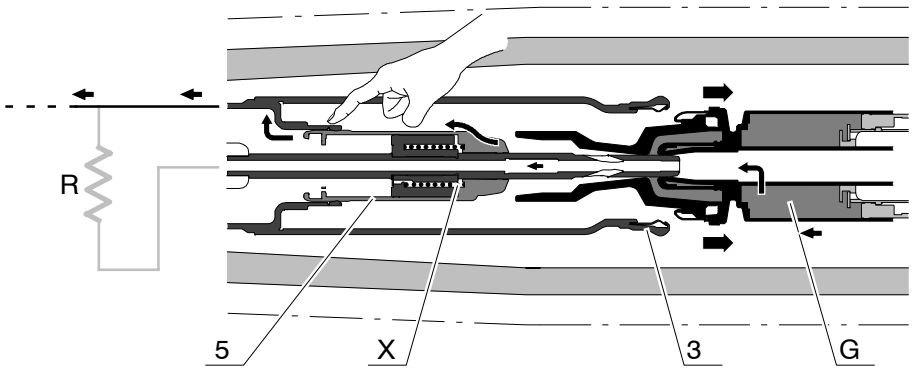
When an electrical or manual opening order is given, the energy accumulated in the opening spring (9) is released.

The insulating tie- rod (10), directly activated by the opening spring (9), transmits the movement to the transfer mechanism (11) inside the housing which causes the contacts to separate simultaneously in both chambers.



Self- timing of the resistor insertion device

After the separation of main contacts (3) and beginning of gas compression (G), the resistor insertion device (5) return is time- delayed by pneumatic effect (depression of the “X” volume).



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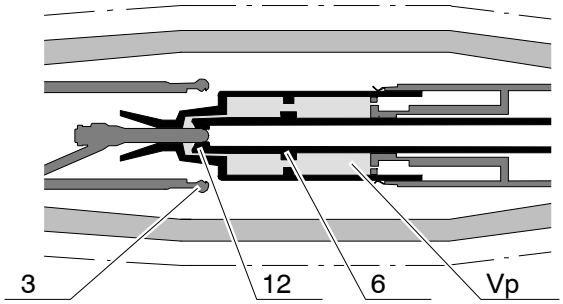
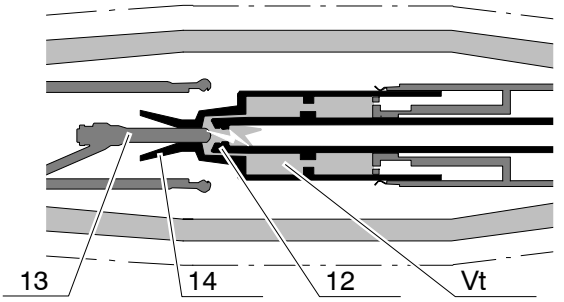
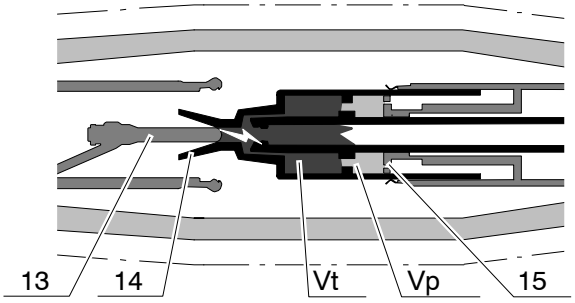
Opening, continued

Operation

The table below gives the stages of opening :

Stage	Description
Start of opening	When the moving contact (6) separates from the main contacts (3), the current is switched onto the arc contacts (12). The compression of the (Vp) volume causes the first rise of pressure. 
Thermal effect	When the contacts (12) separate, the arc appears and its energy causes the pressure to rise in the thermal expansion volume (Vt), closed by the fixed contact rod (13) and the insulating nozzle (14). 
Interrupting and assistance at opening	When the rod (13) comes out of the nozzle (14), the thermal overpressure in the volume (Vt) is released causing an energy blast to occur, just before the current zero passage, ensuring final quenching of the arc. The (Vp) volume pressure decreases to the ambient pressure by means of the valve (15) to allow the end of the opening. 

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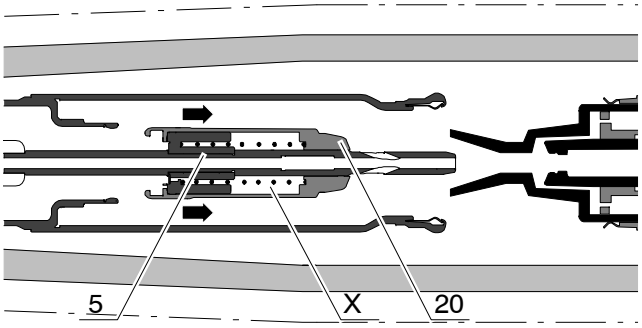
Opening, continued

Return of the resistor insertion device

The resistor insertion device (5) is restored to its initial position - actuated by a spring (20) and the end of "X" volume depression - **only after interruption**.

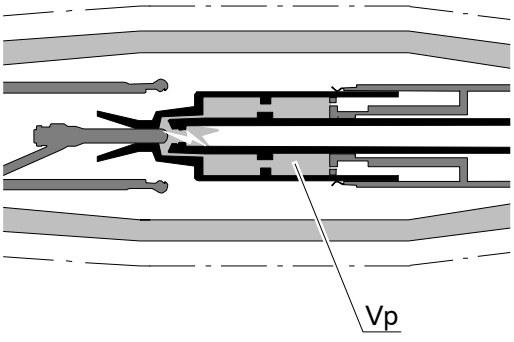


Molecular sieve

The arc has been extinguished.
The SF_6 molecules, separated by the arc, are re- formed instantaneously.
Residual gases left over from the interruption operation are adsorbed by the molecular sieve situated at the base of the pole. A few powdery compounds are deposited in the form of dust which is quite harmless for the circuit breaker.

Special case of small currents

For small currents (example : operating no- load lines, transformers or capacitor banks), the thermal energy of the arc is too low to provide enough excess pressure.
Consequently, the conventional autopneumatic effect developing in the volume (Vp) is used mainly, to blast the arc.



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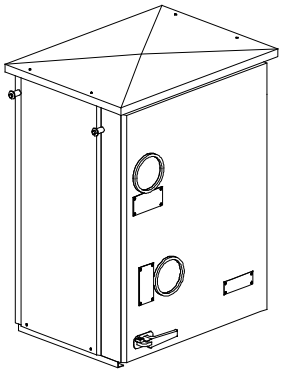
Presentation

Introduction

The operating device is a spring operating mechanism of type **FK3- 4**.
The operating mechanism is usually electrically remote- controlled.
During commissioning or when auxiliary voltage is lacking, operations can also be performed directly on the mechanism.



Warning

OPERATION AUTHORIZED ONLY IF THE OPERATING DEVICE IS CONNECTED TO THE CIRCUIT BREAKER.
THE CIRCUIT BREAKER MUST NOT BE OPERATED AT A SF_6 PRESSURE GAS LOWER THAN THE MINIMAL PRESSURE FOR THE INSULATION p_{me}.

In this module

This module contains the following topics :

Description of the mechanism

Drive shaft

- The main shaft (1) is linked up to the the circuit- breaker pole by means of a cylinder (2).
- A damper (4) is linked up to the lever (32).
- In the “CLOSED” position, the main shaft (1) rests on the opening latch (6) by means of the lever (5).
- In the “OPEN” position, the lever with roller (11) rests on the closing cam (10).
- The opening spring (3) activates the lever (33) by means of the chain (34). This spring is a pressure helical type.

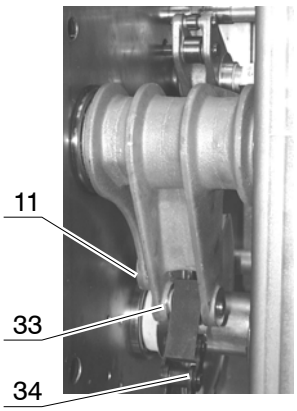
NOTE : The levers (5)- (11)- (32) (33) form one piece only.

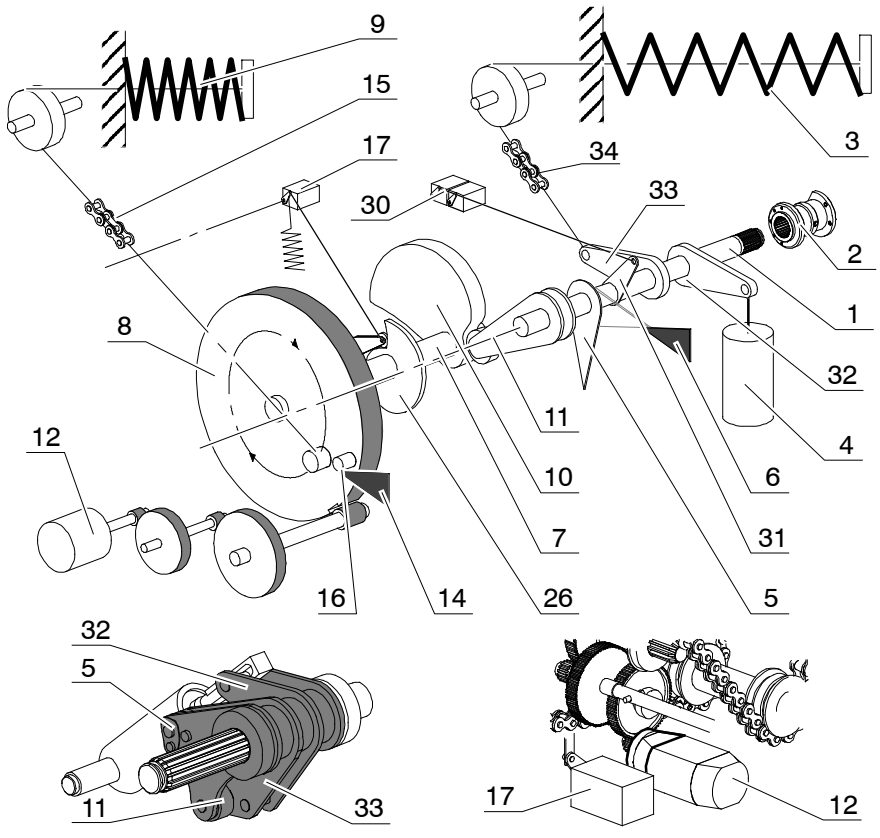
Closing shaft

- On the closing shaft (7) are placed :
- The inertia flywheel (8).
- The closing cam (10).
- The cam (26) that engages the limit switch (17) of the motor (12).
- The closing spring (9) activates the inertia flywheel (8) by means of the chain (15). This spring is a pressure helical type.

The rotation torque - created on the inertia flywheel (8) by means of the loaded closing spring (9) - is balanced by closing latch (14) / roller (16).

Diagram





Auxiliary fittings

Reloading the closing spring

The closing spring (9) is loaded by means of the reducing gears (13) and the motor (12).

Auxiliary electric fittings

- The **auxiliary contacts** (30) are activated by a rod and a lever (31), the latter is activated by the main shaft (1).
- The **limit switch of the motor** (17) is activated by the cam (26)
The cam (26) is installed on the closing shaft (7).
- The **closing latch** (14) and the opening latch (6) are electrically activated by coils (22) “Closing” and (27) “Opening”.

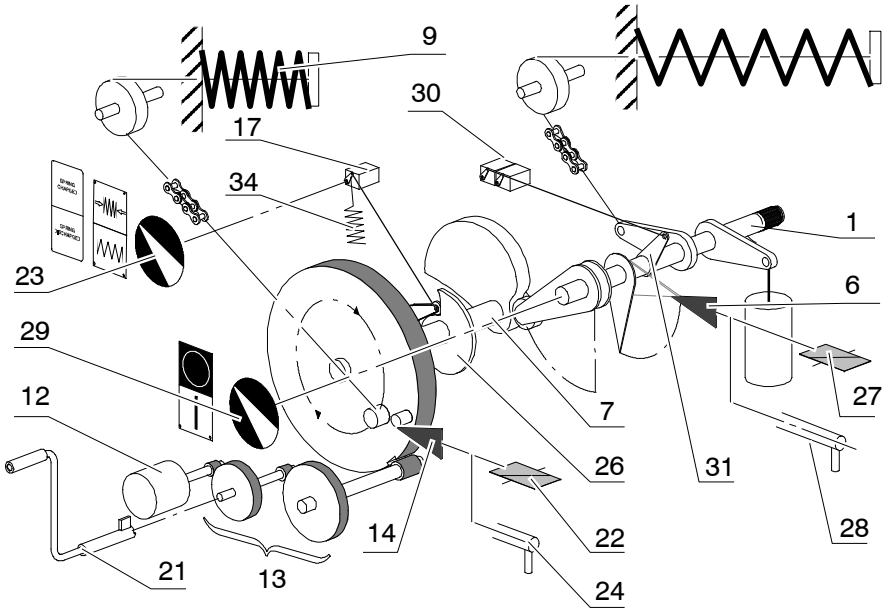
Auxiliary mechanical fittings

- The operating mechanism can be activated by the **manual levers** (24) “Closing” and (28) “Opening”.

WARNING : Operating the mechanism by the manual levers (24) “Closing” and (28) “Opening” overrides electrical interlocks. Ensure it is electrically safe to operate the equipment when using these levers to defeat electrical interlocks and lockouts.

- The **indicator** (29) gives the “OPEN” or “CLOSED” positions of the circuit-breaker. An operation counter gives the number of realized operations.
- The **indicator** (23) gives the “CHARGED” or “DISCHARGED” states of the closing spring.
- If the auxiliary current supply fails, the **hand- held crank** (21) permits the closing spring to be fully charged.

Diagram



Operating principle

Warning

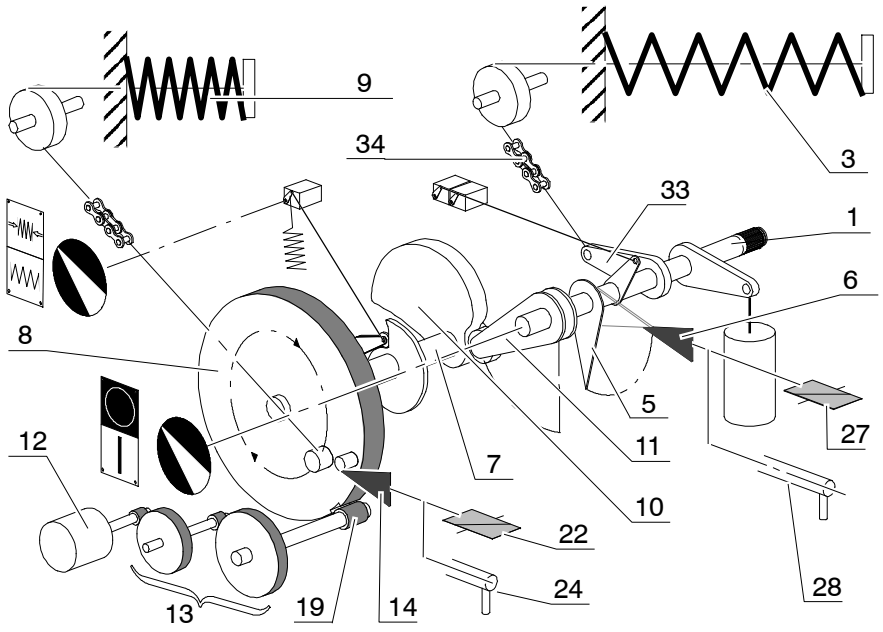
OPERATION AUTHORIZED ONLY IF THE OPERATING DEVICE IS CONNECTED TO THE CIRCUIT BREAKER.
THE CIRCUIT BREAKER MUST NOT BE OPERATED AT A SF_6 PRESSURE GAS LOWER THAN THE MINIMAL PRESSURE FOR THE INSULATION p_{me}.

Closing

- When the closing coil is energized or the manual closing lever is operated, the closing latch (14) releases the inertia flywheel (8).
- The closing shaft (7) effects a 180° rotation generated by the loaded closing spring (9).
- The cam (10) rotates the main shaft (1) by means of the lever with roller (11). After a 60° rotation, the lever (5) rests on the opening latch (6).
- Simultaneously, the opening spring (3) is loaded by means of the chain (34) activated by the rotation of the lever (33).
- A freewheel, installed on the gear wheel (19), avoids the reducing gears (13) and the motor (12) being driven by the gear wheel of the inertia flywheel (8).

NOTE : A mechanical device (not shown) prevents all closing operations if the circuit- breaker is already in the “CLOSED” position.

Diagram



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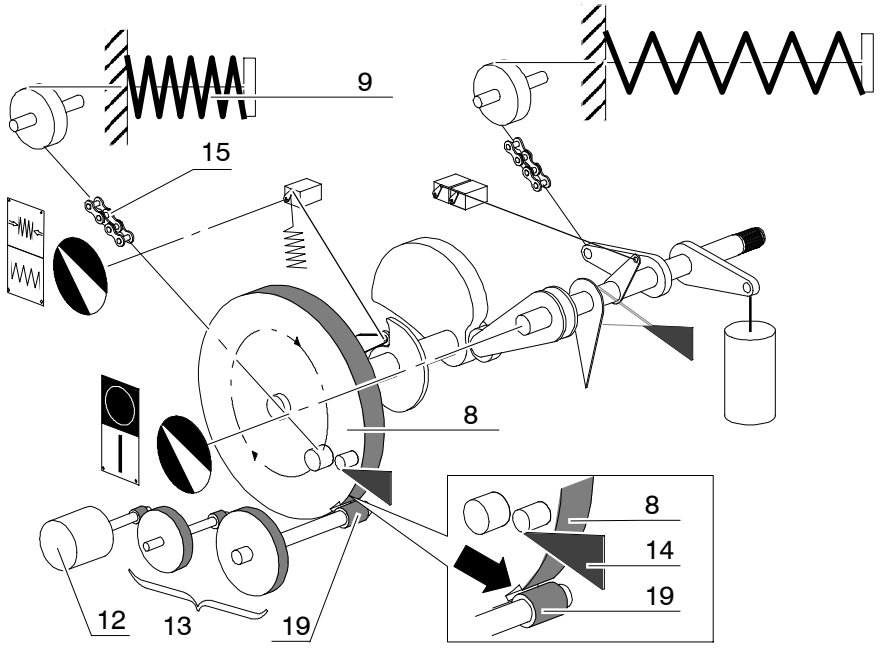
Operating principle, continued

Reloading the closing spring

- When the motor (12) is supplied with current, it immediately starts to load the closing spring (9) by means of the reducing gears (13) of the inertia flywheel (8) and the chain (15).
- At the full stroke, the gear (19) is at the no tooth sector of the inertia flywheel (8) and the reducing gears (13) can decelerate without causing strain on the closing latch (14).

NOTE : During the loading of the closing spring, the supplying circuit of the closing coil is cut to avoid an untimely closing operation.

Diagram



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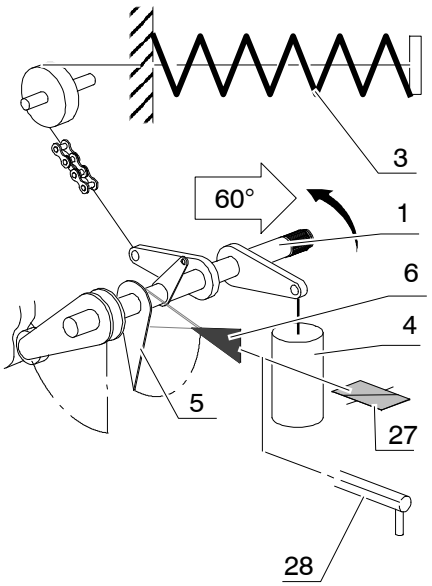
Operating principle, continued

Opening

- When the opening coil (27) is energized or the manual opening lever (28) is operated, the opening latch (6) releases the lever (5).
- The main shaft (1) effects a 60° clockwise rotation - generated by the loaded opening spring (3) - before reaching the circuit- breaker “OPEN” position.
- A damper (4) dampens the excess energy to smoothly finish travel.

Diagram



Presentation

Introduction

The circuit- breaker uses pressurized SF_6 gas as electric arc quenching gas. The SF_6 gas pressure monitoring is essential to assure the circuit- breaker performances.

Principle

There is two SF_6 gas pressure monitoring types :

- Permanent monitoring with the help of a threshold densimeter.
- Periodic monitoring with the help of a dial densimeter (visual control)

Symbols

IEC symbols for the apparatus technical characteristics.

Symbol	Designation
p_{re}	Filling rated pressure for the insulation
p_{ae}	Alarm pressure for the insulation
p_{me}	Minimal pressure for the insulation

In this module

This module contains the following topics :

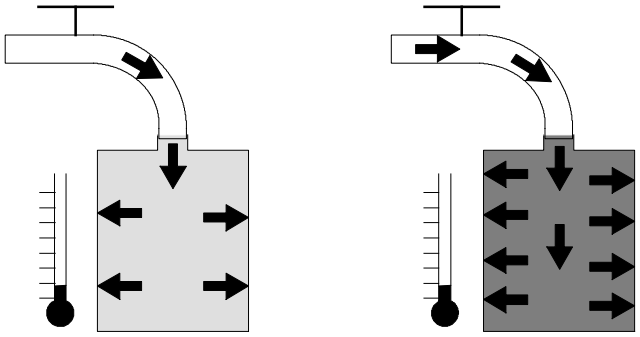
Gas pressure and density

Introduction

The electrical characteristics of switchgear depend on the density of SF_6 gas i.e. the mass of gas pumped into a compartment of a given volume.

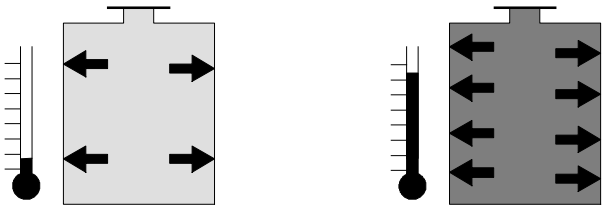
Constant temperature

At constant temperature, an increase of gas density results in a higher gas pressure against the walls of compartment.



Constant density

At constant density, with an fixed compartment volume, the pressure changes in the same way as the temperature. Since the gas density remains invariable owing to the fact that no modification occurs in the quantity of gas or the volume of the relevant compartment, the electrical characteristics of the switchgear will remain unchanged.



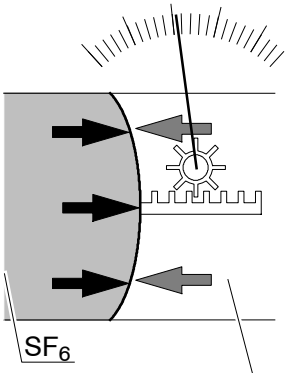
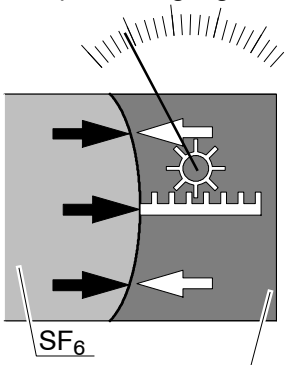
Conclusion

Since it is difficult to measure the gas density directly, it is essential to know accurately its absolute pressure and temperature.

Pressure measurement

Effective pressure ?
Absolute pressure ?

Absolute pressure = effective pressure + atmospheric pressure

Pressure	Description	Diagram
Effective	The pressure of SF_6 gas is measured by of a standard pressure gauge with a deformable diaphragm actuating an indicating pointer. One surface of the diaphragm is in contact with the SF_6 gas, while the other is in contact with the atmosphere. The difference between the gas and the atmosphere is thus measured, taking atmospheric pressure as a reference. This is the measurement of the effective pressure of the SF_6 gas.	Standard pressure gauge  SF_6 Atmospheric pressure
Absolute	If the deformable diaphragm, one surface of which is in contact with the SF_6 gas, blocks a volume where a vacuum has been developed, the pressure gauge measures the pressure difference between that of the SF_6 gas and the vacuum. Since the latter is zero, the pressure gauge measures the absolute pressure of the gas. The absolute pressure of the SF_6 gas, independent of atmospheric pressure, reflects the quantity of gas introduced into the compartment and hence its density at the present temperature. This is measured by means of an absolute pressure gauge which is less generally used and more delicate than a effective pressure gauge. <u>This is the reason why a effective pressure gauge is used, provision being made for corrections required by atmospheric pressure variations resulting from atmospheric disturbances and differences of elevation</u>.	Absolute pressure gauge  SF_6 Vacuum volume

Measuring density

Pressure units

- The international unit pressure is the Pascal (Pa).
- The practical unit is the bar (14.503 p.s.i.)

1 bar = 1,000 hPa
1 bar = 100 kPa
10 bar = 1 MPa

- Standard atmospheric pressure is equal to 101.3 kPa at sea level and an air temperature of 20°C (68°F).

Measuring density

When it is not possible to directly measure density, this may be checked using an industrial pressure gauge capable of measuring the **effective pressure**.
An effective pressure value corresponds to the rated density, determined for normal atmospheric pressure (101.3 kPa) and an ambient temperature of 20°C (68°F).

For each pressure reading (filling, inspection of densimeter thresholds...), the rated effective pressure should be corrected according to the ambient temperature and atmospheric pressure of the site at the time the reading is taken. See the module "**Calculation of the SF_6 gas filling pressure to using the pressure gauge (tool)**".

The real pressure is therefore :

$$P_{real} = P_{rated\ effective\ in\ accordance\ with\ temperature} + \Delta Pp*$$

* Δ**Pp** : **correction in accordance with atmospheric pressure**.

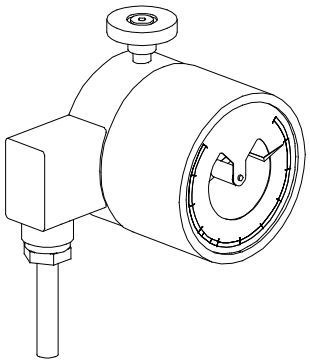
Densimeter

Function

- Permanent SF_6 gas density monitoring.
- Visual SF_6 gas real pressure information (MPa - psi).

Localization

The densimeter is situated onto the bottom of the pole of the circuit- breaker, and joined to the gas volume of the circuit- breaker.



Working

The densimeter is fitted with internal contacts. These contacts close successively if the gas's density diminishes and determine 2 distinct thresholds. These contacts are wired to the terminal block inside the cubicle and are usually left at the user's disposal for the following use :

- Alarm pressure "$\boldsymbol{p}_{ae}$" acts as a warning (topping up necessary).
- Minimum functional pressure for insulation "$\boldsymbol{p}_{me}$" must be used either to lock the circuit- breaker in position or to cause automatic opening. The option is chosen by the client in keeping with operating requirements.

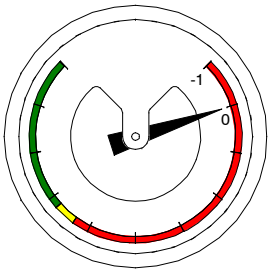
All the circuit- breaker's rated performances are guaranteed up to the minimum specified ambient temperature and the minimum functional pressure for insulation "$\boldsymbol{p}_{me}$".

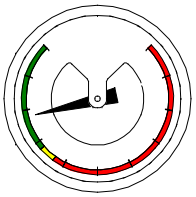
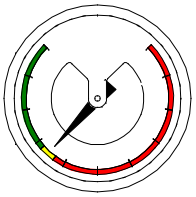
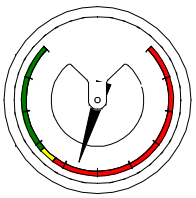
Continued on next page.

Densimeter, continued

Reading the dial

The dial is divided into three colored areas : Green, Yellow and Red. The position of the needle indicates the SF_6 gas **absolute pressure** value.



Needle position	Colored area	Direction
	GREEN	None
	YELLOW	Perform a topping- up operation.
	RED	Abnormally low density, find the origin of the leak and contact **Grid Solutions After- sales Service**.

Presentation

Information

The different parts of the poles (chambers and column) are filled with nitrogen (N_2) for transport purposes to an effective pressure of 0.03 MPa at 20°C (68°F).

In this module

This module contains the following topics :

Packaging

Introduction

For transport, the different parts of the apparatus are divided-up between several cases :

- Interrupting chambers + (corona rings chambers).
- Columns + (corona rings, electrical connections ...).
- Operating devices : each operating device is vacuum-wrapped in a protective bag containing desiccants.
- Frames if the latter is supplied by Grid Solutions.
- The SF_6 bottle(s) or - in particular instances - SF_6 bottle(s) and CF_4 bottle(s).
- Marshalling cubicle.
- Assembly products (grease, oil, etc.) used for installation.
- Capacitors (if the apparatus is equipped with these).

Characteristics of packaging cases

The table below gives the characteristics of the circuit-breaker components packaging cases depending on the apparatus :

Packaging case type		Qty	Length cm	Width cm	Height cm	Gross weight kg
Interrupting chambers **x 3**		1	513	181	136	
Interrupting chambers with resistors * **x 3**		1	706	218	133	
Columns (2 insulators)		1	503	188	108	
Columns (3 insulators)		1	532	191	105	
Columns (4 insulators)		1	627	191	105	
Frame (H = 2503 mm)		1	308	96	96	
Frame (H = 3377 mm)		1	396	96	96	
Frame (H = 4877 mm)		1	546	96	96	
Operating device		1	318	103	144	
SF_6 gas		*				
(SF_6+CF_4) gas mixture	SF_6 gas	*				
	CF_4 gas	*				
Marshalling cubicle		1	131	76	172	284
Necessities (products) for assembly		1	60	60	70	37
Capacitors *		1	266	141	124	

***** Depending of the apparatus

NOTE : the values in the above table are given as an indication so that an appropriate means of lifting can be envisaged.

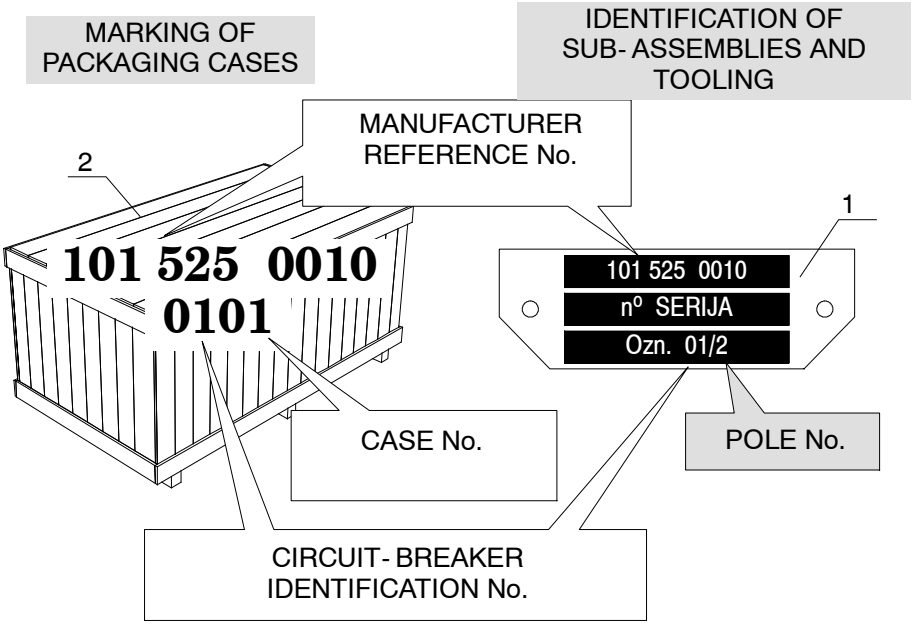
Identifying sub- assemblies and their packaging

Introduction

Each circuit- breaker sub- assembly (poles, operating mechanism, etc.) is identified by a plate giving its reference numbers.
These numbers are marked on the packaging cases of each sub- assembly.

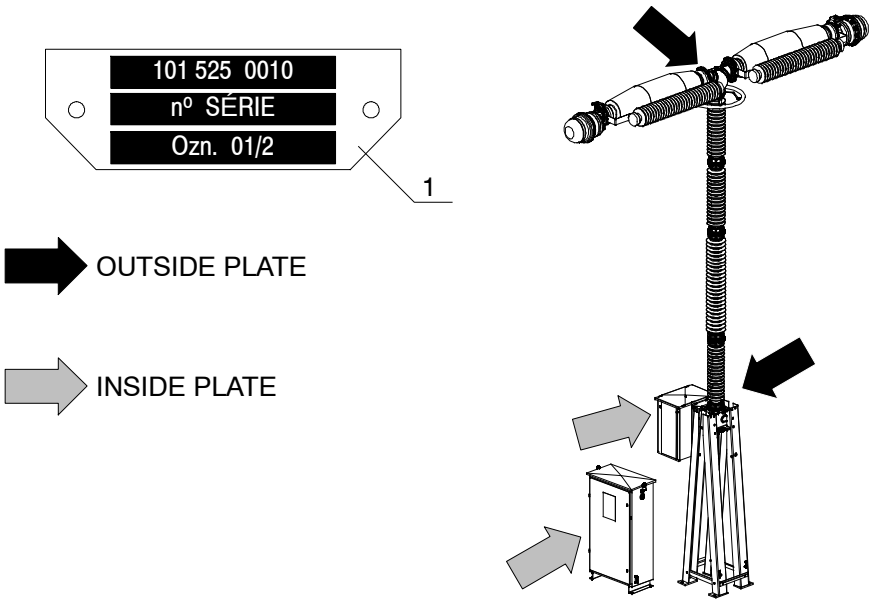
Example of marking and identifying

- Manufacturer reference No. = 101 525
- Circuit- breaker identification No. 1
- Pole No. 2



Place of the plates

Choose and install the components identified by the plate (1).



Storage

Introduction

The storage procedures defined below are for storage times of less than 2 years. For longer periods, special packaging must be designed and appropriate procedures devised.

Short- term storage (6 months)

The apparatus must be stored in its transport packaging and placed on beams in a flood- proof place.

Medium- term storage (less than 2 years)

The table below indicate how to stock the main components of the circuit- breaker for a medium- term storage :

Component	Storage
Components of the circuit- breaker pole	The apparatus must be stored with its transport packaging open whilst placed on beams in a closed (indoor), but ventilated, flood- proof place.
Operating device	The operating device should be stored in the same place as the circuit- breaker, these two sub- assemblies being inseparable. Check that the vacuum packaging is leak- tight. If this has been damaged, proceed as follows : • The operating device should be placed so that air can enter through the vents of the rear plate and side panels. • In order to prevent corrosion damage due to formation of condensation, it is mandatory that the heating circuit be switched on.

Continued on next page.

Storage

Centralizing cubicle	The centralizing cubicle should be stored in the same place as the circuit- breaker and the operating device, these three sub- assemblies being inseparable. • In order to prevent corrosion damage due to formation of condensation, it is mandatory that the heating circuit be switched on. Put vetically the centtralizing cubicle for that air can enter through the vents.

ANY CHANGE OF LOCATION OF THE APPARATUS (EVEN AFTER COMMISSIONING) SHOULD BE DONE AT A REDUCED PRESSURE OF 0.03 MPa.

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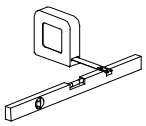
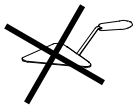
Erection general instructions

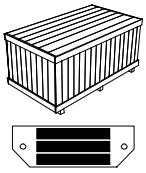
Instructions of environment

The table below gives the instructions of environment to respect for the erection :

Instruction	Comment	
A		Verify the Civil engineering work : dimensions, levels of concrete pads (structure fixation), in accordance with the tolerances given by Civil work standards (refer to circuit- breaker outline).
B		Avoid any dust production and masonry work during erection of the circuit- breaker.

Erection instructions

The table below gives the instructions to respect for proper erection of the circuit- breaker :

Instruction	Comment	
1		Read all the “Installation” modules completely before beginning erection works. The erection instructions describe all the procedures to be carried out as well as their chronological order.
2		Handle sub- assemblies in a correct manner, **particularly insulators**.
3		The shipping case should be open as required during erection procedures. **<u>CAUTION</u> : Respect sub- assemblies identification.**
4		When shipping covers are removed, proceed to the next assembly sequence in as short as possible time. Store the shipping covers under shelter, for a possible future use.
5		Respect references to other modules, i.e. :“Tightening torques”.

Warning

No responsibility is taken over by Grid Solutions for damages and disturbances resulting out of non- adherence to the “Installation” modules.

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Presentation

Introduction

In the assembling with screws, all the fastening screws must be “greased” before torque tightening.

Products used

The table below gives the list of the used products for the screws before tightening :

Designation	Grid Solutions item reference	Supplier	Supplier item reference
Grease	- 01835208 (1kg box)	MOBIL OIL	MOBILPLEX 47 MOBILUX EP3
Contact grease	- 01835118 (200g tube)	EPMF	CONTACTAL HPG
Silicon grease	- 01835265 (100g tube)	SAMARO	MOLYKOTE 111
Glue	- 01818327 (250 ml)	LOCTITE	LOCTITE 225

In this module

This module contains the following topics :

Screw greasing before tightening

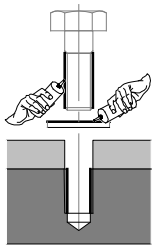
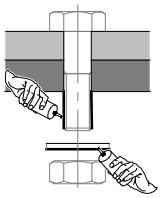
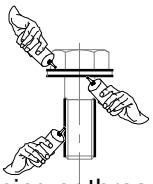
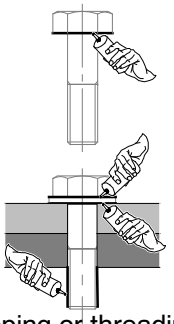
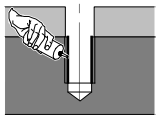
Choice of the product to use

The table below gives the product to use for the screws before tightening depending on the assembling type :

If assembling...	Product to use ...
usual	MOBILPLEX 47 MOBILUX EP3
electrical connections	CONTACTAL HPG
with seals	<table><tr><th>Can be dismantled ?</th><th>Product ...</th></tr><tr><td>YES</td><td>MOLYKOTE 111</td></tr><tr><td>NO</td><td>LOCTITE 225</td></tr></table>

Where to apply the product ?

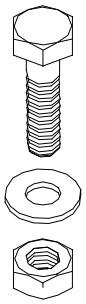
The table below indicates the part of the screws to treat with the appropriate product before tightening depending on the assembling type :

If assembling...	With screws	With bolts
usual		
electrical connections	 Tapping or threading	 Tapping or threading
with seals		

Tightening torques values

Values table

The tool and the tightening method must be such that the torque actually applied to the screw head corresponds with the reference torque shown in the table below, to within a tolerance of ± 20%.



	TIGHTENING TORQUES in **daN.m** STEEL SCREWS	
	CLASS 6.8 or STAINLESS A2- 70, A4- 70 STAINLESS A2- 80, A4- 80	CLASS 8.8
M2,5	0,05	0,06
M3	0,09	0,11
M4	0,19	0,26
M5	0,38	0,51
M6	0,66	0,88
M8	1,58	2,11
M10	3,20	4,27
M12	4,97	6,63
M14	8,67	11,56
M16	13,42	17,90
M20	26,22	34,98
M24	45,68	60,93
M30	90,44	120,65

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Presentation

Introduction

During the erection of the circuit- breaker, some particular mounting or checking operations will be realized.

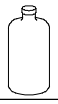
In this module

This module contains the following topics :

Preparing and installing static seals

Necessary products

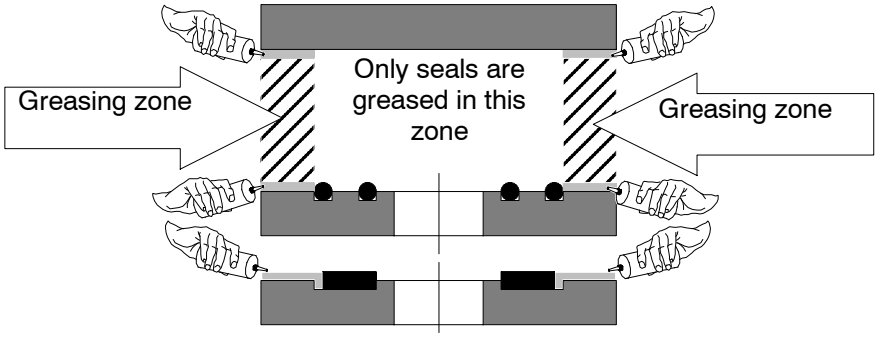
List of the Grid Solutions products necessary for the installing :

Grid Solutions reference	Diagram	Designation
- 01861262		Can of ISOPROPANOL (1l)
- 01835265		MOLYKOTE 111 (100g tube)

Process

The table below gives the steps of installing static seals :

Step	Action	Comment
1	Clean bearing grooves and surfaces using ISOPROPANOL.	
2	Rid the seal of all foreign bodies such as paintbrush bristles or filings... Remove (where applicable) the color identification point with fingernail, never with a sharp instrument.	Check the condition of the seal which should present no scratches or deformation (it should be neither flattened, stretched, nor broken).
3	Lightly lubricate the seal by hand using MOLYKOTE 111 grease.	Do not use a brush to do this. Eliminate excess grease by squeezing the seal between fingers, leaving only a thin layer on the entire surface.
4	Put the seal(s) in place.	
5	Lubricate both bearing surfaces with MOLYKOTE 111. Fill the residual volume of the seal's outside groove with grease.	Do not put grease on the inside surface.



Screw sealing

Introduction

To prevent humidity from penetrating SF_6 gaskets, the outer mounting screws should be sealed by applying an appropriate product.

NOTE : This procedure should be applied to all assemblages of parts submitted to SF_6 pressure and electrical connection assembling.

Necessary products

List of the Grid Solutions products and accessories necessary for the screw sealing :

Grid Solutions reference	Diagram	Designation
- 01818327		LOCTITE 225 (250ml)
- 01835265		MOLYKOTE 111 (100g tube)
- 01835118		CONTACTAL HPG (200g tube)

Choice of the product to use

The table below gives the product to use for the screw sealing depending on the assembling type :

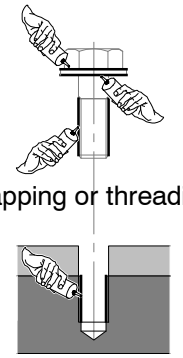
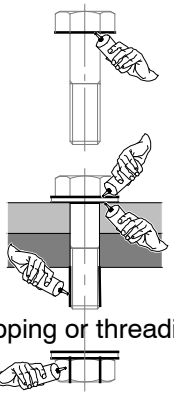
If assembling...	**Product to use ...**
with seals	**Can be dismantled ?** / **Product ...** YES / MOLYKOTE 111 NO / LOCTITE 225
electrical connections	CONTACTAL HPG

Continued on next page.

Screw sealing, continued

Where to apply the product ?

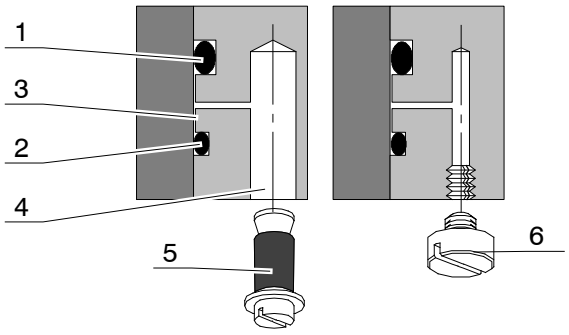
The table below indicates the part of the screws to treat with the appropriate product before tightening depending on the assembling type :

Assembling **with screws**	Assembling **with bolts**
 Tapping or threading	 Tapping or threading

Using a water pressure gauge

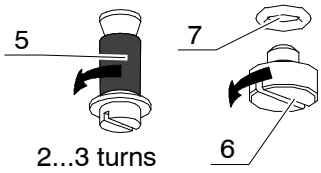
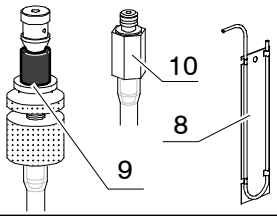
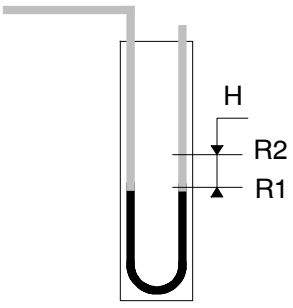
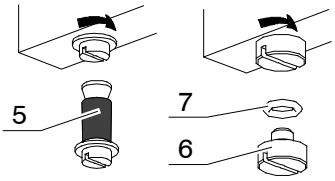
Introduction

In each assemblage performed using a double seal (1) and (2), the volume (3) communicates with the outside by a channel (4), blocked- off by a plug (5) or (6), so that leak- tightness can be checked.



Process

The table below gives the steps of the leak- tightness checking using a water pressure gauge :

Step	Action	Diagram
1	Remove the leak test plug (5) or (6) and its seal (7) if necessary, <u>leave open for half an hour</u>.	
2	Connect up the water pressure gauge (8), using the adapter (9) or (10).	
3	Fill the water pressure gauge's U tube to half way up. **<u>NOTE</u>** : If temperature is less than 0°C, use an anti- freeze mixture instead of water. ● <u>After a few minutes</u> note the water column level **R1**. ● Note the water column level **R2** again <u>after half an hour</u>. The displacement **H** should be <u>less than 10 mm</u>.	
4	At the end of the inspection, pull the adaptor of the water pressure gauge and replace the leak test plug (5) or (6) and its seal (7), where required.	

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Checking for presence of nitrogen (N_2) in pole parts

Presentation

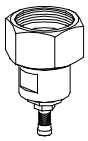
Introduction

The pole parts (chambers and columns) are filled with nitrogen (N_2) for transport purposes to an effective pressure of 0.03 MPa at 20°C.

It is of prime importance that the presence of N_2 gas in pole be verified before going any further with installation.

Necessary tools

List of the necessary Grid Solutions tools for the checking for presence of N_2 gas in poles :

Mark	Diagram	Designation	Number
(3)		Filling tool	1

In this module

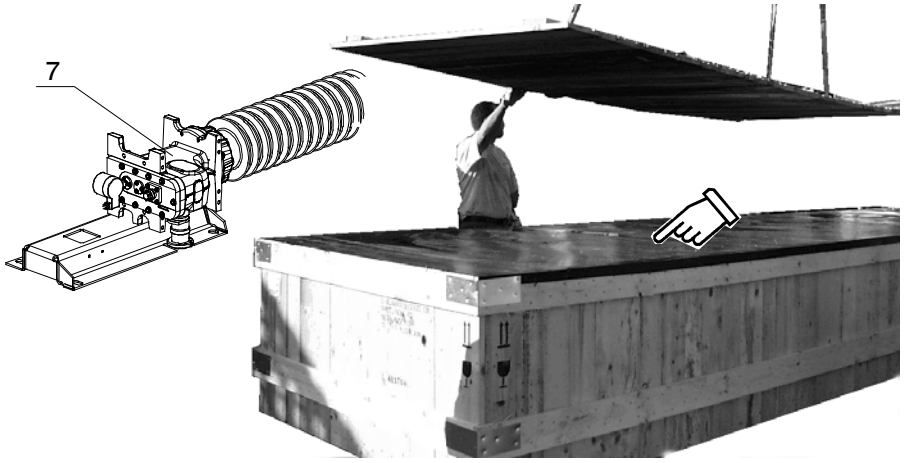
This module contains the following topics :

Checking for presence of N_2 gas in columns

Opening the case of the columns

Remove only the cover of the case. Remove packaging protection ☜ to free the housing (7) of the column.

NOTE : Keep the packaging protection ☜ for later utilization.



Visual inspection of the column

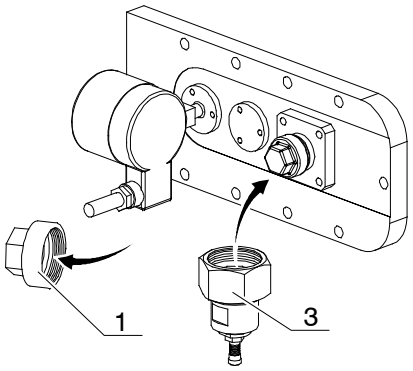
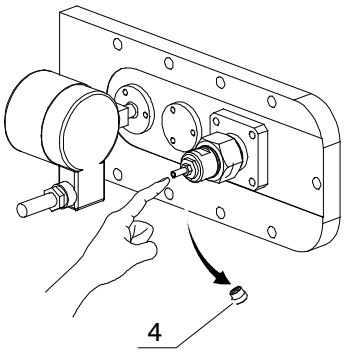
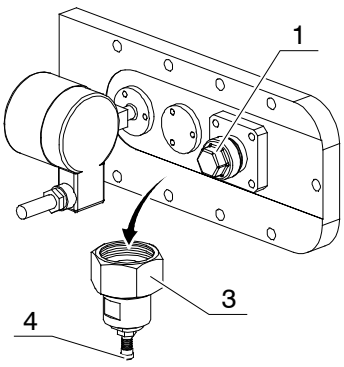
Begin visual inspection to check the condition of ceramic envelopes. Make sure that their enamel has not been chipped or in any way damaged during transportation.

Continued on next page.

Checking for presence of N_2 gas in columns, continued

Process

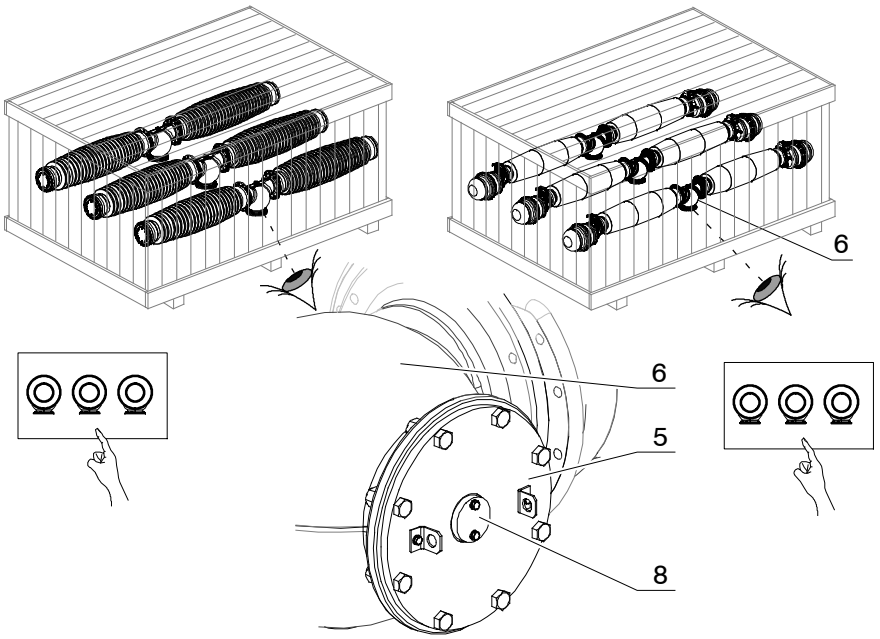
The table below gives the steps of manual checking for presence of N_2 gas in columns :

Step	Action	Diagram
1	Remove the plug (1) and install the filling tool (3), tighten the filling tool **BY HAND**.	
2 	Unscrew the valve- cap (4) and press on the valve briefly : some gas should escape. **If no gas is expelled, contact our Customer Service.**	
3	• Replace the valve- cap (4) and remove the filling tool (3). • Re- install the plug (1), applying a tightening torque of 4 daN.m; leak- tightness is only guaranteed if this condition is respected.	

Checking for presence of N_2 gas in interrupting chambers

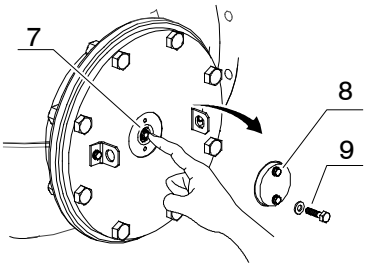
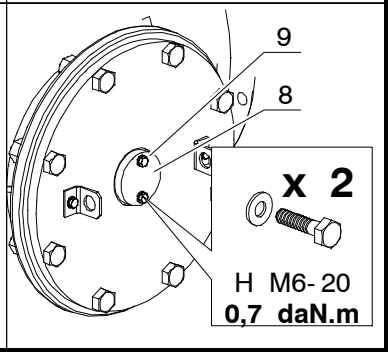
Comment

A transport cover (5) is installed on the housing (6) common to both interruption chambers. This cover is equipped with a test valve, in turn protected by a plug (8).



