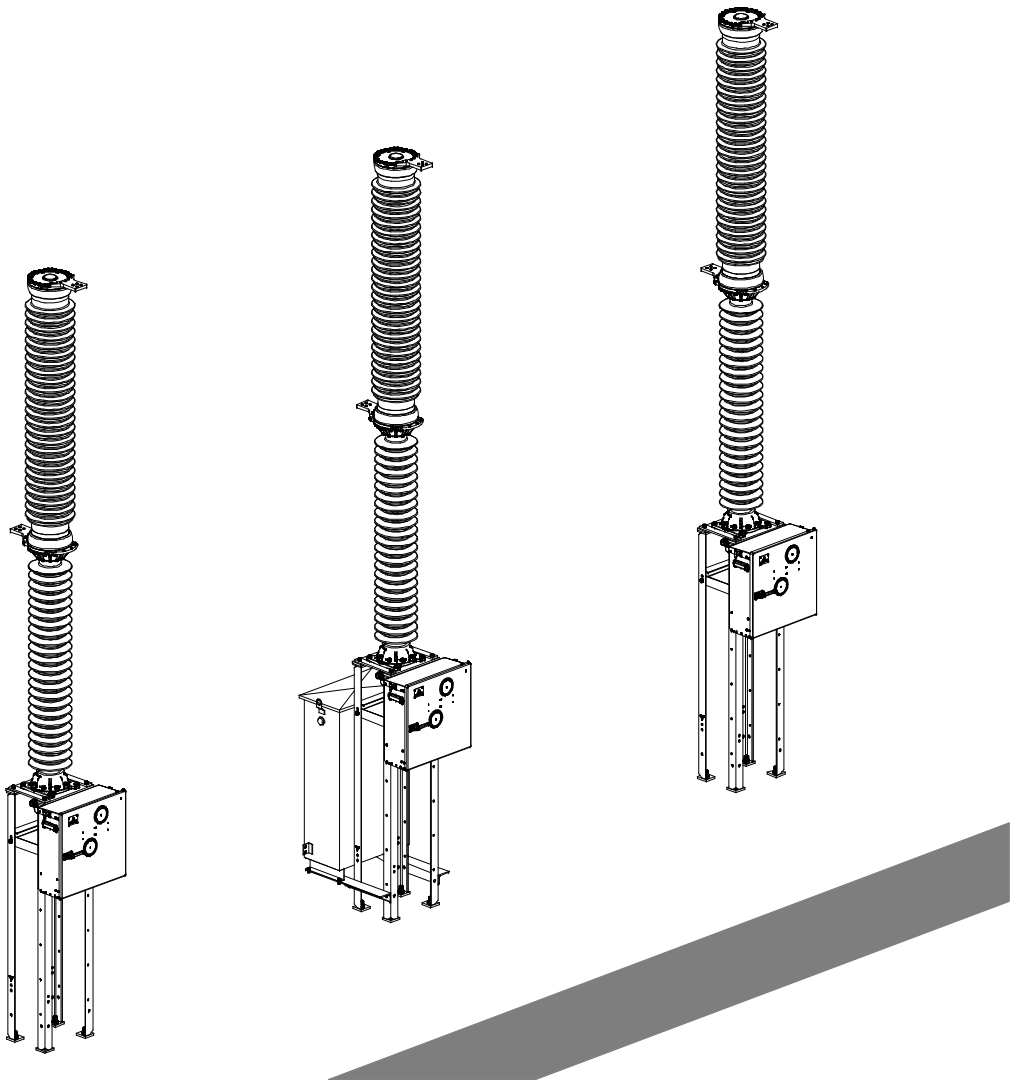
SF_6 circuit breaker
GL314 P.
With spring operating system
FK3-07



This equipment contains a greenhouse effect gas (SF_6), covered by the Kyoto Protocol, with a Global Warming Power of 22200 (GWP).
The SF_6 must be recovered and must not be released into the atmosphere.
For more information on use and handlling of SF_6 refer to norm CEI 62271 : High-voltage switchgear - Part 303 : Use and handling of Sulphur Hexafluoride (SF_6).

Administrator	Emission	Prepared by	Approved by
AHT	22-03-2010	J. Bossu	G. Doummar

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Safety

Technical data

Description and Functionalities

Packaging - Transport and Storage

Installation

Commissioning

Maintenance

Appendices

End of equipment service life

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GL314 P circuit breaker with FK3-07 spring operating system

Description

The device comprises three poles actuated, respectively, by three spring operating mechanisms.

Illustration

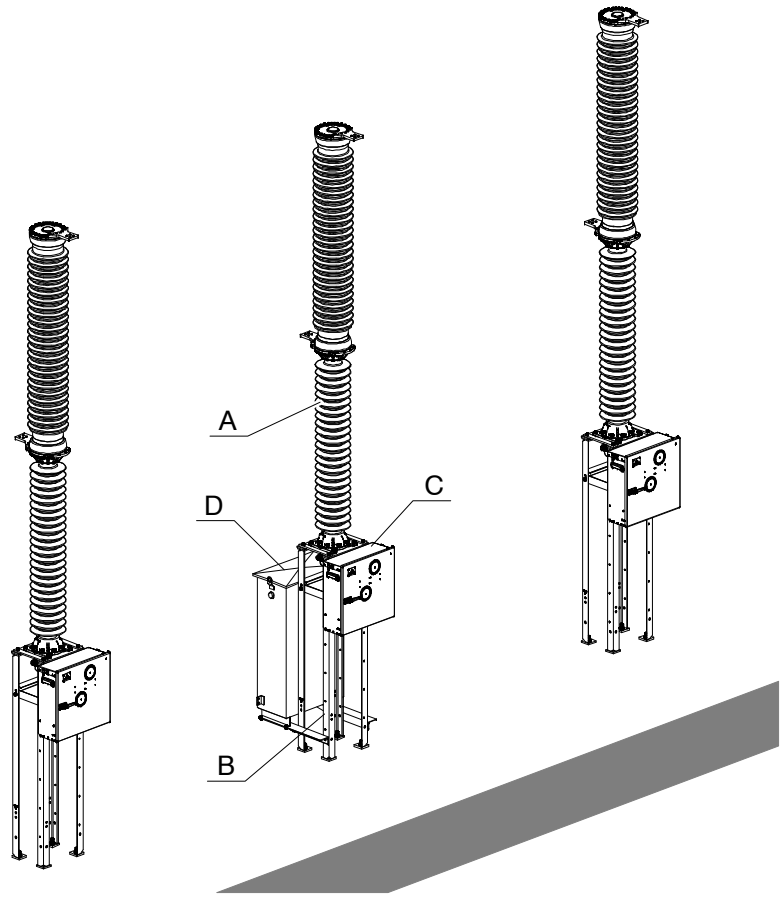


Table of Elements

The following table lists the main components of the circuit breaker :

Mark	Component	Page
A	Circuit breaker pole	2
B	Support frame	3
C	Operating mechanism	4
D	Cable box	5

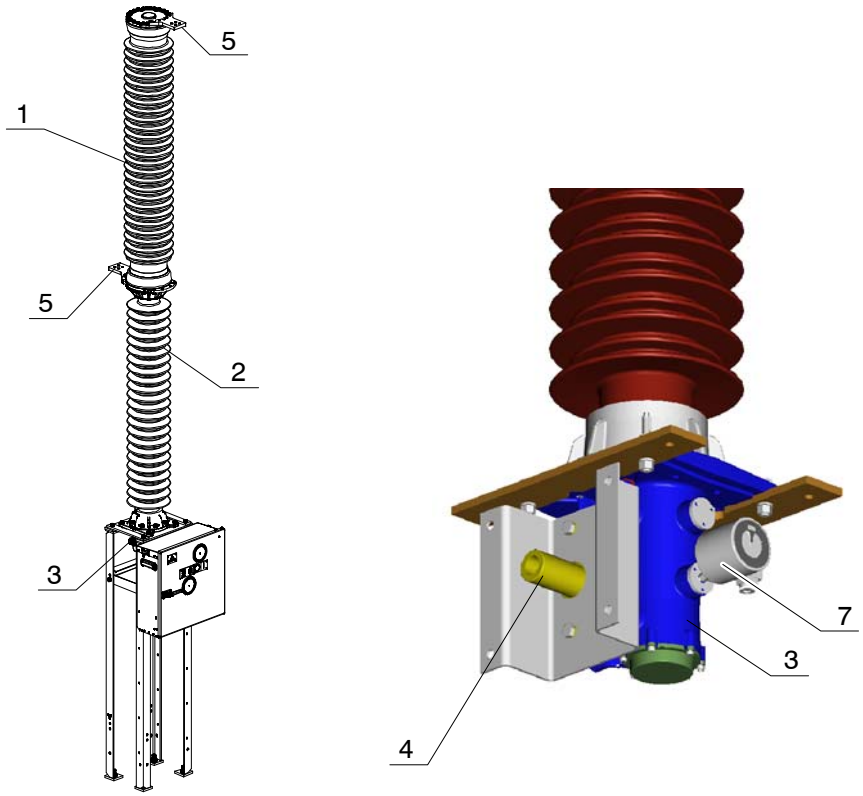
Circuit breaker pole

Description

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

- The breaking chamber (1).
- The support column (2).
- The mechanism casing (3).

Illustration



Breaking chamber

The pole comprises a breaking chamber (1), in ceramic casing, placed vertically, with the upper end of each fitted with a power supply terminal (5).

Support Column

Comprising one or more ceramic insulators, the support column (2) is used to provide earthing insulation for the circuit breaker and encloses the insulating operating rod, attached to the moving parts of the breaking chamber.

Mechanism casing

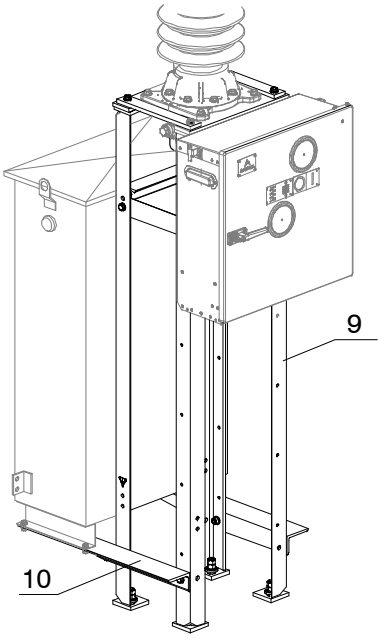
A casing (3), located at the base of the column, encloses the operating rod-crank attached to the moving parts.
The filling and monitoring device for the SF_6 (7) gas is also located in the casing.
An external sleeve (4) mechanically connects the pole to the operating mechanism.

Support frame

Description

The support frame (9) is attached to the ground and supports all of the circuit breaker components.
The support frame can by provided by the client or by ALSTOM Grid.
The support frame (9) is equipped with a cabinet (10).

Illustration

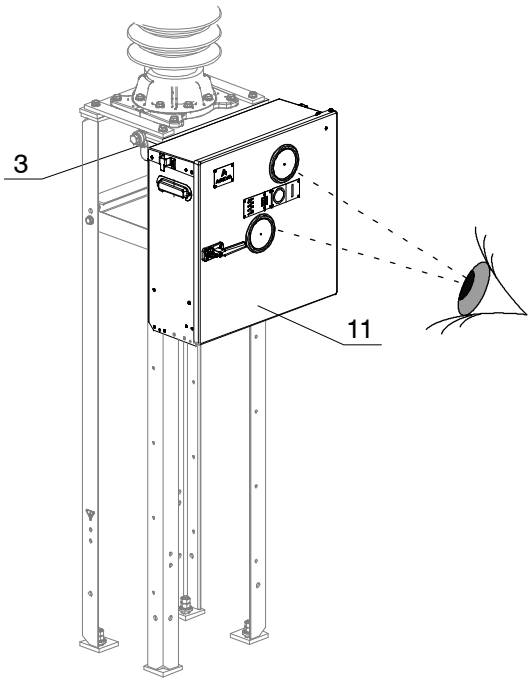


Operating mechanism

Description

The operating mechanism (11) is an FK3-07 type spring operating mechanism.
The door of the operating mechanism is fitted with two inspection windows. These windows are used to view the optical position indicators for the circuit breaker and the status of the closing spring.

Illustration



Fixings

The operating mechanism is fixed to the casing (3).

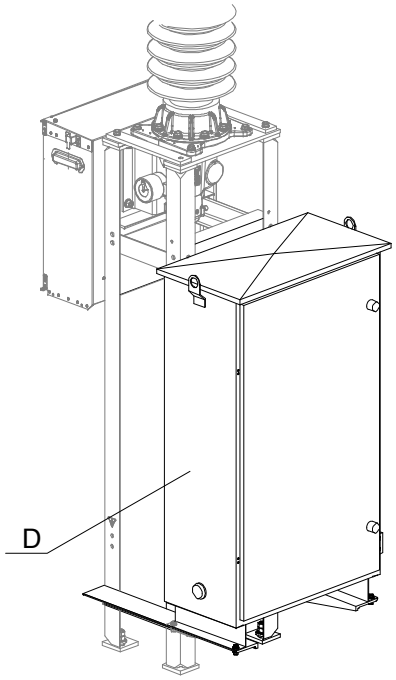
Cable box

Description

The cable box (D) is fixed to the frame.
This comprises :

- Relays required for CB operations
- Connecting terminals.
- Customer terminals

Illustration



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Description of the breaking chamber

Presentation

Extinguisher environment

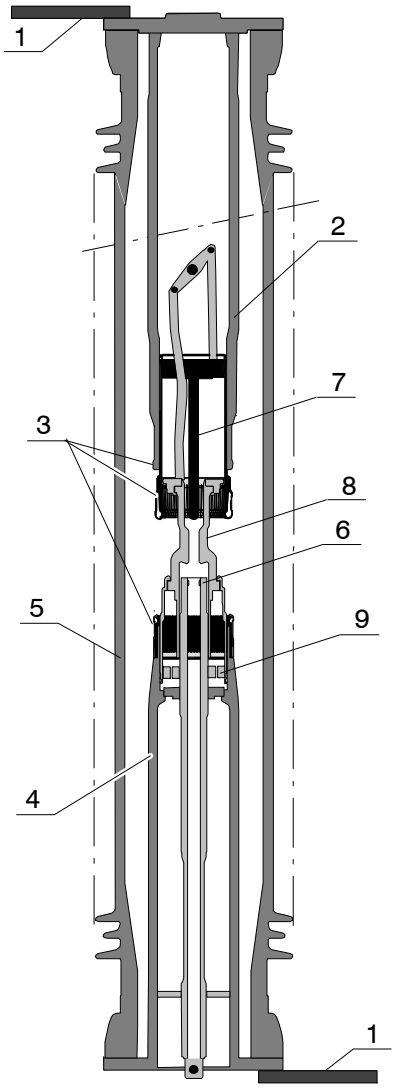
The extinguisher environment is SF_6 gas under pressure or, exceptionally, a mix of SF_6 gas +CF_4 under pressure.

Principle of breaking

The breaking chamber is thermal blowing by arc energy type, with auxiliary auto-pneumatic effect.

Description

The breaking chamber was designed to increase the mechanical and electrical endurance of the active part and take advantage of the benefits of the low wear of the contacts subjected to the arc in the SF_6. The active part is enclosed in a sealed ceramic envelope, for insulation between the input and the output of the circuit breaker.
The chamber is comprised of the following components :



Mark	Component
1	Power supply terminal
2	Rod-side contact holder
3	Main contacts
4	Tulip-side contact holder
5	Envelope
6	Arc contact tulip
7	Arc contact rod
8	Insulating nozzle
9	Valve

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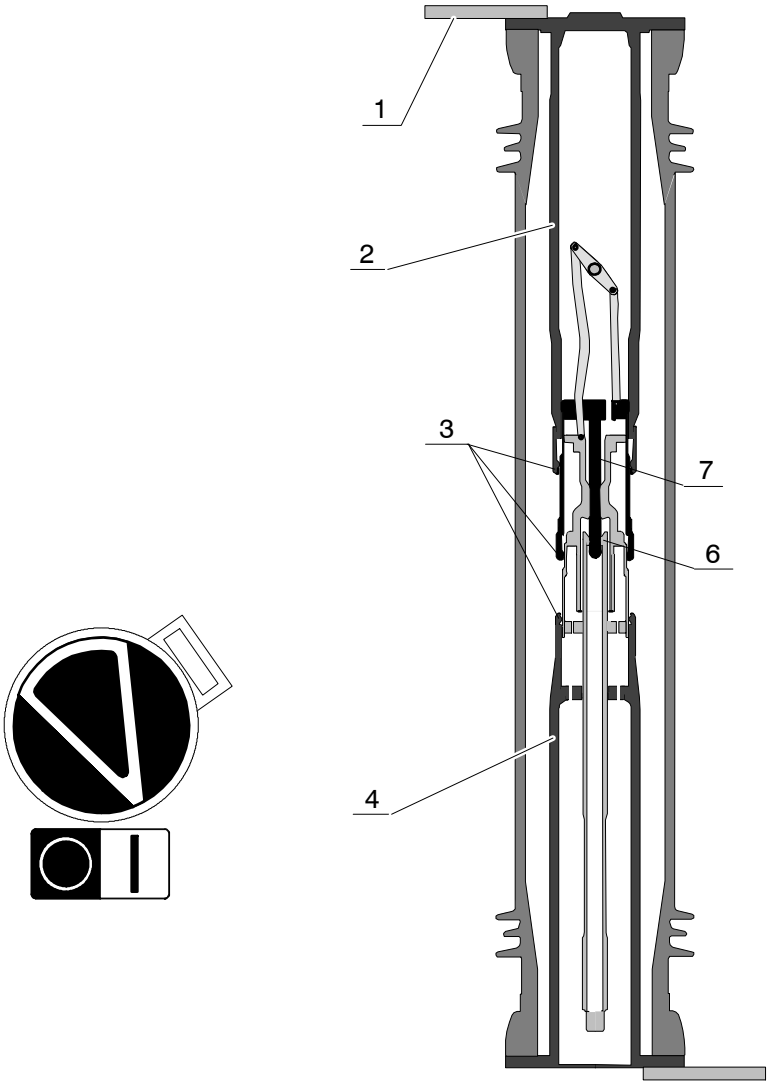
Presentation

Introduction

In ”CLOSED” position, the current passes by :

- the power supply terminal (1),
- the rod-side contact holder (2),
- the main contacts (3),
- the arc contact rod (7),
- the shaft contact tulip (6),
- the tulip-side contact holder (4),
- the opposed power supply terminal (1),



In this module

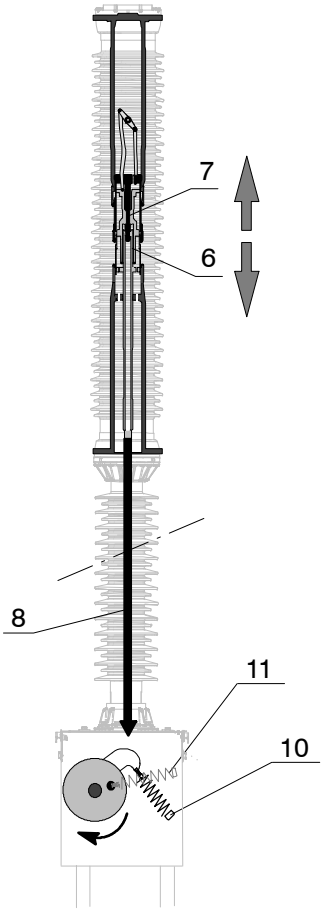
This module deals with the pole’s operating phases:

Opening

Description

On electrical or manual order to open, the energy accumulated in the opening spring (10), located in the operating mechanism, is freed.

The insulating operating rod (8), actuated by the opening spring (10), transmits the movement to the mobile parts (6) and (7), which ensures separation of the contacts.

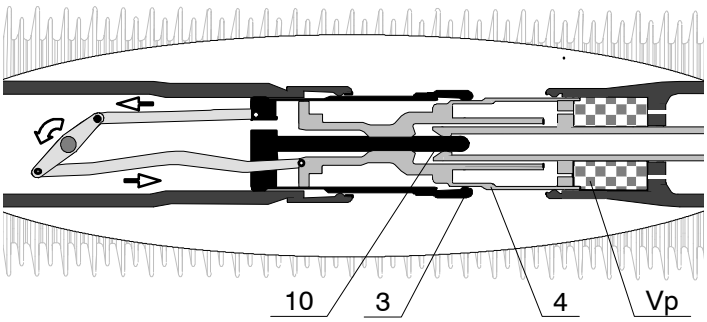
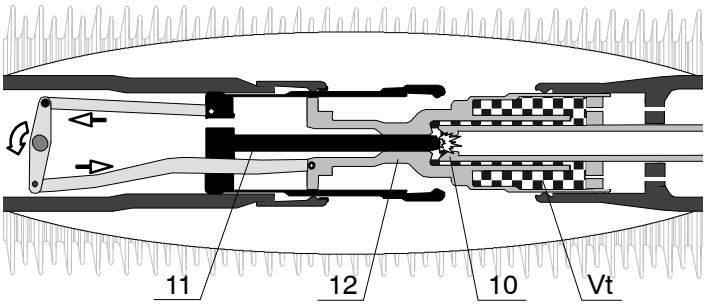
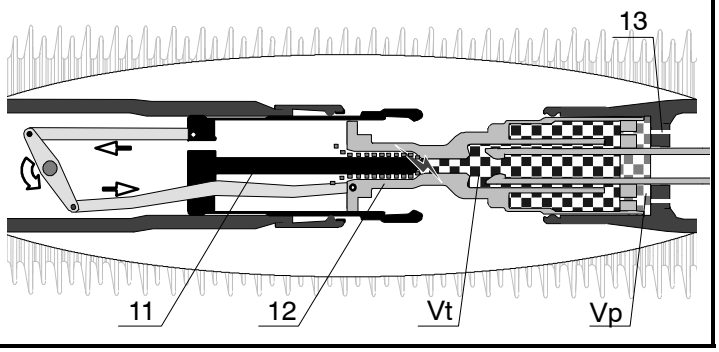


Continued on next page.

Opening, continued

Operation

The following table gives the opening phases:

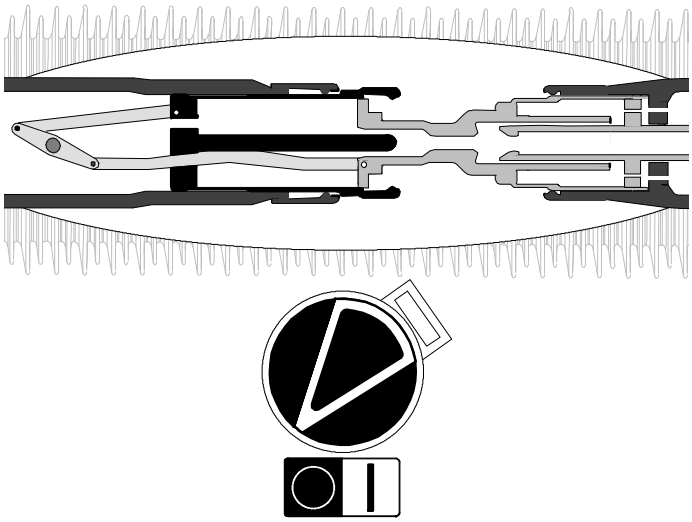
Phase	Description
Start of opening	When the mobile contact (4) leaves the main contacts (3), the current is switched on the arc contacts (10). The volume compression (Vp) creates an initial increase in pressure. 
Thermal effect	On separation of the contacts (10), the arc appears and its energy causes a pressure increase in the volume of thermal expansion (Vt) colsed by the contact rod (11) and the insulating nozzle (12). 
Cuts and assistance on opening.	When the rod (11) leaves the nozzle (12), the thermal overpressure in the volume (Vt) is freed, which causes energetic blowing, just before the zero-crossing of the current, ensuring the final extinction of the arc. The overpressure of the volume (VP) escapes via the valve (13). 

Continued on next page.

Opening, continued

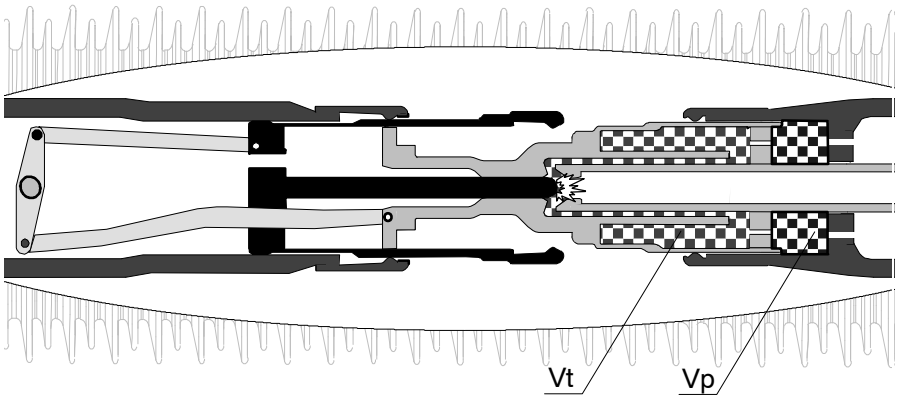
Operation, continued

The following table continues the opening phases:

Phase	Description
"OPEN" position	The arc goes off. The molecules of SF_6 dissociated by the arc are instantaneously reconstituted. The residual gases from the break are adsorbed by the molecular sieve, located at the base of the pole. Some powdered products are deposited in the form of dust, without impact on the circuit breaker. 

Particular case of small currents

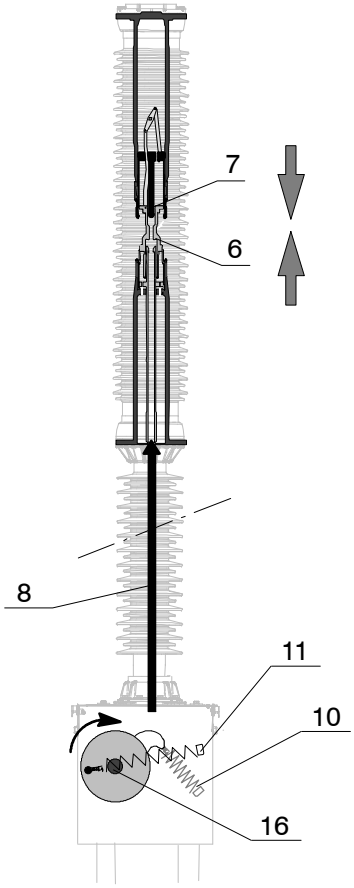
In the case of weak currents(eg : operating unloaded lines, transformers, or capacity banks), the arc's thermal energy is too weak to cause enough overpressure.
As a result, to obtain the arc blowing, the traditional auto-pneumatic effect is mainly used; it develops in the volume (Vp), and blows in the volume(Vt) until arc contact.



Closing

Description

On electrical or manual order to close, the energy accumulated in the opening spring (11), located in the operating mechanism, is freed. This energy is transmitted to the operating shaft (16) of the pole, and ensures closing.
The liberation of the energy stored in the closing spring (11) causes the displacement of the mobile components and therefore the closing of the breaking chamber, as well as resetting the opening spring (10).



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Presentation

Introduction

The circuit breaker uses pressurised SF_6 gas like arc extinguisher gas.
It is therefore indispensible to monitor the SF_6 gas to guaranty the circuit breaker performance.

Principle

There are two ways to monitor SF_6 gas pressure:

- Permanent monitoring, using a contact densimeter.
- Periodic monitoring, using a dialled densimeter (visual verification).

Symbols

IEC symbols for the technical characteristics of the equipment.

Symbol	Description
p_{re}	Assigned filling pressure for insulation
p_{ae}	Alarm pressure for insulation
p_{me}	Minimum insulation pressure

In this module

This module covers the following subjects:

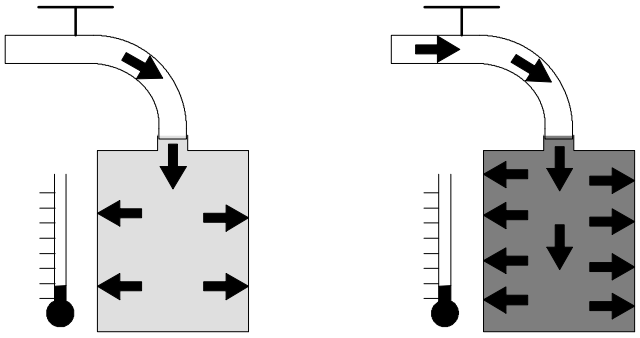
Pressure and density

Introduction

The characteristics of the apparatus depend on the density of the SF6 gas, meaning the mass of the mix introduced into a given compartment volume.

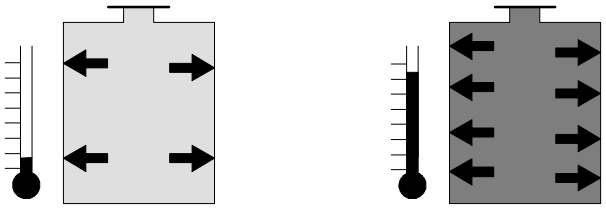
Constant temperature

At constant temperature, increased density results in an increase in the pressure exerted by the mix on the compartment walls.



Constant density

At constant density, with the volume of the compartment invariable, the gas pressure varies in the same way as temperature. The gas density stays invariable, as the quantity of gas does not change, nor does the volume of the compartment containing it, and nor do the electrical characteristics of the eauipment.



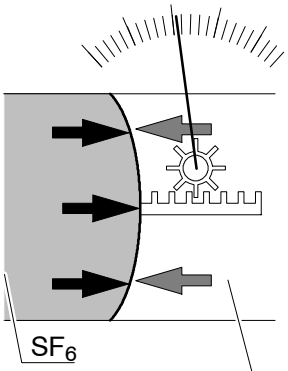
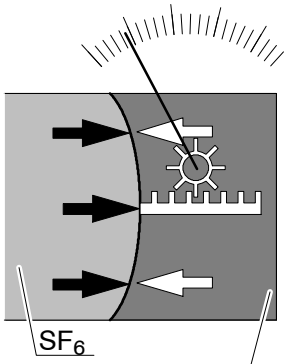
Conclusion

As it is difficult to directly measure the density of the gas, the absolute pressure and pressure and temperature of the mix must be measured with a high degree of precision.

Calculating the pressure

Relative pressure?
Absolute pressure?

Absolute pressure = relative pressure + atmospheric pressure

Pressure	Description	Illustration
Relative	The pressure of the SF_6 gas is measured using an industrial--type pressure guage. This pressure gauge has a distortable membrane that guides an indicating needle. Onse side of the membrane is in contact with the SF6, the other with the atmosphere. The pressure difference between the gas and the atmosphere is measured : with the atmospheric pressure as a reference, only the relative pressure of the SF_6 is measured. The relative pressure of the SF_6 gas therefore depends on the local atmospheric pressure at the time of measurement.	Industrial pressure guage  SF_6 Atmospheric pressure
Absolute	If the membrane is distortable, in contact on one side with the SF6 gas, on the other a vacuum, the pressure gauge measures the pressure difference between the SF6 and the vacuum. As the vacuum has a value of zero, the pressure gauge measures the absolute pressure of the mix. The absolute pressure of the SF_6 gas, which is independent of the atmospheric pressure, descrives the quantity of gas introduced in the compartment, and therefore characterises the the density of the SF_6 gas at a given temperature. To measure it, an absolute pressure gauge is required,which is an instrument that is less common and more delicate than a relative pressure gauge. This is why a relative pressure gauge is used, making corrections for atmospheric pressure variations due to atmospheric distur-bances and altitude variations.	Absolute pressure gauge  SF_6 Vacuum compartment

Determination of density

Units of pressure

- The international unit of pressure is the pascal (Pa).
- The practical unit is the bar

  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 at a temperature of 20°C.

Measuring the density

When it is not possible to directly measure the density, it is measured indirectly using an industrial pressure gauge that measures the **relative pressure**.
For each assigned density, there is a corresponding assigned relative pressur evalue, defined for normal atmospheric pressure (101.3 kPa) and an ambient temperature of 20°C.

For each pressure measurement (filling, verifying the densimeter thresholds, etc.), the assigned relative pressure must be corrected for the site's atmospheric pressure and the ambient temperature at the time of measurement. See the "**Calculating the SF_6 gas filling pressure for use of the pressure gauge (tools)**" module.

The real pressure is therefore :

$$P_{real} = P_{assigned\ relative\ and\ corrected\ for\ temperature} + \Delta Pp*$$

* **ΔPp**: **correction for atmospheric pressure**.

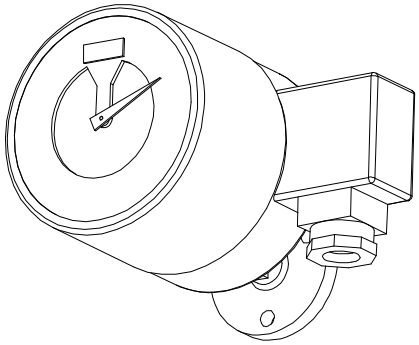
Densimeter

Functions

- Premanent monitoring of the SF_6 gas density.
- Visual indication of the real SF_6 gas pressure (MPa – psi).

Localisation

The densimeter is located at the base of the circuit breaker pole, and is connected to the gas volume of the circuit breaker.



Internal contact

The densimeter is equipped with internal contacts. These contacts close in succession in the event of decrease in gas density, and determine 2 distinct thresholds. The contacts are cabled to the electrical cabinet terminals and are generally left available to the operator for the following use:

- Alarm pressure "$\boldsymbol{p}_{ae}$" acts as a warning (additional filling may be required).
- Minimum pressure for insulation "$\boldsymbol{p}_{me}$" must serve either to lock the circuit breaker in position or to cause automatic opening. the client chooses according to operating needs.

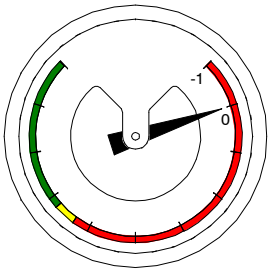
All performance assigned to the circuit breaker is guaranteed to the specified minimum ambient temperature for insulation, "$\boldsymbol{p}_{me}$".

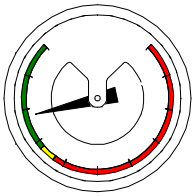
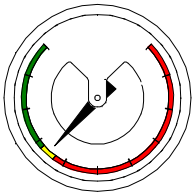
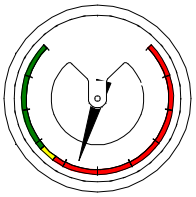
Continued on next page.

Densimeter, continued

Reading the dial

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



Position of the needle	Colour zone	Instructions
	GREEN	Nil
	YELLOW	Carry out an additional filling
	⚠ RED	Density abnormally low, search for a new leak and contact **ALSTOM Grid After-Sales Department**.

Presentation

Information

The poles are filled with SF_6 gas for transportation at a relative pressure of 0.3 bar at 20°C (1 013 hPa).

In this module

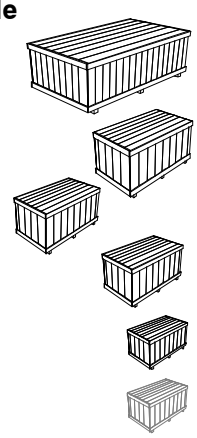
This module covers the following subjects:

Packing

Introduction

The various component parts of the switchgear are divided into a number of packages for transport. The number of packages and their individual contents are dependant on the dimensions of the circuit breaker pole.

Example



- A main case, which contains :

- The poles.
- The frame components, if it is provided by ALSTOM Grid.

- A case containing the operating mechanisms, vacuum-packed in a heat-welded plastic cover containing bags of desiccant.
- A case containing the cable box.
- Depending on the individual situation, one case contains the SF_6 gas bottle(s), or the SF_6 and CF_4 bottles.
- One case contains any anciliaries required for fitting (grease, oil, etc.).
- One case contains the accessories : Spare parts, etc.

Type of case	GL314 P.			
	Length cm	**Width** cm	**Height** cm	**Gross weight** kg
Poles	495	185	115	2680
	595			3410
Operating mechanism (x3)	247	62	108	310
Cable box	178	72	113	182
Chassis	273	73	92	600
SF_6 gas *	120	60	55	75
Fitting accessories	45	45	52	17
Accessories *				

* Depends on apparatus

NOTE : The values in the table above are for information only for the organisation of appropriate lifting equipment.

