

## **Operating Instructions No. 188 A (EN)**

**Device:** SF<sub>6</sub> Circuit Breaker  
GL 311 F1/4031/VR  
GL 312 F1/4031/VR

**Manufacturer:** AREVA Energietechnik GmbH  
High Voltage Products  
Lilienthalstr. 150  
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## Preliminary Remarks

1. The operating instructions consist of two parts:  
Part A: Erection and Commissioning  
Part B: Inspection, Maintenance, and Reconditioning
2. It is not possible to include in the operating instructions every possible eventuality that might occur when using technical equipment. Please contact your authorized AREVA representative if a situation arises that is not covered in detail by this manual.
3. Type GL circuit breakers have been specifically developed to be low-maintenance and to allow for long maintenance intervals. Experience has shown that the operational reliability of the equipment is guaranteed by proper servicing and by following the instructions given in this manual.
4. This document and the equipment described herein are subject to change without notice in the interest of further development.
5. No claims may be derived from the specifications, figures, or descriptions.
6. No part of this document may be duplicated in any way or passed on to a third party without the written consent of AREVA Energietechnik GmbH.

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## 1 Safety Instructions

### 1.1 General Safety Requirements

The circuit breaker operator must make sure

- that erection, commissioning, and reconditioning of the equipment described in these operating instructions are carried out only by a properly trained and qualified electrical technician or  
under the direction and supervision of a properly trained electrical technician in compliance with electrical codes and regulations;
- that both the circuit breaker and all adjacent active parts are de-energized before any work is begun and that the de-energized state is maintained until work is completed;
- that all installation, operating, and maintenance personnel are familiar with these operating instructions, including all safety instructions and warnings, with all safety regulations applicable locally, and with instructions regarding action to be taken in the event of accidents, and that they can consult these documents at any time.

The assigned personnel must keep in mind

- that the specified maintenance intervals and instructions for reconditioning and part replacement must be followed,
- that certain parts of the circuit breaker will carry hazardous voltage levels and be under gas pressure during operation,
- that linkages and levers may suddenly move abruptly and unpredictably as the result of external control operations.

### 1.2 Special Safety Requirements

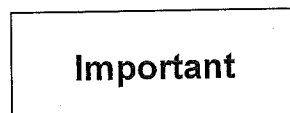
Special safety requirements are incorporated in the text of this manual and are specifically identified as follows:



Immediate danger that could potentially lead to death or serious injury.



Dangerous situation that could potentially lead to minor injuries or damage to the product or to something nearby.



Useful tips and information

### 1.3 Handling SF<sub>6</sub> Gas

Sulfur hexafluoride (SF<sub>6</sub>) is a colorless, odorless gas. Pure SF<sub>6</sub>, in compliance with IEC 376, is not toxic. It is not a hazardous substance and is therefore not subject to regulations governing hazardous materials.

The applicable toxicity standard internationally is IEC 1634.



When SF<sub>6</sub> is used in high voltage switchgear, decomposition products of varying toxicity are formed as the result of electrical discharge and arcs.

These products can irritate mucous membranes, the respiratory tract, as well as other unprotected skin surfaces.

Personnel must therefore observe the following safety measures at all times when working on open switchgear:

- ⇒ Eating, drinking, smoking, and the storage of food are absolutely prohibited in rooms containing SF<sub>6</sub> systems. This applies particularly to maintenance work, when gas compartments are open.
- ⇒ Do not touch parts in the vicinity of the insulating gas without proper protective clothing and/or equipment.
- ⇒ Do not stir up the powdery decomposition products.
- ⇒ Make sure the room is well ventilated when working on indoor breakers.
- ⇒ Use only the minimum number of personnel absolutely necessary for performing the work.
- ⇒ Wash the body thoroughly after work.

Personnel must be equipped with the following items when doing any work involving used or contaminated SF<sub>6</sub> gas:

- ⇒ Appropriate protective respiratory equipment such as a full-face respirator (gas mask) or a respirator plus gas-tight safety glasses per DIN EN 175
- ⇒ Dust-tight protective suit made of nonwoven material (disposable coveralls)
- ⇒ Rubber gloves or disposable gloves
- ⇒ Rubber boots or disposable boots

After work is completed, clean the respirator, safety glasses, rubber boots, and rubber gloves with water. Collect the water. Dispose of both the water and the protective coveralls separately.

#### 1.4 Transportation and Handling at the Erection Site

##### **Important**

All pressure specifications are given in relative values.



##### **Caution**

Pole columns are shipped at a gas gauge pressure of approximately 0.05 MPa (0.5 bar).

If handled improperly, the support porcelains may burst and cause damage to persons and property.

⇒ To minimize the consequences of porcelain breakage, never move the pole columns if the pressure exceeds the shipping pressure.

The applicable safety regulations and the safety instructions given in Section 1 of this manual must be followed during all transport and handling operations.

The circuit breaker operator shall be responsible for compliance with safety regulations.

## 2 Technical Description

### 2.1 Technical Data: Circuit Breaker

Type (see nameplate)		GL311- F1/4031/VR	GL312- F1/4031/VR
Rated voltage	kV	123	145
Rated normal current	A	3150	3150
Rated frequency	Hz	50/60	50/60
Rated power-frequency withstand voltage 50 Hz, 1 min			
– To ground	kV	230	275
– Across open switching device	kV	230	275
Rated lightning impulse withstand voltage			
– To ground	kV	550	650
– Across open switching device	kV	550	650
Rated switching impulse withstand voltage (Un > 245 kV)			
– To ground	kV	Not applicable	Not applicable
– Across open switching device	kV	Not applicable	Not applicable
Rated short-circuit breaking current			
– R.m.s. value of the a.c. component of current	kA	40	40
– Percentage of d.c. component	%	36	36
Minimum opening time	ms	35	35
First-pole-to-clear factor		1.5	1.5
Rated transient recovery voltage			
– Peak value	kV	211	249
– Rate of rise	kV/μs	2.0	2.0
Short-line fault			
– Surge impedance	Ω	450	450
– Peak factor		1.6	1.6
Rated short-circuit making current	kA	104	104
Rated out-of-phase breaking current	kA	10	10
Rated duration of short circuit	s	3	3
Rated operating sequence		O-0.3s-CO-3min-CO or CO-15s-CO	
Rated line-charging breaking current	A	31.5	50
Rated cable-charging breaking current	A	140	160
SF <sub>6</sub> weight per breaker	kg	12	12

## 2.2 Technical Data: Spring Operating Mechanism

FK 3-..

Type (see nameplate)

Motor for charging the closing spring:

Rated voltage (preferred values)

- Direct voltage V 60/110/125/220/250 \*)
- Alternating voltage V 120/230 \*)

Allowable rated voltage deviation

85 to 110 % Un

Power consumption

W <750 \*\*)

Closing spring charging time

s < 15

Shunt releases, closing and opening:

Rated supply voltage

(preferred values only with direct voltage)

V 60/110/125/220/250 \*)

Allowable rated supply voltage deviation

85 to 110 % Un

- Shunt closing release

70 to 110 % Un

- Shunt opening release

Power consumption of releases

- Shunt closing release

W 340

- Shunt opening release

W 340

Minimum pulse duration

ms 10

Auxiliary circuits:

Rated continuous load current

A 10

Auxiliary contact tripping capability

- At 230 V alternating voltage

A 10

- At 220 V direct voltage in an inductive circuit with a time constant of  $L/R = 20$  ms

A 2

Anti-condensation heating:

Rated voltage (alternating voltage)

V 120 or 230 \*)

Power consumption

W 80

\*) Specify when ordering.

\*\*) The exact value is shown on the motor nameplate.

## 2.3 Design, Operation, and Weights

### 2.3.1 Circuit Breakers

The circuit breakers described in this manual differ from one another only as regards technical data. Design and operation are identical.

A SF<sub>6</sub> circuit breaker (Figure A 2.3.1) consists of the following main components: pole columns, base frame, operating mechanism, and supports.

Each pole column consists of a support porcelain for insulating operational voltage to ground and a chamber insulator in which the interrupter unit is located. The pole columns and the SF<sub>6</sub> piping form a common gas compartment. The movable contacts of the interrupter unit are connected to the mechanism by the insulating rods, the torque shafts and pole column levers, and the connecting rods in the base frame.

When the current is interrupted, a transition from the conductive to the insulating state occurs within a few milliseconds. During the opening operation, an arc is formed; it is quenched by gas flow within the interrupter unit.

In third-generation SF<sub>6</sub> circuit breakers that incorporate double motion technology, the required quenching pressure is generated in a pressure chamber by the energy of the arc itself as a function of current. The operating mechanism supplies only the energy for contact movement and an auxiliary piston.

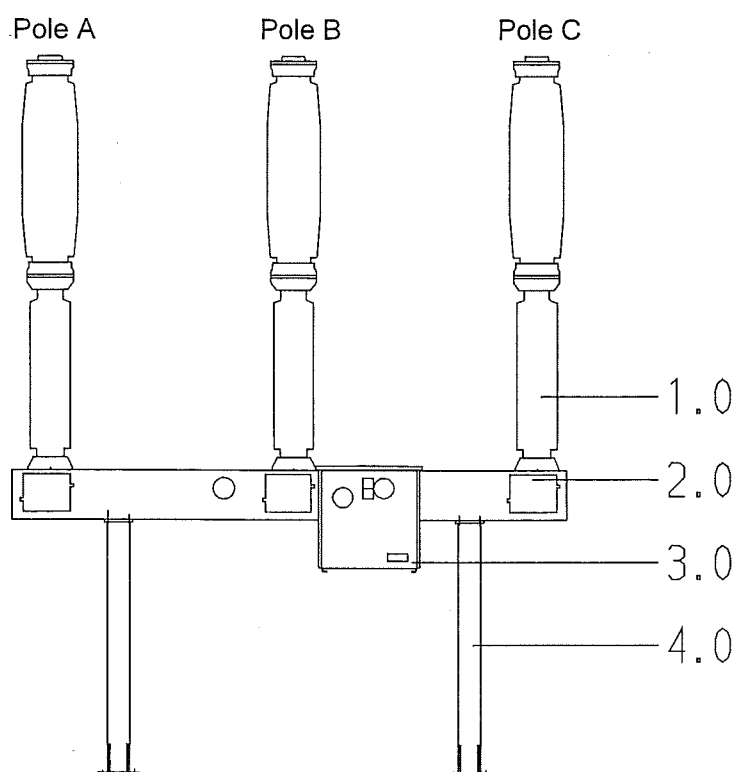


Figure A 2.3.1: Type GL 311 / 312 circuit breaker (front view)

		Qty.	Unit Wt.	Total Wt.
1.0	Pole columns	3	295 kg	885 kg
3.0	Spring operating mechanism	1	120 kg	120 kg
2.0	Base frame	1	165 kg	165 kg
4.0	Supports (optional)	2	85 kg	170 kg

### 2.3.2 Spring Operating Mechanism

The mechanism consists of a self-supporting steel structure protected against corrosion. The doors, floor, rear panel, removable side panels, and roof are made of aluminum sheet.

For storing the required operating energy, helical compression springs are charged by an electric motor via a gear unit (Figure A 2.3.2 a). Electrical actuation of the closing and opening coils causes latches to be unlatched, which releases the energy of the springs for operating purposes. The spring energy is transmitted by the lever on the rear of the drive, the drive rod, and the connecting rods to the pole columns.

#### Charging the Closing Energy Storage Mechanism

After control voltage has been applied, the motor (70.01) immediately starts up and charges the closing spring (70.25) via the gear unit (70.04), crank wheel (70.30), and chain (70.26). This operation is terminated once the crankpin (70.29) with linked chain (70.26) has gone beyond top dead center and supports the roller (70.28) of the crank wheel (70.30) on the closing latch (70.05).

At the conclusion of the charging process, the tooth space (70.27) of the crank wheel (70.30) has reached the driving pinion. This makes it possible for the gear unit (70.04) and the motor (70.01), which has been turned off by the control cam (70.22) and the motor limit switch (70.24), to run down and stop unimpeded and without loading the closing latch (70.05).