Process

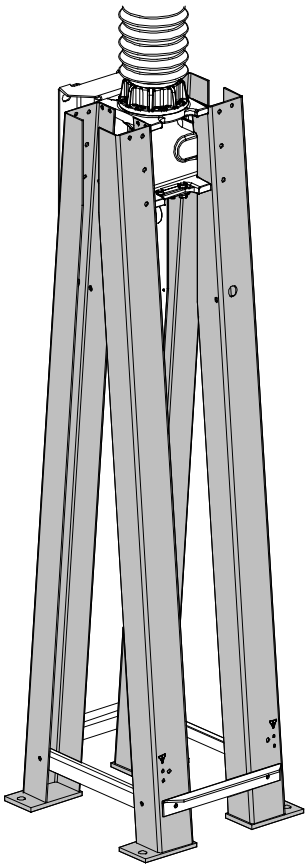
The table below gives the steps of checking for presence of N_2 gas in the interrupting chambers :

Step	Action	Diagram
1	Remove the plug (8) by undoing the screws (9) and briefly press on the valve clapper (7) : some gas should escape. **If no gas is expelled, contact our Customer Service.**	
2	Re- install the plug (8) using the screws (9).	

Presentation

Reminder

Frames may be supplied by either Grid Solutions or the customer.



In this module

This module contains the following topics:

Components necessary for the operation

Necessary product

Grease MOBILPLEX47 - MOBILUXEP3 (screws greasing).

Necessary tools

List of the tools necessary for the installing:

Mark	Diagram	Designation	Number
(1)		Lifting strap (3 m)	2

Handling

The support- frame assembly operations and lifting the pole should be performed by at least two persons.

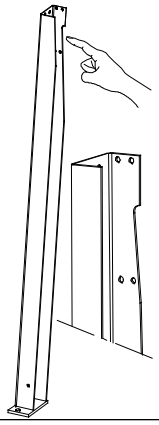
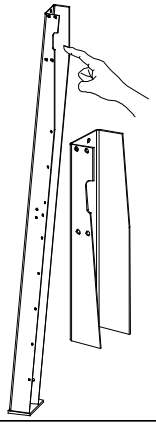
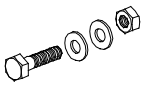
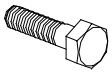
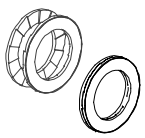
Support- frame components (per pole)

Introduction

If the support- frame is supplied by Grid Solutions check the necessary components to the assembling.

Necessary components

List of the Grid Solutions components necessary for the assembling:

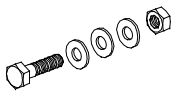
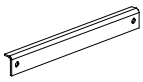
Mark	Diagram	Designation	Number
(2)		Support	2
(3)		Support	2
(5)		Screws H M16- 45	1
(7)		Screws H M16- 35	16
(9)		Washer NORDLOCK NL16 SS	16

Continued on next page.

Support- frame components (per pole), continued

Necessary components, continued

List of the Grid Solutions components necessary for the assembling:

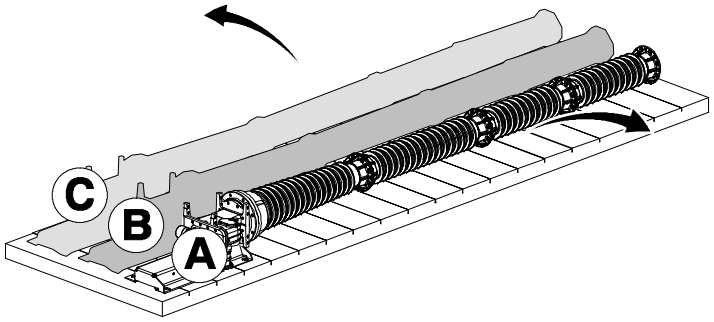
Mark	Diagram	Designation	Number
(20)		Screws H M16- 45	8
(21)		Strengthening piece	2
(22)		Strengthening piece	2

Preparing the column

Dismantling the case of the poles

Remove the side panels of the case.

NOTE : The extraction of the columns will be in the order **A**, B and C.

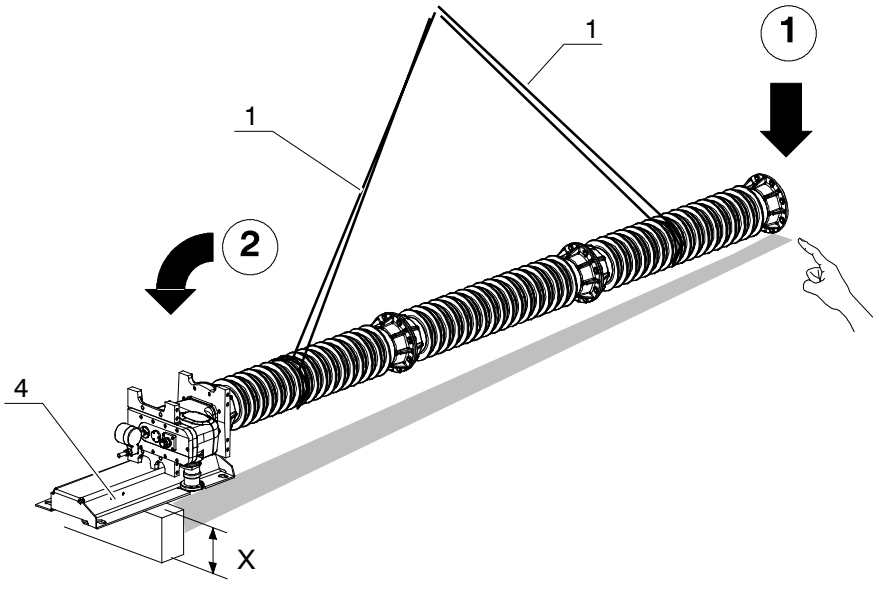


Preparing the pole

- Sling the “A” column with the aid of two flexible lifting straps (1).
- Extract the column from the case and put it down on the case wood cover laying:

- first, the end of the column,
- second, the support of the operating mechanism (4) on a wedge to ensure the correct installing of the frame supports.

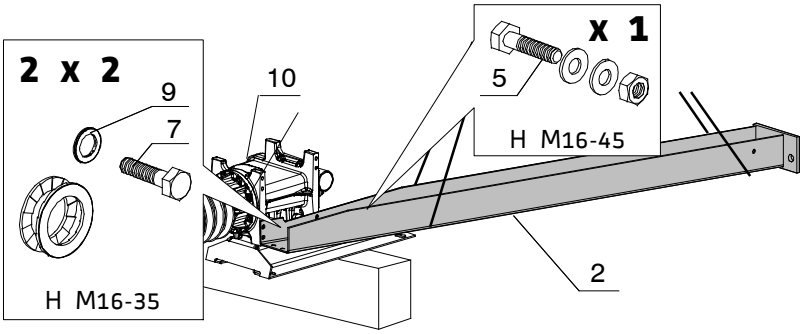
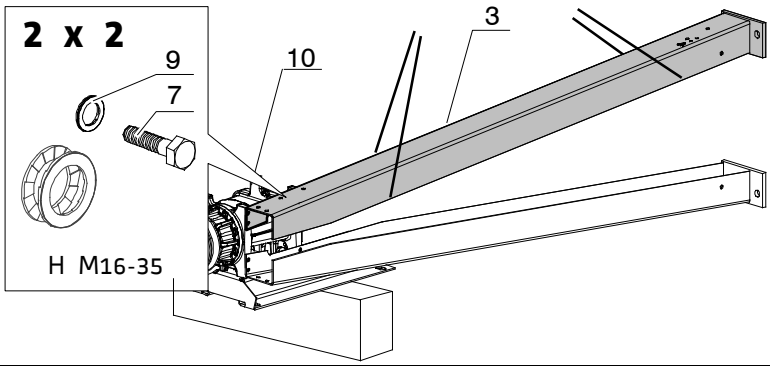
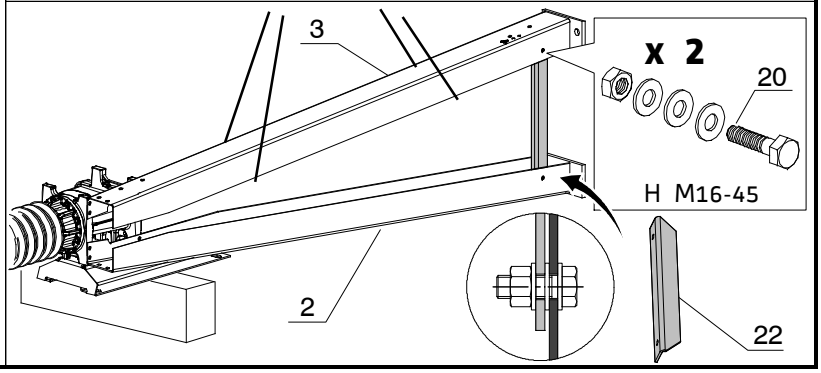
X minimumminimum **= 260 mm**



Frame- support assembly

Process

The table below gives the steps of installing the supports of the frame:

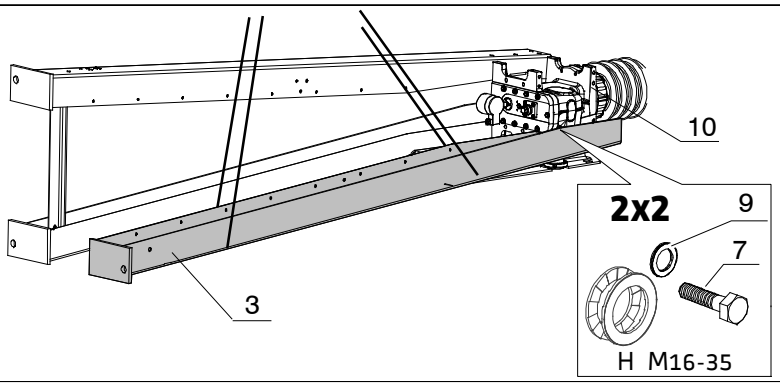
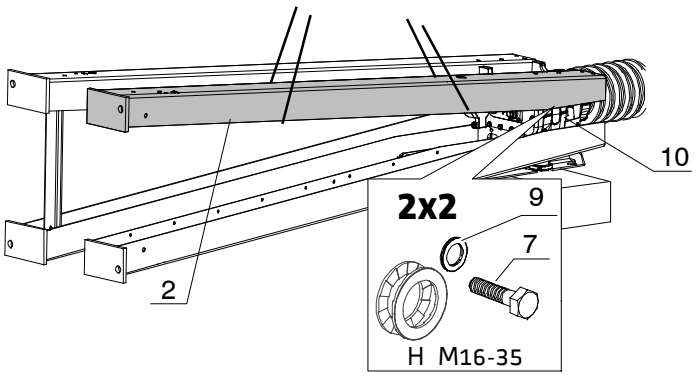
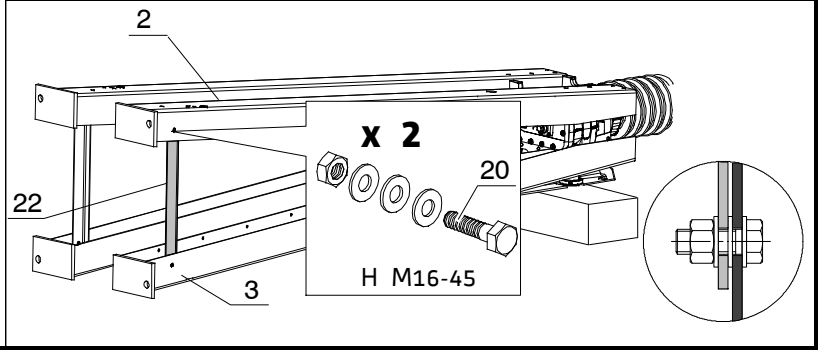
Step	Action
1	With the aid of two flexible lifting straps, position the frame- support (2) onto the housing (10) and fasten it with the use of the screws (7) and NORDLOCK washers (9). **Do not tighten the screws (7).** - Install the screw (5) only on this support.
	
2	With the aid of two flexible lifting straps, position the frame- support (3) onto the housing (10) and fasten it with the use of the screws (7) and NORDLOCK washers (9). **Do not tighten the screws (7).**
	
3	Install the strengthening piece (22) inside the frame- support (3) with the use of the screws (20). Adjust the distance between the support and fasten the strengthening piece on the frame- support (2). **Do not tighten the screws (20).**
	

Continued on next page.

Frame- support assembly, continued

Process, continued

The table below gives the steps of installing the supports of the frame:

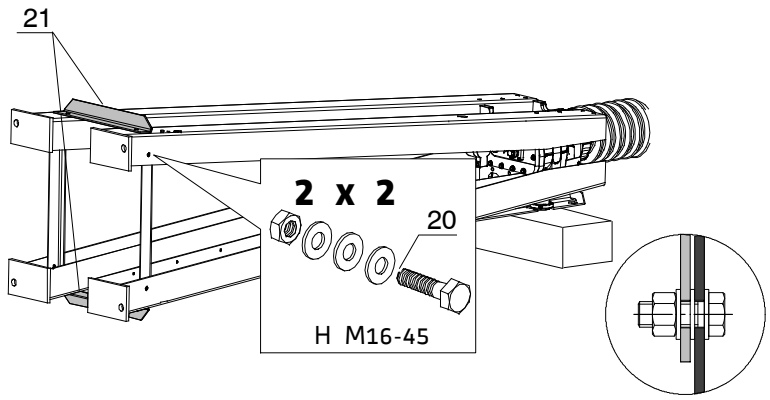
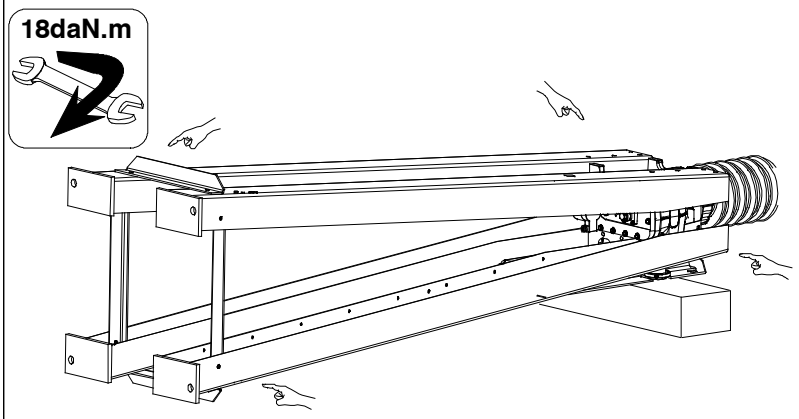
Step	Action
4	With the aid of two flexible lifting straps, position the frame- support (3) onto the housing (10) and fasten it with the use of the screws (7) and NORDLOCK washers (9). **Do not tighten the screws (7).**
	
5	With the aid of two flexible lifting straps, position the frame- support (2) onto the housing (10) and fasten it with the use of the screws (7) and NORDLOCK washers (9). **Do not tighten the screws (7).**
	
6	Install the strengthening piece (22) inside the frame- support (3) with the use of the screws (20). Adjust the distance between the support and fasten the strengthening piece on the frame- support (2). **Do not tighten the screws (20).**
	

Continued on next page.

Frame- support assembly, continued

Process, continued

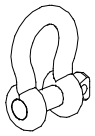
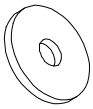
The table below gives the steps of installing the supports of the frame:

Step	Action
7	Install the strengthening pieces (21) outside the frame- support with the use of the screws (20).
	
8	Tighten all the screws to the recommended torques.
	

Installing the lifting tools

Necessary tools

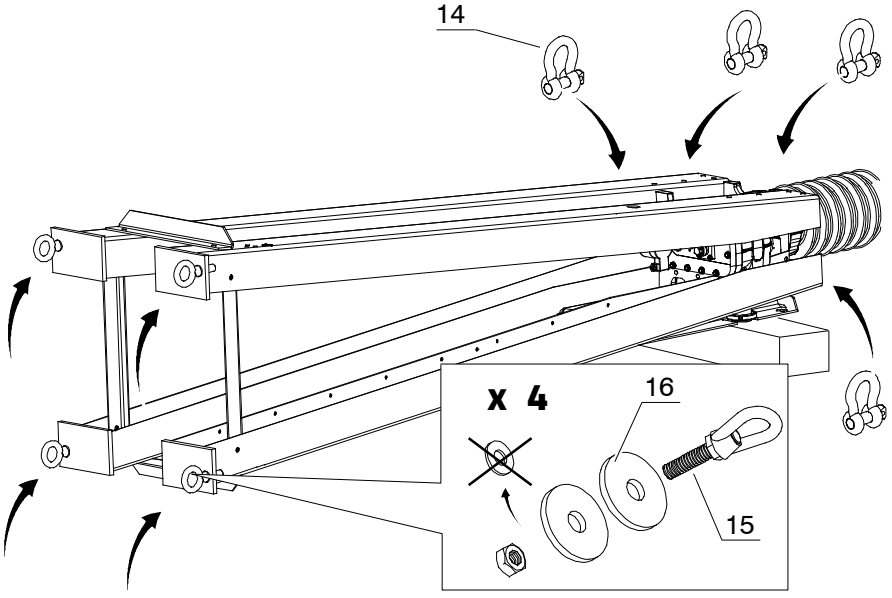
List of the lifting tools to install on the frame:

Mark	Diagram	Designation	Number
(14)		Lifting shackle	4
(15)		Ring bolt	4
(16)		Washer	8

Process

The table below gives the steps of installing the lifting tools on the support-frame:

Step	Action
1	Install the lifting shackle (14) in the holes of the frame.
2	Install the ring bolts (15) on the base of the frame, inserting the thick washers (16).



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Presentation

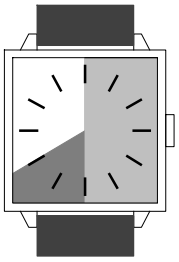
Markings

Before coupling the chambers and column, check that the markings on the breaking chambers correspond with those on the column

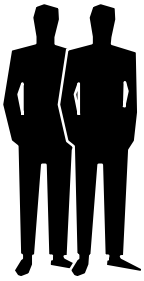
Time taken for coupling operation

The final chamber/column coupling operations should be completed in a time of ≤ 40 min.

NOTE: **The coupling operations must be carried out by a minimum of two people.**

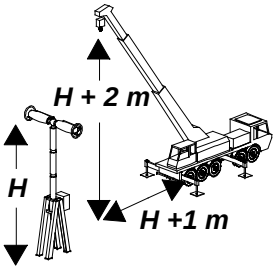


T(max) ≤ 40 min



Lifting means

Provide an adequate means of hoisting:
3,000 daN (minimum)



Stages of the coupling operation

The chamber- column coupling operation can be broken down into a number of stages:

Step	Subject	Page
A	Positioning the chamber casing	2
B	Preparing the breaking chambers	3
C	Checking of the insertion resistor	4
D	Preparing the column's corona shield	5
E	Preparing the elements required for the coupling operation	6
F	Hoisting and preparing the column	8
G	Final coupling	9

Positioning the chamber casing

Introduction

To facilitate pole hoisting and to improve working safety it is indispensable that the casings be positioned correctly with respect to the lifting equipment.

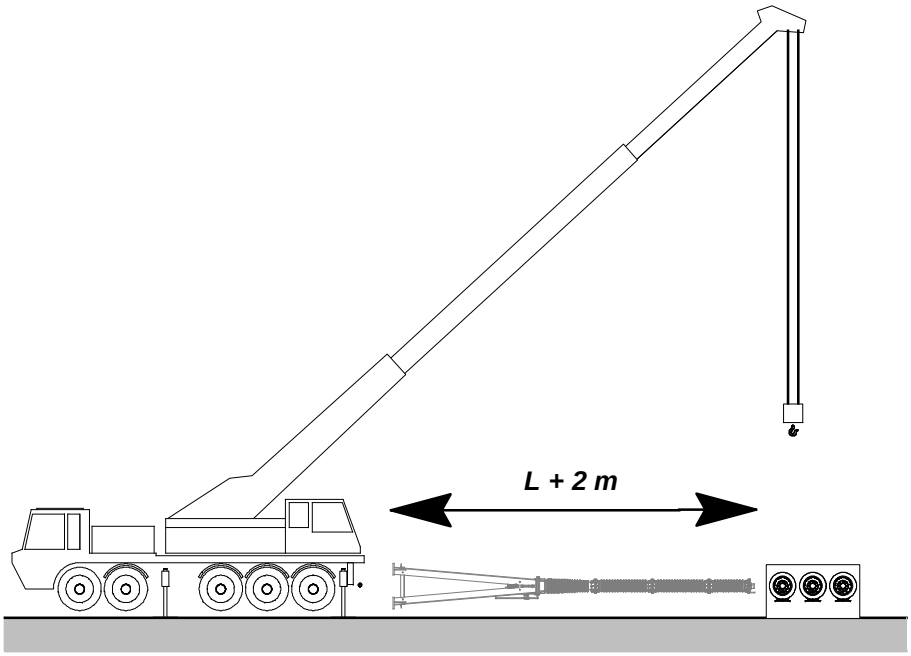
Positioning the casing

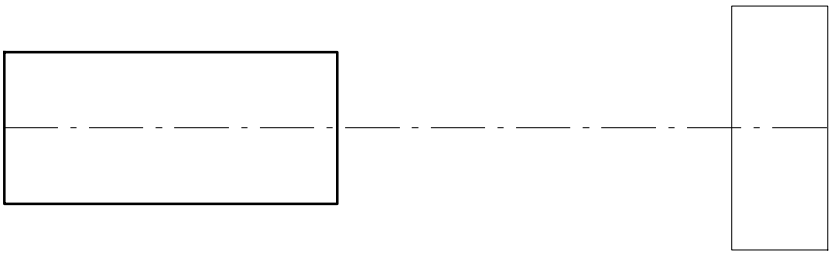
Using the appropriate lifting equipment, position the chamber casing so that:

- The centreline of the chambers is perpendicular to the plane of the lifting equipment,
- The distance between the casing and the lifting equipment is greater than the total length of the column fitted to the chassis "L" + 2 m.

NOTE: The cradle on the first chamber will be used in the column-chamber coupling for all three circuit breaker poles

Illustration

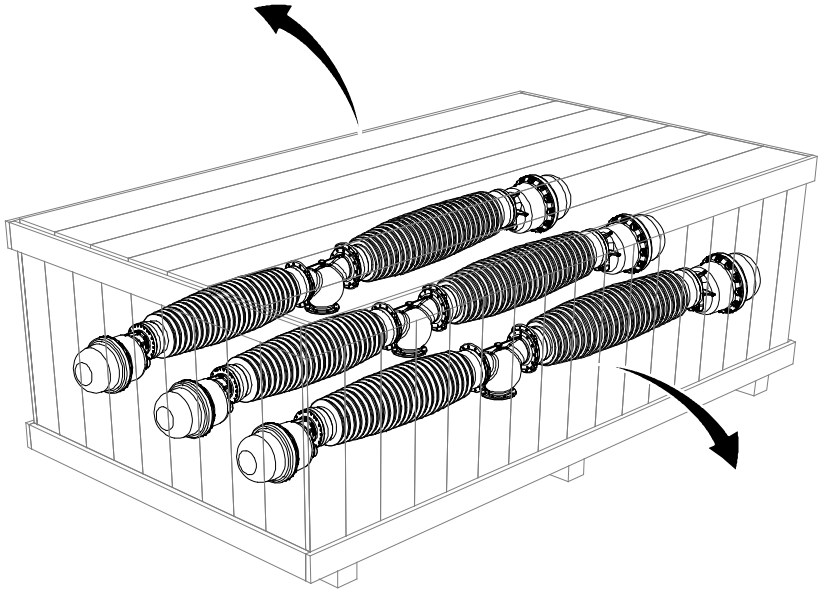




Preparing the breaking chambers

Removing the chamber casing

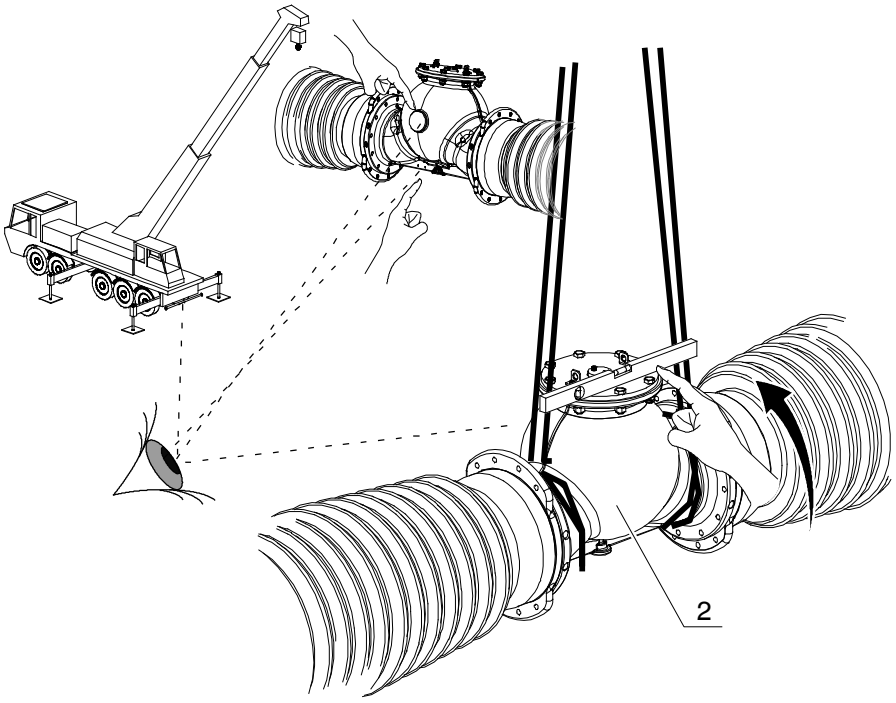
Remove the side panels and cover from the case.



Rotating the chambers

Using two flexible slings, swing the chambers through 180° then level the transport covers.

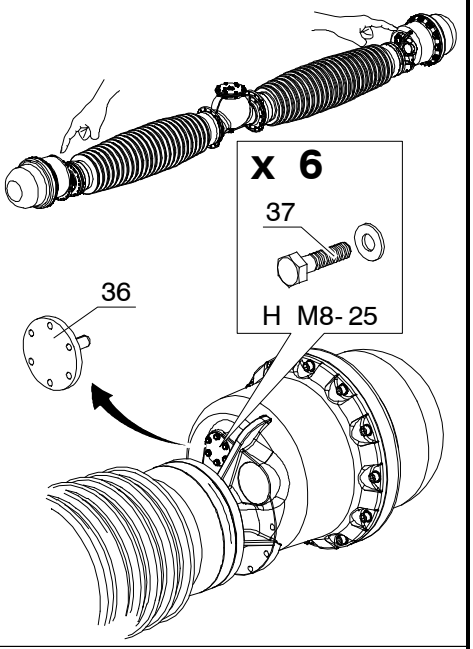
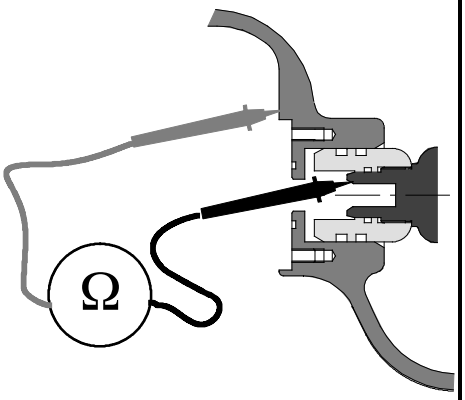
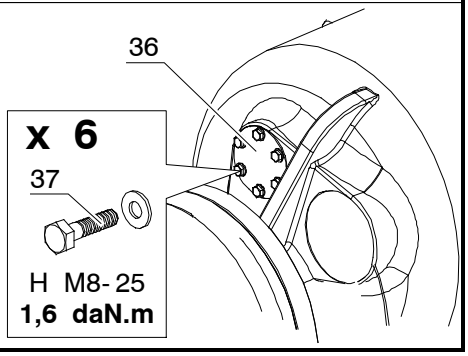
NOTE: **Turn the breaking chamber casing (2) so that the face with the two 'humps' is facing the lifting equipment.**



Checking of the insertion resistor

Process

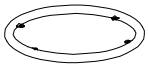
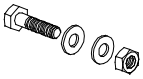
The table below gives the steps of checking of the insertion resistor :

Step	Action	Diagram
1	On each resistor, remove the plug (36) fixed by screws (37).	
2 	Measure the ohmic value using a multimeter. **If the measured value does not correspond to the value indicated on the plug, contact our Customer Service.**	
3 	Re-install the plugs (36) using the screws (37), referring to “Screw sealing” in ”Erection general procedures”.	

Preparing the column's corona shield

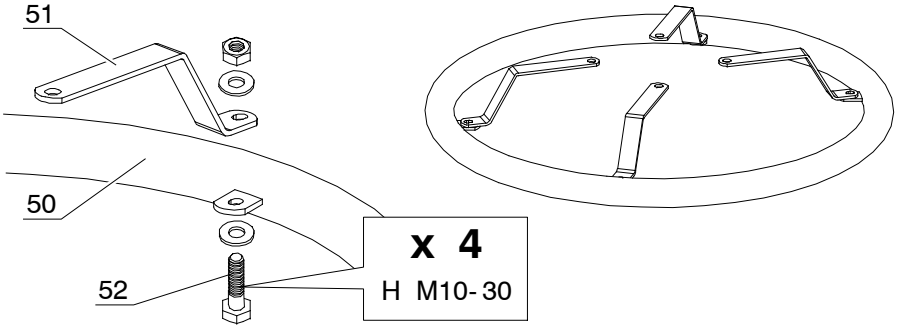
Elements required: Grid Solutions

List of Grid Solutions elements required for assembly (per pole):

Mark	Illustration	Description	Quantity
(50)		Corona shields	1
(51)		Lugs	4
(52)		Fittings H M10-30	4

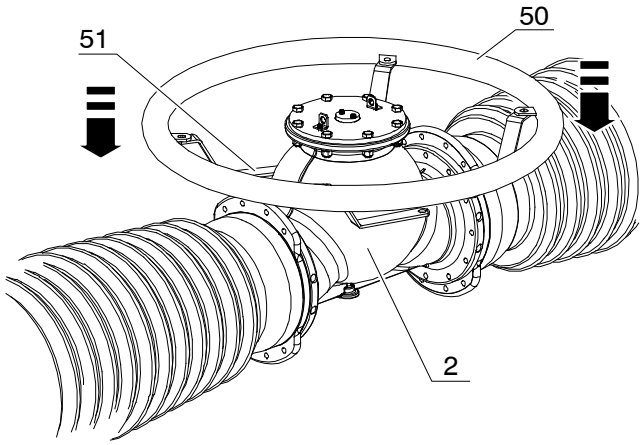
Assembly

Attach the lugs (51) to the corona shield (50) using the fittings (52) **without overtightening**.



Positioning

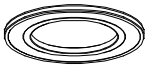
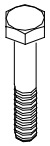
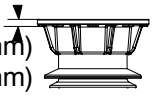
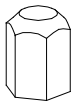
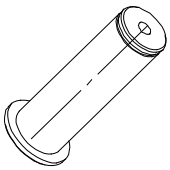
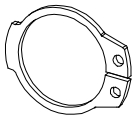
Temporarily position the corona shield (50) and lugs (51) on the casing (2).



Preparing the elements required for the coupling operation

Elements required: Grid Solutions

List of Grid Solutions items necessary for the operation:

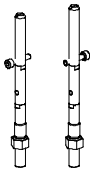
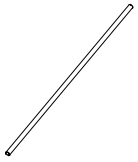
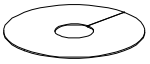
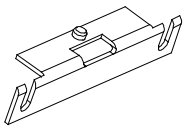
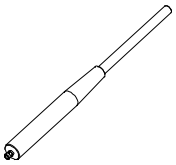
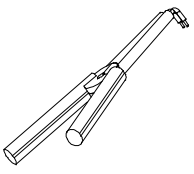
Mark	Illustration	Description	Quantity
(20)		Seal	1
(21)		Screws H M16- 65 (19 mm) H M16- 75 (30 mm) 	8
(22)		Washer M16	16
(23)		Nut	8
(24)		Coupling pin	1
(25)		Circlips	1

Continued on next page.

Preparing the elements required for the coupling operation (continued)

Tools required Grid Solutions

List of Grid Solutions tools necessary for the operation:

Mark	Illustration	Description	Quantity
(30) (31)		”Short” centring pin ”Long” centring pin	1
(32)		Lever	1
(33)		Protective mask	1
(34)		Trolley stop	1
(35)		Fitting tool for coupling pin	1
(36)		(80 cm) Rigid electrical wiring cable	1
(37)		Circlip clamp (not supplied).	1

Products required

- **MOLYKOTE M111 Grease**: greasing contact surfaces
- **LOCTITE 225**: locking fitting in place
- **MOBILPLEX 47 - MOBILUX EP3**: greasing fittings

Hoisting and preparing the column

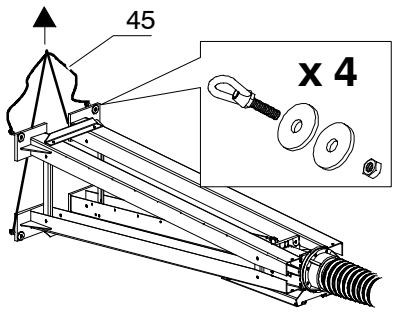
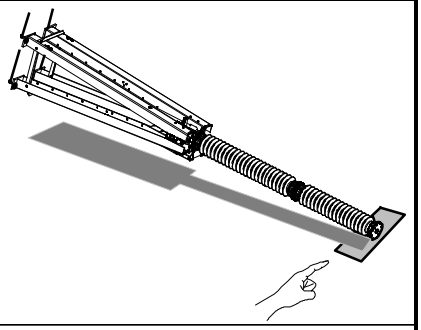
Tools required

List of tools required:

Mark	Illustration	Description	Quantity
(45)		Hoisting strap (3 m)	4

Instructions

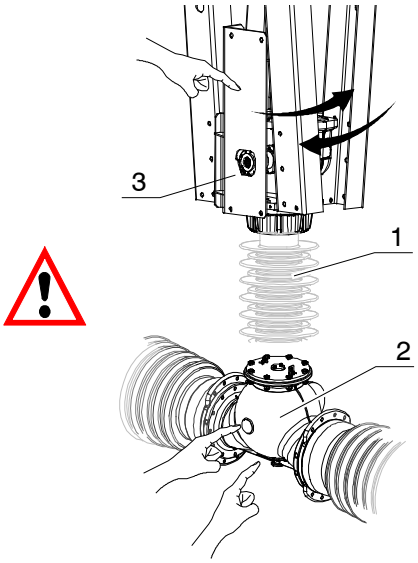
The following table shows the steps to follow when lifting the column:

Step	Action	Illustration
1	Fit the lifting straps (45) to the ends of the chassis feet	
2	Lift the column	
3	Hold the column suspended to give access to its lower end.	

Final coupling

Orientation of column

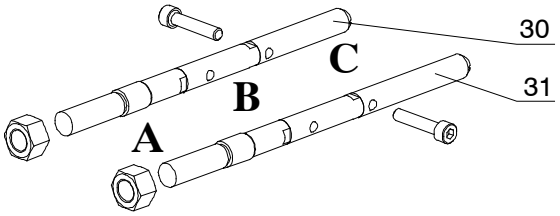
Rotate the column (1) so that the control mount (3) is the same side as the two 'humps' on the breaking chamber casing (2).



Assembling the centring pins

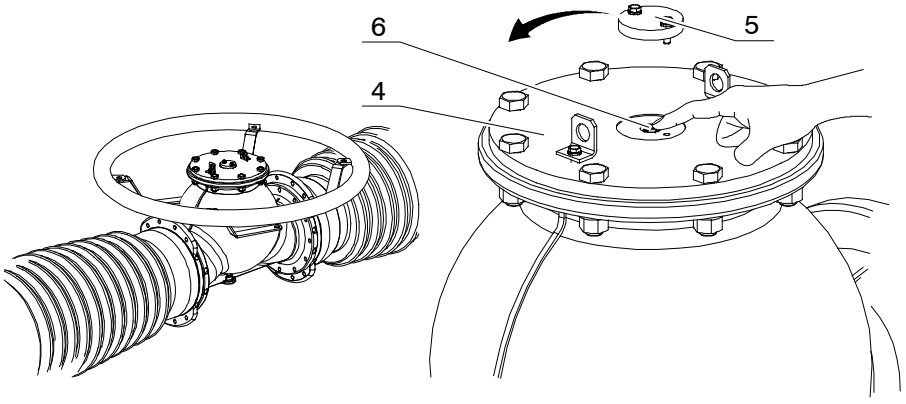
Fit parts A, B & C to the centring pins (30) & (31) without locking them in place so that they may be easily removed later on.

NOTE: **Pin (31) is longer than pin (30).**



Depressurizing the chambers

- Remove the cap (5) from the transport cover (4) and operate the valve (6) to re- establish atmospheric pressure within the chambers.
REMINDER: transport pressure nitrogen: azote (N_2) at 0.03 MPa at 20°C (101.3 kPa).
- Refit the cap (5).

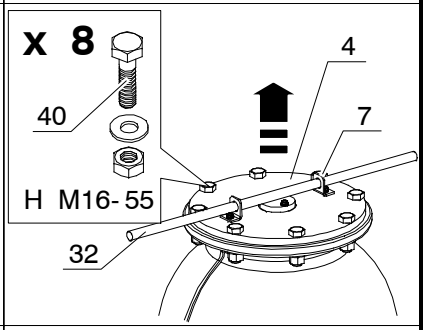
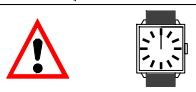
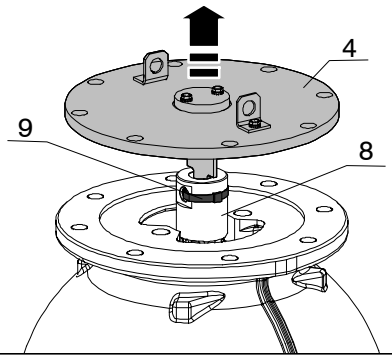
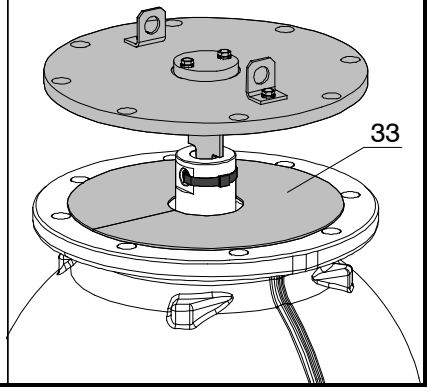


Continued on next page.

Final coupling, continued

Removing the chamber transport cover

The table below shows the steps for removing the chamber transport cover:

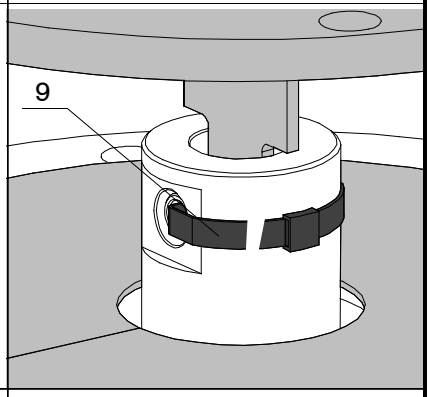
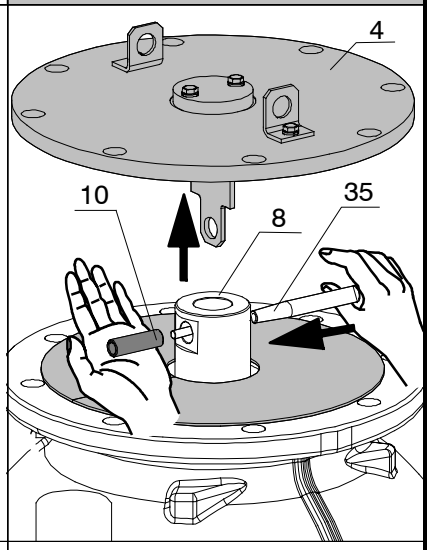
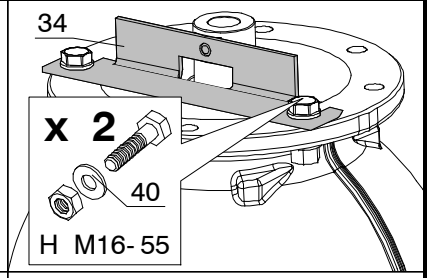
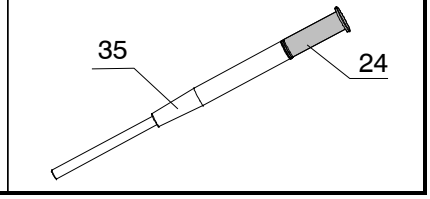
Step	Action	Illustration
1	Remove the fixings (40) and insert the lever (32) through the bracket rings (7). Pull on the lever (32) to open the cover (4). Hold on two two of the cover bolts (40) for later use.	
2	**Start timing**. (The final chamber/column coupling operations should be completed within **≤ 40 min**).	
3	Pull off the cover (4) to free the stop ring (8) and 'rilsan' collar (9).	
4	Fit the protective cover (33).	

Continued on next page.

Final coupling, continued

Removing the chamber transport cover

The table below shows the steps for removing the chamber transport cover:

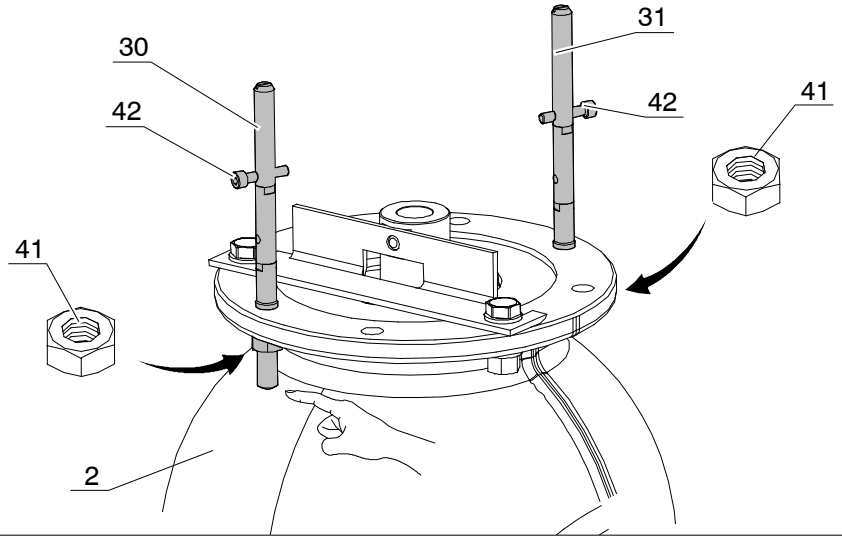
Step	Action	Illustration
5	Using wire cutters, cut through the 'Rilsan' collar (9) holding the connector tube and remove it.	
6	Using the coupling tool (35), remove the tube (10) and separate the cover (4) from the stop ring (8).	
7	Fit the trolley stop (34) and fix in place using the bolts (40) recovered from the transport cover, hand tightening them.	
8	Prepare the fitting tool (35) by screwing the coupling pin (24) onto its end, hand tightening.	

Continued on next page.

Final coupling, continued

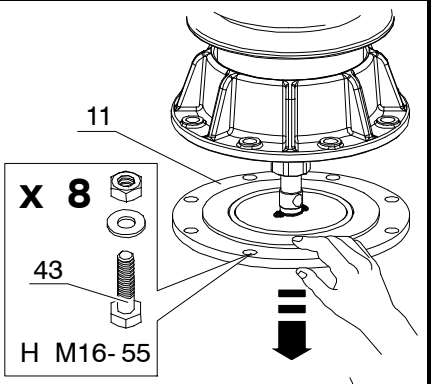
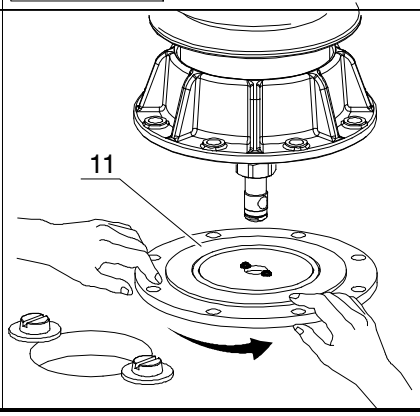
Fitting the centring pins

Fit the centring pins (30) & (31) hard against the spherical casing (2), lightly tighten the nuts (41).
Fit the screws (42) to the centring pins (30) and (31).



Removing the column cover

The table below shows the steps for removing the column cover:

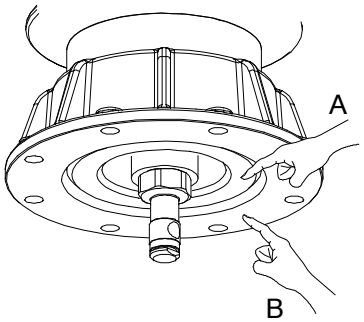
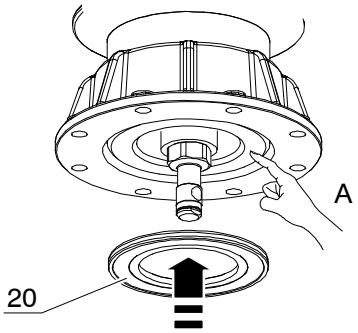
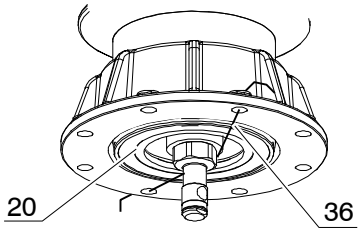
Step	Action	Illustration
1	Remove the fittings (43) and open the cover (11).	
2	Turn the cover (11) through 90° to remove it.	

Continued on next page.

Final coupling, continued

Fitting the seal

The table below shows the steps for fitting the seal:

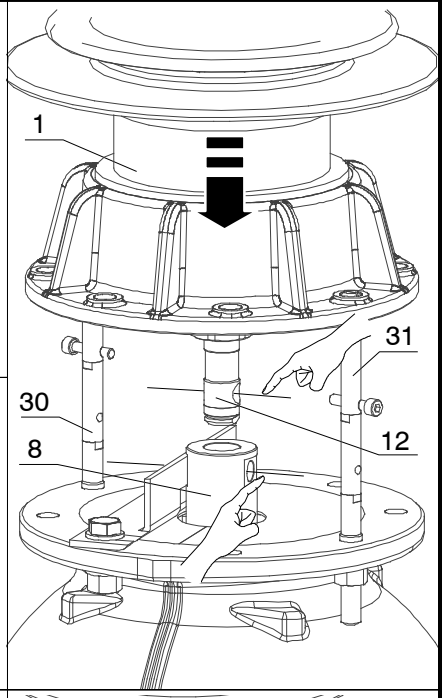
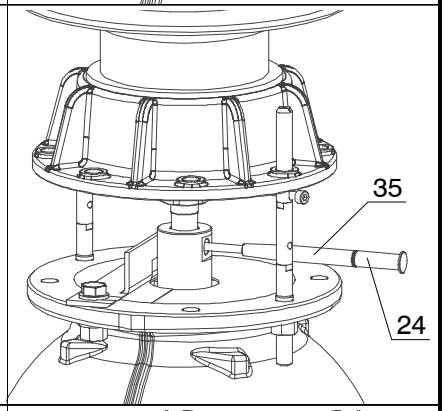
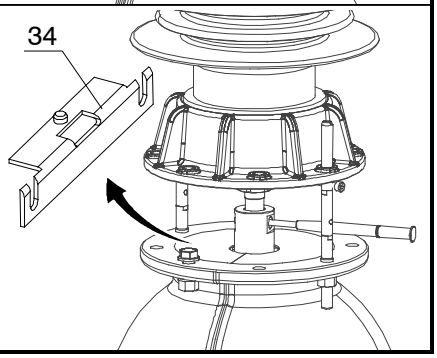
Step	Action	Illustration
1	Clean the contact surfaces "**A**" and "**B**" with ISOPROPANOL. Only coat surface **"B"** with MOLYKOTE M111 lubricant.	
2 	Fit a new seal (20) and place it on surface "**A**", referring to "**Preparing and fitting static seals**". See module **'General assembly procedures'.**	
3	Temporarily fit a rigid cable (36) to counter the effects of the seal (20) coming apart during the coupling process	

Continued on next page.

Final coupling, continued

Fitting the coupling pin

The table below shows the steps for fitting the chamber- column coupling pin:

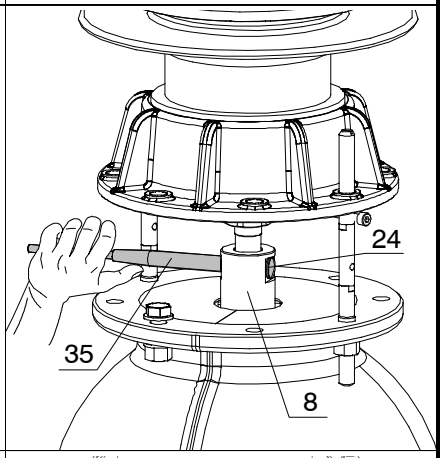
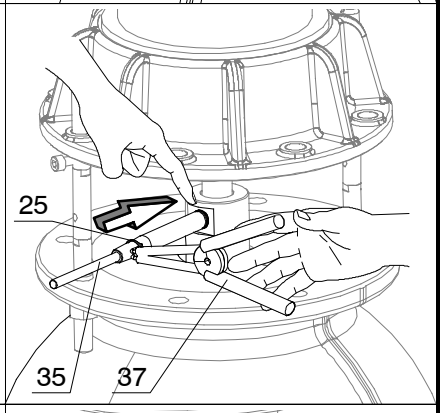
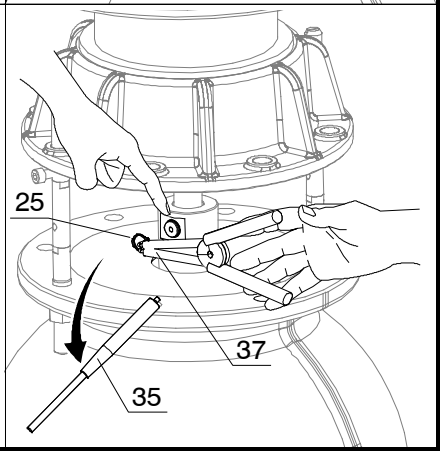
Step	Action	Illustration
1	Slowly lower the column (1), inserting the centring pins (30) & (31) into the holes in the flange. Make sure both pins are correctly aligned.	
2	Slower lower the column to align the pin with the holes in the cylinder (8) and the rod (12).	
3	Insert the fitting tool (35) with the coupling pin (24) on its end.	
4	Slightly loosen the two screws holding the trolley stop (34) in place and remove it.	

Continued on next page.

