Outdoor - GIS
Condenser Bushings
Type SEKGFt / EKGFt

Mounting
Operating
and
Maintenance Instructions

SAFTETY INSTRUCTIONS

These instructions are valid for mounting, operation and maintenance of condenser bushings type SEKGFt and EKGFt

Mounting, operation and maintenance works involve following safety risks:

- Perilious, electrical voltages
- High voltage
- Moving machines
- Large weight
- Handling of moving masses
- Injuries caused by slipping, stumbling or falling

Especially rules and instructions for these topics have to be obeyed when handling such equipment. Disregarding of these instructions can induce severe injuries of persons, death, damages of products and materials or following industrial injury and/or consequential damages.

In addition to these rules national and international safety rules have to be obeyed.

In these instructions we have marked risks of injuries or persons and material with following signs near the texts and mounting steps:

Personal injuries or fatal damages

Industrial injury and/or consequential damages

These operation and maintenance instructions are valid for types SEKGFt and EKGFt. For each bushing type these instructions are valid only together with the respective bushing specification, which contains all technical details and the dimension drawing. It is an integral part of these operation and maintenance instructions

CONTENT

1 Description

1.1 Construction

Fig.7

OUTDOOR CONNECTIONS
Depending upon bushing design

Flat terminal for bolt connection (Fig.7) (optional)

Flat terminal connecting surface (Fig.4)
Aluminium 100x200 or 100x100

Round connection (Fig.3)
E-Cu or aluminium

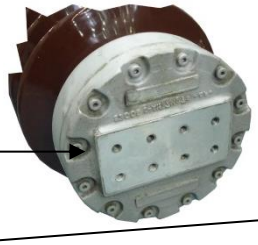


Fig.4

Fig.3

DESIGN BUSHING

Type SEKGFt (Fig.1)
Insulating body made of epoxy resin impregnated special paper and capacitive grading by inserted aluminium layers.

Silicone composite housing with dry filling between active part and composite housing

Armatures and adapting flange made of weather-resistant aluminium alloy

Type EKGFt (Fig.2)
Insulating body made of epoxy resin impregnated special paper and capacitive grading by inserted aluminium layers.

Porcelain housing with dry filling between active part and porcelain housing

Armatures and adapting flange made of weather-resistant aluminium alloy

Adapting flange depending upon design welded or casted with lifting eyes and test tap

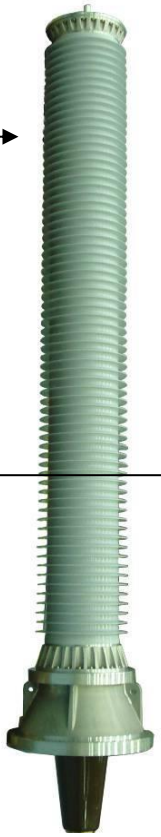


Fig.1

Fig.2

SF_6-SIDE CONNECTIONS
Depending upon bushing design

Round connection (Fig.6)
E-Cu, silver coated design as plug pin

Flat connecting terminal (Fig.5)
E-Cu, silver coated, various designs

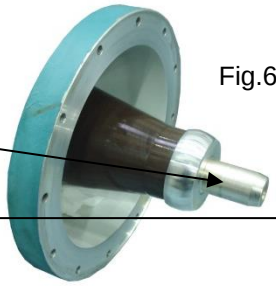


Fig.6

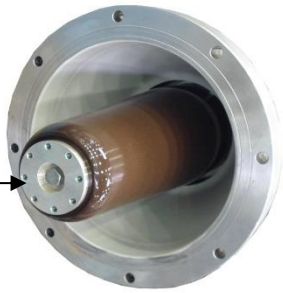


Fig.5

TRANSPORT STORAGE
Protection cover (Fig.8)
Depending upon bushing design and specification made of metal (Al) or plastic (PVC)

Fig.8

1.2 Design

A = Design with silicone composite housing, Types SEKGFt
B = Design with porcelain insulator, Types EKGFt
C = GIS-side connection as plug connection

The main insulation of the bushing type SEKGFt and EKGFt is an insulating body (10). It is made of special paper impregnated under vacuum with epoxy resin and coaxially placed grading layers (11) made of aluminium foil to guarantee uniform voltage distribution.

This insulating body is impregnated directly onto the current conductor.