The repositioned motor limit switch (70.24) has closed the closing circuit, and the spring position indicator (70.31) has been switched to "closing spring charged."

#### Closing Operation

The closing latch (70.05) is released by the electrical command to the closing coil (70.06) or by operating the manual closing mechanism (70.07). The closing shaft (70.09) is accelerated by action of the closing spring (70.25) linked to the crank wheel (70.30).

The cam disc (70.10) turns the roller follower (70.11) bearing against it in the closing direction. The circuit breaker is closed by means of the main shaft (70.12), the drive lever (70.18), and a coupled linkage. At the completion of the closing motion, after rotating 60°, the main shaft (70.12), thanks to the specially designed cam disc (70.10), is lowered onto the opening latch (70.16) safely and with low impact by a lever arm of the roller follower (70.11). At the same time, the cam disc (70.10) has left the roller follower (70.11), and the circuit breaker is locked in the closed position and can now be opened.

In the course of the closing motion, the opening springs (70.20 and 1.8.06) are charged. The excess residual energy is stored again in the closing spring.

Control, indicating, and latching functions at the end of the closing motion:

- The auxiliary switch (70.21) coupled to the main shaft (70.12) has closed the opening coil circuit and interrupted the closing circuit. The circuit breaker can be opened electrically, but another closing operation or a pulse applied to the closing coil is prevented.
- A lever (not shown) that is controlled by the main shaft (70.12) has blocked the closing latch (70.05) and thus also prevents another closing operation mechanically.
- The position indicator (70.52) was turned by the main shaft (70.12) to the closed position.
- The motor limit switch (70.24) actuated by the control cam has closed the motor circuit.

- The closing coil circuit has been interrupted by a contact of the motor limit switch (70.24). This prevents another electrical closing operation.
- At the same time, the spring position indicator (70.31) has been set to "closing spring discharged."

### **Recharging the Closing Energy Storage Mechanism**

When the motor limit switch (70.24) is moved by the control cam (70.22) at the end of the closing motion, the motor circuit is closed, and the closing spring (70.25) is automatically re-charged.

### **Opening Operation**

The opening latch (70.16) is released by the electrical command to the opening coil (70.15) or by operating the manual opening mechanism (70.13). The action of the charged opening springs (70.20 and 1.8.06) accelerates the main shaft (70.12) and the circuit breaker connected to it in the open direction. Towards the end of the opening operation, the opening brake (70.17) becomes active and brakes the moving circuit breaker and mechanism parts until they come to a complete stop.

Control, indicating, and latching functions at the end of the opening motion:

- The auxiliary switch (70.21) coupled to the main shaft (70.12) has interrupted the opening coil circuit and closed the closing circuit. This prevents another electrical opening operation. An electrical closing operation is again possible.
- A lever (not shown) that is controlled by the main shaft (70.12) has again released the closing latch (70.05) for a subsequent closing operation. The circuit breaker can be closed mechanically.
- The position indicator (70.52) has been turned by the main shaft to the open position.

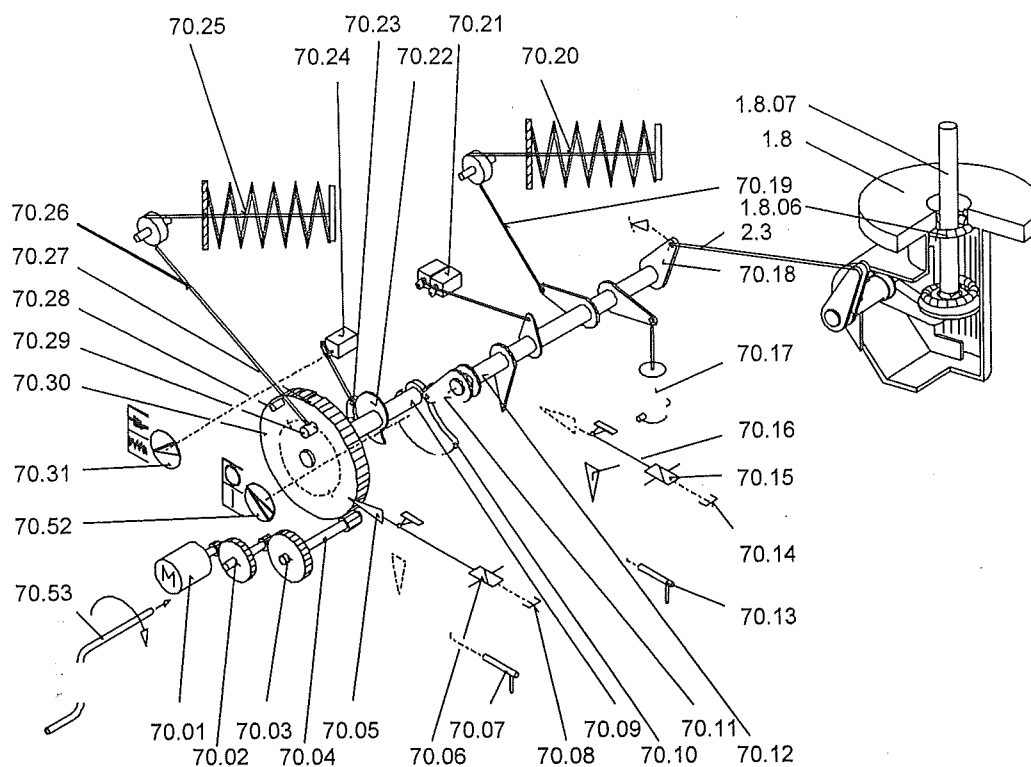


Diagram in open position, closing spring is discharged

Figure A 2.3.2 a: FK 3-... spring operating mechanism (schematic diagram)

1.8	crankcase	70.16	opening latch
1.8.06	opening spring	70.17	opening brake
1.8.07	insulating rod	70.18	drive lever
2.3	drive rod	70.19	chain
70.01	motor	70.20	opening spring
70.02	backstop	70.21	auxiliary switch
70.03	free-wheeling mechanism	70.22	control cam
70.04	gear unit	70.23	lever
70.05	closing latch	70.24	motor limit switch
70.06	closing coil	70.25	closing spring
70.07	manual closing lever	70.26	chain
70.08	close button	70.27	tooth space
70.09	closing shaft	70.28	roller
70.10	cam disc	70.29	crankpin
70.11	roller follower	70.30	crank wheel
70.12	main shaft	70.31	spring position indicator
70.13	manual opening lever	70.52	position indicator
70.14	open button	70.53	hand crank
70.15	opening coil		

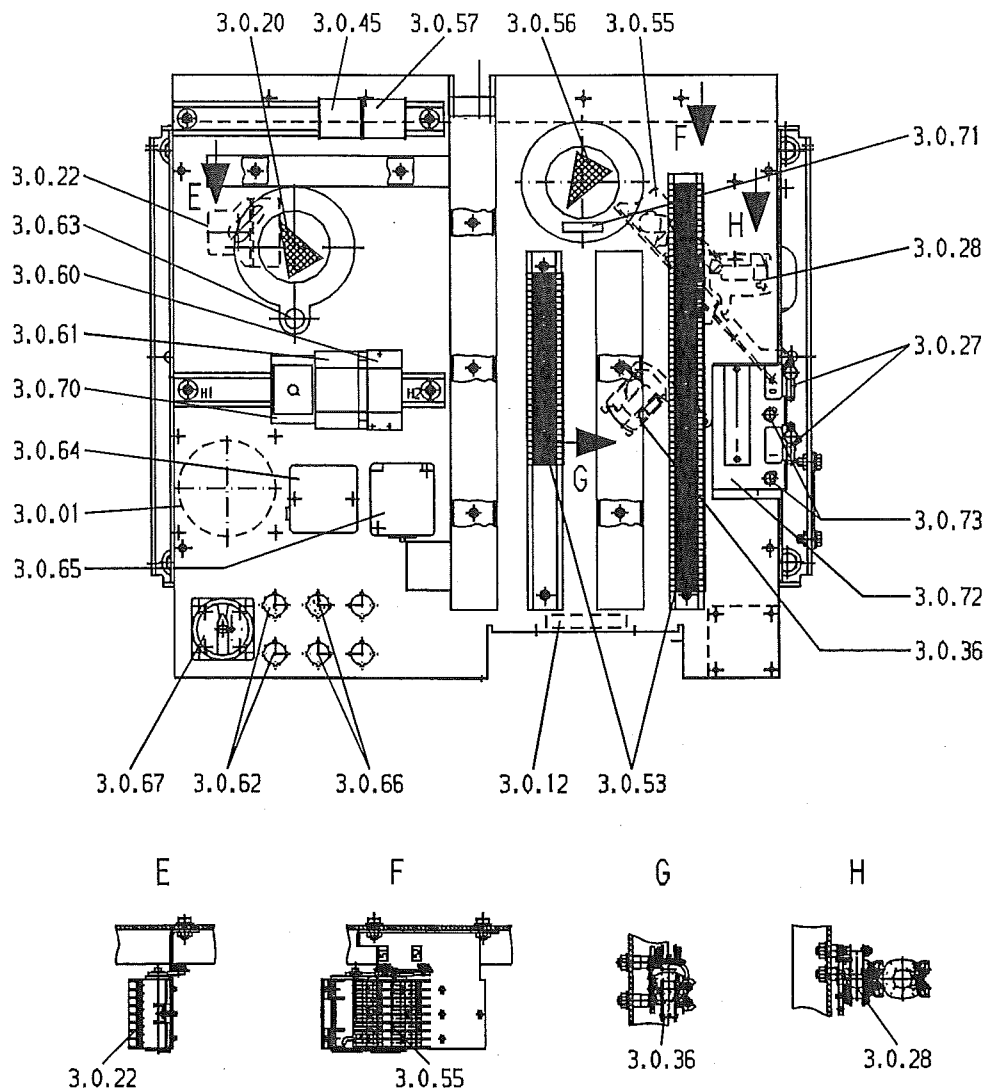


Figure A 2.3.2 b: FK 3-.. spring operating mechanism... (auxiliary equipment)

- |  |   |
|--|---|
| 3.0.01 motor                                 | 3.0.61 motor protection switch (optional)         |
| 3.0.12 anti-condensation heater              | 3.0.62 close and open buttons (optional)          |
| 3.0.20 position indicator for closing spring | 3.0.63 shaft for hand crank                       |
| 3.0.22 motor limit switch                    | 3.0.64 thermostat (optional)                      |
| 3.0.27 manual operation lever                | 3.0.65 socket (optional)                          |
| 3.0.28 shunt opening release                 | 3.0.66 close and open indicator lights (optional) |
| 3.0.36 shunt closing release                 | 3.0.67 remote-local switch (optional)             |
| 3.0.45 anti-pumping relay                    | 3.0.70 extended operation monitor (optional).     |
| 3.0.53 terminals                             | 3.0.71 operations counter                         |
| 3.0.55 auxiliary switch                      | 3.0.72 locking plate                              |
| 3.0.56 position indicator                    | 3.0.73 locking bolts                              |
| 3.0.57 contactor, SF <sub>6</sub> lockout    |   |
| 3.0.60 overload release                      |   |

## 2.4 Nameplate

The standardized nameplate per IEC is located on the outside of the unit on the door of the mechanism.


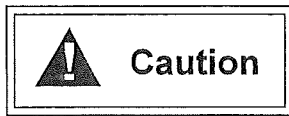
 AREVA			
Type		Rated line-charging breaking current	A
Serial No.		Rated SF <sub>6</sub> pressure for arc extinction p <sub>a</sub>	MPa
Rated voltage	kV	Rated supply voltage for closing and opening devices	V
Rated lightning impulse withstand voltage	kV	Rated supply voltage for auxiliary circuits	V
Rated switching impulse withstand voltage	kV	Rated supply voltage for motor	V
Rated frequency	Hz	Weight of SF <sub>6</sub> charge	kg
Rated normal current	A	Weight	kg
Rated duration of short circuit	S	Nominal operating sequence	
Rated short-circuit breaking current	kA	Year of manufacture	
First-pole-to-clear factor		Temperature class	°C
Rated out-of-phase breaking current	kA		
Made in Germany			

Figure A 2.4: Nameplate

### 3 Packaging and Storage

SF<sub>6</sub> gas cylinders, if ordered, are shipped in separate transport units.