Final coupling, continued

Fitting the coupling pin

The table below shows the steps for fitting the chamber- column coupling pin:

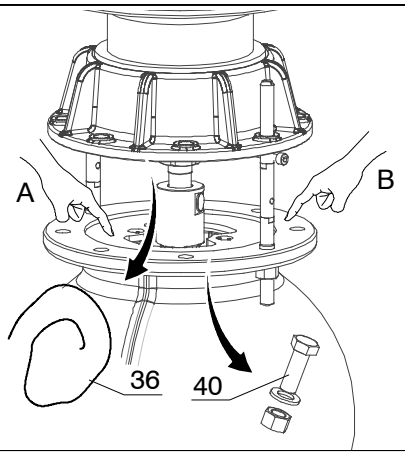
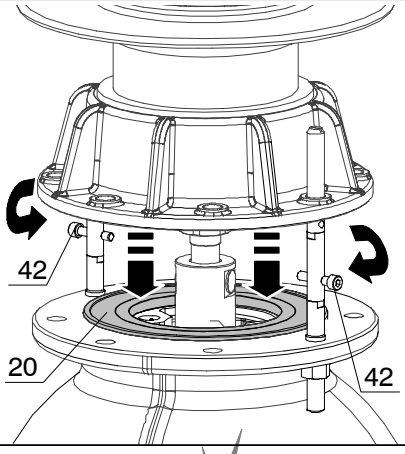
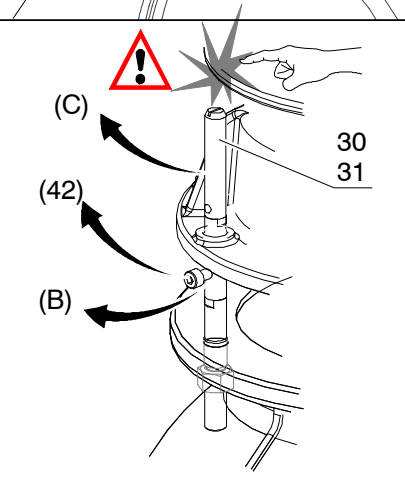
Step	Action	Illustration
5	Fit the coupling pin (24) by manually pulling on the fitting tool (34) until it stops on the cylinder (8).	
6	Fit the circlips (25), sliding them along the fitting tool (35) using circlips pliers (37). See the second method (7).	
7	Remove the fitting tool (35) from the coupling pin, loosening it by hand. Second method: Fit circlips (25) using circlip pliers (37).	

Continued on next page.

Final coupling, continued

Connection chambers/column

The table below shows the steps for fitting the chamber- column coupling pin:

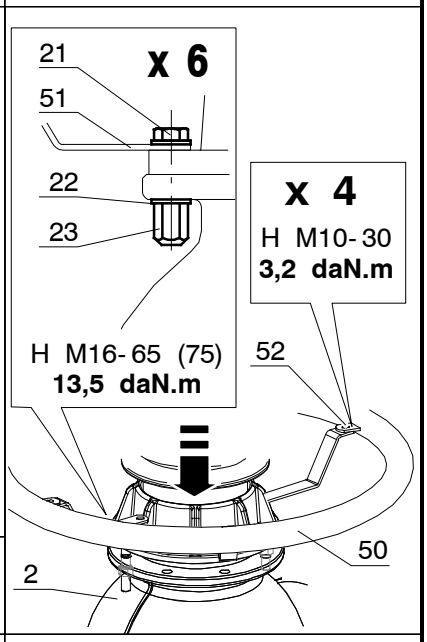
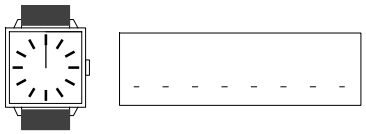
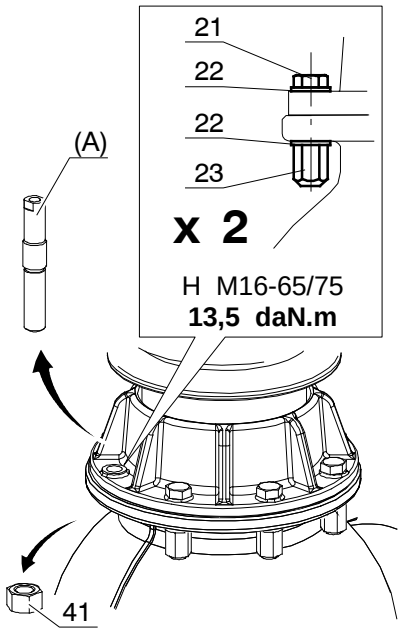
Step	Action	Illustration
1	Clean the contact surfaces "**A**" and "**B**" with ISOPROPANOL. Only coat surface **"B"** with MOLYKOTE M111 lubricant. Remove the rigid cable (36). Remove the trolley stop fixing screws (40).	
2	Lower the seal (20) onto the chamber casing. Lower the screws (42) on the centring pins.	
3	Continue to slowly lower the column, removing the first two sections of centring pin (30 & 31) when they are no longer of any use as a guide, in the following order: - First section **(C)** - Screw (42) - Second section **(B)** ***NOTE:*** **The aim of this operation is to prevent the centring pins coming into contact with the porcelain fins on the column.**	

Continued on next page.

Final coupling, continued

Connection chambers/column

The table below shows the steps for connecting the chambers to the column:

Step	Action	Illustration
4	Slowly lower the column onto the breaking chamber casing (2). Position the lugs (51) for the corona shield (50) on the rim of the column then attach using bolts (21), washers (22) and special nuts (23) - See '**Locking Fixings**'. See module **'General assembly procedures'.** Lock the nuts (23) at the appropriate torque, immobilising the bolt heads (21).	
5	Tighten all fixings (52) to their appropriate torque level.	
6	End of coupling operation - stop the timer and note the time taken.	
7	Remove the last section **(A)** and the nut (41) from the centring pins. Fix the last bolts (21), washers (22) and special nuts (23) referring to "**Locking fixings**". See module **'General assembly procedures'.** Lock the nuts (23) at the appropriate torque, immobilising the bolt heads (21).	

Continued on next page.

Final coupling, continued

Vacuum extraction and filling with gas

Once the coupling operation has been completed, continue with:

- **The air extraction operation**
- **The gas filling operation**

Tipping down the pole of the circuit- breaker and vacuum operation

Presentation

Introduction

The column- chambers coupling is now finished - the pole is yet maintained by the lifting equipment. In order to continue the pole installation, it is necessary now to lay it on the ground.

In this module

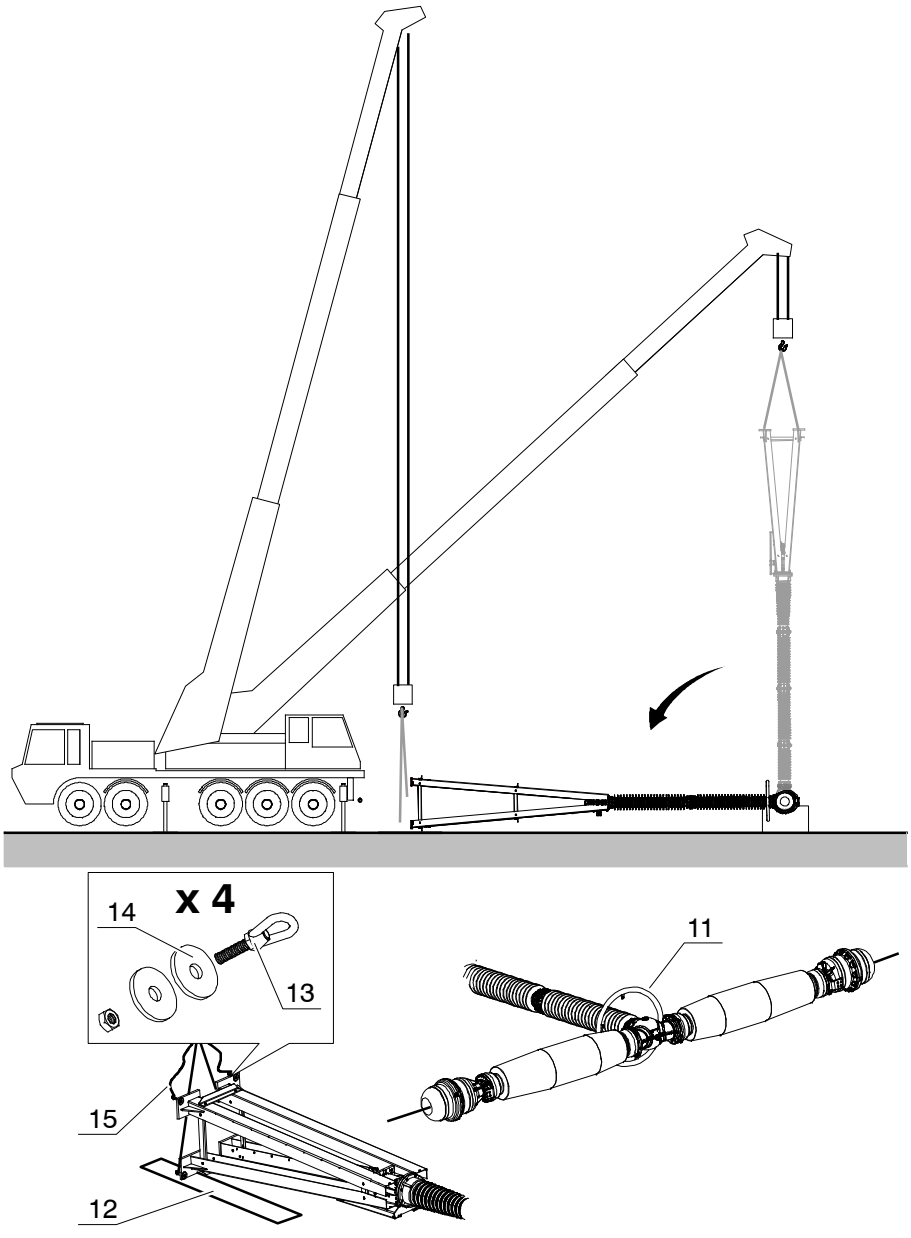
This module contains the following topics :

Tipping down the pole of the circuit- breaker

Process

The table below gives the steps of tipping down the pole of the circuit-breaker :

Step	Action
1	Using the lifting device, slowly tip down the pole around the axis of the interrupting chambers until the ground. Pay attention to do not damage the stress- shields ring (11).
2	Lay the supports of the frame on two wood boards (12).
3	Remove the flexible lifting straps (15).
4	Remove the ring bolts (13) and the thick washers (14).



Vacuum operation

Principle

The procedure of the vacuum operation **depends on the duration of chambers/column coupling**.

Process

See module :

- “Connection the vacuum pump.
- “Vacuum operation”.

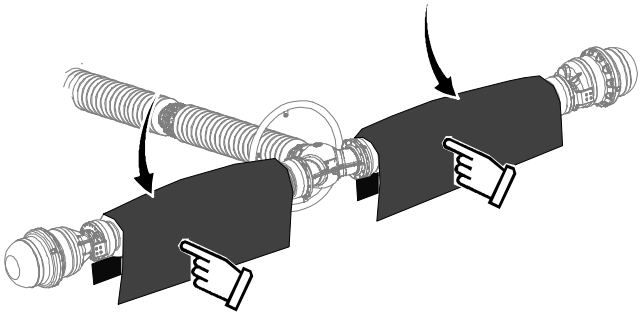
Protection of the interrupting chambers

Introduction

It is important to protect the insulators of the interrupting chambers during the next operations (installing the terminals, installing the capacitors ...)

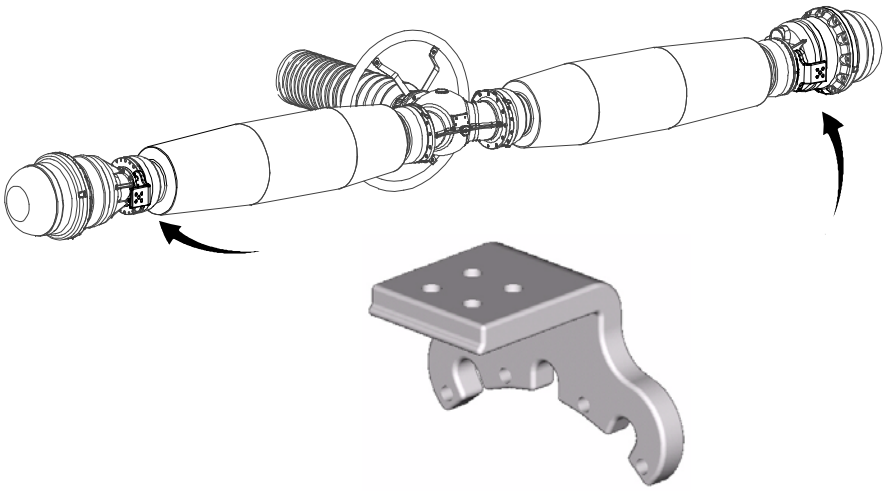
Process

To protect the interrupting chambers, use packaging protection ☜ retained from the opening of the column case.



Presentation

Diagram



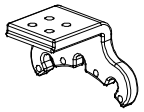
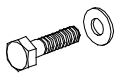
In this module

This module contains the following topics :

Components, products and accessories

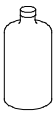
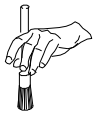
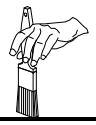
Necessary components

List of the Grid Solutions components necessary for the assembling (per pole) :

Mark	Diagram	Designation	Number
(1)		Terminal	2
(3)		Screws H M12- 45	8

Necessary products and accessories

List of the Grid Solutions products and accessories necessary for the installing :

Grid Solutions reference	Diagram	Designation
- 01861262		Can of ISOPROPANOL (1l)
- 01835106		Vaseline 204- 9
- 01835118		Contactal grease
- 01831320		Abrasive paper A400
- 02212337		Scotch Brite A- VF
- 02212334		Rag
- 02211842		Round brush No.4
- 02211831		Brush No.16

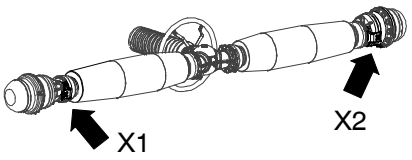
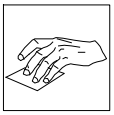
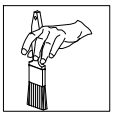
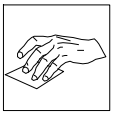
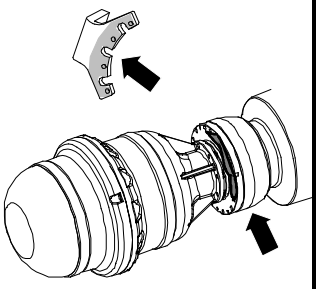
Preparing the contact surfaces

Preparing the contact grease

The contact grease is a mixture composed of Vaseline and Contactal grease.
CONTACT GREASE = 50% Vaseline + 50% Contactal grease

Preparing the contact surfaces

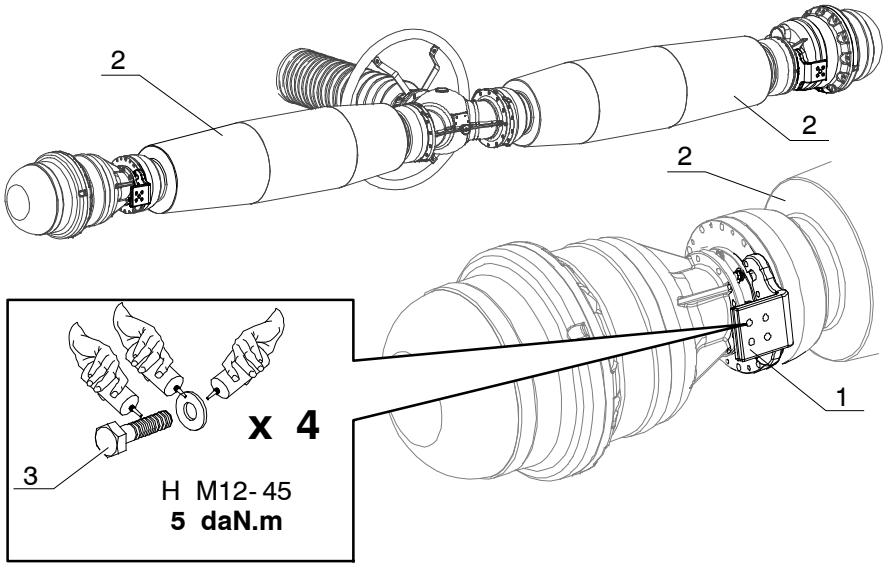
The table below gives the steps of preparing the contact surfaces :

Step	Action	Diagram
1	Remove the temporary screws from the terminal pads X1 and X2.	
2	Dry rub with fine emery cloth.	
3	Eliminate the dust produced.	
4	Coat with CONTACT GREASE.	
5	Wipe with a clean rag, leaving just a thin layer of grease.	
6	Rub over the grease with waterproof abrasive paper A400.	
		

Installing terminals

Process

Assemble immediately the terminals (1) on the interrupting chambers (2) after preparation of contact surfaces. Fasten the terminals using screws (3); use CONTACT GREASE to seal the screws.



Comment

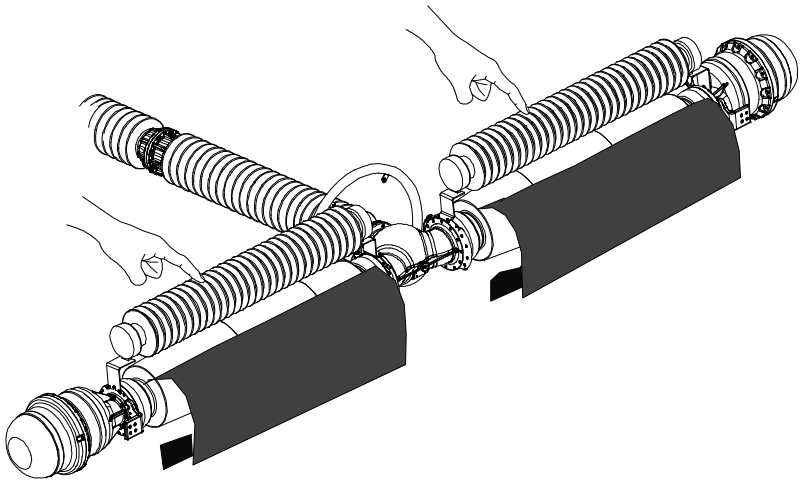
- The electrical resistance value of the assembly should be :

$$R \leq 2\mu\Omega$$

- Before installing H.V. connectors, prepare the contact surfaces in the same way.

Presentation

Diagram



Necessary tools

List of the tools necessary :

Mark	Diagram	Designation	Number
(12)		Lifting strap (3 m)	2

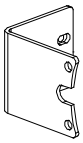
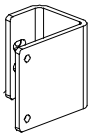
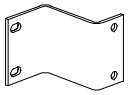
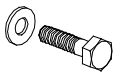
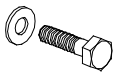
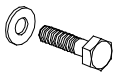
In this module

This module contains the following topics :

Components and products

Necessary components

List of the Grid Solutions components necessary for the assembling (per pole) :

Mark	Diagram	Designation	Number
(1)		Capacitor	2
(3)		Support	2
(4)	 or 	Support (depending on the apparatus)	2
(5)		Screws H M12-30	8
(8)		Screws H M12-45	4
(9)		Screws H M12-25	4
(1)		Spacer	4

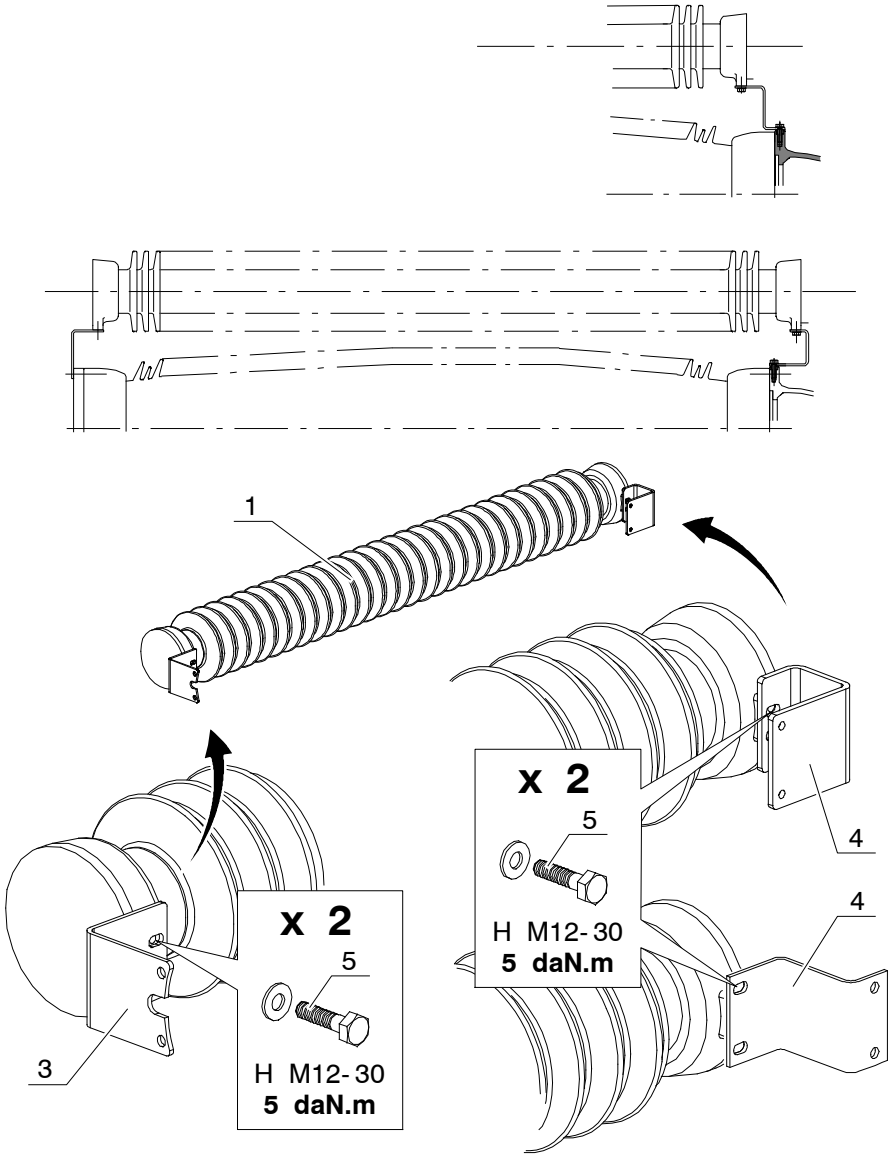
Necessary product

Grease MOBILPLEX 47 (screws greasing)

Preparing the capacitors

Installing the supports

- Install the support (3) on the capacitor (1) using the screws (5).
- Install the support (4) on the capacitor (1) using the screws (5).

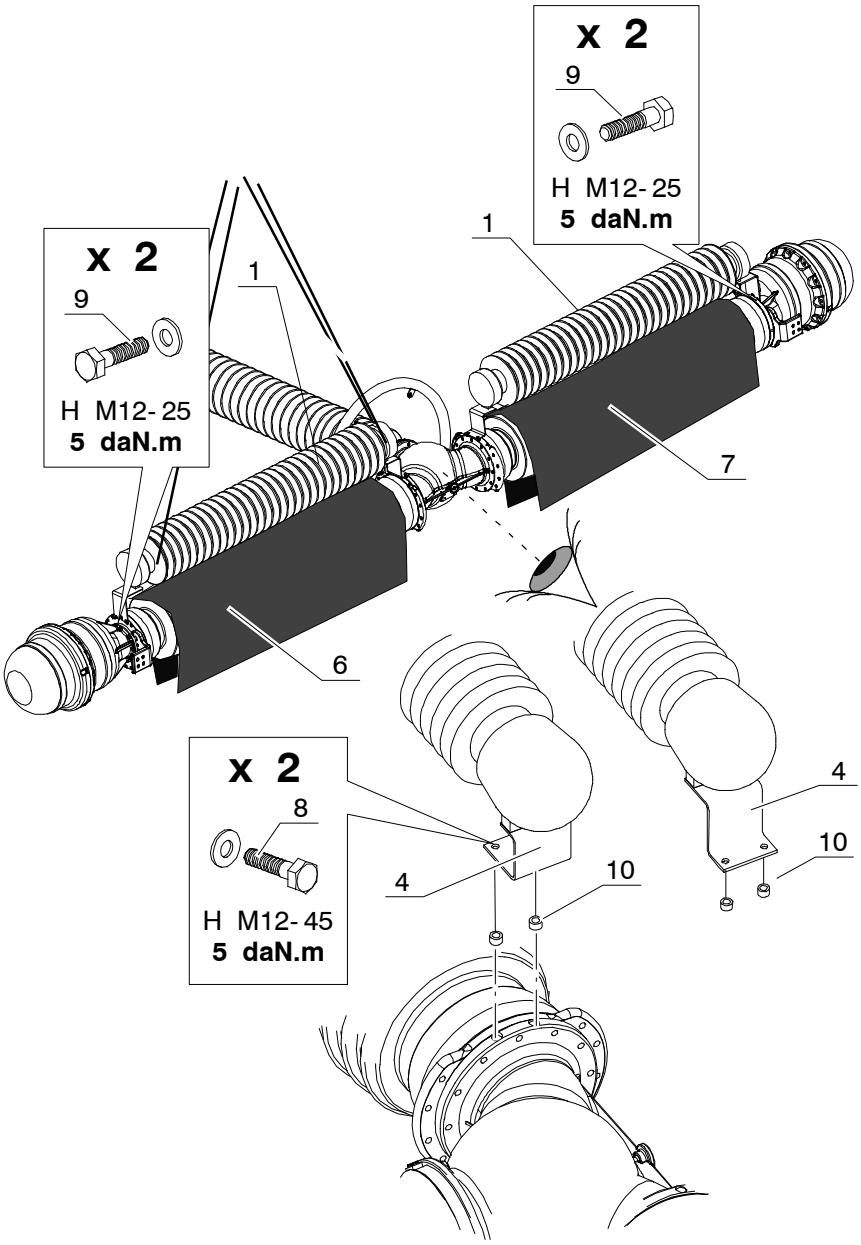


Installing the capacitors

Process

Install the capacitors (1) on the interrupting chambers (6) and (7) using the screws (8) and (9).

NOTE : Use the two spacers (10) to install the capacitors - capacitor support (4) side.



Presentation

Necessary tools

List of the necessary Grid Solutions tools for the lifting and positionning of the pole :

Mark	Diagram	Designation	Number
(1)		LIFTING STRAP (3 m - 1000 kg)	4
(2)		LIFTING STRAP (6 m- 1000 kg)	4

In this module

This module contains the following topics :

Warning

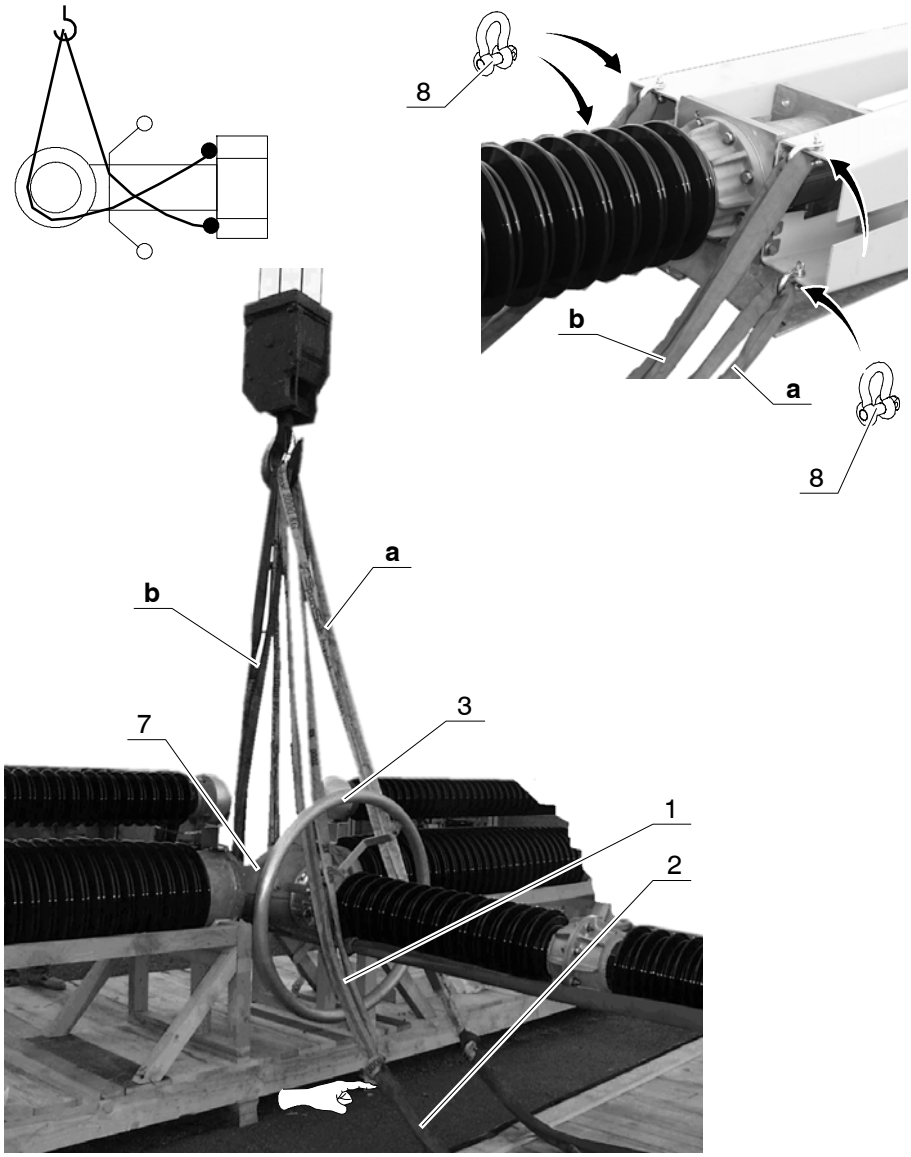
“Procedure limited to pole installation only. For removal, contact Grid Solutions.”
“Any faults or cracks in the column may render the procedure dangerous.”

Positioning the lifting straps

Process

The table below gives the steps of positioning the lifting straps :

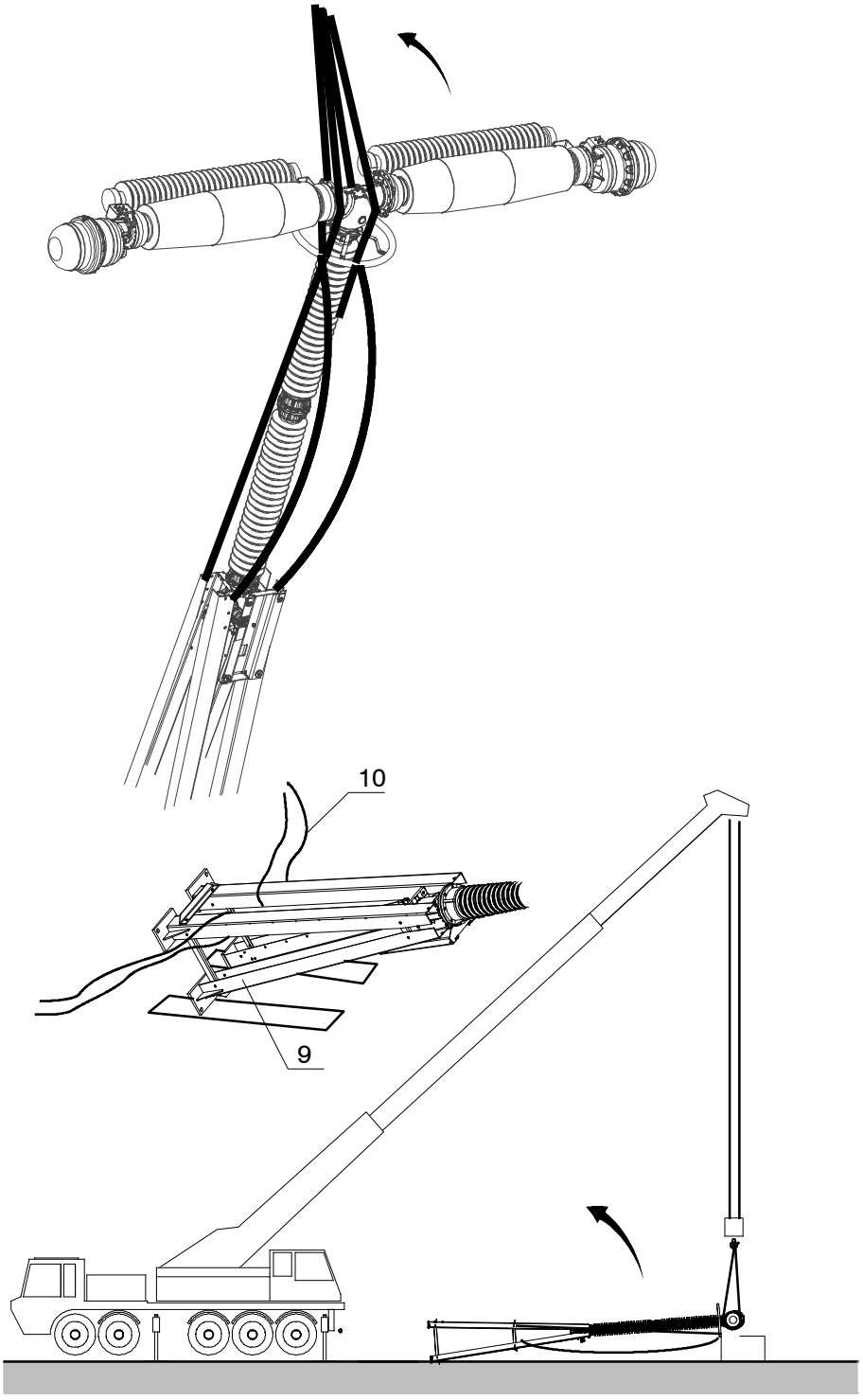
Step	Action
1	● For poles of circuit- breakers fitted with a column made up with three insulators, four 6 m lifting straps are sufficient. ● For columns made up with four insulators, prepare four wholes : one 3 m lifting strap (1) knotted with one 6 m lifting strap (2).
2 ⚠	Pass the lifting straps like the picture below. - The lifting straps "**a**" pass **over** the housing (7). - The lifting straps "**b**" pass **under** the housing (7).
3	Cross the lifting straps "**a**" and "**b**" and place them onto the frame using the four lifting shackles (8).



Lifting the pole

Process

By means of a lifting device hoist the pole up whilst allowing it to rest on the base of the frame.
Place the trip ropes (10) on the support legs of the chassis frame (9) to ensure guidance of the pole at the time of lifting.
Lift the pole with precaution.

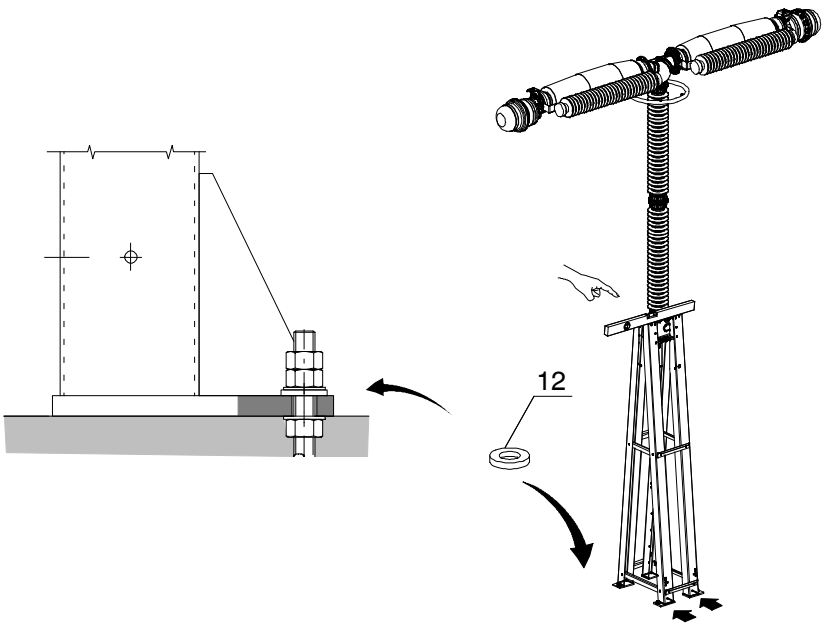


Positioning the pole

Process

The table below gives the steps of positioning the pole :

Step	Action
1 	Use a lifting device to position the chassis frame onto its ground attachment points but do not secure it, whilst respecting the orientation of the pole indicated on the sketch of the device.
2	If necessary, place shims under the supports of the frame so that the upper plate is level.
3	Install the washers (12) and clamp the whole to the ground using nut.
4	Remove the lifting straps.
5 	Check the tightening torques of all frame screws.
6 	Tighten the fixings on the two floor seatings in accordance with the module entitled '**Tightening Torques**' and in accordance with the diameters of the anchoring points.



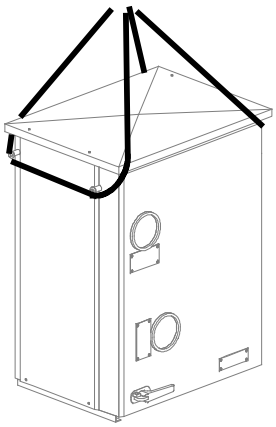
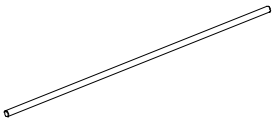
Presentation

Necessary product

Grease MOBILPLEX 47 or MOBILUX EP3 (screws greasing)

Necessary Grid Solutions tools

List of the Grid Solutions tools necessary for the installing :

Mark	Diagram	Designation	Number
(1)		Lifting strap	1
(6)		Lever	1

Lifting equipment

Provide an appropriate lifting equipment (300 daN).

Process

The table below gives the steps of installing the operating device on the pole- support :

Preparing the operating device

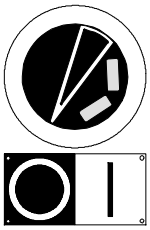
Unpacking

Remove packaging protection and check that operating device and pole reference numbers are the right ones.

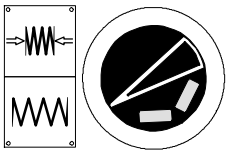
Optical signalizations

Check the position of operating device optical signalization :

Circuit- breaker
Open

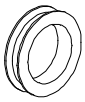


Closing spring
Released



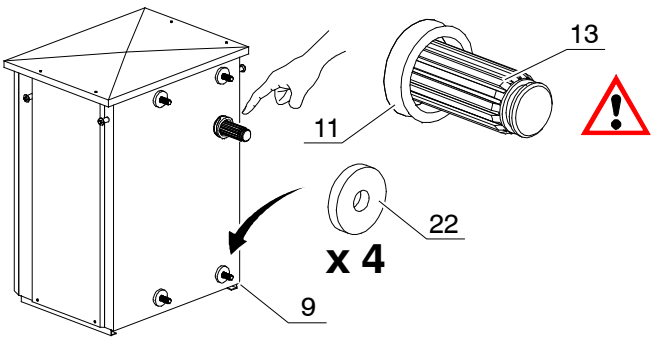
Necessary components

List of the Grid Solutions components necessary for the operation :

Mark	Diagram	Designation	Number
(11)		Seal	1
(22)		Spacer	4

Installing the necessary components

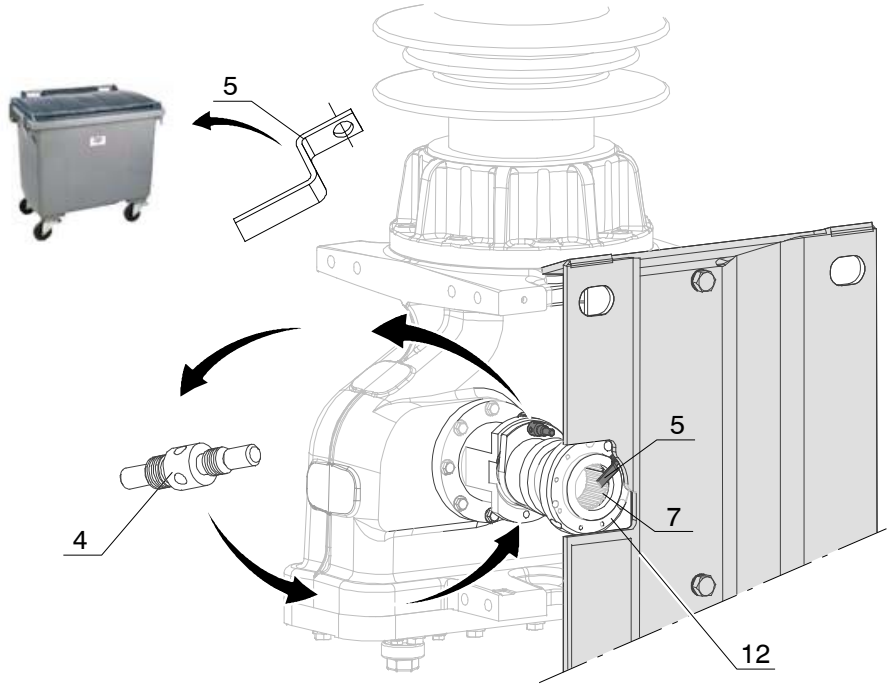
- Install the spacers (22) on the screws (9) outside the operating device.
- Install the seal (11) on the operating shaft (13).
- Check the presence of grease (ASEOL 0- 365.2) on the operating shaft (13).



Preparing the pole operating shaft

Introduction

For transport the pole is fitted with a securing tool (4) and a safety plate (5), temporarily attached to the end of the handle (12)
To fit the operating lever, you must:
a - Remove the securing tool (4).
b - **Manually open the pole.**
c - Refit the securing tool (4) ("open" position).
d - Remove the safety plate (5).



Grease

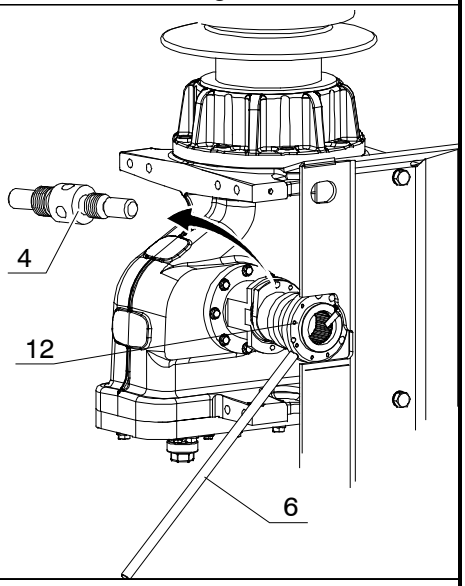
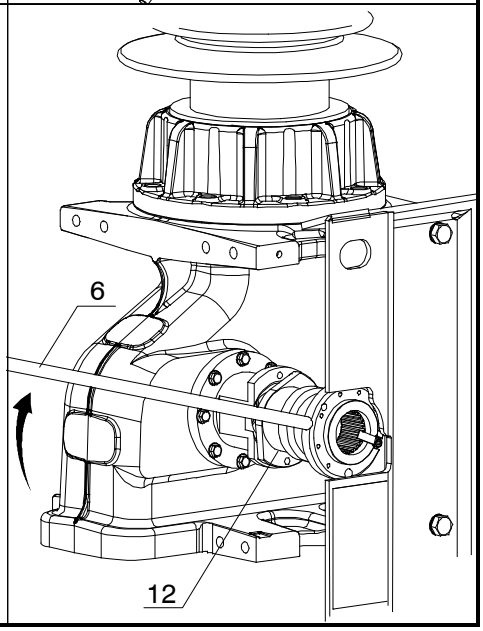
Check the presence of grease (ASEOL 0- 365.2) on the pole operating shaft.

Continued on next page.

Preparing the pole operating shaft, continued

"Manual opening" operation

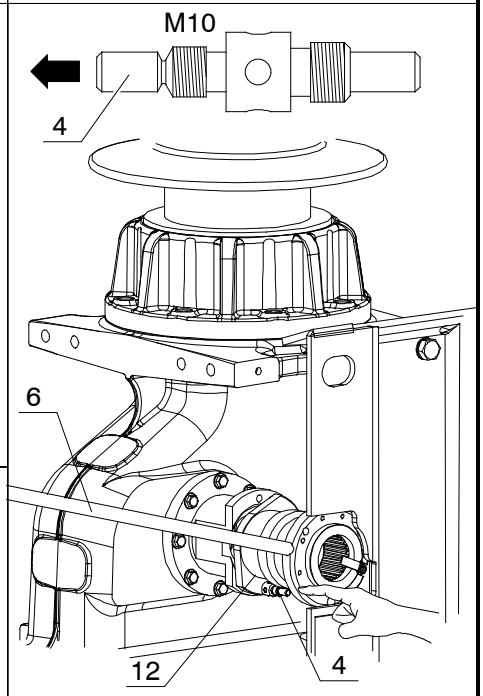
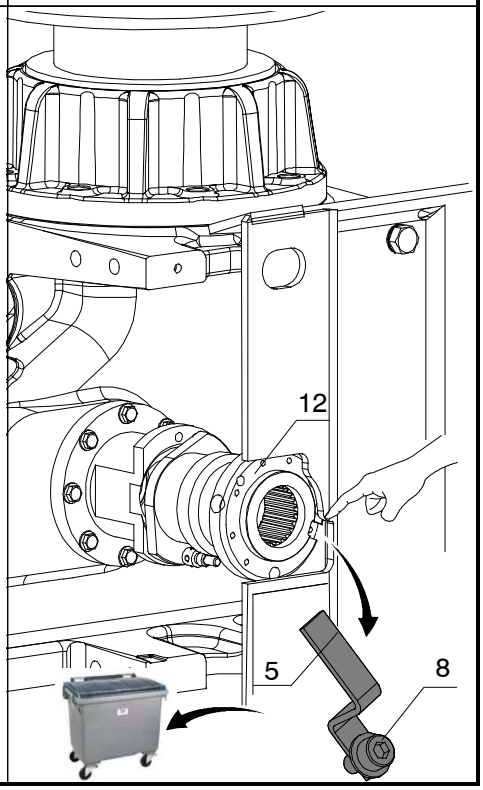
The table below gives the steps of "manual opening" operation :

Step	Action	Diagram
1	Remove the securing tool (4) then screw the operating lever (6) onto the flange on the front of the handle sleeve (12).	
2	With the help of the lever (6), effect a 60° rotation of the sleeve (12).	

Preparing the pole operating shaft, continued

"Manual opening" operation, continued

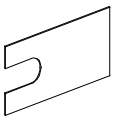
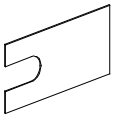
The table below gives the steps of "manual opening" operation :

Step	Action	Diagram
3	Put back the blocking tool (4) on the flange of the sleeve (12). **NOTE** : This tool ensure the angular positioning of pole operating shaft during the coupling with the operating mechanism.	
4	Remove the lever (6).	
5	Remove the safety plate (5) and the screws from the flange on the front of the handle sleeve (12).	

Coupling the operating device

Necessary components

List of the Grid Solutions components necessary for the operation :

Mark	Diagram	Designation	Number
(10)		Washer M20	4
(22)		Spacer	1
(26)		Spacer	1
(23)		Eccentric spacer	2
(14)		Nut H M20	4
(24)		Wedge (thickness 1 mm)	1
(25)		Wedge (thickness 0,5 mm)	2

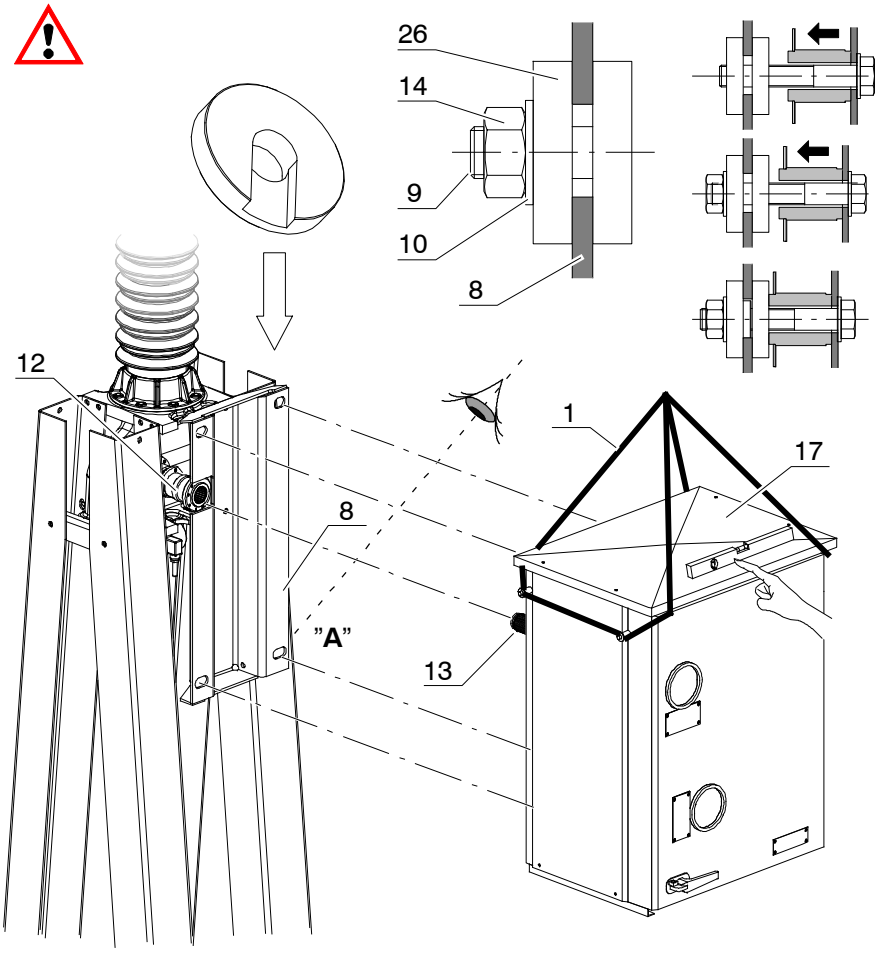
Continued on next page.

Coupling the operating device, continued

Coupling

The table below gives the steps of the operating device coupling :

Step	Action
1	Sling the operating device using a lifting strap (1) like diagram. **NOTE** : Do not remove the roof (17) of the operating device before slinging.
2	Lift the operating device and make this level. Approximate weight 300 kg.
3	Approach the operating device in assembly position, the jib of the lifting equipment must be under the stress- shields ring (to avoid that the cables touch the stress- shields ring). **The final approach must be done with extreme caution.**
4	Introduce the operating mechanism shaft (13) into the cylinder (12) of the pole operating shaft.
5	As soon as the lower fastening screw (9) "**A**" emerge from the hole of the operating mechanism support (8), install the spacer (26), washer (10) and the nut (14). **NOTE** : Do not tighten the nut (14).