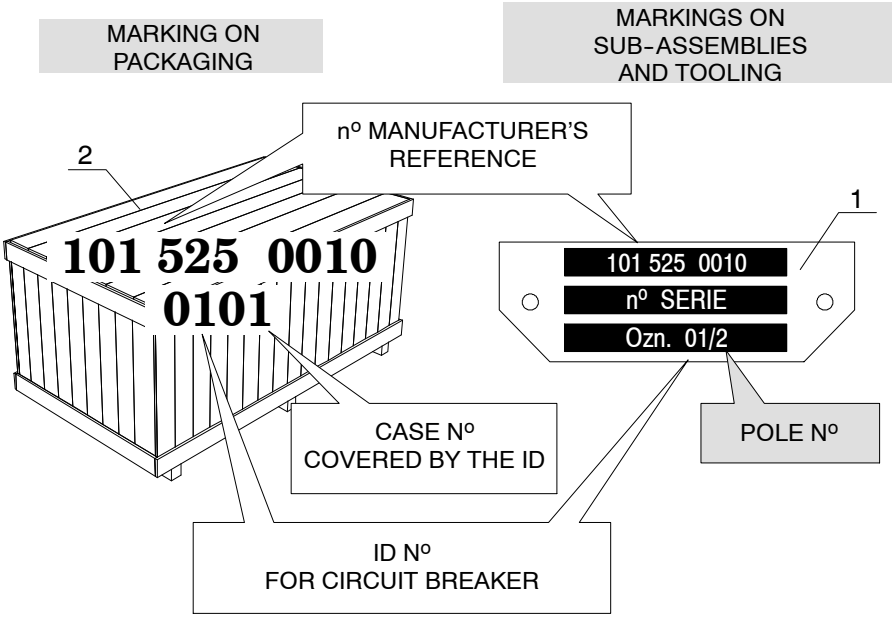
Marking of sub-assemblies and packaging.

Introduction

Each individual circuit breaker component (pole, operating mechnism, etc.) is identified by a plate.
The IDs of each element are marked on the package.

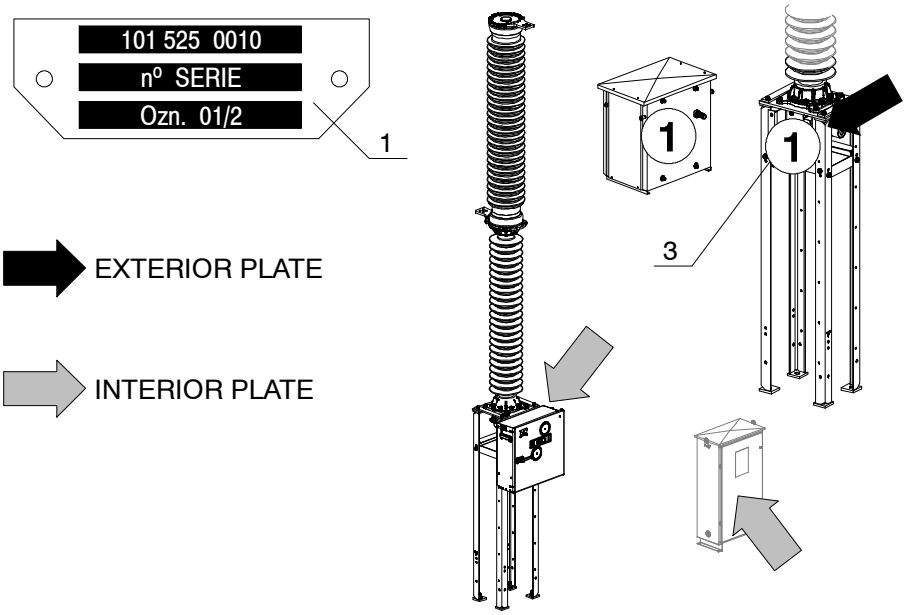
Example of markings and indications.

- N° Manufacturer's reference = 101 525
- Circuit breaker No.1
- Pole n° 2



Location of plates

Select and assemble the components identified by the plate(1) and sticker(3).



Storage

Introduction

The storage procedures given below correspond to storage durations not exceeding 2 years in length. For storage durations of greater than 2 years, special packaging and particular processes must be employed.

Short-term storage (6 months)

The equipment should be stored in its transportation packaging, placed on timber baulks, in a flood-proof space.

Storage medium term (Less than 2 years)

The following table gives the manner in which the main circuit breaker components should be stored for the medium term :

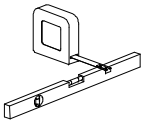
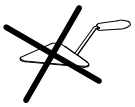
Component	Storage
Circuit breaker pole	The equipment should be stored with its transportation packaging open, placed on timber baulks, in an enclosed (indoor), well ventilated, flood-proof space.
Operating mechanism 	The operating mechanism should be stored in the same location as the circuit breaker as the two sub-- assemblies are indissociable. Check the sealing of the vacuum-packaging. If it has deteriorated, apply the following recommendations : • Completely remove the protective packaging so as to ensure air enters via the vent grilles in the bottom plate and side panels. • To avoid corrosion damage caused by the condensation of water, the heating circuit must be connected.
Cable box	The cable box should be stored in the same location as the circuit breaker and operating mechanism as the three sub-assemblies are indissociable. • To avoid corrosion damage caused by the condensation of water, the heating circuit must be connected. Position the cable box vertically to ensure air can get in through the vent grilles.

ANY MOVEMENT OF THE DEVICE (EVEN AFTER COMMISSIONING) MUST BE CARRIED OUT WITH THE PRESSURE REDUCED TO 0.3 BAR.

General mounting recommendations

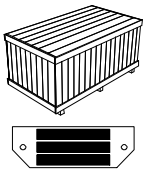
Recommendations concerning the environment

The following table gives the environmental recommendations to be respected during installation:

Recommendation	Comments	
A		Check the civil engineering structures : dimensions, fixing support levels, taking tolerances provided by construction norms into account. (Refer to diagram of circuit breaker).
B		Avoid producing dust and all masonry during installation of the apparatus.

Recommendations when mounting

The following table gives the recommendations to be respected for proper installation of the circuit breaker:

Recommendation	Comments	
1		Do not begin the assembly work without first having read and understood all of the “Installation” modules. The assembly instructions describe all of the assembly operations in chronological order.
2		Make sure you handle the sub-assemblies properly, **in particular the insulators**.
3		Open the cases as you need them. **<u>CAUTION</u> : Respect the component markings.**
4		When the transportation covers are removed, proceed with the assembly steps as quickly as possible. The transportation covers should be stored in shelter for any possible subsequent use.
5		Respect references to other modules, for example : ”Tightening torque values.”

Warning

ALSTOM Grid declines all responsibility for failures generated by the non-respect of these directives from the ”Installation” brochure.

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Presentation

Introduction

During fastener assembly, all fixation bolts must be ”greased” before torque tightening.

Products used

The following table provides the list of products used for the fasteners before tightening:

Description	Reference ALSTOM Grid	Supplier	Reference supplier
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 covers the following subjects:

Greasing the fasteners before tightening

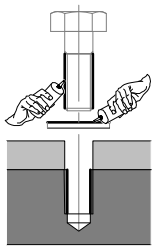
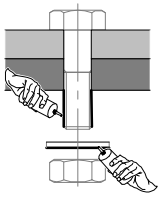
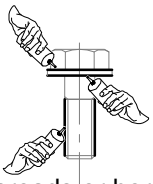
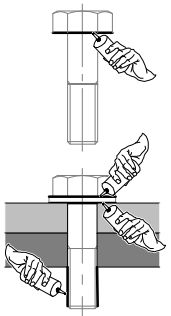
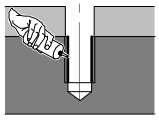
Choice of product to be used

The following table indicates the product to be used for the fasteners before tightening according to the type of assembly :

If assembly ...	Product to be used...
current	MOBILPLEX 47 MOBILUX EP3
electrical connections	CONTACTAL HPG
with seals and gaskets	**Removable?** / **Product...** YES / MOLYKOTE 111 NO / LOCTITE 225

Where to apply the product?

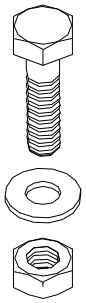
The following table indicates the part of the fasteners to treat with the product before tightening according to the type of assembly :

If assembly ...	With screws	With bolts
current		
electrical connections		
with seals and gaskets	Threads or bores 	Threads or bores 

Torque tightening values

Table of values

The tightentening tool and method must ensure the torque actually applied to the screw head corresponds to the torque in the following reference table with a tolerance of ± 20%.

	TIGHTENING TORQUE VALUES in **daN.m** STEEL SCREW	
	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.

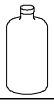
In this module

This module contains the following topics :

Preparing and installing static seals

Necessary products

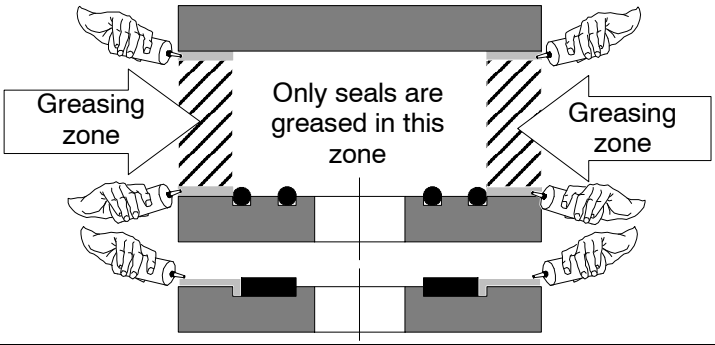
List of the ALSTOM Grid products necessary for the installing :

ALSTOM Grid 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 ALSTOM Grid products and accessories necessary for the screw sealing :

ALSTOM Grid 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 :

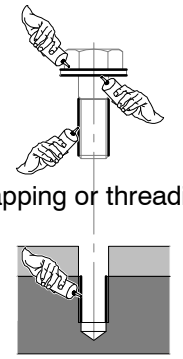
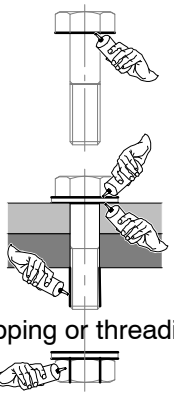
If assembling...	**Product to use ...**
with seals	**Can be dismantled ?** / **Product ...** YES / MOLYKOTE 111 NO / LOCTITE 225
electrical connections	CONTACTAL HPG

Continued on next page.

Screw sealing, continued

Where to apply the product ?

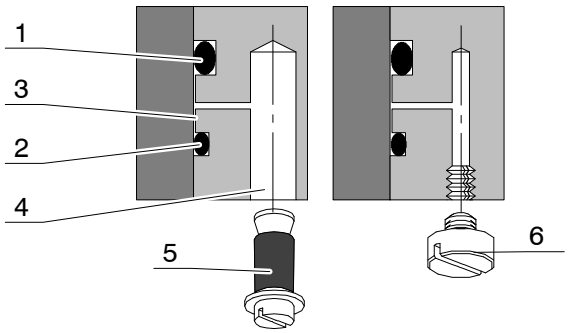
The table below indicates the part of the screws to treat with the appropriate product before tightening depending on the assembling type :

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

Using a water pressure gauge

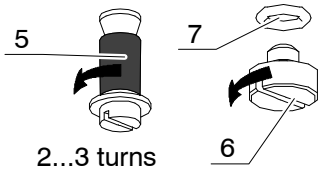
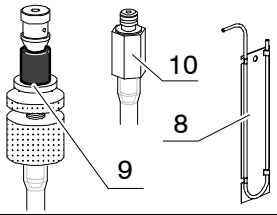
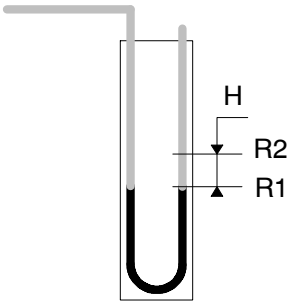
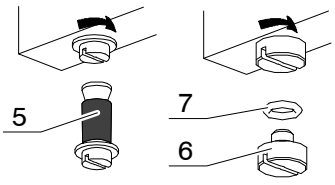
Introduction

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 adapter of the water pressure gauge and replace the leak test plug (5) or (6) and its seal (7), where required.	

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Verification of the presence of SF_6 gas in the poles

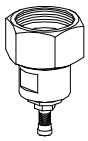
Presentation

Introduction

The poles are filled with SF_6 gas for transportation at a relative pressure of 0.03 bar at 20°C (101.3 kPa).

Tools required

List of ALSTOM Grid tools required for checking the presence of SF_6 gas in the poles :

Mark	Illustration	Description	Quantity
3		Filling tool	1

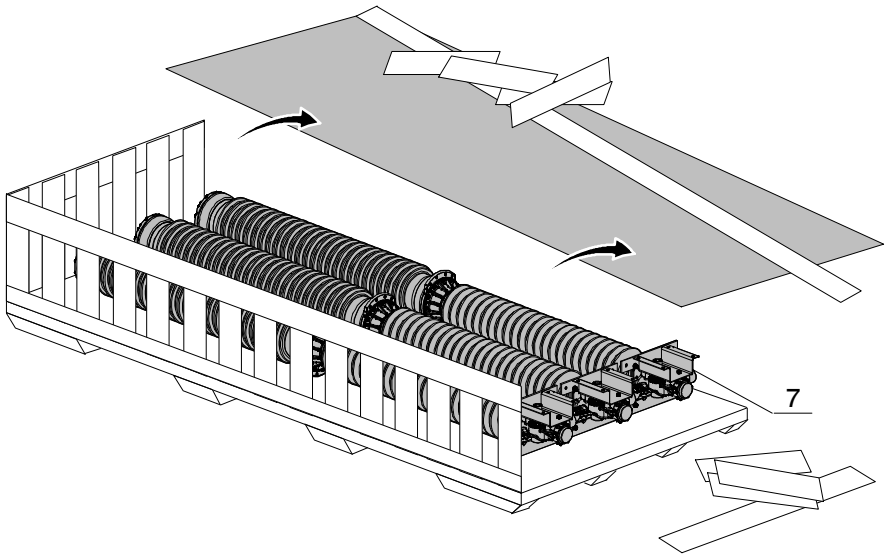
In this module

This module covers the following subjects:

Checking the poles on opening the cases in-site

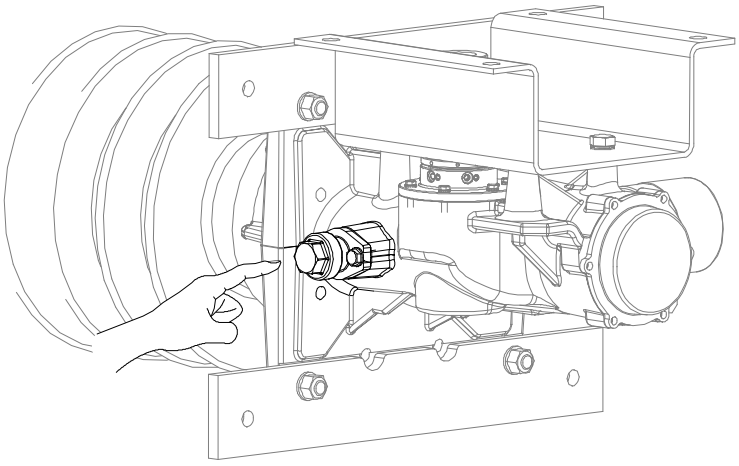
Preparing the pole

Only remove the cover of the case. Partially remove the packaging protection in order to be able to reach the pole casing (7).



Examining the poles

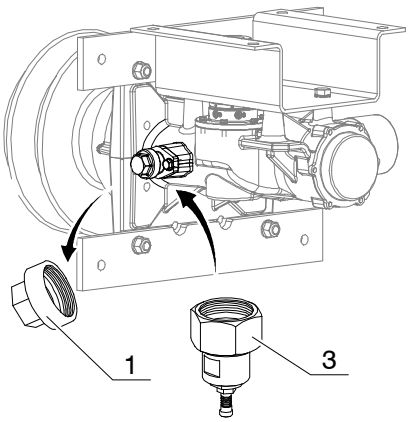
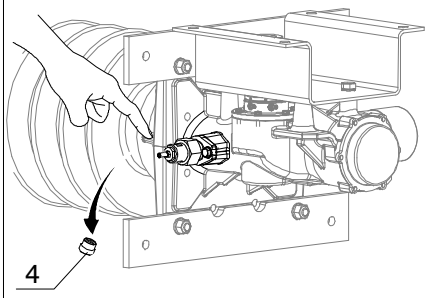
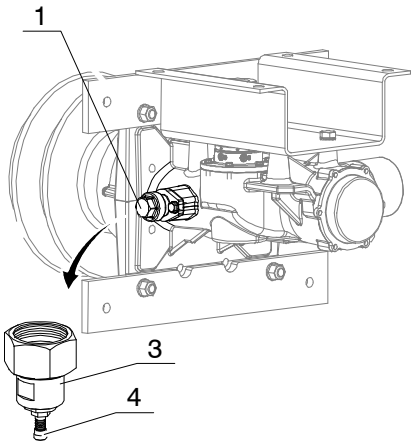
- Proceed with a visual inspectionof the state of the porcelain. Make sure the transport did not give rise to significant bursts or deterioration of the enamel.
- It is indispensible to check for the presence of SF_6 gas in the pole components before continuing with the installation.



Verification of the presence of SF_6 gas in the poles

Instructions

The following table lists the verification steps for checking the presence of SF_6 gas in the poles:

Step	Action	Illustration
1	Remove the plug (1) to fit the filling tool (3) and tighten it **BY HAND**.	
2 	Unscrew the cap (4)and press briefly on the valve damper : gas should escape. **If no gas escapes, contact our Customer Service.**	
3	• Screw the cap (4) back on and remove the filling tool (3). • Fit the plug (1) back on and apply a tightening torque of 4 daN.m. Leaktightness will only be guaranteed by doing this.	

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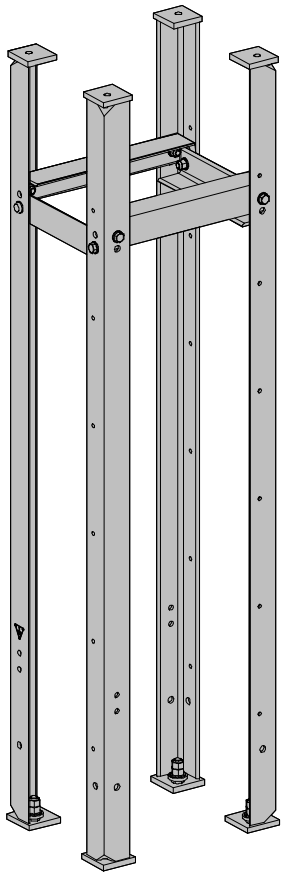
Presentation

Reminder

The support frames can by provided by the client or by ALSTOM Grid.



In this module

This module covers the following subjects:

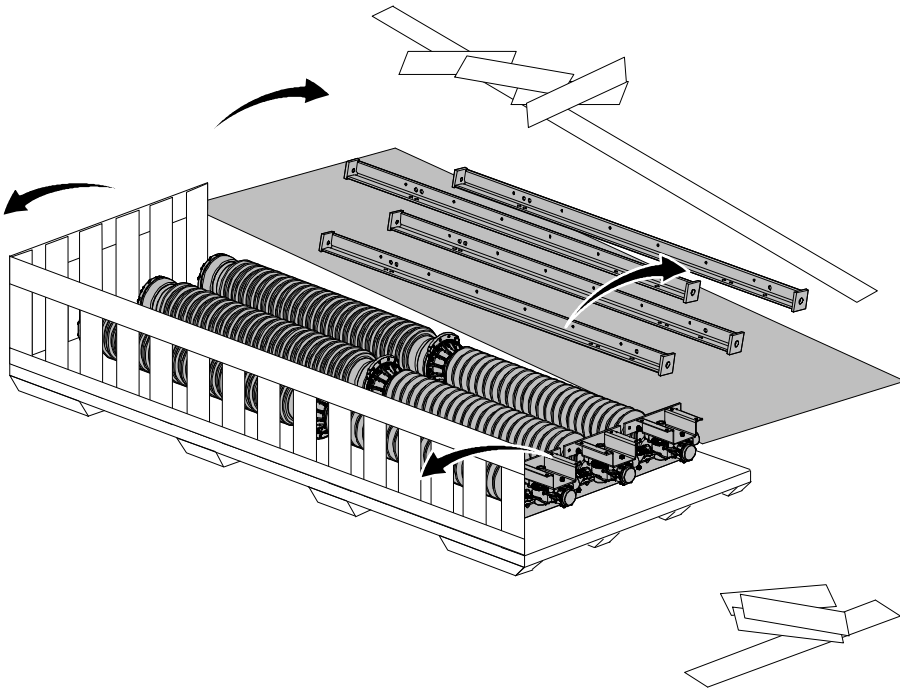
Required components

Required product	MOBILPLEX 47 – MOBILUX EP3 grease (greasing for the fasteners).
Handling	Frame handling operations must be carried out by at least two people. 

Preparing the frame components

Dismantling the pole case

Remove the case reinforcements and side panels and clear the frame legs.
Keep the side panels for later operations.



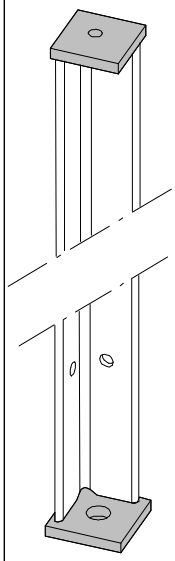
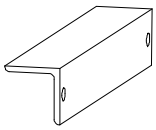
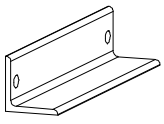
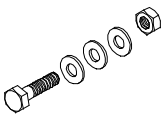
Support frame components (by pole)

Introduction

If the support frames have been provided by ALSTOM Grid, make sure all components required for assembly are present.

Necessary components

List of ALSTOM Grid items necessary for the operation :

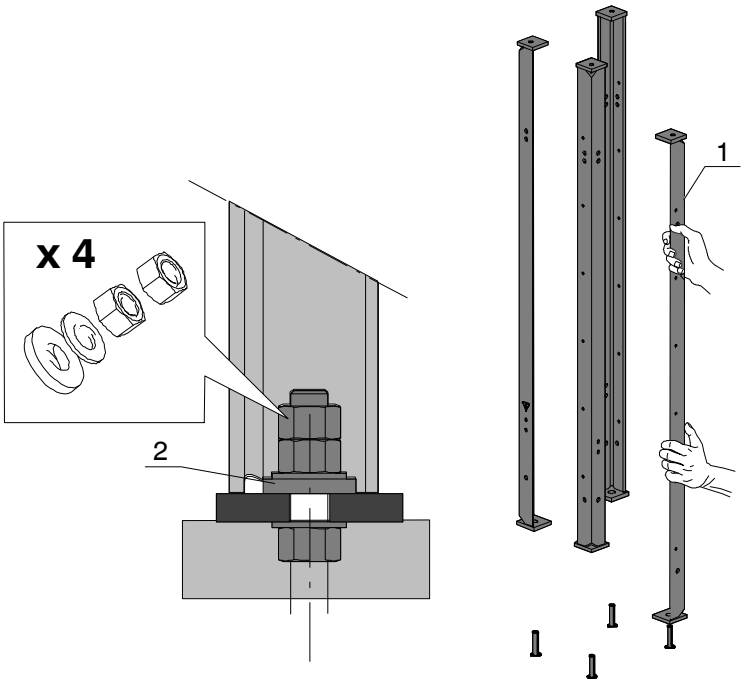
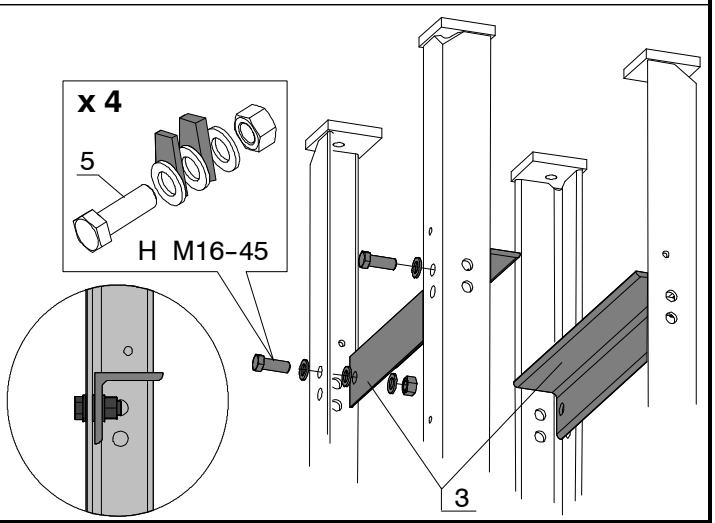
Mark	Illustration	Description	Quantity
(1)		Leg	4
(2)		Heavy washer	4
(3)		Long reinforcement	2
(4)		Short reinforcement	2
(5)		Fittings H M16-45	8

Continued on next page.

Mounting the frame legs

Instructions

The table below shows the steps for fitting the frame legs :

Step	Action
1	Position the frame legs (1) on the anchoring lugs, respecting the direction of the installation diagram.
2	Place a heavy washer (2), the washer, nut, and locking nut of the lug fastener. Do not block the fasteners.
3	Repeat these operations for the three other legs.
4	
5	Mount the two long reinforcements (3), making sure to respect the direction of installation. Do not block the fasteners (5). 

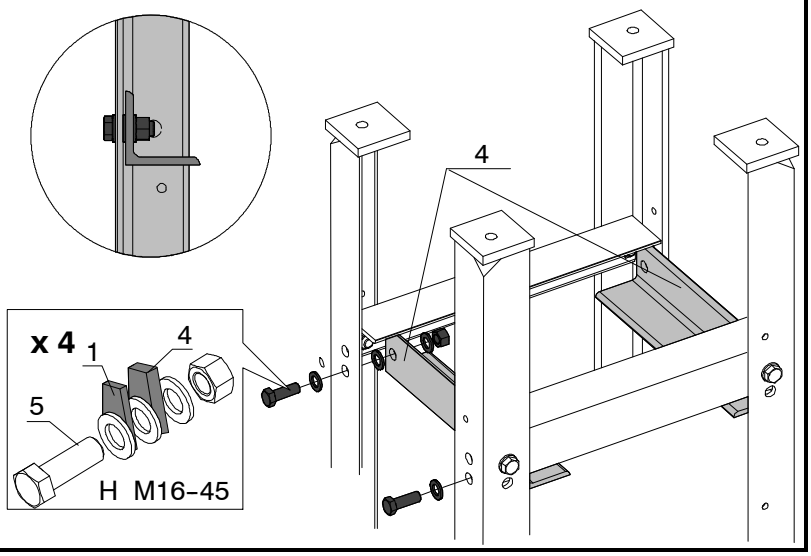
Continued on next page.

Mounting the frame legs, continued

Instructions

The table below shows the steps for fitting the frame legs :

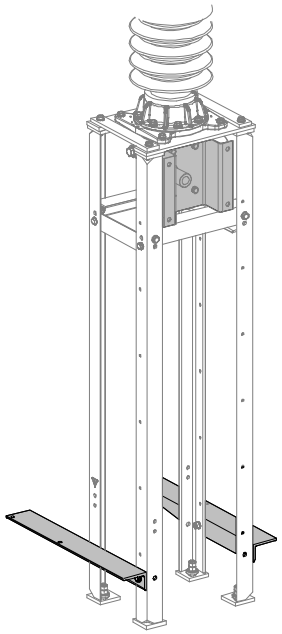
Step	Action
6	Mount the two short reinforcements (4), making sure to respect the direction of installation. Do not block the fasteners (5).



Mounting the two cabinet supports, optional

Reminder

The cabinet supports can by provided by the client or by ALSTOM Grid.

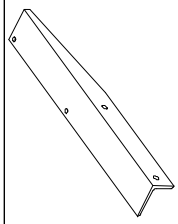
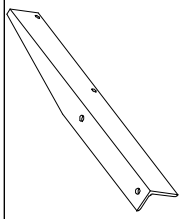
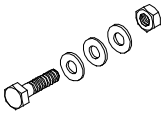


Introduction

If the support frames have been provided by ALSTOM Grid, make sure all components required for assembly are present.

Necessary components

List of ALSTOM Grid items necessary for the operation :

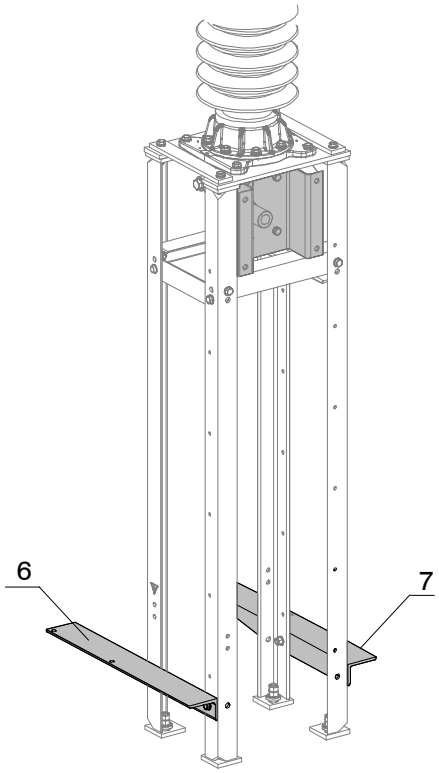
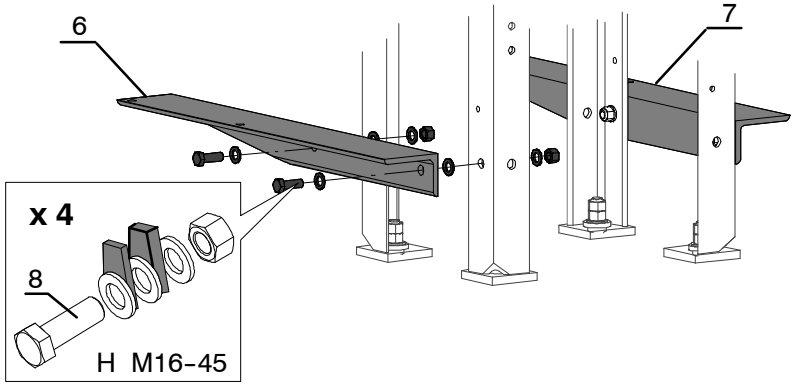
Mark	Illustration	Description	Quantity
(6)		Left cabinet support (Optional)	1
(7)		Right cabinet support (Optional)	1
(8)		Fittings H M16-45	4

Continued on next page.

Mounting the two cabinet supports, optional

Instructions

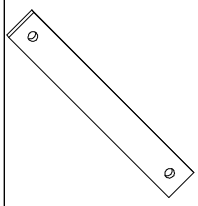
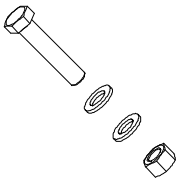
The table below shows the steps for fitting the frame legs:

Step	Action
1	Position the two supports in the right direction. The cabinet should be opposite the control. 
2	Mount the left (6) and right (7) reinforcements using the fasteners (8). Do not block the fasteners (5). 
3	**Leave the frame as-is, as the pole must be present before the frame can be completely fixed in place.**

Presentation

Necessary components

List of ALSTOM Grid items necessary for the operation :

Mark	Illustration	Description	Quantity
(1)		Cross-brace	2
(2)		Fittings H M16-75	4

Tools required

List of tools required for hoisting and installing the pole :

Mark	Illustration	Description	Quantity
(3)		HOISTING STRAP (3 m - 1000 kg)	2

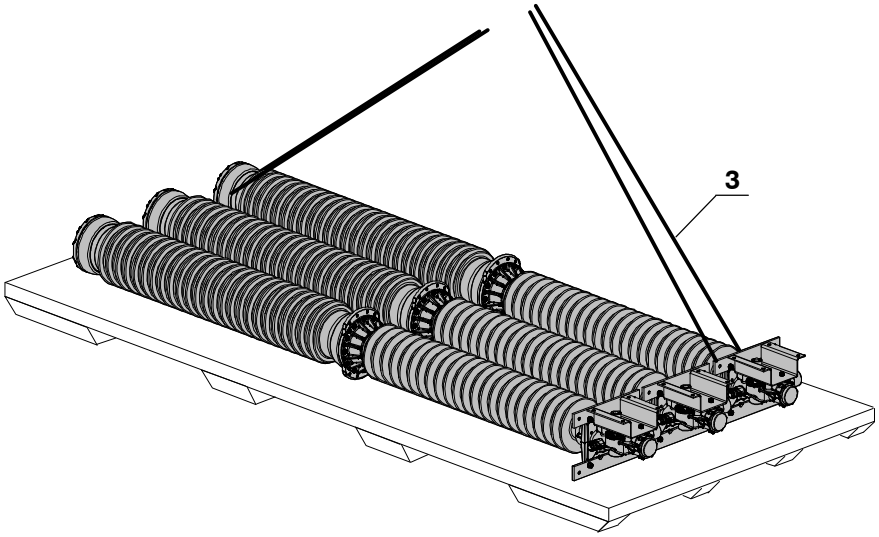
In this module

This module covers the following subjects:

Preparing the pole

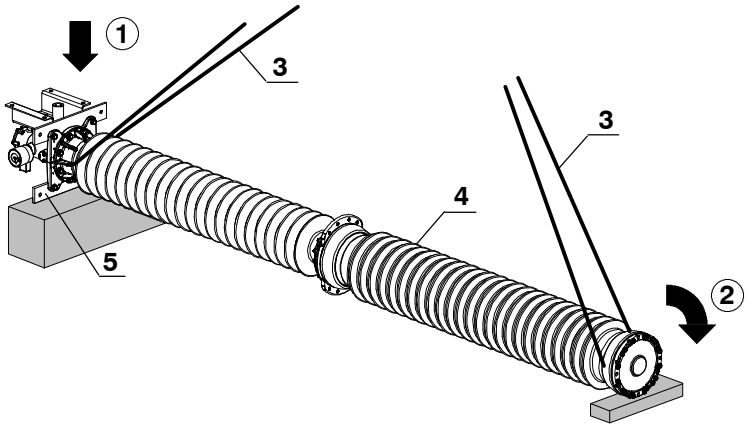
Instructions

Remove the side panels from the case.
Sling the pole to the two ends using the flexible straps (3).
Using a hoisting device, carefully raise the pole.



- Take the pole from the case and place it on the ground on the cover of the case, by placing :

– first, the upper casing base plate (5) on a wooden shim.
– second, the end of the breaking chamber (4) on a wooden shim.

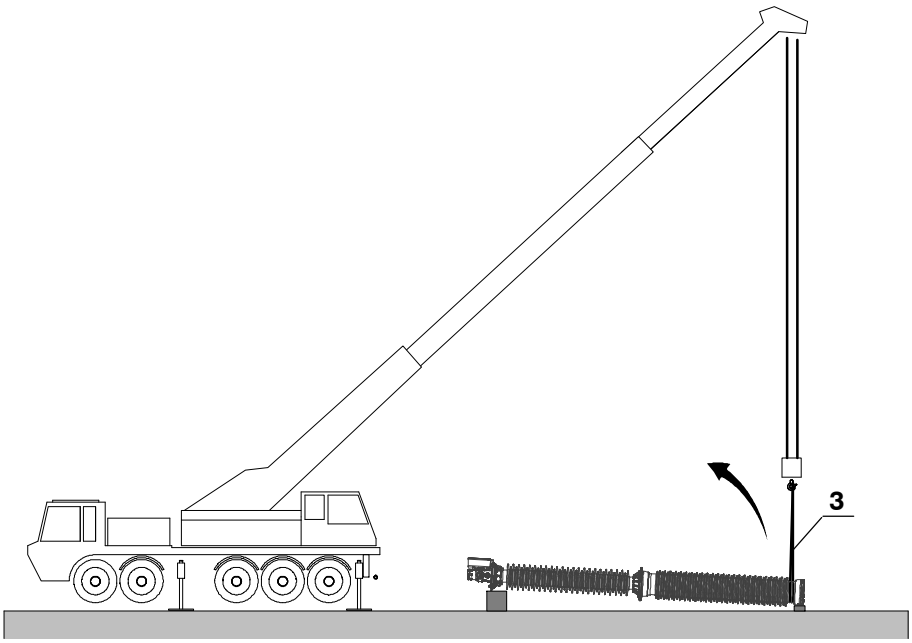


Continued on next page.