Improper handling of the transport units can result in serious accidents.

⇒ Follow the directional markings on the packaging.

#### 3.1 Types of Packaging

##### 3.1.1 Surface Transport (Road or Rail)

Transport units:

- 1 wooden rack containing 3 pole columns (1.0) and the base frame (2.0)
- 1 pallet supporting the spring mechanism (3.0), mounting brackets and a crate containing accessories (8.0)
- 1 pallet with supports (optional, not shown)

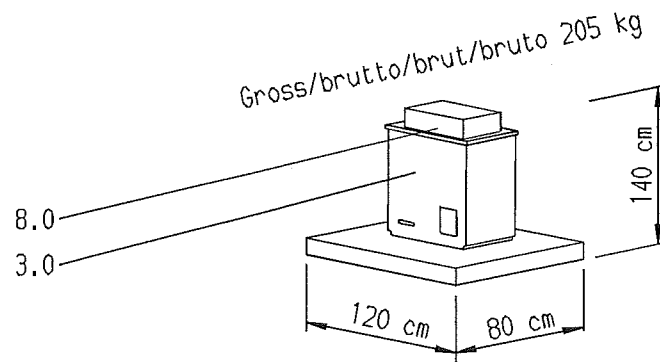
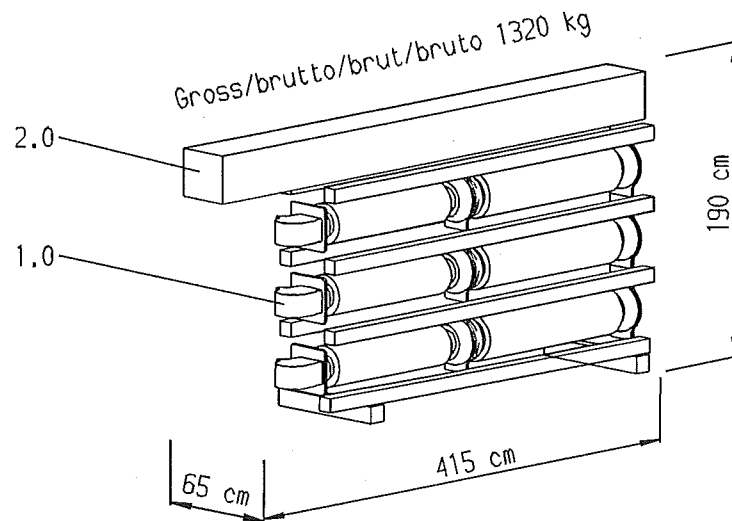


Figure A 3.1.1: Transport units for surface transport

### 3.1.2 Ocean Transport

Transport units:

- 1 crate containing 3 pole columns (1.0), the base frame (2.0), the spring mechanism (3.0) and mounting brackets, and a crate containing accessories (8.0)
- 1 pallet with supports (optional, not shown)

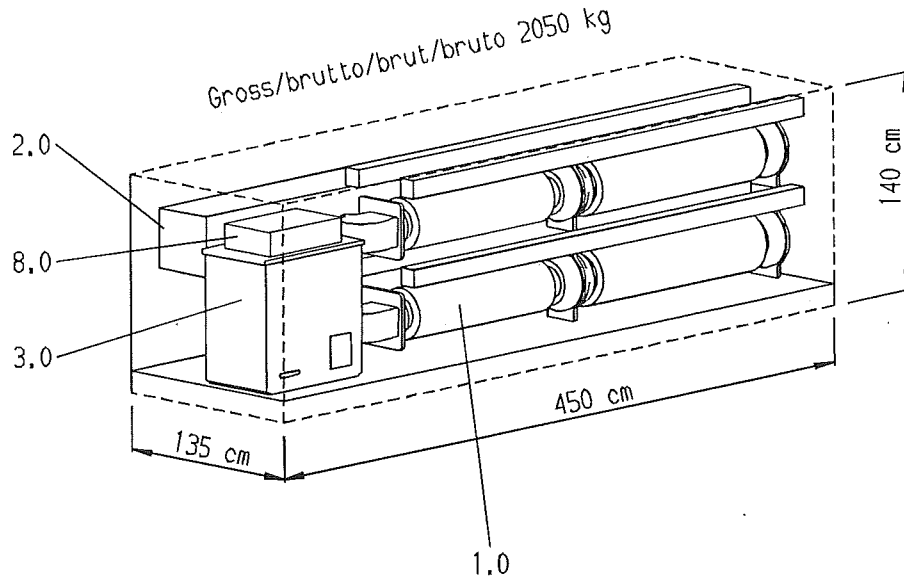


Figure A 3.1.2: Transport unit for ocean transport

### 3.2 Storage

The transport packaging is only designed for a limited storage period. The following points regarding storage must therefore be observed:

- a) The maximum storage period for equipment in transport packaging when stored outdoors is 4 months from the shipping date.
- b) The maximum storage period for equipment in transport packaging in a dry room is 6 months from the shipping date.
- c) Unpacked circuit breakers may be stored indefinitely in dry rooms.
- d) Unpacked circuit breakers may be stored indefinitely outdoors or under a protective roof if the mechanism is in an upright position and the anti-condensation heater is connected to prevent condensation and corrosion.

#### Important

The mechanism is protected by aluminum foil to prevent moisture from getting in.

⇒ If the foil has been damaged, the contents must be unpacked and stored in accordance with the instructions under c) or d).

## **4 Preparations for Assembly and Erection**

### **4.1 Documentation**

The following documents must be available at the erection site in order to carry out erection and commissioning.

- Shipping documents
- Operating instructions including "Check List for Erection and Commissioning"
- Dimension drawing
- Schematic diagram
- Routine test certificate

### **4.2 Check List**

If used properly, the enclosed "Check List for Erection and Commissioning" will ensure that all the important procedures that guarantee breaker operating safety and reliability will be carried out and documented.

It is included in this manual as a colored sheet and can be found at the end of this chapter.

When using the check list, follow the instructions below:

- Fill in all the general information such as customer, station, type, and year of manufacture.
- A check list is valid for only one circuit breaker.
- Enter the breaker serial number on each sheet.
- Perform all procedures listed on the check list.
- Always comply with the specified values (measured quantities and test statistics).
- Record all measured values.
- After work is completed, the check list must be dated, stamped with the company name, and signed by the individual responsible for commissioning.
- A copy of the check list must be sent to AREVA Energietechnik GmbH, High Voltage Products, Lilienthalstr. 150, 34123 Kassel, Dept. TDS-DHK/CS.

<b>Important</b>
------------------

If this check list is not on file when warranty claims are made, the extent of the warranty claim may be reduced.

## Check List for Erection and Commissioning

<b>Breaker Data:</b>			
Type:		Serial No.:	
Customer:			
Station:			
<b>Erection</b>			
<b>No.:</b>	<b>Operation to be Performed</b>	<b>Section:</b>	<b>✓</b>
1	Safety instructions have been carefully read and understood	1	
2	Materials provided by station checked for completeness	4.3	
3	Shipment checked for completeness and lack of damage	4.5.1	
4	Serial numbers on pole columns, base frame, mechanism, and drive rod have been checked and are in agreement	4.5.1	
5	SF <sub>6</sub> shipping pressure in each pole column checked	4.5.2	
6	Based frame connected to the supports, nuts (8 x M20 x 60 8 TZN) tightened (400 Nm)	5.2	
7	Base frame and supports adjusted to anchor bolts, nuts on anchor bolts tightened (250 Nm)	5.2	
8	Mechanism fastened to brackets on base frame, bolts (4x M16 x 90, A2-70) tightened (202 Nm), and bolts (4x M 12 x 25, A2-70) tightened (83 Nm)	5.3	
9	Drive rod connected to mechanism lever, bolt(s) lubricated, secured, and tightened (10 Nm)	5.4.2	
10	Lever of pole column B checked for factory labeling, mounted, secured, and tightened (49 Nm)	5.4.3	
11	Drive and connecting rods connected to lever of pole column B, bolts lubricated, secured, and tightened (10 Nm)	5.4.3	
12	Bolted joint connecting pole B to base frame tightened (202 Nm)	5.4.3	
13	Lever of pole column A mounted in accordance with factory labeling, secured, and tightened (49 Nm)	5.5.1	
14	Connecting rod connected to lever of pole A, bolt lubricated, secured, and tightened (10 Nm)	5.5.1	
15	Bolted joint connecting pole A to base frame tightened (202 Nm)	5.5.1	
16	Lever of pole column C mounted in accordance with factory labeling, secured, and tightened (49 Nm)	5.5.1	
17	Connecting rod connected to lever of pole C, bolt lubricated, secured, and tightened (10 Nm)	5.5.1	
18	Bolted joint connecting pole C to base frame tightened (202 Nm)	5.5.1	
19	Transport lock on mechanism removed	5.3	
20	High voltage terminal pads brushed, cleaned, lubricated, mounted, and tightened (202 Nm)	5.6	
21	Base frame and supports grounded	5.7	

Commissioning		Serial No.:	
No.:	Operation to be Performed	Section:	✓ or Value
1	SF <sub>6</sub> density monitor electrically connected	6.1.1	
2	Density monitor contacts checked	6.1.2	
3	Resistance of anti-condensation heater checked [in ohms]	6.1.3	
4	Supply voltages connected as per schematic diagram	6.1.4	
5	SF <sub>6</sub> piping connected to the pole columns (2 wrenches / 30 Nm)	6.2.1	
6	Pole columns inspected visually	6.2.2	
7	SF <sub>6</sub> gas topped up to nominal pressure per nameplate	6.2.2	
8	SF <sub>6</sub> piping seals checked using SF <sub>6</sub> leak detector	6.2.2	
9	Five (5) closing and 5 opening operations carried out by remote control	6.3.1	
10	Motor charging time [sec.] of closing spring checked	6.3.2	
11	Closing time [ms] checked	6.3.3	A B C
12	Opening time [ms] checked	6.3.3	A B C
13	Manual closing & opening operations checked	6.3.4	
14	Anti-pumping system checked	6.3.5	
15	Functional lockout (density monitor) checked	6.3.6	
16	Testing and measuring equipment removed	6.4	

Please return one completed and signed copy of the check list to:

AREVA Energietechnik GmbH, High Voltage Products, Dept. TDS-DHK/CS  
Lilienthalstr. 150, 34123 Kassel, Germany, **Fax: +49(0)561-502-2774**

City	Date	Stamp	Signature
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### 4.3 Materials and Equipment to be Provided by Station

#### 4.3.1 Materials

- Foundation, anchor bolts, nuts, and washers
- Grounding connections and fasteners

If not included with order:

- Supports in accordance with AREVA Energietechnik GmbH drawing
- High voltage terminal pads and fasteners

#### 4.3.2 Tools and Hoisting Equipment

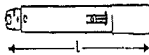
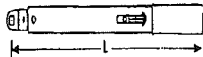
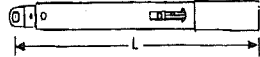



- Crane of sufficient height and load-carrying capacity
- Rope loops and lifting tackle (shackles, eyebolts, etc.) of appropriate load-bearing capacity for weight specifications given above
- Gas-filling device with pressure-reducing valve and Dilo supply connection (DN8)
- Stainless steel wire brush

#### Important

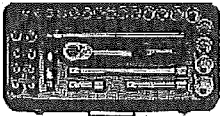





For standard insulation height (2300 mm above upper ground edge), the required crane height is 6 m.

⇒ For different insulation heights, please refer to the dimension drawing.

