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Title

## Technical requirements Circuit breakers and disconnectors

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## **1 General**

### **1.1 Scope**

These requirements cover the general demands of E.ON Energidistribution AB in respect of circuit-breakers, disconnecting circuit breaker, disconnectors and earthing switches. The requirement apply to the voltage for equipment of 12-145 kV, rated frequency 50 Hz for indoor or outdoor designs.

These requirements are complement to the requirements set out in the Facility Directive Regional Network.

These requirements are a translation from the Swedish requirements D10-0015671. If the content of this document differs from the Swedish version, the Swedish requirements shall prevail.

### **1.2 Standards**

The apparatuses shall be designed, manufactured and tested in accordance with the most recent edition of applicable Swedish standards.

In the absence of such standards, the European Standard (EN) and IEC publications apply.

In the event of disparities between this document and the relevant standard, these Technical Regulations shall apply.

### **1.3 Labelling**

For terminal blocks, the manufacturer's labelling must be located on the equipment side. The cable side shall be free of labelling; intended for E.ON's own labels.

Cables and cable parts in the operating mechanism, between the operating mechanism and other components, shall be labelled at both ends.

Earthing switches shall be fitted with yellow/black warning labels on earthing blades and manoeuvre tubes.

## **2 Changes relative to previous issue**

Changes relative to the previous issue are shown with a vertical line in the right-hand margin.

Updated Appendix for connections.

### 3 Electrical and mechanical requirements

#### 3.1 Insulation levels

For insulation level phase-earth and the phase distance refer to "Facility Directive Regional network". Requirements for the insulation level over the disconnecting distance for disconnectors and disconnecting circuit breakers are presented below.

Highest Voltage for equipment	Insulation level [kV]
12 kV	LI85 AC32
24 kV	LI145 AC60
36 kV	LI195 AC80
52 kV	LI290 AC110
72.5 kV	LI325 AC140
72.5 kV	LI375 AC160 DCB
82.5 kV	LI440 AC175
145 kV	LI650 AC275
145 kV	LI750 AC315 DCB

#### 3.2 Mechanical design

The apparatus shall be dimensioned for the static and dynamic forces in the most unfavourable direction.

Earthing switches that extend other apparatus shall have at least the same short circuit strength as this.

#### 3.3 Connections

High voltage connections for outdoor circuit breakers and disconnectors 12-52 kV shall be made of copper/copperalloy or aluminium. See Appendix 1.

High voltage connections for outdoor circuit breakers and disconnectors over 52 kV shall be made of aluminium or silver-plated copper/copper alloy. See Appendix 1.

Cable shields and any reinforcement shall be earthed at both ends.

Terminal blocks according to Facility directive Regional Networks.

#### 3.4 Breaking and insulation medium

Circuit breakers with SF<sub>6</sub> gas for isolation and arc quenching shall only be used unless there are no other acceptable alternatives, for environmental reasons.

If SF<sub>6</sub>-gas are used, mixed gas is only permitted for stations with a minimum temperature lower than -40°C.

### 3.5 Composite Insulators

Shall be performed and tested according to applicable standards and SS-EN 61462.

## 4 Functional requirements

### 4.1 General

Disconnecting circuit breakers shall always be equipped with added earthing switches.

### 4.2 Circuit-breakers

#### 4.2.1 Monitoring

Circuit-breakers with gas shall be equipped with a density monitor for gas monitoring in each two steps according to the following:

12-36 kV: Level 1: ALARM

52-145 kV: Level 1: ALARM  
Level 2: BLOCKING

There shall be manometers for direct reading of the gas pressure.

Signal contact for "Level 1: ALARM" shall be a free contact that makes at a low gas pressure.

Circuit-breakers shall be prepared for monitoring of tripping circuits.

#### 4.2.2 Indication

The circuit-breaker's position shall be mechanically indicated with the signs **TILL** or **1** and **FRÅN** or **0**.

For circuit-breakers the operating mechanism's standby position is shown with the mechanical position indication of the closing springs stated with the text **SPÄND** and **EJ SPÄND**.

Circuit-breakers shall be equipped with a mechanical counter for the number of executed operating cycles (Closed/Open). The counter shall be at least 4-digit and shall not be possible to reset.

Motor operated apparatus shall be equipped with the following free auxiliary contacts:

4 connected in closed position

4 connected in open position

2 connected when the motor is running

#### 4.2.3 **Operating mechanism**

There shall be a device for manual charging of the closing springs for the circuit-breaker. The device shall be so designed that it releases if the motor starts or a two-way breaking of the motor circuit take place automatically when the device is used.