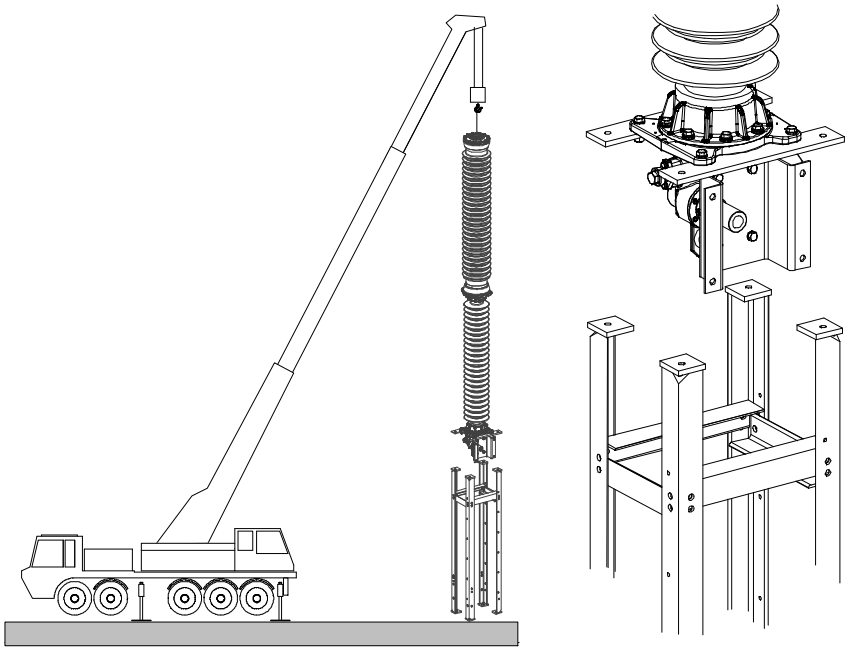
Hoisting the pole

Preparing the pole

Sling the pole using two flexible straps (3).



Raise the pole to the vertical, and position it for coupling with the frame.

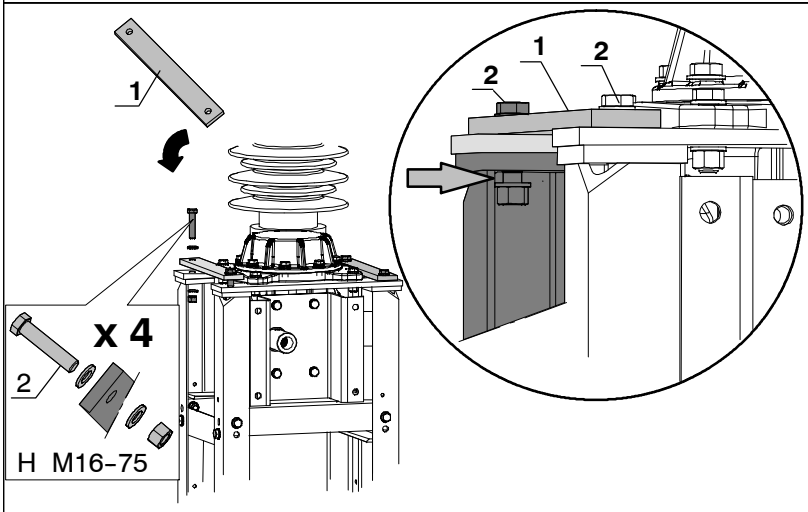
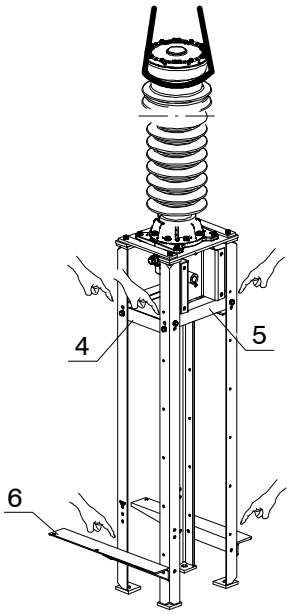


Continued on next page.

Installing the pole

Instructions

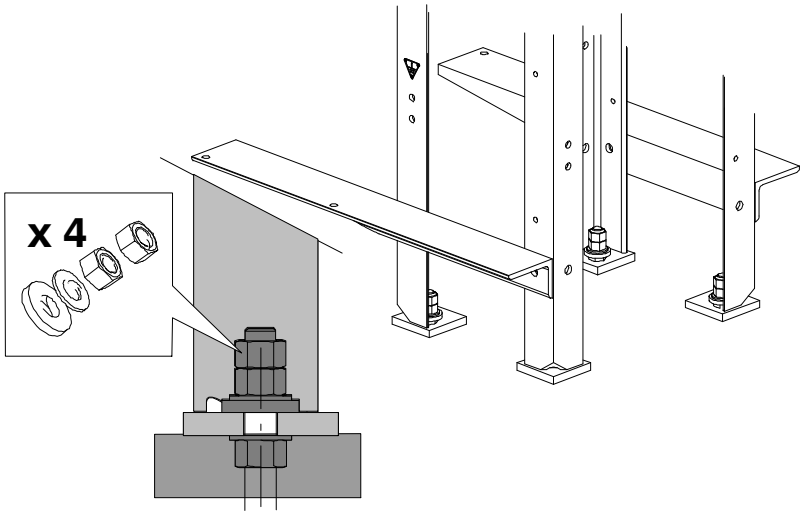
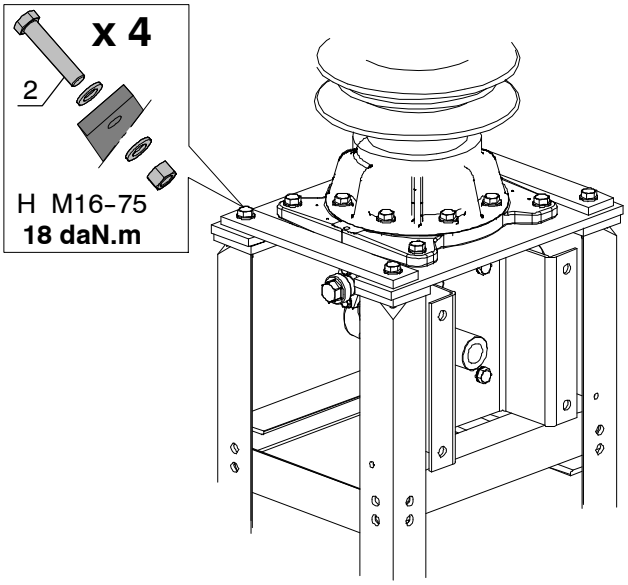
The following table gives the steps for installing the pole before tightening the frame :

Step	Action
1	Place the pole on the frame, install the two cross members (1), and the fasteners (2). Do not tighten the fasteners (2).
	
2 18 daNm	While leaving the pole slung, tighten all of the frame fasteners to the indicated torque. Fasten the reinforcements (4) and (5). Fasten the two cabinet supports (6) (if option validated).
	

Installing the pole, continued

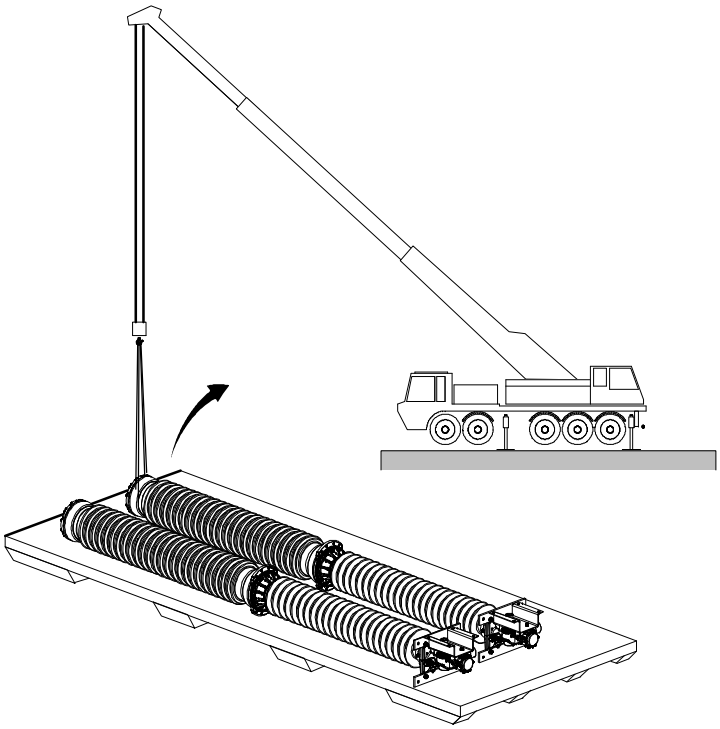
Instructions

The table below shows the steps for fitting the frame legs :

Step	Action
3	Tighten the fixings of the four frame legs to the ground according to the ”Tightening torques” module and according to the diameter of the anchoring lugs.
	
4	Fix the pole to the frame with the fasteners (2).
	

Installing the pole, continued

Repeat these operations from the hoisting step for the two other poles.

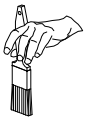


Fitting the power supply terminals with preparation of the contact surfaces

Presentation

Required products and accessories

List of ALSTOM Grid products and accessories necessary for the operation :

Reference ALSTOM Grid	Illustration	Description
-01861262		ISOPROPANOL can (1l)
-01835106		Vaseline 204-9
-01835118		Contactal grease
-01831320		A400 sandpaper
-02212334		Wiping cloth
-02211842		Round paintbrush n°4
-02211831		Flat paintbrush n°16

Document required

have a diagram of the apparatus to know the orientation of the power supply terminals.

In this module

This module covers the following subjects:

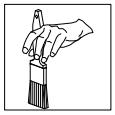
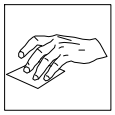
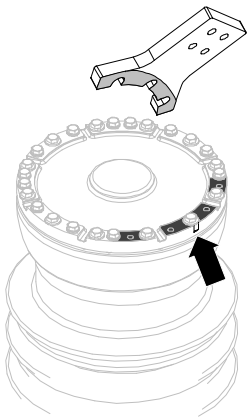
Preparing the contact surfaces

Preparing the contact grease

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

Preparing the contact surfaces

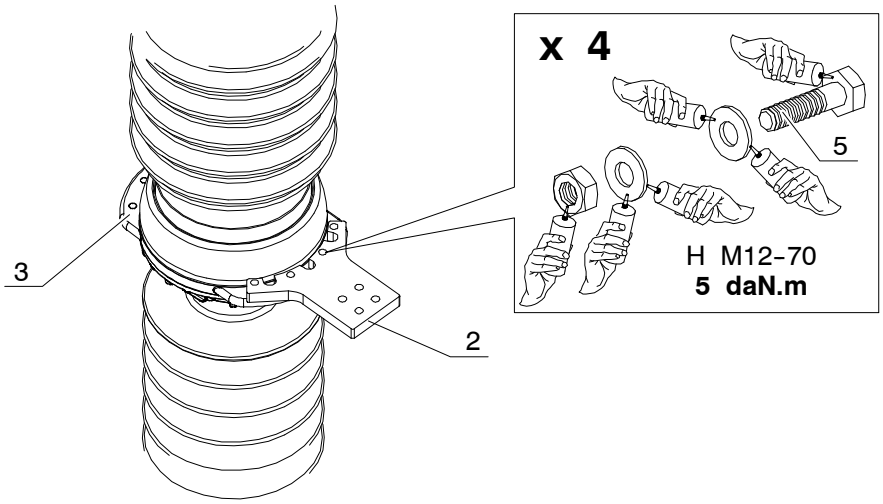
The table below shows the steps for preparing the contact surfaces :

Step	Action	Illustration
1	Verify the orientation of the power supply terminals using the diagram of the apparatus.	
2	Remove the temporary screws from the **X1** plate.	
3	Sand with fine emery cloth.	
4	Remove all resulting dust.	
5	Coat with CONTACT GREASE.	
6	Wipe with a clean cloth to avoid leaving even a tiny particle.	
7	Use the A400 sandpaper, and sand on top of the grease.	
		

Fitting the power supply terminal

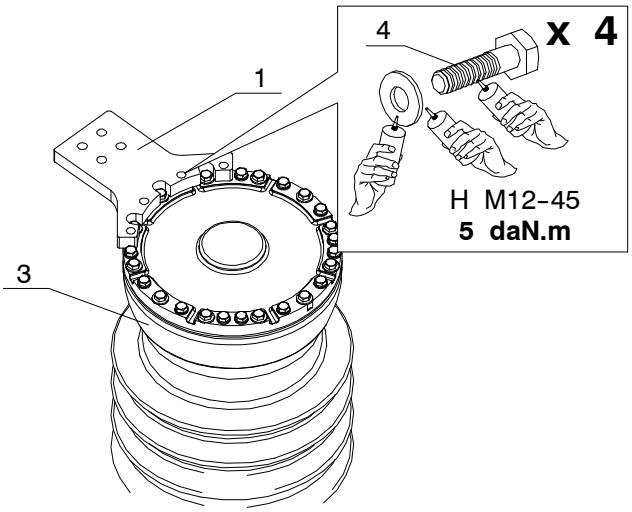
Power supply terminal, lower

Immediately assemble the lower power supply terminal (2) on the breaking chamber (3) after preparing the contact surfaces. Attach the terminals using the fasteners (5); use the CONTACT GREASE to plug the fasteners.



Power supply terminal, upper

Immediately assemble the upper power supply terminal (1) on the breaking chamber (3) after preparing the contact surfaces. Attach the terminals using the fasteners (4); use the CONTACT GREASE to plug the fasteners.



Information

- The electrical resistance value of the assembly must be:

  $\mathbf{R \leq 2\mu\Omega}$

- When connecting the H.V. connectors, prepare the contact surfaces in the same way.

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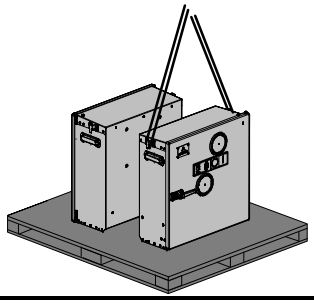
Presentation

Required product

MOBILPLEX 47 – MOBILUX EP3 grease (greasing for the fasteners).

Tools required ALSTOM Grid

List of ALSTOM Grid tools necessary for assembly :

Mark	Illustration	Description	Quantity
(1)		Hoisting strap	1

Lifting means

Provide an adequate means of hoisting (60 daN).

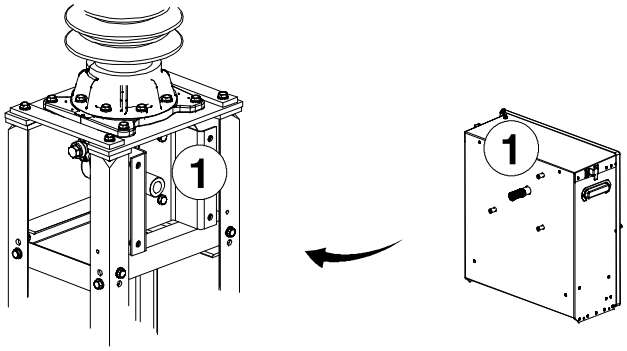
Instructions

The following table gives the steps for installing the operating mechanism on the pole support:

Preparing the operating mechanism

Unpacking

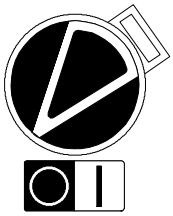
Remove the packing protection and check that the operating mechanism marking corresponds to the circuit breaker pole.



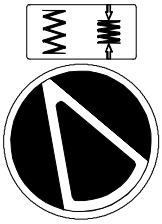
Position indicators

Check the operating mechanism position indicators statuses are as follows:

Circuit-breaker **Open**

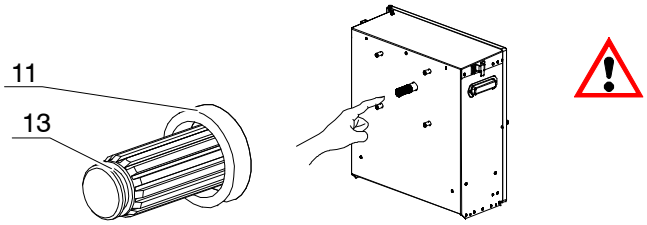


Closing spring **Unarmed**



Mechanism shaft

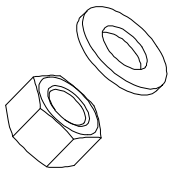
Check the seal (11) is present on the mechanism shaft (13).
Check lubricant (ASEOL 0-365.2) is present on the mechanism shaft (13).



Coupling the operating mechanism

Necessary components

List of ALSTOM Grid items necessary for the operation :

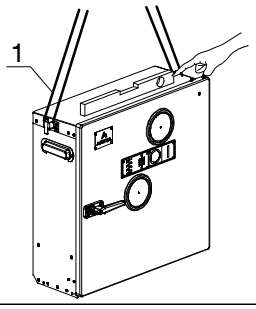
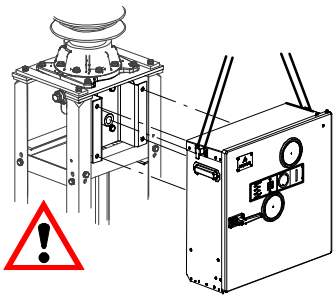
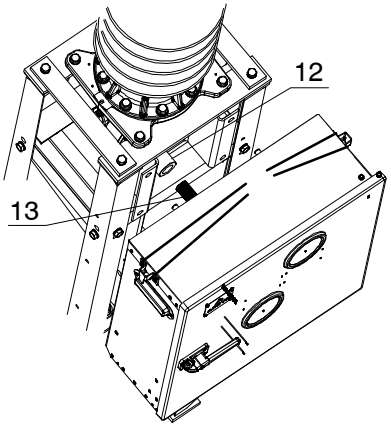
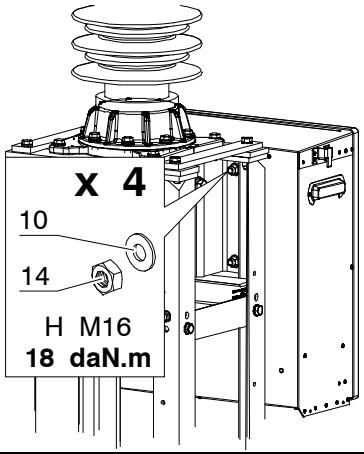
Mark	Illustration	Description	Quantity
9		Fittings H M16	4

Continued on next page.

Coupling the operating mechanism, continued

Coupling

The table below shows the steps for coupling the operating mechanism:

Step	Action	Remark
1	Sling the operating mechanism using the hoisting strap (1) as shown in the illustration.	
2	Lift up the operating mechanism and place it level.	
3	Bring the operating mechanism to installation position. **The final approach must be performed with care.**	
4	Insert the pin of the operating mechanism (13) into the sleeve (12).	
5	• Place the washers (10) and nuts (14), and then tighten to the indicated torque value. • Remove the hoisting strap.	

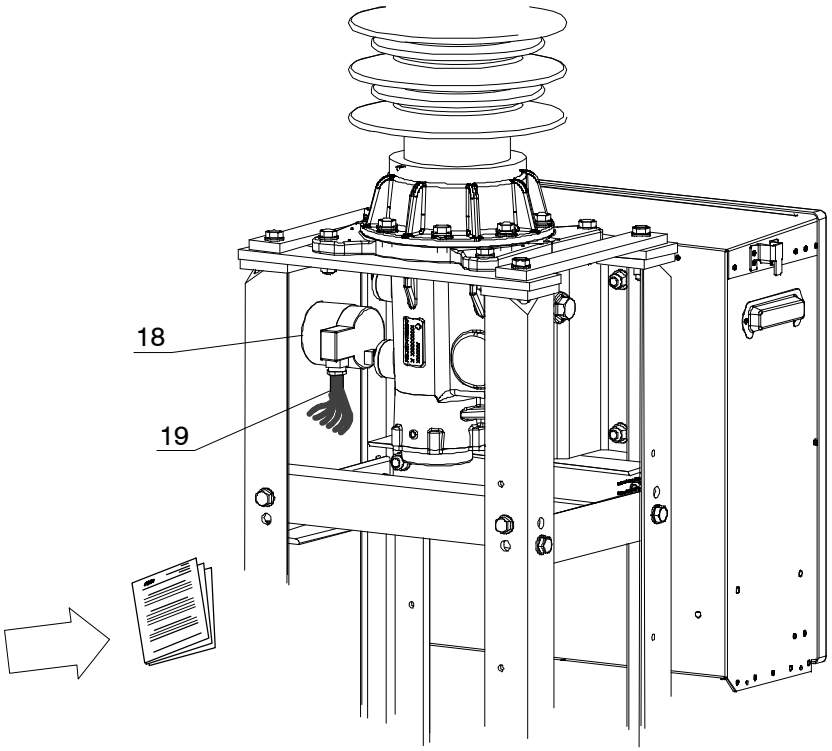
Low voltage electric wiring

Instructions

Install the electric wiring for the operating mechanism as shown in the circuit-breaker's electric diagram.
If the circuit-breaker is fitted with a cable box, install the wiring between the aoperating mechanism and the cable box.

Connecting the contact densimeter cable

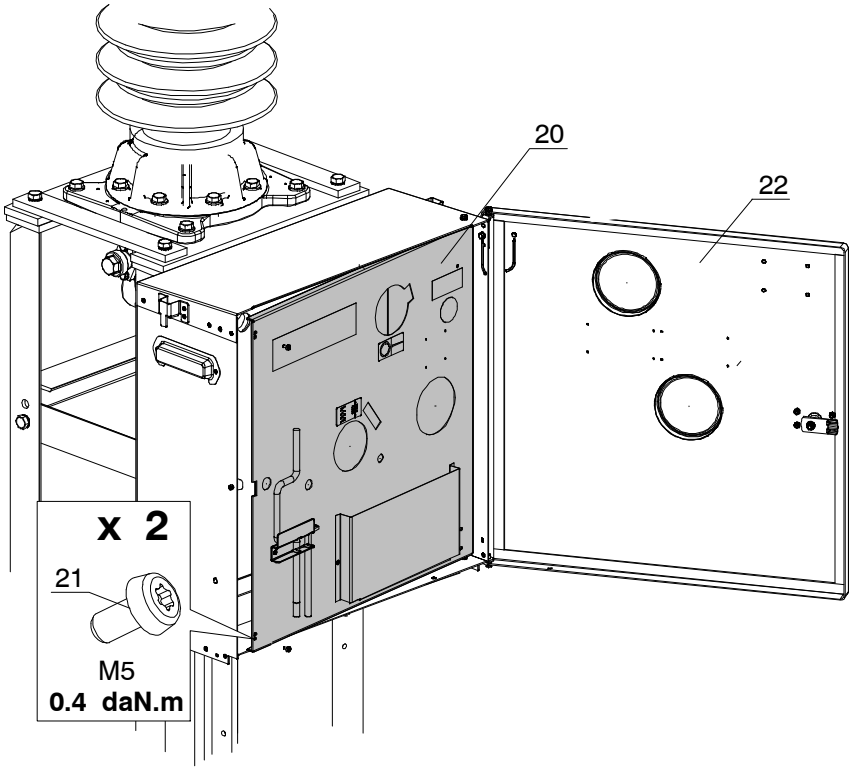
Connect the wires of the cable for the (19) SF_6 contact densimeter (18) to the operating mechanism terminal strip in accordance with the relevant diagram.



Returning to normal operating conditions

Resumption of service.

After making all connections, close the first door (20) of the operating mechanism and fasten it in place (21).
Reclose the outer door (22), which latches shut.



Permanent heating

Instructions

Provide power for permanent heating of the operating mechanism (in summer and winter) to avoid condensation and resulting corrosion risks.

TO AVOID RESETTING OF THE CLOSING SPRING DO NOT POWER THE CONTROL MOTOR .
THE CIRCUIT-BREAKER MUST NOT BE ACTUATED AT AN SF_6 GAS PRESSURE BELOW THE MINIMUM PRESSURE FOR ISOLATION p_{me}.

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Presentation

Introduction

The SF_6 gas perssure values, for filling, must be read on the pressure gauge 0...1 MPa (tooling). Do not take any account of the reading on the densimeter dial (MPa – psi), as it is not precise enough for the filling.

Pressure gauge 0...1 MPa

Units of pressure (reminder)

- The international unit of pressure is the pascal (Pa).

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

Symbols

IEC symbols for the technical characteristics of the equipment.

Symbol	Description
p_{re}	Assigned filling pressure for insulation
p_{ae}	Alarm pressure for insulation
p_{me}	Minimum insulation pressure

In this module

This module covers the following subjects:

Technical data

SF_6 gas

The following table gives the characteristics of the SF_6 gas:

Absolute pressure at 20°C			
p_{re}	Absolute filling pressure for insulation		**0.75 MPa**
For a relative pressure at 20°C and101.3 kPa			
p_{re}	Assigned relative filling pressure for insulation	+ 0,01 - 0	0,65 MPa
p_{ae}	Relative alarm pressure for insulation	+ 0,02 - 0	0,54 MPa (p_{me}+0.03 MPa)
p_{me}	Minimum relative insulation pressure	+ 0,02 - 0	0,51 MPa
Density of SF_6 gas			
p_{re}			49.59 kg/m^3
p_{ae}			41.66 kg/m^3
p_{me}			39.55 kg/m^3
Minimum permissible temperature up to			**-30°C**

Example

Determination of the filling pressure in SF_6 gas for a circuit breaker.

Parameters	Values
p_{re} Assigned relative filling pressure for insulation in SF_6 gas	**0,65 MPa** (94.27 psi)
Ambient Temperature	**5°C**
Local atmospheric pressure	**93,2 kPa**

Filling with SF_6 gas

The following table gives the steps for calculating the filling pressure for SF_6 gas:

Step	Action	Result
1	In the table (page 4) "Relative pressure values for SF_6 gas corrected for temperature," read the value p_{re} situated in the range t°C = 5.	0,603 MPa
2	Calculate the atmospheric pressure variation : 0,1013 - 0,0932	0,0081 MPa
3	Calculate the assigned relative pressure p_{re} for 5°C : 0,603 + 0,0081	0,6111 MPa
4	The filling takes place at the assigned pressure, increaed by 0.01 MPa so: 0,6111 + 0,01	Filling with SF_6 gas **0,6211 MPa**

Calculating the filling pressure on site

Measuring

Write the measurements in the corresponding boxes :

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

Calculating the SF_6 gas filling pressure

Read the values inthe corresponding boxes and write down the results:

Using the table (page 4) "Relative pressure values for SF_6 gas corrected for temperature," determine the value "p_{re}" corrected according to the ambient temperature (**B**) ▶	p_{re} C ---,-------
Reference atmospheric pressure value in MPa	D 0 , 1 0 1
Read the local atmospheric pressure value (**A**) ▶	A -- ,-------
Calculate the atmospheric pressure variation (**D - A**) ▶	E ---,-------
Read the value (**C**) ▶	C+--,-------
Calculate the assigned relative pressure (**E + C**) ▶	F ---,-------
Filling with SF_6 gas will take place until the calculated pressure,increased by 0,01 MPa. (**F + 0.01**) ▶	+ 0, 0 1 G ---,-------

Values of the relative pressures for SF_6 gas corrected for temperature

Assigned relative pressure 0.65 MPa

Values of the relative pressures (**MPa**) for SF_6 gas corrected for 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}
-30	0,492	0,409	0,387	**16**	0,637	0,530	0,500
-29	0,495	0,412	0,389	**17**	0,641	0,532	0,503
-28	0,498	0,415	0,391	**18**	0,644	0,535	0,505
-27	0,501	0,417	0,394	**19**	0,647	0,537	0,508
-26	0,505	0,420	0,396	**20**	0,65	0,54	0,51
-25	0,508	0,422	0,399	**21**	0,653	0,543	0,512
-24	0,511	0,425	0,401	**22**	0,656	0,545	0,515
-23	0,514	0,428	0,404	**23**	0,659	0,548	0,517
-22	0,517	0,430	0,406	**24**	0,663	0,550	0,520
-21	0,520	0,433	0,409	**25**	0,666	0,553	0,522
-20	0,524	0,435	0,411	**26**	0,669	0,556	0,525
-19	0,527	0,438	0,414	**27**	0,672	0,558	0,527
-18	0,530	0,441	0,416	**28**	0,675	0,561	0,530
-17	0,533	0,443	0,419	**29**	0,678	0,564	0,532
-16	0,536	0,446	0,421	**30**	0,682	0,566	0,535
-15	0,539	0,449	0,424	**31**	0,685	0,569	0,537
-14	0,543	0,451	0,426	**32**	0,688	0,571	0,540
-13	0,546	0,454	0,429	**33**	0,691	0,574	0,542
-12	0,549	0,456	0,431	**34**	0,694	0,577	0,545
-11	0,552	0,459	0,433	**35**	0,697	0,579	0,547
-10	0,555	0,462	0,436	**36**	0,701	0,582	0,550
-9	0,558	0,464	0,438	**37**	0,704	0,584	0,552
-8	0,562	0,467	0,441	**38**	0,707	0,587	0,554
-7	0,565	0,469	0,443	**39**	0,710	0,590	0,557
-6	0,568	0,472	0,446	**40**	0,713	0,592	0,559
-5	0,571	0,475	0,448	**41**	0,716	0,595	0,562
-4	0,574	0,477	0,451	**42**	0,720	0,597	0,564
-3	0,577	0,480	0,453	**43**	0,723	0,600	0,567
-2	0,580	0,483	0,456	**44**	0,726	0,603	0,569
-1	0,584	0,485	0,458	**45**	0,729	0,605	0,572
0	0,587	0,488	0,461	**46**	0,732	0,608	0,574
1	0,590	0,490	0,463	**47**	0,735	0,611	0,577
2	0,593	0,493	0,466	**48**	0,738	0,613	0,579
3	0,596	0,496	0,468	**49**	0,742	0,616	0,582
4	0,599	0,498	0,470	**50**	0,745	0,618	0,584
5	0,603	0,501	0,473	**51**	0,748	0,621	0,587
6	0,606	0,503	0,475	**52**	0,751	0,624	0,589
7	0,609	0,506	0,478	**53**	0,754	0,626	0,591
8	0,612	0,509	0,480	**54**	0,757	0,629	0,594
9	0,615	0,511	0,483	**55**	0,761	0,631	0,596
10	0,618	0,514	0,485	**56**	0,764	0,634	0,599
11	0,622	0,516	0,488	**57**	0,767	0,637	0,601
12	0,625	0,519	0,490	**58**	0,770	0,639	0,604
13	0,628	0,522	0,493	**59**	0,773	0,642	0,606
14	0,631	0,524	0,495	**60**	0,776	0,645	0,609
15	0,634	0,527	0,498				

Presentation

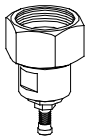
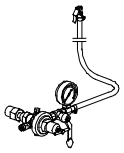
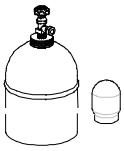
Warning

DUE TO THE RISK OF DAMAGE CAUSED BY TRANSPORT OF PORCELAIN, ALL PERSONS PRESENT DURING GAS FILLING MUST TAKE SHELTER OR REMAIN AT A MINIMUM SAFETY DISTANCE (ROUGHLY 50 m).

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 ALSTOM Grid equipment and tools necessary for filling with SF_6 gas:

Mark	Illustration	Description	Quantity
2		Filling tool	1
8		Mano-relief valve	1
6		SF_6 gas cylinders	*
14		Manometer 0...1 MPa	1

* depends on apparatus

In this module

This module covers the following subjects:

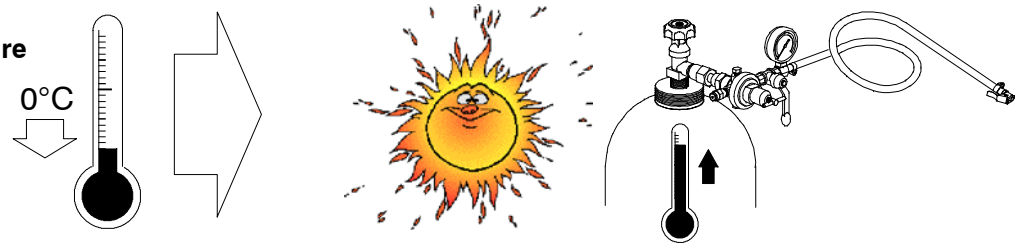
Filling with SF_6 gas

Calculation of the filling pressure

Calculate the SF_6 gas pressure as a function of the local atmospheric pressure and temperature.
The filling takes place at the calculated pressure, increaed by 0.01 MPa.

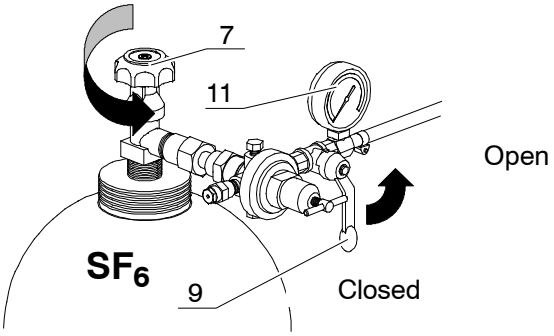
See module "**Monitoring SF_6 gas**" (Calculation of filling pressure on-site).

Ambient temperature



Instructions

The following table gives the steps for the filling operation for SF_6 gas:

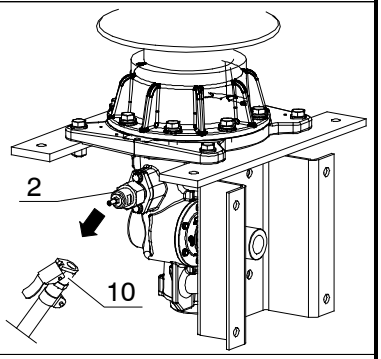
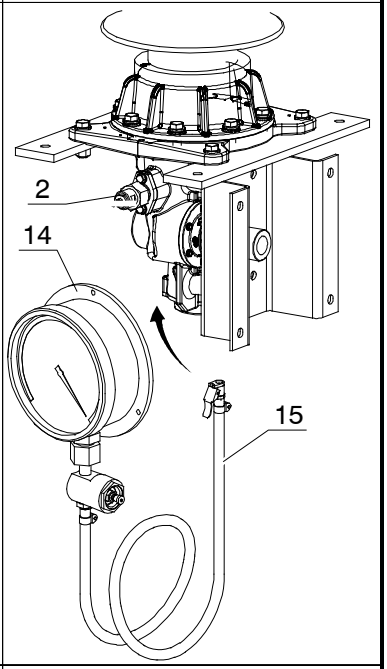
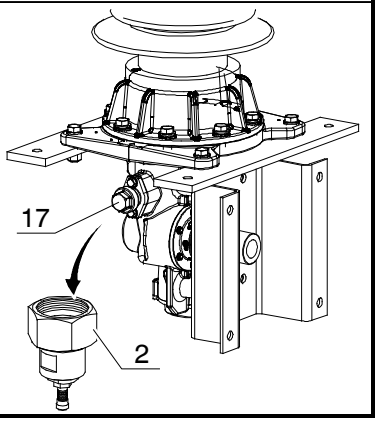


Step	Action	Remark
1	Open the tap (7) on the SF_6 cylinder and adjust the gas outlet using the reducing valve (9) (**low rate of flow**). 	From time to time, close the tap (7) to read the pressure on the pressure gauge (11).
2	Resume filling until the desired pressure is reached.	
3	Close the tap (7) and the valve (9) in that order.	

Confirming the pressure

Instructions

The following table gives the steps for confirming the filling pressure of SF_6 gas:

Step	Action	Remark/Illustration
1	Disconnect the reducing valve tube (10), from the filling toom (2). **NOTE** : Keep the end of the disconnected tube (10) in a high position to keep the SF_6 inside and avoid entry of humid air.	
2	• Connect the pressure gauge 0...1 MPa (14) pipe (15) to the filling tool (2). • When the desired pressure is confirmed, remove the pressure gauge (14) and store it away from humidity.	
3	Remove the filling toom (2) and replace the cap (17) (4 daN.m).	

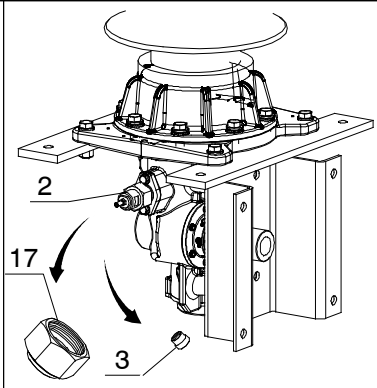
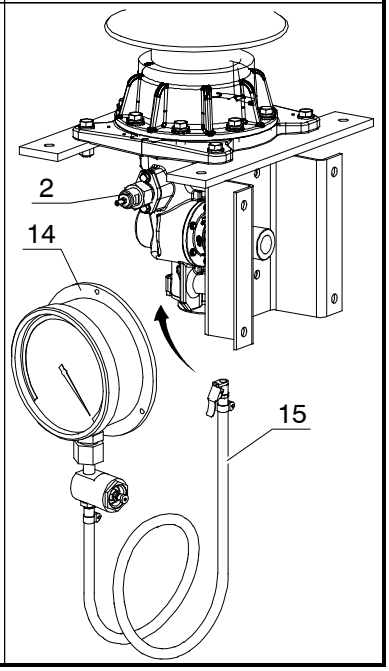
Checking the pressure

Principle

After allowing the temperature to stabilize for at least 12 hours after filling, it is necessary to check and definitively set the pressure to its corrected value, defined according to ambient temperature and atmospheric pressure.