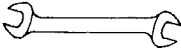
#### Torque wrenches and accessories

Tool-No.	Description	Illustration	Order-No.
T001	Torque wrench 8...40 Nm; Seat 9x12 mm; length ≤ 390 mm		2008994
T002	Torque wrench 40...200 Nm; Seat 14x18 mm		2008995
T003	Torque wrench 80...400 Nm; Seat 14x18 mm		2008996
T004	Ratchet handle; Reversible for torque wrenches ½"; seat 9x12 mm		2008997
T005	Ratchet handle; Reversible for torque wrenches ½"; seat 14x18 mm		2008998
T006	Seat-Adapter; Use of 14x18mm plug-ins with torque wrench seats 9x12 mm		2009000

## Plug-in-Tools for Torque Wrenches

Tool-No.	Description	Illustration	Order-No.
T007	Socket wrenches; Seat ½"; set of: – Ratched spanner – Extensions – Plug-in-Tool  10...34 mm for hexagon head cap screw 4...14 mm for hexagon socket head cap screws		2008999
T008	Open-ring-wrench 19 mm; Plug-in-tool for torque wrenches; seat 9x12 mm		2009001
T009	Open-ring-wrench 24 mm; Plug-in-tool for torque wrenches; seat 9x12 mm		2009002
T010	Open-end-wrench 27 mm; Plug-in-tool for torque wrenches; seat 14x18 mm		2009003
T011	Open-end-wrench 36 mm; Plug-in-tool for torque wrenches; seat 14x18 mm		2009004
T012	Ring-wrench 36 mm; Plug-in-tool for torque wrenches; seat 14x18 mm		2009005

## Double open ended wrenches

Tool-No.		Order-No.
T013	10x11 mm	1053523
T014	12x13 mm	1053560
T015	16x17 mm	1053602
T016	18x19 mm	1053638
T017	22x24 mm	1053687
T018	27x30 mm	1053729
T019	32x36 mm	1053742
T020	36x41 mm	1053766

#### **4.3.3 Testing and Measuring Equipment**

- Multimeter
- SF<sub>6</sub> leak detector
- Timer for operating times and motor charging time

#### **4.3.4 Indirect Materials and Supplies**

- Molykote BR2 plus grease                      for lubricating screws and bolts
- SF 1377 silicone grease                      for lubricating bolted contact surfaces and,  
where necessary, gaskets and sealing surfaces
- Type 243 Loctite (blue)                      for locking bolts and screws

If not included with order:

- SF<sub>6</sub> gas, grade in compliance with IEC 376 (for minimum quantity see Section 2.1)

#### 4.4 Unpacking the Transport Units

- After the transport units have been received, check them against the accompanying documents for completeness and also for possible shipping damage.
- If any shipping damage is detected, notify the freight forwarder and the nearest AREVA representative immediately.

##### 4.4.1 Base Frame and Pole Columns



Improper handling can result in serious damage or injury caused by falling loads.

- ⇒ Use a crane and rope of sufficient load-bearing capacity.
  - ⇒ Secure the rope only on the terminal faces, never on the terminal pads.
  - ⇒ Set the pole columns down only on flat surfaces.
- Lift off the base frame using two rope loops and two shackles and set it down on square timbers.
  - Lift off the pole columns one by one using two rope loops (Figure A 4.4.1) and set each of them down on two square timbers. Secure the pole columns so that they will not roll off.

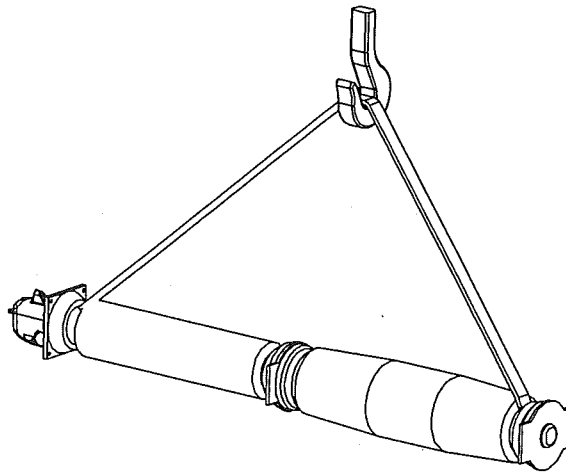


Figure A 4.4.1: Hoisting the pole column horizontally

##### 4.4.2 Mechanism, Brackets, and Accessories

- Carefully unpack the mechanism and accessories.
- Remove the foil from the mechanism.

##### 4.4.3 Drive and Connecting Rods

The two connecting rods and the drive rod are secured inside the base frame. The drive rod is taped to the connecting rods.

- Cut the tape and remove the rods from the base frame.

## 4.5 Checking the Shipment

### 4.5.1 Completeness and Lack of Damage

#### Important

Check all labeled components to make sure they show the circuit breaker serial number.

The serial number can be found at the following locations:

- stamped on each pole column on the lower flange of the support porcelain
- on a label on the base frame in the area of pole B
- on a label in the mechanism door
- on a label on the drive rod
- stamped on each lever of the pole columns

To save space, some of the components are only identified by the last three digits of the serial number.

Before beginning assembly and erection, check the shipment for completeness and possible damage as follows:

- Inspect components visually for damage, particularly the pole column porcelains.
- Compare the labeling on the individual components with the serial number on the shipping documents.

### 4.5.2 SF<sub>6</sub> Shipping Pressure

In order to detect shipping damage on a pole column before erection, check the SF<sub>6</sub> shipping pressure (approx. 0.02 to 0.05 MPa) as follows:

- Unscrew the cap (1.8.39) from the SF<sub>6</sub> coupling (1.8.31) and briefly press the poppet valve (1.8.38). You must be able to hear the SF<sub>6</sub> gas escaping.
- If this is not the case, then fill the pole column to 0.1 MPa and check it for leaks using a SF<sub>6</sub> leak detector.

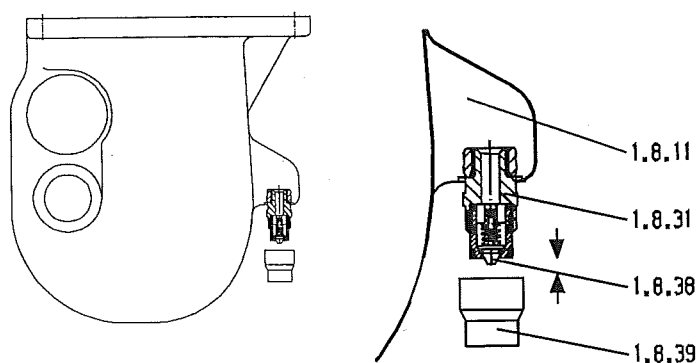


Figure A 4.5.2: SF<sub>6</sub> coupling on the pole columns

- 1.8.11 crankcase
- 1.8.31 SF<sub>6</sub> coupling
- 1.8.38 poppet valve
- 1.8.39 cap

## 5 Erection

### 5.1 General Instructions

- All settings and adjustments have already been made at the factory. The drive rod of the mechanism has been adjusted and locked with a locking compound.
- Pole columns and mechanism are shipped in the open position. Both springs of the mechanism are discharged.
- In the spring operating mechanism, the opening latch assembly has been secured for shipping by a cable tie.

Note: The main shaft of the mechanism is fixed in the open position by the opening spring located in the mechanism.

- The breaker poles have been evacuated at the factory and filled with SF<sub>6</sub> for transport purposes (gauge pressure 0.05 MPa = 0.5 bar).
- Whenever the instructions call for "bolt and locking adhesive," always use the liquid locking adhesive Loctite (blue).
- In the following sections, the side of the circuit breaker where the mechanism is located will be referred to as the "front."
- Parts set off in the text by square brackets (e.g. [bolt M20 x 60 8.8 TZN]) are included in the crate containing accessories.
- Time required for erection: approximately 5 man-hours



Fasteners (bolts, nuts, coupling pins, etc.) that do not have the required strength may fail during erection, commissioning, or operation and cause serious damage or injury.

- ⇒ Use only the fasteners supplied with the circuit breaker.
- ⇒ Always use the proper grade and type of fastener (check the text and strength specifications).
- ⇒ Always tighten fasteners to the specified torques (lubricate bolt threads per specifications).



Improper handling can result in serious damage or injury caused by falling loads.

- ⇒ Standing under suspended loads is prohibited.
- ⇒ Assigned personnel must wear protective headgear (hard hats).

## 5.2 Supports and Base Frame

### Important

⇒ The useful thread length of the anchor bolts must be in compliance with the length shown in Figure A 5.2 a.

- Screw two nuts (4.3) on each anchor bolt (Figure A 5.2 a) and align them with one another horizontally.
- Place supports (4.0) on anchor bolts, and screw on nuts (4.3) with washers (4.4). Leave a gap of a few millimeters for later adjustment.

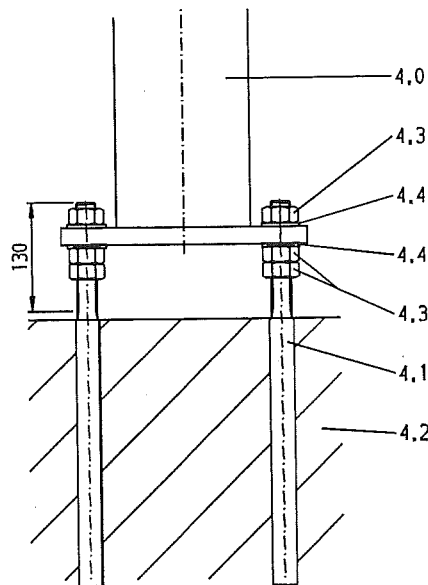


Figure A 5.2 a: Mounting the supports on the anchor bolts

- 4.0 supports
- 4.1 anchor bolt M24 (steel,  $R_{p0.2} > 220 \text{ N/mm}^2$ )
- 4.2 foundation
- 4.3 nut (M24 8 TZN)
- 4.4 washer

- Place the base frame on the supports and fasten it with bolts [602], nuts [603], and plain washers [604]. Tighten bolted joints to a torque of 400 Nm (Figure A 5.2 b).
- Then, using a level, align the base frame (2.0) in a longitudinal and transverse direction by adjusting the nuts (4.3) on the anchor bolts (4.1) so that the frame is level. Tighten the nuts to a torque of 250 Nm and lock them.

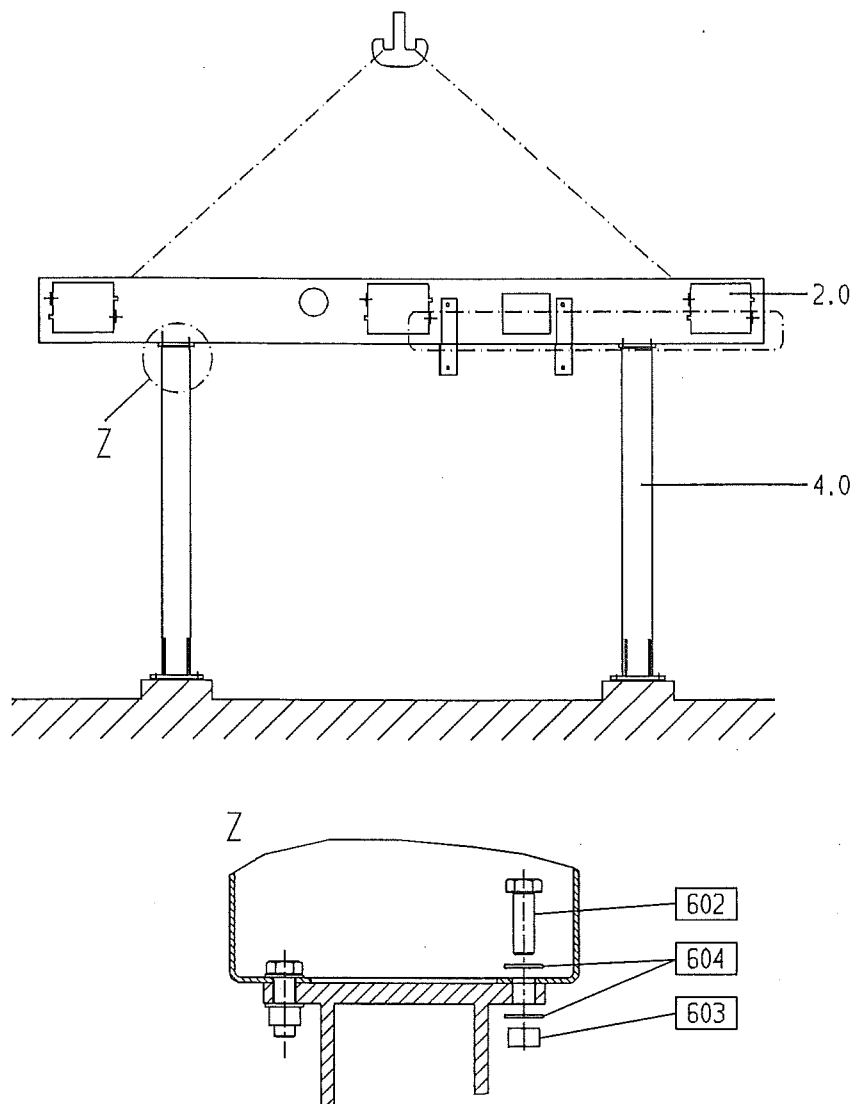


Figure A 5.2 b: Mounting the base frame on the supports

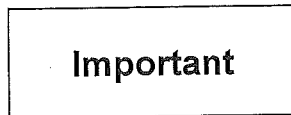
2.0	base frame	
4.0	supports	
[602]	bolt (M20 x 60 8.8 TZN)	8 each
[603]	nut (M20 A2-70)	8 each
[604]	washer ( $\varnothing$ 21 A2)	16 each

### 5.3 Spring Operating Mechanism



Off-load operations may result in damage to the mechanism and personal injury due to excess energy.