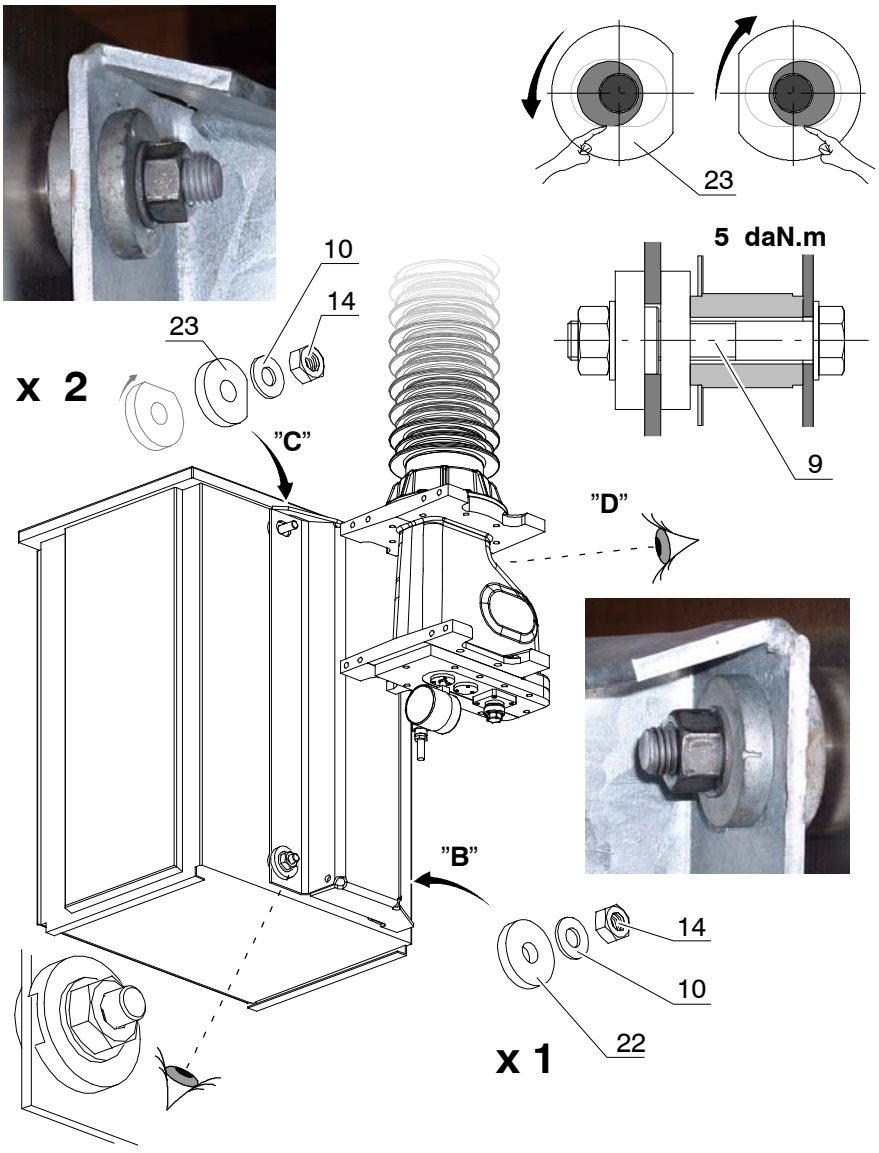


Fastening the operating device

Installing the fastening nuts

The table below gives the steps of installing the operating device fastening nuts :

Step	Action
1	Install the spacer (22), washer (10) and the nut (14) on the lower fastening screw "**B**". **NOTE** : Do not tighten the nut (14).
2	Install the eccentric spacers (23), washers (10) and the nuts (14) on the upper fastening screws "**C**" and "**D**". **NOTE** : Do not tighten the nuts (14).
3	Rotate the eccentric spacers (23) to do the contact with the lower edge of the pole- support oblong holes.
4	Tighten - temporarily at the indicated tightening torque - the fastening screws (9).

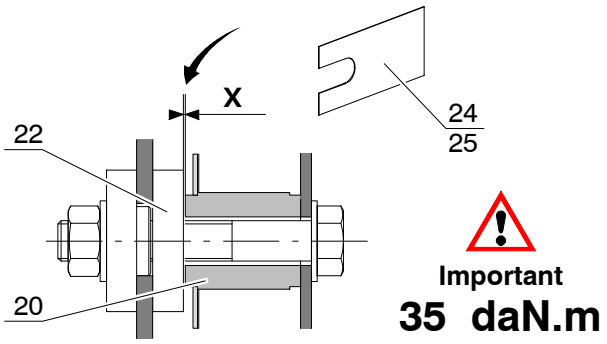


Continued on next page.

Fastening the operating device, continued

Wedging and tightening

The table below gives the wedging procedure for the fastening screws depending to the X play :



If the X play is ...	Action
X <1 mm	**Tighten to the indicated tightening torque.**
X ≥1 mm	• Wedge between the spacer (22) and the operating device (20) with the provided wedges (24)- (25). • **Tighten the screw to the indicated tightening torque.**

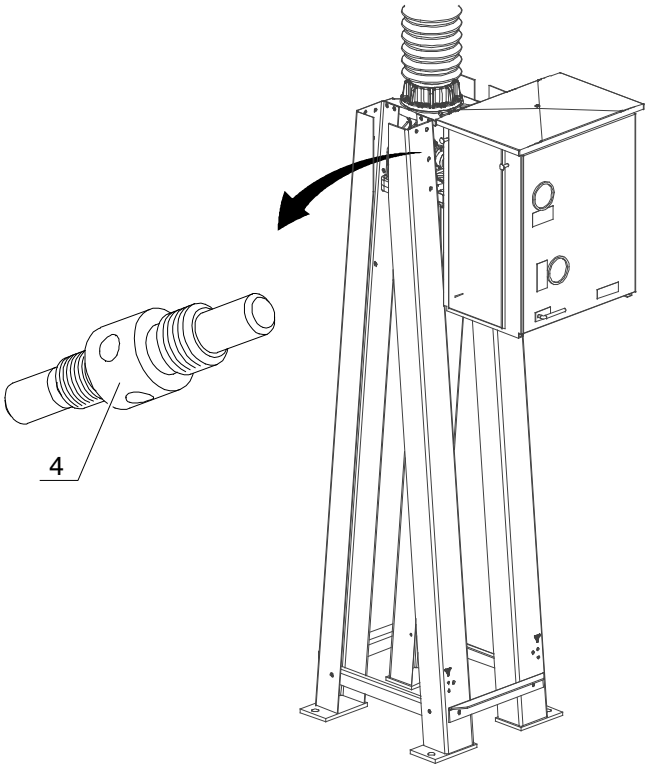
Lifting strap

Remove the lifting strap.

Removing the blocking tool

Process

REMOVE THE BLOCKING TOOL (4).



Low voltage electrical wiring

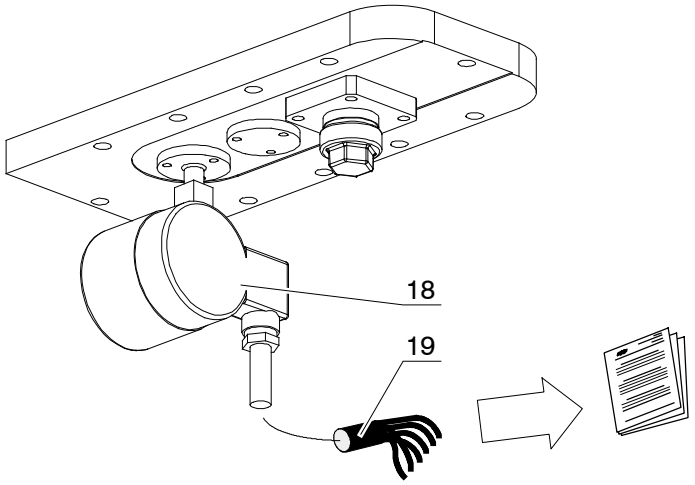
Process

Connect up the operating device's wires refer to the wiring diagram of the circuit- breaker.
Connect up the operating device's wires.

NOTE : Use the holes provided on the supports of the frame to fix the cables.

Connecting up the contact densimeter cable

Connect the wires from the electrical contact SF_6 densimeter (18) cable (19) to the operating mechanism terminal block, in accordance with the relative diagram.



Permanent heating system

Process

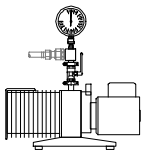
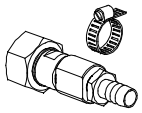
Switch on the permanent heating system of the operating device (in both summer and winter) to avoid condensation, and the corrosion which might result from this.

DO NOT SUPPLY THE OPERATING MECHANISM MOTOR WITH CURRENT TO AVOID THE CLOSING SPRING BEING RELOADED.
THE CIRCUIT BREAKER MUST NOT BE OPERATED AT A SF_6 PRESSURE GAS LOWER THAN THE MINIMAL PRESSURE FOR THE INSULATION p_{me}.

Presentation

Necessary Grid Solutions tools

List of the Grid Solutions tools necessary for the installing :

Mark	Diagram	Designation	Number
(1)		VACUUM PUMP (OPTIONAL) 110/220 V 50 Hz (4.5 m^3/h) or 115/230 V 60 Hz (4.5 m^3/h)	1
(2)		UNIVERSAL CONNECTION 1/2” GAZ ET 1/2” NPT	1

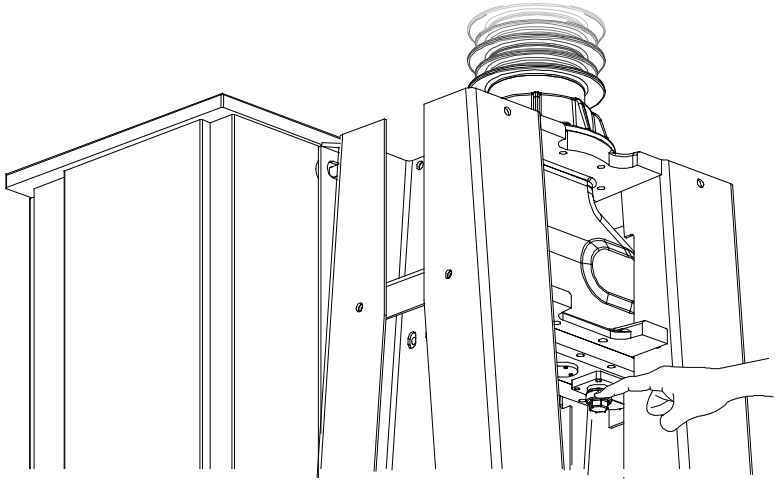
In this module

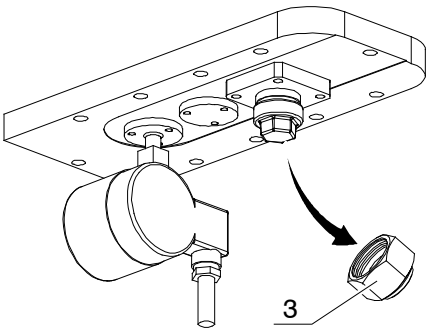
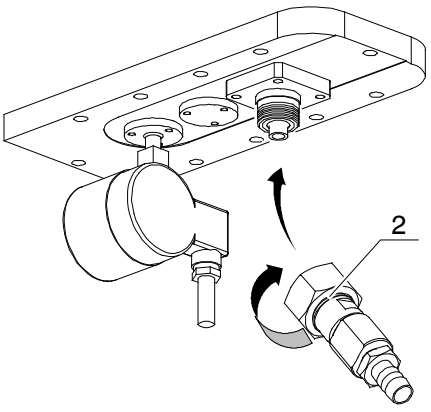
This module contains the following topics :

Installing the universal connection

Process

The table below gives the steps of installing the universal connection :



Step	Action	Diagram
1	Remove the plug (3).	
2	Install the universal connection (2)) (hand tightening of nut is sufficient).	

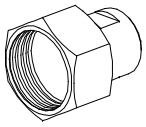
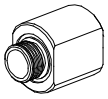
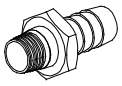
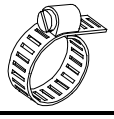
Connection the tube of the customer supply vacuum pump

Operation on the vacuum pump

Close the tap of the vacuum pump.

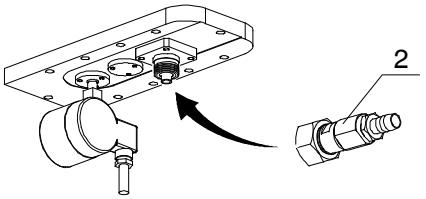
Universal connection components

List of the universal connection components :

Mark	Diagram	Designation	Number
(5)		“DILO” union	1
(6)		1/2” GAS union	1
(7)		1/2” NPT union **NOTE** : Minimum inside diameter of the tube to use Ø 16.25mm.	1
(8)		Collar	1

Connection

The table below gives the connection procedure of the vacuum depending of the used tube union :

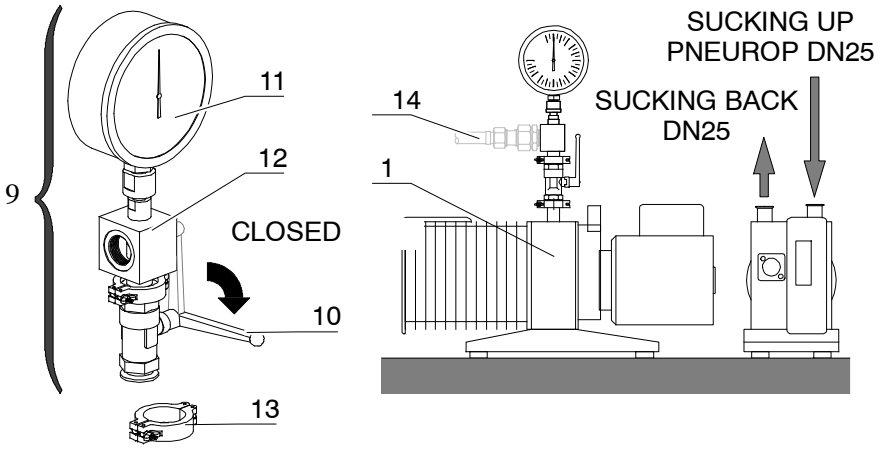


If the tube is equipped with an union ...	Action
DILO DILO	Remove the universal connection (2) and connect directly the tube.
1/2” GAS	Remove the parts (6) - (7) of the universal connection (2) and connect the tube onto the part (5).
1/2” NPT	Remove the part (7) of the universal connection (2) and connect the tube onto the part (6).
No union (to avoid, not very reliable)	Connect the tube directly onto the part (7) of the universal connection (2) using collar (8).

Connection the Grid Solutions supply vacuum pump

Vacuum pump equipment

The table below describes the accessory (9) main components of the vacuum pump (1) :



Mark	Component	Information
(10)	Tap	Opening - Closing of the vacuum pump.
(11)	Pressure gauge	Reading the pressure.
(12)	Distribution block	Connection the vacuum pump.
(13)	Close tap	Fastening the accessory (9).

Process

The table below gives the steps of the vacuum pump connection :

Step	Action	Comment
1	Install the accessory (9) on the “SUCKING UP” exit of the vacuum pump (1).	Use the close tap (13).
2	Close the tap (10).	
3	Connect one end of the tube (14) to the distribution block (12).	The tube (14) is not provided by Grid Solutions.
4	Connect the other end of the tube (14) to the SF_6 checking block.	Refer to “Connection the tube of the customer supply vacuum pump

Presentation

Principle

The procedure of the vacuum operation **depends on the duration of chambers/column coupling**.

Decision table

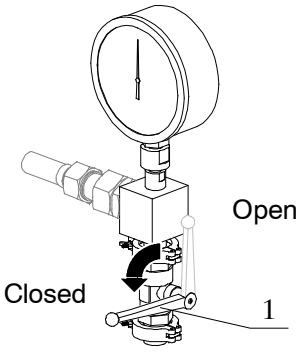
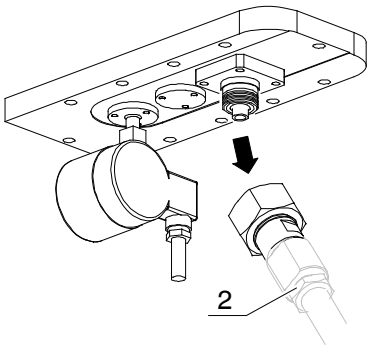
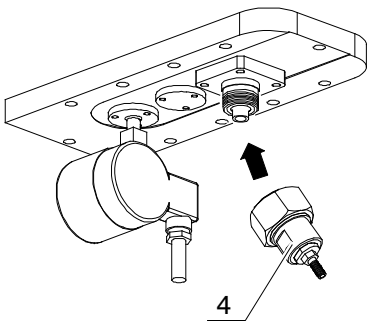
The table below gives the vacuum operation procedure depending on the duration of chambers/column coupling :

If the duration of the chambers/ column coupling is ...	Action	Page
≤ **40 min**	Simple vacuum operation	2
> **40 min**	Vacuum operation with nitrogen purging (N_2)	3

Simple vacuum operation

Process

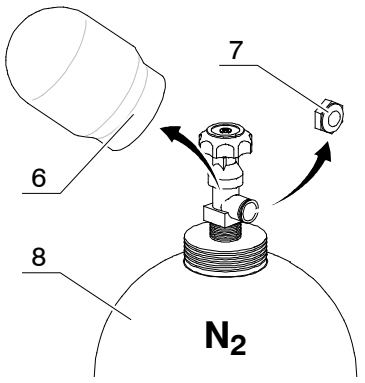
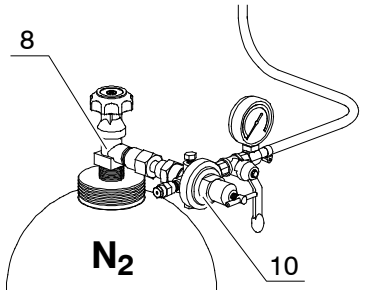
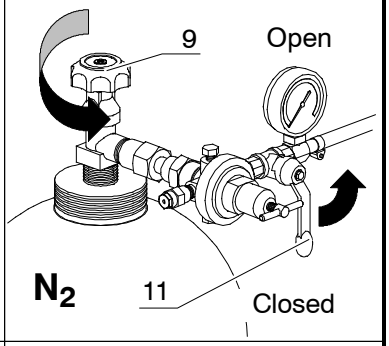
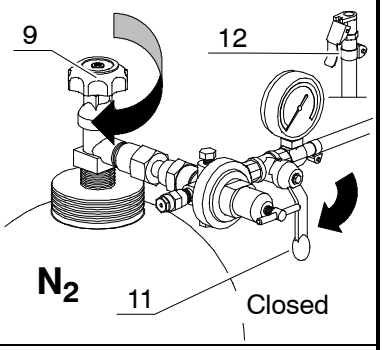
The table below gives the steps of the simple vacuum operation :

Step	Action	Comment/Diagram
1	Start the vacuum pump to evacuate the pole to a value ≤ **1 mbar (100 Pa)**.	**KEEP THE PUMP RUNNING FOR AT LEAST 1 HOUR AT THIS VALUE.**
2	Close the tap (1) of the vacuum pump.	
3	Stop the vacuum pump.	
4	Disconnect the vacuum pump tube (2).	
5	Fit the filling tool (4) - HAND TIGHT.	
END OF PROCEDURE		

Vacuum operation with nitrogen purging (N_2)

Preparing the nitrogen bottle (N_2)

The table below gives the steps of preparing the nitrogen bottle (N_2) :

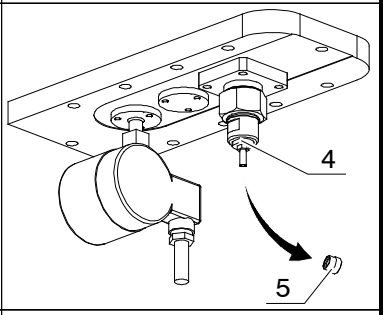
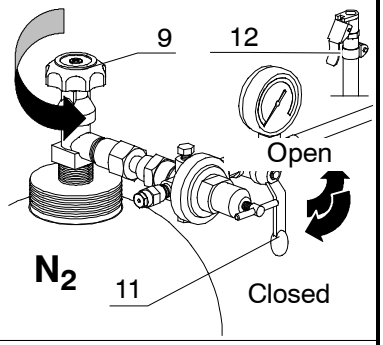
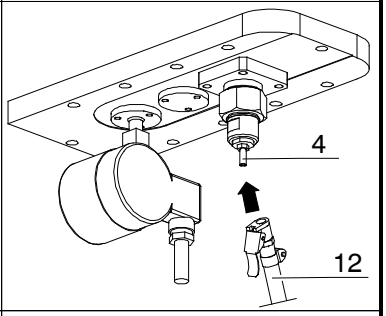
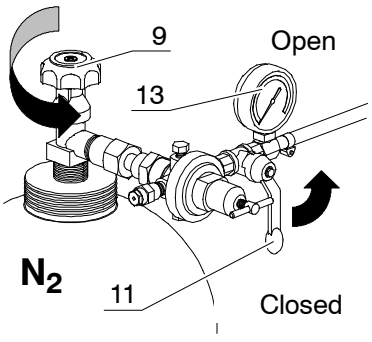
Step	Action	Diagram
1	Remove the cover (6) and plug (7) from the nitrogen (N_2) bottle (8).	
2	Fit the pressure reducer (10) on the nitrogen (N_2) bottle (8).	
3	Briefly open the nitrogen (N_2) bottle tap (9) and the cock (11) of the pressure reducer to eliminate any air inside the piping (approx. 20 s at low flow- rate).	
4	Close the bottle tap (9) and the cock (11) of the pressure reducer. **NOTE** : Keep the end of the tube (12) in high position to keep the nitrogen (N_2) which it contains and to prevent damp air from entering.	
END OF PROCEDURE		

Continued on next page.

Vacuum operation with nitrogen purging (N_2), continued

Vacuum operation

The table below gives the steps of the vacuum operation with nitrogen purging (N_2) :

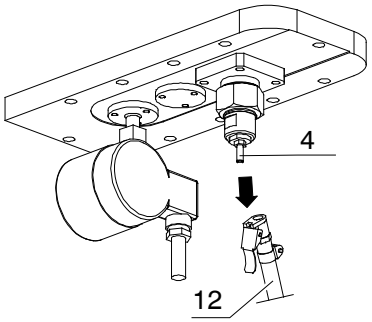
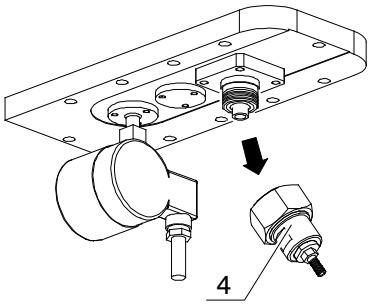
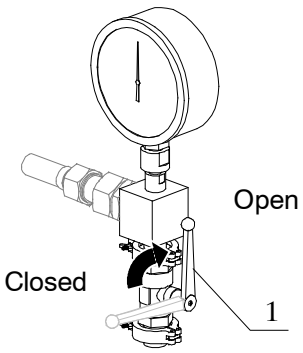
Step	Action	Comment/Diagram
1	**Carry out a simple vacuum operation.**	**≤ 1 mbar (100 Pa) during 1 hour.**
2	Remove the valve cap (5) of the filling tool (4).	
3	• Open the nitrogen (N_2) bottle tap (9). • Open and close the cock (11) of the pressure reducer to eliminate any air inside the tube (12) (approx. 3 s at low flow- rate). • Close the nitrogen (N_2) bottle tap (9).	
4	Connect the tube (12) to the filling tool (4).	
5	Open the nitrogen (N_2) bottle tap (9) and adjust gas output by acting on the cock (11) of the pressure reducer (reduced flow rate). • Close the tap (9) from time to time to check pressure on the gauge (13). • Start filling again until the required pressure about **0.03 MPa** is reached. • Close in this order : the tap (9), then the cock (11).	

Continued on next page.

Vacuum operation with nitrogen purging (N_2), continued

Vacuum operation, continued

The table below gives the continuation of the steps of the vacuum operation with nitrogen purging (N_2) :

Step	Action	Comment/Diagram
6	Disconnect the tube (12) from the filling tool (4).	
7	Remove the filling tool (4) with the valve cap.	
8	Connect the vacuum pump and open the tap (1) to bring the volume of pole back to ambient pressure (filled with nitrogen at 0.03 MPa).	
9	**Carry out a new simple vacuum operation.**	**≤ 1 mbar (100 Pa) during 1 hour.**
END OF PROCEDURE		

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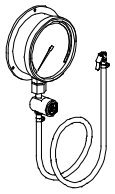
Calculation of the SF_6 gas filling pressure for using the pressure gauge (tool)

Presentation

Introduction

SF_6 pressure values, for the filling, must obligatorily be read on the pressure gauge 0- 1 MPa (tooling). Pay no attention to indications given by the dial densimeter (MPa - psi), it is not accurate enough for the filling.



Pressure gauge 0...1 MPa

Pressure units (reminder)

- The international unit pressure is the Pascal (Pa).

1 bar (14.503 psi) = 1,000 hPa
1 bar = 100 kPa
10 bar = 1 MPa

Symbols

IEC symbols for the apparatus technical characteristics.

Symbol	Designation
p_{re}	Filling rated pressure for the insulation
p_{ae}	Alarm pressure for the insulation
p_{me}	Minimal pressure for the insulation

In this module

This module contains the following topics :

Important

The filling pressure may be incorrectly shown at low temperatures due to the risk of partial liquefaction of the SF_6 gas. It is therefore not recommended that filling or top- up operations be carried out at low temperatures (★) from the tables entitled ”Effective, temperature- corrected SF_6 gas pressure values”.

Technical data

SF_6 gas

The table below gives the SF_6 gas characteristics :

<u>Absolute</u> pressure at 20°C(68°F)			
p_{re}	Filling absolute pressure for the insulation		**0.65 MPa** (94.27 p.s.i.)
i.e. <u>effective</u> pressure at 20°C(68°F) and 101.3 kPa			
p_{re}	Filling rated effective pressure for the insulation	+ 0,01 - 0	0.55 MPa (79.77 p.s.i.)
p_{ae}	Alarm effective pressure for the insulation	+ 0,02 - 0	0.45 MPa (p_{me}+0.03 MPa) (65.27 p.s.i.)
p_{me}	Minimal effective pressure for the insulation	+ 0,02 - 0	0.42 MPa (60.92 p.s.i.)
SF_6 gas density			
p_{re}			42,38 kg/m^3
p_{ae}			35,38 kg/m^3
p_{me}			33,31 kg/m^3
Minimum admissible temperature up to			**- 35°C**

Example

Determination of the circuit- breaker's filling pressure with SF_6 gas.

Parameters	Values
p_{re} SF_6 gas rated filling <u>effective</u> pressure for the insulation	**0,55 MPa** (79.77 psi)
Ambient temperature	**5°C**
Local atmospheric pressure	**93,2 kPa**

SF_6 gas filling

The table below gives the calculation steps of the pure SF_6 filling pressure :

Step	Action	Result
1	In the chart (page 4) "Values of the SF_6 gas <u>effective pressures</u> in accordance with the temperature", read the p_{re} value on the t°C = 5 row.	0,51 MPa
2	Calculate the difference of the atmospheric pressure : 0,1013 - 0,0932	0,0081 MPa
3	Calculate the rated effective pressure p_{re} : 0,510 + 0,0081	0,5181 MPa
4	Filling is carried out to the calculated pressure, plus 0,01 MPa, that is to say : 0,5181 + 0,01	Pure SF_6 gas filling pressure **0,5281 MPa**

Calculation of the filling pressure at site

Measurement

Write down the result measurement into the corresponding box :

Measure the atmospheric pressure in MPa.	A ---,-------
Measure the ambient temperature in °C.	B ----------

Calculation of the pure SF_6 gas filling pressure

Transfer the values into the corresponding box and write down the result :

With the help of the table (page 4) "Values of the SF6 gas effective pressures in accordance with the temperature", determine the value "p_{re}" in accordance with the ambient temperature (**B**) ▶	p_{re} C ---,-------
Value of the reference atmospheric pressure in MPa	D 0 , 1 0 1
Transfer the value of the local atmospheric pressure (**A**) ▶	A- --,-------
Calculate the difference of the atmospheric pressure (**D - A**) ▶	E ---,-------
Transfer the value (**C**) ▶	C+ -,-------
Calculate the rated effective pressure (**E + C**) ▶	F ---,-------
The filling with SF_6 gas is carried out to the calculated pressure, plus 0.01 MPa, (**F + 0.01**) ▶	+ 0, 0 1 G ---,-------

Values of the SF_6 gas effective pressures in accordance with the temperature

Rated effective pressure 0.55 MPa

Values of the SF_6 gas effective pressures (**MPa**) corrected in accordance with temperature for an atmospheric pressure of 101.3 kPa :

t°C	p_{re}	p_{ae}	p_{me}	t°C	p_{re}	p_{ae}	p_{me}
-35	★	★	★	**13**	0.531	0.435	0.406
-34	★	★	★	**14**	0.534	0.437	0.408
-33	★	★	★	**15**	0.537	0.439	0.410
-32	★	★	★	**16**	0.539	0.441	0.412
-31	★	★	★	**17**	0.542	0.443	0.414
-30	★	★	★	**18**	0.545	0.446	0.416
-29	★	★	★	**19**	0.547	0.448	0.418
-28	0.422	0.345	0.322	**20**	0.550	0.450	0.420
-27	0.425	0.347	0.324	**21**	0.553	0.452	0.422
-26	0.428	0.349	0.326	**22**	0.555	0.454	0.424
-25	0.430	0.352	0.328	**23**	0.558	0.457	0.426
-24	0.433	0.354	0.330	**24**	0.561	0.459	0.428
-23	0.436	0.356	0.332	**25**	0.563	0.461	0.430
-22	0.438	0.358	0.334	**26**	0.566	0.463	0.432
-21	0.441	0.360	0.336	**27**	0.569	0.465	0.434
-20	0.444	0.362	0.338	**28**	0.571	0.468	0.436
-19	0.446	0.365	0.340	**29**	0.574	0.470	0.438
-18	0.449	0.367	0.342	**30**	0.577	0.472	0.441
-17	0.452	0.369	0.344	**31**	0.579	0.474	0.443
-16	0.454	0.371	0.346	**32**	0.582	0.476	0.445
-15	0.457	0.373	0.348	**33**	0.585	0.478	0.447
-14	0.460	0.376	0.350	**34**	0.587	0.481	0.449
-13	0.462	0.378	0.352	**35**	0.590	0.483	0.451
-12	0.465	0.380	0.354	**36**	0.593	0.485	0.453
-11	0.468	0.382	0.356	**37**	0.595	0.487	0.455
-10	0.470	0.384	0.358	**38**	0.598	0.489	0.457
-9	0.473	0.387	0.361	**39**	0.601	0.492	0.459
-8	0.475	0.389	0.363	**40**	0.603	0.494	0.461
-7	0.478	0.391	0.365	**41**	0.606	0.496	0.463
-6	0.481	0.393	0.367	**42**	0.609	0.498	0.465
-5	0.483	0.395	0.369	**43**	0.611	0.500	0.467
-4	0.486	0.397	0.371	**44**	0.614	0.503	0.469
-3	0.489	0.400	0.373	**45**	0.617	0.505	0.471
-2	0.491	0.402	0.375	**46**	0.619	0.507	0.473
-1	0.494	0.404	0.377	**47**	0.622	0.509	0.475
0	0.497	0.406	0.379	**48**	0.625	0.511	0.477
1	0.499	0.408	0.381	**49**	0.627	0.513	0.479
2	0.502	0.411	0.383	**50**	0.630	0.516	0.482
3	0.505	0.413	0.385	**51**	0.632	0.518	0.484
4	0.507	0.415	0.387	**52**	0.635	0.520	0.486
5	0.510	0.417	0.389	**53**	0.638	0.522	0.488
6	0.513	0.419	0.391	**54**	0.640	0.524	0.490
7	0.515	0.422	0.393	**55**	0.643	0.527	0.492
8	0.518	0.424	0.395	**56**	0.646	0.529	0.494
9	0.521	0.426	0.397	**57**	0.648	0.531	0.496
10	0.523	0.428	0.399	**58**	0.651	0.533	0.498
11	0.526	0.430	0.402	**59**	0.654	0.535	0.500
12	0.529	0.432	0.404	**60**	0.656	0.538	0.502

★ Not recommended filling

Pre- filling with SF_6 gas at 0.05 MPa

Presentation

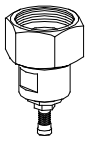
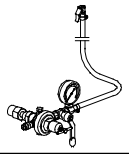
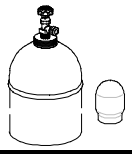
Principle

The pre- filling of the pole with SF_6 gas at 0.05 MPa must be done **after the vacuum operation**.

NOTE : You are reminded that the gas used to fill the pole must conform to the requirements laid out in IEC 60376.

Necessary equipment and tools

List of the necessary ALSTOM Grid equipment and tools for the pre- filling with SF_6 gas :

Mark	Diagram	Designation	Number
(4)		Filling tool	1
(10)		Pressure reducer	1
(8)		SF_6 gas bottle(s)	*

* depending on the aparatus.

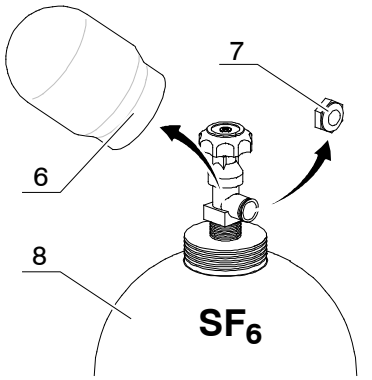
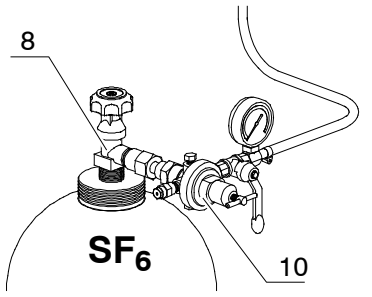
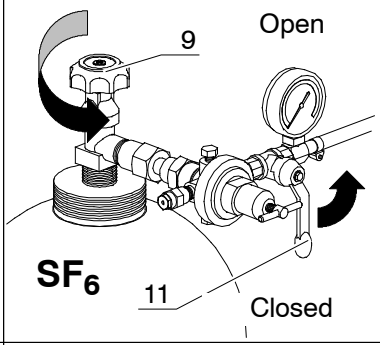
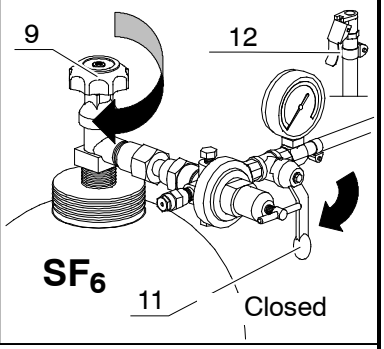
In this module

This module contains the following topics:

Preparing the SF_6 gas bottle

Process

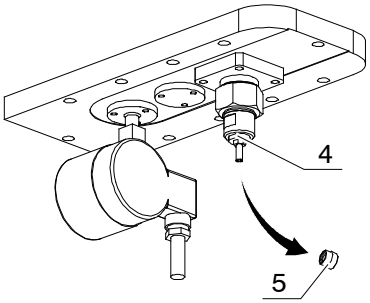
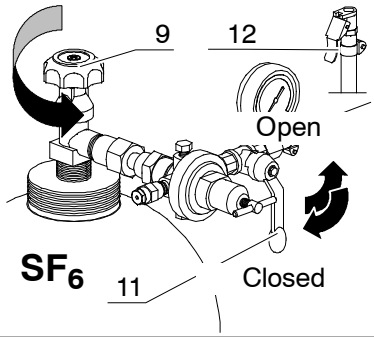
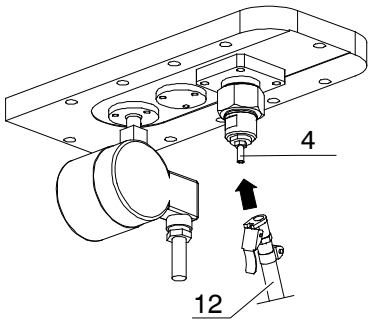
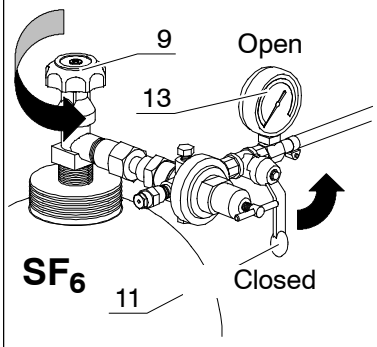
The table below gives the steps of preparing the SF_6 gas bottle :

Step	Action	Diagram
1	Remove the cover (6) and plug (7) from the SF_6 gas bottle (8).	
2	Fit the pressure reducer (10) on the SF_6 gas bottle (8).	
3	Briefly open the SF_6 gas bottle tap (9) and the cock (11) of the pressure reducer to eliminate any air inside the piping (approx. 20 s at low flow- rate).	
4	Close the SF_6 gas bottle tap (9) and the cock (11) of the pressure reducer. **NOTE** : Keep the end of the tube (12) in high position to keep the SF_6 gas which it contains and to prevent damp air from entering.	
END OF PROCEDURE		

Pre- filling with SF_6 gas

Process

The table below gives the steps of the pre- filling with SF_6 gas operation :

Step	Action	Comment/Diagram
1	Remove the valve cap (5) of the filling tool (4).	
2	• Open the SF_6 gas bottle tap (9). • Open and close the cock (11) of the pressure reducer to eliminate any air inside the tube (12) (approx. 3 s at low flow- rate). • Close the SF_6 gas bottle tap (9).	
3	Connect the tube (12) to the filling tool (4).	
4	Open the SF_6 gas bottle tap (9) and adjust gas output by acting on the cock (11) of the pressure reducer (reduced flow rate). • Close the tap (9) from time to time to check pressure on the gauge (13). • Start filling again until the required pressure about **0.05 MPa** is reached. • Close in this order : the tap (9), then the cock (11).	
END OF PROCEDURE		

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Filling with SF_6 gas

Presentation

Warning

**DUE TO THE RISK OF PROBLEMS DURING TRANSPORT,
BEFORE ANY INITIAL FILLING & COMMISSIONING OPERATIONS,
AFTER MAINTENANCE OR INTERVENTIONS,
THE CONDITION OF THE INSULATORS MUST BE VERIFIED VISUALLY.
ALL PERSONS PRESENT MUST TAKE SHELTER OR REMAIN AT
A MINIMUM SAFETY DISTANCE.**

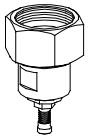
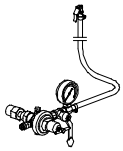
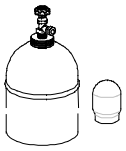
**FOR CERAMIC DEVICES: APPROXIMATELY 50m
FOR COMPOSITES: THE HEIGHT OF THE DEVICE.**

NOTE : It should be noted that the filler gas used must conform to IEC 60376.

Presentation, continued

Necessary equipment and tools

List of the necessary Grid Solutions equipment and tools for the filling with SF_6 gas :

Mark	Diagram	Designation	Number
2		Filling tool	1
8		Pressure reducer	1
6		SF_6 gas bottle(s)	*
14		Gauge 0...1 MPa	1

* depending on the apparatus.

In this module

This module contains the following topics :

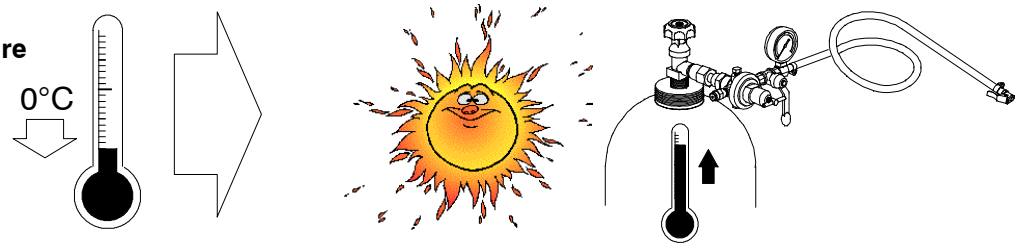
Filling with SF_6 gas

Filling pressure calculation

Calculate the SF_6 gas filling pressure in accordance with the temperature and the local atmospheric pressure.
Filling is carried out to calculated pressure plus 0.01 MPa.

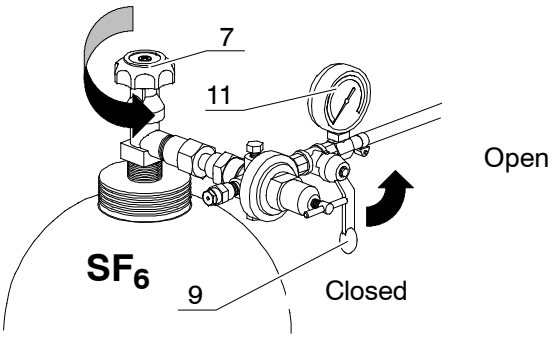
See the module "**SF_6 gas monitoring**" (Calculation of the filling pressure at site).

Ambient temperature



Process

The table below gives the steps of the filling with SF_6 gas operation :

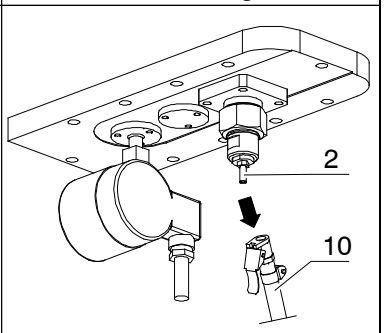
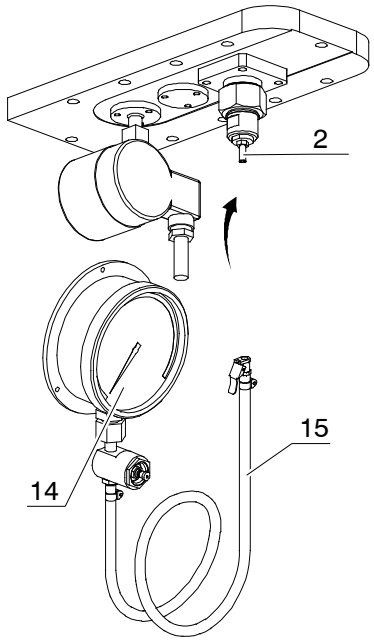
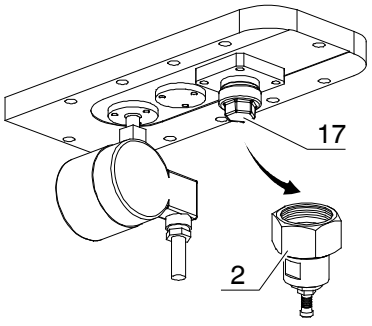


Step	Action	Comment
1	Open the SF_6 gas bottle tap (7) and adjust gas output by acting on the cock (9) of the pressure reducer (**reduced flow rate**). 	Close the tap (7) from time to time to check pressure on the gauge (11).
2	Start filling again until the required pressure is reached.	
3	Close in this order : the tap (7), then the cock (9).	

Confirm the pressure

Process

The table below gives the confirmation operation steps of the filling pressure with SF_6 gas :

Step	Action	Comment/Diagram
1	Disconnect the tube (10) - of the pressure reducer - from the filling tool (2). **NOTE** : Keep the unconnected end of the tube (10) higher than the other end, to stop the SF_6 gas which it contains from escaping and to prevent moisture entering.	
2	• Connect the tube (15) - of the gauge 0- 1 MPa (14) - to the filling tool (2). • When the required pressure is confirmed, remove the gauge (14) and and store it away from humidity.	
3	Remove the filling tool (2) and refit the plug (17) (4 daN.m)	

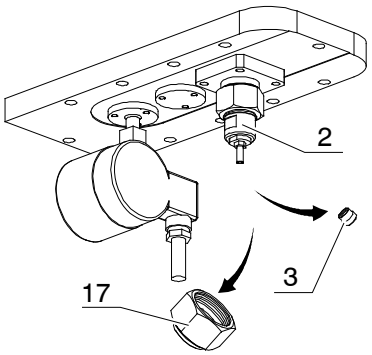
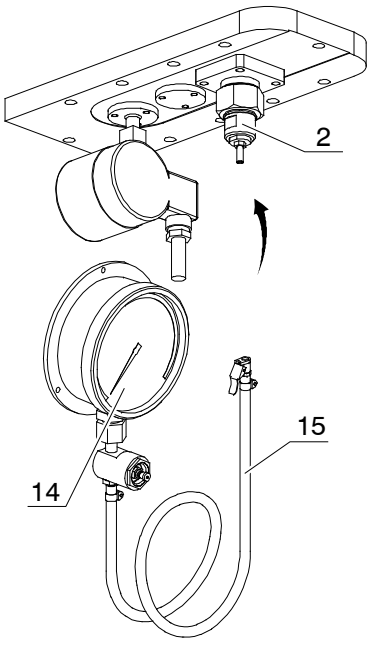
Checking pressure

Principle

Having allowed the temperature to remain steady for at least 12 hours after filling, it is necessary to check and definitively adjust the pressure to its corrected value - defined according to both ambient temperature and atmospheric pressure.

Preparation

The table below gives the preparation steps before checking pressure :

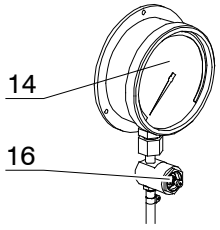
Step	Action	Diagram
1	• Remove the plug (17) and install the filling tool (2). • Unscrew the valve- cap (3).	
2	• Connect the tube (15) - of the gauge 0- 1 MPa (14) - to the filling tool (2).	

Continued on next page.

Checking pressure, continued

Decision table

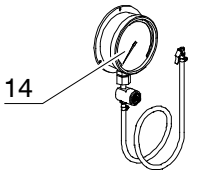
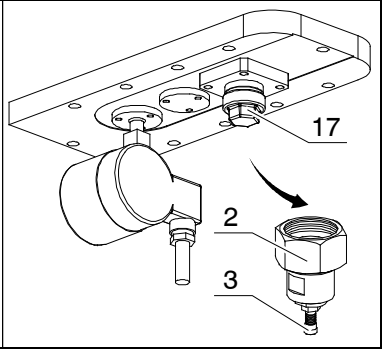
The table below gives the process depending the pressure measured :



If the pressure measured is ...	Action
correct	End of control
too high	Adjust the pressure by means of valve (16) on the gauge (14) to reach the required corrected pressure.
too low	Top- up with SF_6 gas **If the pressure adjustment is ...** / **Action** ≤ 0.05 MPa : End of control > 0.05 MPa : Proceed to a new inspection after a stabilization period of 2- 3 hours.

End of control

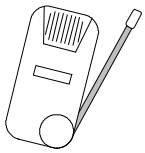
The table below gives the end steps of the checking pressure :

Step	Action	Diagram
1	Disconnect the gauge (14) 0- 1 MPa.	
2	• Remove the filling tool (2) and re- install the plug (17), applying a tightening torque of 4 daN.m; leak- tightness is only guaranteed if this condition is respected. • Screw the valve- cap (3) on the filling tool (2).	

Checking gas- tightness

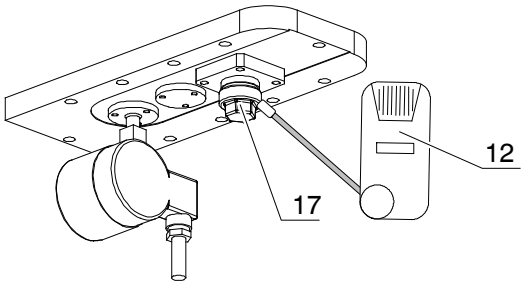
Necessary Grid Solutions tools

List of the Grid Solutions tools necessary for the tightness inspection :

Mark	Diagram	Designation	Number
12		Leak detector (optional)	1

Process

Make sure that the plug (17) is perfectly leak- tight using the leak detector (12).



Moisture content of SF_6 gas in circuit- breaker

Principle

This measurement is not required, the equipment being provided with molecular sieves in sufficient quantity to give a dew point of ≤ 0°C (32°F) for an ambient temperature of 20°C (68°F), this applies for a unit filled to its nominal pressure for 2 or 3 months.

Presentation

Introduction

After installation of the bay, completion of all earth circuit and electrical connections, it is necessary to perform certain pre- commissioning inspections. These inspections should be performed with the apparatus ready to be commissioned (energized), in other words

- LV electrical circuits conforming, in voltage and type, with the low- voltage diagrams and rating plate of the apparatus.
- SF_6 or SF_6+CF_4 envelopes at rated SF_6 or SF_6+CF_4 pressure.

NOTE : Rated pressure, pressure of equipment after SF_6 or SF_6+CF_4 gas filling.

- Flexible connections linking circuit- breaker to busbar installed.

Caution

DURING OPERATIONS REQUIRED AS PART OF INSPECTION PROGRAMME PRIOR TO COMMISSIONING, ALL POSSIBLE SAFETY PRECAUTIONS SHOULD BE TAKEN TO PROTECT PERSONNEL WORKING ON THE EQUIPMENT.

In this module

This module contains the following checking inspections :

Important reminder

May we remind you that the Test Report prior to Commissioning
RES * M ***
Enclosed with this notice absolutely must be completed.

It must be filled in, dated, signed and sent back within two weeks following the tests to

Grid Solutions SAS
Service Contrats
21 rue Cyprian
69611 Villeurbanne
FRANCE

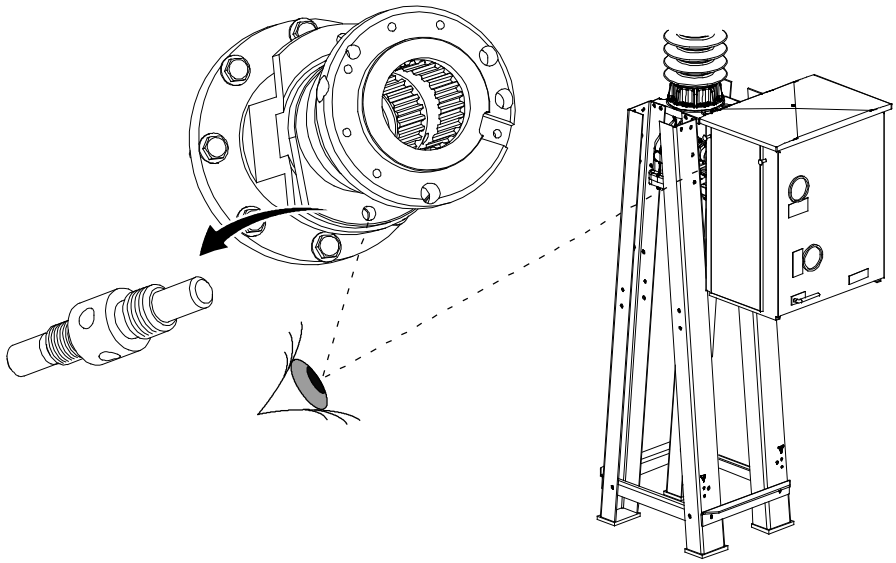
Failing a return of the report within the allowed deadline, the warranty for the switchgear cannot be taken into account and the customer's liability may be pursued.

* There may be several RES

Pole/operating device coupling sleeve

Checking

Check that the blocking tool **is not on** the flange of the sleeve. **Otherwise remove it imperatively**.



Orientation and identification of interrupting chambers

Inspection

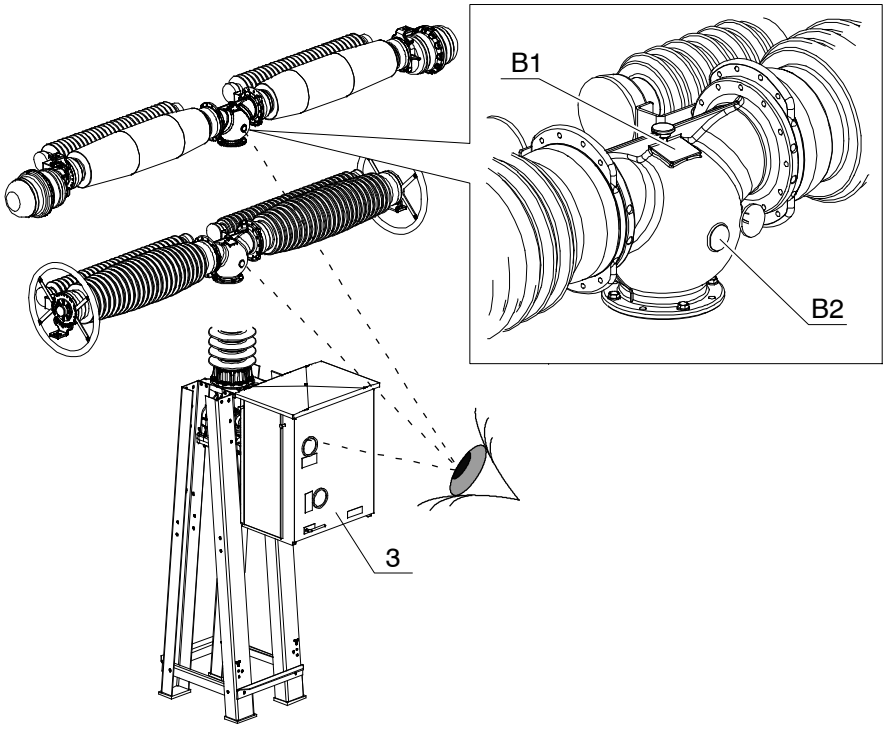
Check that the interruption chambers are disposed correctly, the bosses (B1) and (B2) must be situated on the same side as the operating mechanism (3).