Preparation

The following table defines the steps for preparing for the pressure check :

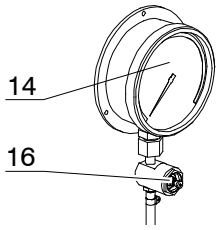
Step	Action	Illustration
1	• Remove the plug (17) and fit the filling tool (2). • Unscrew the cap (3).	
2	• Connect the pressure gauge 0...1 MPa (14) pipe (15) to the filling tool (2).	

Continued on next page.

Checking the pressure, continued

Decision-making procedure table

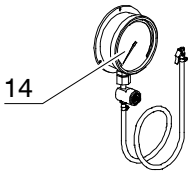
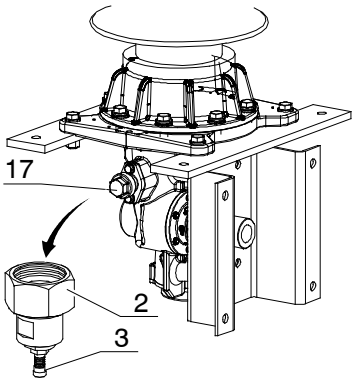
The table below shows the procedure to follow according to the pressure measured:



<table>
<tr><th>If the pressure measured is ...</th><th>Action</th></tr>
<tr><td>correct</td><td>End of check</td></tr>
<tr><td>too high</td><td>Adjust the pressure using the manometer (14) valve (16) to reach the required corrected pressure.</td></tr>
<tr><td>too low</td><td>Addition of SF_6 gas
<table>
<tr><th>If the pressure adjustment is ...</th><th>Action</th></tr>
<tr><td>≤ 0.05 MPa</td><td>End of check</td></tr>
<tr><td>> 0.05 MPa</td><td>Carry out another check after a 2 to 3 hour stabilization period.</td></tr>
</table></td></tr>
</table>

End of check

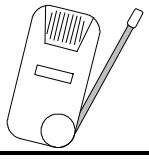
The following table defines the steps ending the pressure check:

Step	Action	Illustration
1	Disconnect the pressure gauge 0...1 MPa (14).	
2	• Remove the filling tool (2) and screw the plug (17) on, applying a tightening torque of 4 daN.m; leaktightness is only guaranteed if this requirement is fulfilled. • Screw the cap (3) onto the filling tool (2).	

Leaktightness check

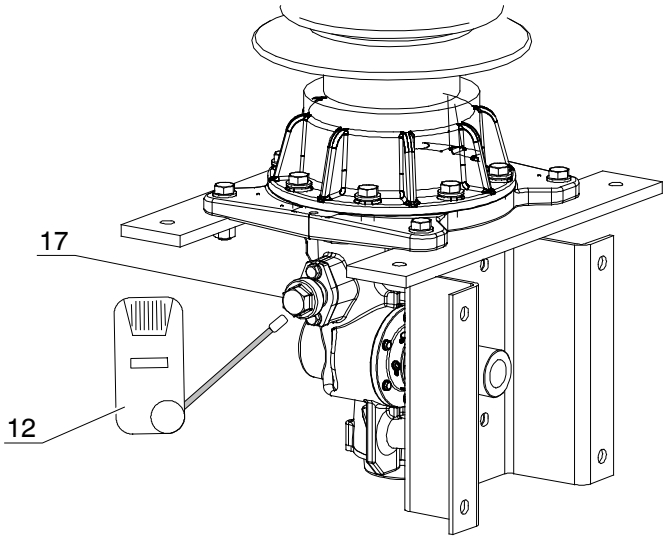
Tools required ALSTOM Grid

List of ALSTOM Grid tools necessary to check leaktightness :

Mark	Illustration	Description	Quantity
12		Leak detector (option)	1

Instructions

Check the leaktightness of the plug (17), using a leak detector (12).



Humidity of gaz SF_6 gas in the circuit breaker

Principle

This measurement is not necessary, as the equipment has enough molecular sieves to provide a dewpoint ≤ 0°C for an ambient temperature of 20°C, for an apparatus filled at its nominal pressure for 2 to 3 months.

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Presentation

Introduction

After installing the equipment, completion of all electrical connections and earthing, inspections must be carried out before commissioning.
These inspections must be carried out on an apparatus ready to be commissioned (under power), meaning :

- L.V. electric circuits in accordaance with the voltage and type on the low voltage wiring diagram and the rating plate.
- Assigned pressure of the gas SF_6 or SF_6+CF_4 in the eclosures.

NOTE : Assigned pressure, pressure the equipment is at after filling with SF_6 or SF_6+CF_4 gas.

- Flexible connections connecting the circuit breaker to the bus bar in place.

Caution

DURING PRE-COMMISSIONING INSPECTION OPERATIONS, ALL PRECAUTIONS MUST BE TAKEN TO ENSURE THE PROTECTION OF PERSONNEL WORKING ON THE EQUIPMENT.

In this module

This module covers the following 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

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Service Contrats
130 rue Léom BLUM
69611 Villeurbanne
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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

SF_6 or SF_6+CF_4 gas

Reminder

The SF_6 or SF_6+CF_4 enclosures are at the pressure assigned when they were filled with SF_6 or SF_6+CF_4 gas.

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

Parameters

Read the following parameters :

- the site altitude, in metres,
- the site atmospheric pressurela in kPa,
- the site temperature in °C.

Verification of the SF_6 or SF_6+CF_4 gas

The SF_6 or SF_6+CF_4 pressure values must be read on the verification pressure gauge (tools). Do not take any account of the reading on the densimeter dial located on the filling control unit (if applicable), as it is not precise enough for the inspection.

See "**Calculating the SF_6 or SF_6+CF_4 gas filling pressure for use of the pressure gauge (tools)**".

The following table defines the inspection steps :

Step	Action	Remark
1	Measure the SF_6 or SF_6+CF_4 gas pressure using the verification pressure gauge (tools).	Follow the instructions in the module "Filling with SF_6 or SF_6+CF_4 gas."
2	Correct the pressure read.	Follow the instructions in the module "Calculating the SF_6 or SF_6+CF_4 gas filling pressure for use of the pressure gauge (tools)".

Rate of humidity of the SF_6 or SF_6+CF_4 gas

It is not necessary to check the rate of humidity of the SF_6 ou SF_6+CF_4, as the equipment has a molecular sieve to to provide a dewpoint less than or equal to 0°C for an ambient temperature of 20°C, for an apparatus filled at its assigned presure for 2 to 3 months.

Verification of the leaktightness of the assemblies under SF_6 or SF_6+CF_4 pressure

Each assembly pressurised with SF_6 ou SF_6+CF_4 gas on site is mounted with seals. The quality of the assembly must be checked.
This inspection must be carried out after all filling and pressure inspection operations have finished.

Carry out this inspection by following the instructions in the module "Filling with SF_6 or SF_6+CF_4 gas."

Operating mechanism

Measurements	Reading the motor power supply voltage at the operating mechanism terminals.
Check	The normal opperation of the following devices must be checked : – heating, – connections to the terminals (no excessive tightening).

Test operations

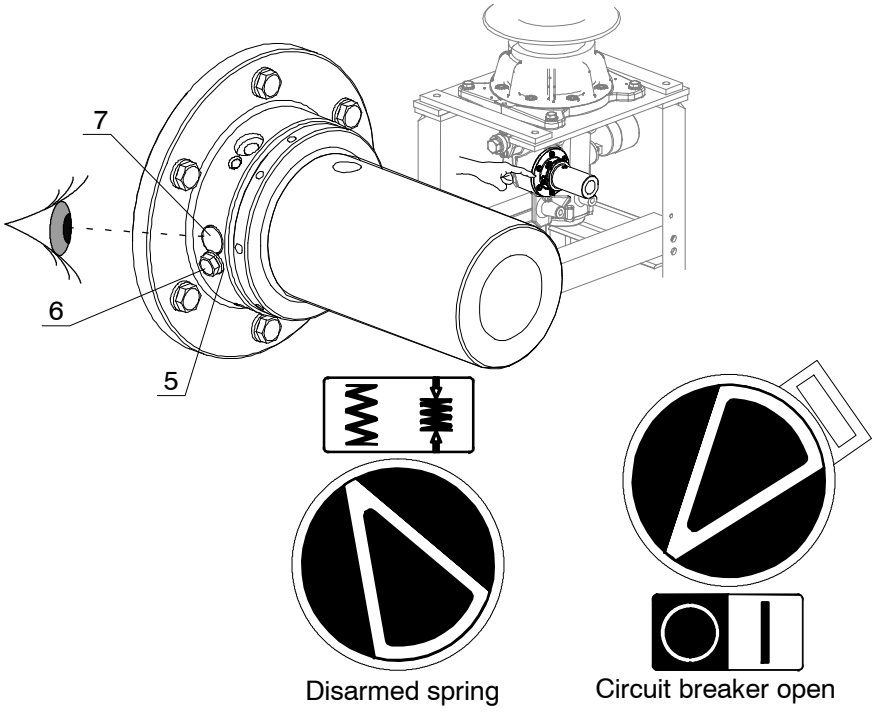
OPERATION AUTHORISED ONLY IF THE SF_6 or SF_6+CF_4 GAS PRESSURE IS GREATER THAN THE MINIMUM INSULATING PRESSURE p_{me}.

Caution

DUE TO THE RISK OF DAMAGE CAUSED BY TRANSPORT OF PORCELAIN, ALL PERSONS PRESENT DURING GAS FILLING MUST TAKE SHELTER OR REMAIN AT A MINIMUM SAFETY DISTANCE (ROUGHLY 50m).

Test operations

- The connection of the wuxiliary circuits has sufficiently progressed for remote control.
- Electrically remote control 1 CLOSING – OPENING cycle.
- Make sure the control is in open position by looking at the mimic diagram, and that there is no damage visible on the fuse pin (7), the washer (5) or the screw (6).



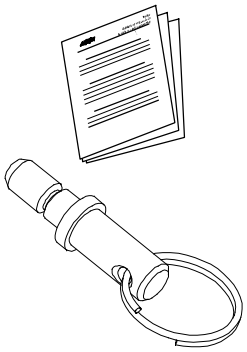
- Electrically remote control 4 more CLOSING – OPENING cycles.

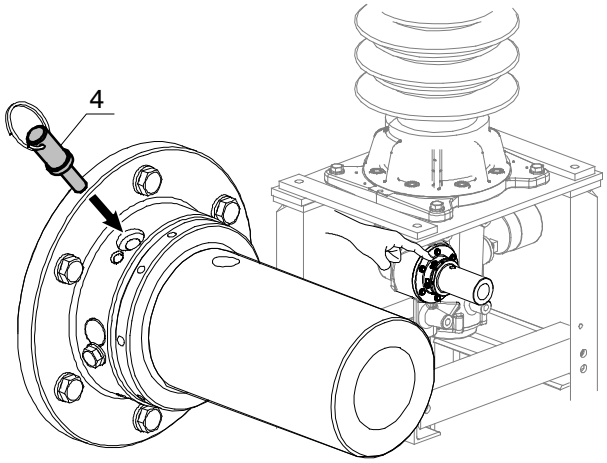
Test operations, continued

VERY IMPORTANT

AFTER THE FIRST TEST OPERATION, IT IS FORBIDDEN TO DISMANTLE THE OPERATION MECHANISM WITHOUT USING THE HOLDING TOOL (4).

NOTE : To dismantle the operating mechanism, seen, in ”Maintenance”, the module ”**Replacing the FK3-07 operating mechanism**”.





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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**

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

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

CLIENT / CUSTOMER / *CLIENTE* _____

Poste/Substation/Subestación _____

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

Commande ALSTOM N°
ALSTOM order N° _____
N° de pedido ALSTOM

Repère
Item _____
Ref

Norme
Standard _____
Norma

Spécification du client
Customer's specification _____
Especificación del cliente

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 absolue du gaz SF6 à 20°C :
Absolute SF6 gas pressure at 20°C : _____Mpa
Presión absoluta del gas SF6 à 20°C

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 ____ V(____)
Bobinas

Moteur
Motor ____ V(____)
Motor

Chauffage
Heater ____ V(____)
Calefación

Signalisation
Alarm ____ V(____)
Señalización

Circuit de commande
Control circuit ____ V(____)
Circuito de mando

Cablage alimentations / Supply voltage wiring

Définitif/ definitive ☐
Temporaire/ Temporary ☐

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).

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

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

Constat sur le site Verification at site *Verificación en el sitio*		**Pôle** **Pôle A** *Polo*	**Pôle** **Pôle B** *Polo*	**Pôle** **Pôle C** *Polo*
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*			
Réalisation du 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 présence de la pression SF6 de transport Checking of transport SF6 pressure *Comprobación de la presión de SF6 de transporte*				

Observations – Remarks – *Observaciones*

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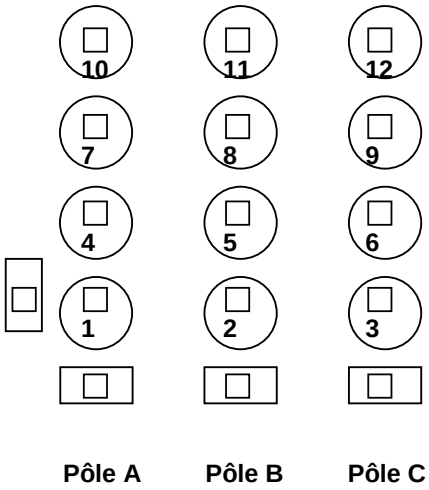
IDENTIFICATION
IDENTIFICATION
IDENTIFICACIÓN

Pôle Pole *Polo*	**Repère / N° têtes / N° colonnes** Item / N° heads / N° columns *Referencia / N° cabezas / N° columnas*	
Pôle A	1 _____	4 _____
	7 _____	10 _____
Pôle B	2 _____	5 _____
	8 _____	11 _____
Pôle C	3 _____	6 _____
	9 _____	12 _____



Nombre d'armoires Number of cubicles __ *Numero de armarios*	**Fonctionnement unipolaire** One pole operation ____ *Funcionamiento unipolar*	**Fonctionnement tripolaire** Three-pole operation ____ *Funcionamiento tripolar*

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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*	

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

	Pôle/Pole/*Polo* **Pôle A**	**Pôle/**Pole/*Polo* **Pôle B**	**Pôle/**Pole/*Polo* **Pôle C**
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 numero de maniobras de los contadores durante el llenado en SF6 y acoplamiento al polo*	_____	_____	_____

OBSERVATIONS – REMARKS – *OBSERVACIONES*

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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

Appareil de mesure – test equipment	**N° de série** – serial number	Calibration date	Observations

Application d'une tension d'essai de _____ **kV (valeur efficace) pendant** _____ **s, entre la filerie et le bâti.**
Application of a test voltage of _____ kV (rms value) for _____ s, between wiring and the base.
Aplicación de una tensión de ensayo de _____ *kV, (valor eficaz) durante* _____ *s, entre la cableria y la base.*

Les moteurs et les équipements, déjà essayés conformément à leur propre spécification, ont été déconnectés pendant ces essais.
The motors and equipments tested previously in accordance with their own specification were disconnected during these tests.
Los motores y equipos sometidos anteriormente a ensayos de acuerdo con sus especificaciones propias fueron desconnectados durante estos ensayos.

MESURAGE DE LA RÉSISTANCE DU CIRCUIT PRINCIPAL

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

Appareil de mesure – test equipment	**N° de série** – serial number	Calibration date	Observations

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

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

Valeurs en / Values in / *Valores en* : µΩ

Pôle **Pôle A** *Polo*		**Pôle** **Pôle B** *Polo*		**Pôle** **Pôle C** *Polo*	
1 _____	4 _____	2 _____	5 _____	3 _____	6 _____
7 _____	10 _____	8 _____	11 _____	9 _____	12 _____

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

Appareil de mesure – test equipment	**N° de série** – serial number	Calibration date	Observations

☐ **SF6 pur** / pure SF6 / *SF6 puro*

☐ **Mélange SF6/CF4 /** mix SF6/CF4 / *mezcla SF6/CF4* ⇒ **Valeurs en pression absolue**
Values in absolute pression
Valores en la presión absoluta

_____ % SF6 _____ % CF4

Altitude
Altitude _____ m
Altitud

Pression barométrique
Barometric pressure _____ hPa
Presión barométrica

Température
Temperature _____ °C
Temperatura

Pression absolue / Absolute pressure *Pressión absoluta*	**Pole 1**	**Pole 2**	**Pole 3**
Mesurage de la pression de remplissage Filling pressure measurement *Medición de la presión de llenado*	_____	_____	_____
Valeur calculée équivalente à 20°C en MPa absolue Equivalent computed values at 20°C in MPa absolute *Valores computados equivalentes para 20°C en MPa absolutos*	_____	_____	_____

Pression relative / relative pressure *Presión relativa* At 20°C and 1013 hPa	**Pole 1**	**Pole 2**	**Pole 3**
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*	_____	_____	_____

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	**N° de série** – serial number	Calibration date	Observations

Pression barométrique
Barometric pressure _____hPa
Presión barométrica

Température
Temperature _____
Temperatura

	Pole 1			**Pole 2**			**Pole 3**		
	Seuil Threshold *Umbral* **1**	**Seuil** Threshold *Umbral* **2**	**Seuil** Threshold *Umbral* **3**	**Seuil** Threshold *Umbral* **1**	**Seuil** Threshold *Umbral* **2**	**Seuil** Threshold *Umbral* **3**	**Seuil** Threshold *Umbral* **1**	**Seuil** Threshold *Umbral* **2**	**Seuil** Threshold *Umbral* **3**
Mesurage des pressions des seuils Thresholds pressures measurement *Medición de las presiones des 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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ESSAIS DE FONCTIONNEMENT MÉCANIQUE
MECHANICAL OPERATING TESTS
ENSAYOS DE FUNCIONAMIENTO MECÁNICO

DURÉES DE FONCTIONNEMENT
OPERATING TIMES ms
TIEMPO DE OPERACIÓN

Appareil de mesure – test equipment	**N° de série** – serial number	Calibration date	Observations

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

		Pôle Pôle A *Polo*				**Pôle Pôle B** *Polo*				**Pôle Pôle C** *Polo*			
		1	4	7	10	2	5	8	11	3	6	9	12
Manœuvre de fermeture Closing operation *Maniobra de cierre*	**C**												
	SC												
Manœuvre d'ouverture Opening operation *Maniobra de apertura*	way 1 **C**												
	way 1 **SC**												
Manœuvre d'ouverture Opening operation *Maniobra de apertura*	Way 2 **C**												
	Way 2 **SC**												
Cycle de manœuvre 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*													
Séquence de manœuvre Operating sequence : O-CO *Secuencia de maniobra*	O												
	C												
	O												
Durée d'ouverture-fermeture Open-close time *Tiempo de apertura-cierre*													
Durée de fermeture Close-Open time *Tiempo de cierre-apertura*													

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

Entre éléments de coupure d'un même pôle
Between breaking elements of a same pole
Entre elementos de interrupción de un mismo polo

	Pôle Pôle A *Polo*	**Pôle Pôle B** *Polo*	**Pôle Pôle C** *Polo*
Fermeture Closing *Cierre*	_____	_____	_____
Ouverture voie 1 Opening way 1 *Apertura via 1*	_____	_____	_____
Ouverture voie 2 Opening way 2 *Apertura via 2*	_____	_____	_____

Entre pôles
Between poles
Entre polos

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 ms
MEDICIÓN DE DURACIONES DE FUNCIONAMIENTO DE LOS CONTACTOS AUXILIARES

Type de contact Contact type *Tipo de contacto*	**Pôle Pôle A** *Polo*	**Pôle Pôle B** *Polo*	**Pôle Pôle C** *Polo*
Manœuvre de fermeture Closing operation *Maniobra de cierre* 52 b	_____	_____	_____
52a	_____	_____	_____
Manœuvre d'ouverture Opening operation *Maniobra de apertura* 52b	_____	_____	_____
52a	_____	_____	_____

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MESURAGE DE LA RÉSISTANCE DE LA CHAMBRE AUXILIAIRE
MEASUREMENT OF THE AUXILIARY CHAMBER RESISTOR
MEDICIÓN DE LA RESISTENCIA DE LA CAMARA AUXILIAR

Appareil de mesure – test equipment	**N° de série** – serial number	Calibration date	Observations

Valeur en
Values in Ω
Valores en

Pôle A		Pôle B		Pôle C	
1 _____	4 _____	2 _____	5 _____	3 _____	6 _____
7 _____	10 _____	8 _____	11 _____	9 _____	12 _____

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

Sécurité à l'ouverture de la résistance
Safety at resistor opening
Securitad a la apertura de la resistencia

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

1 _____	4 _____	2 _____	5 _____	3 _____	6 _____
7 _____	10 _____	8 _____	11 _____	9 _____	12 _____
1 _____	4 _____	2 _____	5 _____	3 _____	6 _____
7 _____	10 _____	8 _____	11 _____	9 _____	12 _____

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

_____	_____	_____

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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 localemécanique/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 thereshold ☐ *Señalisación de falta de SF6 1o umbral*
Chauffage permanent Permanent heating ☐ *Calefacción permanente*	**Signalisation défaut SF6 2nd seuil** SF6 fault indication – 2nd thereshold ☐ *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*

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

Pôle A	Pôle B	Pôle C
_____	_____	_____

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 interuptors 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.

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OBSERVATIONS – REMARKS – *OBSERVACIONES*

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CA 104 100 3 REFERENCE TRAME IOG-QG3 90 010/ D1	CRITERES D'ACCEPTATION *ACCEPTANCE CRITERIA NUMBER*

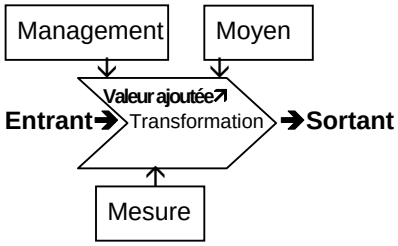
DISJONCTEUR GL 314P À COMMANDE MECANIQUE FK3.07 - MONTAGE SITE
CIRCUIT BREAKER GL314P WITH SPRING MECHANISM FK3.07- SITE ERECTION

SERVICES EMETTEURS : Qualité Montage

PARENTS

PROCESSUS PARENT : ANIMATION QUALITE — REF. **Q1**
INSTRUCTION OPERATIONNELLE : QG3 91 000
TITRE : PROCESSUS COORDINATION QUALITE

PLAN DU PROCESSUS



- **V**ALEUR AJOUTEE
- **E**NTRANT
- **T**RANSFORMATION
- **S**ORTANT
- **M**ANAGEMENT
- **M**OYENS
- **M**ESURE

LIEU DE PRESENCE DU DOCUMENT	

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

Rédacteur(s) : <MALATIER Thierry> Signé le 11/07/2011	Approbateur(s) : ALAMEDDINE Alaa Signé le 21/07/2011	Vérificateur(s) : DOUMMAR Georges Signé le 21/07/2011

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CA 104 100 3	CRITERES D'ACCEPTATION *ACCEPTANCE CRITERIA NUMBER*

VALIDITÉ
VALIDITY

DISJONCTEUR : GL314 P UNIPOLAIRE
CIRCUIT BREAKER

PRESSION SF6 : Pre = 0,75 a 1.0 MPA
SF6 PRESSURE

COMMANDE : MÉCANIQUE FK 3.07
MECHANISM : FK3.07 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.

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 -250 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.

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.

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.*

***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 –250 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.*

***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 poles contacts are separated during the opening operation.*

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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*	77	97
Ouverture O1/O2 - *Opening O1/O2*	14	24
Fermeture par relais FINDER - *Closing with relay FINDER*	90	130
Ouverture par relais FINDER O1/O2 *Opening with relay* FINDER *O1/O2*	20	58
Fermeture de CO - *Closing of CO*	77	97
Ouverture de CO - *Opening of CO*	43	65
CO	40	70
1ère Ouverture de O-CO - *1st Opening of O-CO*	14	24
Fermeture de O-CO - *Closing of O-CO*	77	97
2ème Ouverture de O-CO - *2nd Opening of O-CO*	43	65

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*	78	108
Type b / Fermeture de CO - *Closing of CO*	58	88
Type a / Ouverture de CO - *Opening of CO*	34	59
Type b / Ouverture de CO - *Opening of CO*	43	68
Type a / 1ère Ouverture de O-CO - *1st Opening of O-CO*	7	27
Type b / 1ère Ouverture de O-CO - *1st Opening of O-CO*	16	36
Type a / Fermeture de O-CO - *Closing of O-CO*	78	108
Type b / Fermeture de O-CO - *Closing of O-CO*	58	88
Type a / 2ème Ouverture de O-CO - *2nd Opening of O-CO*	34	59
Type b / 2ème Ouverture de O-CO - *2nd Opening of O-CO*	43	68

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

MANOEUVRE *OPERATION*	Maximum
Fermeture – *Closing* réseau *network* 50 Hz réseau *network* 60Hz	5 4
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*	8

RESISTANCE DE CONTACT DU CIRCUIT PRINCIPAL (avec prise de courant)
(en μΩ sous courant continu de 100A)
MAIN CIRCUIT RESISTANCE (with HV terminal)
(in μΩ with a 100A direct current)

Type de chambre *Type of chamber*	Maximum
105 /4 -250	35
105/ 5 -280	37
105/ 7 -280	39
105/ 12 -280	39
105/ 13 -280	37
105/ 14 -280	39

Presentation

Introduction

GL circuit breakers use pure SF_6 gas as an extinguisher environment for the arc (or a mix of SF_6+CF_4 gas) and only require very limited maintenance.

In this module

This module covers the following subjects:

Maintenance plan

Frequency of maintenance

Under normal service conditions, the maintenance plan can be defined as follows:

Type of inspection	Frequency	Remark
Maintenance visits	Once or twice per year	**We recommend at least 2 CO cycles CO per year for circuit breakers that are infrequently used, to check proper functioning of the circuit breaker and the associated command--control circuits.**
Inspections	Every 5 years	Inspection requires the equipment to be shut off. Nonetheless the breaking chambers and other sub--assemblies do not need to be dismantled.
Revision	Once one of the following criteria is met : ● service duration ≥ 20 years ● number of mechanical cycles ≥ 3 000 ● electrical wear	We nonetheless recommend inspecting the most used pole or circuit breaker, and adapting the maintenance plan for the other equipment in accordance with the observed results.

Maintenance operations

Guide to

The following table is a guide to the operations to be carried out at each maintenance step :

MAINTENANCE VISIT (1 or 2 times per year) **INSPECTION** (every 5 years) **REVISION** (SERVICE LIFE : 20 years) **REVISION** (MECANICAL ACTUATORS : 3 000 cycles) **REVISION** (ELECTRICAL WEAR : see 'Limit of electrical wear")					
■	■	■	■	■	Read the actuator counters.
■	■	■			General inspection : visual aspect (corrosion, paint, trace of heat).
■	■	■	■	■	Check the permanent heating functions. Check the condition of the air vents
■	■	■			If the circuit breaker is equipped with a SF_6 densimeter with a dial, check that the needle is in the green zone.
■					We recommend at least 2 CO cycles CO per year **for circuit breakers that are infrequently used**, to check proper functioning of the circuit breaker and the associated command-control circuits.
	■	■			Check the SF_6 contact densimeter thresholds. Then adjust the pressure to nominal pressure.
	■	■	■		Check the tightening of the fasteners for components not under pressure (frame, plate, cabinet).
*	■	■	■		Check the tightening of the low voltage terminals (* 6 months after commissioning).
	■	■	■		Check the relays are functioning.
		■			Change the door, side panels and ceiling seals.
	■	■	■	■	Measure the pole and auxiliary contact duration of opertion.
	■	■	■	■	Carry out operations at recommended cycles and nominal voltage.
			■	■	Replace (or recondition) the breaking chambers.
			■		Check to see that the opening damper piston of the control is not leaking oil.

Details of maintenance operations

Caution

DURING MAINTENANCE OPERATIONS ALL SAFETY MEASURES SHALL BE TAKEN IN ORDER TO ENSURE PROTECTION OF PERSONNEL INTERVENING ON THE EQUIPMENT.

General condition of the equipment

Visual inspection of the equipment, if traces of corrosion, proceed with reconditioning the points concerned.
The table below shows the procedure to follow according to the support and protection :

Support	Inspection	Action
Galvanized steel	Oxidised parts	• Careful brushing of oxidised parts. • Degreasing with solvent. • Application of a layer of galvanized paint
Painted galvanized steel or alloy with painted aluminium	Slight scratches	• Careful degreasing with solvent. • Application of a layer of lacquer by brush.
	Deep scratches or scaling	• Take the shine off the paint with 400 paper. • Careful degreasing with solvent. • Application of a layer of primer, then let dry 24 hours. • Application of a layer of polyurethane lacquer by brush.

Products used :

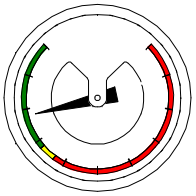
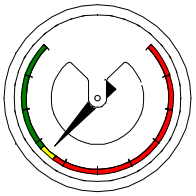
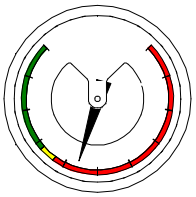
- RUMCOAT EEVA primer from DERIVERY reference 333103;
- Polyurethane lacquer 780 from DERIVERY reference depends on colour of equipment.

Continued on next page.

Details of maintenance operations, continued

Pressure of SF_6 gas

If the circuit breaker has a ”dial densimeter” for SF_6 gas, check the position of the needle.

Position of the needle	Colour zone	Instructions
	GREEN	Nil
	YELLOW	Carry out an additional filling
	 RED	Density abnormally low, search for a new leak and contact **ALSTOM Grid After-Sales Department**.

NOTE : If the needle is either in the yellow zone or in the red zone, with no particular indication from the contact densimeter, make sure teh informationis correct then find the defective component and replace it.

Operating mechanism

The air vents must be clean, free of dust, and unobstructed. If encessary, clean them with solvent.
Make sure the permanent resistors are functioning by observing the heat they give off and the absence of traces of overheating (area obviously burned).
For thermo-stat resistors, use a thermostat to check they are turned on and off properly at the power supply terminals (recommended theromstat temperature : +5°C
If necessary change the defective resistors.
For the opening damper, if a leak is observed, contact ALSTOM Grid, After Sales Service to change it.

Operation counter

Read the operating counter(s), write the reading in the ”Maintenance visits” monitoring document.
The number of circuit breaker operations determines subsequent maintenance operations.

Continued on next page.

Details of maintenance operations, continued

Contact densimeter thresholds	Check the SF_6 contact densimeter thresholds. If the values are outside tolerances, replace the densimeter.
Tightening the fasteners	Check and readjust the tightening torque values of the fixings for unpressurised components using a torque wrench. The tightening torque values are those incicated in the module ”Tightening torque values.”
Operation of the relays	Check the relays are functioning by carrying out the following circuit breaker sequences : – locking the closing, – automatic opening, – antipumping,
Tightening the terminals L.V.	With the electrical cabinet turned off, make sure the cable lugs or end pieces are tightly on the electrical conductors, and check the tightening torque of the connection fasteners. **CAUTION : THE TERMINAL SCREWS MUST NOT BE TIGHTENED TOO MUCH.**
Insulating enclosures	Check the state of the insulating enclosures. They must have no traces of shocks, bursting, cracks, deposits, dust, pollution, etc. If necessary clean the insulating enclosures with a dry cloth. In case of anomaly in the state of the insulating enclosures contact : ALSTOM Grid, After Sales Service, in order to envisage changing the deteriorated parts.
Breaking chambers	Check the state of the breaking chambers. This operation requires the complete dismantling of the breaking chamber for access to the components that must be inspected, and must be carried out by ALSTOM Grid, After Sales Service, who should be contacted prior to any operation of this type, at the time of scheduling.

Limit of electrical wear

Estimate

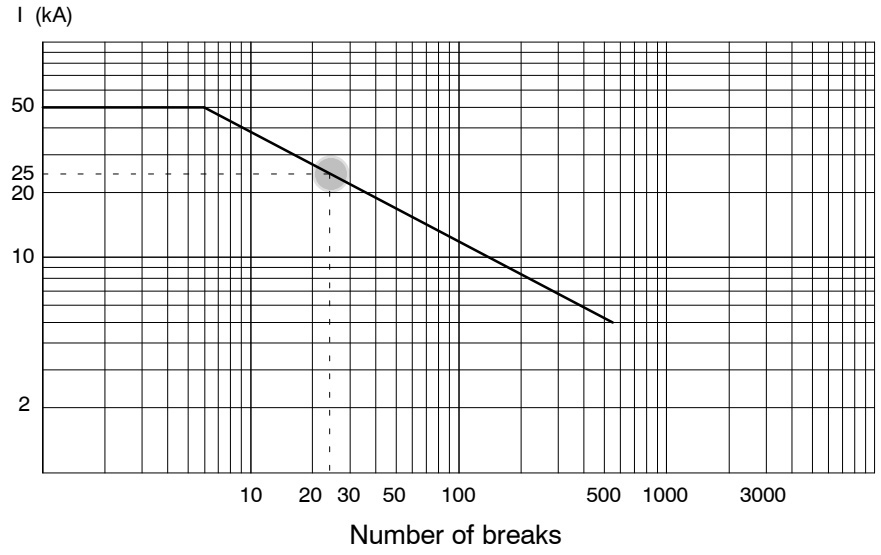
L'Electrical wear can be estimated according to the curve below. This curve corresponds to the formula :

$\Sigma NI^2 = 15\ 000\ kA^2$ (*)
N = nuomber of breaks at a value I.

For example, a current of 25 kA can be broken 24 times.

(*) Normal warranty. For particular uses other values can be guaranteed.

Illustration



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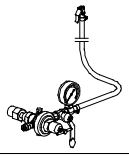
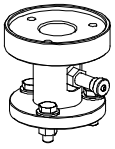
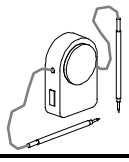
Presentation

Tools required

List of ALSTOM Grid tools necessary for the operation:

Mark	Illustration	Description	Reference	Quantity
(11)		Manometer 0...0,765 MPa	HBL-02842117 + HB0005499001	1
		Manometer 0...1 MPa	HBL-02842118 + HB0005499001	
(17)		Mano-relief valve 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 covers the following subjects:

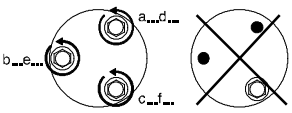
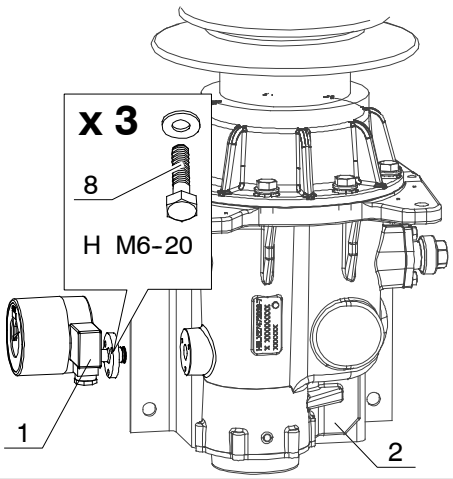
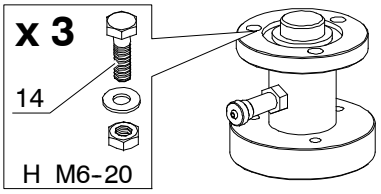
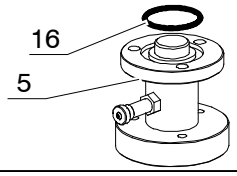
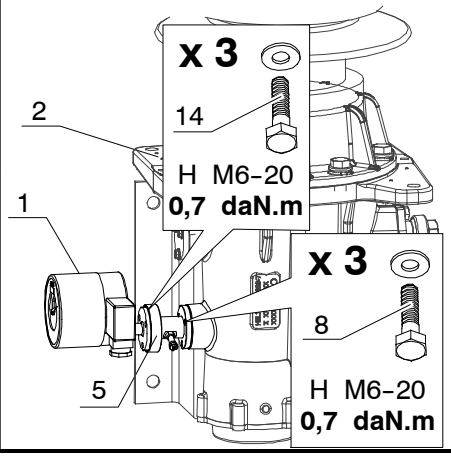
Preparing the densimeter

Introduction

The densimeter is at the base of the circuit-breaker pole. It is linked to the circuit-breaker's volume of SF_6 gas (or SF_6+CF_4).
To check the contact densimeter's thresholds, it is mandatory to isolate the densimeter's volume from the pole's volume of SF_6 gas (or SF_6+CF_4).