⇒ Never charge or operate the mechanism unless it is mechanically connected to the pole columns.



The type of the mechanism can be taken from the nameplate.

#### Type FK 3-1 Mechanism

For this mechanism type, the two upper mounting points are located directly on the base frame, and the two lower mounting points are in the mechanism brackets (2.100):

- Attach the mechanism brackets securely to the base frame using bolts, nuts, and washers (Figure A 5.3 c).
- Align the upper holes in the brackets with the hole configuration in the base frame (using an M16 bolt, for example).

#### Type FK 3-2 Mechanism

For this mechanism type, all four mounting points are located directly on the base frame. Mechanism brackets (2.100) are not required.

#### Mounting the Operating Mechanism

- Place the mechanism (3.0) on suitable supports in front of the base frame.
- Remove the side covers of the mechanism (Figure A 5.3 a):  
Remove the two M5 bolts on each side, pull the bottom of the side covers out and then down, and take off the side covers.
- Remove the mechanism roof:  
First loosen the four M5 bolts, and then lift off the roof.
- Remove the guard in front of the springs:  
First loosen the two M6 bolts, and then take off the guard.



Do not remove the guard in front of the springs until you have made sure that both mechanism springs are discharged.

⇒ First check the indicators:  
Spring                      "Spring discharged"  
Mechanism                "Open"

- Lift up the mechanism in front of the base frame using two rope loops attached to the lifting lugs (Figure A 5.3 c).
- Slowly insert the drive lever on the rear of the mechanism into the opening in the base frame.
- Fasten the mechanism to the base frame with M16 x 90 A2-70 bolts [615], M16 A2-70 nuts [607], and washers [608] (Figure A 5.3 c).
- Tighten first the upper bolted joint on the mechanism and then the lower one to a torque of 202 Nm.

- Tighten the bolted joint on the brackets to a torque of 83 Nm (only for mechanism type FK 3-1).
- Remove the transport lock (cable tie) from the opening latch mechanism (Figure A 5.3 b).
- Replace the guard in front of the springs, the mechanism roof, and the side cover.

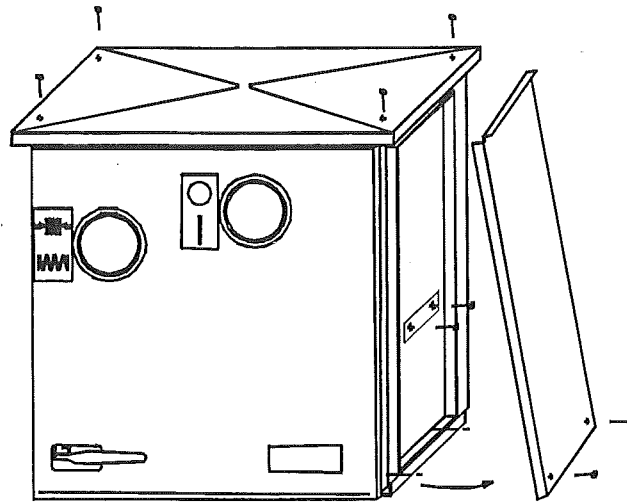


Figure A 5.3 a: Removing the covers from the mechanism

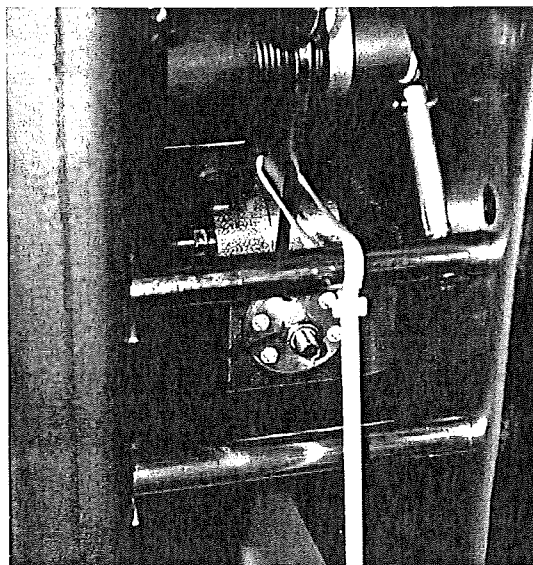


Figure A 5.3 b: Transport lock on opening latch mechanism

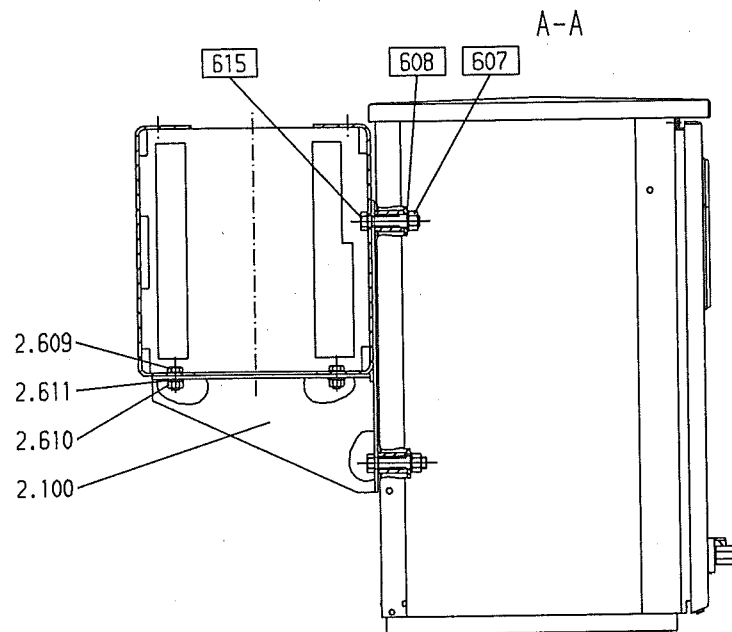
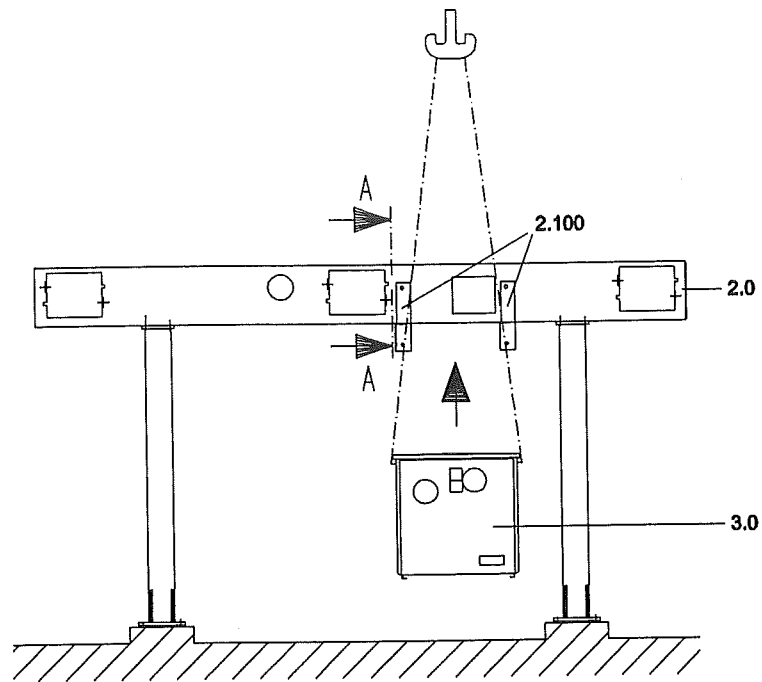


Figure A 5.3 c: Mounting the spring operating mechanism on the base frame  
(example of mechanism type FK 3-1)

2.0	base frame	
2.100	mechanism bracket	2 each (only for mechanism type FK 3-1)
[2.609]	bolt (M12 x 25 A2-70)	4 each
[2.610]	nut (M12 A2-70)	4 each
[2.611]	washer (Ø 13 A2)	4 each
3.0	FK 3-.. spring operating mechanism	
[607]	nut (M16 A2-70)	4 each
[608]	washer (Ø 17 A2)	4 each
[615]	bolt (M16 x 90 A2-70)	4 each

## 5.4 Pole Column B

- Remove the three covers (2.600) on the base frame by loosening two M8 x 20 bolts each (2.800) (Figure A 5.4.1 b).

### 5.4.1 Mounting the Pole Column

- Fasten two rope loops and appropriate lifting tackle (shackles and eyebolts) to the upper terminal faces of the pole column (Figure A 5.4.1 a).
- Slowly lift up the pole column and roll it down over the radius of the crankcase. Make sure that the pole column does not twist.
- Lift the pole column to the proper position above the base frame.
- Turn the pole column axis clockwise approximately 30° (Figure A 5.4.1 b).
- Carefully lower the pole column until the spline shaft of the crankcase is completely inside the base frame.
- Turn the pole column back to the mounting position and lower it until there is only a gap of about 2 mm between the flange and the base frame.
- Insert the bolts [606] (M16 x 50 A2-70) and washers from below, and fasten the pole column by tightening the bolts until they are finger-tight.

#### Important

Leave the pole column suspended in the rope loops until final alignment. Do not yet tighten the bolts to the specified torque.



#### Caution

- ⇒ When lowering the pole column, watch out for the SF<sub>6</sub> piping in order to prevent damage.
- ⇒ Make sure the pole column is always in the proper position so as to avoid damaging the SF<sub>6</sub> connection or the spline shaft.