Rule

When facing bosses (B1) and (B2) :

- chamber "**1**" is on the **left**,
- chamber "**2**" is on the **right**.

Diagram



SF_6 or SF_6+CF_4 gas

Reminder

SF_6 or SF_6+CF_4 envelopes are at rated pressure following the SF_6 or SF_6+CF_4 gas filling operation.

NOTE : You are reminded that the gas used to fill the pole must conform to the requirements laid out in IEC 60376.

Parameters

Take note of parameters below :

- site altitude, in meters,
- atmospheric pressure of site in kPa,
- site temperature in °C.

Checking SF_6 or SF_6+CF_4 gas

SF_6 or SF_6+CF_4 pressure values must obligatorily be read on the pressure inspection gauge (tooling). Pay no attention to indications given by the dial densimeter on the filling control block (where applicable) ; it is not accurate enough for this inspection.

See the module "**Calculation of the SF_6 or SF_6+CF_4 gas filling pressure to using the pressure gauge (tool)**".

The table below gives the steps of checking :

Step	Action	Comment
1	Measure SF_6 or SF_6+CF_4 gas pressure by means of the pressure inspection gauge (tooling)	Follow the instructions given in module "Filling with SF_6 or SF_6+CF_4 gas".
2	Correct pressure found.	Follow the instructions given in module "Calculation of the SF_6 or SF_6+CF_4 gas filling pressure to using the pressure gauge (tool)".

SF_6 or SF_6+CF_4 gas humidity level

The SF_6 or SF_6+CF_4 humidity level need not be known as the equipment is fitted with molecular sieves in sufficient numbers to give a dew point lower than, or equal to, 0°C at an ambient temperature of 20°C, for an apparatus filled to its rated pressure for 2 or 3 months.

Checking tightness of assemblages under SF_6 or SF_6+CF_4 pressure

Each on site assemblage of parts subjected to SF_6 or SF_6+CF_4 gas requires seals. The quality of these assemblages must be checked.
This inspection should be undertaken once all the filling and pressure control operations are finished.

Execute this checking according to instructions given in module "SF_6 or SF_6+CF_4 gas monitoring".

Operating device

Measurements	Note the supply voltage of motors on the operating mechanism terminals.
Inspection	Check that the following items are working correctly : - heating, - lighting (where applicable), - connections on terminals (no excessive tightening).

Finish and test operations

Finish

Check the general appearance of the apparatus and touch up paint if necessary before commissioning.

Test operations

- The connection of auxiliary circuits is sufficiently advanced to allow remote controls to be used.
- Perform 5 CLOSING - OPENING cycles electrically, by remote control.

**DUE TO THE RISK OF PROBLEMS DURING TRANSPORT,
BEFORE ANY INITIAL FILLING & COMMISSIONING OPERATIONS,
AFTER MAINTENANCE OR INTERVENTIONS,
THE CONDITION OF THE INSULATORS MUST BE VERIFIED VISUALLY.
ALL PERSONS PRESENT MUST TAKE SHELTER OR REMAIN AT
A MINIMUM SAFETY DISTANCE.**

**FOR CERAMIC DEVICES: APPROXIMATELY 50m
FOR COMPOSITES: THE HEIGHT OF THE DEVICE.**

NOTE : It should be noted that the filler gas used must conform to IEC 60376.

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21 rue Cyprian
69611 VILLEURBANNE Cedex
France

Service Qualité Quality Department *Servicio de calidad*	**RAPPORT D'ESSAIS AVANT MISE EN SERVICE** COMMISSIONING TEST REPORT *RELACIÓN DE ENSAYOS ANTES DE LA PUESTA EN SERVICIO* **Formulaire RES 310 M** **Page /** *Página :* 1/12

DISJONCTEUR À HEXAFLUORURE DE SOUFRE TYPE
SULFUR HEXAFLUORIDE CIRCUIT BREAKER TYPE _____
INTERRUPTOR DE HEXAFLUORURO D'AZUFRE TIPO

avec / with / *con* __ **commande(s) mécanique(s)** / mechanical control mechanism(s) / *organo(s) de maniobra mecànico* **type** / type / *tipo* _____

CLIENT / CUSTOMER / *CLIENTE* _____

Poste/Substation/Subestación _____

Référence client /Customer's reference/ *Referencia del cliente* _____

N° de série GRID SOLUTIONS
GRID SOLUTIONS Serial N° _____
N° de serie GRID SOLUTIONS

Norme
Standard _____
Norma

CARACTÉRISTIQUES/CHARACTERISTICS/*CARACTERISTICAS*

Tension/Voltage/ *Tensión* _____ kV **Fréquence** / Frequency / *Frecuencia* ____ Hz

Courant en service continu /Normal current/ *Corriente en servicio continuo* _____ A

Pouvoir de coupure en court-circuit/Short-circuit breaking current/
Poder de corte en corto circuito _____ kA

Pression relative du gaz SF6 à
Relative SF6 gas pressure at 20°C and 1013 hPa :___ Mpa
Presión relativa del gas SF6 à

Tension d'alimentation des circuits auxiliaires/Supply voltage of auxiliary circuits/
Tensión de alimentación de los circuitos auxiliares

Bobines / Coils / *Bobinas* ____ V(____)
Moteur / Motor / *Motor* ____ V(____)
Chauffage / Heater / *Calefación* ____ V(____)

Signalisation / Alarm / *Señalización* ____ V(____)
Circuit de commande / Control circuit / *Circuito de mando* ____ V(____)

Bobine à manque/ MU coil/Bobina falta tension ____

Cablage alimentations / Supply voltage wiring/

Alimentacion de los circuitos

Définitif/ definitive/permanente ☐
Temporaire/ Temporary/ Temporal ☐

Le matériel a subi les contrôles et essais avant mise en service, conformément au fascicule (contrôles avant mise en service).
The material was subjected to the inspections and tests prior to commissioning as required in sections (inspections commissioning).
El material fue sometido a las inspecciones y a los ensayos antes de la puesta en servicio como requerido en las secciones (inspecciones antes de la puesta en servicio).

Grid Solutions SAS
21 rue Cyprian
69611 VILLEURBANNE Cedex
France

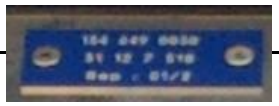
CONTRÔLES PRÉLIMINAIRES AVANT INSTALLATION
PRELIMINARY INSPECTIONS BEFORE INSTALLATION
INSPECCIÓNES PRELIMINARES ANTES DE LA INSTALACIÓN

Points de contrôle Verification at site *Verificación en el sitio*		**Phase/**Phase/ *Fase*		**Phase/**Phase/ *Fase*		**Phase/**Phase/ *Fase*	
		Pole A	**Pole A'**	**Pole B**	**Pole B'**	**Pole C**	**Pole C'**
État des emballages Condition of packings *Condición de los embalajes*	**Organe de manœuvre** Operating mechanism *Organo de maniobra*	_____		_____		_____	
	Élément de pôle Pole element *Elemento de polo*	_____		_____		_____	
Conditions de stockage Storage *Almacenamiento*	**Sous abri** Under shelter *Al abrigo*	_____		_____		_____	
	Correcte Satisfactory *Correcto*	_____		_____		_____	
	Défectueuse Unsactisfactory *Defectuoso*	_____		_____		_____	
Alimentation du chauffage des commandes Heating system supply of mechanisms *Alimentación del calamiento de los mandos*		_____		_____		_____	
Vérification de la pression de transport Checking of transport pressure *Comprobación de la presión de transporte*		_____		_____		_____	

Observations – Remarks – *Observaciones*

Grid Solutions SAS
21 rue Cyprian
69611 VILLEURBANNE Cedex
France

IDENTIFICATION
IDENTIFICATION
IDENTIFICACIÓN



Phase/Phase/*Fase*	**N° Tête** Head N° *N° Cabeza*	**N° Colonne** Column N° *N° Columna*	N° FK N° FK N° FK	**N° PID FK** PID FK N° *N° PID FK*
Pole A				
Pole A'				
Pole B				
Pole B'				
Pole C				
Pole C'				

VÉRIFICATION APRÈS MONTAGE
CHECKS AFTER ERECTION
COMPROBACIÓN DESPUÈS INSTALACIÓN

Schéma de câblage Wiring diagram _____ *Esquema de alambrado*	**Croquis de montage** Assembly drawing _____ *Dibujo de instalación*
Conformité croquis montage Conformity to instalation drawing _____ *Conformidad con dibujo de montaje*	**Conformité schéma filerie** Conformity to wiring diagram _____ *Conformidad con esquema de alambrado*
Vérification de l'assemblage Vérification of assembly _____ *Comprobación del montaje*	**Conformité signalisation optique** Confomity of optical indication _____ *Conformidad de la señalización optica*
Notice Instructions manual _____ *Manual de instrucciónes*	

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RELEVÉS DES COMPTEURS DE MANOEUVRES
NOTED DOWN THE COUNTER READINGS
ANOTAR NUMERO DE MANOBRIAS DE LOS CONTADORES

Relevé des compteurs de manœuvres pendant remplissage en SF6 et accouplement au pôle Noted down the counter readings during the filling up of SF6 and coupling of the pole Anotar número de maniobras de los contadores durante el llenado en SF6 y acoplamiento al polo	**Phase/**Phase/*Fase*		**Phase/**Phase/*Fase*		**Phase/**Phase/*Fase*	
	Pole A	**Pole A'**	**Pole B**	**Pole B'**	**Pole C**	**Pole C'**

OBSERVATIONS – REMARKS – *OBSERVACIONES*

MESURAGE DE LA RÉSISTANCE DU CIRCUIT PRINCIPAL
MEASUREMENT OF THE RESISTANCE OF THE MAIN CIRCUIT
MEDICIÓN DE LA RESISTENCIA DEL CIRCUITO PRINCIPAL

Non applicable/ Not applicable/No aplicable ☐

Test optionnel/Optional test/Ensayos opcional: Le mesurage de la résistance des circuits principaux est nécessaire que si les éléments de coupure ont été assembles sur site./Measurement of the résistance of the main circuit need only be made if interrupting units have been assembled on site./Medicion de la resitancia del circuito principal se debe hacer si elementos de corte se montan en sitio.

Appareil de mesure – test equipment – Herramienta de calibracion	**N° de série** – serial number – N° de serie	**Date de calibration** - Calibration date – Fecha de calibracion	**Observations** – Remark - Observaciones

Courant continu d'essai
Test direct current 100 A
Corriente continúa de ensayo

Température au moment des essais
Temperature at testing time _____ °C
Temperatura al momento de las pruebas

Type de chambre (référence de l'isolateur)
Chamber type (insulator reference) 105/4
Tipo de cámara (referencia del aislador)

Valeurs en
Values in
Valores en : μΩ

	Phase/Phase/*Fase*		**Phase/**Phase/*Fase*		**Phase/**Phase/*Fase*	
	Pole A	**Pole A'**	**Pole B**	**Pole B'**	**Pole C**	**Pole C'**
Prise/Terminal/Toma	_____	_____	_____	_____	_____	_____

Date de fin de montage Erection completion date _____ Fecha de conclusion *de montaje*	**Réalisé par** Performed by _____ *Realizado por*	**Pour le client** For the customer_____ *Para el cliente*

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Nota: **Validation de la fin de montage et signatures obligatoires avant de procéder aux tests suivants/** Erection completion and signatures mandatory before proceeding to further tests/ Validacion de montaje and firmas obligatorios antes de realizar los siguientes ensayos

VÉRIFICATION DE LA PRESSION DU GAZ
GAS PRESSURE CHECK
COMPROBACIÒN DE LA PRESIÒN DEL GAS

Appareil de mesure – test equipment – Herramienta de calibracion	**N° de série** – serial number – N° de serie	**Date de calibration** - Calibration date – Fecha de calibracion	**Observations** – Remark - Observaciones

Type de gaz / Gas type / Tipo de gas:

☐ **SF6 pur** / pure SF6 / *SF6 puro*

☐ **Mélange SF6/CF4 /** mix SF6/CF4 / *mezcla SF6/CF4* ⇒

_____ % SF6 _____ % CF4

Valeurs en pression absolue
Values in absolute pression
Valores en la presión absoluta

Caractéristiques/ Parameters/ Características :

Altitude
Altitude _____ m
Altitud

Pression barométrique
Barometric pressure _____ hPa
Presión barométrica

Température
Temperature _____ °C
Temperatura

La mesure en pression relative suivante est applicable pour le SF6 pur/ The following relative pressure measurement is applicable for pure SF6/El medido en presión relativa siguiente es aplicable por el puro SF6

Pression relative / relative pressure *Presión relativa* At 20°C and 1013 hPa	**Phase/**Phase/*Fase*		**Phase/**Phase/*Fase*		**Phase/**Phase/*Fase*	
	Pole A	**Pole A'**	**Pole B**	**Pole B'**	**Pole C**	**Pole C'**
Mesurage de la pression de remplissage Filling pressure measurement *Medición de la presión de llenado*	_____	_____	_____	_____	_____	_____
Valeur calculée équivalente en MPa Equivalent computed values in MPa *Valores computados equivalentes en MPa*	_____	_____	_____	_____	_____	_____

La mesure en pression absolue suivante est applicable pour le Mélange SF6/CF4
The following absolute pressure measurement is applicable for Mix SF6/CF4
El medido en presión absoluta siguiente es aplicable por la mezcla SF6/CF4

Pression absolue / Absolute pressure *Presión absoluta*	**Phase/**Phase/*Fase*		**Phase/**Phase/*Fase*		**Phase/**Phase/*Fase*	
	Pole A	**Pole A'**	**Pole B**	**Pole B'**	**Pole C**	**Pole C'**
Mesurage de la pression de remplissage en MPa absolue Filling pressure measurement in MPa absolute *Medición de la presión de llenado en MPa absolutos*	_____	_____	_____	_____	_____	_____
Valeur calculée équivalente en MPa Equivalent computed values in MPa *Valores computados equivalentes en MPa*	_____	_____	_____	_____	_____	_____

Observations – Remarks – *Observaciones*

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CONTRÔLE DES DENSIMÈTRES DE SURVEILLANCE DE LA PRESSION
GAS PRESSURE MONITORING DENSIMETERS INSPECTION
COMPROBACIÓN DE LOS DENSIMETROS DE VIGILANCIA DE LA PRESIÓN

(pression relative en MPa)
(relative pressure in MPa)
(pressión relativa en MPa)

Appareil de mesure – test equipment – Herramienta de calibracion	**N° de série** – serial number – N° de serie	**Date de calibration** - Calibration date – Fecha de calibracion	**Observations** – Remark - Observaciones

Pression barométrique
Barometric pressure ________ hPa
Presión barométrica

Température
Temperature ________ °C
Temperatura

	Phase/Phase/*Fase*			**Phase**/Phase/*Fase*			**Phase**/Phase/*Fase*		
Seuil *Threshold* *Umbral*	**P1 /Pre** *Complément remplissage/ Alarm / Umbral* 1	**P2/1 /Pae** *Baisse pression /Lockout/Umbral* 2	**P2/2 /Pme** *Baisse pression /Lockout/Umbral* 3	**P1 /Pre** *Complément remplissage/ Alarm / Umbral* 1	**P2/1 /Pae** *Baisse pression /Lockout/Umbral* 2	**P2/2 /Pme** *Baisse pression /Lockout/Umbral* 3	**P1 /Pre** *Complément remplissage/ Alarm / Umbral* 1	**P2/1 /Pae** *Baisse pression /Lockout/Umbral* 2	**P2/2 /Pme** *Baisse pression /Lockout/Umbral* 3
	Pole A			**Pole B**			**Pole C**		
Mesurage des pressions des seuils Thresholds pressures measurement *Medición de las presiones de los umbrales*	_____	_____	_____	_____	_____	_____	_____	_____	_____
Valeur calculée équivalente à 20°C 1013 hPa en MPa Equivalent computed values *Valores computados equivalentes*	_____	_____	_____	_____	_____	_____	_____	_____	_____
	Pole A'			**Pole B'**			**Pole C'**		
Mesurage des pressions des seuils Thresholds pressures measurement *Medición de las presiones de los umbrales*	_____	_____	_____	_____	_____	_____	_____	_____	_____
Valeur calculée équivalente à 20°C 1013 hPa en MPa Equivalent computed values *Valores computados equivalentes*	_____	_____	_____	_____	_____	_____	_____	_____	_____

Observations – Remarks – *Observaciones*

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VERIFICATION DE LA QUALITE DU GAZ
GAS QUALITY CHECK
COMPROBACIÓN DE LA CALIDAD DEL GAS

Test Non applicable/ Test Not applicable/ Ensayo No aplicable ☐

Test optionnel/Optional test/Ensayos opcional: Cette verification de qualitée du gaz n'est pas requise sur les équipments scéllés et lors de l'utilisation de gaz neuf venant d'une bouteille scélée/ These quality checks are not required on sealed equipment and new gas used from sealed bottles/ Los ensayos de calidad de gas no se debe hacer en equipos sellados y cuando se usó un gas nuevo de una botella sellada.

Appareil de mesure – test equipment – Herramienta de calibracion	**N° de série** – serial number – N° de serie	**Date de calibration** - Calibration date – Fecha de calibracion	**Observations** – Remark - Observaciones

	Phase/Phase/*Fase*		**Phase/**Phase/*Fase*		**Phase/**Phase/*Fase*	
	Pole A	**Pole A'**	**Pole B**	**Pole B'**	**Pole C**	**Pole C'**
Température/Temperature/Temperatura (°C)	———	———	———	———	———	———
Point de rosée/ Dew Point/Punto de roció (°C)	———	———	———	———	———	———
SO2 (PPM)	———	———	———	———	———	———
Puretée/Purity/Pureza SF6 %	———	———	———	———	———	———

Observations – Remarks – *Observaciones*

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ESSAIS DE FONCTIONNEMENT MÉCANIQUE
MECHANICAL OPERATING TESTS
ENSAYOS DE FUNCIONAMIENTO MECÁNICO

DURÉES DE FONCTIONNEMENT
OPERATING TIMES ms
TIEMPOS DE OPERACIÓN

Appareil de mesure – test equipment – Herramienta de calibracion	**N° de série** – serial number – N° de serie	**Date de calibration** - Calibration date – Fecha de calibracion	**Observations** – Remark - Observaciones

Tension d'alimentation sur le site.
Supply voltage on site ____ V(DC)
Tensión de alimentación sobre el sitio

		Phase/Phase/*Fase*		**Phase/**Phase/*Fase*		**Phase/**Phase/*Fase*	
		Pole A	**Pole A'**	**Pole B**	**Pole B'**	**Pole C**	**Pole C'**
Durée de fermeture Closing time *Tiempo de cierre*	**Direct bobine** Direct coil Directo bobina	____	____	____	____	____	____
	Avec relais With relay Con relé	____	____	____	____	____	____
Durée d'ouverture Voie 1 Opening time Way 1 *Tiempo de apertura Vía 1*	**Direct bobine** Direct coil Directo bobina	____	____	____	____	____	____
	Avec relais With relay Con relé	____	____	____	____	____	____
Durée d'ouverture Voie 2 Opening time Way 2 *Tiempo de apertura Vía 2*	**Direct bobine** Direct coil Directo bobina	____	____	____	____	____	____
	Avec relais With relay Con relé	____	____	____	____	____	____
Cycle de durée de fermeture-ouverture Close-open operating cycle : CO *Ciclo de maniobras de cierre-apertura*	C	____	____	____	____	____	____
	O	____	____	____	____	____	____
Durée de fermeture-ouverture Close-open time *Tiempo de cierre-apertura*	CO	____	____	____	____	____	____
Séquence de manœuvre Operating sequence : O-CO *Secuencia de maniobra*	O	____	____	____	____	____	____
	C	____	____	____	____	____	____
	O	____	____	____	____	____	____
Durée d'ouverture-fermeture Open-close time *Tiempo de apertura-cierre*	*OC*	____	____	____	____	____	____
Durée de fermeture Close-Open time *Tiempo de cierre-apertura*	CO	____	____	____	____	____	____

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MESURAGE DES ÉCARTS DE SIMULTANÉITÉ
COINCIDENCE DEVIATION MEASUREMENT
MEDICIÓN DE LAS DESVIATIONES DE SIMULTANEIDAD

ms

Entre éléments de coupure d'une même phase
Between breaking elements of a same phase
Entre elementos de interrupción de un mismo fase

	Phase/Phase/Fase		Phase/Phase/Fase		Phase/Phase/Fase	
	Pole A	**Pole A'**	**Pole B**	**Pole B'**	**Pole C**	**Pole C'**
Fermeture Closing *Cierre*	_____		_____		_____	
Ouverture voie 1 Opening way 1 *Apertura via 1*	_____		_____		_____	
Ouverture voie 2 Opening way 2 *Apertura via 2*	_____		_____		_____	

Entre phases
Between phases
Entre fases

Fermeture Closing *Cierre*	_____
Ouverture voie 1 Opening way 1 *Apertura via 1*	_____
Ouverture voie 2 Opening way 2 *Apertura via 2*	_____

MESURAGE DES DURÉES DE FONCTIONNEMENT DES CONTACTS AUXILIAIRES
MEASUREMENT OF AUXILIARY CONTACT OPERATING DURATIONS
MEDICIÓN DE DURACIONES DE FUNCIONAMIENTO DE LOS CONTACTOS AUXILIARES

ms

Type de contact Contact type *Tipo de contacto*	**Phase/**Phase/*Fase*		**Phase/**Phase/*Fase*		**Phase/**Phase/*Fase*	
	Pole A	**Pole A'**	**Pole B**	**Pole B'**	**Pole C**	**Pole C'**
Manœuvre de fermeture Closing operation *Maniobra de cierre* — 52b	_____	_____	_____	_____	_____	_____
52a	_____	_____	_____	_____	_____	_____
	Pole A	**Pole A'**	**Pole B**	**Pole B'**	**Pole C**	**Pole C'**
Manœuvre d'ouverture Opening operation *Maniobra de apertura* — 52b	_____	_____	_____	_____	_____	_____
52a	_____	_____	_____	_____	_____	_____

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MESURAGE DE LA RÉSISTANCE D'INSERTION
MEASUREMENT OF THE INSERTION RESISTOR
MEDICIÓN DE LA RESISTENCIA DE INSERCION

Test Non applicable/ Test Not applicable/ Ensayo No aplicable ☐

Test optionnel/Optional test/Ensayos opcional: Applicable seulement si présence de résistance d'insertion/ Applicable only if insertion resistor is present/Applicable solamente si presencia de Resistencia de insercion

Appareil de mesure – test equipment – Herramienta de calibracion	**N° de série** – serial number – N° de serie	**Date de calibration** - Calibration date – Fecha de calibracion	**Observations** – Remark - Observaciones

Valeur en
Values in Ω
Valores en

Phase/Phase/*Fase*		**Phase/**Phase/*Fase*		**Phase/**Phase/*Fase*	
Pole A	**Pole A'**	**Pole B**	**Pole B'**	**Pole C**	**Pole C'**
____	____	____	____	____	____

DURÉE D'INSERTION DE LA RÉSISTANCE
RESISTOR INSERTION TIME ms
TIEMPO DE INSERCIÓN DE LA RESISTENCIA

Test Non applicable/ Test Not applicable/ Ensayo No aplicable ☐

Test optionnel/Optional test/Ensayos opcional: Applicable seulement si presence de résistance d'insertion/ Applicable only if insertion resistor is present/Applicable solamente si presencia de Resistencia de insercion

Durée d'insertion de la résistance
Resistor insertion time
Tiempo de inserción de la resistencia

Phase/Phase/*Fase*		**Phase/**Phase/*Fase*		**Phase/**Phase/*Fase*	
Pole A	**Pole A'**	**Pole B**	**Pole B'**	**Pole C**	**Pole C'**
____	____	____	____	____	____

MESURAGE DES DURÉES DE RÉARMEMENT DE L'ORGANE DE COMMANDE
MEASUREMENT OF OPERATING MECHANISM RECLOSING DURATIONS s
MEDICIÓN DE DURACIONES DE REARME DEL ORGANO DE MANIOBRA

Durée de réarmement après un C
Reclosing duration after one C
Duración de rearme despues de una C

Phase/Phase/*Fase*		**Phase/**Phase/*Fase*		**Phase/**Phase/*Fase*	
Pole A	**Pole A'**	**Pole B**	**Pole B'**	**Pole C**	**Pole C'**
____	____	____	____	____	____

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VÉRIFICATION DIVERSES
VARIOUS CHECKINGS
COMPROBACIÓNES DIVERSAS

Dispositif d'anti-pompage Anti-pumping device *Dispositivo de anti-bombeo* ☐	**Ouverture de secours** Emergency opening Apertura de emergencia ☐
Fermeture locale mécanique/électrique Local closing mechanical/electrical *Cierre local mecánico/electrico* ☐	**Ouverture locale mécanique/électrique** Local opening mechanical/electrical *Apertura local mecánico/electrico* ☐
Fermeture à distance Remote closing *Cierre à distancia* ☐	**Ouverture à distance** Remote opening *Apertura à distancia* ☐
Chauffage thermostaté Thermostated heating *Calefacción con termostats* ☐	**Signalisation défaut SF6 1er seuil** SF6 fault indication – 1st threshold *Señalisación de falta de SF6 1o umbral* ☐
Chauffage permanent Permanent heating *Calefacción permanente* ☐	**Signalisation défaut SF6 2nd seuil** SF6 fault indication – 2nd threshold *Señalisación de falta de SF6 2o umbral* ☐
Serrage des bornes BT Tightening of LV terminals *Apriete de las terminales BT* ☐	**Peinture et protection contre la corrosion.** Painting and protection against corrosion *Pintura y protección contra la corrosion* ☐
Séquence de fonctionnement Operating sequence *Secuencia de maniobra* ☐	**Contrôle de l'étanchéité SF6 des assemblages** SF6 tightness testing of assemblies *Comprobación de estanqueidad SF6 de los montajes* ☐

RELEVÉS DES COMPTEURS DE MANOEUVRES
NOTED DOWN THE COUNTER READINGS
ANOTAR NUMERO DE MANOBRIAS DE LOS CONTADORES

Relevé des compteurs de manœuvres
Reading of operating counters
Lectura de contadores de maniobra

Phase/Phase/*Fase*		**Phase/**Phase/*Fase*		**Phase/**Phase/*Fase*	
Pole A	**Pole A'**	**Pole B**	**Pole B'**	**Pole C**	**Pole C'**
____	____	____	____	____	____

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ESSAIS DE TENUE **À LA TENSION DES CIRCUITS AUXILIAIRES ET DE COMMANDE**
VOLTAGE WITHSTAND TESTS ON AUXILIARY AND CONTROL CIRCUITS
ENSAYOS DE TENSIÓN SOPORTADA DE LOS CIRCUITOS AUXLIARES Y DE MANDO

Test Non applicable/ Test Not applicable/ Ensayo No aplicable ☒

Test réalisé en usine/Test performed in factory/Ensayos realizados en fabrica

INDICATION/INDICATION/INDICACION

Dans le cas des appareils en T un minimum de 50 manœuvres doit être réalisées sur site.
D'après norme CEI 62271-100 pour validation des accouplements réalisés sur site.
For the T shaped breakers a minimum of 50 operations has to be done on site.
According to IEC 62271-100 standard to validate coupling made on site.
En el caso de interruptores en T, se debe llevar a cabo un mínimo de 50 maniobras en la obra.
de acuerdo con la norma IEC 62271-110 para validación de los acoplamientos realizados en la obra.

OBSERVATIONS – REMARKS – *OBSERVACIONES*

☐ **Grid Solutions**

☐ **Client** / Customer / *Cliente*

Date des essais de mise en service Commissioning date _____ *Fecha de puebras para puesta en servicio*	**Réalisés par** Performed by _____ *Realizado por*	**Pour le client** For the customer_____ *Para el cliente*

CA 103 171-3	CRITERES D'ACCEPTATION

DISJONCTEUR GL 315(D) - 316(D) - 317(D) A COMMANDE MECANIQUE FK3.4 - MONTAGE SITE
CIRCUIT BREAKER TYPE GL 315 (D) – 316 (D) – 317 (D)
WITH SPRING MECHANISM FK 3.4 SITE ERECTION

SERVICES EMETTEURS :

PARENTS

PROCESSUS PARENT : ANIMATION QUALITE — REF. **Q1**

INSTRUCTION OPERATIONNELLE : QG3 91 000

TITRE : PROCESSUS COORDINATION QUALITE

IOG ASSOCIEE(S)

REF.	TITRE
CA 103 000	liste des critères d'acceptation disponible sur les performances GL

DOCUMENTS ASSOCIES

* Document informatique géré par le logiciel utilisé

SUIVI DES MODIFICATIONS

DATE	INDICE	OBJET	AUTEUR
20/01/2017	009	Logo GE	Thierry MALATIER
05/04/2011	008	passage au logo alstom et mise en conformité de la première page	Thierry MALATIER
16/05/2008	007	modification de la durée d'insertion	Thierry MALATIER

VALIDATION

	nom	Fonction
Rédacteur	**Thierry MALATIER**	SQM
Approbateur	**Cyril GREGOIRE**	ARC
Vérificateur	**Philippe DUCRET**	ST

VALIDITÉ

VALIDITY

DISJONCTEUR	: GL 315 (D) / GL 316 (D) / GL317(D)
CIRCUIT BREAKER	
PRESSION SF6	: Pre = 0,75 to 1,0 MPa (abs.)
COMMANDE	: MÉCANIQUE FK 3.4
MECHANISM	*: SPRING MECHANISM*

DÉFINITION DES DURÉES

DURÉE DE FERMETURE : Intervalle de temps entre l'instant de mise sous tension du circuit de fermeture et l'instant où les contacts se touchent dans tous les pôles.

DURÉE D'OUVERTURE : Intervalle de temps entre l'instant de mise sous tension du déclencheur et l'instant de la séparation des contacts d'arc sur tous les pôles (ou des contacts du simulateur commandés par la charge fictive).

DURÉE D'OUVERTURE-FERMETURE : Intervalle de temps entre l'instant de séparation des contacts dans tous les pôles, et l'instant où les contacts se touchent dans le premier pôle pendant une manœuvre de refermeture (refermeture : l'appareil est refermé automatiquement après un intervalle de temps prédéterminé - 195 ms-).

DURÉE DE FERMETURE-OUVERTURE : Intervalle de temps entre l'instant où les contacts se touchent dans le premier pôle pendant une manœuvre de fermeture, et l'instant où les contacts d'arc sont séparés dans tous les pôles pendant la manœuvre d'ouverture qui lui fait suite (le déclencheur d'ouverture est mis sous tension au moment où les contacts se touchent dans le premier pôle pendant la fermeture).

ÉCART DE SIMULTANÉITÉ ENTRE CHAMBRES D'UN MÊME PÔLE : Pour la même manœuvre différence de temps maximale entre les instants où les contacts des chambres se touchent à la fermeture et différence de temps maximale entre les instants de séparation des contacts des chambres à l'ouverture.

ÉCART DE SIMULTANÉITÉ ENTRE PÔLES :
Pour la même manœuvre, différence de temps maximale entre les instants où les contacts de pôles se touchent à la fermeture et différence de temps maximale entre les instants de séparation des contacts des pôles à l'ouverture. Dans le cas de pôle multi-chambres, le pôle est considéré fermé quand la dernière chambre est fermée et il est considéré ouvert quand la première chambre est ouverte.

DUREE D'INSERTION DE LA RESISTANCE : sur une manœuvre de fermeture, intervalle de temps entre l'entrée en contact des contacts d'arc et l'entrée en contact des contacts de l'inséreur (résistance court-circuitée).

Remarque : la durée de fermeture au sens de la norme CEI et pour les appareils avec résistance d'insertion correspond à la somme de la durée de fermeture et de la durée d'insertion telles que définies précédemment.

TIME DEFINITION

***CLOSING TIME** : Interval of time between energizing the closing circuit and the instant when the contacts touch in all poles.*

***OPENING TIME** : Interval of time between the instant of energizing the opening release and the instant when the arcing contacts have separated in all poles (or simulator contacts controled by the dummy load).*

***OPEN-CLOSE TIME** : Interval of time between the instant when the arcing contacts have separated in all poles and the instant when the contacts touch in the first pôle during a reclosing operation (reclosing : the equipment is automatically reclosed after a predetermined interval of time -195 ms-).*

***CLOSE OPEN TIME** : Interval of time between the instant when the contacts touch in the first pole during a closing operation, and the instant when the arcing contacts have separated in all poles during the subsequent opening operation (the opening release is energizing when the contacts touch in the first pole during the closing operation).*

***DEVIATION BETWEEN CHAMBERS OF THE SAME POLE** : For the same operation maximum deviation between the instants when the chambers contacts touch during the closing operation and maximum deviation between the instants when the chambers contacts are separated during the opening operation.*

***DEVIATION BETWEEN POLES** : For the same operation maximum deviation between the instants when the poles contacts touch during the closing operation and maximum deviation between the instants when the pales contacts are separated during the opening operation.*
In the case of multichambers poles, the pole is considered closed when the last chamber is closed and it is considered opened when the first chamber is opened.

***RESISTOR INSERTION TIME** : during a closing operation, interval of time between the instant when the arcing contacts are touching and the instant when the inseror contacts are touching (resistance short-circuited).*

Note : the closing time according the IEC standard for circuit-breakers with switching resistors is equal to the sum of *the closing time* and *resistor insertion time* as défined above.

DURÉES DE FONCTIONNEMENT **(en ms à tension assignée)**
MECHANICAL OPERATING TIMES ***(in ms at rated voltage)***

DURÉES DES CHAMBRES
TIMINGS OF CHAMBERS

MANOEUVRE ***OPERATION***	**Minimum**	**Maximum**
Fermeture - *Closing*	92	112
Ouverture O1/O2 - *Opening O1/O2*	18	26
Fermeture de CO - *Closing of CO*	92	112
Ouverture de CO - *Opening of CO*	40	56
CO	45	70
1ère Ouverture de O-CO - *1st Opening of O-CO*	18	26
Fermeture de O-CO - *Closing of O-CO*	92	112
2ème Ouverture de O-CO - *2nd Opening of O-CO*	40	56
Insertion de la résistance à la fermeture – *Resistor insertion on closing*	5.5	9,0

DURÉES DES RELAIS
TIMINGS OF RELAY

Pour relais Allen Bradley *For Allen Bradley relay*	Enclenchement *Closing*		Déclenchement *Opening*	
	Mini	Maxi	Mini	Maxi
Durée en ms à U assignée *Time relais at nominal voltage*	16	28	16	28

Pour relais FINDER *For FINDER relay*	Enclenchement *Closing*		Déclenchement *Opening*	
	Mini	Maxi	Mini	Maxi
Durée en ms à U assignée *Time relais at nominal voltage*	7	13	7	13

DURÉES DES CONTACTS AUXILIAIRES
TIMINGS OF AUXILIARY CONTACTS

TYPE DE CONTACT - MANOEUVRE ***TYPE CONTACT - OPERATION***	**Minimum**	**Maximum**
Type a / Fermeture de CO - *Closing of CO*	98	128
Type b / Fermeture de CO - *Closing of CO*	75	105
Type a / Ouverture de CO - *Opening of CO*	26	56
Type b / Ouverture de CO - *Opening of CO*	37	67
Type a / 1ère Ouverture de O-CO - *1st Opening of O-CO*	9	22
Type b / 1ère Ouverture de O-CO - *1st Opening of O-CO*	20	33
Type a / Fermeture de O-CO - *Closing of O-CO*	98	128
Type b / Fermeture de O-CO - *Closing of O-CO*	75	105
Type a / 2ème Ouverture de O-CO - *2nd Opening of O-CO*	26	56
Type b / 2ème Ouverture de O-CO - *2nd Opening of O-CO*	37	67

ÉCART ENTRE CHAMBRES D'UN MÊME POLE (en ms à tension assignée)
DEVIATIONS BETWEEN CHAMBERS OF THE SAME POLE (in ms at rated voltage)

MANOEUVRE *OPERATION*	Maximum
Fermeture - *Closing*	2
Ouverture - *Opening*	2

ÉCART ENTRE POLES (en ms à tension assignée)
DEVIATIONS BETWEEN POLES (in ms at rated voltage)

MANOEUVRE *OPERATION*	Maximum
Fermeture - *Closing*	5
Ouverture - *Opening*	3

DURÉES DE REARME (en s à tension assignée)
CHARGING TIME (in s at rated voltage)

Tension Moteur en V *Motor Voltage in V*	Maximum
toutes *all*	10

RESISTANCE DE CONTACT DU CIRCUIT PRINCIPAL (sans prise de courant)
(en μΩ sous courant continu de 100 A)
MAIN CIRCUIT RESISTANCE (without HV terminal)
(in μΩ with a 100 A direct courrent)

Type de chambre *Type of chamber*	Maximum
105/ 4	90
105/ 5	93
105/ 7	95
105/ 11	93
105/12	95
105/13	93

Presentation

Introduction

GL circuit- breakers use pure SF_6 gas as an arc quenching medium (or a SF_6+CF_4 gas mixture) and require only a reduced amount of maintenance.

In this module

This module contains the following topics:

Maintenance plan

Maintenance frequency

Under normal operating conditions, the maintenance plan may be defined as follows:

Type of examination	Frequency	Comment
Maintenance visits **(M1)**	Once or twice a year	**It is advisable to perform at least 2 CO duty cycles per year, when apparatus are scarcely used, in order to check that the circuit- breaker and associated control circuits are working properly.**
Inspections **(M2)**	Every five years	This necessitates circuit- breaker shutdown. It is not necessary, however to dismantle interrupting chambers and other sub- assemblies.
Overhaul **(M4)**	Perform when one of the following criteria is reached: • operating life time ≥ 20 years • number of mechanical cycles ≥ 3,000 • electric wear limit	However, it is recommended to proceed with inspection of the pole or circuit- breaker used the most, then to adapt the maintenance programme for the other breakers depending on the results observed.

Maintenance operations

Guide

The table below is a guide of the operations to be carried out at each maintenance stage:

(M1) MAINTENANCE VISITS (1 or 2 times a year) **(M2) INSPECTION** (every 5 years) **(M4) OVERHAUL** (OPERATING TIME: 20 years) **(M4) OVERHAUL** (MECHANICAL OPERATIONS: 3 000 cycles) **(M4) OVERHAUL** (ELECTRICAL WEAR: see "Electrical wear limits")					
■	■	■	■	■	Operation counter reading.
■	■	■			Overall inspection: appearance (corrosion, paintwork, signs of overheating).
■	■	■	■	■	Check operation of permanent heating. Check condition of air vents.
■	■	■			If the circuit- breaker is fitted with an SF_6 dial densimeter or a pressure gauge, check SF_6 pressure (or SF_6+CF_4 gas mixture).
■					It is advisable to perform at least 2 CO duty cycles per year, **when apparatus are scarcely used**, in order to check that circuit- breaker and associated control circuits are working properly.
	■	■			Check SF_6 densimeter thresholds. Then adjust pressure to its rated value.
	■	■	■		Check tightening of parts not subjected to pressure (frame - deck - cubicle).
■	■	■	■		Check tightening of low voltage terminals (***** 6 months after commissioning).
	■	■	■		Check relay operation.
		■			Change door seal, side panels seal and roof seal.
	■	■	■	■	Measure operating times for poles and auxiliary contacts.
	■	■	■	■	Carry out operations at recommended duties and rated voltage.
			■	■	Change (or recondition) interrupting chambers.
			■		Check that the damper piston for the opening of the control presents no oil leak.

Continued on next page.

Maintenance operations, continued

Guide

The table below is a guide of the operations to be carried out at each maintenance stage:

(M1) - MAINTENANCE VISITS (1 or 2 times a year) **(M2) - INSPECTION** (every 5 years) **(M4) - OVERHAUL** (OPERATING TIME: 20 years) **(M4) - OVERHAUL** (MECHANICAL OPERATIONS: 3 000 cycles) **(M4) - OVERHAUL** (ELECTRICAL WEAR: see "Electrical wear limits")					
☆					Monitoring devices and/or Point on Wave relays: Check for the presence of alarms on the front panel. Carry out a download from the equipment and save the archive & config. files to a local hard drive for analysis.
	☆	☆	☆	☆	Monitoring devices and/or Point on Wave relays: Check for the presence of alarms on the front panel. Carry out a download from the equipment and save the archive & config. files to a local hard drive for analysis.
	☆	☆	☆	☆	Point on Wave relays: update the time taken for breaking chamber and auxiliary contact operations (time shift), then reset the adaptive control.

☆ Compulsory for monitoring device and/or Point on Wave relays
Conditional maintenance for Point on Wave relays:
Caution: When using with a shunt, if the number of operations per day is greater than or equal to 1, carry out the operation every two years:
Update the time taken for breaking chamber and auxiliary contact operations (time shift), then reset the adaptive control.

Detail of maintenance operations

Caution

DURING MAINTENANCE OPERATIONS ALL POSSIBLE SAFETY PRECAUTIONS SHOULD BE TAKEN TO PROTECT PERSONNEL WORKING ON THE EQUIPMENT.
(Disconnect CB from HV system, remove LV supplies etc.)

General condition of the apparatus

The apparatus should be subjected to visual inspection. If patches of corrosion are found begin reconditioning of the affected parts.
The table below gives the process respecting surface finish and protection:

Support	Inspection	Action
Galvanized steel	Oxidized parts	• Thorough brushing of oxidized parts. • Degreasing with solvent. • Application of a coat of zinc paint.
Painted galvanized steel or painted aluminium alloy	Light scratches	• Thorough degreasing with solvent. • Application of a coat of lacquer using a brush.
	Deep scratches or flaking	• Scouring of paint surface with emery paper 400. • Thorough degreasing with solvent. • Application of a coat of primer, then drying for 24 h. • Application of a coat of polyurethane lacquer using a brush.

Products used:

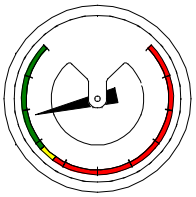
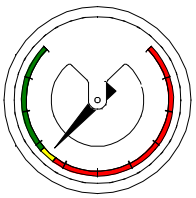
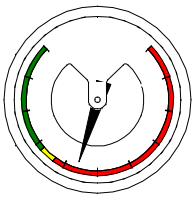
- RUMCOAT EEVA primer by DERIVERY ref. 333103.
- Polyurethane lacquer 780 by DERIVERY, ref. depending on color of equipment.

Continued on next page.

Detail of maintenance operations, continued

SF_6 pressure gas

For a circuit- breaker equipped with a ”dial- type” SF_6 gas densimeter, check the position of the needle.

Needle position	Colored area	Direction
	GREEN	None
	YELLOW	Perform a topping- up operation.
	 RED	Abnormally low density, find the origin of the leak and contact **Grid Solutions After- sales Service**.

NOTE: If the intersection is in either the yellow or red zone, without any particular indication from the electrical contact densimeter, verify the concordance of different information sources to find the defective element and then replace it.

Operating device

Air- vents should be clean, free of dust and unobstructed. If necessary clean using a solvent.
Make sure that the permanent resistors are working properly by checking that these give off heat and that there are no overheating marks (a zone notorious for this).
For thermally controlled resistors, check that energizing and de- energizing takes place correctly at voltage supply terminals by means of a thermostat (recommended thermostat temperature: +5°C.
If necessary, change resistors found to be defective.
For the opening damper, if any leak is observed, please contact
Grid Solutions, After- Sales Department, to proceed with any changes

Operation counter

Read indications given by the counter(s) and note these on the inspection sheet ”Maintenance visits”.
The number of circuit- breaker operations recorded influences future maintenance operations.

Continued on next page.

Detail of maintenance operations, continued

Electrical densimeter thresholds	Check the electrical contact SF_6 densimeter thresholds. If the values found are outside required tolerances replace the densimeter.
Tightening of mountings	Check and adjust, with a torque wrench, the tightening torques of screws on sub- assemblies not subjected to gas pressure. The tightening torques are given in paragraph "Tightening torques".
Relay operation	Check relay operation by executing the following circuit- breaker sequences: - closing lock- out, - automatic opening (where applicable), - anti- pumping.
Tightening LV terminals	With the electric cubicle out of service, check that the connectors and tips of conductors are tightened correctly and check the torque of connection mountings. Tool used: 4 mm diameter screw driver, for terminals of the "Entrelec" type (for example). **CAUTION: SCREWS ON TERMINALS MUST NOT BE OVER- TIGHTENED.**
Insulating envelopes	Check the condition of insulating envelopes, these should be free from impact marks, splintering, cracks, dust deposits, pollution etc... If necessary, clean these using a dry rag. If anomalies are found contact: Grid Solutions, After- sales Service in order to change the defective parts.
Interrupting chambers	Check the condition of interrupting chambers. This operation necessitates complete dismantling of the interrupting chamber to gain access to the elements to be inspected and should obligatorily be performed by Grid Solutions, After- sales Service - to be contacted before all operations of this kind, preferably at the maintenance planning stage.

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Electrical wear limits

Estimation

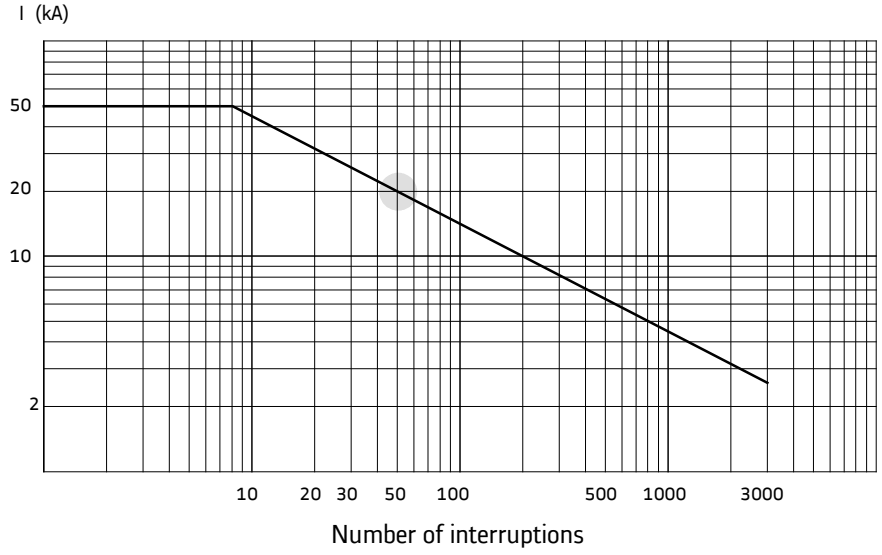
Electrical wear can be determined by means of the curve below. This curve corresponds with the formula:

$\Sigma NI^2 = 20{,}000\ kA^2$ (*)
N = number of interruptions on value I.

Example: it is possible to perform 50 interruptions on a current of 20 kA.

(*) Normal guarantee. In certain special operation conditions, other values may be guaranteed.

Diagram



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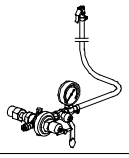
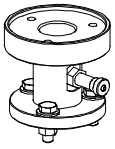
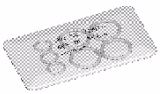
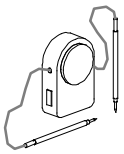
Presentation

Necessary tools

List of the Grid Solutions tools necessary for the operation:

Mark	Diagram	Designation	Reference	Number
(11)		Gauge 0...0,765 MPa	HBL- 02842117 + HB0005499001	1
		Gauge 0...1 MPa	HBL- 02842118 + HB0005499001	
(17)		Pressure reducer 0...1 MPa	HBL- 02557392 + HBLN55161601	1
(5)		Connection valve block	HB0005649001	1
		Set of seals	HB0000270121	1
		Test lamp	HBL- 02861501	1

In this module

This module contains the following topics:

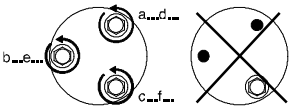
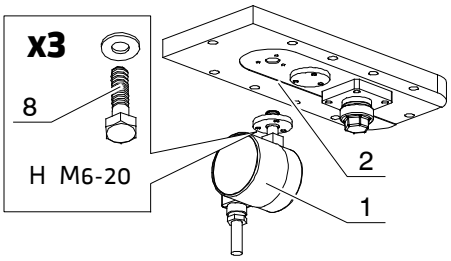
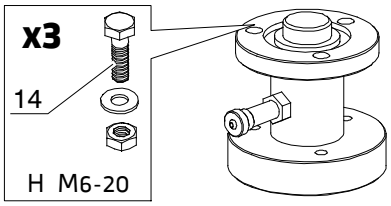
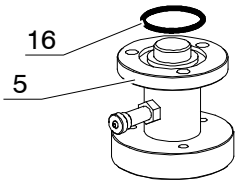
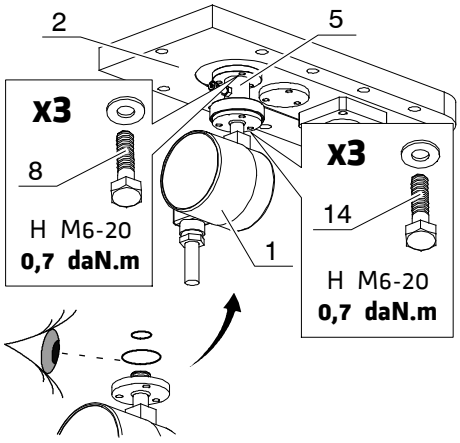
Preparing the densimeter

Introduction

The densimeter is located at the base of the pole of the circuit- breaker, and is joined to the SF_6 (or SF_6+CF_4) gas volume of the circuit- breaker.
To realize the electrical contact densimeter threshold inspection, it is imperative to isolate the densimeter volume from the pole SF_6 (or SF_6+CF_4) gas volume.

Process

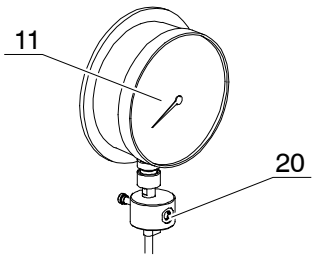
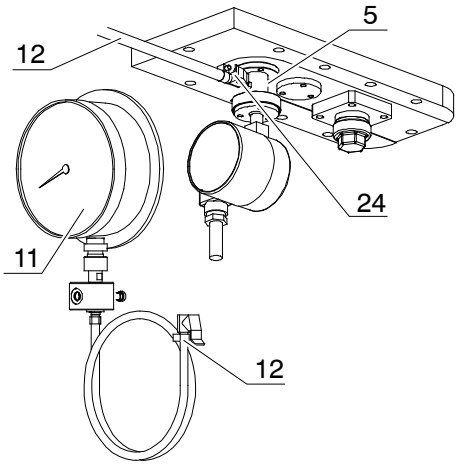
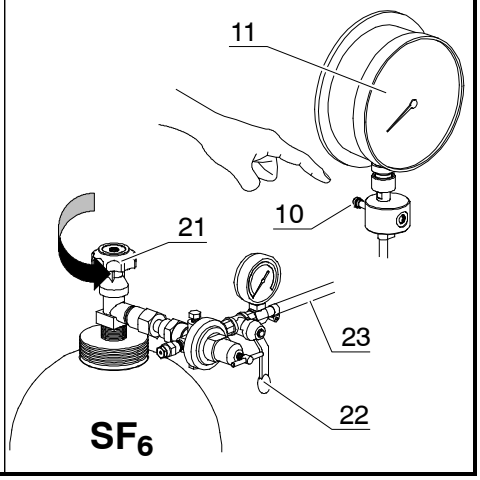
The table below gives the process to preparing the densimeter:

Step	Action	Diagram
1	Remove the densimeter (1), held in place by screws (8), on the housing cover (2) of the circuit- breaker. 	
2	Remove the screws (14).	
3	Install the seal (16) on the connection valve block (5).	
4	Install the connection valve block (5) on the housing cover (2), of the circuit- breaker, using screws (8).	
5	Install the densimeter (1) on the connection valve block (5) using screws (14). **NOTE**: Before installing, check the presence of seals on the densimeter.	