Instructions

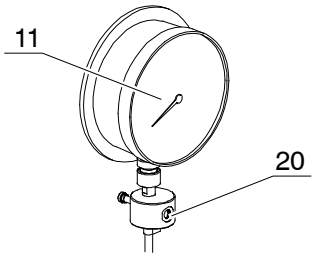
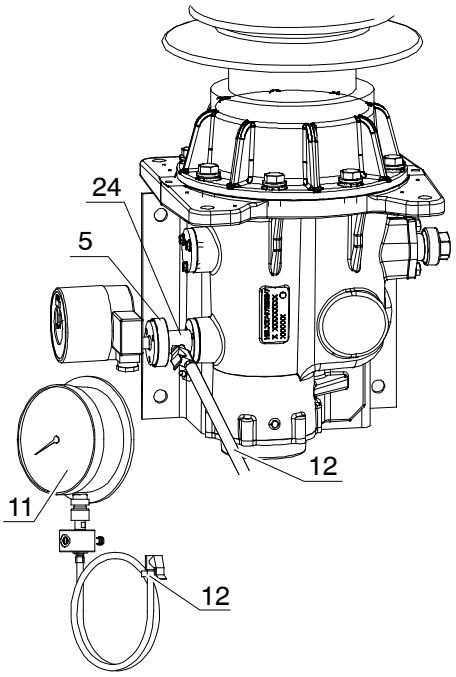
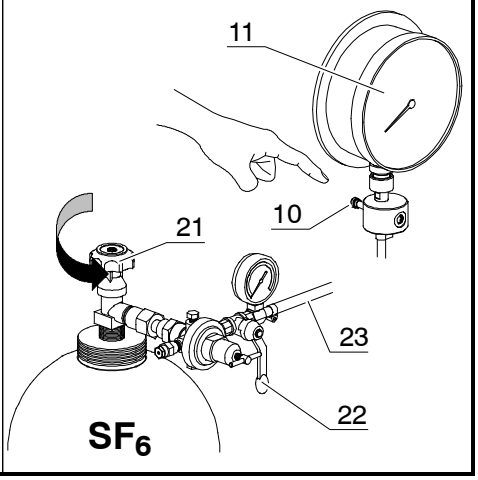
The following table defines the procedure for preparing the densimeter:

Step	Action	Illustration
1	Remove the densimeter (1), attached by the fastener (8) to the circuit breaker pole casing (2). 	
2	Remove the fastener (14).	
3	Install the seal (16) on the connection valve block (5).	
4	Install the connection valve block (5) on the circuit breaker pole casing (2) using the fastener (8).	
5	Install the densimeter (1) on the connection valve block (5) using a fastener (14). **NOTE** : Before installation, check for the presence of seals on the densimeter.	

Connecting the densimeter to the inspection tools

Instructions

The following table defines the procedure for connecting the densimeter to the test tool :

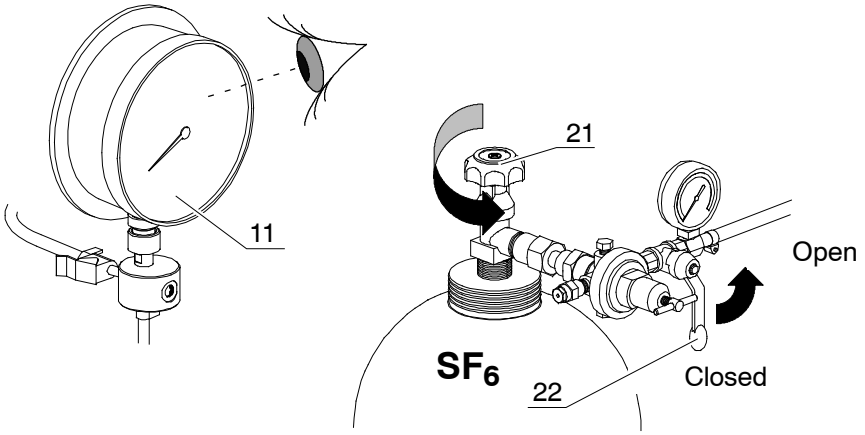
Step	Action	Illustration
1	Check the pressure gauge's (11) "REGULATION" (20) screw is in the "check valve closed" position (screwed down).	
2	Connect the pressure gauge's (11) pipe (12) to the valve (24) of the connection valve block (5).	
3	Open the tap (21) on the SF_6 gas bottle for a brief instant, and the reducing valve (22) to expel the air contained in the pipe (23) (20 s approx. at a low rate of flow). Connect the pipe (23) to the pressure gauge's (10) valve (11).	

Checking densimeter thresholds

Adjusting the pressure of the SF_6 gas

The following table defines the steps for adjusting SF_6 pressure in the connection valve unit (5):

Step	Action	Remark
1	Open the tap (21) on the SF_6 cylinder and adjust the gas outlet using the reducing valve (22 (low rate of flow). From time to time, close the tap (21) to read the pressure on the pressure gauge (11).	See the "**Calculating the SF_6 gas filling pressure for use of the pressure gauge (tools)**" module.
2	Resume filling until the desired pressure is reached.	
3	Close the tap (21) and the valve (22) in that order.	

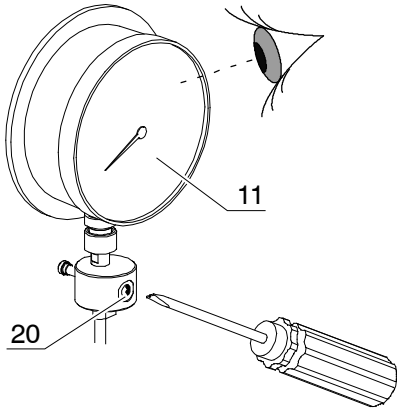


Continued on next page.

Checking densimeter thresholds, continued

Check

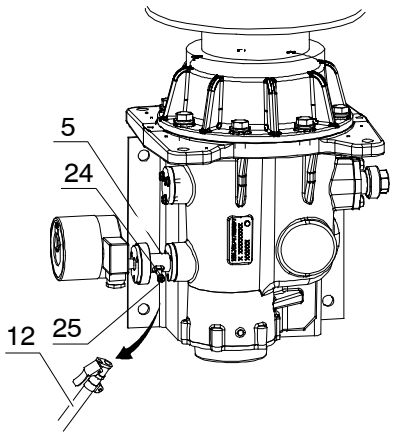
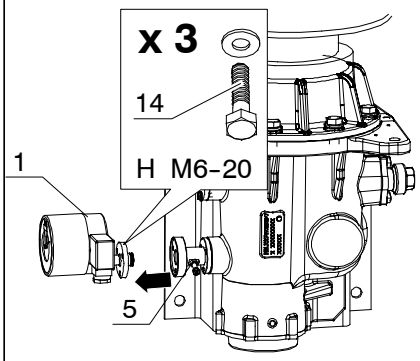
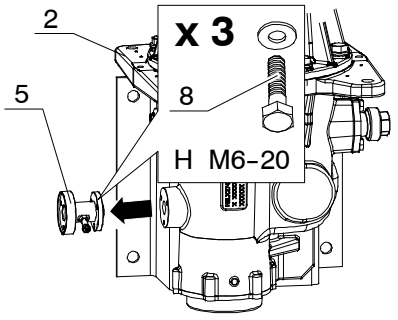
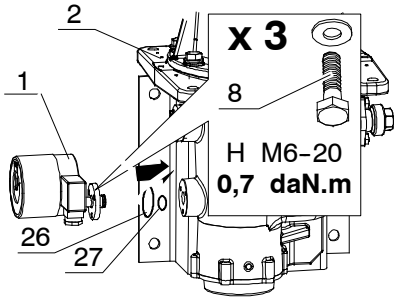
The following table defines the steps for checking the densimeter :

Step	Action	Remark
1	Connect a test lamp to the densimeter's "Alarm pressure for isolation" contact p_{ae}.	Connection to the operating mechanism terminal block, according to the electric diagram.
2	Calculate the relative pressure for switchover of the **"Alarm pressure for isolation" contact** p_{ae}, corrected according to local atmospheric pressure and temperature.	Value p_{ae} : see technical characteristics. See "**Calculating the SF_6 gas filling pressure for use of the pressure gauge (tools)**" module.
3	• Create a leak by unscrewing the pressure gauge's (20) "REGULATION" screw (11), and check the contact switches over at the previously calculated value. • Proceed in the same way to check the "Minimum pressure for isolation" contact p_{me}.	 In a case where one of the thresholds does not comply with the specified value, replace the densimeter.

Re-installation of the densimeter

Instructions

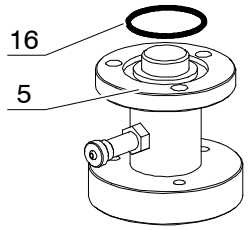
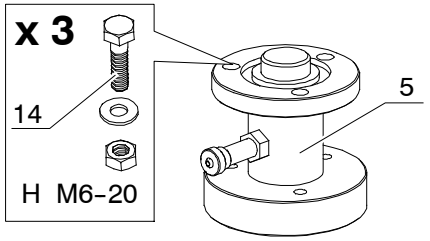
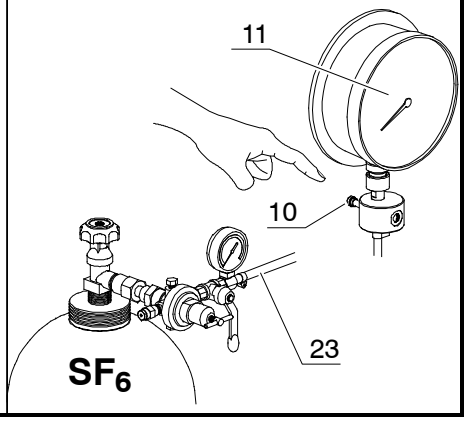
The following table defines the procedure for re-installing the densimeter:

Step	Action	Illustration
1	Disconnect the pipe (12) from the connection valve block (5) valve (24). Screw the cap (25) onto the valve (24).	
2	Remove the densimeter (1) on the connection valve block (5) using a fastener (14).	
3	Remove the connection valve block (5) from the circuit breaker pole casing (2) using the fastener (8). **NOTE** : If the connection valve block (5) is not longer used, refer to the next paragraph, "Storing inspection tools."	
4 	Install new seals (26) and (27) on the densimeter, referring to **"Preparing and installing static seals"** in **"General installation procedures."** Install the densimeter (1) on the cover (2) of the circuit breaker pole casing using the fastener (8).	

Storage of the checking tools

Instructions

The following table defines the steps for storing the checking tools:

Step	Action	Illustration
1	Delicately remove the seal (16) from the connecting valve block (5) and store it in the box ”SET OF SEALS” in the densimeter threshold inspection case.	
2	Mount the fastener (14) on the connection valve block (5). Store the connection valve block (5) in the case.	
3	Disconnect the pipe (23), between theSF_6 gass bottle and the valve (10) on the pressure gauge (11).	

Special case with two densimeters

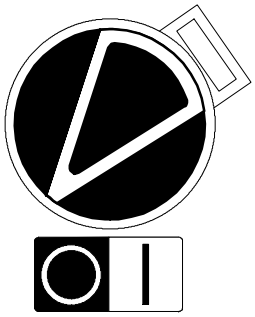
Instructions

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

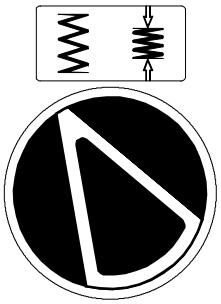
Presentation

Warning

BEFORE ANY INTERVENTION ON THE OPERATING MECHANISM, MAKE SURE THE CIRCUIT-BREAKER IS OPEN AND THE STATUS OF THE OPERATING MECHANISM INDICATOR IS AS SHOWN BELOW.



Circuit-breaker
Open



Closing spring
Unarmed

NEVER HANDLE AN OPERATING MECHANISM THAT IS NOT CONNECTED TO THE CIRCUIT BREAKER.

In this module

This module covers the following subjects:

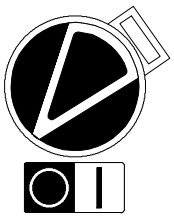
Position indicator statuses

Warning

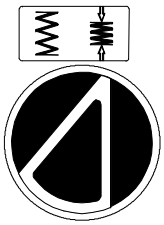
CAUTION : despite the appearance of the symbol on the front, the FK3.07 springs are under load when stretched, they are tension springs rather than compression springs. As the symbol has been standardised we must use it to show the 'loaded' state of the spring.

Status "A"

Circuit-breaker **Open**

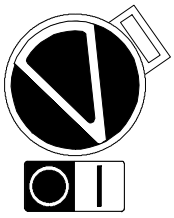


Closing spring **Armed**

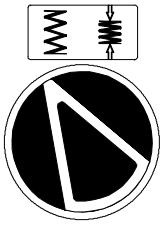


Status "B"

Circuit-breaker **Closed**

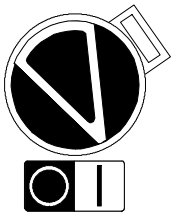


Closing spring **Unarmed**

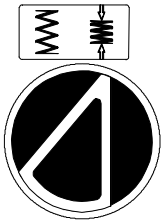


Status "C"

Circuit-breaker **Closed**

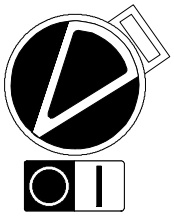


Closing spring **Armed**

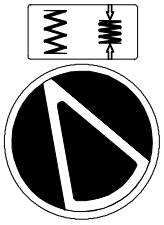


Status "D"

Circuit-breaker **Open**



Closing spring **Unarmed**



Safety measures

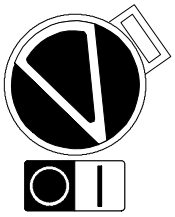
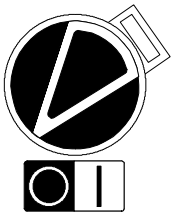
General preparation of the circuit-breaker

The table below shows the steps to take to be able to work in complete safety on the circuit-breaker:

Step	Action	Remark
1	Isolate the circuit-breaker from the network.	Put the circuit-breaker out of operation, power it down and ground it.
2	Interrupt the resetting motor power supply.	
3	Check the SF_6 gas pressure.	The SF_6 gas pressure must be $\geq p_{me}$. **Below this level, no mechanical operations are authorized.**

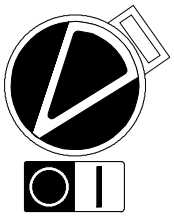
Release the springs

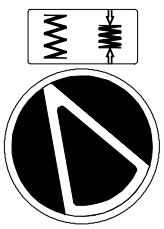
The following table gives the procedure for disarming the closing spring and opening spring according to the circuit-breaker position:

If the circuit-breaker position is ...	**Action**
Closed 	In the operating mechanism, actuate the opening handle and closing handle as follows : **1** - Open **2** - Close **3** - Open
Open 	Actuate the closing handle and opening handle as follows : **1** - Close **2** - Open

Checking the visual signaling

Check that the operating mechanism's visual signaling displays the symbols below:

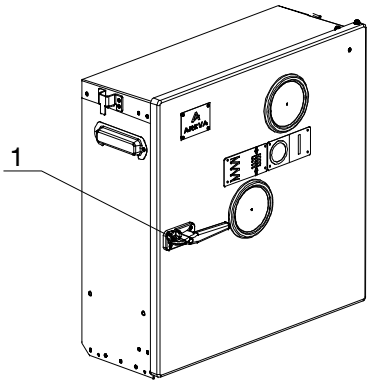
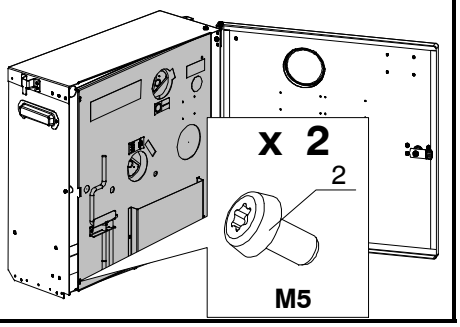
Circuit-breaker **Open** 

Closing spring **Unarmed** 

Preparing the operating mechanism

Opening the two doors

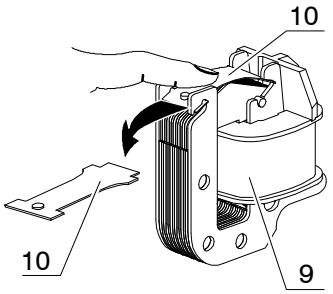
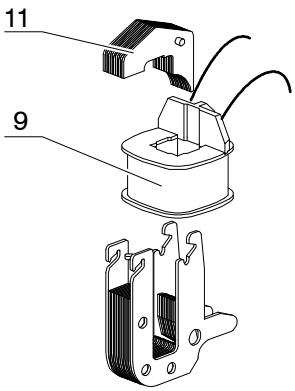
The following table lists the steps for opening the door and inner door:

Step	Action	Illustration
1	Use the handle to open the outer door (1).	
2	To open the inner door, remove the fasteners (2), and put them to one side for when you replace the door.	

Replacing a closing or opening electro-magnet

Instructions

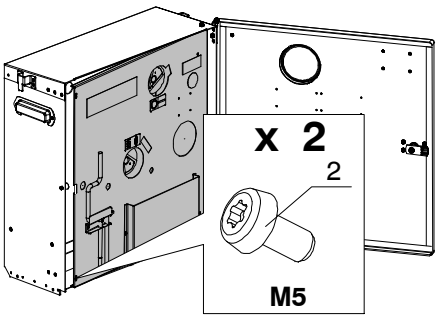
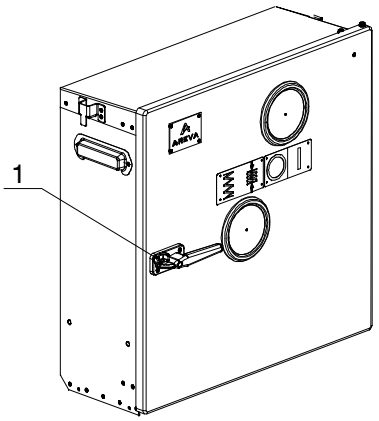
The following table lists the steps for replacing a closing or opening electro-magnet:

Step	Action	Illustration
1	Disconnect the power supply wires from the coil (9).	
2	Extract the spring-blade (10) be exerting outward finger pressure on the rivet.	
3	Remove the core (11).	
4	Remove the defective coil and replace it with a new coil with the same reference.	
5	Refit the core (11).	
6	Reinstall the spring blade (10).	
7	Connect the power supply wires to the new coil (9).	

Resumption of service

Closing the two doors

The following table lists the steps for closing the doors.

Step	Action	Illustration
1 	Close the inner door and fix it in position with the fastener (2).	
2	Close the outer door and fix it in position with the handle (1).	

Continued on next page.

Resumption of service, continued

Turning the power on

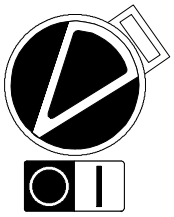
The following table lists the steps for resuming circuit breaker pole service:

Step	Action	Remark
1	Turn the opening and closing circuit power back on.	
2	Cut off the motor power circuits,	The motor starts and resets the closing spring.

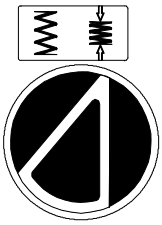
Checking the visual signaling

Check that the operating mechanism's visual signaling displays the symbols below:

Circuit-breaker **Open**



Closing spring **Armed**



Conclusion

The circuit breaker is ready for normal operation.

Lubrication

Principle

No lubricant is necessary later on. The support bearings and rollers were greased in our workshops with special lubricant:

ASEOL SYLITEA 4-018

This grease supports low temperatures very well and is very age-resistant. So these qualities are not altered during use, **it is forbidden to**:

- Mix this grease with any other lubricant.
- Carry out subsequent lubrication using any other oil.
- Spray, over the equipment components, any anti-corrosion protective liquid or lubricating oil whatsoever.

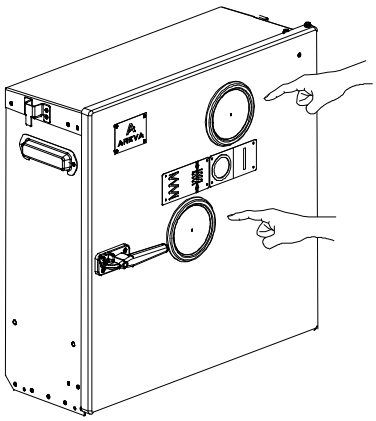
Mixing it with other lubricants cound cause the layer of grease to harden too much.

Cleaning the inspection windows

Recommended product

For cleaning the inspection windows, use soapy water exclusively.

DO NO USE A SCOURING PAD.



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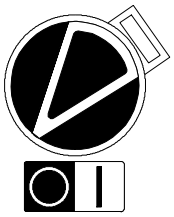
Presentation

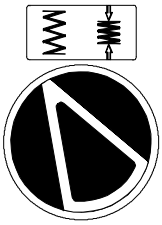
Warning

BEFORE ANY INTERVENTION ON THE OPERATING MECHANISM, MAKE SURE THE CIRCUIT-BREAKER IS OPEN AND THE STATUS OF THE OPERATING MECHANISM INDICATOR IS AS SHOWN BELOW.

Circuit-breaker **Open**



Closing spring **Unarmed**

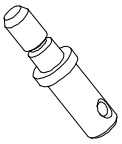


Lifting means

Provide an adequate means of hoisting (60 daN).

Tools required

List of ALSTOM Grid tools required to remove the operating mechanism:

Mark	Illustration	Description	Quantity
(1)		Hoisting strap	1
(4)		HOLDING TOOL	1

Steps for replacement

The operating mechanism is replaced in several steps:

Safety measures

General preparation of the circuit-breaker

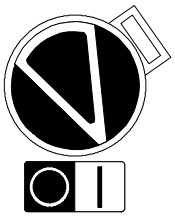
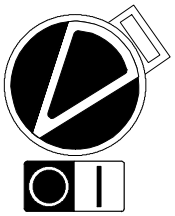
The table below shows the steps to take to be able to work in complete safety on the circuit-breaker:

Step	Action	Remark
1	Isolate the circuit-breaker from the network.	Put the circuit-breaker out of operation, power it down and ground it.
2	Interrupt the resetting motor power supply.	
3	Check the SF_6 gas pressure.	The SF_6 gas pressure must be $\geq p_{me}$ (P2). **Below this level, no mechanical operations are authorized.**.

Release the springs

The following table gives the procedure for releasing the closing spring and opening spring according to the circuit-breaker position :

NOTE : For manual release of the closing spring, refer to the appendices, "**Manual operations**" module 48.020.249.

If the circuit-breaker position is ...	Action
Closed 	In the operating mechanism, actuate the opening handle and closing handle as follows : **1** - Open **2** - Close **3** - Open
Open 	Actuate the closing handle and opening handle as follows : **1** - Close **2** - Open

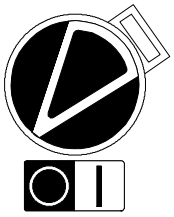
Continued on next page.

Safety measures, continued

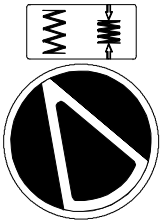
Checking the visual signaling

Check that the operating mechanism's visual signaling displays the symbols below:

Circuit-breaker **Open**



Closing spring **Unarmed**



Deflating the pole

Instructions

Deflate the pole using a recovery unit.

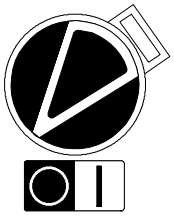
BRING THE PRESSURE OF THE CIRCUIT-BREAKER'S SF_6 GAS TO 0.3 bar AT 20°C (1 013 hPa) BY REFERRING TO THE MODULE IN THE APPENDICES "**Directives for handling used SF6 gas and its by-products**" .

Maintaining the pole coupling sleeve

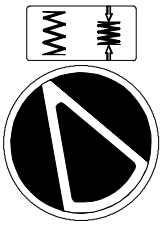
Position indicators

Check the operating mechanism position indicators statuses are as follows:

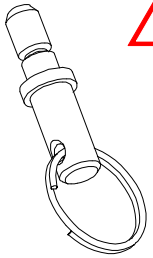
Circuit-breaker **Open**



Closing spring **Unarmed**



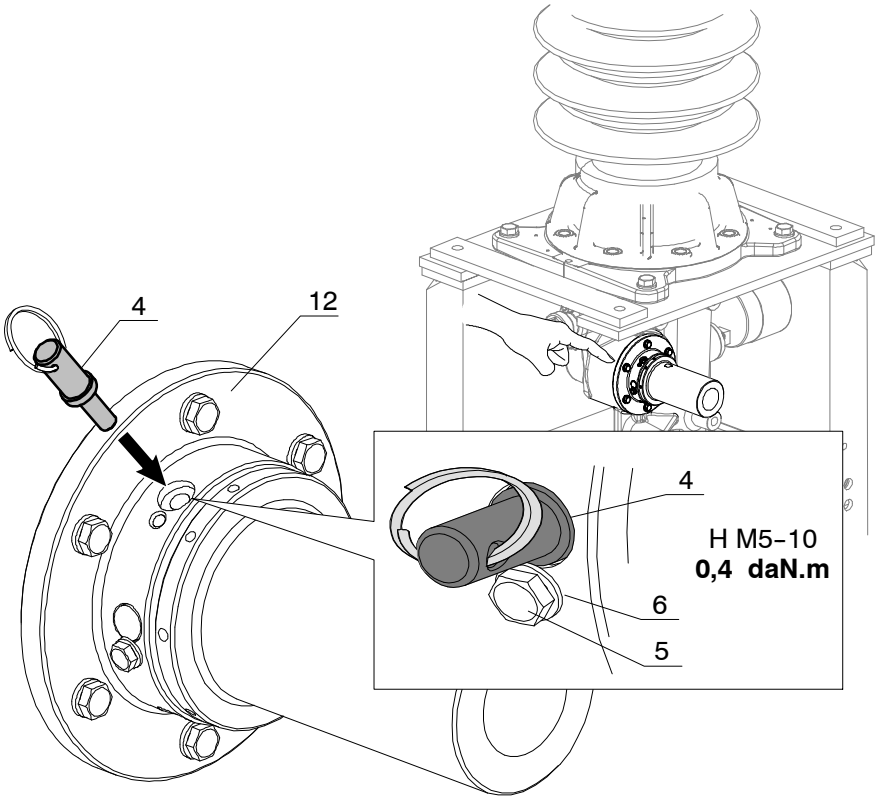
Holding tool



Insert the holding tool (4) in the empty hole provided on the sleeve (12) and hold it using the screw (5) and washer (6).

NOTE : the screw (5) and washer (6) are not part of the ALSTOM Grid supply.

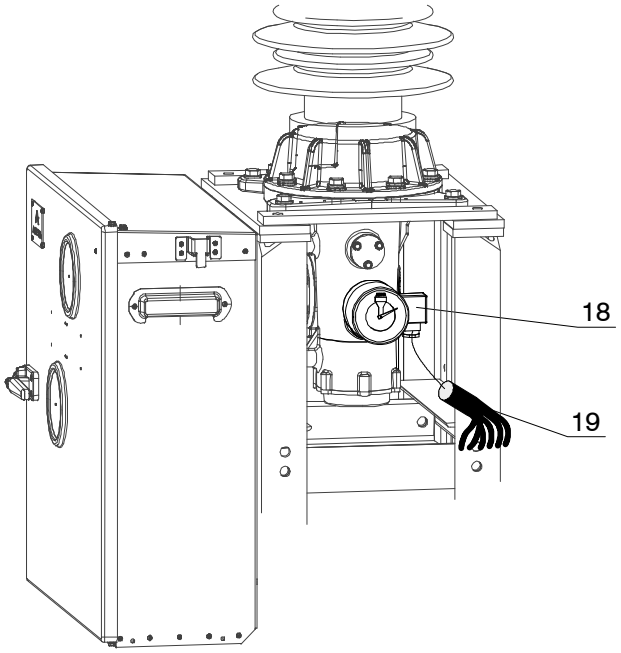
This holding tool (4) must remain in position throughout the operation to reassemble the operating mechanism.



Disconnecting the low voltage cables

Disconnecting the contact densimeter cable

Disconnect the wires of the cable for the (19) SF_6 contact densimeter (18) on the operating mechanism terminal strip.



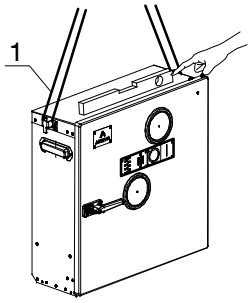
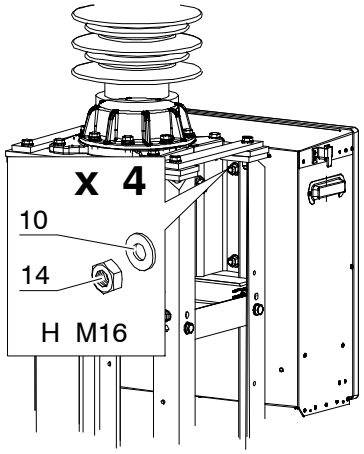
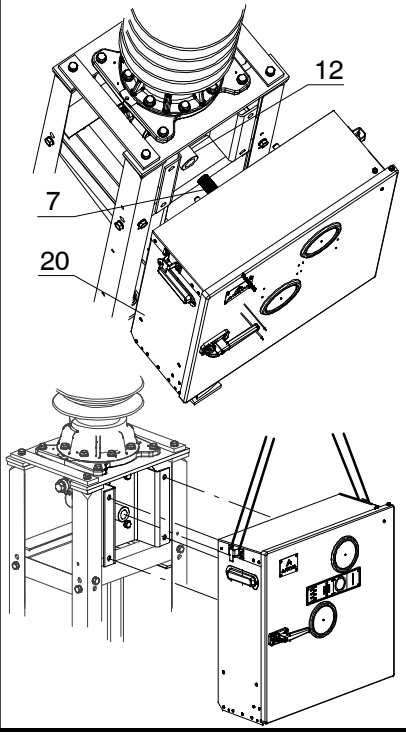
LV cables

Disconnect all the LV cables on the operating mechanism terminal strip.

Removing the operating mechanism

Instructions

The table below shows the steps for removing the operating mechanism :

Step	Action	Illustration
1	Sling the operating mechanism using the hoisting strap (1) as shown in the illustration.	
2	Remove the nuts (14) and the washers (10).	
3	Extract the mechanism's pin (7) from the sleeve (12) and remove the operating mechanism (20).	

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Mounting the new operating mechanism

Warning

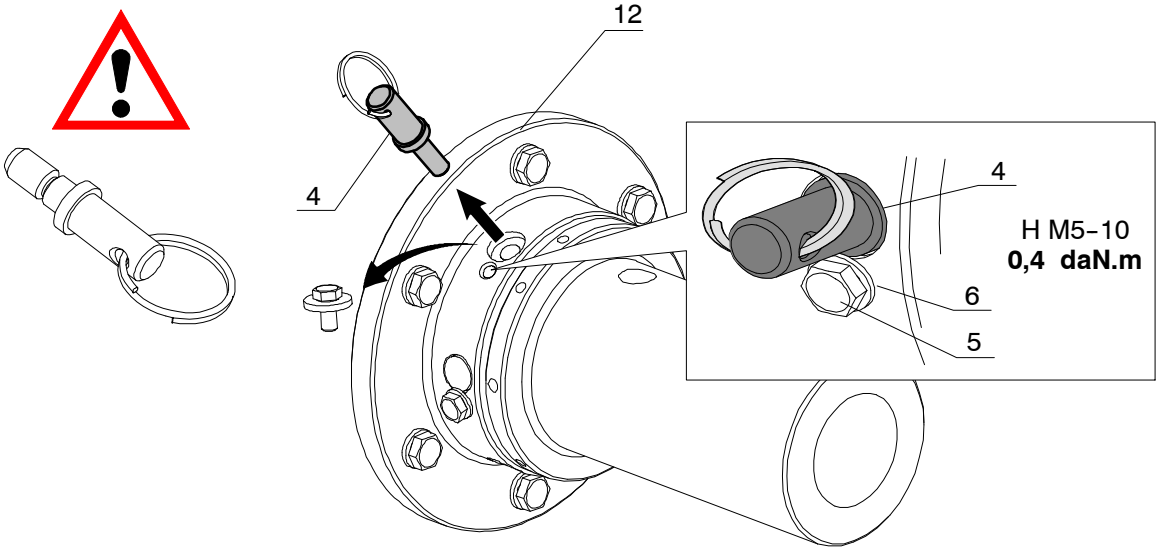
NEVER HANDLE AN OPERATING MECHANISM THAT IS NOT CONNECTED TO THE CIRCUIT BREAKER.

Instructions

For this operation, refer to the module "**Mounting the operating mechanism**".

Removing the maintaining tool

AFTER INSTALLING A NEW OPERATING MECHANISM, IT IS IMPERATIVE TOHAVE THE MAINTENANCE TOOL (4) BEFORE FIRST ACTUATING THE CIRCUIT BREAKER.



THE CIRCUIT-BREAKER MUST NOT BE ACTUATED AT AN SF_6 GAS PRESSURE BELOW THE MINIMUM PRESSURE FOR ISOLATION p_{me}.

Reinflating the pole

TO AVOID RESETTING THE CLOSING SPRING DO NOT POWER THE CONTROL MOTOR .
THE CIRCUIT-BREAKER MUST NOT BE ACTUATED AT AN SF_6 GAS PRESSURE BELOW THE MINIMUM PRESSURE FOR ISOLATION p_{me}.

Instructions

For this operation, refer to the modules :

- **Calculating the SF_6 gas filling pressure for use of the pressure gauge (tools)**
- **Filling with SF_6** gas

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Presentation

Introduction

Some specifc tools are necessary for :

- ★ the commissioning,
- ☆ maintaining the circuit breaker.

Only those tools and accessories specified in the order are delivered.
Commone commercially-available tools(e.g. : spanners, torque wrench, spirit level...) are excluded from the supply.

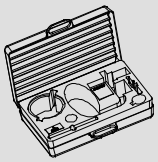
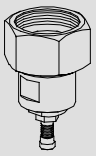
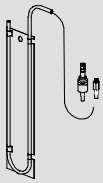
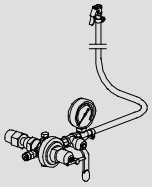
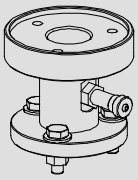
In this module

This module covers the following subjects:

Special tools

Table of special tools

The following table lists the special ALSTOM Grid tools (case SF_6):

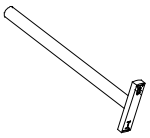
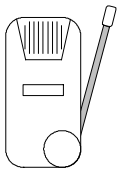
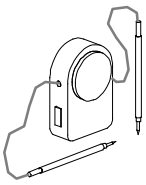
NUMBER	DESCRIPTION		USE
HBLD001875 ★☆		EMPTY TRANSPORT CASE (OPTIONAL)	Transport of filling and inspection tools for SF_6 gas. Checking densimeter thresholds
HBLN55000401 ★☆		FILLING TOOL	Filling SF_6, additional filling.
HBL-02842117 + HB0005499001 ★☆		PRESSURE GAUGE 0...1 MPa	Filling SF_6, additional filling. Checking densimeter thresholds
HBL-02842118 + HB0005499001 ★☆		PRESSURE GAUGE 0...1.6 MPa	
HBL465059004 ☆		WATER PRESSURE GAUGE (OPTIONAL) ☆	Verification waterproofing.
HBL-02557392 + HBLN55161601 ★☆		MANO-RELIEF VALVE 0...1 MPa	Filling SF_6, additional filling. Checking densimeter thresholds
HB0005649001 ☆		CONNECTION VALVE BLOCK	Checking densimeter thresholds
HB0000270121 ☆		SET OF SEALS	Checking densimeter thresholds

Continued on next page.

Special tools, continued

Table of special tools, continued

The following table continues the list of special ALSTOM Grid tools:

NUMBER	DESCRIPTION		USE
HB0004240002 ☆		HOLDING TOOL	Tool for holding the pole mechanism shaft for replacement of the operating mechanism.
HBLP12623505 ☆		HANDLE	Closing spring reset.
HB0013983001 ☆		MANUAL OPERATING TOOL	Manual operating tool for mechanism.
HBLD00220301 ★☆		HOISTING STRAP	Pole handling. Handling the operating mechanism.
HBLD00001901 ★☆		LEAK DETECTOR	Checking of l'leaktightness of the filling plug for SF_6 Looking for leaks of SF_6
HBL-02861501 ☆		TEST LAMP	Checking densimeter thresholds Checking switchgear finger wear

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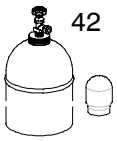
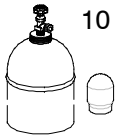
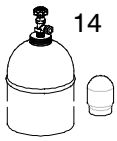
Accessories

Table of accessories

The following table gives the list of ALSTOM Grid accessories:

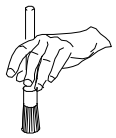
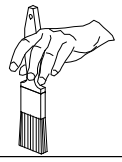
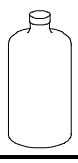
NUMBER	DESCRIPTION		USE
HBL-01861432 ★☆	 42 kg	SF_6 CYLINDER	Filling SF_6. Additional filling.
HBL-01861435 ★☆	 23 kg	SF_6 CYLINDER	Filling SF_6. Additional filling.
HBL-01861434 ★☆	 10 kg	SF_6 CYLINDER	Filling SF_6. Additional filling.
HBL-01861443 ★☆	 8 kg	SF_6 CYLINDER	Filling SF_6. Additional filling.
HBL-01861455 ★☆	 32 kg	CF_4 CYLINDER	Filling CF_4. Additional filling.
HBL-01861454 ★☆	 14 kg	CF_4 CYLINDER	Filling CF_4. Additional filling.
HBL-01818336		LOCTITE 262 (50 ml)	Locking fasteners.
HBL-01818327		LOCTITE 225 (250 ml)	Clogging of fasteners.
HBL-01835265		GREASE MOLYKOTE 111 (100 g)	Preparation of SF_6 seals
HBL-01835203		GREASE MOBILUX EP3 (400 r)	Greasing fasteners before torque tightening.