There shall be a device that prevents pumping after tripping with remaining closing pulses.

Operating mechanism for circuit-breakers shall be equipped with double electrically tripping magnets that work independently of each other. Normally only one closing magnet is required but it shall be possible to supply the circuit breaker with an additional magnet.

#### 4.2.4 **Connection of capacitor banks**

Circuit breakers for capacitor banks should be capable to connecting both single and parallel capacitor banks. The circuit breakers shall meet the requirements SS-EN 62271-100 §4.107 Table 9 or higher value of the current required in the application.

Data for the inrush current can be calculated using SS-EN 62271-100 Annex H.

In order to reduce the inrush current, controlled switching or/and current limiting reactor can be used. If controlled switching is used, the circuit breaker shall be dimensioned for non-controlled switching.

Capacitor bank circuit breakers shall be designed for controlled switching, as per chapter 4.2.6.

#### 4.2.5 **Connection of reactors**

Circuit breakers for reactor shall meet the requirements of SS-EN 62271-110.

Reactor circuit breakers shall be designed for controlled switching, as per chapter 4.2.6

#### 4.2.6 **Controlled connection**

Objects who should be provided with a controlled connection are capacitor banks, reactors and in some special cases also power transformers. Circuit-breakers intended for controlled connection shall have been tested and approved for at least 10,000 operating cycles.

If the voltage-setting circuit breaker for transformers is to be controlled, the controlled connection shall be done by measuring the transformer's remedy.

Controlled disconnection of shunt reactors shall provide non-reignition breakings, in accordance with the requirements of SS-EN 62271-110.

Deviations in operating-time due to mechanical spreading shall be lower than:

Closing time:  $\pm 1$  ms

Opening time:  $\pm 1$  ms

Deviations in operating-time at resting period less than 64 hours shall be lower than:

Closing time:  $\pm 1$  ms

Opening time:  $\pm 2$  ms

### 4.3 Disconnectors

#### 4.3.1 Control

Disconnectors equipped with hand operated or motor drive according to the technical specification.

#### 4.3.2 Indication

The disconnector's position shall be mechanically indicated with the signs **SLUTEN** or **1** and **ÖPPEN** or **0**.

#### 4.3.3 Operating mechanism

Disconnectors equipped with hand operated or motor drive according to the technical specification.

The grip part of the operating device shall be insulated or of an insulating material. At least one operating device of each type shall be supplied.

### 4.4 Earthing switches

#### 4.4.1 Control

Earthing switches are always designed with three-way operation.

#### 4.4.2 Operating mechanism

Earthing switches to be equipped with hand operated or motor drive according to the technical specification.

Earthing switches added to disconnecting circuit breakers are always equipped with a motor drive.

The grip part of the operating device shall be insulated or of an insulating material. At least one operating device of each type shall be supplied.

#### 4.4.3 Indication

The earthing switch's position shall be mechanically indicated with the signs **1** and **0** or **Earth symbol** and **0**.

## 4.5 Common

### 4.5.1 Auxiliary voltages

Operating and motor equipment shall be designed for 110 V DC.  
Heating equipment shall be designed for 230 V DC.

### 4.5.2 Indication

Operating push/buttons shall be equipped with signs with the text **MANÖVER** and the operating device shall have the symbols **0** and **1**.

### 4.5.3 Operating mechanism

Operating mechanisms for outdoor use shall be equipped with heating to prevent condensation. The heating element and all parts of the 230 V AC circuits shall be touch protected design. Monitoring of the heating via potential-free contacts shall be installed.

Motors shall be fully disconnected in rest position.

The motor shall be protected against overload by means of a direct-on-line starter that shall be possible to operate on/off by hand. The direct-on-line starter shall be equipped with a sign with the text **MOTOR**.

The operating device shall have the symbols **0** and **1**.

A direct-on-line starter or switch are not required for indoor circuit/breakers with the highest voltage for equipment 12-36 kV.

Motor circuits shall be galvanic separated from other circuits.

### 4.5.4 Interlocking

There shall be a mechanical interlocking between added earthing switches and disconnectors.

There shall be mechanical and electrical interlocking between added earthing switches and disconnecting circuit breakers.

### 4.5.5 Operating functions for disconnectors and earthing switches

Electric operation shall be prevented at locking by blocking the control circuits.