Linking the densimeter on the control tool

Process

The table below gives the process to link the densimeter on the control tool:

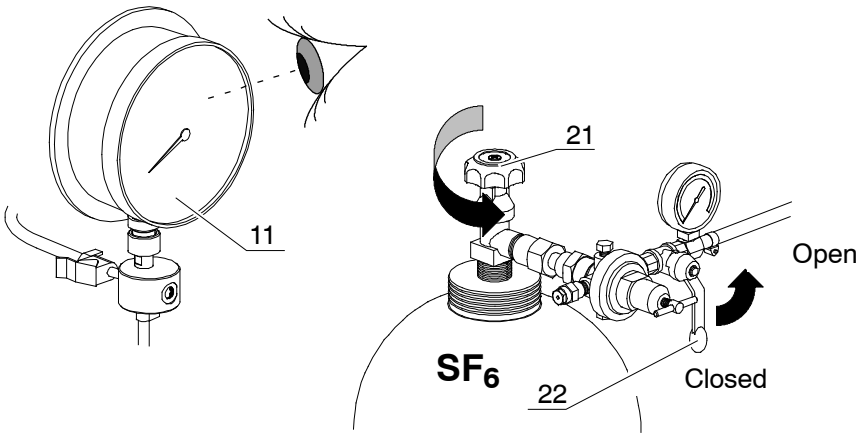
Step	Action	Diagram
1	Check that the "REGULATION" screw (20) - of the gauge (11) - is in "valve closed" position (screwed).	
2	Connect the pipe (12) of the gauge (11) on the valve (24) of the connection valve block (5).	
3	Briefly open the SF_6 gas bottle tap (21) and the cock (22) of the pressure reducer to eliminate any air inside the pipe (23) (approx. 20 s at low flow- rate). Connect the pipe (23) on the valve (10) of the gauge (11).	

Densimeter threshold inspection

SF_6 gas pressure adjustment

The table below gives the steps of SF_6 gas pressure adjustment of the connection valve block (5):

Step	Action	Comment
1	Open the SF_6 gas bottle tap (21) and adjust gas output by acting on the cock (22) of the pressure reducer (reduced flow rate). Close the tap (21) from time to time to check pressure on the gauge (11).	See the module **"Calculation of the SF_6 gas filling pressure to using the pressure gauge (tool)".**
2	Start filling again until the required pressure is reached.	
3	Close in this order : the tap (21), then the cock (22).	

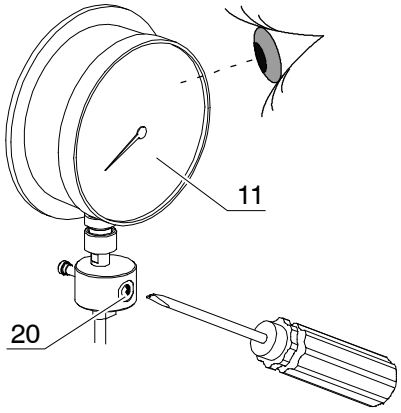


Continued on next page.

Densimeter threshold inspection, continued

Testing

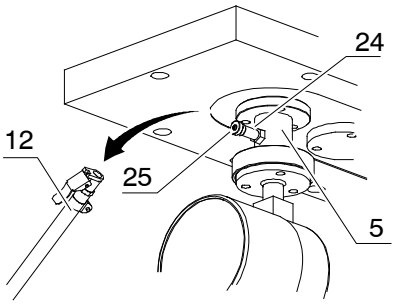
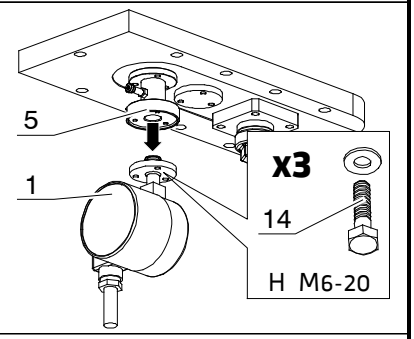
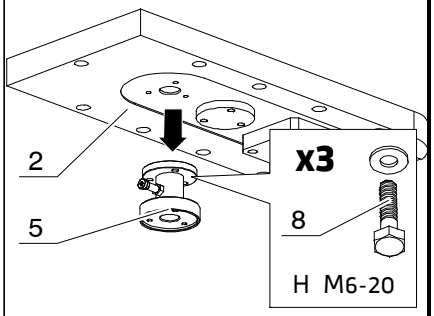
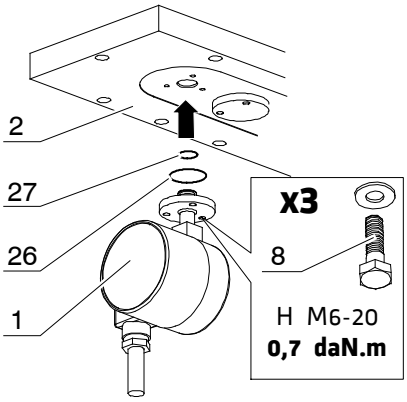
The table below gives the steps of densimeter testing:

Step	Action	Comment
1	Connect a test lamp to the "Alarm pressure for the insulation" p_{ae} densimeter threshold.	Connection to the terminal block of the operating mechanism in accordance with the electrical diagram.
2	Calculate the effective pressure at which the **"Alarm pressure for the insulation"** p_{ae} contact switches over - corrected in keeping with temperature and local atmospheric pressure.	Value p_{ae} : see technical characteristics). See the module **"Calculation of the SF_6 gas filling pressure to using the pressure gauge (tool)".**
3	• Create a leak by unscrewing the "REGULATION" screw (20) - of the gauge (11) -, making sure that the contact switches over at the previously calculated value. • Proceed in the same way to check the contact of "Minimal pressure for the insulation" p_{me}.	 If one of the thresholds does not comply with the specified value, replace the densimeter.

Replacing the densimeter

Process

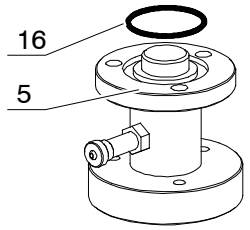
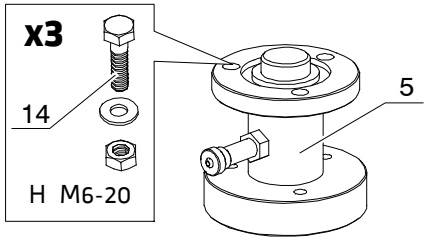
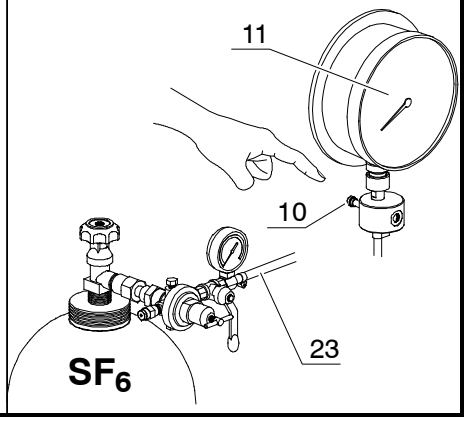
The table below gives the process to replace the densimeter:

Step	Action	Diagram
1	Disconnect the pipe (12) from the valve (24) of the connection valve block (5). Screw the valve- cap (25) on the valve (24).	
2	Remove the densimeter (1), held in place by screws (14), on the connection valve block (5).	
3	Remove the connection valve block (5), held in place by screws (8), on the housing cover (2) of the circuit-breaker. **NOTE**: If the connection valve block (5) is any more used, see the next paragraph "Putting away the control tool".	
4	Install new seals (26) and (27) on the densimeter (1), referring to **"Preparing and installing static seals"** in **"Erection general procedures".** Install the densimeter (1) on the housing cover (2), of the circuit- breaker, using screws (8).	

Putting away the control tool

Process

The table below gives the steps of putting away the control tool:

Step	Action	Diagram
1	Take precautions to remove the seal (16) from the connection valve block (5) and put it away into the “SET OF SEALS” box of the densimeter threshold inspection case.	
2	Install screws (14) on the connection valve block (5) Put away the connection valve block (5) into the case.	
3	Disconnect the pipe (23) from the valve (10) of the gauge (11).	

Special case with two densimeters

Instructions

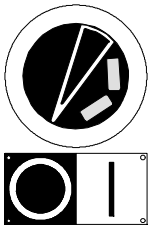
If the apparatus is equipped with a second densimeter, repeat the operations on pages two to seven.

Presentation

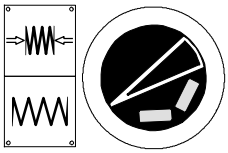
Warning

BEFORE ALL INTERVENTION ON THE OPERATING DEVICE, MAKE SURE THAT THE CIRCUIT-BREAKER IS OPEN AND ITS POSITION INDICATOR IS IN THE POSITION BELOW.

Circuit-breaker **Open**



Closing spring **Released**



NEVER WORK THE OPERATING DEVICE WHEN THIS IS NOT COUPLED TO THE CIRCUIT-BREAKER.

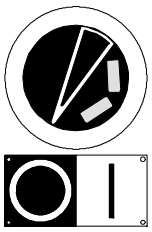
In this module

This module contains the following topics :

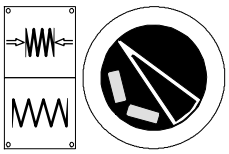
Positions of optical signalization

“A” position

Circuit- breaker **Open**

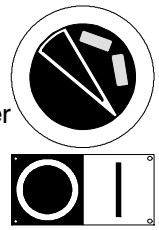


Closing spring **Loaded**

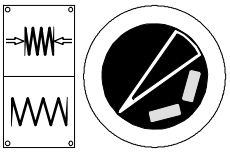


“B” position

Circuit- breaker **Closed**

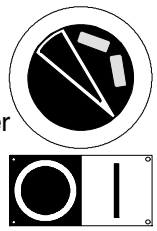


Closing spring **Released**

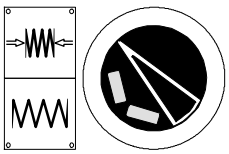


“C” position

Circuit- breaker **Closed**

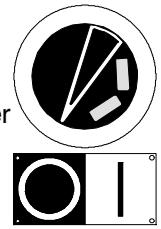


Closing spring **Loaded**

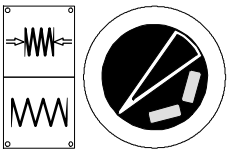


“D” position

Circuit- breaker **Open**



Closing spring **Released**



Safety measures

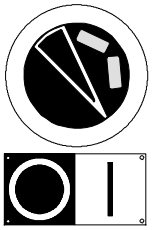
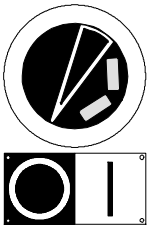
Circuit-breaker general preparing

The table below gives the steps to prepare the circuit-breaker to work safely :

Step	Action	Comment
1	Isolate the circuit-breaker from the network.	Shut down the circuit-breaker, de-energize and earth it.
2	Switch-off the supply circuit of the reloading motor.	
3	Check the SF_6 pressure gas.	Make sure that the SF_6 pressure gas is $\geq p_{me}$. **Below this level, no mechanical operating is allowed.**

Release the springs

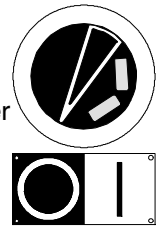
The table below gives the procedure to release the closing spring and the opening spring depending the circuit-breaker state :

If the circuit-breaker position is ...	**Action**
Closed 	In the operating device, activate the opening handle and the closing handle like below : **1** - Open **2** - Close **3** - Open
Open 	Activate the closing handle and the opening handle like below : **1** - Close **2** - Open

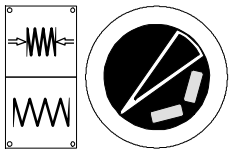
Check the optical signalization

Check that the operating mechanism's optical signalization shows the symbols below :

Circuit-breaker **Open**



Closing spring **Released**



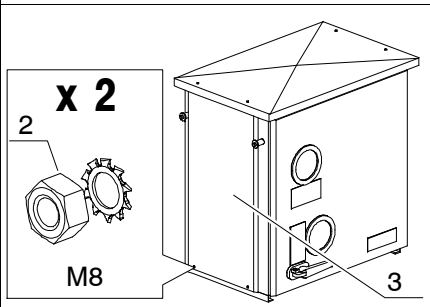
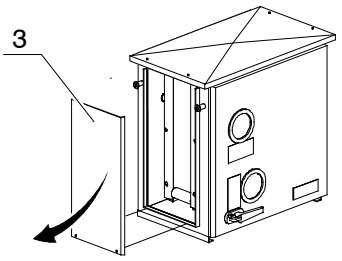
Preparing the operating device

Introduction

In order to perform certain maintenance operations inside the operating device it is necessary to remove some cabinet parts.

Removing side panels

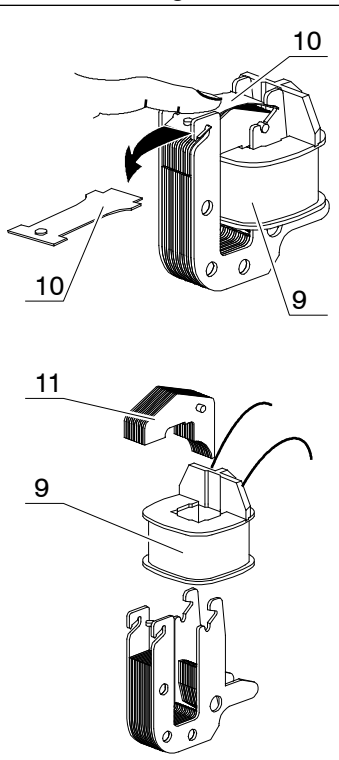
The table below gives the steps of side panels removing :

Step	Action	Diagram
1	Remove the nuts (2) from the left side panel (3).	
2	Take hold of the left side panel (3) from underneath, pull slightly towards the outside, then downwards to remove it.	
3	Proceed in the same way for the right side panel.	

Replacing an opening or closing electro-magnet

Process

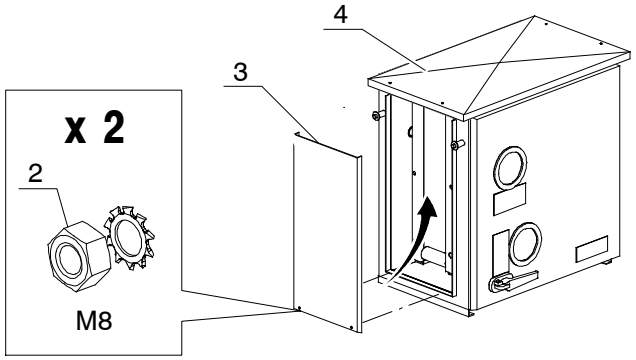
The table below gives the steps of replacing an opening or closing electro-magnet :

Step	Action	Diagram
1	Disconnect the supply wires from the coil (9).	
2	Extract the blade spring (10) by pressing outwards on the rivet with a finger.	
3	Remove the core (11).	
4	Remove the faulty coil and replace it by a new one carrying the same reference.	
5	Reinstall the core (11).	
6	Reinstall the blade spring (10).	
7	Connect supply wires to the new coil (9).	

Resumption of service

Installing the side panels

Insert the side panel (3) under the edge of the roof plate (4). Press it down to insert the mounting screws and fasten using nuts (2).



Continued on next page.

Resumption of service, continued

Energizing

The table below gives the resumption of service steps of the circuit-breaker pole :

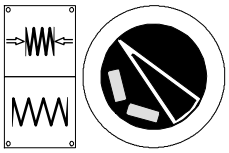
Step	Action	Comment
1	Re-energize the closing and opening circuits.	
2	Switch-on the motor supply circuit.	The motor starts-up and reloads the closing spring.

Check the optical signalization

Check that the operating mechanism's optical signalization shows the symbols below :

Circuit-breaker **Open**

Closing spring **Loaded**



Conclusion

The circuit-breaker is ready for normal use.

Lubrication

Principle

No future lubrication will be necessary. The bearings and rollers have been lubricated in our workshops with special grease :

ASEOL SYLITEA 4-018

This grease can easily endure very low temperatures and has an excellent resistance to ageing. So that its qualities are not modified during use, **it is prohibited to** :

- Mix this grease with any other lubricant.
- Lubricate later with any other oil.
- Spray parts of the apparatus with a protective liquid against corrosion or with any kind of lubricating oil.

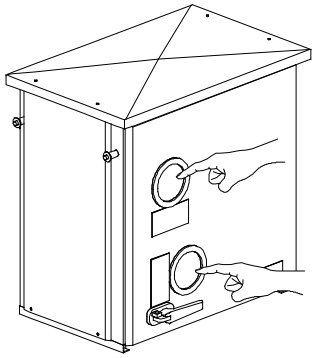
Mixture with other lubricants can cause the layer of grease to become too hard.

Cleaning the windows

Recommended product

To clean the windows, use exclusively soapy water.

DO NOT USE SCOURING PAD.



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Presentation

Introduction

Special tooling is necessary for :

★ commissioning,

☆ maintenance of the circuit- breaker.

Only the tools and accessories specified on ordering are delivered. Commercially available tools (e.g. : spanners, torque wrenches, spirit levels...) are not supplied.

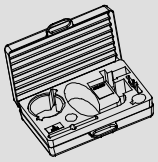
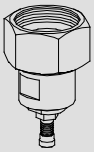
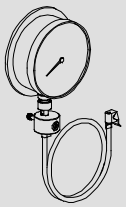
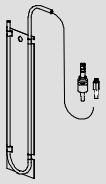
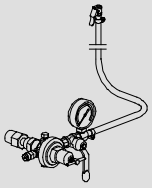
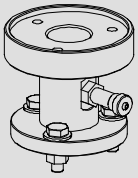
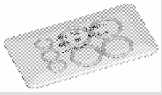
In this module

This module contains the following topics :

Special tools

Table of special tools

The table below gives the Grid Solutions special tools (SF_6 case) :

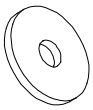
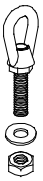
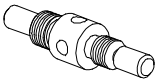
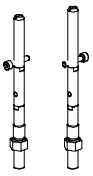
NUMBER	DESIGNATION		USE
HBLD001875.. ★☆		EMPTY TRANSPORT CASE (OPTIONAL)	Transport of SF_6 gas filling tools and control tools. Inspection of densimeter thresholds.
HBLN55000401 ★☆		FILLING TOOL	SF_6 filling, topping-up.
HBL- 02842117 + HB0005499001 ★☆		PRESSURE GAUGE 0...0,765 MPa	SF_6 filling, topping-up. Inspection of densimeter thresholds.
HBL- 02842118 + HB0005499001 ★☆		PRESSURE GAUGE 0...1 MPa	
HBL465059004 ☆		WATER PRESSURE GAUGE (OPTIONAL) ☆	Checking for leaks
HBL- 02557392 + HBLN55161601 ★☆		PRESSURE REDUCER 0...1 MPa	SF_6 filling, topping-up. Inspection of densimeter thresholds.
HB0005649001 ☆		CONNECTION VALVE BLOCK	Inspection of densimeter thresholds.
HB0000270121 ☆		SET OF SEALS	Inspection of densimeter thresholds.

Continued on next page.

Special tools, continued

Table of special tools, continued

The table below gives the continuation of Grid Solutions special tools :

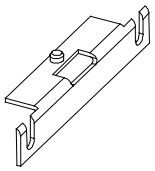
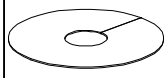
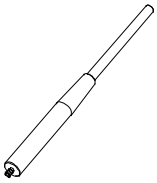
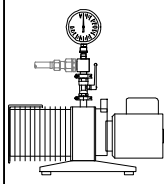
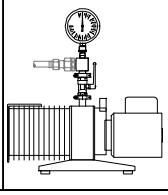
NUMBER	DESIGNATION		USE
HB0001652002 ★☆ (x4/station)		LIFTING STRAP (3m)	Handling of the pole.
HB0001652001 ★☆ (x4/station)		LIFTING STRAP (6m)	Handling of the pole.
HBL- 02236071 ★ (x4/station)		LIFTING SHACKLE	Handling of the pole.
HBLD00786901 ★ (x8/station)		WASHER	Handling of the column.
HBLN55069303 ★ (x4/station)		RING BOLT	Handling of the column.
HB0004570001 ★ (x1/pole installed in factory)		BLOCKING TOOL	Blocking tool of the pole operating shaft for replacing the operating device.
HB0000482002 ★☆ (x1/station)		CENTRING SPINDLES	Chambers/column coupling.

Continued on next page.

Special tools, continued

Table of special tools, continued

The table below gives the continuation of Grid Solutions special tools :

NUMBER	DESIGNATION		USE
HB0015532001 ★☆ (x1/station)		STOP	Chambers/column coupling.
HB0000571001 ★☆ (x1/station)		LEVER	Installing the operating device.
HB0000504001 ★☆ (x1/station)		PROTECTION	Chambers/column coupling.
HB0015511001 ★☆ (x1/station)		COUPLING PIN	Chambers/column coupling.
HBLN55001903 ★		VACUUM PUMP 110/220V 50 Hz (4,5 m^3/h)	Vacuum operation in pole.
HBLN55001904 ★		VACUUM PUMP 115/230V 60 Hz (4,5 m^3/h)	

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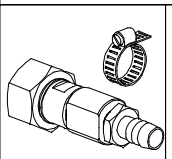
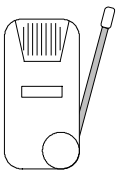
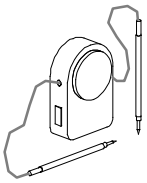
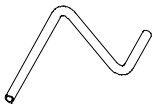
Special tools, continued

Table of special tools, continued

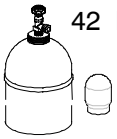
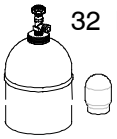
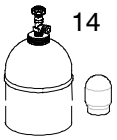
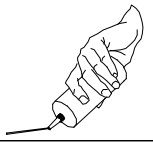
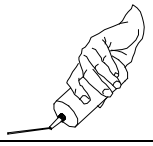
The table below gives the continuation of Grid Solutions special tools :

NUMBER	DESIGNATION		USE
HBLN55000406 ★		UNIVERSAL CONNECTION 1/2” GAZ AND 1/2” NPT	Vacuum operation in pole.
HBLD00001901 ★☆		LEAK DETECTOR	Checking gas- tightness of SF_6 filling plug. SF_6 leak detection.
HBL- 02861501 ☆		TEST LAMP	Inspection of densimeter thresholds. Inspection of interruption contact wear.
HB0005220001 FK3- 2 ☆		CRANK HANDLE	Spring reloading.
HB0006053007 FK3- 4 / FK3- 5 ☆			

Accessories

Table of accessories

The table below gives the Grid Solutions accessories :

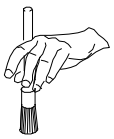
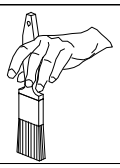
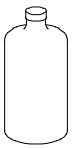
NUMBER	DESIGNATION		USE
HBL- 01861432 ★☆	 42 kg	SF_6 BOTTLE	SF_6 filling topping- up.
HBL- 01861435 ★☆	 23 kg	SF_6 BOTTLE	SF_6 filling topping- up.
HBL- 01861434 ★☆	 10 kg	SF_6 BOTTLE	SF_6 filling topping- up.
HBL- 01861443 ★☆	 8 kg	SF_6 BOTTLE	SF_6 filling topping- up.
HBL- 01861455 ★☆	 32 kg	CF_4 BOTTLE	CF_4 filling topping- up.
HBL- 01861454 ★☆	 14 kg	CF_4 BOTTLE	CF_4 filling topping- up.
HBL- 01818336		LOCTITE 262 (50 ml)	Screw locking.
HBL- 01818327		LOCTITE 225 (250 ml)	Screw sealing.
HBL- 01835265		MOLYKOTE 111 GREASE	Preparation of SF_6 seals.
HBL- 01835203		GREASE MOBILUX EP3	Lubricating screws before tightening to torques.

Continued on next page.

Accessories, continued

Table of accessories, continued

The table below gives the continuation of Grid Solutions accessories :

NUMBER	DESIGNATION		USE
HBL- 01835106		VASELINE (80 g)	Preparation of electrical contact surfaces.
HBL- 01835118		CONTACTAL GREASE	Preparation of electrical contact surfaces.
HBL- 01835251		GREASE ASEOL	General lubrication.
HBL- 02212337		SCOTCH BRITE A - VF	Preparation of electrical contact surfaces.
HBL- 01831320		ABRASIVE PAPER A400	Preparation of electrical contact surfaces.
HBL- 02212334		RAG	Preparation of electrical contact surfaces.
HBL- 02211842		ROUND BRUSH Nº 4	Preparation of electrical contact surfaces.
HBL- 02211831		BRUSH Nº16	Preparation of electrical contact surfaces.
HBL- 01861262		CAN OF ISOPROPANOL (1 l)	Preparation of SF_6 seals.

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S U M M A R Y

of PRODUCT SAFETY SHEETS
for equipment * manufactured by
Grid Solutions - AHT

SUBJECT	Reference N°	Revision	Remarks
Summary	PS 0000EN	05	Rev. 05 – Oct. 2016 : Corporate name change
Working environment	PS 0001EN	04	Rev. 05 – Oct. 2016 : Corporate name change
Handling Operations	PS 0002EN	04	Rev. 05 – Oct. 2016 : Corporate name change
Pressurized Equipment	PS 0003EN	04	Rev. 05 – Oct. 2016 : Corporate name change
SF_6 : Use and Handling.	PS 0004EN	04	Rev. 05 – Oct. 2016 : Corporate name change Not applicable to pneumatically operated circuit breakers
Chemicals	PS 0005EN	04	Rev. 05 – Oct. 2016 : Corporate name change
Electrical Equipment	PS 0006EN	04	Rev. 05 – Oct. 2016 : Corporate name change
Machinery	PS 0007EN	05	Rev. 05 – Oct. 2016 : Corporate name change
Operation	PS 0008EN	05	Rev. 05 – Oct. 2016 : Corporate name change
Maintenance	PS 0009EN	05	Rev. 05 – Oct. 2016 : Corporate name change

***** : excluding lightning arresters.

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SAFETY SHEET

WORKING ENVIRONMENT

CAUSE OR ORIGIN OF HAZARD.

Any negligence as regards site organisation may cause an accident.

WORK REQUIREMENTS.

All remedial action, for all life-cycles of the equipment, must be carried out in a safe working environment.

SAFETY INSTRUCTIONS.

OBSERVE ALL GENERAL INSTRUCTIONS GOVERNING INSTALLATION, COMMISSIONING AND OPERATION IN ACCORDANCE WITH CURRENTLY ACCEPTED PRACTICES AS WELL AS THOSE LAID DOWN IN THE DOCUMENTATION SUPPLIED WITH THE EQUIPMENT.

SAFETY INSTRUCTIONS	PACKING	TRANSPORT	INSTALLATION	START-UP	OPERATION	MAINTENANCE	SCRAPPING & RECYCLING
1 Personnel : - Appropriate clothing, gloves, helmet, safety boots, harness, etc.. - The personnel concerned must be familiar with the basic working regulations governing a given work station: mechanical, dielectric, pressure hazards, etc..	X	X	X	X	X	X	X
2 Handling Equipment : - This must be in good working order, regularly maintained, properly adjusted and compliant with the standards in force in the country of use.	X	X	X	X	X	X	X
3 Tools in General : - Only use tools appropriate to the type of work to be carried out.			X	X	X	X	X
4 Working Area : - Make sure the floor is safe (free from oil, blunt objects, etc.). - The site must be properly demarcated and kept clear.			X	X	X	X	X

SAFETY SHEET

HANDLING OPERATIONS

CAUSE OR ORIGIN OF HAZARD.

Any handling operation may involve danger :
- for the personnel,
- for the equipment being handled,
- for the installations or equipment in the vicinity.

WORK REQUIREMENTS.

As a general rule, handling operations must be carried out by personnel familiar with the basic handling regulations, using equipment in good working order, and wearing the appropriate protective clothing or equipment.

Ensure that the condition of the cases is such that they can be safely handled (state of the wood, shock-resistance, etc.).

SAFETY INSTRUCTIONS.

OBSERVE ALL GENERAL INSTRUCTIONS GOVERNING INSTALLATION, COMMISSIONING AND OPERATION IN ACCORDANCE WITH CURRENTLY ACCEPTED PRACTICES AS WELL AS THOSE LAID DOWN IN THE DOCUMENTATION SUPPLIED WITH THE EQUIPMENT.

SAFETY INSTRUCTIONS	PACKING	TRANSPORT	INSTALLATION	START-UP	OPERATION	MAINTENANCE	SCRAPPING & RECYCLING
Handling operations must be carried out by personnel familiar with the basic handling regulations.	X	X	X	X	X	X	X
Personnel must be qualified to operate lifting equipment, cranes, overhead conveyors, etc..	X	X	X	X	X	X	X
Equipment in proper working order : - Equipment must be checked and maintained regularly in accordance with local regulations. - All equipment must be properly housed.	X	X	X	X	X	X	X
Familiarity with the load to be handled (see details on the case).	X	X	X	X	X	X	X
Use of the appropriate handling equipment : - Type of sling(s), - Correct slinging methods, - Use of special Grid Solutions handling equipment.	X	X	X	X	X	X	X
Follow the handling instructions on : - the cases (pictorial symbols: centre of gravity, slinging points, etc.), - the assembly instructions.	X	X	X				
Compliance with the relevant work station safety instructions (proximity of electrical equipment).		X	X	X	X	X	X
Operator Safety : - use of gloves, helmets, safety boots, etc., - loads not to be carried with personnel underneath.	X	X	X	X	X	X	X

SAFETY INSTRUCTIONS	PACKING	TRANSPORT	INSTALLATION	START-UP	OPERATION	MAINTENANCE	SCRAPPING & RECYCLING
Handling of insulating jackets at transport pressure (300 hPa maximum).	X	X	X				
Ensure that cases have not been damaged during handling or prolonged storage.			X				
Follow the stacking instructions.	X	X	X				
It is essential to open cases from the top and to take care when unpacking.			X				
Before handling any hydraulically operated component, bring oil pressure back to atmospheric pressure.						X	X
Before handling any mechanically operated component, disable the springs.						X	X
Bring insulating jacket working pressure back to transport pressure (300 hPa maximum).						X	X

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SAFETY SHEET

PRESSURIZED EQUIPMENT

CAUSE OR ORIGIN OF HAZARD.

Our equipment includes gas pressure assemblies (SF_6, nitrogen, air, etc.) or fluids (oil).

WORK REQUIREMENTS.

- Comply with the storage, transport and operating instructions supplied with our equipment.
- Before initial filling and pressurizing, check the overall condition of the shielding concerned :
  - no signs of impact, splitting or chipping on the porcelain components, etc.,
  - no visible damage to hoses and/or rigid pipes (cuts, folds, corrosion, etc.) or to fittings and metal protection (accumulators, tank, etc.).

SAFETY INSTRUCTIONS.

OBSERVE ALL GENERAL INSTRUCTIONS GOVERNING INSTALLATION, COMMISSIONING AND OPERATION IN ACCORDANCE WITH CURRENTLY ACCEPTED PRACTICES AS WELL AS THOSE LAID DOWN IN THE DOCUMENTATION SUPPLIED WITH THE EQUIPMENT.

As a general rule, all work on pressurized equipment must be carried out by qualified personnel.

SAFETY INSTRUCTIONS		PACKING	TRANSPORT	INSTALLATION	START-UP	OPERATION	MAINTENANCE	SCRAPPING & RECYCLING
1	**Pressurized Equipment : General.**							
1.1	Comply with the assembly instructions shown on both our equipment and the gas bottles.	X	X	X	X	X	X	X
1.2	Before starting work on any pressurized piece of equipment, make sure there is no pressure.			X	X	X	X	
1.3	Before any handling, check to see how the equipment is fixed to its frame and how the frame is itself anchored.			X	X	X	X	
1.4	High-pressure pipes must be fixed or otherwise made safe.			X	X	X	X	
1.5	Before initial pressurization, check that all circuits are properly sealed.			X	X	X	X	
1.6	Never tighten a pressure fitting.			X	X	X	X	
1.7	Ensure that for every bolted connection for a volume under pressure there is an appropriate and properly fastened bolt at each relevant point.			X			X	
1.8	It is strictly forbidden to lift or otherwise move a piece of equipment inflated to a pressure in excess of 300 hPa of gas.			X	X	X	X	X
1.9	Before giving any orders to move equipment, check visually or by ear that all the relevant pipe fittings are tight.			X	X		X	
1.10	Comply with the standard instructions governing the use of compressed gas bottles (e.g. keep the bottle away from any source of heat).	X	X	X	X	X	X	X

SAFETY INSTRUCTIONS	PACKING	TRANSPORT	INSTALLATION	START-UP	OPERATION	MAINTENANCE	SCRAPPING & RECYCLING
2 SF6 Pressure Equipment.							
2.1 See SF_6 Safety Sheet.	X	X	X	X	X	X	X
2.2 An effective pressure of 300 hPa, used for the transport and storage of our products, is not regarded as a potential hazard.	X	X	X			X	X
2.3 Always fill the unit using the appropriate equipment, which should include a safety valve.			X		X	X	
2.4 Do not inflate over and above the prescribed pressure.			X		X	X	
2.5 It is strictly forbidden to release SF_6 to atmosphere. All discharged gas must without exception be recovered.			X	X	X	X	X
3 Hydraulic Equipment.							
3.1 Circuit Purging. This must be done under pressure. Use the appropriate equipment.			X			X	
3.2 Hydraulic Control Unit. The doors must be kept shut except when control tests are being carried out.				X	X		

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SAFETY SHEET

SF6

Use and Handling

CAUSE OR ORIGIN OF HAZARD.

Sulphur hexafluoride (SF_6) is a gas which in its basic state is colourless, odourless and tasteless. It is not toxic, but it cannot sustain life. It is a heavy gas that is dispersed slowly into the atmosphere.

In its natural state, SF_6 is delivered and stored in pressurized tanks (bottles or spheres) at a pressure of approximately 20 bar at 20°C (in its liquid form) and complies with IEC standard 376.

However, under the effect of the electric arc, the SF_6 molecules break up and the elements mostly recombine during cooling either due to extinction of the arc or by regeneration caused by the presence of active absorbent charges within the circuit breaker.
Various chemical reactions, associated with the volatilization of the materials in contact with the electric arc, create either fluoridized or sulphurous secondary gas products or solid products in the form of metallic fluoride powder ; or again, in the presence of traces of water or moisture, hydrofluoric acid or sulphur dioxide.

In the life-cycle of the equipment, SF_6 can be observed not only in its pure state, but also in its contaminated state :

- the use of new SF_6 for filling or adding,
- leaks under normal operating conditions,
- maintenance involving the opening of circuit breakers containing old SF_6 (decomposition products),
- abnormal conditions (internal arc fault causing the shielding to break),
- circuit breaker recycling on end of life-cycle.

WORK REQUIREMENTS.

Follow the instructions for the transport of pressurized containers.

The storage of these containers is governed by the same storage regulations as compressed gas bottles :

- keep away from any source of heat and in a cool, dry and well-ventilated area,
- always fit a pressure reducing valve.

Whilst SF_6 in its pure state is not toxic, the decomposition products have varying degrees of toxicity. They may irritate the skin, the eyes and the mucous membranes; and in massive amounts may cause serious lesions (oedema, heart failure, circulatory disorders and unconsciousness).
However, very rapidly and before there is any real danger, signs such as a pungent smell, irritation of the mucous of the nose, the eyes and the mouth will give a warning and the personnel concerned will have sufficient time to take the necessary safety actions.

Where the gas is used or handled within enclosed premises, ensure adequate ventilation, especially low down.
If the gas is inhaled, the area concerned must be evacuated immediately.

Under normal operating conditions, leaks are exceptionally minor and not critical, even when the gas contains impurities (due to the regenerating filters in the circuit breaker).

Filling and where necessary topping up operations must be carried out using the appropriate tools.

During maintenance operations, or at the end of the life-cycle, dust inside the equipment must be removed by a vacuum extractor and the operator should wear a mask. Gas recovery must be carried out using the appropriate gas recovery equipment.

Gases and decomposition products must be treated and/or disposed of by specialist organizations.

Under extremely abnormal conditions (e.g. break in the shielding) in an enclosed space, individual protective equipment is recommended.

Lastly, it is forbidden to smoke, drink, eat or keep food in the vicinity of open SF_6 equipment, whether indoors or outside (harmful dust).

SAFETY INSTRUCTIONS.

OBSERVE ALL GENERAL INSTRUCTIONS GOVERNING INSTALLATION, COMMISSIONING AND OPERATION IN ACCORDANCE WITH CURRENTLY ACCEPTED PRACTICES AS WELL AS THOSE LAID DOWN IN THE DOCUMENTATION SUPPLIED WITH THE EQUIPMENT.

It is essential that both the fitter and the user **read IEC Technical Report 1634** regarding the use and handling of sulphur hexafluoride gas.

SAFETY INSTRUCTIONS	PACKING	TRANSPORT	INSTALLATION	START-UP	OPERATION	MAINTENANCE	SCRAPPING & RECYCLING
Transport of SF_6	X	X					
Pure SF_6	X	X	X	X		X	
Contaminated SF_6					X	X	X

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SAFETY SHEET

CHEMICALS

CAUSE OR ORIGIN OF HAZARD.

Generally speaking, the products used for installation and commissioning are bought chemical products, namely :

- Hydraulic oil
- Grease
- Loctite
- Touching-up paint
- Isopropanol
- Drying agents

These must be kept in their original packing and the tops replaced after use.

Some packing products require careful handling as they may contain preservatives.

WORK REQUIREMENTS.

As a general rule, chemical products must be used and stored away from any source of heat. Smoking is to be avoided.

Avoid contact with the skin and any splashes to the eyes.

Take the basic health and safety precautions.

Products and packing must be destroyed in accordance with local environmental regulations.

SAFETY INSTRUCTIONS.

OBSERVE ALL GENERAL INSTRUCTIONS GOVERNING INSTALLATION, COMMISSIONING AND OPERATION IN ACCORDANCE WITH CURRENTLY ACCEPTED PRACTICES AS WELL AS THOSE LAID DOWN IN THE DOCUMENTATION SUPPLIED WITH THE EQUIPMENT.

Other products: SF_6 (see relevant sheet)

SAFETY INSTRUCTIONS	PACKING	TRANSPORT	INSTALLATION	START-UP	OPERATION	MAINTENANCE	SCRAPPING & RECYCLING
Drying Agents	X	X	X			X	X
Hydraulic Oil	X	X	X	X	X	X	X
Consumables (Grease & Paint) (Isopropanol)	X	X	X	X		X	
Loctite			X			X	

SAFETY SHEET

ELECTRICAL EQUIPMENT

CAUSE OR ORIGIN OF HAZARD.

Our equipment is subjected to high and low tension loads that could expose the personnel to the risk of electrocution.

WORK REQUIREMENTS.

The operating company is responsible for ensuring compliance with the safety instructions governing high tension.

The basic regulations in respect of low tension installations must also be complied with.

SAFETY INSTRUCTIONS.

OBSERVE ALL GENERAL INSTRUCTIONS GOVERNING INSTALLATION, COMMISSIONING AND OPERATION IN ACCORDANCE WITH CURRENTLY ACCEPTED PRACTICES AS WELL AS THOSE LAID DOWN IN THE DOCUMENTATION SUPPLIED WITH THE EQUIPMENT.

All work on high-tension networks and low-tension installations must be performed by qualified operators wearing personal protective clothing and using the appropriate tools and equipment.

SAFETY INSTRUCTIONS	PACKING	TRANSPORT	INSTALLATION	START-UP	OPERATION	MAINTENANCE	SCRAPPING & RECYCLING
1 High Tension.							
1.1 Comply with the regulations governing the work station.			X	X	X	X	X
1.2 In the case of items equipped with capacitors, make sure they are discharged prior to removal and short-circuited while work is being carried out.						X	X
2 Low Tension.							
2.1 Prior to any work on the low-tension circuit or equipment, cut off the power supply.			X	X	X	X	X
2.2 When replacing an electrical component on the control equipment, follow the safety instructions shown in the "Machinery" safety sheet.					X	X	

SAFETY SHEET

M A C H I N E R Y

CAUSE OR ORIGIN OF HAZARD.

Our equipment contains moving parts (linkage, levers, etc.), reserve power (springs, accumulators, etc.) and pressurized sheathing ; the associated hazards are dealt with in safety sheet "Pressurized Equipment" PS 0003/A.

WORK REQUIREMENTS.

Follow the relevant Grid Solutions operating and maintenance instructions.

Prior to any work on the control equipment and the motion transfer mechanism, disable the springs on mechanically operated units and bring pressure back to zero for hydraulically operated units.

SAFETY INSTRUCTIONS.

OBSERVE ALL GENERAL INSTRUCTIONS GOVERNING INSTALLATION, COMMISSIONING AND OPERATION IN ACCORDANCE WITH CURRENTLY ACCEPTED PRACTICES AS WELL AS THOSE LAID DOWN IN THE DOCUMENTATION SUPPLIED WITH THE EQUIPMENT.

As a general rule, work on the control equipment and transmissions must be performed by qualified operators wearing personal protective clothing and using the appropriate tools and equipment.

SAFETY INSTRUCTIONS	PACKING	TRANSPORT	INSTALLATION	START-UP	OPERATION	MAINTENANCE	SCRAPPING & RECYCLING
1 Moving Parts.							
1.1 Before any work is carried out on transmission components, ensure that the control equipment has been deactivated.			X	X	X	X	X
2 Spring-operated Mechanism.							
2.1 Before any work is carried out, cut off all power to the reset motor.			X	X	X	X	X
2.2 Deactivate the opening and closing springs in accordance with Grid Solutions instructions.			X	X	X	X	X
2.3 Make sure that all safety rules are complied with while the work is being carried out.			X	X	X	X	X
3 Hydraulic Mechanism.							
3.1 Before any work is carried out, cut off power to the motor pump.			X	X	X	X	X
3.2 Reduce the pressure of the hydraulic circuit to zero.			X	X	X	X	X

SAFETY SHEET

OPERATION

CAUSE OR ORIGIN OF HAZARD.

If the unit shows any sign of an unwanted condition, it must be examined by the user.

WORK REQUIREMENTS.

The operators concerned must be suitably qualified and must comply with the normal operating and maintenance instructions issued by Grid Solutions.

Depending on the severity of the fault observed, the necessary corrective measures must be taken, e.g :

- replenish the SF_6 gas in the event of a leak,
- isolate the system in the event of a major malfunction.

SAFETY INSTRUCTIONS.

OBSERVE ALL GENERAL INSTRUCTIONS GOVERNING INSTALLATION, COMMISSIONING AND OPERATION IN ACCORDANCE WITH CURRENTLY ACCEPTED PRACTICES AS WELL AS THOSE LAID DOWN IN THE DOCUMENTATION SUPPLIED WITH THE EQUIPMENT.

	SAFETY INSTRUCTIONS	PACKING	TRANSPORT	INSTALLATION	START-UP	OPERATION	MAINTENANCE	SCRAPPING & RECYCLING
COMPLY WITH THE SPECIFIC INSTRUCTION PROVIDED IN THE FOLLOWING CASES :	Opening malfunction : - to do with the sequencing chain, - following a mechanical fault.				X	X		
	Cut-off failure.					X		
	External dielectric flash-over.					X		
	SF_6 pressure drop due to either : - major leak (switch to 2nd threshold), - no 1st threshold alarm complement.				X	X		
	Loss of motor power : - oil, compressed air, component failure.				X	X		
	Activation of safety device, if fitted.					X		
	Use only the appropriate products recommended by Grid Solutions.			X	X	X	X	
	Abnormal noise.				X	X		

SAFETY SHEET

MAINTENANCE

CAUSE OR ORIGIN OF HAZARD.

- To ensure safe and unimpaired operation of the equipment, regular maintenance is essential.

  Neglected maintenance can create hazards.

- Maintenance operations involve hazards that must be guarded against.

WORK REQUIREMENTS.

- Comply with the maintenance programme and service intervals shown in the Grid Solutions manuals.
- In addition, every maintenance operation must comply with the following requirements :
  - it must be carried out by suitably qualified personnel,
  - both the work involved and the associated hazards must be clearly identified beforehand,
  - the tools and equipment used (standard or specific to Grid Solutions) must be appropriate and in proper working order,
  - any replacement parts must be Grid Solutions parts.

SAFETY INSTRUCTIONS.

OBSERVE ALL GENERAL INSTRUCTIONS GOVERNING INSTALLATION, COMMISSIONING AND OPERATION IN ACCORDANCE WITH CURRENTLY ACCEPTED PRACTICES AS WELL AS THOSE LAID DOWN IN THE DOCUMENTATION SUPPLIED WITH THE EQUIPMENT.

- Refer to the relevant SAFETY sheets.
- The safety instructions below are general and not exhaustive. They should therefore be modified and/or supplemented for all specific maintenance operations to be carried out.

SAFETY INSTRUCTIONS	PACKING	TRANSPORT	INSTALLATION	START-UP	OPERATION	MAINTENANCE	SCRAPPING & RECYCLING
Identify the equipment to be worked on and ensure it is switched off.					X	X	X
Obtain as much information as possible from the user regarding the condition of the unit.					X	X	X
Check that the unit is earthed both upstream and downstream.					X	X	X
Demarcate the work area.					X	X	X
Ensure that the operator is equipped with the personal protective clothes and equipment required (safety glasses, gloves, safety boots, harness, etc.).					X	X	X
Ensure that the equipment used is compliant and in good condition (scaffolding, slings, suspended platforms, electrical equipment, tools, etc.).					X	X	X
Ensure that the safety instructions in respect of each particular hazard are complied with.					X	X	X

Presentation

In this module

This module contains the following subjects:

I - Introduction

During the elimination phase for a High Voltage gas insulated circuit breaker, at the end of its service life, the quality of the treatment of wastes generated represents the essential environmental aspect.

This manual proposes, for each element of a High Voltage gas insulated circuit breaker, the recommended method of elimination for the various materials it comprises, as well as any possible precautions to be taken.

II - General remarks

It is necessary to proceed with a maximum amount of dismantling, so as to ensure the best recycling possible of the materials.

Various categories of materials can be distinguished depending on the waste processing channel followed:

- The SF6 gas to be recycled or reprocessed
- The metals to be recycled (without taking into account any surface treatment, paintwork or electro- silverplating)
- Waste products to be destroyed by incineration or sent to the waste dump depending on the channel available.
- Special wastes

III - Categories and treatment of the materials

1 - Treatment of SF6 gas

The SF6 gas will be recycled in accordance with the recommendations of the IEC 60480 Standard.

However, when recovering the SF6 gas, it is important to respect the following precautions:

- Weigh the recipients used before and after filling, so as to ensure traceability of the weights recovered
- For each recipient, carry out a measurement of the purity of the SF6 gas and a search for the decomposition products (SO2, HF)

In case of absence of a local waste processing channel for the recycling of SF6, we recommend a return to our site in Villeurbanne, where we propose reprocessing via our European service providers.

2 - Materials to be recycled

Metals form the main constituent of a gas insulated substation.

The main types of metal making up a substation are:

- Steel: steelwork structure, fasteners, electrical cubicle frames, etc.
- Aluminium: moulded or mechanical welded enclosures, conductor bars, electrodes, etc.
- Bolted fasteners, threaded rods, rating and name plates
- Bare copper: electrical contacts, etc.
- Insulated copper: electrical cable

It is important to separate these different metals when dismantling the substation at the end of its service life. In particular for small sub- assemblies made up of various materials.

In certain simple cases, it is sufficient to remove the fasteners ensuring the assembly and, in other cases, specific instructions shall be given.

The aluminium and copper elements must, under no circumstances, be mixed. Specific waste processing channels associated with these materials do not allow for perfect separation during their processing. In cases where it is impossible to separate them, the component must be sent for incineration.

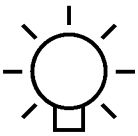
III - Categories and treatment of the materials (contd.)

3 - Waste products to be destroyed by incineration

This type of waste includes the rest of the materials used in the composition of a gas insulated substation, other than for a few very specific cases.

These waste products mainly include:

- Parts in epoxy resin: insulating cone in the case of circuit breakers with insertion resistance
- Plastic parts loaded with glass fibre (insulating tubes, etc.)
- Seals and gaskets, rubber bands, roller bearings
- Insulators (support or interrupting chamber) composites etc.



Where possible, we recommend that this type of waste be sent via incineration channels with waste heat recovery.

4 - Special wastes

Certain elements, due to their function or the material constituting them, cannot be sent via a recycling or incineration channel.

They include the following components:

- Insulating parts from the interrupting chamber
- Absorbent molecular sieves
- The active elements in electrical cubicles
- Ceramic insulators (support or interrupting chamber) or those still called porcelain, etc.

These waste products will follow specific channels and/or undergo certain types of processing.
Precise instructions will be supplied for these types of components.

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SF6 gas : Environmental impacts

Introduction

<u>The SF6 gas contributes to the greenhouse effect:</u>

The greenhouse effect is a natural phenomena, which by capturing a part of the infra- red rays reflected from ground to space, enables the Earth to have an average temperature of 15 C.

The most abundant gases, which participate in the creation of this greenhouse effect are Water Vapour, Carbon Dioxide, Methane. However, since the beginning of the industrial era, Man has released gases into the atmosphere, which artificially increase the greenhouse effect.
Even if Sulphur Hexafluoride (SF6) is only present in the environment in low levels, it creates a greenhouse gas, which has the capacity to absorb the infra- red rays emitted by the Earth, which is 22,800 times higher than that of Carbon Dioxide.

<u>N.B.</u>: 1 kg of SF6 gas emissions are, thus, the equivalent of 22,800 kg of Carbon Dioxide, which corresponds to the greenhouse effect gas waste released by a gasoline vehicle covering 120,000 km.

SF6 gas is used in High- and Medium- Voltage switchgear for its breaking and insulation capacities.
The SF6 emissions can be generated in the equipment manufacturing, operating, maintenance and decommissioning processes. The losses are, either, accidental (equipment breakage),or structural (equipment's leaktightness).
Under no circumstances, SF6 gas should be released to the environment:

<u>N.B.</u>: In accordance with the International Kyoto Agreements, European Regulations on fluorinated gases and IEC 62271- 303 applicable standards (e.g.. IEC 61634), SF6 gas handling operations (filling, recovery) must be carried out by trained and qualified personnel, using tools and procedures enabling gas releases to be limited.

SF_6 gas safety rules

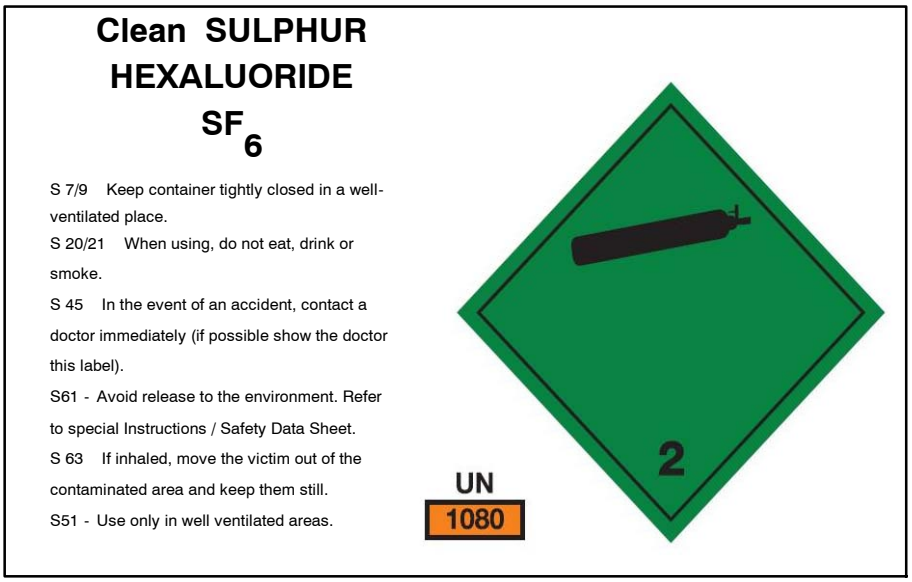
New SF_6

- Sulphur Hexafluoride (SF6) is a colourless, odourless and non- toxic gas.
- However, it is a gas, which does not maintain life.