The bushing housing is the mechanically supporting unit. Depending upon the design it is made of a silicone composite housing with cemented armatures (13), or a one-piece porcelain housing, dependent upon size several elements glued together (12).

The armatures (14) of the composite housing are joint to the basic tube in a special joining technique and vulcanized onto it. The armatures of the porcelain housing are cemented in well-proven technique.
The gap between the insulating body and the bushing housing is filled with a flexible dry insulating material (8), which creates a mechanically solid joint, but compensates the different extension of the materials.

For type SEKGFt the bushing head is created by the flange armature of the composite housing, through which the current conductor (2) is led outside. The point of passage is sealed by a sealing and a pressure disc (3) (also see Fig. 3).
For the porcelain design the head is created by a cover (5) which is screwed to the head armature (7) of the porcelain housing and sealed. The design of the external bolt connection is the same as for the composite design. If the bushing has a flat terminal connection (2) (also see Fig. 4) the conductor bolt is connected through a contact piece (6) with the help of special spring-contact bands (9).

The bushing flange is designed as adapting flange. The dimensions are adapted to the GIS-concept of the GIS-manufacturer. The bottom armature (14) of the housing is fixed to the flange by screws and is sealed. Further sealings to the GIS-volume (16, 18) are provided for the insulating body. The adapting flange is equipped with the test tap (17), lifting eyes (19) and depending upon the design grounding connections.

The GIS-side current connection (22) is a round connection (Fig. 6) or a flat terminal (Fig.5). In case of a flat terminal the current connection is provided by a contact piece (21), which is connected to the conductor bolt of the bushing by MC-contact bands. In the insulating body this area is shielded by special designed inner layers.

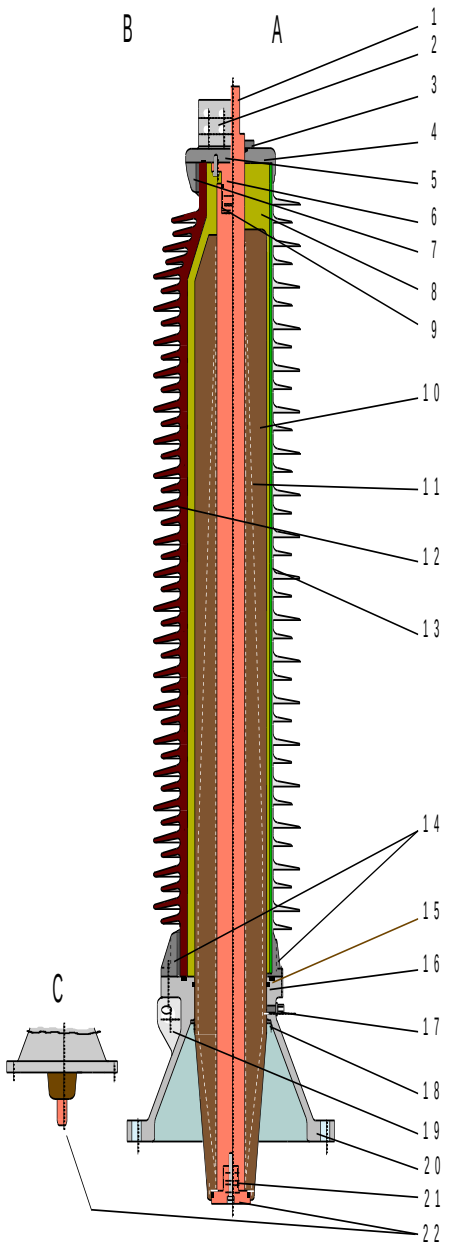


Fig.9

1.3 General Operating Conditions

Application:	Bushing for the application in gas insulated switchgears (GIS) or in SF_6 - dead tanks
Classification:	Epoxy resin impregnated paper, capacitive grading, Outdoor – SF_6 - Bushing
Ambient temperature:	Outdoor side: - 30° up to + 40°C ** ambient temperature Gas side: dependent upon GIS-configuration -25° up to +80°C**
Installation height:	< 1000 a.s.l. **
Rain level and humidity:	1-2 mm rain/min. vertical and horizontal in acc. to IEC 60060-I
Pollution class:	Acc. to specific creepage distance *** acc. to IEC 60815
Immersion medium:	SF_6 -side: SF_6 – insulating gas or mixed gas (SF_6 / N_2) **
Gas pressure:	Operating pressure, min. operating pressure, test and bursting pressure see corresponding bushing specification **
Possibility of evacuate:	No restrictions regarding level and duration
Corrosion protection:	All armatures and fixing materials made of corrosion-resistant material
Marking:	Acc. to IEC 60137 **
Packing:	Wooden crate, ventilated, bushing supported by styro-foam cushions at the head and at the flange, packed in sealed plastic foil with desiccant bags. Gas side with transport protection cover or moisture protection with N_2 – filling with max. 25 kPa internal pressure **