#### **BLOCKED**

It shall be possible lock the operating mechanism in both end positions. The locking device must be approved by E.ON. Locking shall be performed using padlocks with a shackle, diameter 9 mm. Locking shall be on the outside of the operating mechanism.

Two-way opening shall be performed automatically by motor and control circuits.

#### **DISTANCE**

Electric, two-way distance operation shall be possible.



**MANUAL**

Mechanical operation shall be possible using a crank or handle. Two-way opening shall be performed automatically by motor and control circuits.

**4.5.6 Operating functions for circuit-breakers and disconnecting circuit-breakers.**

No push-buttons or knobs for electric local operation are to be found on the operating mechanism. Mechanical disconnection shall be possible and well described in the user's manual, if single-pole operated circuit breakers are used, electric push button are allowed in common cabinet. Emergency mechanical disconnection shall be well marked and with a sign (**Nödfrånslag**). Also the outside of the door shall be fitted with a sign, (**Nödfrånslag bakom denna dörr**). Signs should be red with white text. Electric operation shall be prevented when locking by blocking the control circuits.

**BLOCKED (only disconnecting circuit breaker)**

The circuit-breaker shall be possible to block and lock in the open position. The locking device must be approved by the client. Locking shall be performed using padlocks with a shackle, diameter 9 mm. Locking shall be on the outside.

**DISTANCE**

Electrical distance operation shall be possible.

**MANUAL**

Mechanical spring charging shall be possible using a crank or handle. Mechanical opening shall be possible via a push-button or knob.

**5 Testing**

Unless otherwise specified, testing must conform to the scope and requirements for test results set down in applicable standards.

**6 Documentation**

The documentation shall include information about the capacitive breaking capacity of the apparatus. Any changes from previous versions of the same design shall be evident at procurement and in the documentation.

**7 Appendices**

Appendix 1 Primary connections

Terminals										Notes		
For max current (A)	Cylindrical		Hole numbers	Flat								
	diam (mm)	length (mm)		Sizes (mm)								
				a	b	c	d	e	fig			
Al	400	30	125	2	75	19	40	14	10	1	4000A when double sided 5000A when double sided	
	1250	30	125	4	75	17,5	40	14	15	2		
	1600	40	125	-	-	-	-	-	-	-		
	2500	60	125	-	-	-	-	-	-	-		
	3150	-	-	9	125	22,5	40	14	35	3		
	4000	-	-	12	125	22,5	40	14	35	4		
Cu	1600	30	125	-	-	-	-	-	-	-		double sided double sided
	2500	40	125	4	75	17,5	40	14	10	2		
	4000	60	125	-	-	-	-	-	-	-		
	6300	-	-	4	100	25	50	18	15	2		
	8000	-	-	4	125	30	65	18	18	2		

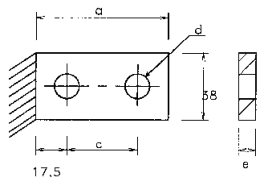


Fig 1

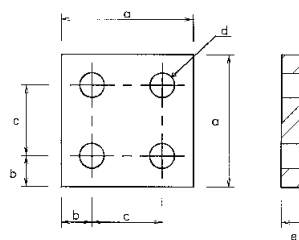


Fig 2

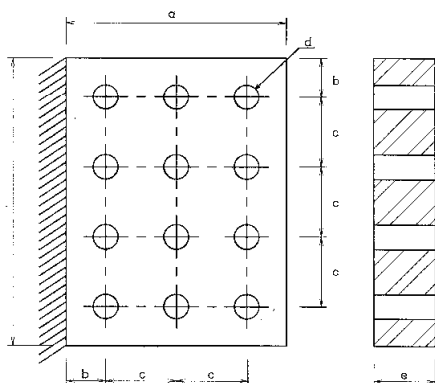


Fig 4

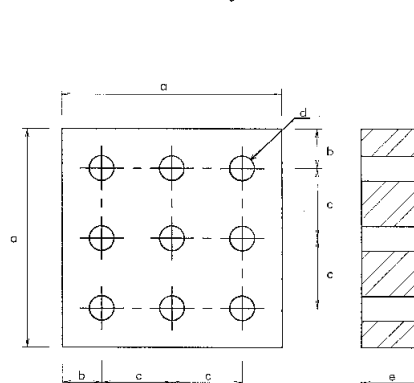


Fig 3

Note! The current value above refers to the maximum load current including the overload capacity of the apparatus.