Continued on next page.

Accessories, continued

Table of accessories, continued

The following table continues the list of special ALSTOM Grid accessories:

NUMBER	DESCRIPTION		USE
HBL-01835106		VASELINE 204-9	Preparing the surfaces of the electrical contacts.
HBL-01835118		GREASE CONTACTAL	Preparing the surfaces of the electrical contacts.
HBL-01835251		GREASE ASEOL 0-365.2 (200g)	General lubrication.
HBL-01831320		SANDPAPER A 400 A 400	Preparing the surfaces of the electrical contacts.
HBL-02212337		SCOTCH BRITE	Preparing the surfaces of the electrical contacts.
HBL-02212334		WIPING CLOTH	Preparing the surfaces of the electrical contacts.
HBL-02211842		ROUND PAINTBRUSH Br.4	Preparing the surfaces of the electrical contacts.
HBL-02211831		FLAT PAINTBRUSH Br.16	Preparing the surfaces of the electrical contacts.
HBL-01861262		CAN OF ISOPROPANOL (1 l)	Preparation of SF_6 seals

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SUMMARY

of PRODUCT SAFETY SHEETS

for equipment * manufactured by

ALSTOM GRID - AHT

SUBJECT	Reference N°	Revision	Remarks
Summary	PS 0000EN	04	
Working environment	PS 0001EN	03	
Handling Operations	PS 0002EN	03	
Pressurized Equipment	PS 0003EN	03	
SF_6 : Use and Handling.	PS 0004EN	03	Not applicable to pneumatically operated circuit breakers
Chemicals	PS 0005EN	03	
Electrical Equipment	PS 0006EN	03	
Machinery	PS 0007EN	04	
Operation	PS 0008EN	04	
Maintenance	PS 0009EN	04	

* : 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 ALSTOM 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 <u>Pressurized Equipment : General</u>.							
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

MACHINERY

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 ALSTOM 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 ALSTOM 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 ALSTOM.

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 ALSTOM.			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 ALSTOM 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 ALSTOM) must be appropriate and in proper working order,
  - any replacement parts must be ALSTOM 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.

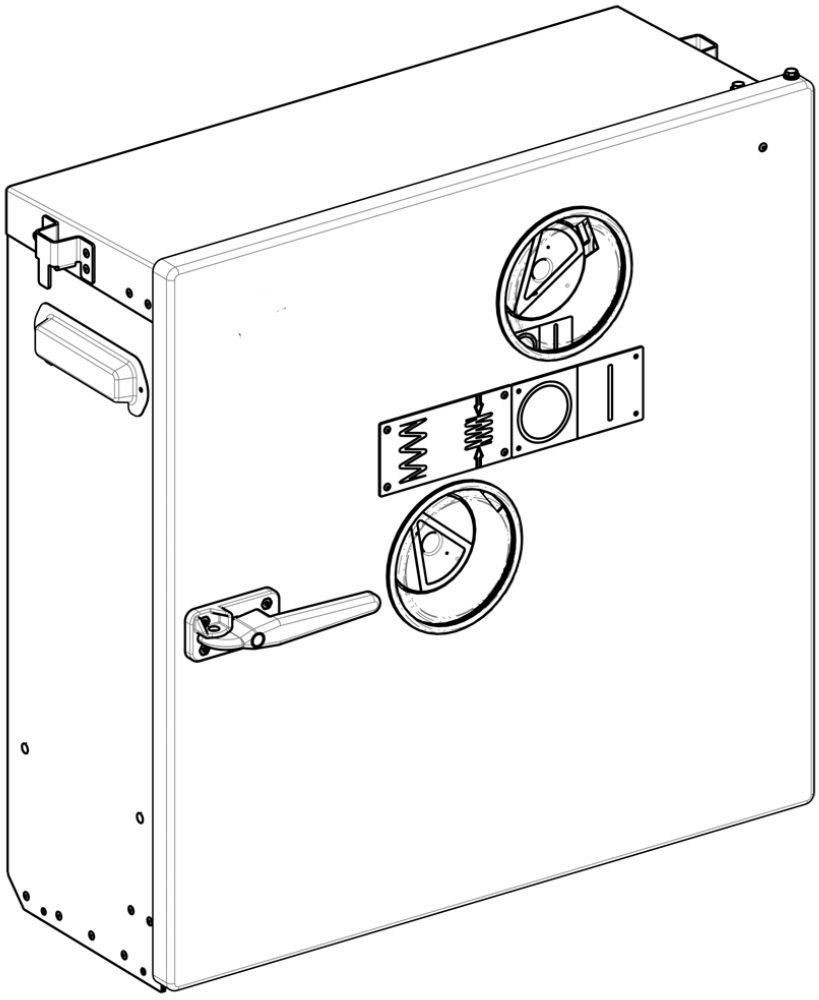
- Refer to the relevant SAFETY sheets.
- The safety instructions below are general and not exhaustive. They should therefore be modified and/or supplemented for all specific maintenance operations to be carried out.

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

Manual operations

Motor-wound spring operating mechanism FK3-07

for outdoor circuit breaker



Administrator	First edition	Created	Changed	Release
SEH	12.04.10	E. Suter, TMK-SEH /hz		K. Pohlink, T-SEH

After-sales service

Our after-sales service is at your disposal at all times to handle your technical and operating problems.

Address for service

ALSTOM Grid AG
Carl-Sprecher-Strasse 3
Service SSO
CH-5036 Oberentfelden
Switzerland

Round-the-clock service: Tel. 0800 73 30 73 30
Tel.: +41 (0)62 737 33 33
Fax: +41 (0)62 737 31 96
Email: td.service@alstom.com

Address for ALSTOM

ALSTOM Grid AG
Carl-Sprecher-Strasse 3
CH-5036 Oberentfelden
Switzerland

Round-the-clock service: Tel. 0800 73 30 73 30
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Motor-wound spring operating mechanism FK 3-07 for outdoor circuit breaker

Contents

Miscellaneous

Information about Instructions

- These instructions enable the operator to use the apparatus safely and efficiently. These instructions are an integral part of the apparatus and must be kept in the immediate vicinity of the apparatus in a place easily accessible to staff members at all times. Before starting any work, staff members must carefully read through and understand these instructions. The absolute prerequisite for working without hazards is the observance of all safety precautions and action directives stipulated in these instructions. In addition, local accident prevention regulations and general safety provisions covering the range of applications of the apparatus must be observed. Illustrations in these instructions serve the user's basic understanding, but they might differ from the actual design / execution of the apparatus.

Copyright protection

- These instructions are protected by copyright and intended solely for the operator. Without written permission from the manufacturer, passing on these instructions to third parties, copying / reproducing the instructions or extracts thereof in any form whatsoever, exploiting them and / or communicating their contents is not permitted, except for in-house purposes. Violations in this respect may lead to claims for damages. The right to further claims is reserved.

Liability limitation

- All statements and information in these instructions were compiled with due regard to current standards and regulations, state-of-the-art technology, and on the basis of our many years of knowledge and experience.
- The manufacturer accepts no liability for damages caused by:
  - Non-observance of the instructions
  - Use for purposes other than those intended
  - Operation by untrained staff
  - Unauthorized conversions
  - Use of non-approved spare parts
- The items actually delivered might differ from the explanations and presentations described here as a result of the customer making use of additional ordering options or due to the latest technical modifications. The obligations agreed to in the supply contract, the general business conditions as well as the manufacturer's terms of delivery and the regulations prescribed by law at the time of concluding the contract shall apply. We reserve the right to make technical modifications to improve the properties / characteristics in use and in the course of continued development.
- The guarantee regulations are included in the manufacturer's general business conditions.

Explanation of symbols

Notes

DANGER!

Draws attention to an imminent hazard from electric current that can cause death or serious injury if it is not avoided.

DANGER!

Draws attention to an imminent hazard that can cause death or serious injury if it is not avoided.

WARNING!

Draws attention to a possibly hazardous situation that can cause death or serious injury if it is not avoided.

CAUTION!

Draws attention to a possibly hazardous situation that can cause slight or mild injury if it is not avoided.

NOTE!

Draws attention to a possibly hazardous situation that can cause damage to property if it is not avoided.

COMMENT!

Emphasizes useful tips and recommendations as well as information to achieve efficient and trouble-free operation.

Safety notes

- This section provides an overview of all key safety aspects for optimizing staff protection and for achieving safe and trouble-free operation.
- Non-observance of the action directives and safety precautions stipulated in these instructions could result in substantial hazards to staff and material.

Warning

WARNING!

A prerequisite for product safety is to use and handle the product in compliance with regulations.

Comment

COMMENT!

The instructions H48020250 "Safety AIS" are an integral part of safety.
Before starting any work, staff members must carefully read through and understand these instructions. The absolute prerequisite for working without hazards is the observance of all safety precautions and action directives stipulated in these instructions.

Warning

WARNING!

Hazard to unauthorized persons!

Unauthorized persons who do not fulfill the requirements stipulated here are not familiar with the hazards in the work area.

Consequently:
- **Keep unauthorized persons out of the work area.**
- **If in doubt, approach such persons and show them out of the work area.**
- **Discontinue work as long as unauthorized persons are in the work area.**

Staff

External personnel

- A qualified staff member is considered to be someone who is capable of assessing the work assigned to him or her and of identifying any possible hazards on the basis of his or her technical training and know-how, as well as experience and knowledge of the appropriate provisions.
- Only those staff members may work on and with the product from whom it can be expected that they will carry out their work reliably. No working methods may be used that impair the safety of persons, the environment or the product.

Note

NOTE!

Contains fluorinated greenhouse gases covered by the Kyoto protocol.

Warning

WARNING!

Injury hazard if not suitably qualified!

Incorrect use or handling could result in serious personal injury and damage to property.

Consequently:

– Have all work carried out only by staff members qualified to do it.

Comment

COMMENT!

Before mounting work is started, all safety regulations according to the instructions H48020250 "Safety AIS" must be taken into account and observed.

Technical data

Type FK3-07

Motor:

• Standard rated voltages DC

acc. to IEC 62271-1, 2007 (+10%/-15%)	48V DC	(40.8 ... 52.8 V DC)
	110V DC	(93.5 ... 121 V DC)
	125V DC	(106.3 ... 137.5 V DC)
	220V DC	(187 ... 242 V DC)
	250V DC	(212.5 ... 275 V DC)
acc. to ANSI C37.06-2000	48V DC	(36 ... 65 V DC)
	125V DC	(90 ... 140 V DC)
	250V DC	(180 ... 280 V DC)
acc. to GB/T 11022-1999 (+10%/-15%)	48V DC	(40.8 ... 52.8 V DC)
	125V DC	(93.5 ... 121 V DC)
	250V DC	(187 ... 242 V DC)

• Standard rated voltages AC

acc. to IEC 62271-1, 2007 (+10%/-15%) 50 and 60 Hz	120V AC	(102 ... 132 V DC)
	230V AC	(195.5 ... 253 V DC)
acc. to ANSI C37.06-2000, 60 Hz	120V AC	(104 ... 127 V DC)
	240V AC	(208 ... 254 V DC)
acc. to GB/T 11022-1999 (+10%/-15%) 50 Hz	110V AC	(93.5 ... 121 V DC)
	220V AC	(187 ... 242 V DC)
	230V AC	(195.5 ... 253 V DC)

Power drawn on DC			
Start	1200 ... 2000	W	dependent on motor voltage and energy setting
Running	1000 ... 1500	W	dependent on motor voltage and energy setting
Power drawn on AC			
Start	2100 ... 3300	VA	dependent on motor voltage and energy setting
Running	1800 ... 2300	VA	dependent on motor voltage and energy setting
Spring winding time			
< 10 s	on rated voltage		dependent on motor voltage and energy setting

Closing energy	< 820 J
Opening energy	< 450 J

Closing and opening release coil

• Standard rated voltages DC according to IEC 62271-1, 2007

	Closing coil (+10%/-15%)	*Opening release coil (+10%/-30%)*
24 V DC	20.4 ... 26.4 V DC	16.8 ... 26.4 V DC
48 V DC	40.8 ... 52.8 V DC	33.6 ... 52.8 V DC
110 V DC	93.5 ... 121 V DC	77 ... 121 V DC
125 V DC	106.3 ... 137.5 V DC	87.5 ... 137.5 V DC
220 V DC	187 ... 242 V DC	154 ... 242 V DC
250 V DC	212.5 ... 275 V DC	175 ... 275 V DC

• Standard rated voltages DC according to ANSI C37.06-2000

	Closing coil	*Opening release coil*
24 V DC	–	14 ... 28 V DC
48 V DC	36 ... 56 V DC	28 ... 56 V DC
125 V DC	90 ... 140 V DC	70 ... 140 V DC
250 V DC	180 ... 280 V DC	140 ... 280 V DC

• Standard rated voltages DC according to GB/T 11022

	Closing coil (+10%/-20%)	*Opening release coil (+20%/-35%)*
24 V DC	19.2 ... 26.4 V DC	15.6 ... 28.8 V DC
48 V DC	38.4 ... 52.8 V DC	31.2 ... 57.6 V DC
110 V DC	88 ... 121 V DC	71.5 ... 132 V DC
220 V DC	176 ... 242 V DC	143 ... 264 V DC

• Power drawn on DC approx. 320 ... 500 W

Closing and opening release coil

• Standard rated voltages AC according to IEC 62271-1, 2007, 50 and 60 Hz

	Closing coil (+10%/-15%)	*Opening release coil (+10%/-15%)*
120 V AC	102 ... 132 V AC	102 ... 132 V AC
230 V AC	195.5 ... 253 V AC	195.5 ... 253 V AC

• Standard rated voltages AC according to ANSI C37.06-2000, 60 Hz

	Closing coil	*Opening release coil*
120 V AC	102 ... 132 V AC	102 ... 132 V AC
240 V AC	208 ... 254 V AC	208 ... 254 V AC

• Standard rated voltages AC according to GB/T 11022, 50 Hz

	Closing coil (+10%/-15%)	*Opening release coil (+20%/-15%)*
110 V AC	93.5 ... 121 V AC	93.5 ... 132 V AC
220 V AC	187 ... 242 V AC	187 ... 264 V AC
230 V AC	195.5 ... 253 V AC	195.5 ... 276 V AC

• Power drawn on AC approx. 320 ... 500 VA

Heater	100 ... 230 V AC
Power drawn	approx. 100 W

Standards, regulations

- The AIS circuit breakers and apparatus supplied by Alstom have been developed, tested and built according to IEC62271-1, -203, -100, -102 etc.

Environmental management

- The procedures depicted in ISO 14001 are used by Alstom.

Introduction

- The following manual operations are described in these instructions:
  – Slowly switch on.
  – Slowly switch off.
  – Manually discharge the closing spring.
- Manual operations according to these instructions are not necessary during mounting work and normal circuit breaker operation.
- Slow switching on or off can be carried out, as required, when setting and inspecting the circuit breaker.
- After incorrect manipulation or malfunctions of the circuit breaker, slow switching on and / or off may be carried out in order to rectify the malfunction and the closing spring can be discharged manually.

Safety precautions

- The motor-wound spring operating mechanism 70.00 FK3-07 has a state-of-the-art design and is operationally safe. Nonetheless, hazards can emanate from this apparatus if it is used improperly.
- In view of this, the operators of circuit breakers must ensure the following as regards the staff they employ:
  – Specialist knowledge of the local as well as customary national safety provisions and accident prevention regulations, especially those concerning high-voltage installations and apparatus
  – Familiarity with and observance of the content of the instructions at hand
  – Sound technical training on circuit breakers, including motor-wound spring operating mechanisms
  – Observance of the safety precautions affixed to the apparatus
  – Commitment to immediately report the occurrence of changes that jeopardize safety

Prerequisite for carrying out manual operations

- The circuit breaker is in the position OFF.
- The circuit breaker is earthed on both sides.
- The control voltage is switched off.

Safety in general

- Any work (manipulation) which is not in compliance with the instructions harbors hazards for the operator and the motor-wound spring operating mechanism.
- If any work (manipulation) on the motor-wound spring operating mechanism is carried out which is not in compliance with the instructions FK3-X and / or FK3-07, a hazard will exist which can result in the death or serious injury of the operator. The motor-wound spring operating mechanism could also be damaged.
- Carry out only that work (manipulation) which complies with the instructions for motor-wound spring operating mechanisms FK3-07.

WARNING!

Carry out only that work (manipulation) which complies with the instructions for motor-wound spring operating mechanisms FK3-07.

Staff safety when working on the operating mechanism

- The closing spring is charged when the control voltage is switched off. Despite the interrupted control voltage, unintentional switching can take place if the operating mechanism is worked on (manipulated).
- Touching moving parts is synonymous with an accident hazard.

WARNING!

Slacken the springs when the control voltage is interrupted by switching off, on and off again using the manual operating device.

- Motor-wound spring operating mechanisms with undervoltage releases immediately switch off when the control voltage is interrupted.
- This could result in injuries when working on (manipulating) the motor-wound spring operating mechanism.

WARNING!

Block the undervoltage releases to avoid unintentional switching off.

- If the motor voltage is switched on, the motor immediately begins to charge the closing spring.
- Touching moving and / or spring-loaded parts is synonymous with an accident hazard.

WARNING!

When switching on the control voltage, keep the body away from moving / spring-loaded parts of the apparatus.

Product safety

- If a motor-wound spring operating mechanism without circuit breaker is switched, the entire energy is activated inside the motor-wound spring operating mechanism.
- As a result, it could cause considerable damage.

NOTE!

Switch the motor-wound spring operating mechanism only when it is connected to a circuit breaker.

- If the gas pressure of the circuit breaker is below the minimum value for mechanical switching (shown on the warning sign in the motor-wound spring operating mechanism), unacceptably high energy is activated inside the motor-wound spring operating mechanism.
- This could damage the circuit breaker and the motor-wound spring operating mechanism.

NOTE!

Switch the motor-wound spring operating mechanism only when using a circuit breaker whose gas pressure is above the minimum value for mechanical switching.

- Dust inside the motor-wound spring operating mechanism could impair the functioning of moving parts, such as pawls, rollers and shafts, as well as the performance of the electrical apparatus.
- This could result in malfunctioning and damage to the motor-wound spring operating mechanism.

NOTE!

The inside of the motor-wound spring operating mechanism must be kept dust-free. The housing door must always be closed properly.

- The use of cleaning agents, anti-rust oils or sprays could result in heavy greasy deposits.
- This could impair functioning of the motor-wound spring operating mechanism.

NOTE!

Use only mechanical means for cleaning purposes when carrying out cleaning and / or corrective maintenance work. Any necessary follow-up lubrication must be carried out according to the lubricating instructions FK3-07.

- Moisture inside the motor-wound spring operating mechanism causes condensation and the subsequent corrosion of steel parts.
- This could result in malfunctioning and damage to the motor-wound spring operating mechanism.

NOTE!

The heater (anti-condensation apparatus) must always be in service regardless of where the circuit breaker is located.

Reference documents

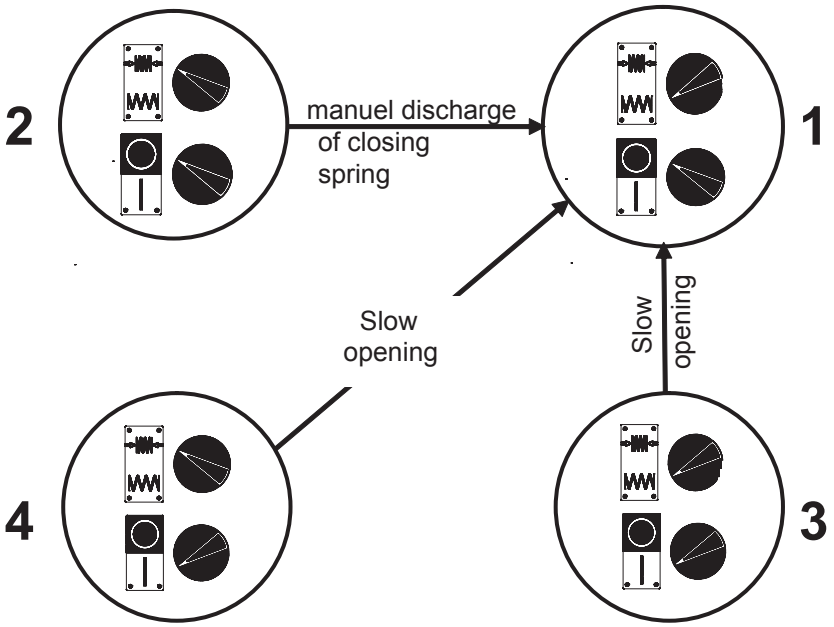
The documents listed in the table below form an integral part of these instructions.

Document number	Designation
H48020186	Lubricating instructions
H48020190	Special tools
H48020198	Transport and storage
H48020244	Design of basic operating mechanism FK3-07
H48020245	Mounting the motor-wound spring operating mechanism FK3-07
H48020246	Operating instructions FK3-07
H48020247	Maintenance FK3-07 AIS
H48020248	Disposal FK3-07 AIS
H48020250	Safety AIS
H48020254	Function description FK3-07

Possible manual operations

Not connected motor-wound spring operating mechanism

- The motor-wound spring operating mechanism is attached to the circuit breaker in accordance with the "Mounting instructions" in its as-delivered state.
- If the as-delivered state of the non-connected operating mechanism has been altered in error, the following manual operations can be carried out to restore it to its as-delivered state.



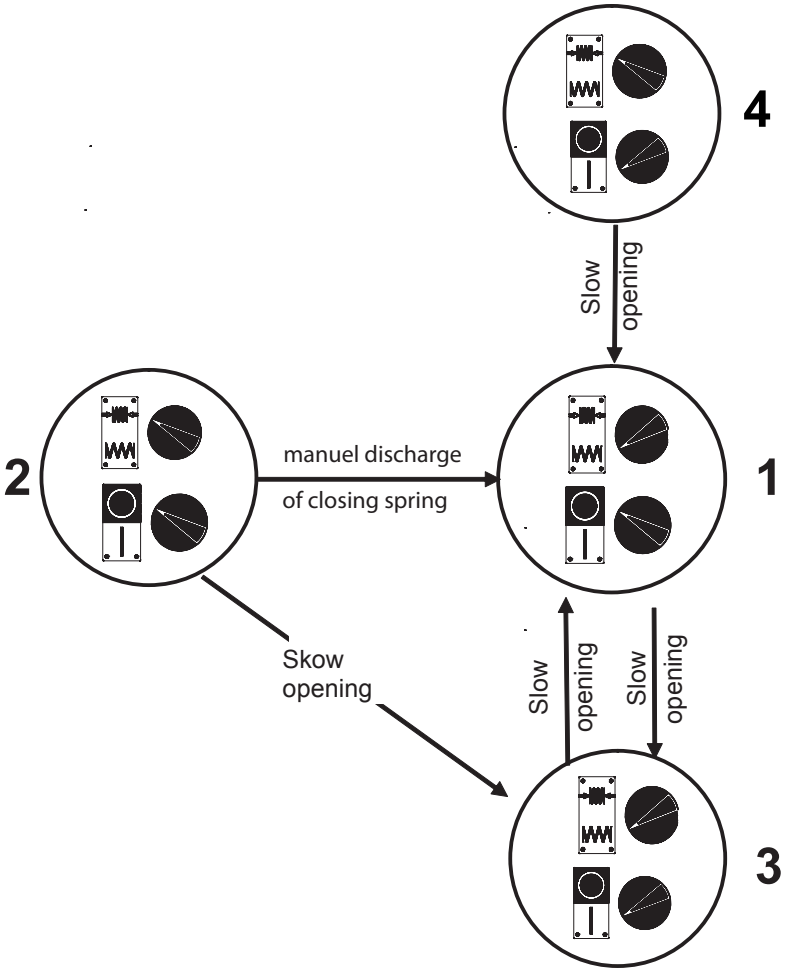
If		Then
Illustration 1	Closing spring discharged Circuit breaker position indicator OFF	• No action (as-delivered state)
Illustration 2	Closing spring charged Circuit breaker position indicator OFF	• Manually discharge the closing spring
Illustration 3	Closing spring discharged Circuit breaker position indicator ON [1)]	• Slowly switch off
Illustration 4	Closing spring charged Circuit breaker position indicator ON [1)]	• Slowly switch off

Note:

[1)] If the motor-wound spring operating mechanism without circuit breaker was switched, contact should be made with the supplier's plant to clarify the situation with regard to any damage.

Motor-wound spring operating mechanism mounted on circuit breaker and connected

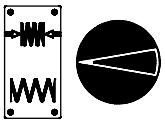
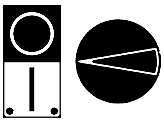
- The following manual operations can be carried out for inspection purposes and to eliminate malfunctions:



If		Then
Illustration 1	Closing spring discharged Circuit breaker position indicator OFF • for inspection purposes and setting work	• Slowly switch on
Illustration 2	Closing spring charged Circuit breaker position indicator OFF • for inspection purposes and setting work • The circuit breaker may not be switched on.	• Manually discharge the closing spring
Illustration 3	Closing spring discharged Circuit breaker position indicator ON • for inspection purposes and setting work	• Slowly switch off
Illustration 4	Closing spring charged Circuit breaker position indicator ON • for inspection purposes and setting work	• Slowly switch off

Spring position indicator and circuit breaker position indicator in an intermediate position

- If the spring position indicator or the circuit breaker position indicator is in an intermediate position, the motor-wound spring operating mechanism or the circuit breaker has a defect.
- Before any manual operations are carried out, contact should be made with the supplier's plant for diagnosis purposes and to clarify how to eliminate malfunctions.

Possible position of position indicator	
	
Spring position indicator in intermediate position	The circuit breaker position indicator in intermediate position

Preparation of motor-wound spring operating mechanism for manual operations

- Open the door.

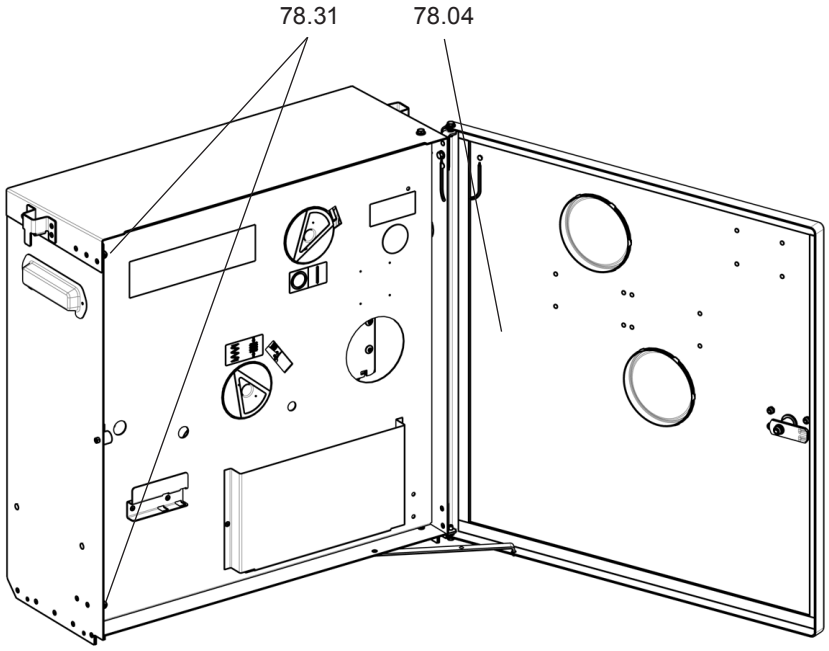


Illustration 01

78.04	Door
78.31	Set screws of protection plate

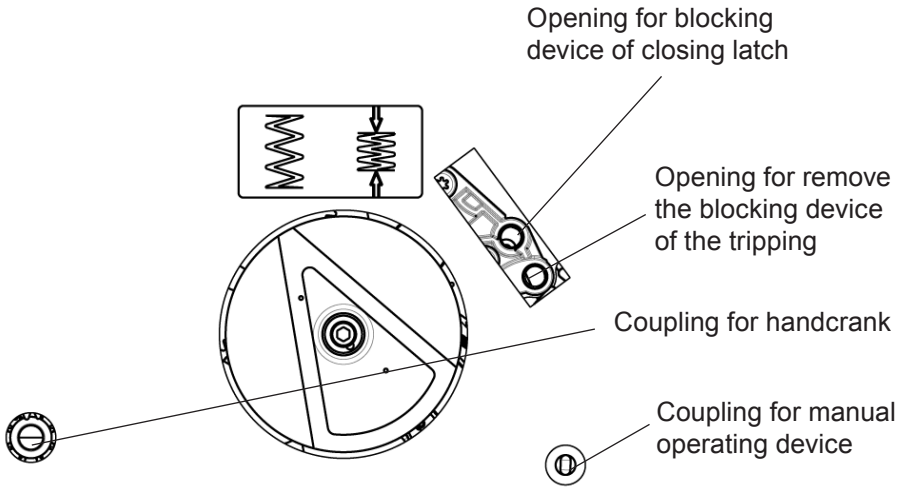
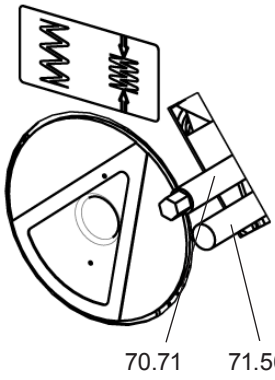
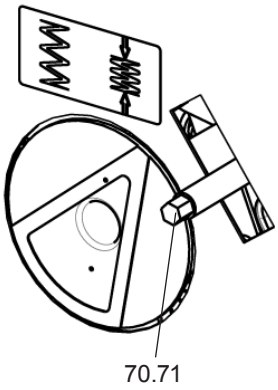
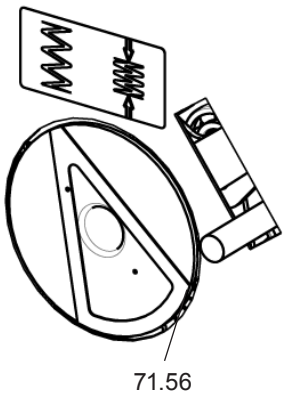


Illustration 02

If	Then
Closing spring charged Operating mechanism at position ON  **Illustration 03**	• Use blocking device of closing latch 70.71. • Use blocking device of tripping latch 71.56.
Closing spring charged Operating mechanism at position OFF  **Illustration 04**	• Use blocking device of closing latch 70.71.
Closing spring discharged Operating mechanism at position ON  **Illustration 05**	• Use blocking device of tripping latch 71.56.

70.71	Closing latch blocking device
71.56	Blocking device of tripping latch

Remove the blocking device of closing latch

- Insert the blocking device of the closing latch 70.71 into the appropriate opening, as shown by illustration 06.

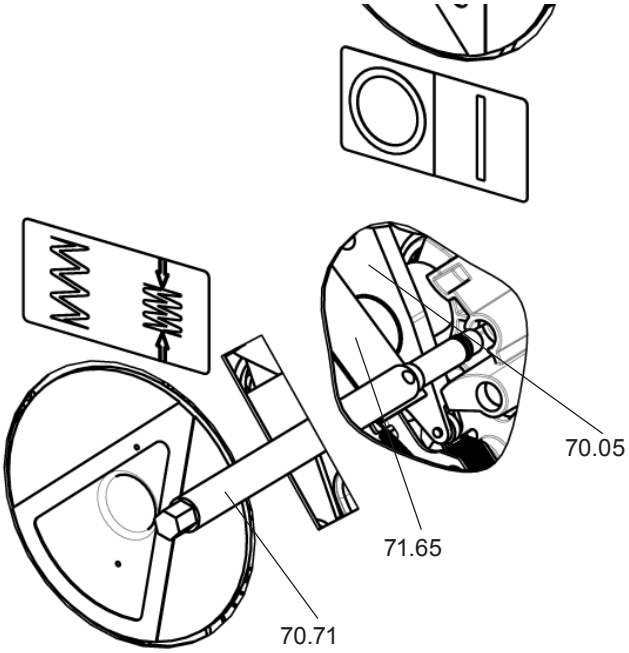


Illustration 06

70.71	Closing latch blocking device
70.05	Closing latch
71.65	Spring

- Insert the blocking device of the closing latch 70.71 until it touches and then turn it counterclockwise until the spring 71.65 is up against the closing latch 70.05, as shown by illustration 07.

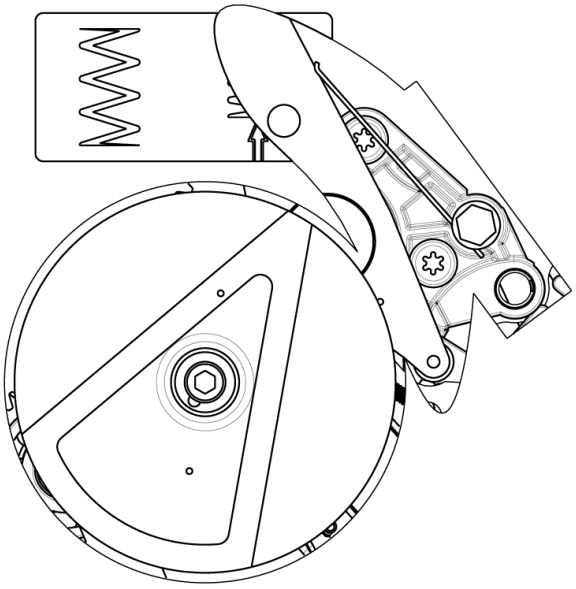


Illustration 07

- Now turn the blocking device of the closing latch 70.71 counterclockwise using a hand-held tool and hold it in this turned position until the spring 71.65 is curved, as shown by illustration 09.

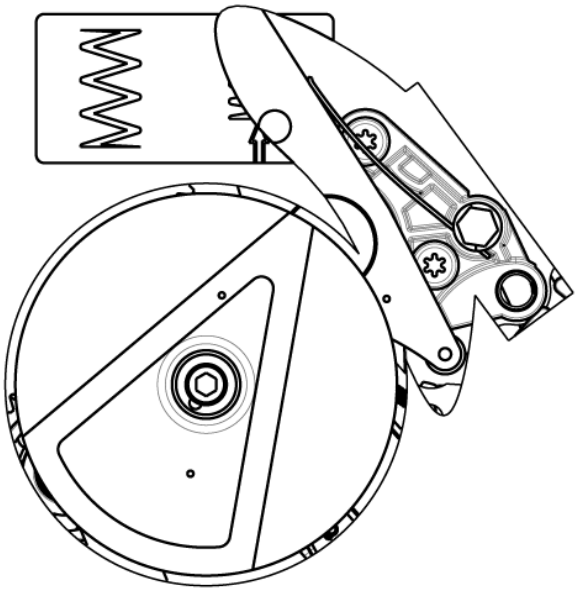


Illustration 08

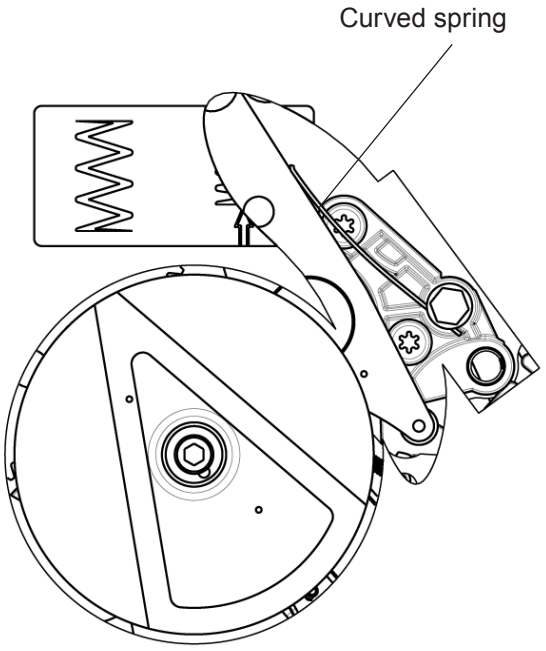


Illustration 09

- The turned-and-held blocking device of the closing latch 70.71 may now be pushed in further in the direction of the arrow until it is up against the end stop (insertion force approx. 60 N), as shown by illustration 10. The blocking device of the closing latch 70.71 is now in place and may be released. It is held by the charged spring 71.65 and the snap-action device.