This gas is heavier than air and the lower parts such as trenches or cable troughs can contain a strong concentration of this gas, which could lead to asphyxia.

N.B.: **The maximum permissible concentration on a workstation, assuming that people stay there 8 hours a day, 5 days a week, is 1000 ppm (i.e. 0.1%) of the volume. This very low level is a standard value for all non- toxic gases, which are not usually present in the atmosphere**.

Every recipient containing new SF6 gas should be labelled as indicated below:



SF_6 gas safety rules (contd.)

Used SF6

- Under the influence of electrical arcing, SF6 gas can be broken down into sub- products, which are more or less toxic and/or corrosive.
- Depending on their nature, these products can be irritant for the mucous membranes, the respiratory tracts and the skin.

The SF6 decomposition products are brought to light, even when present in very low levels, by a strong pungent and sulphur odour.

Every recipient containing used SF6 gas should be labelled:
Used SF6 gas will be stored in a pressurised, leak- tight container, which must be resistant to decomposition products (valves, connectors and piping included) and will be regularly inspected in accordance with the standards in force. The maximum quantity of polluted gas stored on site will be defined in accordance with the rules in force.

Liquid$_{GAS}$, toxic, corrosive, n.s.a.

C - CORROSIVE

T+ - VERY TOXIC

(Contains used Sulphur Hexafluoride SF6)

R 26/27/28 VERY TOXIC BY INHALATION, IN CONTACT WITH SKIN AND IF SWALLOWED.

S 7/9 Keep container tightly closed in a well- ventilated place.
S 20/21 When using, do not eat, drink or smoke.

S 38 In case of insufficient ventilation, wear suitable respiratory equipment.

S 45 In the event of an accident, contact a doctor immediately (if possible show the doctor this label).

S61 - Avoid release to the environment. Refer to special Instructions / Safety Data Sheet.

S 63 If inhaled, move the victim out of the contaminated area and keep them still.
S 51 - Use only in well ventilated areas.

SF_6 gas safety rules (contd.)

Used SF_6

For all interventions, it is necessary to respect the following instructions:
In every zone where the SF6 is implemented

- It is forbidden to smoke, eat, drink or store food.
- Ventilation must be sufficient.
- It is forbidden to use a fuel engine.
- Individual protection must be worn, following the table below.

Individual protection	SF6 Technical grade. Pure SF6 and used gas without toxic products.	Conforming SF6 including low levels of toxic products .	Non- conforming SF6 including toxic products. SF6 (post- arcing). Studies of the com-partment containing polluted SF6.
Wearing of Gloves		●	●
Wearing of Eye Protection		●	●
Wearing of a Simple Face Mask		●	
Wearing of a Cartridge Filter Face Mask			●
Wearing of a Combination			●

N.B.: For the elimination, the individual protection is managed in HIW

- Furthermore, the personnel intervening on the equipment, must respect at minimum the following instructions : after draining gas,

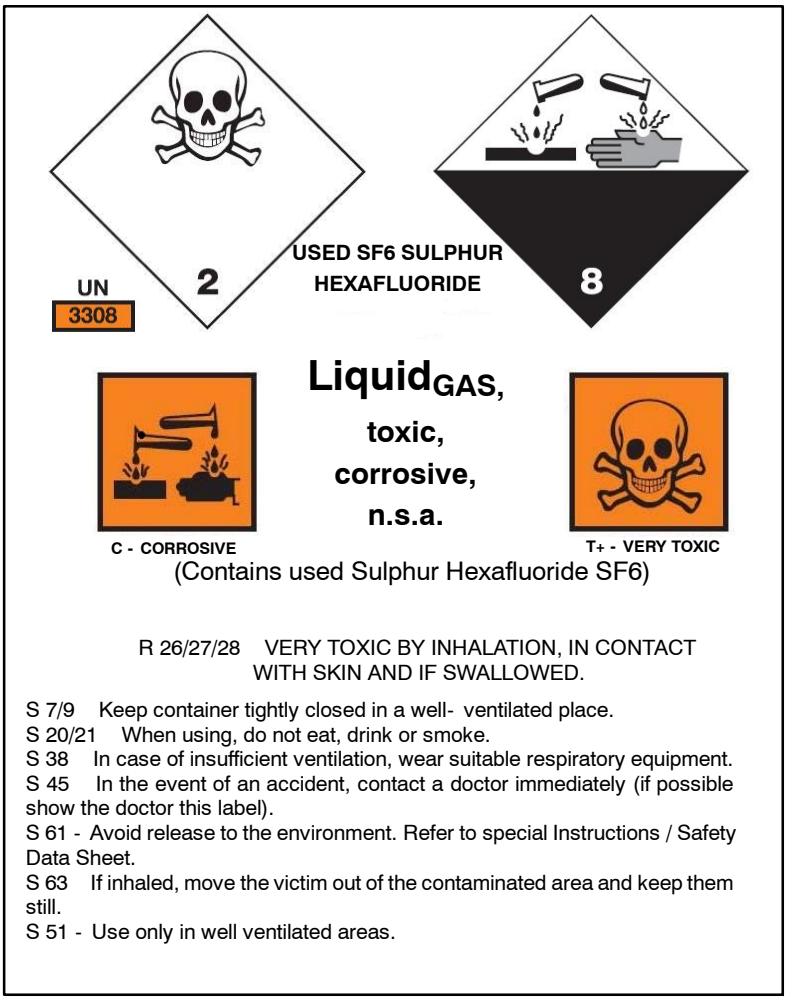
- Remove the SF6 decomposition products immediately after the opening of the equipment in order to avoid a chemical re- combination with water.
- Ventilation must be sufficient.
- Use an appropriate vacuum cleaner equipped with a dust filter and wipe with a clean, dry cloth.
- Avoid shaking the cloth
- Block the SF6 decomposition products (i.e. molecular sieve, cloth soiled with a 3% sodium hydroxide solution during 24 h) and destroy as dangerous waste.

- Avoid contact with soiled parts or dust (Individual Protection)

Soiled individual protection, soiled dusters, soiled molecular sieve, polluted gas, must be destroyed as dangerous industrial waste. Polluted gas will be incinerated or recycled depending on its level of pollution.

Transportation of SF_6 gas

- Transportation of SF6 gas is considered as a transportion of dangerous materials. It must be carried out in accordance with the regulations in force, especially the ADR Regulations in Europe (European Agreement concerning the International Road Transport of dangerous materials).
- For each transport, each container must be labelled, the label must be visible and be combined with a Health & Safety / Transportation label and a Transportation slip for dangerous materials must be drawn up.
- In the event of a transportation of SF6 gas containing toxic products (waste), the document for dangerous materials must include the ADR 2.2 T C classification with a Safety Plan. The combined label will be the following :



- Loading and unloading operations are carried out by trained and qualified personnel in accordance with the instructions in force.

Applicable documentation

International Standards

- **IEC 60 376 :** Technical Quality specifications of Sulphur Hexafluoride (SF6) for use in electrical devices.
- **IEC 60 480 :** guidelines concerning the testing and treatment of Sulphur Hexaluoride (SF6) sampled on electrical devices and specifications concerning re- use.
- **IEC 62 271- 303 :** high- voltage switchgear use and handling operations of Sulphur Hexafluoride (SF6) in high- voltage switchgear.

Technical guides

- **SF6 Practical Handling instructions - CIGRE Brochure 273 :** SF6 Practical Handling guide
- **SF6 Recycling Guide (Revision 2003) - CIGRE Brochure 234 - August 2003 - PARIS** : SF6 recycling guide

European Regulations

European Regulations (EC) N°517/2014 of 16th of June 2014 concerning certain greenhouse effect fluorinated gases.

Presentation

Introduction

These maintenance directives incorporate measures for avoiding the hazards involved in the application of SF_6 gas to switchgear.
Such directives are protective measures and recommendations for the user of SF_6 switchgear.

Fundamental rules

Instructions for performance of work on SF_6 gas switchgear are given in the appropriate instruction manuals.
Switchgear may only be opened after the preparations for scavenging have been completed.

In this module

This module contains the following topics:

Evacuation of SF_6 gas apparatus

Principle and precautions

The table below gives the principle of evacuation of SF_6 gas apparatus and precautions to take:

Step	Action
1	De- energize apparatus, switch- off where applicable and earth.
2	Connect the servicing unit to the gas filling nipple by means of a hose and using an adsorber filter.
3	Remove the SF_6 gas using the vacuum pump. Depending on the gas volume ; it can be stored for re- use as per indications of IEC standard.
4	Fill gas compartment if possible with nitrogen or dry compressed air at rated pressure and subsequently, discharge outdoors (if possible through an absorber filter).

Opening- up SF_6 gas switchgear

Precautions to take

At the time of the opening- up SF_6 gas switchgear, take the precautions below:

- Open- up SF_6 switchgear only after the gas has been evacuated and the pressure inside the apparatus has been reduced to that of atmospheric pressure.
- Put the ventilation system in operation or ensure that fresh air circulates in some other manner when switchgear which contains decomposition products is opened (e.g. circuit- breaker).
- Wear suitable fresh air breathing apparatus if there is even the slightest possibility that personnel working on the equipment could be put in danger through inhalation of hazardous amounts of gas vapor from powdery decomposition products.
- Wear special overalls when working on opened- up SF_6 switchgear which contains powdery decomposition products. After completing work remove overalls.
- Avoid stirring- up dust and powder from SF_6 switchgear. Difficult to remove dust can be removed with dry non- fibrous rags. A vacuum cleaner should be used to remove loose dust. The vacuum cleaner filter should be able to retains particles of a least 1Aμ in size.
- Items (such as rags, vacuum cleaner, throw- away- overalls, gloves, etc.) which come in contact with the decomposition products must be collected and neutralized so that the dust cannot be transferred. Before getting rid of these items neutralize in a 3 percent soda solution for 24 hours. verify the degree of neutralization after 24 hours. When soda is added, no bubbles should be result. If there are bubbles repeat the neutralization.
- Under all circumstances ensure that the decomposition products neither come in contact with skin, eyes, clothes, nor that they are swallowed or inhaled. Pay special attention to cleanliness of body, clothes and work-bench. Dust or powder that comes in contact with skin must be washed away with plenty of water.
  It is advisable to wash face, neck, arms and hands with soap and plenty of water before work- breaks and after stoppage of work.
- Avoid eating, drinking, smoking or storing eatables in rooms or outdoors near to opened SF_6 switchgear which may contain arc- decomposed powder.

Recapitulation of important instructions

Reminder

Pure, non- contaminated SF_6 gas is non- poisonous. Electrical discharges and fault- switching arcs will give rise to different grades of poisonous decomposition products. In small amounts gaseous decomposition products produce - within seconds and before any poisonous effects can take place - warning symptoms, such as an unpleasant piercing odor, nasal, mouth and eye irritations, which enable working personnel to withdraw to safety. Solid decomposition products (powdery residues from switching) can cause skin irritations. SF_6 is about five times heavier than air, and in the absence of turbulence, results in the gas collecting just above ground level and causing suffocation through a deficiency of oxygen.

Important instructions

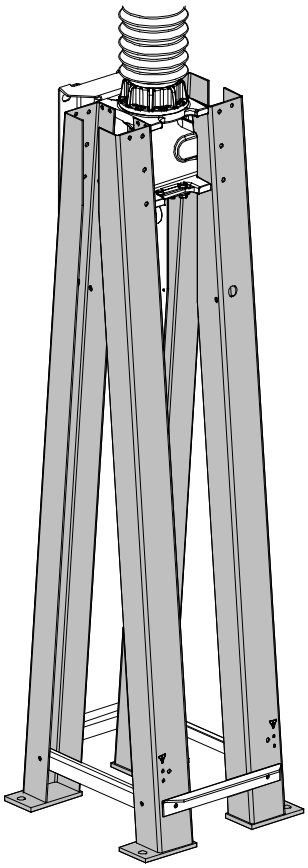
The table below recapitulates the important instructions to follow at the time of handling of used SF_6 gas and decomposition products:

No.	Instruction
1	As soon as an unpleasant, piercing odor from decomposition products becomes perceptible leave the substation room without delay. enter the room only after thorough ventilation or when wearing suitable oxygen breathing masks (with filtering or fresh air device).
2	After disturbances, enter the substation room only after having thoroughly aired the room or when wearing independent of ambient- air operating oxygen breathing masks, or alternatively, after verifying by measurement that the ambient air contains at least 17% volume of oxygen, especially if, one has to reckon with the concentration of SF_6 in hazardous amounts.
3	Enter rooms located below, and connected with the substation- rooms after thorough ventilation only, or when wearing oxygen breathing masks which operate independent of the ambient- air, or alternatively, after having verified by measurement that the ambient air contains at least 17% volume of oxygen.
4	Ensure that the room ventilation operates satisfactorily, whilst maintenance work is being performed on SF_6 switchgear (discharging and filling of gas, opening and cleaning of equipment).
5	When working on opened SF_6 switchgear protect skin against contact with gas and avoid swallowing or inhaling of gas. Ensure body, clothing and work- bench cleanliness. Wear special work- overalls and after completion of work discard latter.
6	Wash skin which comes in contact with powder deposits with plenty of water. Before work- breaks and after work wash face, neck, arms and hands thoroughly with soap and plenty of water.
7	Do not stir- up powder deposits resulting from arc- switching. Remove sticky powder with dry rags. Use suitable vacuum cleaner with paper- filter to remove loose powder. Discard used items and filter- bags in such a manner that powder deposit does not spread. Before discarding neutralize used items.
8	Avoid eating, drinking and storing eatables in rooms with opened SF_6 switchgear which contains powder deposits.

Presentation

Reminder

Frames may be supplied by either Grid Solutions or the customer.



In this module

This module contains the following topics:

Components necessary for the operation

Necessary product

Grease MOBILPLEX47 - MOBILUXEP3 (screws greasing).

Necessary tools

List of the tools necessary for the installing:

Mark	Diagram	Designation	Number
(1)		Lifting strap (3 m)	2

Handling

The support- frame assembly operations and lifting the pole should be performed by at least two persons.

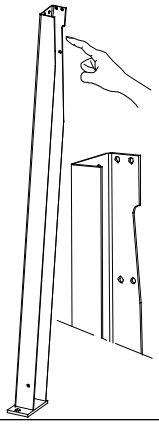
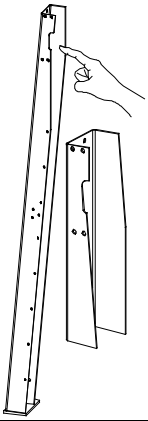
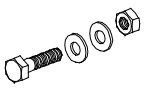
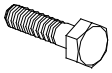
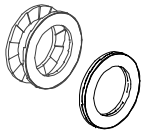
Support- frame components (per pole)

Introduction

If the support- frame is supplied by Grid Solutions, check the necessary components to the assembling.

Necessary components

List of the Grid Solutions components necessary for the assembling:

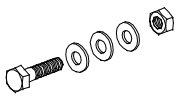
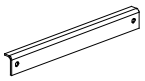
Mark	Diagram	Designation	Number
(2)		Support	2
(3)		Support	2
(5)		Screws H M16-45	1
(7)		Screws H M16-35	16
(9)		Washer NORDLOCK NL16 SS	16

Continued on next page.

Support- frame components (per pole), continued

Necessary components, continued

List of the Grid Solutions components necessary for the assembling:

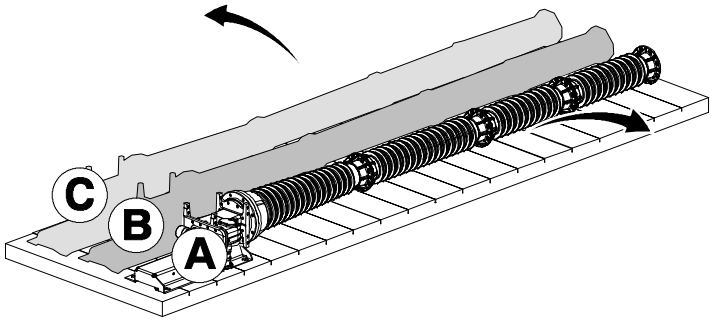
Mark	Diagram	Designation	Number
(20)		Screws H M16-45	8
(21)		Strengthening piece	2
(22)		Strengthening piece	2

Preparing the column

Dismantling the case of the poles

Remove the side panels of the case.

NOTE : The extraction of the columns will be in the order **A**, B and C.

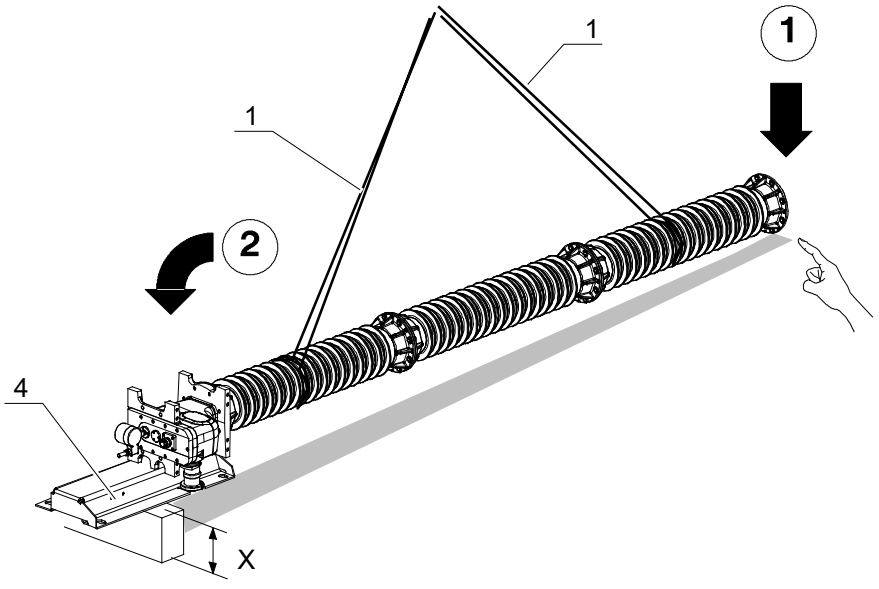


Preparing the pole

- Sling the “A” column with the aid of two flexible lifting straps (1).
- Extract the column from the case and put it down on the case wood cover laying:

- first, the end of the column),
- second, the support of the operating mechanism (4) on a wedge to ensure the correct installing of the frame supports.

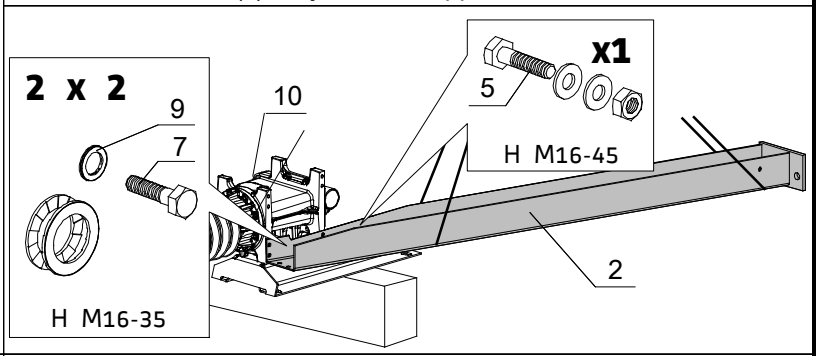
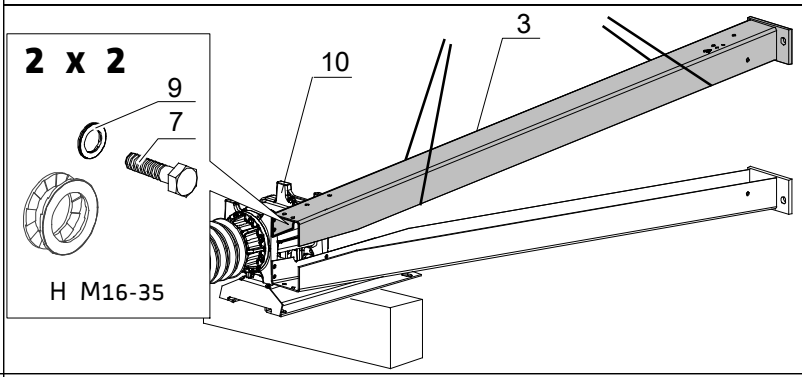
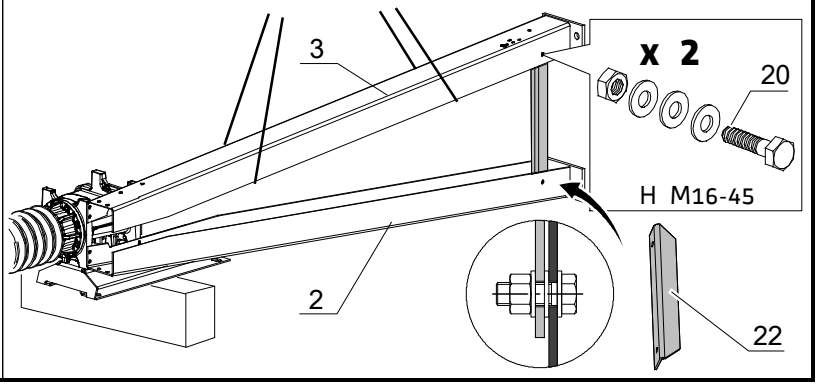
X $_{\text{minimum}}$ **= 260 mm**



Frame- support assembly

Process

The table below gives the steps of installing the supports of the frame:

Step	Action
1	With the aid of two flexible lifting straps, position the frame- support (2) onto the housing (10) and fasten it with the use of the screws (7) and NORDLOCK washers (9). **Do not tighten the screws (7).** - Install the screw (5) only on this support. 
2	With the aid of two flexible lifting straps, position the frame- support (3) onto the housing (10) and fasten it with the use of the screws (7) and NORDLOCK washers (9). **Do not tighten the screws (7).** 
3	Install the strengthening piece (22) inside the frame- support (3) with the use of the screws (20). Adjust the distance between the support and fasten the strengthening piece on the frame- support (2). **Do not tighten the screws (20).** 

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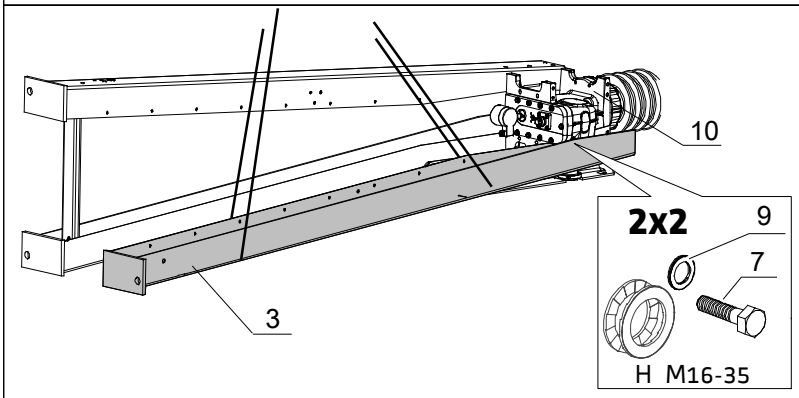
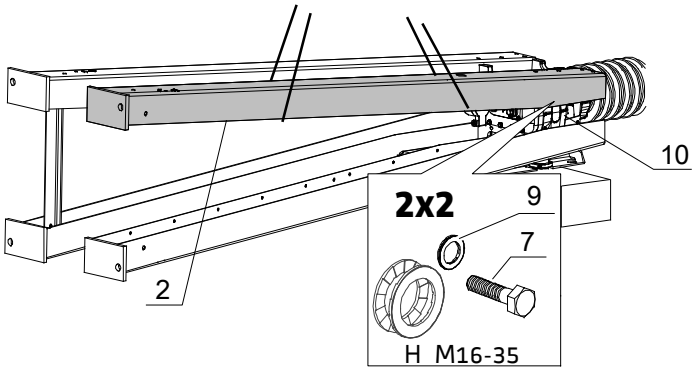
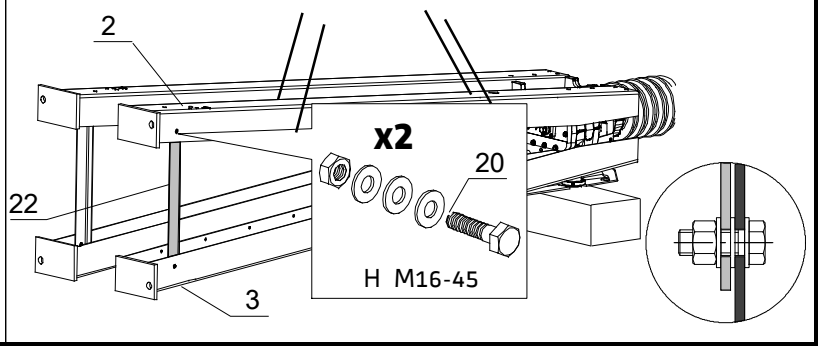
Frame- support assembly, continued

Process, continued

The table below gives the steps of installing the supports of the frame:

Step	Action
4	With the aid of two flexible lifting straps, position the frame- support (3) onto the housing (10) and fasten it with the use of the screws (7) and NORDLOCK washers (9). **Do not tighten the screws (7).**
	
5	With the aid of two flexible lifting straps, position the frame- support (2) onto the housing (10) and fasten it with the use of the screws (7) and NORDLOCK washers (9). **Do not tighten the screws (7).**
	
6	Install the strengthening piece (22) inside the frame- support (3) with the use of the screws (20). Adjust the distance between the support and fasten the strengthening piece on the frame- support (2). **Do not tighten the screws (20).**
	

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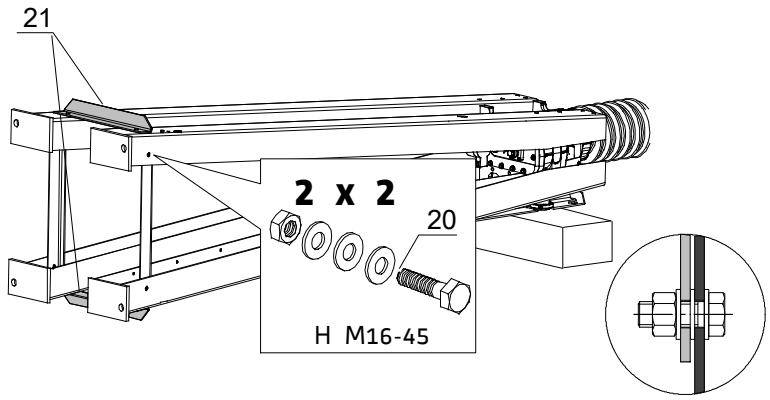
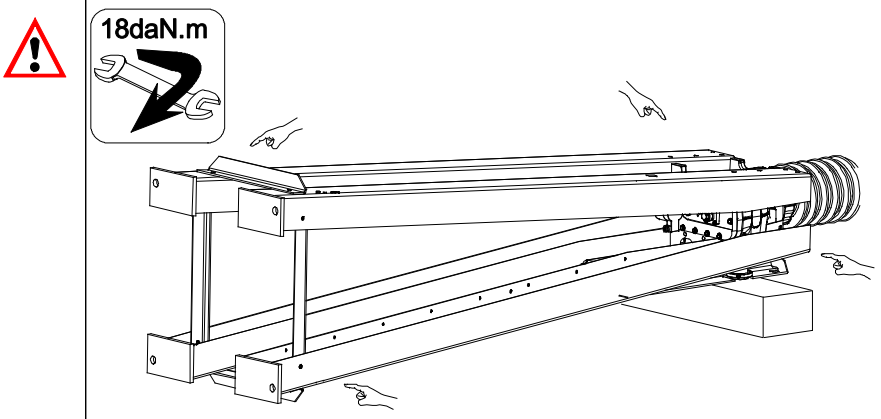
Frame- support assembly, continued

Process, continued

The table below gives the steps of installing the supports of the frame:

Step	Action
7	Install the strengthening pieces (21) outside the frame- support with the use of the screws (20).
	
8	Tighten all the screws to the recommended torques.
	

Presentation

Necessary tools

List of the necessary Grid Solutions tools for the lifting and positionning of the pole :

Mark	Diagram	Designation	Number
(1)		LIFTING STRAP ***"SPANSET"*** (3 m - 1000 kg)	2

In this module

This module contains the following topics :

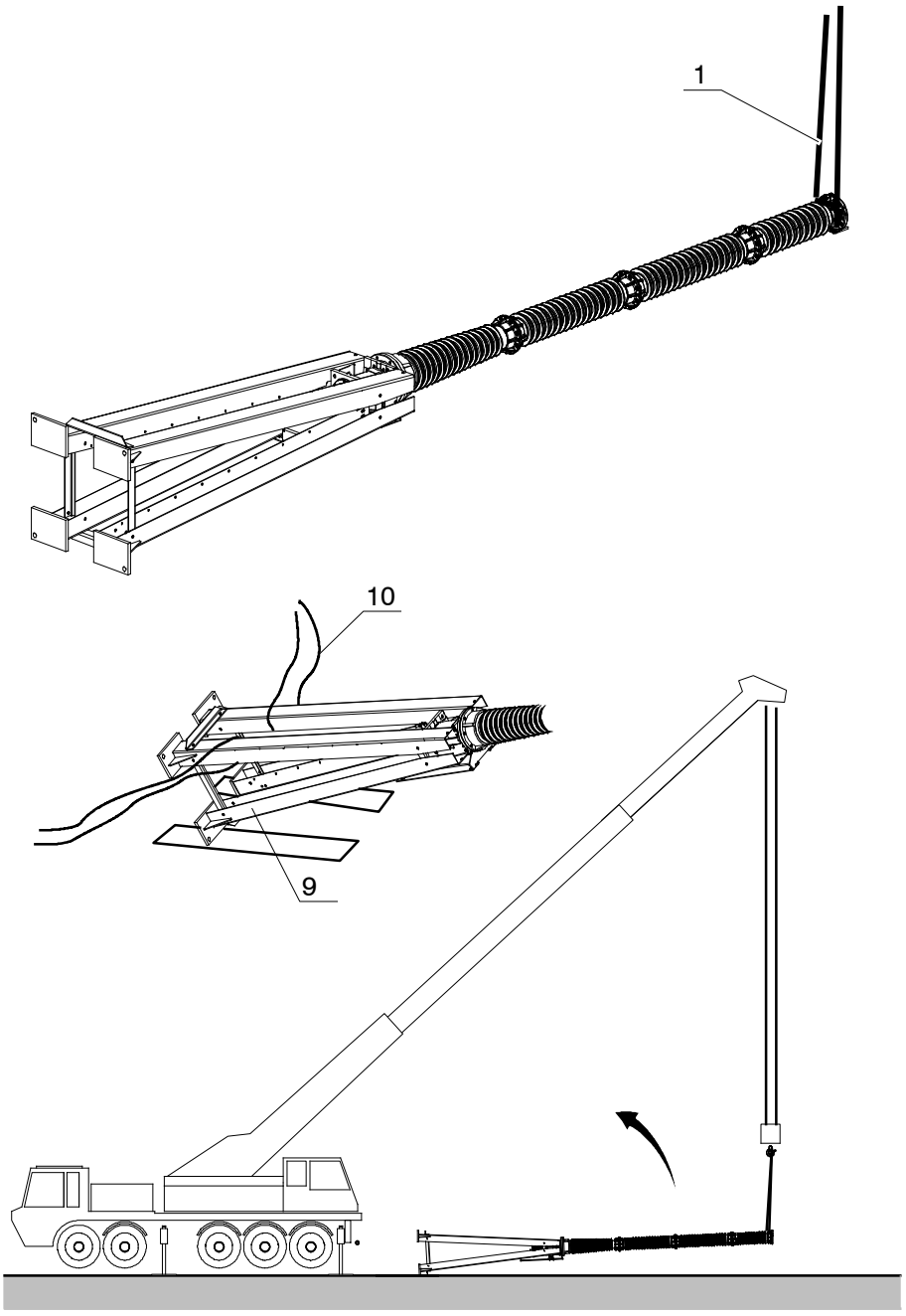
Warning

"Procedure limited to pole installation only. For removal, contact Grid Solutions."
"Any faults or cracks in the column may render the procedure dangerous."

Lifting the pole

Process

Install the two flexible lifting straps (1), placing these at the end of the column.
By means of a lifting device hoist the pole up whilst allowing it to rest on the base of the frame.
Place the trip ropes (10) on the support legs of the chassis frame (9) to ensure guidance of the pole at the time of lifting.
Lift the pole with precaution.

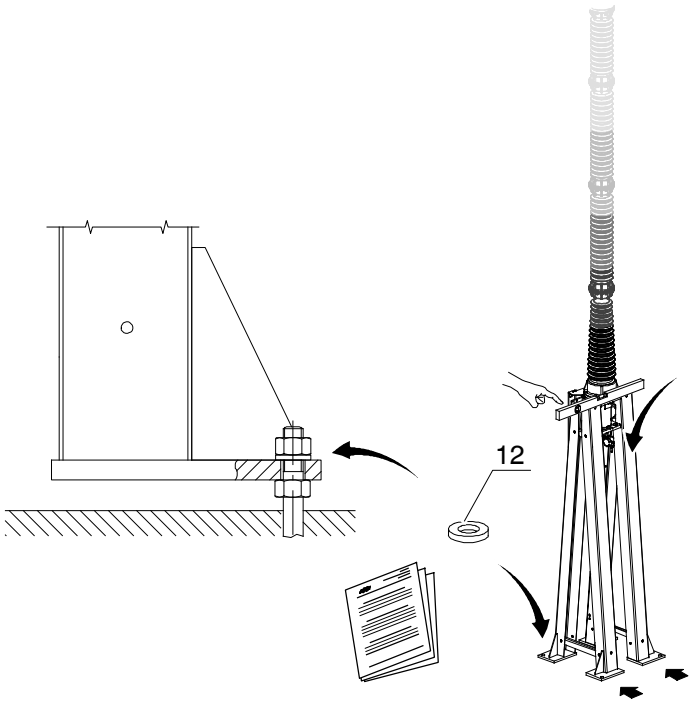


Positioning the pole

Process

The table below gives the steps of positioning the pole :

Step	Action
1 	Use a lifting device to position the chassis frame onto its ground attachment points but do not secure it, whilst respecting the orientation of the pole indicated on the sketch of the device.
2	If necessary, place shims under the supports of the frame so that the upper plate is level.
3	Install the washers (12) and clamp the whole to the ground using nut.
4	Remove the lifting straps.
5 	Check the tightening torques of all frame screws.
6 	Tighten the fixings on the two floor seatings in accordance with the module entitled **'Tightening Torques'** and in accordance with the diameters of the anchoring points.



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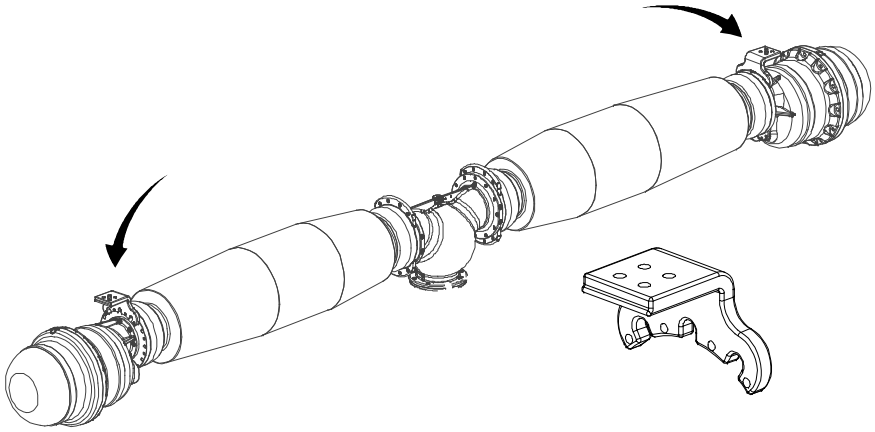
Installing terminals with preparation of contact surfaces

Presentation

Diagram



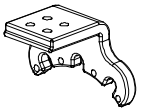
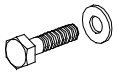
In this module

This module contains the following topics :

Components, products and accessories

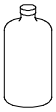
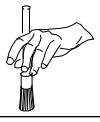
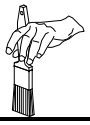
Necessary components

List of the Grid Solutions components necessary for the assembling (per pole) :

Mark	Diagram	Designation	Number
(1)		Terminal	2
(3)		Screws H M12- 45	8

Necessary products and accessories

List of the Grid Solutions products and accessories necessary for the installing :

Grid Solutions reference	Diagram	Designation
- 01861262		Can of ISOPROPANOL (1l)
- 01835106		Vaseline 204- 9
- 01835118		Contactal grease
- 01831320		Abrasive paper A400
- 02212337		Scotch Brite A- VF
- 02212334		Rag
- 02211842		Round brush No.4
- 02211831		Brush No.16

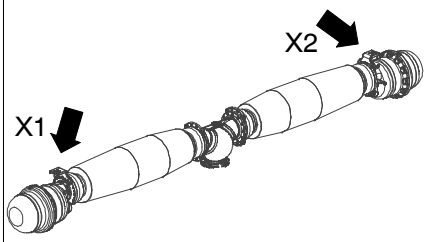
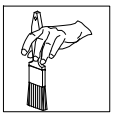
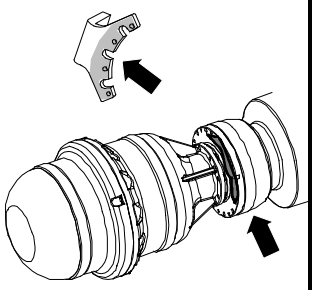
Preparing the contact surfaces

Preparing the contact grease

The contact grease is a mixture composed of Vaseline and Contactal grease.
CONTACT GREASE = 50% Vaseline + 50% Contactal grease

Preparing the contact surfaces

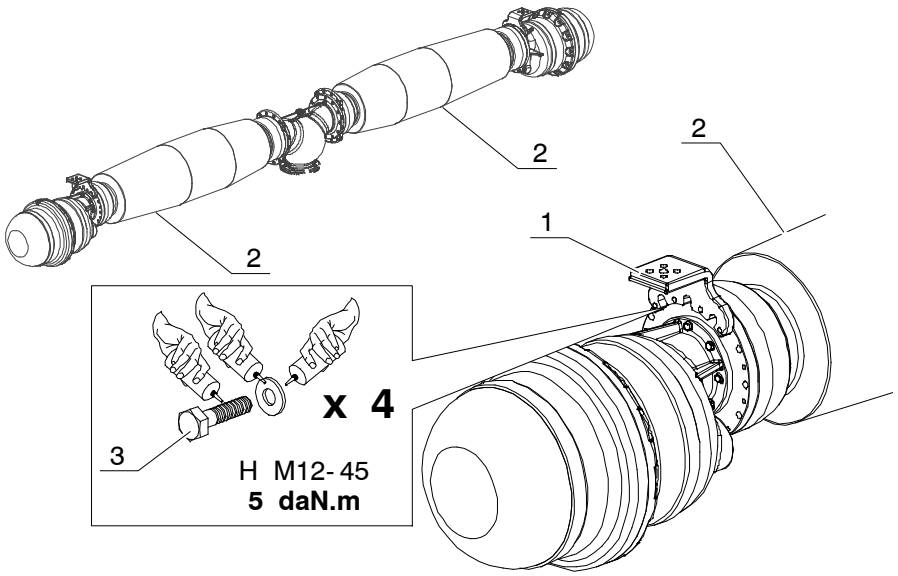
The table below gives the steps of preparing the contact surfaces :

Step	Action	Diagram
1	Remove the temporary screws from the terminal pads X1 and X2.	
2	Dry rub with fine emery cloth.	
3	Eliminate the dust produced.	
4	Coat with CONTACT GREASE.	
5	Wipe with a clean rag, leaving just a thin layer of grease.	
6	Rub over the grease with waterproof abrasive paper A400.	
		

Installing terminals

Process

Assemble immediately the terminals (1) on the interrupting chambers (2) after preparation of contact surfaces. Fasten the terminals using screws (3); use CONTACT GREASE to seal the screws.



Comment

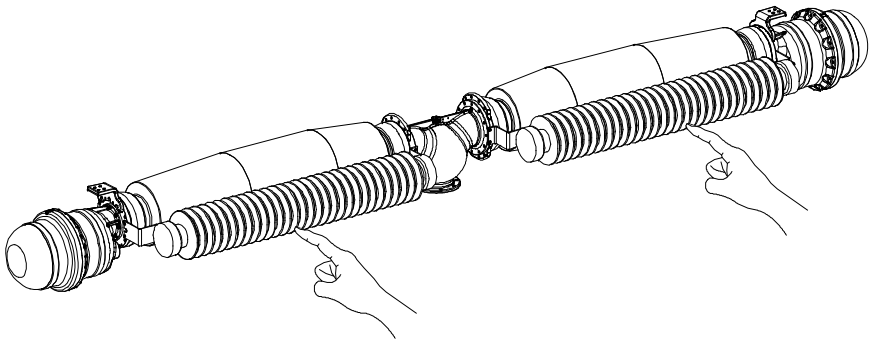
- The electrical resistance value of the assembly should be :

$$R \leq 2\mu\Omega$$

- Before installing H.V. connectors, prepare the contact surfaces in the same way.

Presentation

Diagram



Necessary tools

List of the tools necessary :

Mark	Diagram	Designation	Number
(12)		Lifting strap (3 m)	2

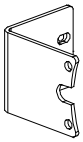
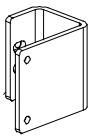
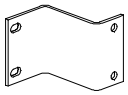
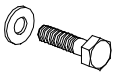
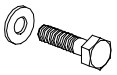
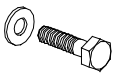
In this module

This module contains the following topics :

Components and products

Necessary components

List of the Grid Solutions components necessary for the assembling (per pole) :

Mark	Diagram	Designation	Number
(1)		Capacitor	2
(3)		Support	2
(4)	 or 	Support (depending on the apparatus)	2
(5)		Screws H M12-30	8
(8)		Screws H M12-45	4
(9)		Screws H M12-25	4
(1)		Spacer	4

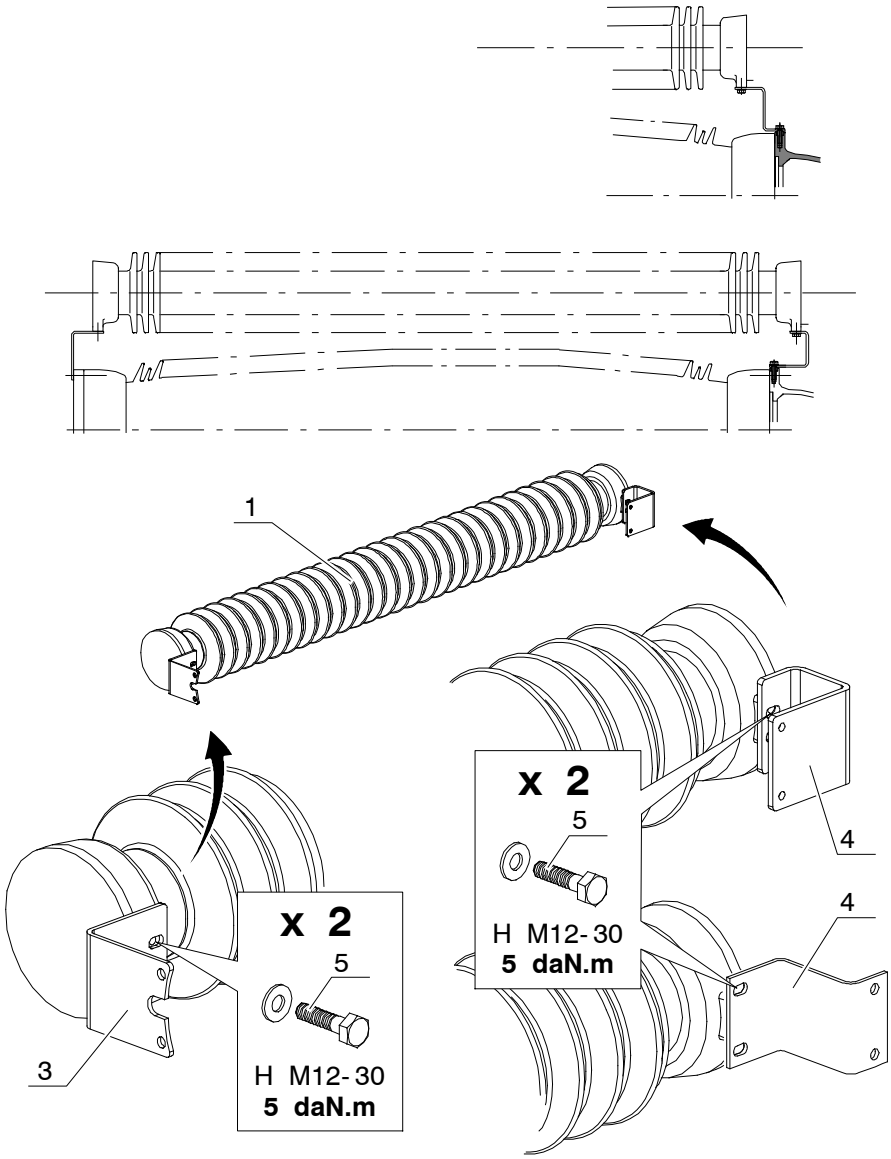
Necessary product

Grease MOBILPLEX 47 (screws greasing)

Preparing the capacitors

Installing the supports

- Install the support (3) on the capacitor (1) using the screws (5).
- Install the support (4) on the capacitor (1) using the screws (5).



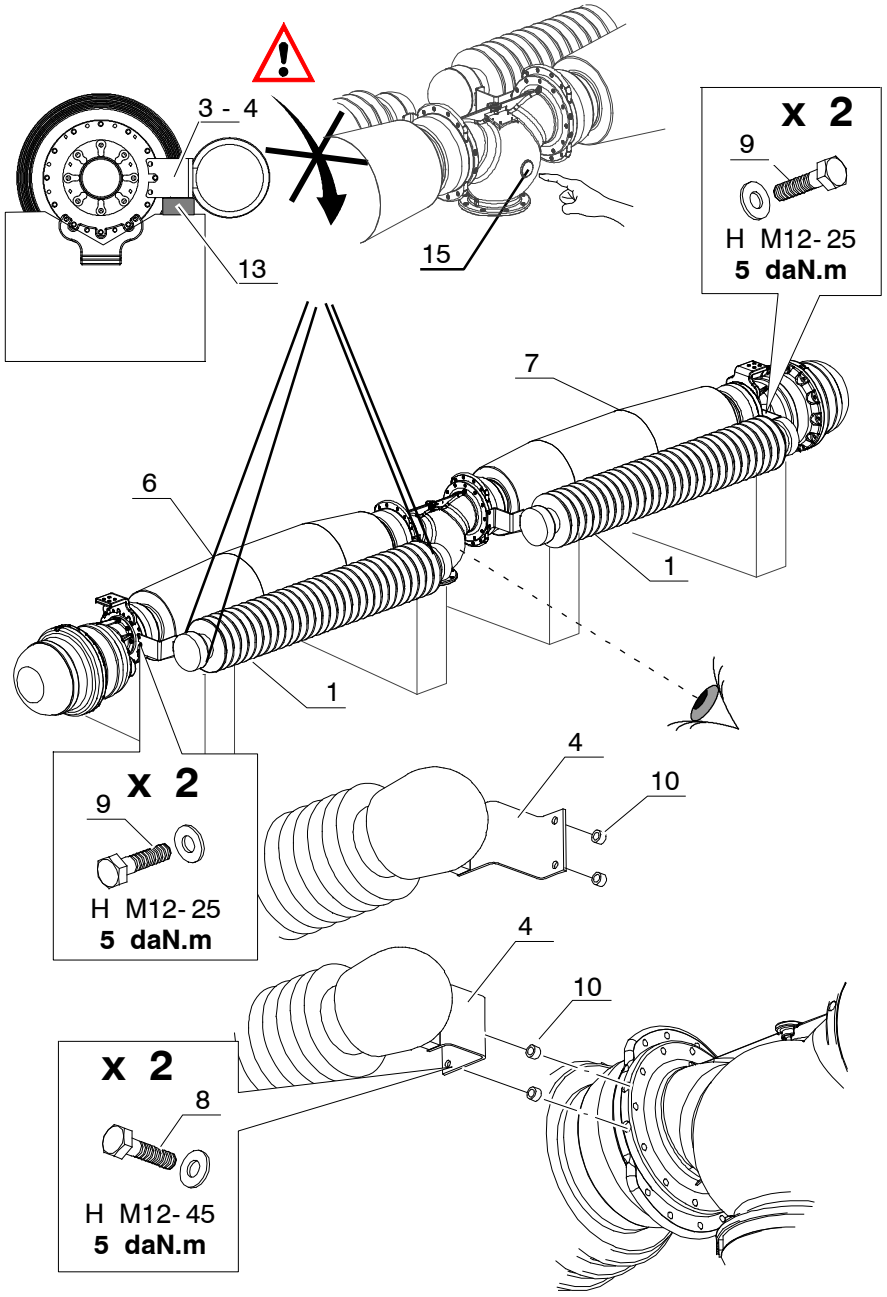
Installing the capacitors

Process

Install the capacitors (1) on the interrupting chambers (6) and (7) - **on the opposite side as the bosse of the housing (13)** - using the screws (8) and (9).

NOTE : Use the two spacers (10) to install the capacitors - capacitor support (4) side.

To avoid the rotation of the interrupting chambers, insert a wedge (13) under the supports of the capacitors (3)- (4) after installing.



Presentation

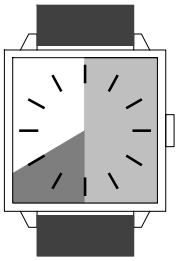
Markings

Before coupling the chambers and column, check that the markings on the breaking chambers correspond with those on the column

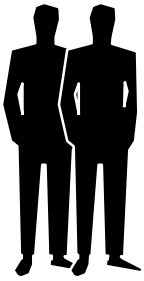
Time taken for coupling operation

The final chamber/column coupling operations should be completed in a time of ≤ **40 min.**

NOTE: The coupling operations must be carried out by a minimum of two people.



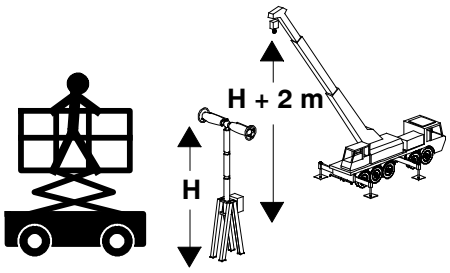
T(max) ≤ 40 min



Lifting means

Provide an adequate means of hoisting:
3,000 daN (minimum).

An aerial basket is mandatory.