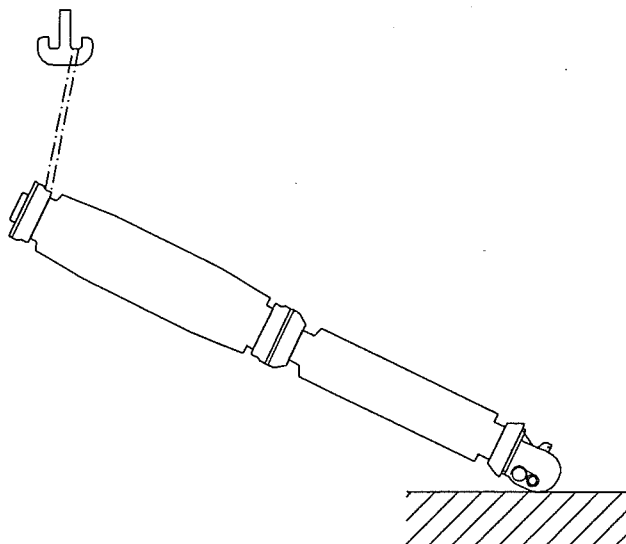


Figure A 5.4.1 a: Hoisting a pole column to upright position

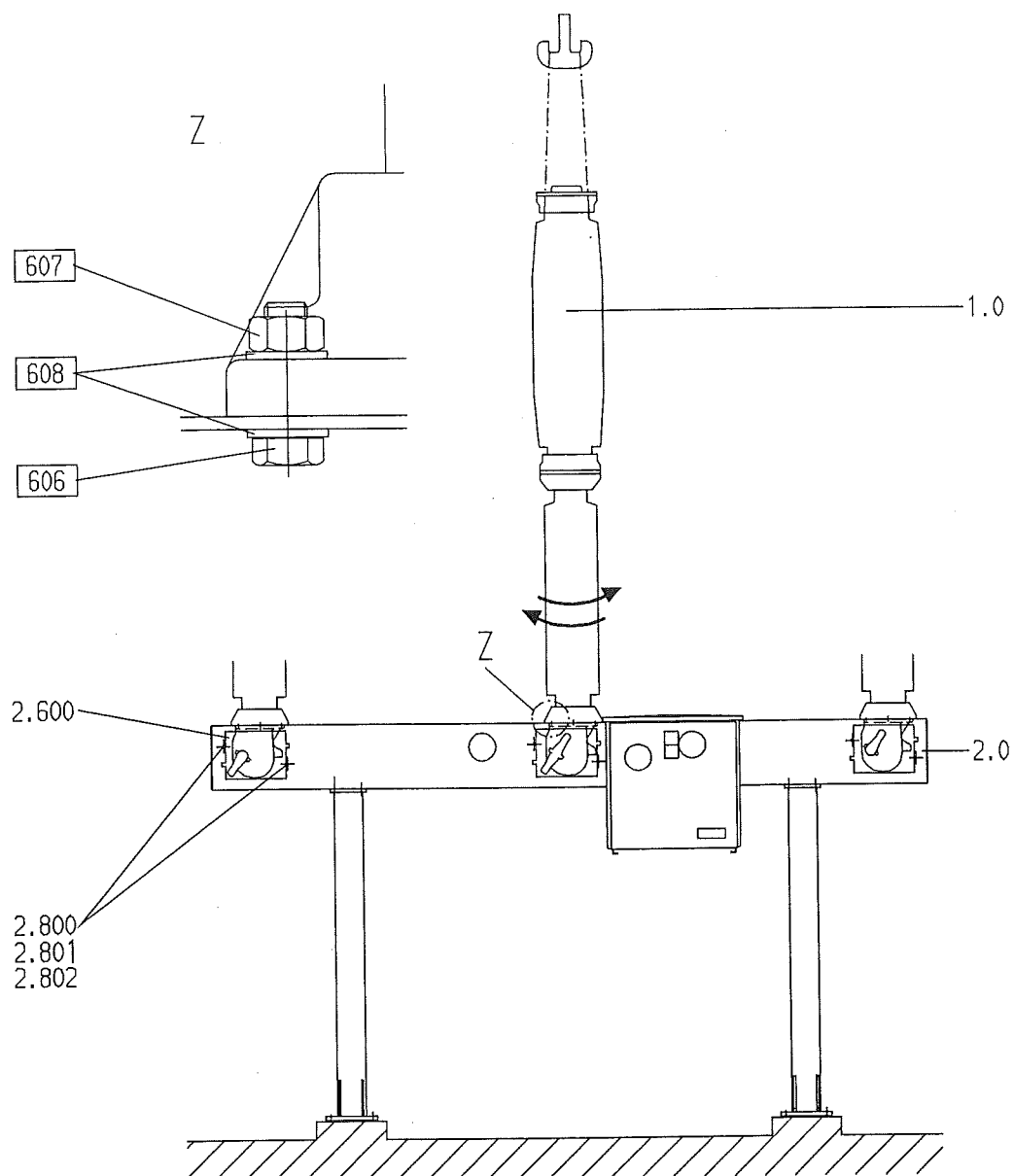


Figure A 5.4.1 b: Mounting a pole column on the base frame

1.0	pole column	
2.0	base frame	
2.600	cover	3 each
2.800	bolt (M8 x 20 A2-70)	6 each
2.801	nut (M8 A2)	6 each
2.802	washer (Ø 8.4 A2)	6 each
[606]	bolt (M16 x 50 A2-70)	12 each
[607]	nut (M16 A2-70)	12 each
[608]	washer (Ø 17 A2)	24 each

#### 5.4.2 Connecting the Drive Rod to the Mechanism

- Lubricate the coupling pin (16x68) [106] with Molykote BR2 plus (Figure A 5.4.3).
- Insert the drive rod (2.3) into the mechanism lever (3.2) and insert the coupling pin [106].
- Fasten the coupling pin [106] using a bolt [612] coated with locking adhesive, sleeve [107], and washer [613], and tighten to a torque of 10 Nm.

#### 5.4.3 Connecting the Drive Rod and Connecting Rods to Pole Column B

##### Important

Lever can only be assembled into four positions.

⇒ Realize the position of lever according to the figure.

- Insert the connecting rods (2.01) into the base frame.  
Insert the connecting rod for pole column A through the opening on the left and the connecting rod for pole column C through the opening on the right.
- Mount the lever [102] for pole column B and fasten it using a bolt [614] coated with locking adhesive and a washer [108]. Tighten the bolt [614] to a torque of 49 Nm (Figure A 5.4.3).  
Make absolutely sure that the lever is correctly matched with the right pole column (see stamped marking) and is in the specified position.
- Lubricate the coupling pin (16x68) [106] with Molykote BR2 plus.
- Insert the drive rod (2.3) and connecting rod (2.01) for pole column A into the lower end of the lever [102] of pole column B.  
Depending on the re-assembly tolerances, it is possible that the holes in the lever and the drive and connecting rods will not be aligned. If this is the case, move pole column B until the coupling pin can be easily inserted.
- Connect the drive and connecting rods to the lever by inserting the coupling pin [106].
- Fasten the coupling pin [106] using a bolt [612] coated with locking adhesive, sleeve [107], and washer [613]. Tighten the bolt [612] to a torque of 10 Nm.
- Lower pole column B to the base frame.
- Tighten the four bolted joints between pole column B and the base frame to a torque of 202 Nm; each joint consists of components [606], [607], and [608].
- Insert the connecting rod (2.01) for pole column C into the upper end of the lever [102] of pole column B.
- Fasten the coupling pin [106] using a bolt [612] coated with locking adhesive, sleeve [107], and washer [613]. Tighten the bolt [612] to a torque of 10 Nm.

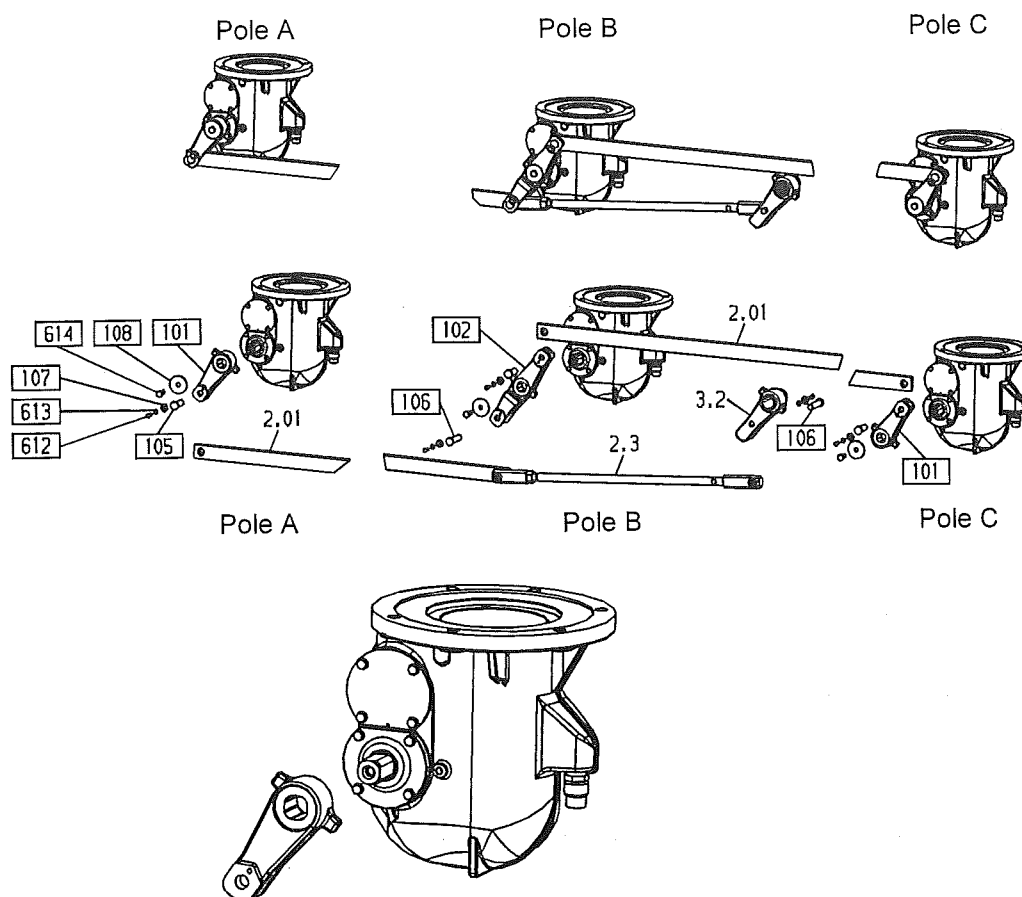


Figure A 5.4.3: Mounting the drive rod and the connecting rods

2.01	connecting rod	2 each	
2.3	drive rod	1 each	
3.2	drive lever	1 each	(factory installed)
[101]	levers A and C	2 each	
[102]	lever B	1 each	
[105]	coupling pin (16x47)	3 each	
[106]	coupling pin (16x68)	2 each	
[107]	sleeve	5 each	
[108]	washer	3 each	
[612]	bolt (M16 x 16 A2-70)	5 each	
[613]	washer (Ø 6.4 A2)	5 each	
[614]	bolt (M10 x 25 A2-70)	3 each	

## 5.5 Mounting Pole Columns A and C

- Position pole A on the base frame as described in Section 5.4.1 (Mounting Pole Column B) and connect it as described in the next section (5.5.1).
- Position pole C on the base frame as described in Section 5.4.1 (Mounting Pole Column B) and connect it as described in the next section (5.5.1).

### 5.5.1 Connecting the Connecting Rods to Pole Columns A and C

#### Important

Lever can only be assembled into four positions.

⇒ Realize the position of lever according to the figure.

- Mount the pole column lever [102] and fasten it using a bolt [614] coated with locking adhesive and a washer [108]. Tighten the bolt [614] to a torque of 49 Nm. Make sure that the lever's factory labeling matches the pole column (see stamped marking) and that the lever is in the specified position.
- Lubricate the coupling pin (16x47) [105] with Molykote BR2 plus.
- Insert the connecting rod in the lever [102] and fasten it with the coupling pin [105]. Depending on the re-assembly tolerances, it is possible that the holes in the lever and the connecting rod will not be aligned. If this is the case, move the pole column until the coupling pin can be easily inserted.
- Fasten the coupling pin [105] using a bolt [612] coated with locking adhesive, sleeves [107], and washers [613]. Tighten the bolt to a torque of 10 Nm.
- Lower the pole column to the base frame.
- Tighten the fastening bolts [606] of the pole column to a torque of 202 Nm.

## 5.6 High-Voltage Terminal Pads

- Before bolting the terminal pad (a) and terminal face (b) together, brush them with a stainless steel wire brush until they are bright.
  - Then wipe them with a clean rag and immediately apply a light coat of SF 1377 silicone grease or acid-free Vaseline.
- If copper terminals are to be used, tin-coated copper is preferable. Copper-plated aluminum shims are then not necessary.

- Fasten the high voltage terminal pads with the accompanying bolts (M16 x 65 A2-70) and tighten them to a torque of 202 Nm.