** Standard values, deviations or modifications see corresponding bushing specification
*** Standard min. 25 mm/kV for heavily polluted environment, for deviations see bushing specification

1.4 Mechanical Stresses

On the high voltage connection:

Test bending load:	Type SEKGFt: 1500 – 3000N, dependent upon bushing size * Type EKGFt: acc.to Standard IEC 60137, Tab.1, class II
Operating load:	50% of the values of the test bending load

* Standard values, deviations see bushing specification

2 Mounting

2.1 Status of Dispatch

The bushing is transported in a ventilated wooden case. It is supported by styro-foam cushions located at the head and at the flange of the bushing. In addition to that the flange of bigger bushings is supported by wooden cross beams.

The whole bushing is packed in plastic foil with inlaid dehydrating bags (Fig.10).

Fig. 10

The bushing is equipped with a protection cover (plastic or metal, please see specification) on the gas side (Fig. 11). Plastic covers are used as transportation protection and are, based on the specification, also equipped with sealings and desiccant bag within the adapter case.

Metal protection covers are used for airtight completion of the Bushing – they are supplied with a non-return valve at the cover bottom. Over this valve a small gauge pressure of 20 – 25 kPa is created, additional desiccant bags are inserted into the Case.

In this packing the bushing can be stored in protected dry rooms for 12 months.
If the bushing is packed in aluminium coated foil instead of plastic foil under the same conditions it can be stored for 24 months.

Fig. 11

Long term storage, (also see chapter 5.0) e.g. for spare parts can only be achieved by a metal protection cover and N_2 excess pressure.

The excess pressure of the N_2 filling serves to monitor the tightness as an indicator that no moisture penetrated. The crate has to be stored in dry or properly ventilated rooms – also opened, but covered by a roof.

We recommend checking the pressure at least once a year and if necessary re-filling with N_2 gas bottle. The pressure may sink up to 5 kPa.
A small manometer* (Fig. 12) is used to check the pressure, which is equipped with a valve nipple which fits into the valve of the protection cover.

Functional principle: (Fig 13)
After the locking screw (1) has been opened and removed** the manometer (2) can be screwed in. The central pressure point of the valve is slowly opened, the valve body (3) pressed down and the path of the gas is released.
When the manometer is removed the valve closes.

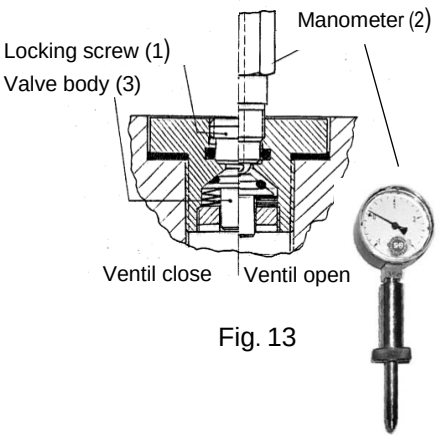


Fig. 13

Fig. 12

* Manometer with valve nipple can be bought from HSP. To re-fill gas the manometer is removed from the valve nipple and a hose connection for the gas is connected (R1/4“-thread)

** The screw (1) is fixed by the internal sealing ring, therefore it has to be touched and removed at its thread carefully.

2.2 Lifting and Erection

Use the lifting eyes to lift the bushing. They are either supplied as detachable ring screws on the adapting flange and on the head, or they are designed as undetachable lifting eyes on the adapting flange. Types with porcelain housing have to be lifted with a lifting gear at the head and at the flange. The rope has to be led through the ring screws at the lifting gear and be attached at the flange.

The detachable lifting eyes have to be removed after mounting of the bushing and the threaded bores have to be closed with plastic caps.

The bushing is lifted with the help of two lifting devices which allow bringing the bushing in any required inclined position for mounting.
Fig. 14-16 show the lifting process with lifting gear.