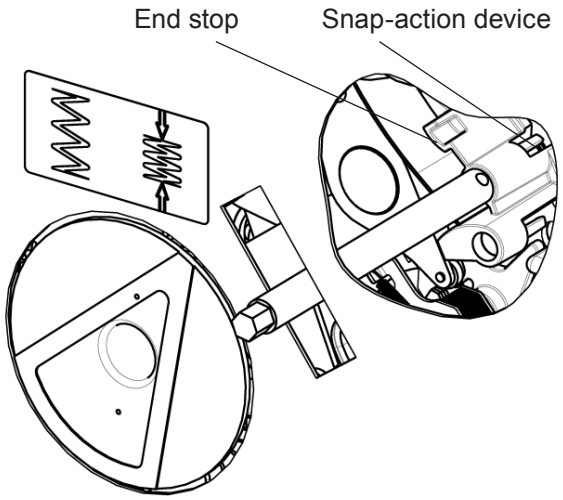


Illustration 10

- The closing latch is now blocked and the operating mechanism cannot be switched on.

Remove the blocking device of the tripping latch

- Insert the blocking device of the tripping latch 71.56 into the appropriate opening, as shown by illustration 11.

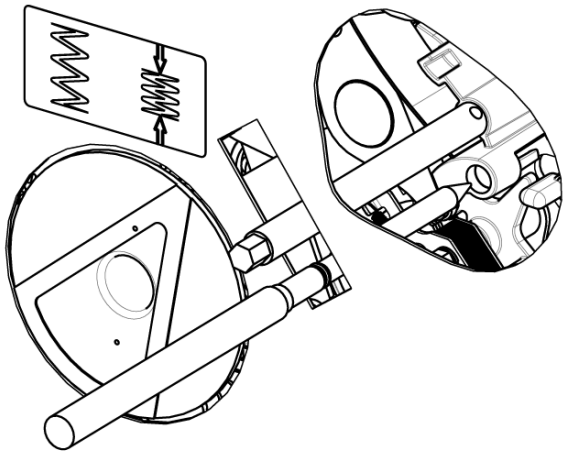


Illustration 11

- Insert the blocking device of the tripping latch 71.56 up to the stop. The blocking device of the tripping latch 71.56 is held in this position by the snap-action device.

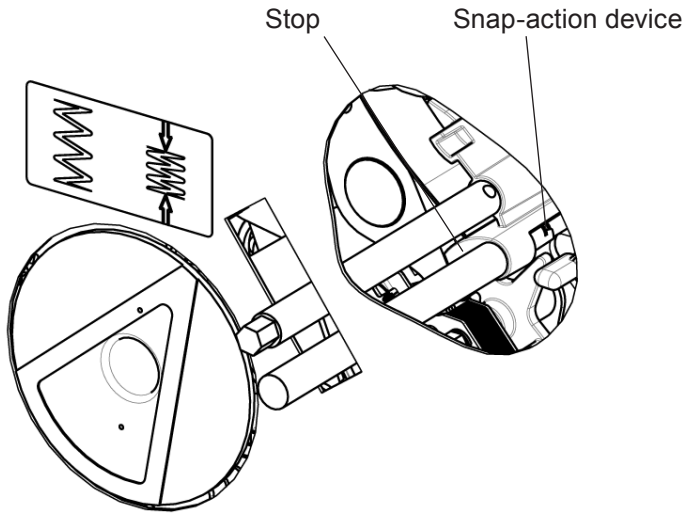


Illustration 12

- Undo the set screws of the protection plate 78.31. Secure the protection plate 78.28 to the fixing bar 78.32 using the removed set screws, as shown by illustration 13.

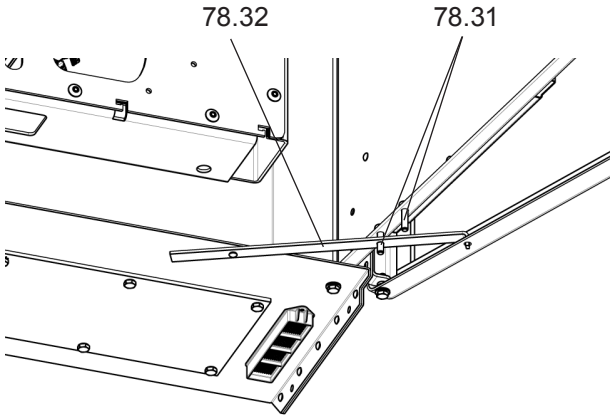


Illustration 13

78.32	Fixing bar
78.31	Set screws of protection plate

Remove the slow device

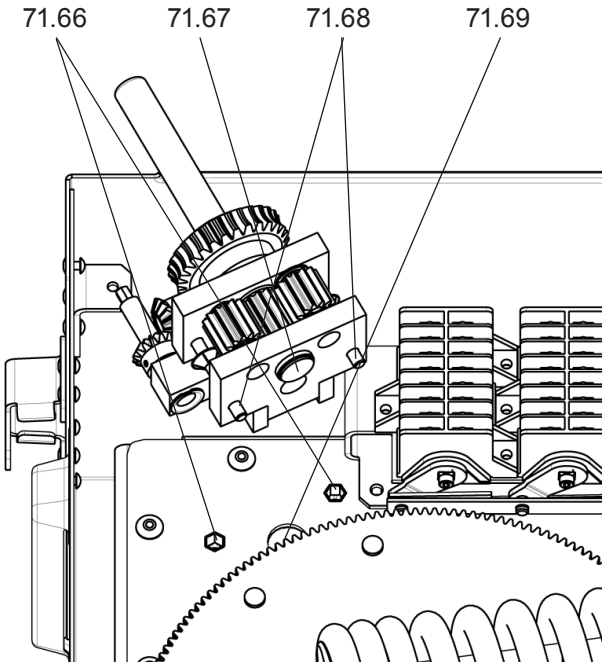


Illustration 14

71.66	Rivet nut M6
71.67	Centering device
71.68	Set screw M6
71.69	Centering bore

- Align the centering device 71.67 and the set screws 71.68 of the slow-movement device with the appropriate holes in the operating mechanism housing. The exact positions of the centering device 71.67 and the set screws 71.68 are obtained by rotating the operating shaft 71.70. Insert the centering device 71.67 into the centering bore 71.70 and tighten the set screws 71.68 to a torque of 9.6 Nm.

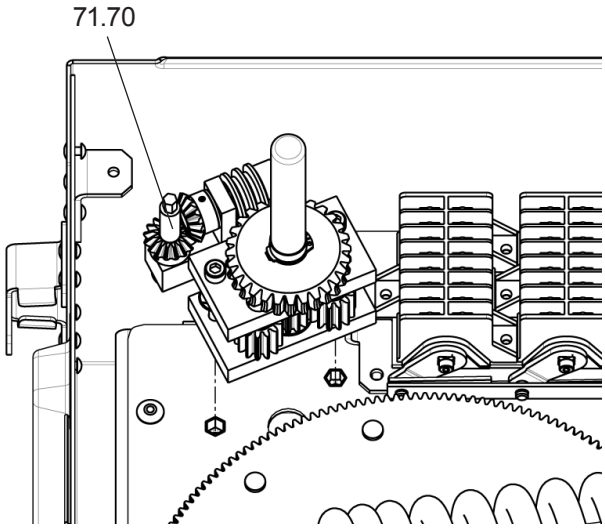


Illustration 15

71.70	Operating shaft

- Slow-movement device in place

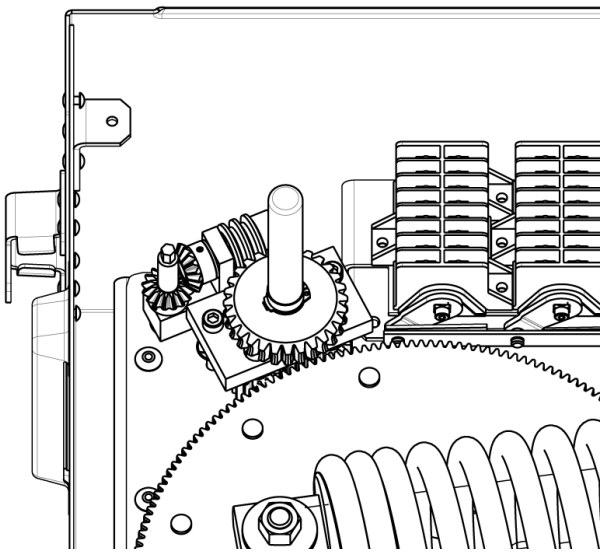


Illustration 16

Remove the blocking device of closing latch

- As soon as the slow-movement device 70.72 is in place, the closing latch blocking device 70.71 can be removed.

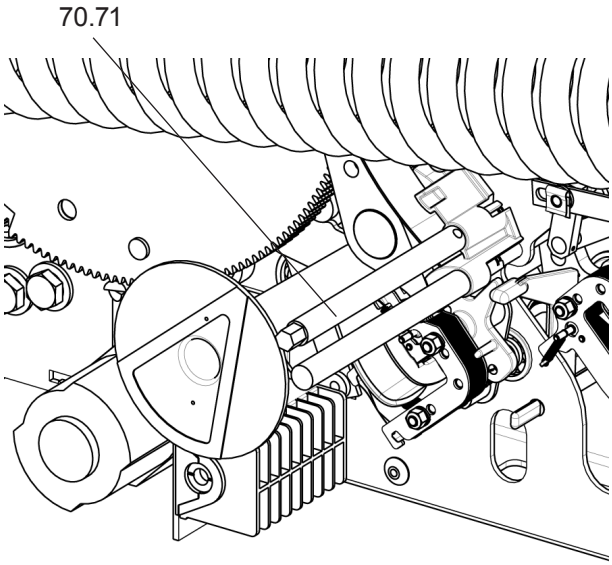


Illustration 17

70.71	Closing latch blocking device

Undervoltage release

- If the motor-wound spring operating mechanism is equipped with undervoltage release and slow switching on or off is necessary, the undervoltage release must be blocked.

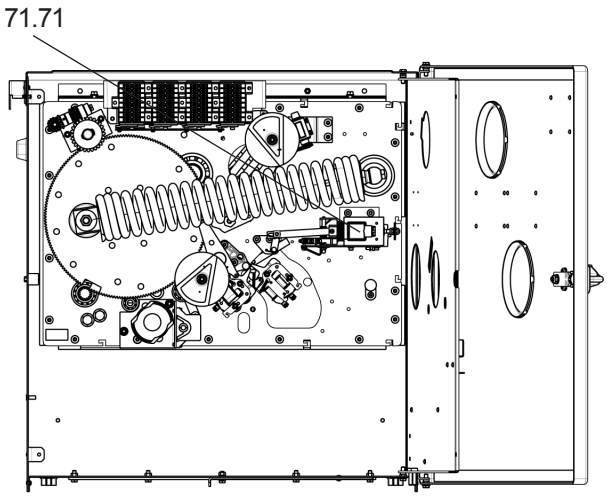


Illustration 18

71.71	Undervoltage release

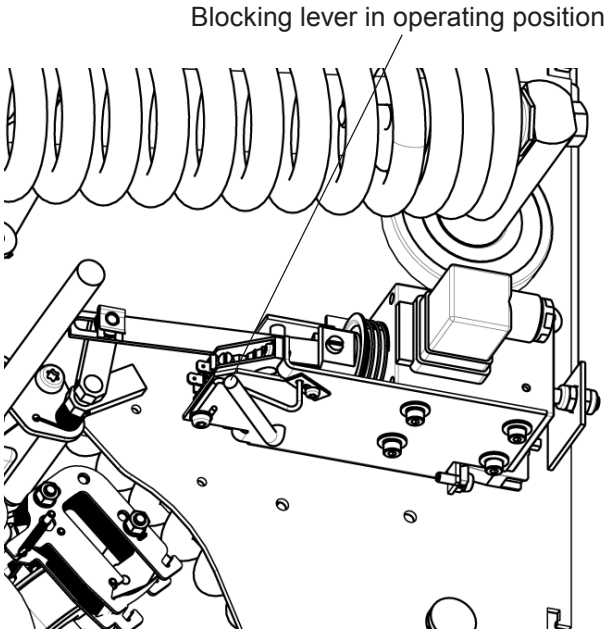


Illustration 19

- Turn the blocking lever from the operating to the blocking position.

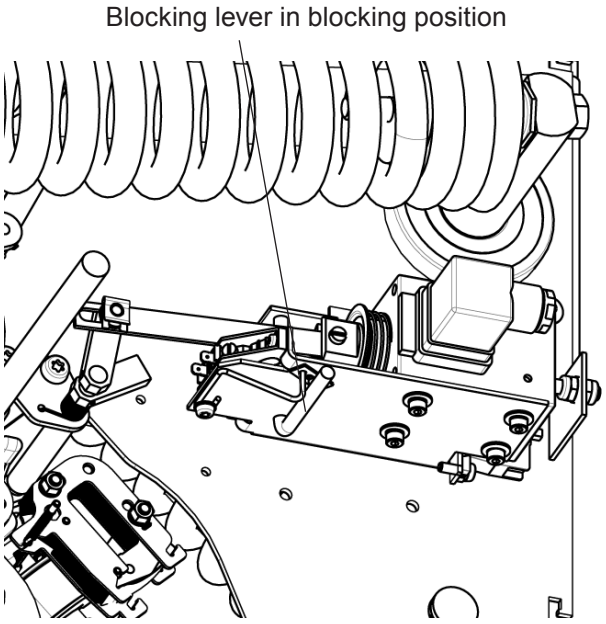
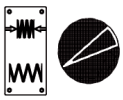
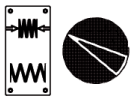
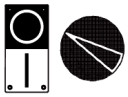


Illustration 20

Slow switch-on

The motor-wound spring operating mechanism is ready for manual operations.

Check the operating states of the circuit breaker and the motor-wound spring operating mechanism

Position of position indicator		
		
Spring position indicator closing spring discharged or charged		The circuit breaker position indicator is at the position OFF.

Remove the blocking device of the tripping latch

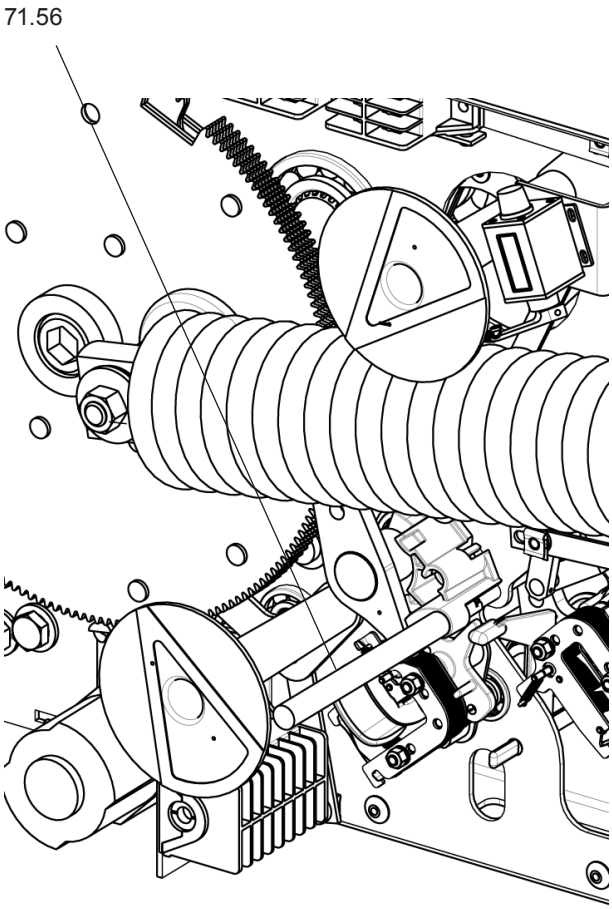
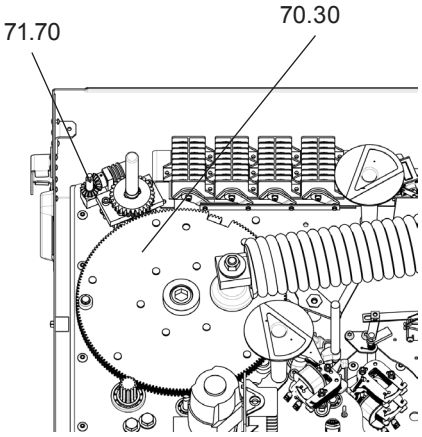
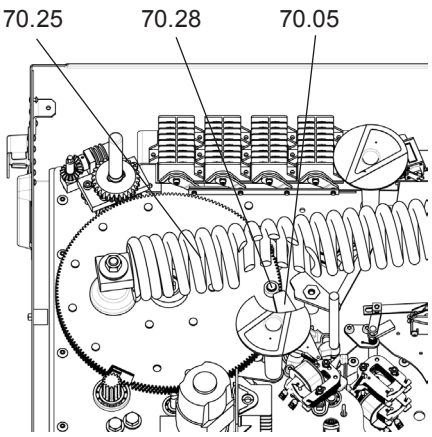


Illustration 21

71.56	Blocking device of tripping latch

If	Then
The closing spring is discharged,  **Illustration 22**	• Charge the closing spring. • Rotate the operating shaft 71.70 clockwise using a hand-held tool with a jaw width 6 and the crank wheel 70.30 will also rotate clockwise.

If	Then
 **Illustration 23**	• The closing spring 70.25 is charged when the roller 70.28 of the crank wheel 70.30 contacts the closing latch 70.05. • If the operating shaft 71.70 is rotated further after roller 70.28 and closing latch 70.05 have contacted, the roller 70.28 and the closing latch 70.05 will be damaged.

70.28	Roller	70.05	Closing latch
70.30	Crank wheel	71.70	Operating shaft
70.25	Closing spring		

Manual operating device in place

- Put the manual operating device in place.

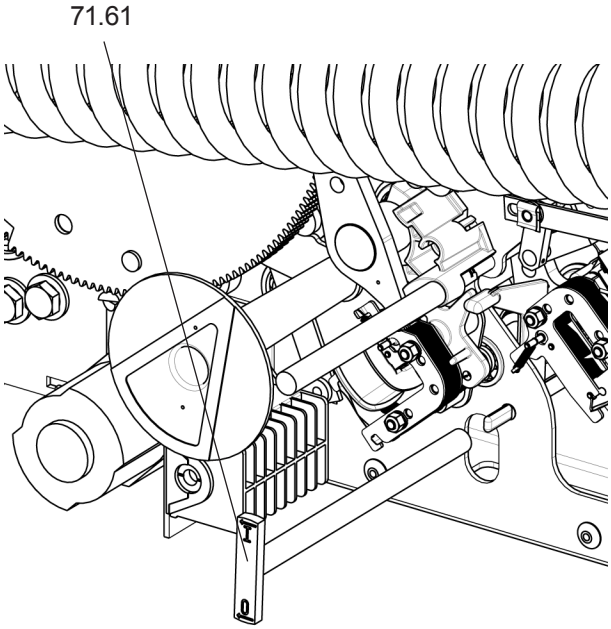


Illustration 24

71.61	Manual operating device

- Turn the manual operating device 71.61 approx. 12° towards ON (counterclockwise) and hold this position.

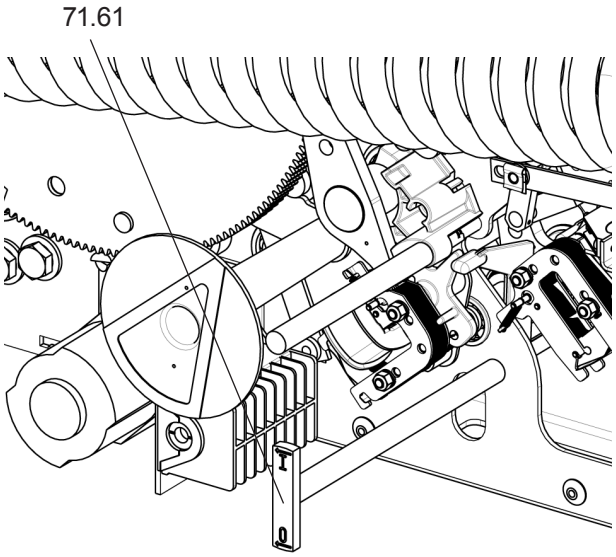


Illustration 25

71.61	Manual operating device

Switch on manually

- Rotate the operating shaft 71.70 clockwise using a hand-held tool with a jaw width 6 and the crank wheel 70.30 will also rotate clockwise. When the roller 70.28 has passed the closing latch 70.05, turn back the manual operating device 71.61 and remove it.

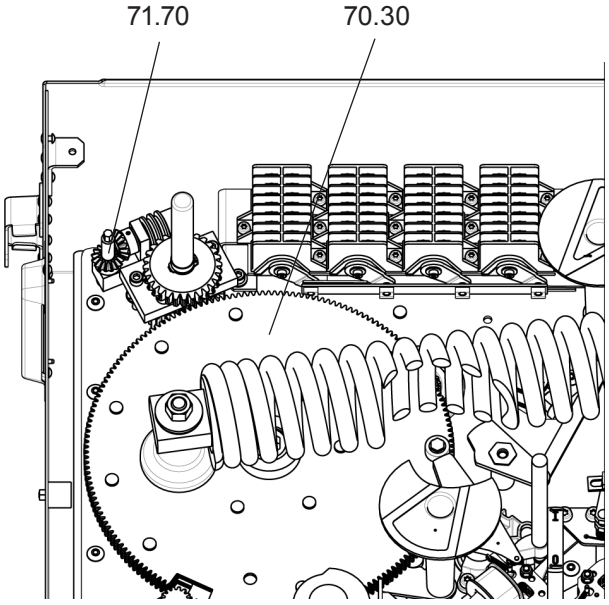


Illustration 26

71.70	Operating shaft
70.30	Crank wheel

- The motor-wound spring operating mechanism 70.00 is at the position ON when the crank wheel 70.30 is at the bottom dead point and the trip spring 70.20 is discharged.

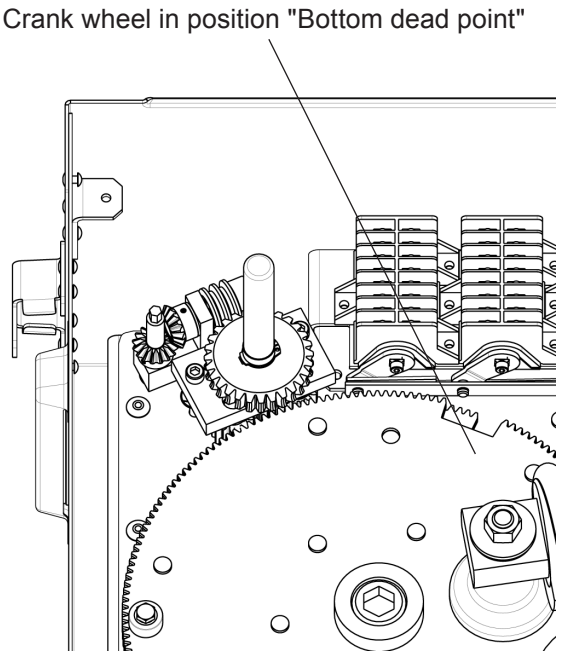
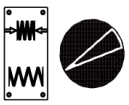
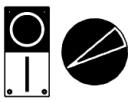


Illustration 27

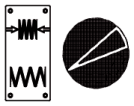
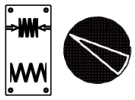
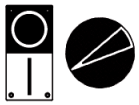
Operating state of motor-wound spring operating mechanism after slow switch-on

Position of position indicator	
	
Spring position indicator closing spring discharged	The circuit breaker position indicator is at the position ON, and the trip spring is charged.

Slow switch-off

The motor-wound spring operating mechanism is ready for manual operations.

Check the operating states of the circuit breaker and the motor-wound spring operating mechanism

Position of position indicator		
		
Spring position indicator closing spring discharged or charged		The circuit breaker position indicator is at the position ON, and the trip spring is charged.

Return stop stop

- Unscrew the M10 bolts 71.73 out of the clamping bar 71.63 of the return stop 70.02 and remove the clamping bar 71.63.

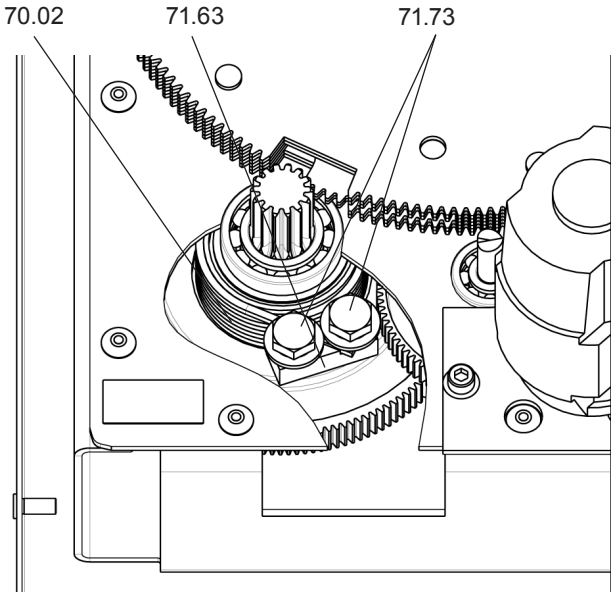
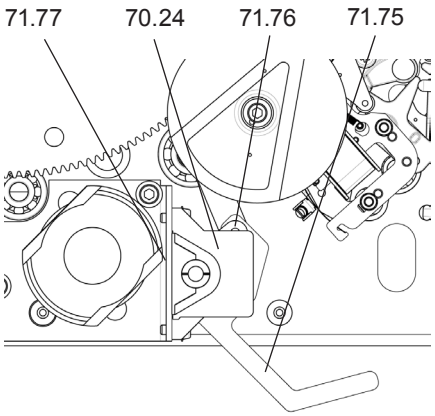
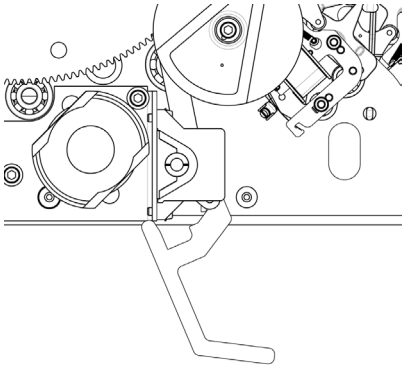
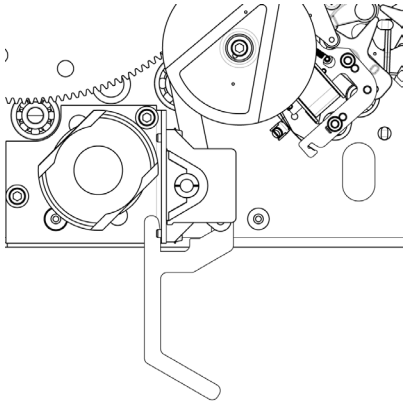


Illustration 28

71.63	Clamping bar
71.73	Bolt M10
70.02	Return stop

Motor limit switch blocking

If	Then
The closing spring is charged.  **Illustration 29**	• Turn the motor limit switch lever 71.76 approx. 90° clockwise by pulling it with the blocking device of the motor limit switch 71.75.
 **Illustration 30**	• The position reached corresponds to the position of the closing spring 70.25 when discharged.
 **Illustration 31**	• Fix the blocking device on the holder 71.77 of the motor limit switch 70.24.

71.77	Holder	71.75	Blocking device of motor limit switch
71.76	Motor limit switch lever	70.24	Motor limit switch

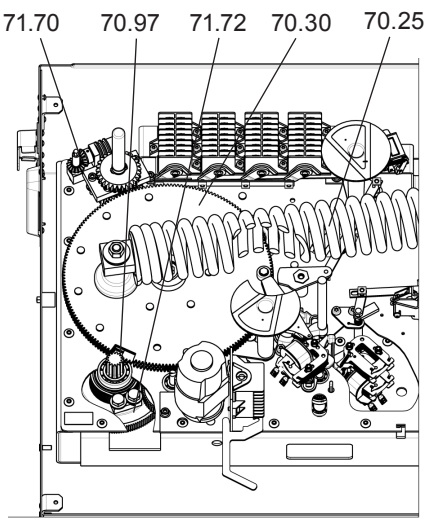


Illustration 32

- The pinion shaft 70.97 can be easily rotated on the spur gear 71.72 by hand until the toothings of pinion shaft 70.97 and crank wheel 70.30 are congruent. Rotate the operating shaft 71.70 counterclockwise using a hand-held tool with jaw width 6 and the crank wheel 70.30 will also rotate counterclockwise.

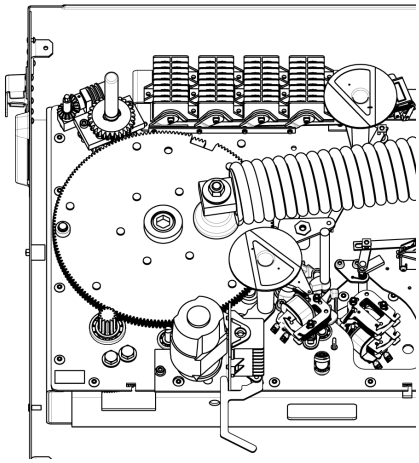


Illustration 33

- When the crank wheel 70.30 reaches the bottom dead point, the closing spring 70.25 is discharged.

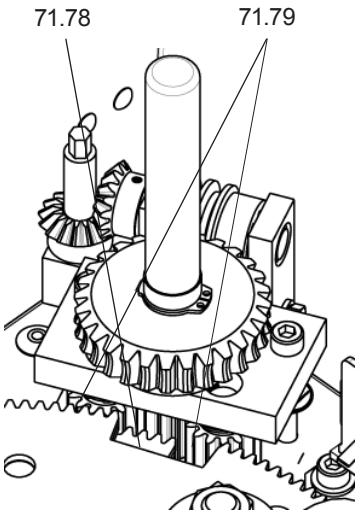
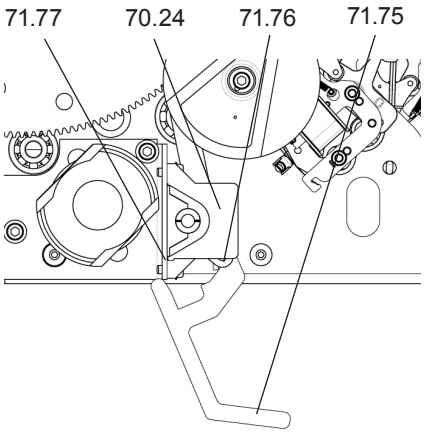
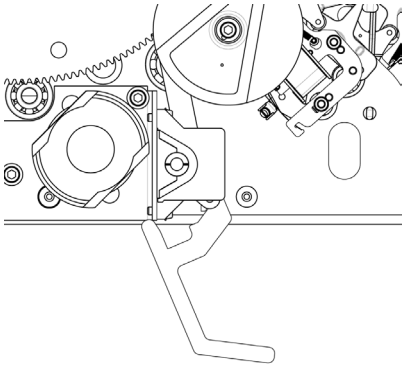


Illustration 34

- Further rotate the operating shaft 71.70 counterclockwise using a hand-held tool with jaw width 6 until the toothed segment 71.78 is between the pinions 71.79 of the slow movement device 70.72.

71.70	Operating shaft	70.30	Crank wheel
70.25	Closing spring	70.97	Pinion shaft
71.78	Toothed segment	71.79	Pinion of slow movement device

If	Then
The closing spring is in the recuperated position.  **Illustration 35**	
 **Illustration 36**	• Fix the device on the holder 71.77 of the motor limit switch 70.24.

71.77	Holder	71.75	Blocking device of motor limit switch
71.76	Motor limit switch lever	70.24	Motor limit switch

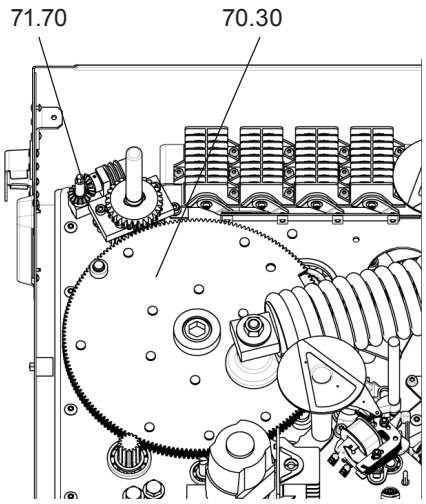


Illustration 37

- Rotate the operating shaft 71.70 counterclockwise using a hand-held tool with jaw width 6 and the crank wheel 70.30 will also rotate counterclockwise.

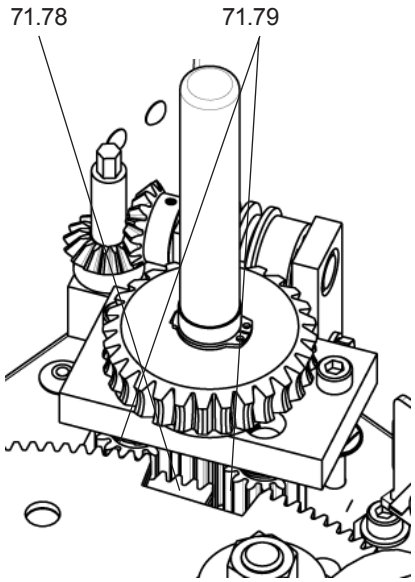


Illustration 38

- Further rotate the operating shaft 71.70 counterclockwise using a hand-held tool with jaw width 6 until the toothed segment 71.78 is between the pinions 71.79 of the slow movement device 70.72.

71.70	Operating shaft	70.30	Crank wheel
71.78	Toothed segment	71.79	Pinion of slow movement device

Remove the blocking device of the tripping latch

71.56

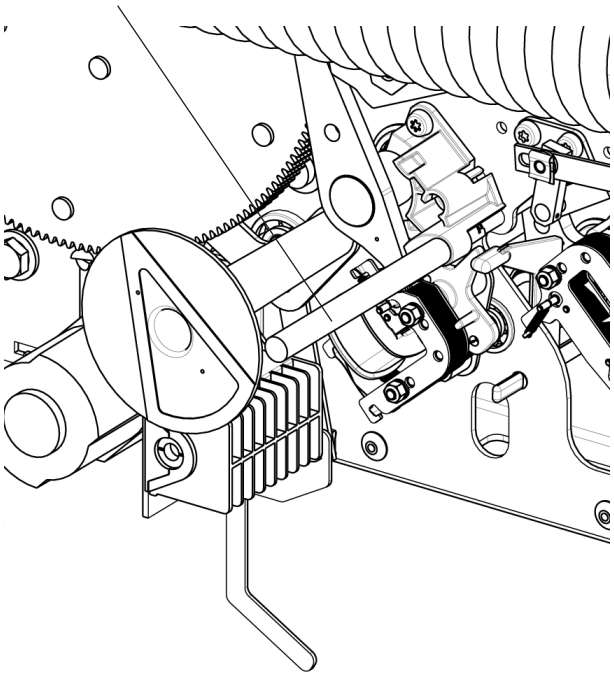


Illustration 39

71.56	Blocking device of tripping latch

Manual operating device in place

71.61

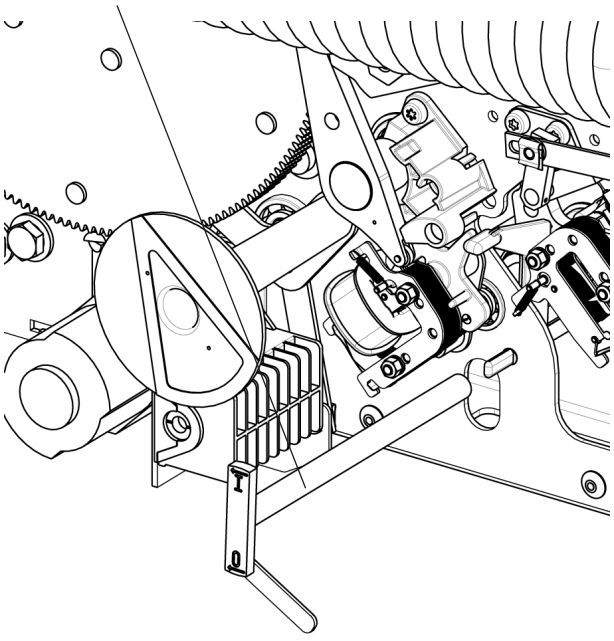


Illustration 40

71.61	Manual operating device

- Turn the manual operating device 71.61 approx. 12° towards OFF (clockwise) and hold this position.