Place a washer under the bolt and another under the nut.

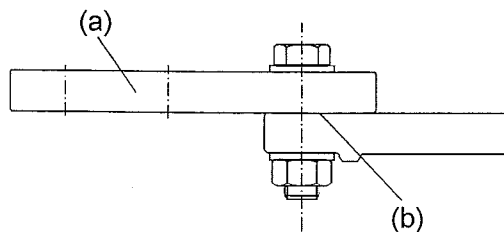


Figure A 5.6: Mounting the high voltage terminal pads

## 5.7 Grounding the Circuit Breaker

- Ground the base frame and supports.

## 6 Commissioning the Circuit Breaker



Follow the safety instructions given in Section 1.

⇒ Make sure that the assembled circuit breaker is isolated from the high voltage system and is properly grounded.

### 6.1 Electrical Connections

#### 6.1.1 Density Monitor

- Insert the density monitor cables into the mechanism through the cable glands on the back side and connect them in accordance with the schematic diagram.

#### 6.1.2 Checking the SF<sub>6</sub> Density Monitor Contacts

For functional testing of the contacts or operating points, only the SF<sub>6</sub> piping is filled with gas. Since the ends of the SF<sub>6</sub> piping system are equipped with check valves, uncontrolled leaks of SF<sub>6</sub> are prevented. A leak is simulated by pressing a poppet valve on the piping.

- Fill the SF<sub>6</sub> piping to nominal density (black dot in the green field of the density monitor dial).
- Checking the UW 1 contact:
  - Lower the SF<sub>6</sub> pressure until the "UW1 (SF<sub>6</sub> alarm)" value is reached.
  - Check operating point UW1 at contacts 1 and 2 using a multimeter.
- Checking the UW 2 contacts:
  - Lower the SF<sub>6</sub> pressure further until the "UW2 (SF<sub>6</sub> lockout)" value is reached.
  - Check operating point UW2 at contacts 3 and 4 using a multimeter.

#### Important

The SF<sub>6</sub> density monitor is temperature-compensated, i.e., the ambient temperature does not affect either the indication or the alarm contacts.

#### 6.1.3 Checking the Anti-Condensation Heater

- Measure the resistance of the anti-condensation heater at the terminals in the mechanism.
- Check the measured value against the reference value on the routine test certificate and enter it in the checklist.

#### 6.1.4 Supply Voltages



⇒ Before installing the supply and control cables, make sure the circuit breaker is not energized.



As soon as the supply voltage has been applied and the motor protection switch is turned on, the motor will charge the closing spring.

⇒ Before applying voltage or turning on the motor protection switch, make sure there are no objects or parts of the body in the charging system area.

When supply voltage has been applied, the anti-condensation heater will be hot. It can burn skin or clothing.

⇒ Do not touch the heater.

- Insert all supply and control cables through cable glands and connect them to the terminals in accordance with the schematic diagram.

## 6.2 SF<sub>6</sub> System

### 6.2.1 Connecting the SF<sub>6</sub> Piping

- Remove the protective caps from the SF<sub>6</sub> piping couplings and the SF<sub>6</sub> connections on the pole columns (2.218, 1.8.31).
- Connect the SF<sub>6</sub> piping to all three pole columns and tighten to a torque of 30 Nm (Figure A 6.2.1).  
Use two wrenches for tightening.
- Check the SF<sub>6</sub> piping joints for tightness, and if necessary retighten to a torque of 30 Nm (Figure A 6.2.1).  
Use two wrenches for tightening.

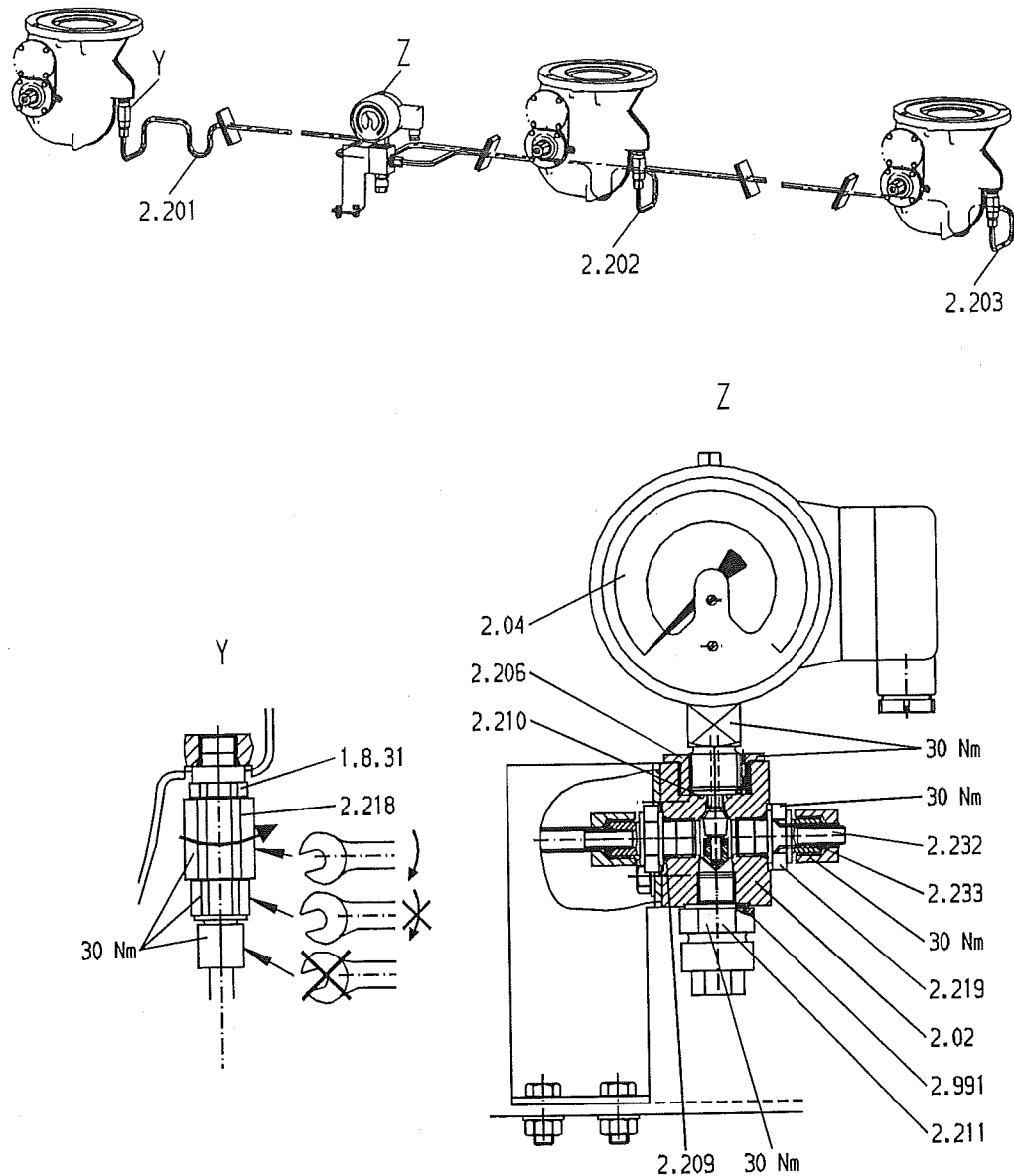


Figure A 6.2.1: Assembling the SF<sub>6</sub> piping

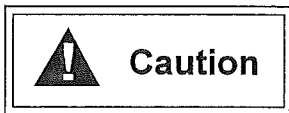
- |  |  |
|--|--|
| 1.8.31 SF <sub>6</sub> connection      | 2.210 O-ring (10.82 x 1.78)                        |
| 2.02 SF <sub>6</sub> distribution unit | 2.211 SF <sub>6</sub> supply connection (Dilo DN8) |
| 2.04 SF <sub>6</sub> density monitor   | 2.218 SF <sub>6</sub> connection                   |
| 2.201 SF <sub>6</sub> pipe, pole A     | 2.219 screw-in fitting                             |
| 2.202 SF <sub>6</sub> pipe, pole B     | 2.232 support sleeve                               |
| 2.203 SF <sub>6</sub> pipe, pole C     | 2.233 O-ring (7.30 x 2.4)                          |
| 2.206 threaded bushing                 | 2.991 O-ring                                       |
| 2.209 O-ring (12.37 x 2.62)            |  |

### 6.2.2 Filling the Breaker with SF<sub>6</sub>



Improper transport or handling can result in damage to the pole columns. If this is the case, pole columns may burst when they are being filled to nominal pressure.

- ⇒ To avoid serious accidents, carry out a visual inspection for damage before filling the breaker.
- ⇒ While the breaker is being filled with SF<sub>6</sub>, all personnel must be in a protected location or at a sufficient distance from the equipment (min. 40 m).



During the filling operation, the pressure-reducing valve of the gas-filling device must not be set any higher than 1.1 times the rated SF<sub>6</sub> pressure. If this pressure is exceeded, it may lead to actuation of the breaker's pressure-relief device. The filling pressure is set manually by adjusting the pressure-reducing valve.

#### Important

The nominal pressure  $p_e$  is given on the nameplate.

If the nameplate is missing, the nominal pressure is indicated by the marking on the density monitor (black dot at the end of the green field on the dial).

- ⇒ If there is any doubt about SF<sub>6</sub> quality (when using unsealed SF<sub>6</sub> cylinders, for example), check the dew point of the SF<sub>6</sub> gas after the filling operation, as described in Part B of the operating instructions.
  - ⇒ Flush the hose of the gas-filling device with SF<sub>6</sub> before the filling operation.
  - ⇒ The density monitor can be checked against the pressure curves (A 6.2.2 a to c) by using a test manometer and a thermometer.
- Connect the supply hose of the gas-filling device (SF<sub>6</sub> cylinder with pressure-reducing valve or gas cart) to the central supply connection (Dilo type, DN 8) of the SF<sub>6</sub> distribution unit.
  - Fill the circuit breaker to nominal pressure. The nominal pressure is indicated by the black dot at the end of the green field on the density monitor dial.
  - After a temperature equalization period of approximately 1 hour, check the SF<sub>6</sub> pressure again and correct it, if necessary.
  - Check all sealing points of the SF<sub>6</sub> piping for leak-tightness using an SF<sub>6</sub> leak detector.