It is also possible to lift the bushing with one lifting device only.
In this case the lifting accessories are led from the crane shackle to the bushing flange. Another lifting device, e.g. a pulley is fixed to the same shackle and the lifting accessories are led to the bushing head. By pulling the pulley the lengths of both lifting accessories are adjusted until the crane shackle is located above the centre of gravity of the bushing. Inclination is achieved by further pulling of the pulley.

Caution: Lengths of both parts, i.e. rope and pulley, have to be chosen in such a way, that the inclined tensile force for detachable lifting eyes does not exceed the permitted angle! (60° from the axial direction of the lifting eye).

Small bushings with little weight can be lifted with the help of one lifting device and a mechanic who guides the bushing manually on the flange.

By no means may the bushing be put down on the lower insulator part to put it into an upright position.

Fig. 14

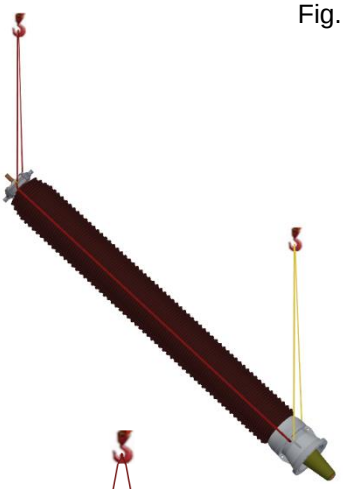


Fig. 15

Fig. 16

Lifting Gear

As example of an available layout see Fig. 17.

The collar made of bent flat bar steel is adapted to the respective diameter of the bushing head with corresponding clearance distance (+5…+10mm). Diametrically opposed are big lifting eyes fixed. Their dimension has to be choosing in a way that ropes with their folded eye can be put through it.

Several mounting brackets distributed equally on the circumference prevent the slip off of the head in direction flange. When lifting the Bushing the maximum Force appears in horizontal position and has to be affiliated by the mounting brackets.

The diameter of the Bushing head is given by the associated specification.

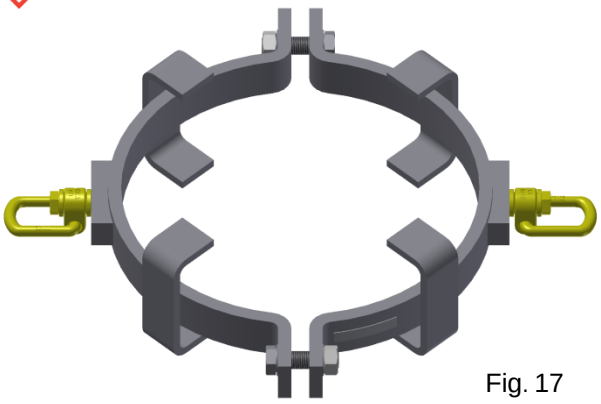


Fig. 17

2.3 Preparation for Installation

After lifting the bushing from the packing it has to be put down on bearing supports at the flange and at the head. The plastic foil has to be removed – do not use a knife, because there is a risk that the silicone sheds are damaged.

Remove the protection cover shortly before the bushing is mounted on the switchgear or switch, remove the desiccant bags, thoroughly clean the inner wall of the adapting flange and the insulating surface with cloths free of fluffs.

If necessary the gasside can be cleaned with solvent (e.g. Ethylacetat).

2.4 Mounting

The bushing is mounted to the switchgear or to the switch according to the rules and instructions of the switchgear manufacturer

The bushing is lifted and put into mounting position as described under 2.2. Treatment of the connections, sealings and mounting steps depends upon the switchgear type and therefore cannot be described here. It has to be taken from the instructions of the switchgear manufacturer.

For the bushing take care that the porcelain housing as well as the silicone sheds are not subjected to mechanical impacts or influence of firm parts. The silicone sheds are flexible, but tear easily in case they are subjected to quick slashes, e.g. by a rope or similar.

2.5 Connections

2.5.1 Grounding

If it is according to the concept of the switchgear, the grounding connections are made by the adapting flange of the bushing. In this case the adapting flange is equipped with grounding surfaces and /or screws.