Stages of the coupling operation

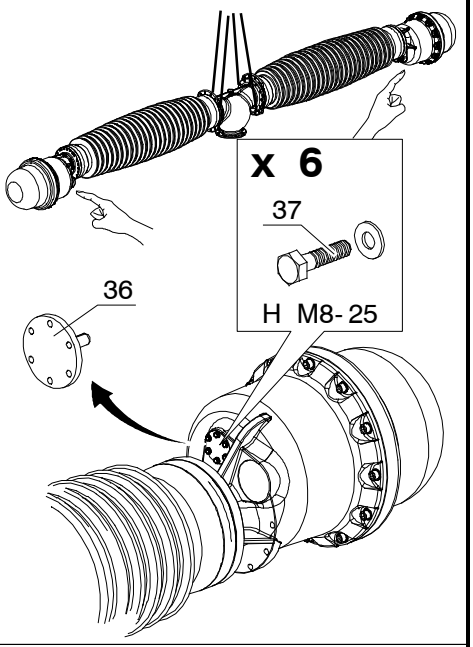
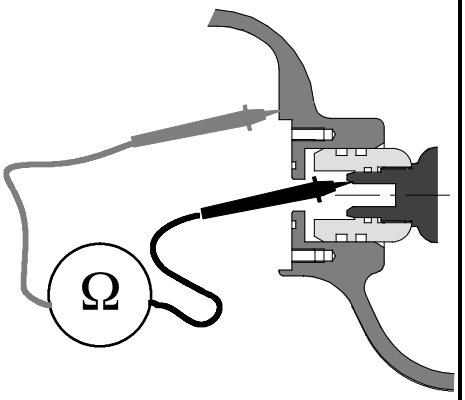
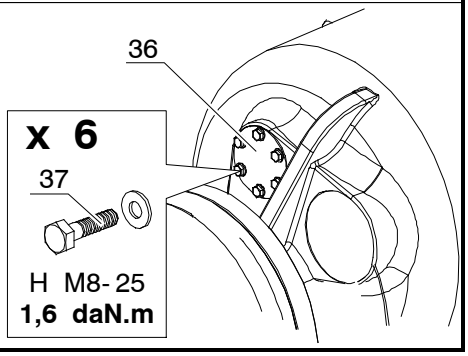
The chamber- column coupling operation can be broken down into a number of stages:

Step	Subject	Page
A	Checking of the insertion resistor	2
B	Preparing the column's corona shield	3
C	Preparing the elements required for the coupling operation	4
D	Hoisting and preparing the breaking chamber	6
E	Final coupling	7

Checking of the insertion resistor

Process

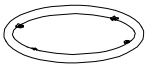
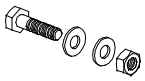
The table below gives the steps of checking of the insertion resistor :

Step	Action	Diagram
1	Using the two straps provided, lift the chambers (approximate weight : 700 kg). On each resistor, remove the plug (36) fixed by screws (37).	
2 ⚠	Measure the ohmic value using a multimeter. **If the measured value does not correspond to the value indicated on the plug, contact our Customer Service.**	
3 📄	Re- install the plugs (36) using the screws (37), referring to “Screw sealing” in ”Erection general procedures”. Put back the chambers.	

Preparing the column's corona shield

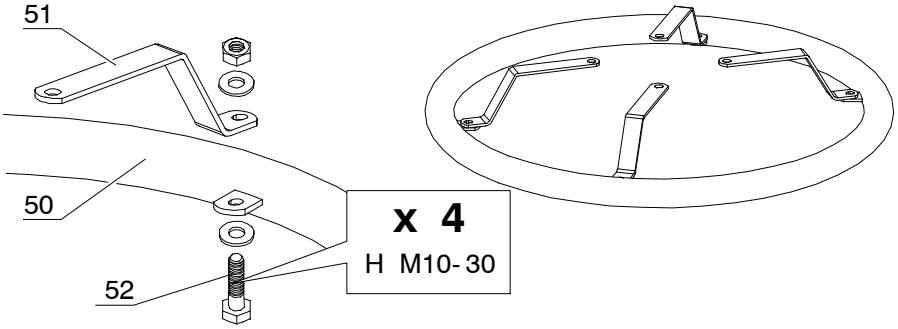
Elements required: Grid Solutions

List of Grid Solutions elements required for assembly (per pole):

Mark	Illustration	Description	Quantity
(50)		Corona shields	1
(51)		Lugs	4
(52)		Fittings H M10-30	4

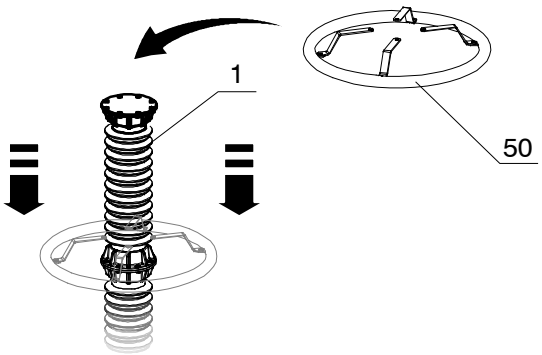
Assembly

Attach the lugs (51) to the corona shield (50) using the fittings (52) **without overtightening**.



Positioning

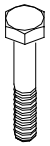
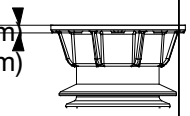
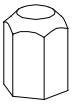
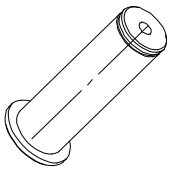
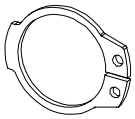
Temporarily fit the corona shield (50) to the base of the first isolator on the column (1).



Preparing the elements required for the coupling operation

Elements required: Grid Solutions

List of Grid Solutions items necessary for the operation:

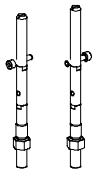
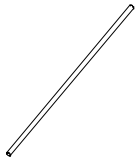
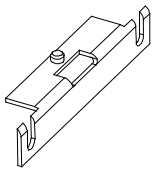
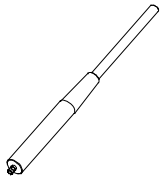
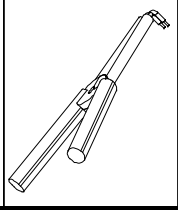
Mark	Illustration	Description	Quantity
(20)		Seal	1
(21)		Screws H M16- 65 (19 mm) H M16- 75 (30 mm) 	8
(22)		Washer M16	16
(23)		Nut	8
(24)		Coupling pin	1
(25)		Circlips	1

Continued on next page.

Preparing the elements required for the coupling operation, continued

Tools required Grid Solutions

List of Grid Solutions tools necessary for the operation:

Mark	Illustration	Description	Quantity
(30) (31)		”Short” centring pin ”Long” centring pin	1
(32)		Lever	1
(33)		Protective mask	1
(34)		Trolley stop	1
(35)		Fitting tool for coupling pin	1
(37)		Circlip clamp (not supplied)	1

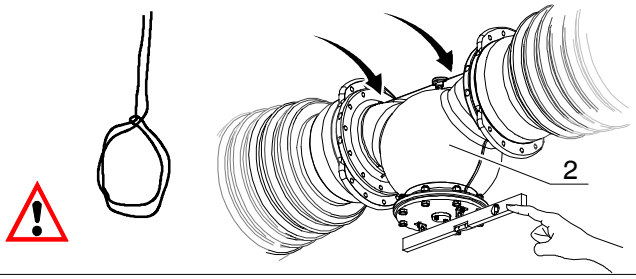
Products required

- **MOLYKOTE M111 Grease**: greasing contact surfaces
- **LOCTITE 225**: locking fitting in place
- **MOBILPLEX 47 - MOBILUX EP3**: greasing fittings

Hoisting and preparing the breaking chamber

Raising the breaking chambers

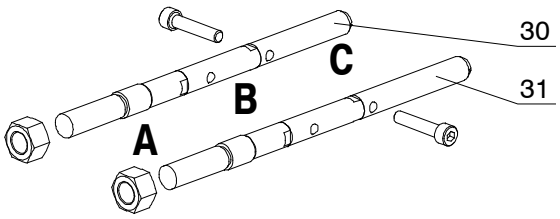
Using two slings, lift the chambers and **LEVEL THEM**, the casing (2) should be at head height (approximate weight: 700 kg).



Assembling the centring pins

Fit parts A, B & C to the centring pins (30) & (31) without locking them in place so that they may be easily removed later on.

NOTE: Pin (31) is longer than pin (30).

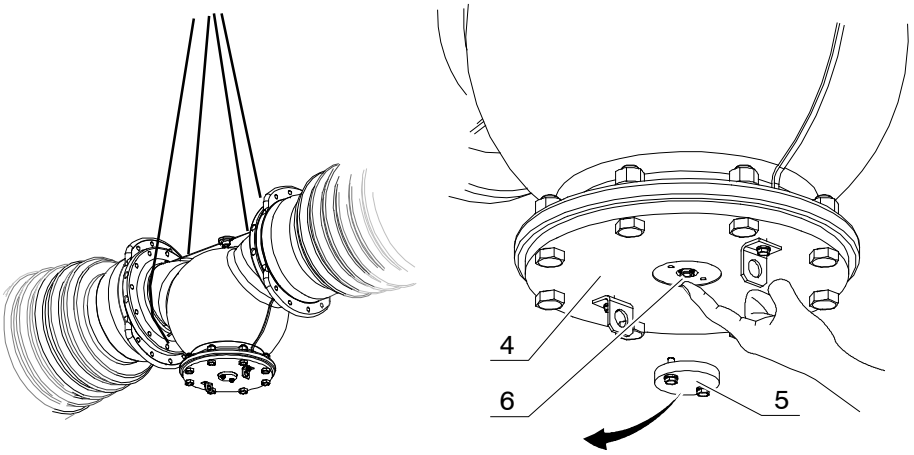


Depressurizing the chambers

- Remove the cap (5) from the transport cover (4) and operate the valve (6) to re- establish atmospheric pressure within the chambers.

REMINDER: transport pressure nitrogen: azote (N_2) at 0.03 MPa at 20°C (101.3 kPa).

- Refit the cap (5).

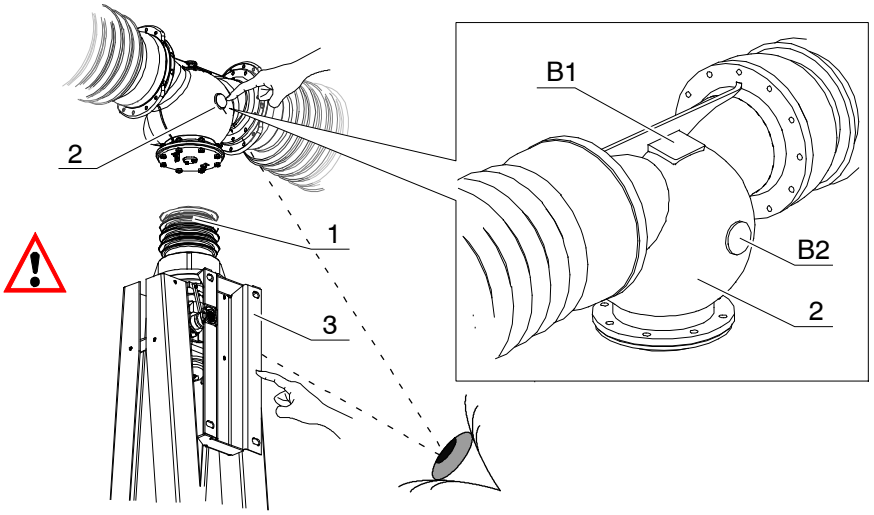


Continued on next page.

Final coupling

Orientation of the chambers

To aid later identification of the chambers it is of the utmost important that they be coupled the right way round.
There are two 'humps' (B1 & B2) on the casing (2).
Set the chambers level with the column (1) so that the humps (B1 & B2) on the casing (2) are on the same side as the control mounting (3).

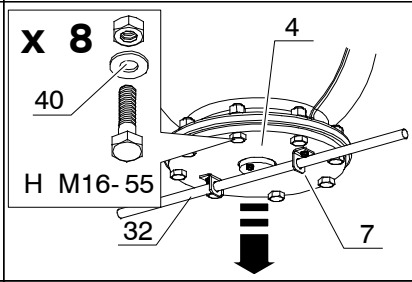
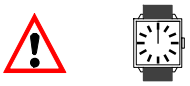
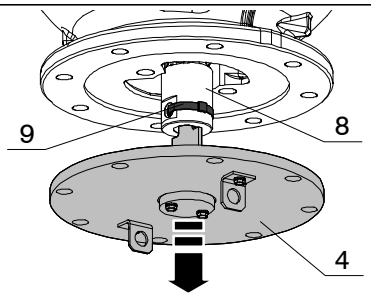
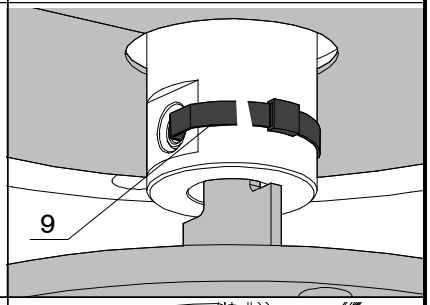
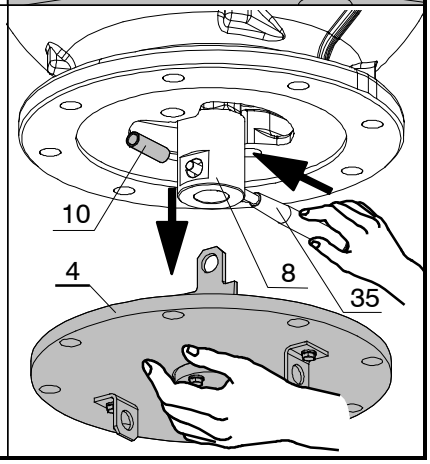


Continued on next page.

Final coupling, continued

Removing the chamber transport cover

The table below shows the steps for removing the chamber transport cover:

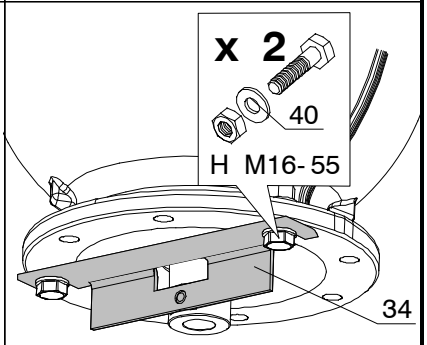
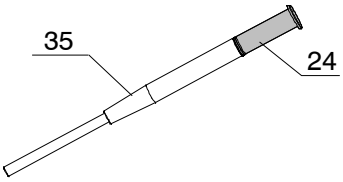
Step	Action	Illustration
1	Remove the fixings (40) and insert the lever (32) through the bracket rings (7). Pull on the lever (32) to open the cover (4). Hold on two two of the cover bolts (40) for later use.	
2	**Start timing**. (The final chamber/column coupling operations should be completed in a time of ≤ 40 min).	
3	Pull off the cover (4) to free the stop ring (8) and 'Rilsan' collar (9).	
4	Using wire cutters, cut through the 'Rilsan' collar (9) holding the connector tube and remove it.	
5	Using the coupling tool (35), remove the tube (10) and separate the cover (4) from the stop ring (8).	

Continued on next page.

Final coupling, continued

Removing the chamber transport cover

The table below shows the steps for removing the chamber transport cover:

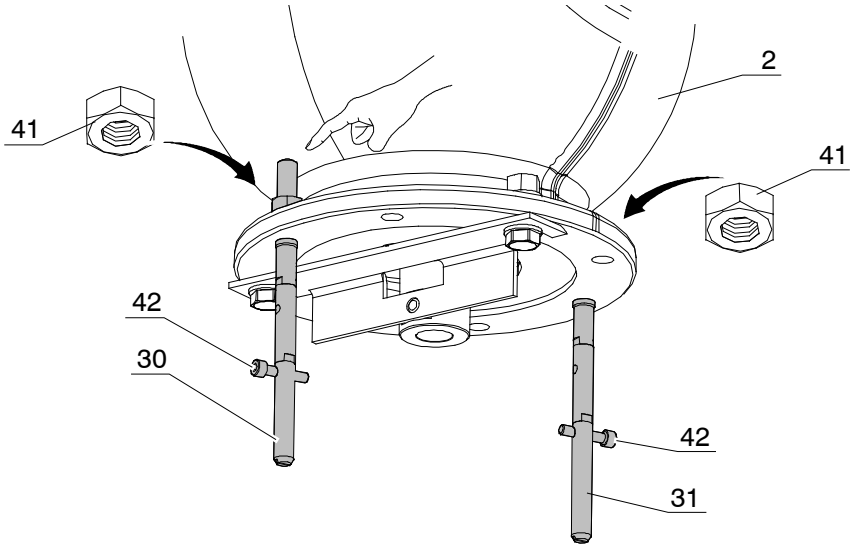
Step	Action	Illustration
6	Fit the trolley stop (34) and fix in place using the bolts (40) recovered from the transport cover, hand tightening them.	
7	Prepare the fitting tool (35) by screwing the coupling pin (24) onto its end, hand tightening.	

Continued on next page.

Final coupling, continued

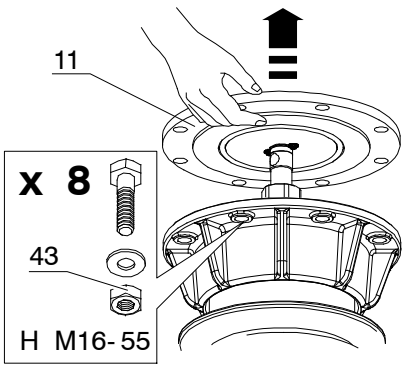
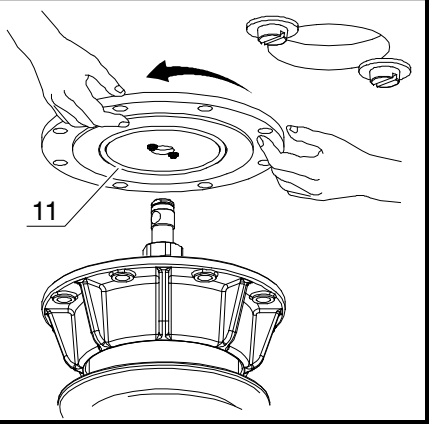
Fitting the centring pins

Fit the centring pins (30) & (31) hard against the spherical casing (2), lightly tighten the nuts (41).
Fit the screws (42) to the centring pins (30) and (31).



Removing the column cover

The table below shows the steps for removing the column cover:

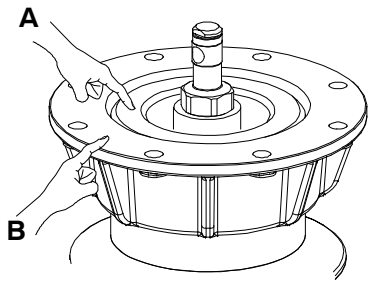
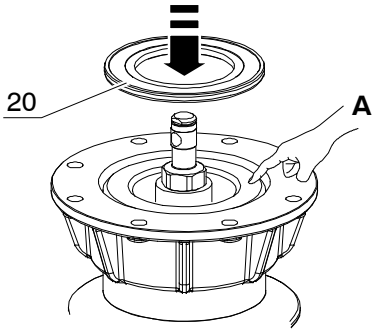
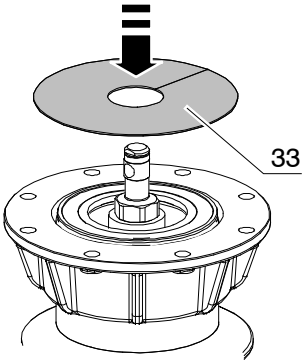
Step	Action	Illustration
1	Remove the fittings (43) and open the cover (11).	
2	Turn the cover (11) through 90° to remove it.	

Continued on next page.

Final coupling, continued

Fitting the seal

The table below shows the steps for fitting the seal:

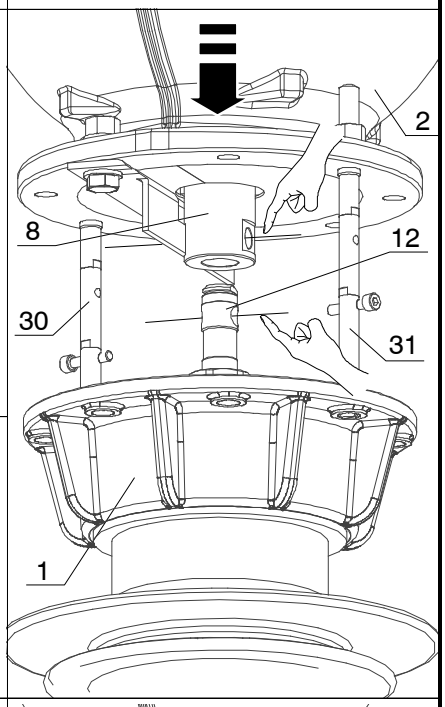
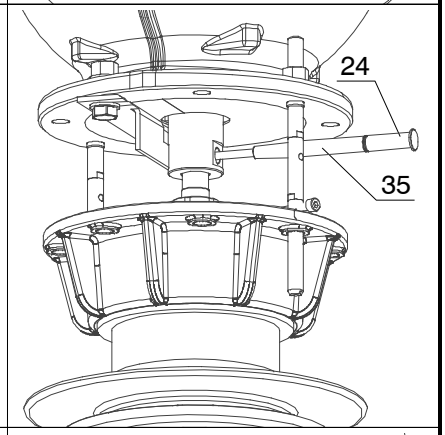
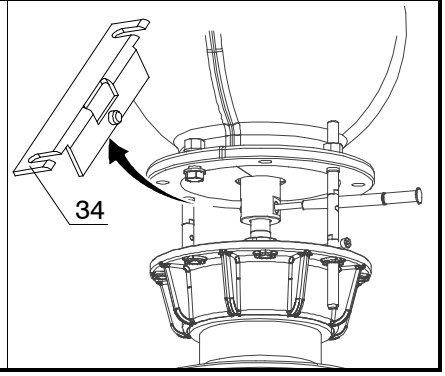
Step	Action	Illustration
1	Clean the contact surfaces "**A**" and "**B**" with ISOPROPANOL. Only coat surface **"B"** with MOLYKOTE M111 lubricant.	
2 	Fit a new seal (20) and place it on surface "**A**", referring to "**Preparing and fitting static seals**". See module **'General assembly procedures'.**	
3	Fit the protective cover (33).	

Continued on next page.

Final coupling, continued

Fitting the coupling pin

The table below shows the steps for fitting the chamber- column coupling pin:

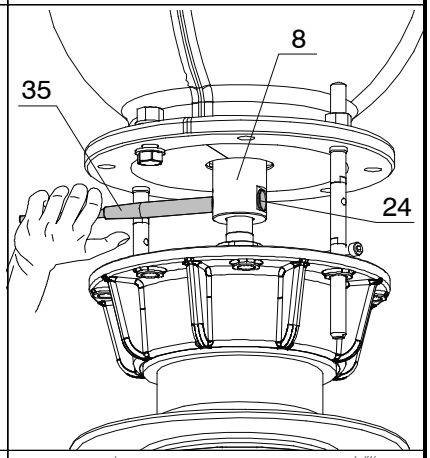
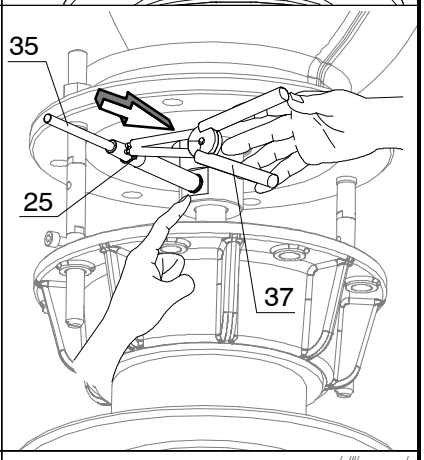
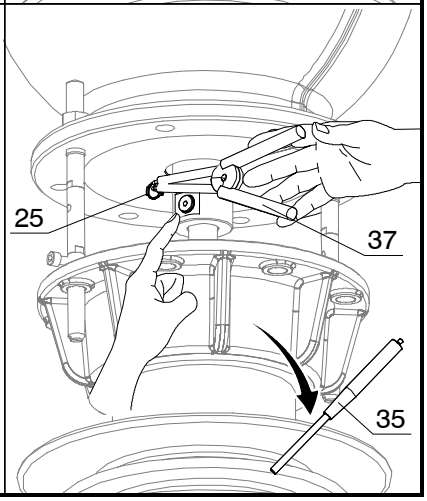
Step	Action	Illustration
1	Slowly lower the breaking chambers (2), inserting the centring pins (30) & (31) into the holes in the column flange (1). Make sure both pins are correctly aligned.	
2	Slower lower the breaking chambers (2) to align the pin with the holes in the cylinder (8) and the rod (12).	
3	Insert the fitting tool (35) with the coupling pin (24) on its end.	
4	Slightly loosen the two screws holding the trolley stop (34) in place and remove it.	

Continued on next page.

Final coupling, continued

Fitting the coupling pin

The table below shows the steps for connecting the chambers to the column:

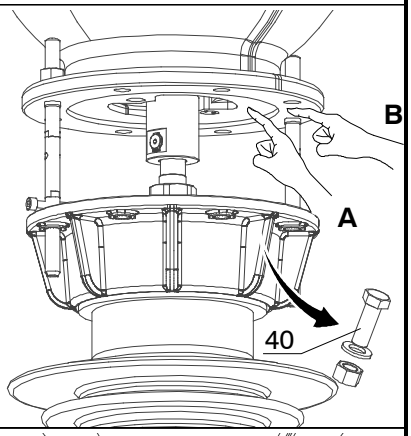
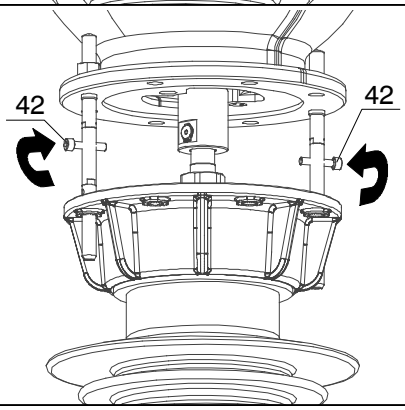
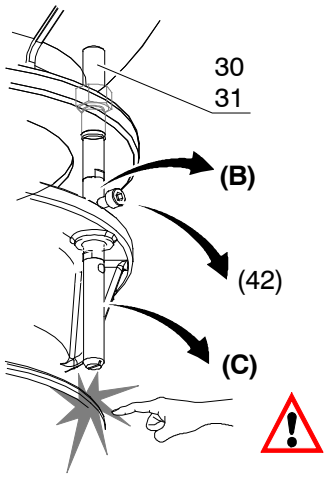
Step	Action	Illustration
5	Fit the coupling pin (24) by manually pulling on the fitting tool (34) until it stops on the cylinder (8).	
6	Fit the circlips (25), sliding them along the fitting tool (35) using circlips pliers (37). See the second method (7).	
7	Remove the fitting tool (35) from the coupling pin, loosening it by hand. Second method: Fit circlips (25) using circlip pliers (37).	

Continued on next page.

Final coupling, continued

Connection chambers/column

The table below shows the steps for connecting the chambers to the column:

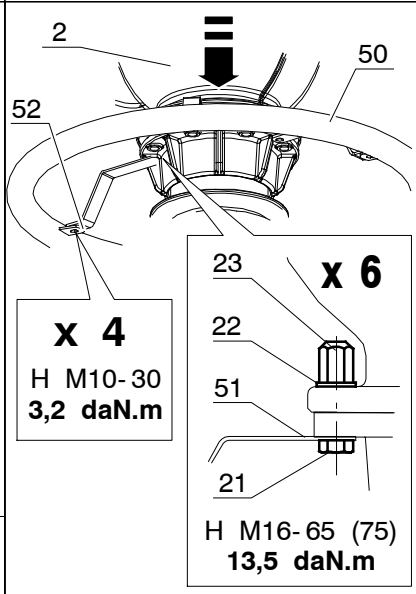
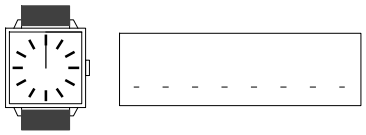
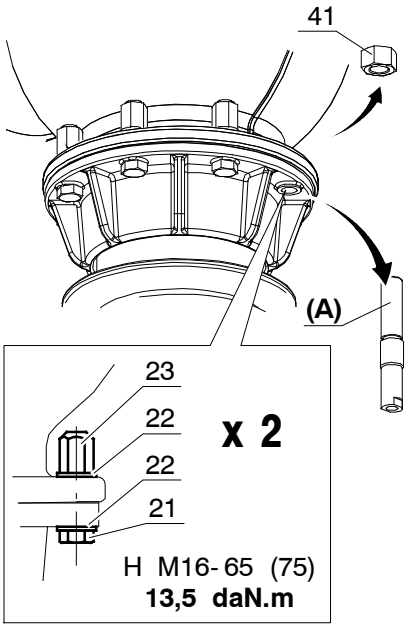
Step	Action	Illustration
1	Clean the contact surfaces "**A**" and "**B**" with ISOPROPANOL. Only coat surface **"B"** with MOLYKOTE M111 lubricant. Remove the trolley stop fixing screws (40).	
2	Remove the screws (42) from the centring pins.	
3	Continue to slowly lower the breaking chamber, removing the first two sections of centring pin (30 & 31) when they are no longer of any use as a guide, in the following order: - First section (C) - Screw (42) - Second section (B) **NOTE**: The aim of this operation is to prevent the centring pins coming into contact with the porcelain fins on the column.	

Continued on next page.

Final coupling, continued

Connection chambers/column

The table below shows the steps for connecting the chambers to the column:

Step	Action	Illustration
4	Slowly lower the breaking chamber casing (2) onto the column. Position the lugs (51) for the corona shield (50) on the rim of the column then attach using bolts (21), washers (22) and special nuts (23) - See '**Locking Fixings**'. See module **'General assembly procedures'.** Lock the nuts (23) at the appropriate torque, immobilising the bolt heads (21).	
5	Tighten all fixings (52) to their appropriate torque level.	
6	End of coupling operation - stop the timer and note the time taken.	
7	Remove the last section (A) and the nut (41) from the centring pins. Fix the last bolts (21), washers (22) and special nuts (23) referring to "**Locking fixings**". See module **'General assembly procedures'.** Lock the nuts (23) at the appropriate torque, immobilising the bolt heads (21).	

Continued on next page.

Final coupling, continued

Vacuum extraction and filling with gas

Once the coupling operation has been completed, continue with:

- **The air extraction operation**
- **The gas filling operation**

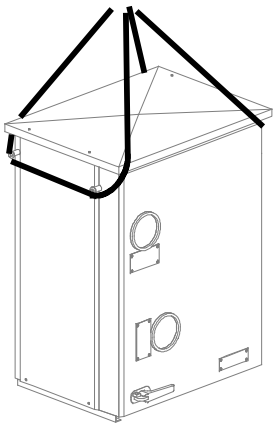
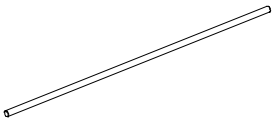
Presentation

Necessary product

Grease MOBILPLEX 47 or MOBILUX EP3 (screws greasing)

Necessary Grid Solutions tools

List of the Grid Solutions tools necessary for the installing :

Mark	Diagram	Designation	Number
(1)		Lifting strap	1
(6)		Lever	1

Lifting equipment

Provide an appropriate lifting equipment (300 daN).

Process

The table below gives the steps of installing the operating device on the pole- support :

Preparing the operating device

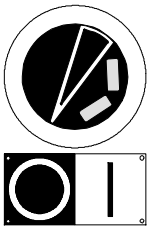
Unpacking

Remove packaging protection and check that operating device and pole reference numbers are the right ones.

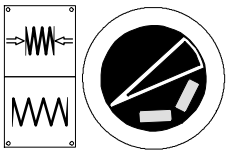
Optical signalizations

Check the position of operating device optical signalization :

Circuit- breaker
Open

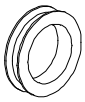


Closing spring
Released



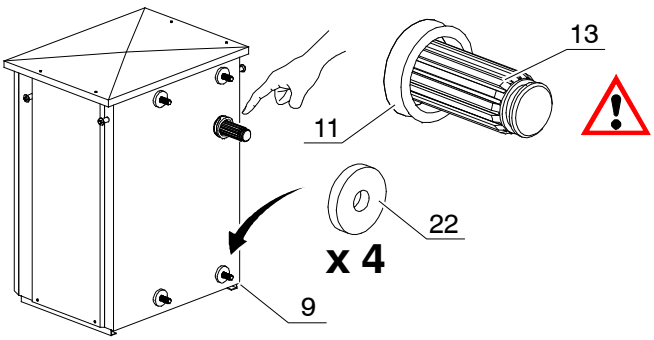
Necessary components

List of the Grid Solutions components necessary for the operation :

Mark	Diagram	Designation	Number
(11)		Seal	1
(22)		Spacer	4

Installing the necessary components

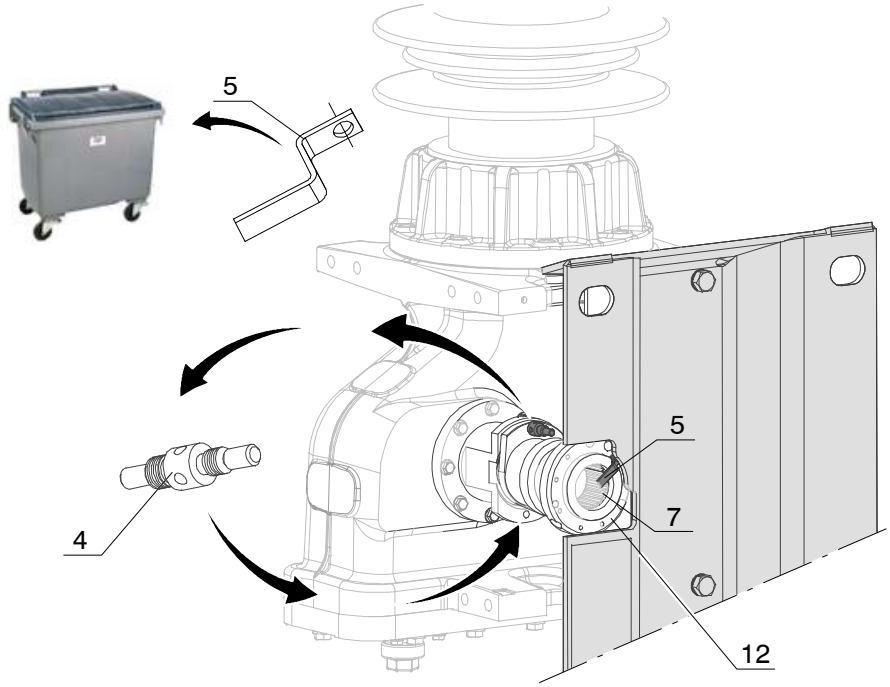
- Install the spacers (22) on the screws (9) outside the operating device.
- Install the seal (11) on the operating shaft (13).
- Check the presence of grease (ASEOL 0- 365.2) on the operating shaft (13).



Preparing the pole operating shaft

Introduction

For transport the pole is fitted with a securing tool (4) and a safety plate (5), temporarily attached to the end of the handle (12)
To fit the operating lever, you must:
a - Remove the securing tool (4).
b - **Manually open the pole.**
c - Refit the securing tool (4) ("open" position).
d - Remove the safety plate (5).



Grease

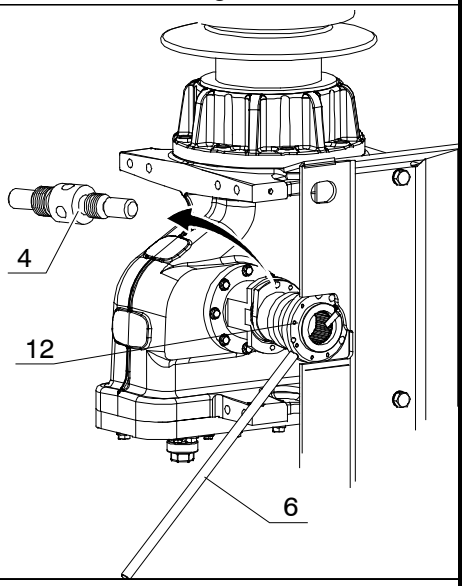
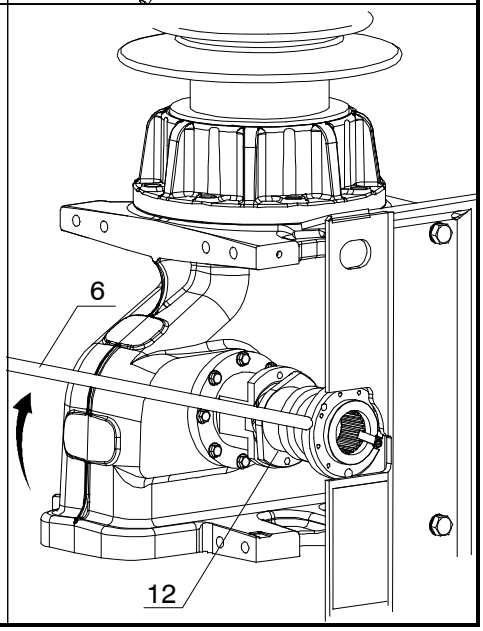
Check the presence of grease (ASEOL 0- 365.2) on the pole operating shaft.

Continued on next page.

Preparing the pole operating shaft, continued

"Manual opening" operation

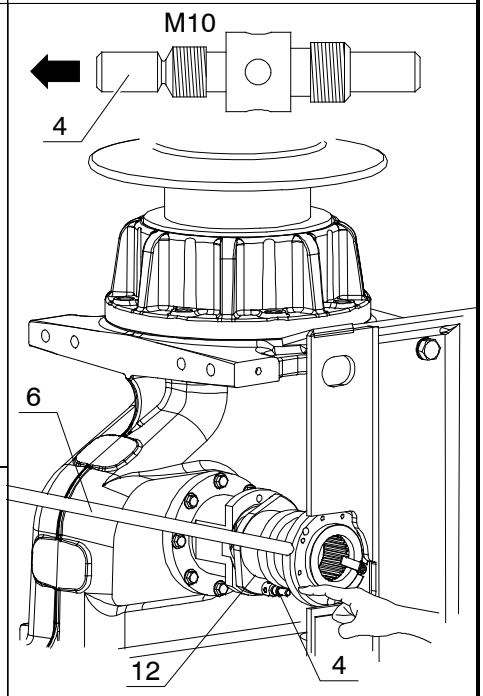
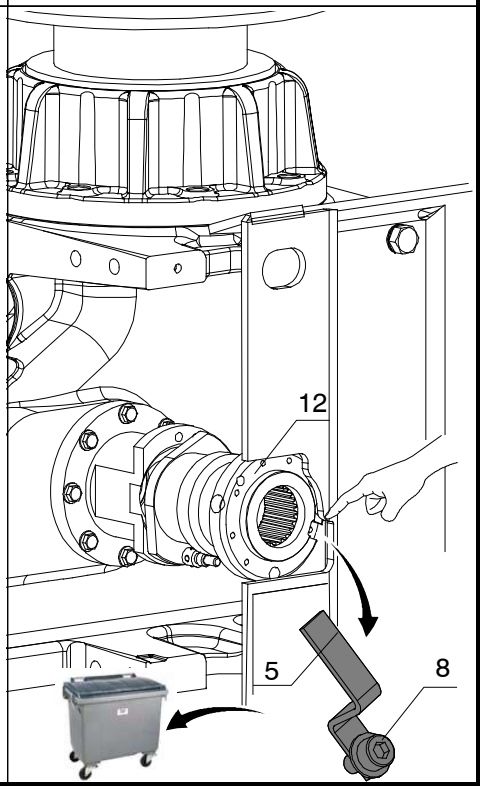
The table below gives the steps of "manual opening" operation :

Step	Action	Diagram
1	Remove the securing tool (4) then screw the operating lever (6) onto the flange on the front of the handle sleeve (12).	
2	With the help of the lever (6), effect a 60° rotation of the sleeve (12).	

Preparing the pole operating shaft, continued

"Manual opening" operation, continued

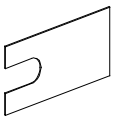
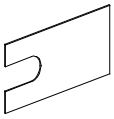
The table below gives the steps of "manual opening" operation :

Step	Action	Diagram
3	Put back the blocking tool (4) on the flange of the sleeve (12). **NOTE** : This tool ensure the angular positioning of pole operating shaft during the coupling with the operating mechanism.	
4	Remove the lever (6).	
5	Remove the safety plate (5) and the screws from the flange on the front of the handle sleeve (12).	

Coupling the operating device

Necessary components

List of the Grid Solutions components necessary for the operation :

Mark	Diagram	Designation	Number
(10)		Washer M20	4
(22)		Spacer	1
(26)		Spacer	1
(23)		Eccentric spacer	2
(14)		Nut H M20	4
(24)		Wedge (thickness 1 mm)	1
(25)		Wedge (thickness 0,5 mm)	2

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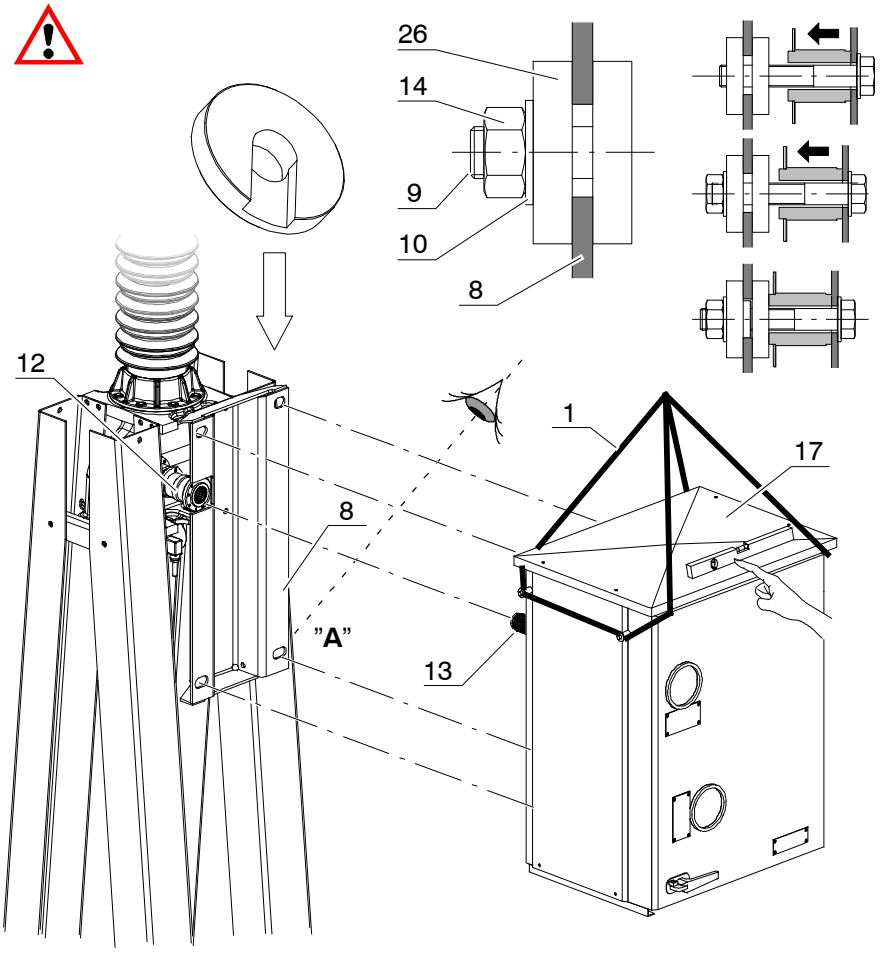
Coupling the operating device, continued

Coupling

The table below gives the steps of the operating device coupling :

Step	Action
1	Sling the operating device using a lifting strap (1) like diagram. **NOTE** : Do not remove the roof (17) of the operating device before slinging.
2	Lift the operating device and make this level. Approximate weight 300 kg.
3	Approach the operating device in assembly position, the jib of the lifting equipment must be under the stress- shields ring (to avoid that the cables touch the stress- shields ring). **The final approach must be done with extreme caution.**
4	Introduce the operating mechanism shaft (13) into the cylinder (12) of the pole operating shaft.
5	As soon as the lower fastening screw (9) "**A**" emerge from the hole of the operating mechanism support (8), install the spacer (26), washer (10) and the nut (14). **NOTE** : Do not tighten the nut (14).

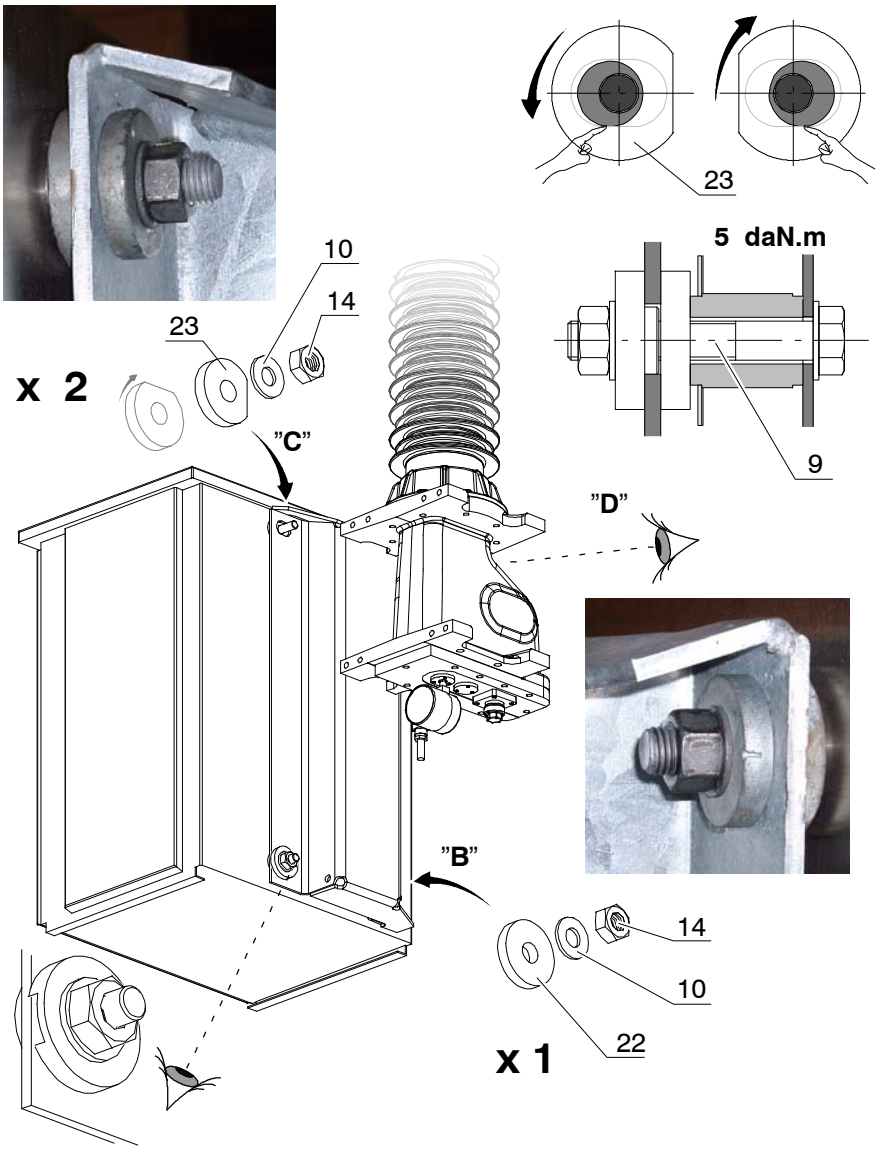


Fastening the operating device

Installing the fastening nuts

The table below gives the steps of installing the operating device fastening nuts :

Step	Action
1	Install the spacer (22), washer (10) and the nut (14) on the lower fastening screw "**B**". **NOTE** : Do not tighten the nut (14).
2	Install the eccentric spacers (23), washers (10) and the nuts (14) on the upper fastening screws "**C**" and "**D**". **NOTE** : Do not tighten the nuts (14).
3	Rotate the eccentric spacers (23) to do the contact with the lower edge of the pole- support oblong holes.
4	Tighten - temporarily at the indicated tightening torque - the fastening screws (9).



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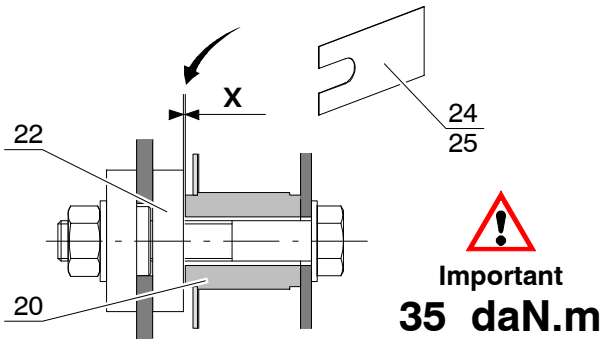
Fastening the operating device, continued

Wedging and tightening

The table below gives the wedging procedure for the fastening screws depending to the X play :



If the X play is ...	Action
X <1 mm	**Tighten to the indicated tightening torque.**
X ≥1 mm	• Wedge between the spacer (22) and the operating device (20) with the provided wedges (24)- (25). • **Tighten the screw to the indicated tightening torque.**

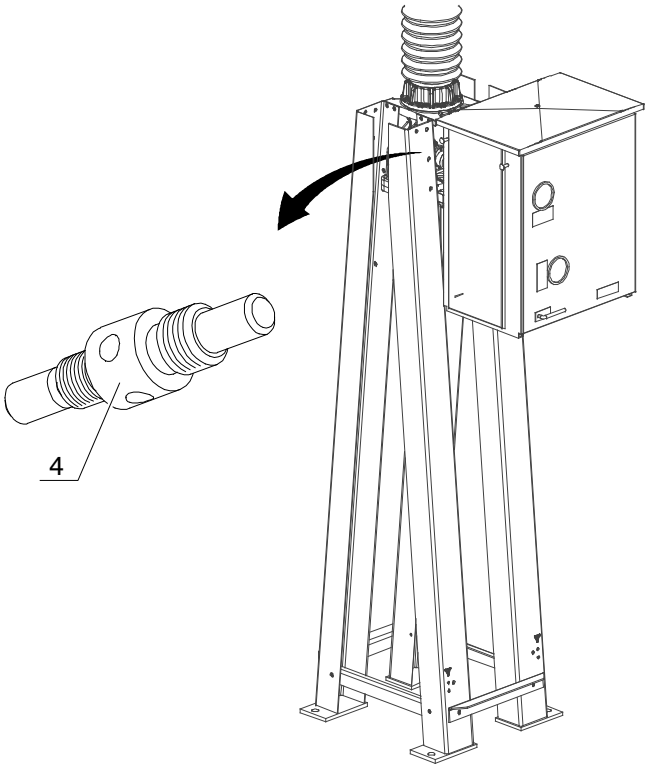
Lifting strap

Remove the lifting strap.

Removing the blocking tool

Process

REMOVE THE BLOCKING TOOL (4).



Low voltage electrical wiring

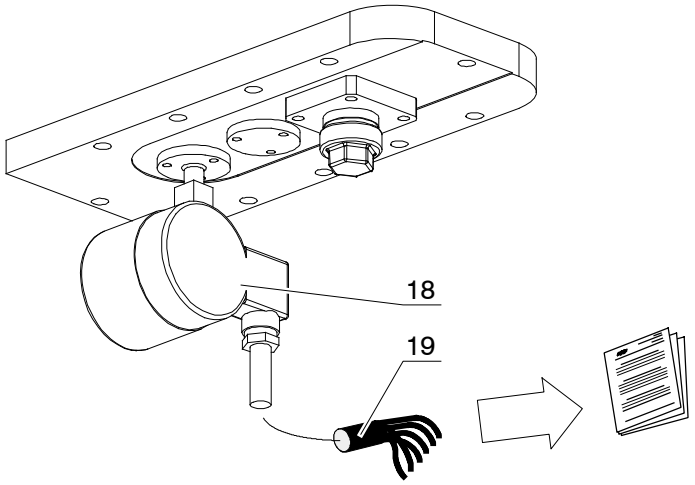
Process

Connect up the operating device's wires refer to the wiring diagram of the circuit- breaker.
Connect up the operating device's wires.

NOTE : Use the holes provided on the supports of the frame to fix the cables.

Connecting up the contact densimeter cable

Connect the wires from the electrical contact SF_6 densimeter (18) cable (19) to the operating mechanism terminal block, in accordance with the relative diagram.



Permanent heating system

Process

Switch on the permanent heating system of the operating device (in both summer and winter) to avoid condensation, and the corrosion which might result from this.

DO NOT SUPPLY THE OPERATING MECHANISM MOTOR WITH CURRENT TO AVOID THE CLOSING SPRING BEING RELOADED.
THE CIRCUIT BREAKER MUST NOT BE OPERATED AT A SF_6 PRESSURE GAS LOWER THAN THE MINIMAL PRESSURE FOR THE INSULATION p_{me}.

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