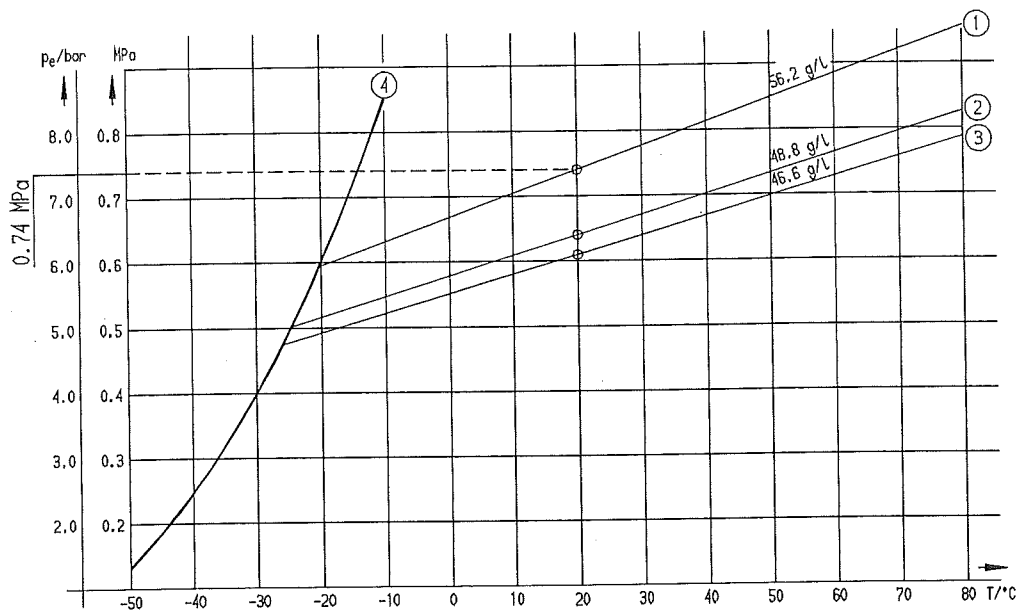


Figure A 6.2.2 a:  $\text{SF}_6$  pressure curve for  $p_e = 0.74 \text{ MPa}$ ,  $\text{UW1} = 0.64 \text{ MPa}$

- 1 nominal pressure curve
- 2 alarm pressure curve
- 3 lockout pressure curve
- 4  $\text{SF}_6$  liquefaction curve

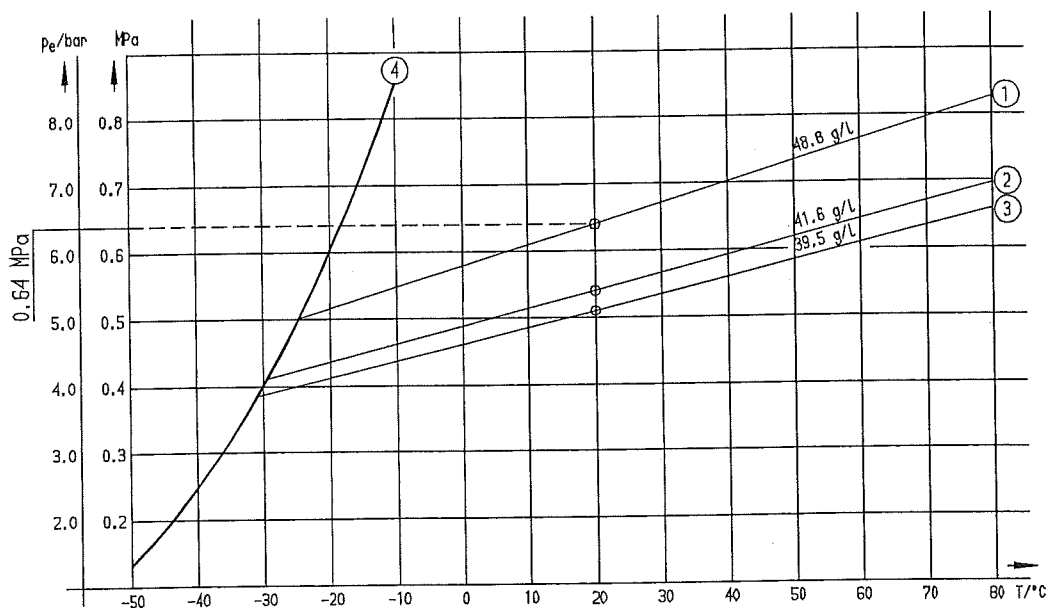


Figure A 6.2.2 b:  $\text{SF}_6$  pressure curve for  $p_e = 0.64 \text{ MPa}$ ,  $\text{UW1} = 0.54 \text{ MPa}$

- 1 nominal pressure curve
- 2 alarm pressure curve
- 3 lockout pressure curve
- 4  $\text{SF}_6$  liquefaction curve

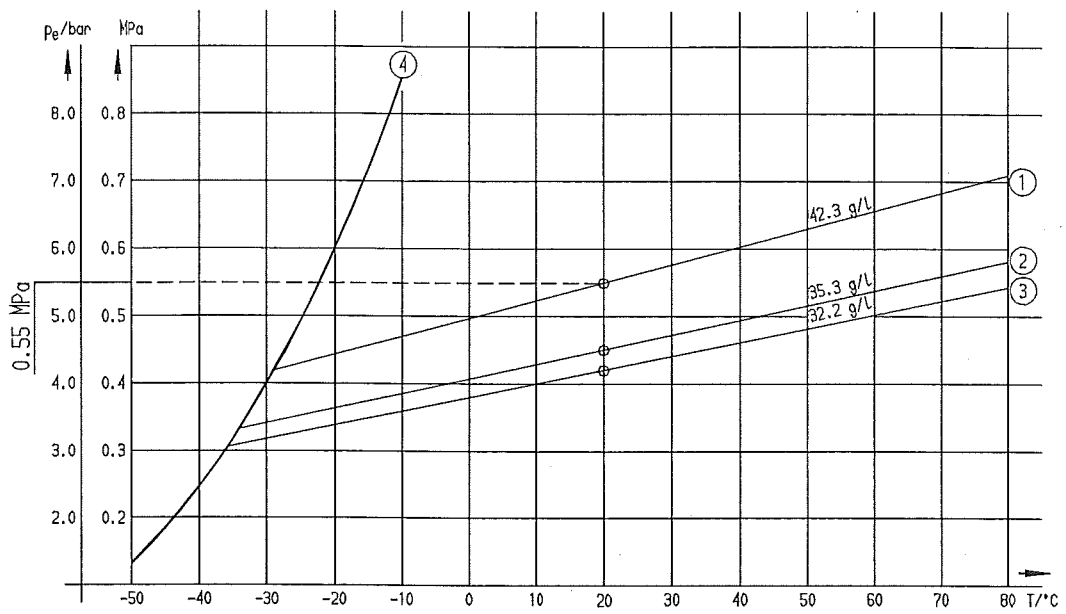


Figure A 6.2.2 c:  $\text{SF}_6$  pressure curve for  $p_e = 0.55 \text{ MPa}$  ,  $UW1 = 0.45 \text{ MPa}$  ( $-35^\circ\text{C}$ )

- 1 nominal pressure curve
- 2 alarm pressure curve
- 3 lockout pressure curve
- 4  $\text{SF}_6$  liquefaction curve

### 6.3 Functional Testing



- ⇒ Follow the safety instructions given in Section 1.
- ⇒ Never operate the circuit breaker when the SF<sub>6</sub> pressure is below the lockout value (red area of the density monitor dial).
- ⇒ During test operations, all personnel must be in a protected location or at a sufficient distance from the equipment (min. 40 m).



Long-lasting voltage loading may destroy the shunt release coils. Only when the breaker has been properly connected, will the internal protective circuit prevent excessive voltage loading.

- ⇒ Never connect coils directly to the control voltage.
- ⇒ Only connect coils via the terminals provided.

#### 6.3.1 Test Operations

- Carry out five closing and five opening operations by remote control.

#### 6.3.2 Motor Charging Time of the Closing Spring

After each closing operation, the motor will charge the closing spring. If the spring is charged, the motor circuit is automatically interrupted by the motor limit switch. The position indicator for the closing spring will then show "spring charged."

- Measure the motor charging time after a closing operation.
- Check the measured charging time against the reference values on the routine test certificate and enter it in the checklist.

#### 6.3.3 Operating Times

The closing time is the time from the start of the closing pulse to the point when the contacts touch.

The opening time is the time from the start of the tripping pulse to the point when the contacts separate.

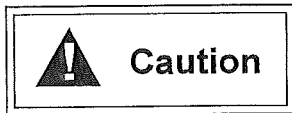
- Attach test leads for measuring operating times to the pole columns of the circuit breaker and connect them to the measuring device.
- Carry out one closing operation and one opening operation while measuring the operating times.
- Check the measured operating times against the reference values in the routine test certificate and enter them in the checklist.

#### 6.3.4 Manual Operation

To prevent accidental operation, the manual operating levers are locked by the locking plate (3.0.72) and locking bolts (3.0.73) (see Figure A 2.3.2 b).

- Loosen the locking bolts approximately one full turn and move the locking plate downward and to the left.
- Carry out one closing operation and one opening operation using the manual operating mechanism.
- Close the locking plate and secure it again with the locking bolts.

If the circuit breaker is operating properly, it will immediately carry out the operations.



When the manual operating mechanism is being used, one operation will be carried out by circumventing all electrical interlocks.

⇒ Always check the SF<sub>6</sub> pressure before any manual operation.

#### 6.3.5 Anti-Pumping System

The anti-pumping system guarantees that in a situation where both a closing and an opening command have been issued, the circuit breaker will always reach the open position.

- To check operation of the anti-pumping system, first move the breaker to the open position.
- While continuously applying an opening command, give also a closing command.  
If the circuit breaker is operating properly, it will execute only one closing operation and one opening operation.
- For the next testing step, put the breaker in the closed position.
- While continuously applying a closing command, give also an opening command.  
If the circuit breaker is operating properly, it will execute only one opening operation.

The anti-pumping system is automatically reset when there are no more operating commands.

#### 6.3.6 Functional Lockout

- Jumper the density monitor contacts at the terminal strip.
- Give one closing command and one opening command.  
If the circuit breaker is operating properly, it will not execute any operation.
- Remove the jumpers from the terminal strip.

#### 6.4 Final Tasks

- Remove all testing and measuring equipment from the breaker.
- Clean up the erection site.

The breaker is ready to be connected to the high voltage system.

## **7 Instructions for Troubleshooting the Control System**

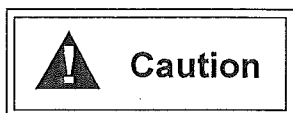
If operating commands are delayed or are not executed, proceed as follows:

- Check the spring charging state.
- Measure the control voltage.
- Interrupt the control circuits.
- Check the SF<sub>6</sub> pressure.
- Check the terminal connections to make sure they are tight and properly connected.
- Check the wiring against the schematic diagrams and correct, if necessary.
- Check the shunt releases and replace any defective coils after determining and eliminating the cause of any overload.
- Check any contactors located in the path of the faulty control circuit and replace them, if necessary.

If any defect is found in the SF<sub>6</sub> density monitor, replace the monitor.

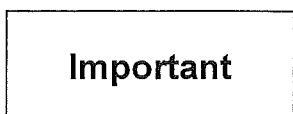
## 8 Inspection, Maintenance, and Reconditioning

Inspection	On occasional basis during station tours, after 6 years maximum.
Maintenance	After 12 and 24 years.
Reconditioning	After 2,500 operations at rated normal current or after a total current as shown in Figure A 8.



Under certain operating conditions, such as operation of shunt reactors, capacitor banks (especially back-to-back conditions), and series gaps, maintenance procedures will be necessary after lower numbers of operations.

Circuit breaker maintenance may only be performed by qualified personnel, as described in Section 1.1.



⇒ The time intervals given above are based on empirical values determined over many years of field experience. Regionally applicable standards and regulations may specify shorter intervals.

Training seminars are held regularly at the manufacturing plant. If necessary, our technical personnel can also be requested at any time.

Replacement of the arcing contacts is necessary if a total current (effective value of the short-circuit breaking current) is reached. Figure A 8 shows the relationship between the number of operations under normal operating conditions and the breaking current.

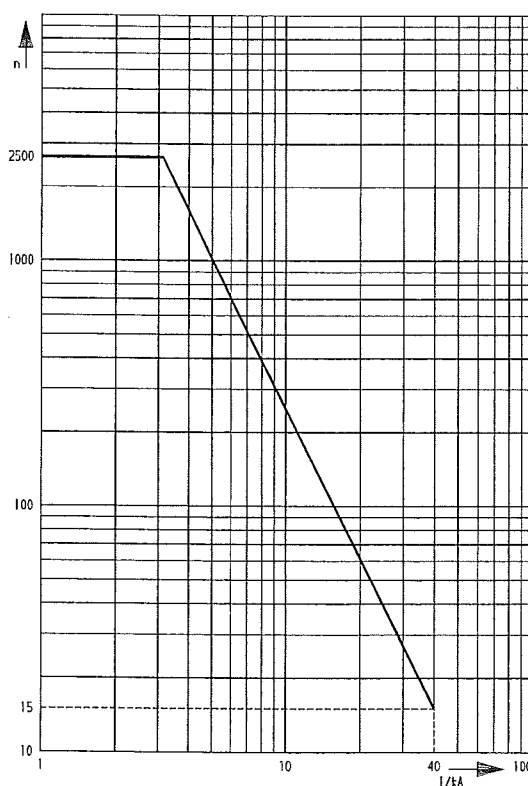


Figure A 8: Permissible number of CO operations (n) until replacement of the arcing contacts as a function of the breaking current (I/kA)