2.5.2 Test Tap

Design A older design (Fig.18)
Design B new design (Fig.19)

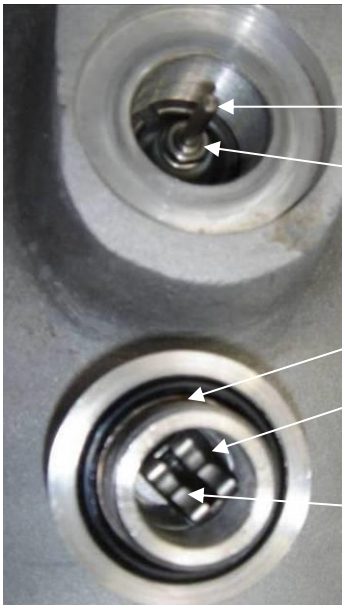
With the test tap the last grading layer of the capacitive grading is led out insulated (1) by a small bushing. The removable cap (2) has a contact socket or a spring (3) in which the connecting pin (4) provides reliable grounding when closed. The cap has an O-ring sealing (5) to guarantee that the inner volume of the test tap remains free of moisture.

During normal operation this connection is always grounded. For possible measurements of the bushing when the switchgear is de-energized to determine capacitance and dissipation factor a measuring lead is connected to the pin.

The test tap is not self-grounding! Therefore the cap has always to be closed tightly during operation! Operation with open test tap leads to a destruction of the insulation of the small bushing (1) in the test tap with influence on the inner volume of the bushing and following damage!

TEST TAP

DESIGN A



Connecting pin (4)

Bushing (1)

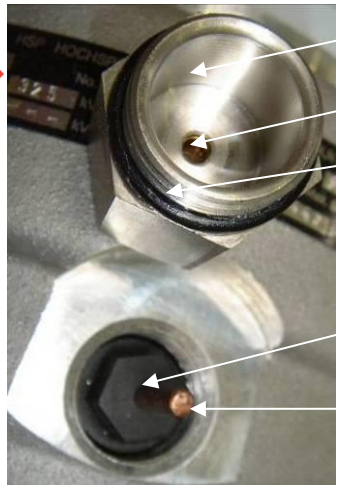
Cap (2)

Sealing (5)

Grounding spring made of non-corrosive steel (3

Fig. 18

DESIGN B



Cap (2)

Contact socket (3)

Sealing (5)

Bushing (1)

Connecting pin (4)

Fig. 19

2.5.3 Lead Connection Head

Dependent upon the design the bushing has round connection (Fig. 20), a round connection with flat terminal (Fig. 21) or a direct flat connecting terminal (Fig. 22) on the bushing head. The materials used can be taken from the bushing specification. In case of aluminium connections the surfaces have to be cleaned and coated with grease for contact surfaces. For the connection of copper and aluminium bi-metal sheets (Cupal) are used.

If not determined by existing standards, the screws can be fastened with the torques mentioned in the table on the left hand side (Fig. 23).

Fig. 20

Fig. 21

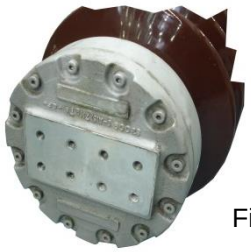


Fig. 22

2.5.4 Connection Gas Side

The design of the gas side is adapted to the concept of the switchgear manufacturer. Therefore the bushings are not interchangeable for different types of switchgears. Examples of connections are terminal connection (Fig. 24) or plug pin (Fig. 25). The mounting procedure is determined by the instructions of the switchgear manufacturer.

screw	torque (Nm)	torque (kpm)
M 4	1,1	0,11
M 5	2,2	0,22
M 6	4,0	0,40
M 8	10,0	1,0
MIO	19,0	1,9
M 12	33,0	3,3
M 14	52,0	5,2
M 16	80,0	8,0
M 18	1 10,0	11,0
M 20	160,0	16,0
M 22	210,0	21,0
M 24	255,0	25,5
M 27	370,0	37,0
M 30	510,0	51,0

The values mentioned in the table are orientation values and refer to screw connections made of non-corrosive steel screws.

Fig. 23

2.6 Evacuation

Evacuation required by the switchgear with respect to the bushing can be carried out without restrictions regarding duration and level.

2.7 Recommended Tests before putting into Operation

Generally during the test of the switchgear on site the values relevant for the bushing are recorded, i.e. a resistivity measurement of the current path and a test with test voltage.

It is useful and therefore recommended to carry out a reference measurement on site. This guarantees that measuring conditions are the same for later measurements and comparable results are achieved.