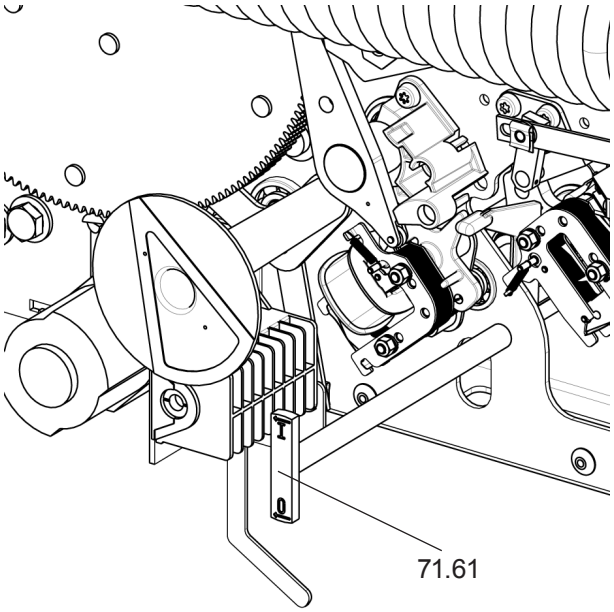


Illustration 41

71.61	Manual operating device

Manually switch off

- Rotate the operating shaft 71.70 counterclockwise using a hand-held tool with jaw width 6 and the crank wheel 70.30 will also rotate counterclockwise.

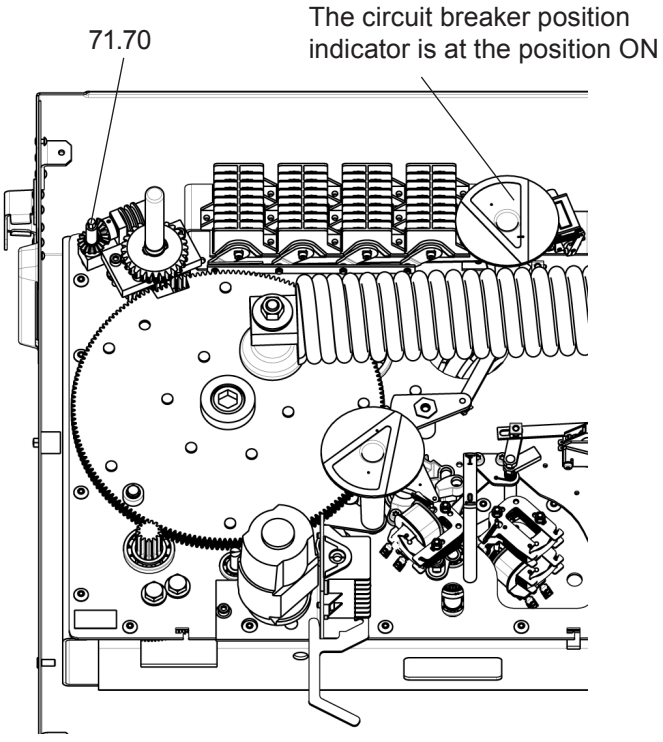


Illustration 42

71.70	Operating shaft

- At the end of the process, the trip spring 70.20 is discharged, the crank wheel 70.30 is at the bottom dead point and the operating mechanism is at the position OFF.

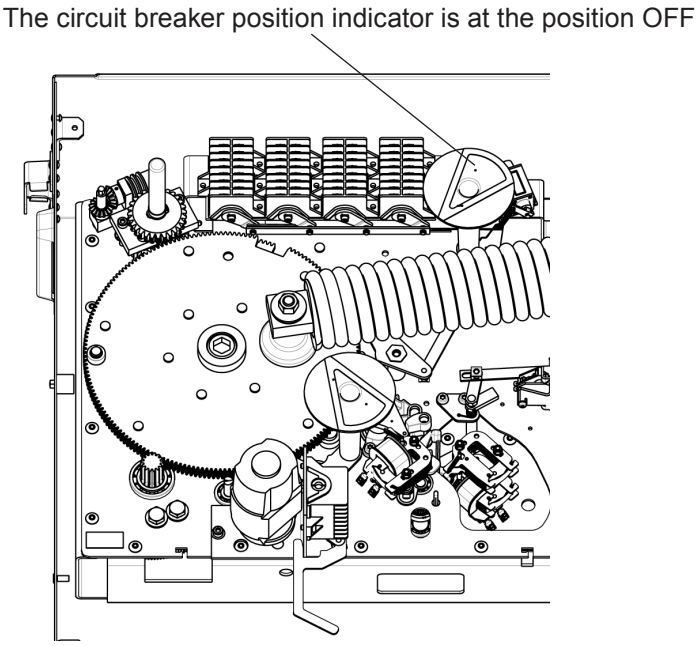


Illustration 43

Return stop mounting

- The straight end of the return stop 70.02 is aligned between the holes for the M10 bolts 71.73 by turning the spur gear 71.72.
- Insert the straight end of the return stop 70.02 into the groove of the clamping bar 71.63 and then screw the M 10 bolts 71.73 into the clamping bar 71.63.
- Tightening torque = 47 Nm±10%

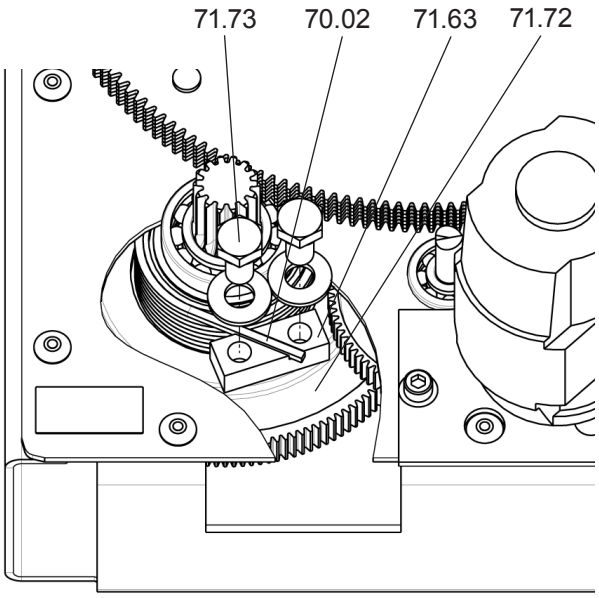
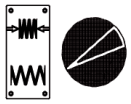


Illustration 44

71.63	Clamping bar	70.02	Return stop
71.72	Spur gear	71.73	Bolt M10

Operating state of motor-wound spring operating mechanism after slow switch-off

Position of position indicator	
	
Spring position indicator closing spring discharged	The circuit breaker position indicator is at the position OFF and the trip spring is charged.

Return stop fastening

- Tighten the M10 bolts 71.73 of the clamping bar 71.63 of the return stop 70.02 to 47 Nm ±10%.
- If the clamping bolts are not tightened to the specified torque, the return stop will not work properly.
- If, in this case, when using the hand crank to charge the closing spring, the hand crank is released before the end position is reached, it will spin backwards at high speed and thus become an accident hazard.

CAUTION!

After doing any work (manipulation) on the return stop, the bolts of the clamping bar of the return stop must be tightened to a torque of 47 Nm ±10%.

- If the clamping bolts are not tightened to the specified torque, the return stop will not work properly.
- If, in this case, when using the motor to charge the closing spring, the motor voltage is interrupted, the closing spring will discharge by rotating the winding gears backwards. This could result in damage to the motor-wound spring operating mechanism.

NOTE!

After doing any work (manipulation) on the return stop, the bolts of the clamping bar of the return stop must be tightened to a torque of 47 Nm ±10%.

Remove the blocking device of the motor limit switch

- The blocking device of the motor limit switch 71.75 must be removed so that the motor limit switch can function again.
- If the blocking device of the motor limit switch is not removed, the motor limit switch will not work.
- If, in this case, the closing spring is charged by the motor, the motor voltage will not be interrupted and the motor will be destroyed as a result.

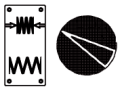
NOTE!

After doing any work (manipulation) on the motor-wound spring operating mechanism that requires the blocking device of the motor limit switch to be fitted, this must be removed.

Manually discharge the closing spring

The operating mechanism is ready for manual operations.

Check the operating states of the circuit breaker and the motor-wound spring operating mechanism

Position of position indicator	
	
Spring position indicator closing spring charged	The circuit breaker position indicator is at the position OFF and the trip spring is charged.

Return stop release

- Unscrew the M10 bolts 71.73 out of the clamping bar 71.63 of the return stop 70.02 and remove the clamping bar 71.63.

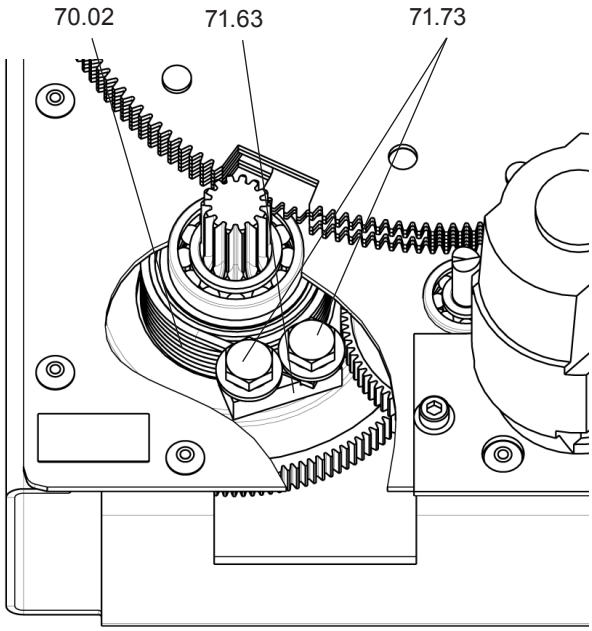


Illustration 45

71.63	Clamping bar
71.73	Bolt M10
70.02	Return stop

- Turn the motor limit switch lever 71.76 approx. 90° clockwise by pulling it

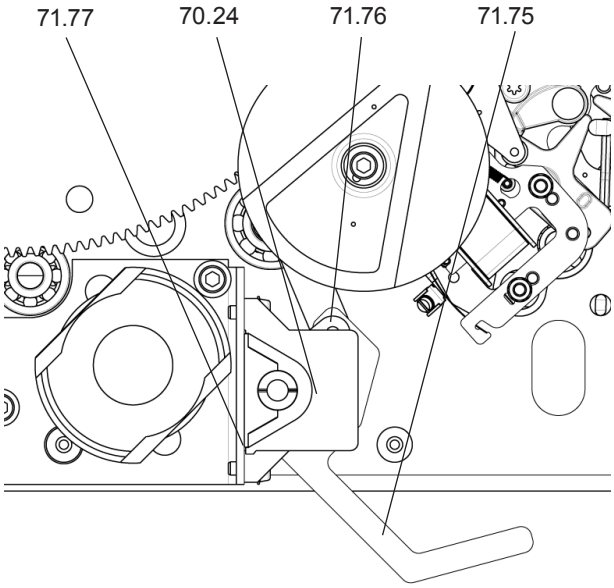


Illustration 46

- with the blocking device of the motor limit switch 71.75.

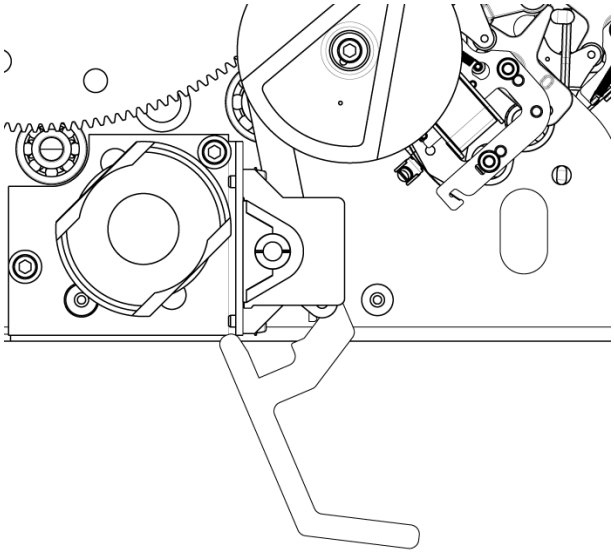


Illustration 47

- Then, fix the device on the holder 71.77 of the motor limit switch 70.24.

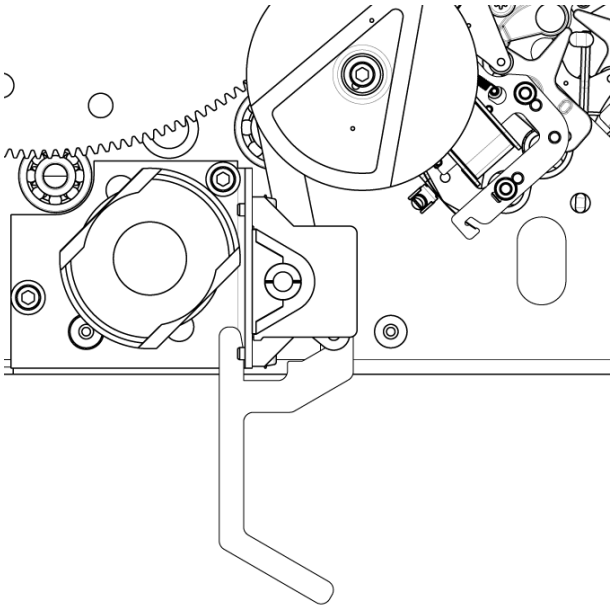


Illustration 48

70.24	Motor limit switch
71.76	Motor limit switch lever
71.75	Blocking device of motor limit switch
71.77	Holder of motor limit switch

Closing spring discharge

- The pinion shaft 70.97 can be easily rotated on the spur gear 71.72 by hand until the toothings of pinion shaft 70.97 and crank wheel 70.30 are congruent. Rotate the operating shaft 71.70 counterclockwise using a hand-held tool with jaw width 6 and the crank wheel 70.30 will also rotate counterclockwise.

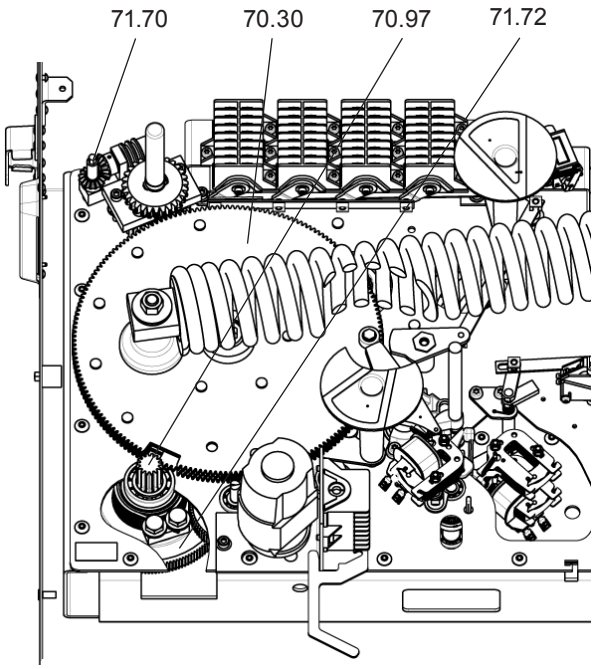


Illustration 49

- When the crank wheel reaches the bottom dead point, the closing spring 70.25 is discharged.

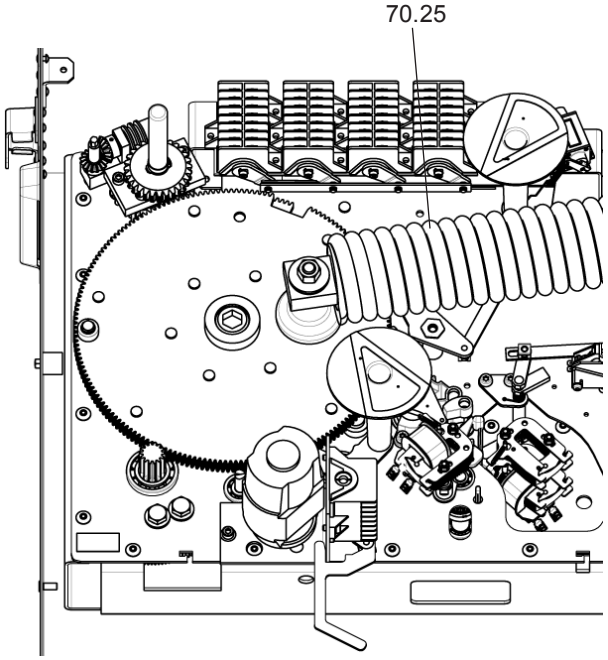


Illustration 50

71.70	Operating shaft	70.30	Crank wheel
70.25	Closing spring	70.97	Pinion
71.72	Spur gear		

Return stop mounting

- The straight end of the return stop 70.02 is aligned between the holes for the M10 bolts 71.73 by turning the spur gear 71.72.
- Insert the straight end of the return stop 70.02 into the groove of the clamping bar 71.63 and then screw the M 10 bolts 71.73 into the clamping bar 71.63.
- Tightening torque = 47 Nm ±10%

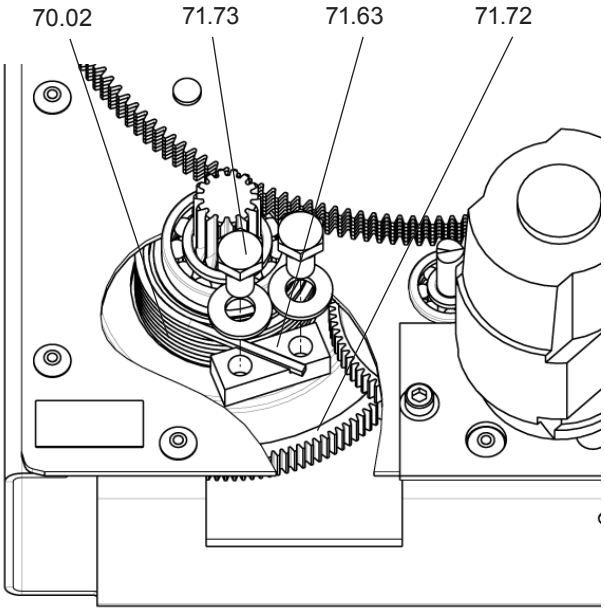
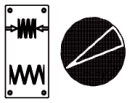
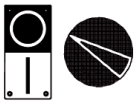


Illustration 51

71.73	Bolt M10	70.02	Return stop
71.63	Clamping bar	71.72	Spur gear

Operating state of motor-wound spring operating mechanism after manually discharging the Closing spring

Position of position indicator	
	
Spring position indicator closing spring discharged	The circuit breaker position indicator is at the position OFF and the trip spring is discharged.

Return stop fastening

- Tighten the bolts 78.31 of the clamping bar 71.63 of the return stop 70.02 to 47 Nm ±10%.
- If the clamping bolts are not tightened to the specified torque, the return stop will not work properly.
- If, in this case, when using the hand crank to charge the closing spring, the hand crank is released before the end position is reached, it will spin backwards at high speed and thus become an accident hazard.

CAUTION!

After doing any work (manipulation) on the return stop, the bolts of the clamping bar of the return stop must be tightened to a torque of 47 Nm ±10%.

- If the clamping bolts are not tightened to the specified torque, the return stop will not work properly.
- If, in this case, when using the motor to charge the closing spring, the motor voltage is interrupted, the closing spring will discharge by rotating the winding gears backwards. This could result in damage to the motor-wound spring operating mechanism.

NOTE!

After doing any work (manipulation) on the return stop, the bolts of the clamping bar of the return stop must be tightened to a torque of 47 Nm ±10%.

Remove the blocking device of the motor limit switch

- The blocking device of the motor limit switch 71.75 must be removed so that the motor limit switch can function again.
- If the blocking device of the motor limit switch is not removed, the motor limit switch will not work.
- If, in this case, the closing spring is charged by the motor, the motor voltage will not be interrupted and the motor will be destroyed as a result.

NOTE!

After doing any work (manipulation) on the motor-wound spring operating mechanism that requires the blocking device of the motor limit switch to be fitted, this must be removed.

Finishing work after ending manual operations

Check the position is OFF on the circuit breaker

- Before carrying out the finishing work, make sure the circuit breaker is at the position OFF.
- If the circuit breaker is at the position ON, proceed according to "Slow switch-off".

Unblock the undervoltage release

- If the motor-wound spring operating mechanism is equipped with an undervoltage release, unblock the undervoltage release.

Blocking lever in blocking position

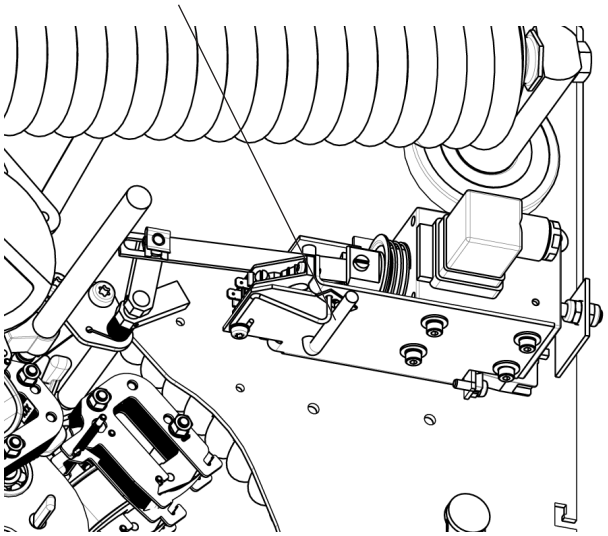


Illustration 52

Blocking lever in operating position

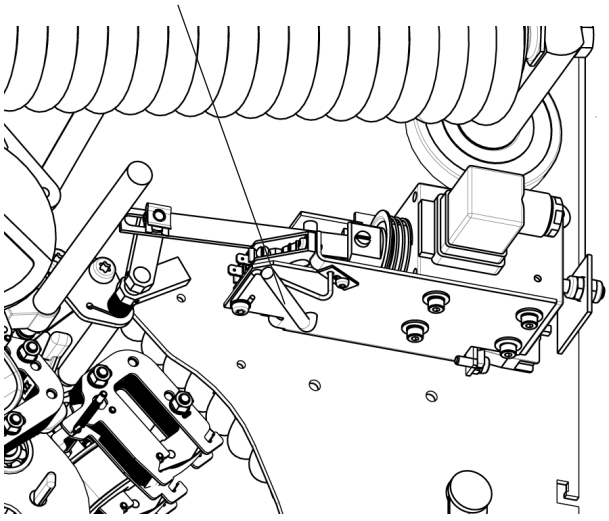


Illustration 53

Remove the slow movement device

- Undo the M6 set screws 71.68 of the slow movement device 70.72 and remove the slow movement device 70.72.

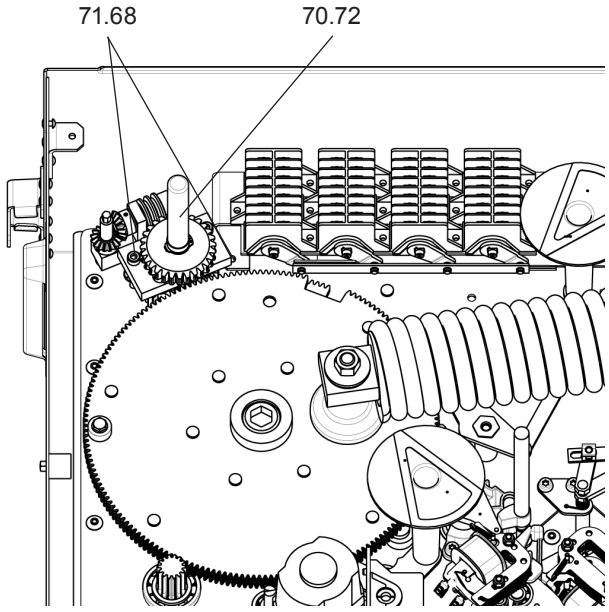


Illustration 54

71.68	Set screw M6
70.72	Slow movement device

Protection plate

- Close the protection plate and fasten it using the protection plate set screws 78.31.

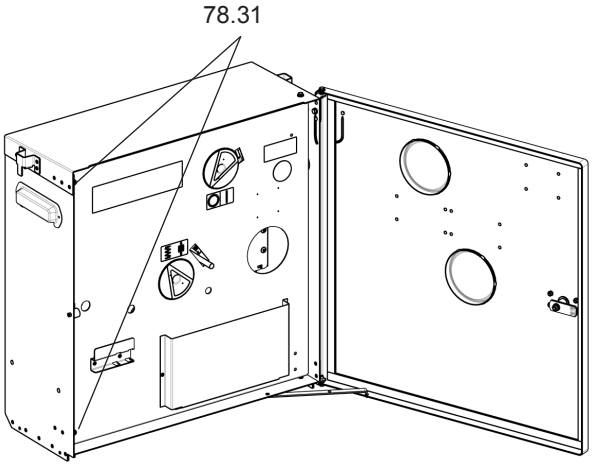


Illustration 55

78.31	Set screws of protection plate

Remove the blocking device of the tripping latch

- Remove the blocking device of tripping latch 71.56.

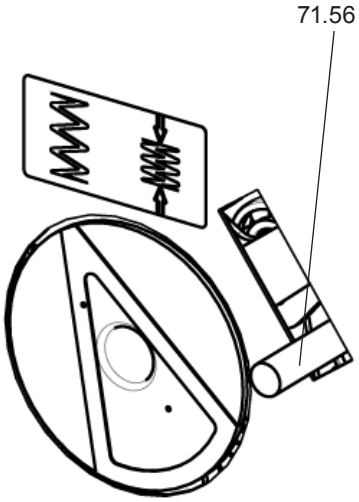


Illustration 56

71.56	Blocking device of tripping latch

Close the housing

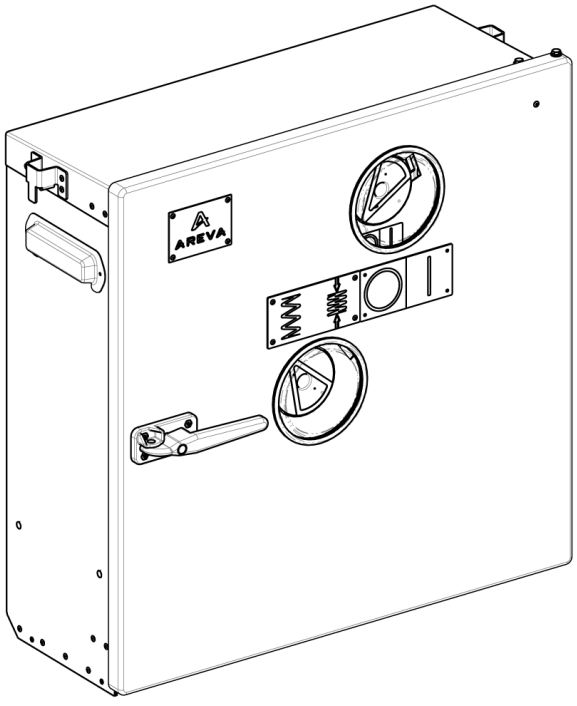


Illustration 57

Putting back into service

- Switch on the control voltage.

Spare parts

Warning

- Use only the manufacturer's original spare parts.

WARNING!

Accident hazard from incorrect spare parts!

The use of incorrect or defective spare parts can impair safety and result in damage, malfunctions or complete failures.

Consequently:
– Use only the manufacturer's original spare parts.

- If spare parts that are not originals from the manufacturer are used, all guarantee, service, compensation and liability claims against the manufacturer or his / her dealers or distributors and representatives or agents become null and void.

Disposal

Comment

- After the components / installations have reached the end of their service life, each installation must be dismantled and the components disposed of in an environmentally compatible way.

COMMENT!

Further information about disposal can be found in the instructions H48020248.

Note

- If no returns or disposal agreement was concluded, have the removed components recycled.

NOTE!

Environmental damage from incorrect disposal!

SF6 gas, electrical scrap, electronic components, lubricants and other auxiliary materials are subject to hazardous waste treatment regulations and may be disposed of only by approved specialized waste disposal companies.

Accident

Comment

COMMENT!

- **Always be prepared for accidents or fire!**
- **First-aid equipment (first-aid boxes, blankets, etc.)**
- **Familiarize staff members with accident reporting, first-aid and rescue facilities.**
- **Always keep clear the access routes for rescue vehicles.**
- **See "First-aid measures" for the action to take in the event of accidents.**

User evaluation

- We have compiled this document to the best of our knowledge. Please do not hesitate to let us know if any information is missing for you as a user or if you have any remarks or additions to the structure or contents.
- We appreciate all feedback that enables us to keep our documentation up-to-date technically and practically at all times.
- Please mail feedback to the address given in the chapter After-sales service.

Key to item numbers

Item	Designation	Illustration						
70.02	Return stop	28	44	45	51			
70.05	Closing latch	06	23					
70.24	Motor limit switch	29	35	46				
70.25	Closing spring	23	32	50				
70.28	Roller	23						
70.30	Crank wheel	22	26	32	37	45	49	
70.71	Blocking device of closing latch	03	04	06	17			
70.72	Slow movement device	54						
70.97	Pinion shaft	32	49					
71.56	Blocking device of trip latch	03	05	21	39	56		
71.61	Manual operating device	24	25	40	41			
71.63	Clamping bar	28	44	45	51			
71.65	Spring	06						
71.66	Rivet nut M6	14						
71.67	Centering device	14						
71.68	Set screw M6	14	54					
71.69	Centering bore	14						
71.70	Operating shaft	15	22	26	32	37	42	49
71.71	Undervoltage release	18						
71.72	Spur gear	32	44	49	51			
71.73	Bolt M10	28	44	45	51			
71.75	Blocking device of motor device	29	35	46				
71.76	Motor limit switch lever	29	35	46				
71.77	Holder	29	35	46				
71.78	Toothed segment	34	38					
71.79	Pinion of slow movement device	34	38					
78.04	Door	01						
78.31	Set screws of protection plate	01	13	55				
78.32	Fixing bar	13						

Dismantling and recovery of components from a circuit breaker

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.

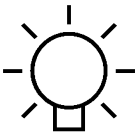
III - Categories and treatment of the materials (contd.)

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 22,200 times higher than that of Carbon Dioxide.

<u>NOTE</u>: 1 kg of SF6 gas emissions are, thus, the equivalent of 22,200 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>NOTE</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.

NOTE: 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:

Clean SULPHUR HEXALUORIDE SF_6

S 7/9 – Keep container tightly closed in a well-ventilated place.
S 20/21 – When using, do not eat, drink or smoke.
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.
S51 - Use only in well ventilated areas.

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.

C - CORROSIVE

Liquid GAS, toxic, corrosive, n.s.a.

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 and used SF6 gas without toxic products	Conforming SF6 including low levels of toxic products .	Non-conforming SF6 including toxic products. SF6 (post-arcing). Studies of the compartment 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			●

NOTE: 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,

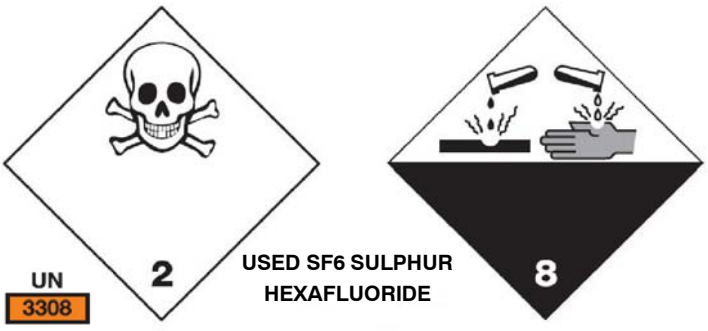
- Remove the SF6 decomposition products immediately after the opening of the equipment in order to avoid a chemical re-combination with water.
- Ventilation must be sufficient.
- Use an appropriate vacuum cleaner equipped with a dust filter and wipe with a clean, dry cloth.
- Avoid shaking the cloth
- 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 :



(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).

S 61 - 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.

- 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°842/2006 of 17th of May 2006 concerning certain greenhouse effect fluorinated gases.

Instructions on the handling of used SF_6 gas and decomposition products

Presentation

Introduction

The present module deals with measures to prevent the dangers which SF_6 gas can represent in the electrical apparatus.
The operator will find herein recommendations and measures for ensuring protection.

Fundamental rules

Respect the instructions in each SF_6 gas eauipment's maintenance manual.
Ensure all preparatory cleaning has been done before opening a piece of SF_6 switchgear.

In this module

This module covers the following subjects:

Draining the apparatus

Principle and precautions

The following table gives the principle for draining apparatus containing SF_6 gas, as well as the precautions to take:

Step	Action
1	Turn the apparatus off then earth it.
2	Connect the vacuum pump tube to the apparatus connection, with an adsorbent filter between the two.
3	Vacuum the SF_6 gas and, depending on the quantities, recover it for re-use in accordance with the directives of norm IEC 60480.
4	Rinse the gas enclosure by filling it with nitrogen or dry air at nominal pressure; then discharge this gas into the free air, preferrably passing it through an adsorbent filter first.

Opening an SF_6 gas insulating apparatus

Precautions to take

When opening an SF_6 gas insulating apparatus, take the following precautions :

- Never try to open an SF_6 gas insulating apparatus before completely draining it of gas and setting it at atmospheric pressure.
- When opening switchgear likely to contain solid by-products (dust), for example circuit breakers, make sure there is efficient local ventilation or, if this is not the case, set up ventilation.
- Wear appropriate masks to avoid inhaling noxious quantities of solid of gaseous by-products.
- Wear special work clothing when working with open SF_6 switchgear with dust by-products. Put this clothing aside as soon as possible for cleaning.
- Do not dust or stir up the dust in SF_6 apparatus: it must be vacuumed up, and what is left wiped up with dry, non-fluffy cloths. The vacuum filter must be able to trap particles of a size on the order of 1 µ.
- Accessories (cloths, vacuum filters, disposable clothing or gloves, etc.) that come in contact with the SF_6 gas dissociation by-products must be collected and neutralised so as to avoid spreading dust.
Neutralisation is by 24-hour immersion in a 3% solution of sodium carbonate; if the addition of sodium causes bubbles to form, repeat the treatment.
- Do not swallow or inhale SF_6 gas dissociation by-products, and avoid dust contact with the skin, eyes and clothing. Make sure the workstation and all clothing are clean.
Avoid all physical contact, and rinse freely int he event of the slightest contact.
- Before breaks and the end of work, we recommend washing the face, neck, arms and hands with soap, rinsing freely and carefully.
- It is forbidden to smoke, drink or eat, or to keep any products to be used for such near open SF_6 apparatus that has dust by-products, whether indoors or outdoors.

Instructions on the handling of used SF_6 gas and decomposition products

Summary of instructions

Reminder

Sulphur hexafluoride, le SF_6, is not toxic. The electrical discharges and arcs or faults can break the molecule up, with recombination possibly creating by-products with varying degrees of toxicity. In a few seconds, even before there is any danger, characteristic signs (sharp and unpleasant odour, mucous gland, mouth and eye irritation) alert personnel to the danger, in time to take the necessary preventive safety measues in the rpesence of gaseous by-products. Dust by-products irritate the skin. SF_6, some five times heavier than air, can form layered deposits on the ground. If it is not diluted by turbulence, the SF_6 replaces and rarifies the oxygen, until there is a risk of asphyxiation.

Recommendations

The following table summarises the instructions to respect when handling used SF_6 gas and by-products :

Nº	Recommendation
1	Immediately leave the room where the characteristic sharp and unpleasant odour signals the presence of gaseous by-products. Only return after the air has been replaced by ventilation or appropriate respiratory apparatus (with a filter or independent of the location).
2	In the event of a high concentration of SF_6 do not enter the room without an respiratory device independent of the ambient air, for so long as the ventilation has not made the air breathable, with a minimum proven oxygen content of 17%.
3	Do not enter rooms located below and communicating with an SF_6 apparatus room without first cold-ventilating them and checking the minimum breathable oxygen content (17%), or wearing appropriate individual respirator.
4	Maintain efficient ventilation throughout all SF_6 apparatus-related work: draining, opening, cleaning, filling.
5	In the presence of solid by-products, avoid contact of the dust with the skin and do not inhale or swallow. Make sure the workstation and all clothing are clean. Wash abundently in the event of physical contact. Wear special clothing, to be taken off when work has finished.
6	Rinse any part of the skin that comes in contact with switchgear dust freely and immediately! Before breaks and at the end of work, wash the face, neck, arms and hands with soap, and rinse freely and carefully.
7	Do not stir up dust by-products. Dry-wipe sticking dust and vacuum up detached dust with an appropriate vacuum cleaner equipped with a paper filter. Carefully dispose of used filters and cleaning material in such a way as to avoid scattering the gathered duct. Neutralise all polluted materials.
8	Do not keep nor drink nor eat beverages or food in the presence of open SF_6 equipment with switchgear dust. Do not smoke.

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