Measurement includes the bushing capacity as main capacity C1 and the dielectric loss factor tan delta. A measurement of the capacity between the last grading layer and the flange is possible, does not provide any information about the main insulation. It only shows the condition of the area around the test tap.
Limit values see item 3.3

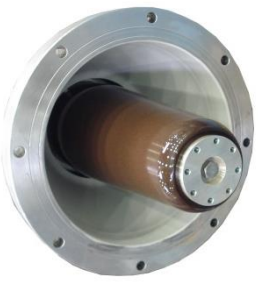


Fig. 24

Fig. 25

3 Maintenance

3.1 Recommended Maintenance and Checks

The bushing requires low maintenance. Check and maintenance refer specifically to the insulator and its condition and the armatures and their condition regarding corrosion. This type of check should be carried out once per year or together with switchgear maintenance.

We recommend carrying out electrical measurements of the bushing after the first 7-10 years of operation, after that depending upon the measurement result every 3 years or more often.

3.2 Cleaning of the Insulator Surface

For porcelain insulators the same cleaning procedures regarding cleaning, which we assume are known, like spray-washing are applicable.

The silicone composite insulator should not be cleaned regularly. Its good features regarding pollution are heavily influenced temporarily by cleaning, because on the surface there is a water-repellent coating which is removed by cleaning.

Cleaning is performed with cloths free of fluffs and soaked with cleaning liquid. As the sheds are flexible do not apply heavy force, but rub more frequently with less force.
Cleaning liquid: Wacker E10 from Wacker Chemie, lot size: 25 ltr. container, consumption 1 ltr. for approx. 3 – 5 m^2 of surface.

After cleaning the features return to their original condition after approx. 1 to 2 days.

An approximate statement about the condition of this so-called hydrophobicity is made by the HC-classification (Fig. 26).

For testing purposes sufficiently spray an area of the size of a hand with water from a spray bottle from a distance of approx. 30 cm during wind still, dry weather and compare the image of the drops with the HC-table (Fig. 26). In case of class HC3 it can be assumed that the features are still sufficient for the location.

It is only a roughly comparing procedure the result of which is not guarantee for the operation behavior.

In addition the insulator should be checked for possible discharge traces. Such traces must not occur, because they damage the surface of the insulator in this area regarding its hydrophobicity. In such a case the cause for the discharges has to be investigated.
Damages of the sheds or on the body, i.e. sharing's, cannot be repaired on site. In case of smaller faults repair in the factory may be possible and has to be agreed upon with the manufacturer in advance.

Possible larger remainders of paint can be pulled off after they have hardened – do not use solvents!

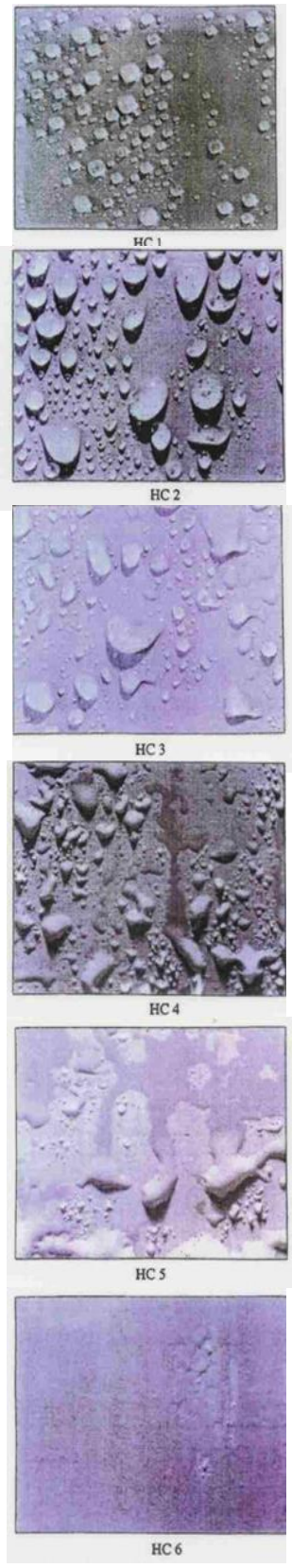


Fig. 26

3.3 Electrical Control Measurements

Measurements on bushings require experience with measuring equipment, test set up and the interpretation of measurement results.
This is for some part due to the relatively small capacitance values, which are corrupted by ambient influence of the environment alone. The measurement of the dielectric dissipation factor can be influenced by humidity, weather etc.

Example of mobile measuring equipment

Fig. 27

3.3.1 Measuring Procedures

Mainly the measuring procedures differ by the coupling of the measuring signal. In case of so-called “not grounded” measurements the test voltage is applied to the conductor of the bushing and the measuring signal is taken at the test tap of the bushing.
The “grounded” measuring procedure is applied, if the bushing which has to be measured does not have a test tap. This is not applicable for the bushings of the type range S/EKGFt.
The devices required for the measurement are usually equipped specifically for the measurement of bushings. The measurement methods are described in comprehensive manuals

3.3.2 Equipment

Measuring equipment is available from several manufacturers. Data can be found in the internet or enquired at HSP (Fig.27)

3.3.3 Limits

For the measurement the influence of the ambient temperature has to be taken into consideration. In the diagram shown on the left side for C and tan delta the variations through temperature are shown (Fig.28).
For the material RIP, resin impregnated paper, there are shown limit values for the deviation of the capacitance and the dielectric dissipation factor with relation to the „new value“.
(Final test by manufacturer or from switchgear final test).

In case the deviations are larger than mentioned in the table below, HSP has to be contacted in any case. When there are very large deviations the bushing may have to be taken out of operation.

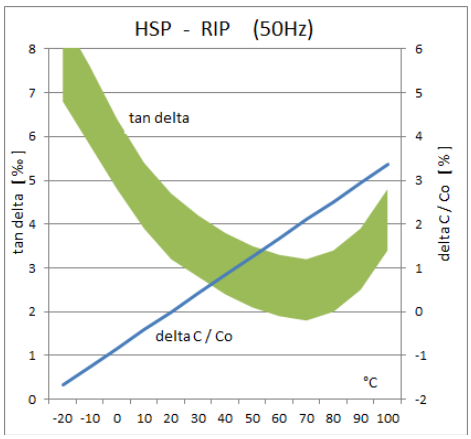


Fig. 28

Voltage level	C – deviation
< 123 kV	10 %
≥ 123 kV	5 %
≥ 245 kV	3 %
≥ 420 kV	1 %
Guide value tan delta	0.004 – 0.006

3.4 Thermo-Control by means of Thermo-Vision

If as a routine thermovision controls are carried out in the installations following items have to be taken into account for S/EKGFt bushings:

An increase of temperature by up to 40K can as a rule be detected at the external contact point, i.e. the lead clamp and is not unusual. Higher temperatures or excess temperatures during low load should lead to a check of the contacts.

Irregularities in the temperatures along the outdoor insulator length, though, may be caused by hotspots and have to be investigated more closely, if necessary contact manufacturer (Fig.29).

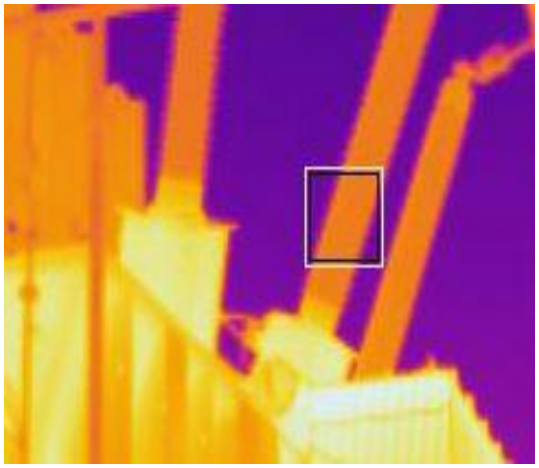


Fig.29

4 Possibilities of Repair

Possible repairs for the bushing types S/EKGFt are restricted to parts which are accessible from outside. Due to the dry filling it is not possible to disassemble the composite or the porcelain housing. The flexible PU-foam in the gap between insulating body and airside housing creates an adhesive connection over the whole surface, therefore the housings cannot by separated without destroying them.

These operating and maintenance instructions are valid for type range S/EKGFt, therefore in case of repair different sectional drawings and parts lists are required to explain the single mounting steps. In case of a repair the documents can be ordered from HSP by quoting the serial number and the specification number and will be transmitted immediately. (Example of a sectional drawing and a parts list, Fig. 30). In addition depending upon the repair requirements short instructions can be given.

Disassembly is not possible. Therefore repair is restricted to external damages of the silicone sheds, which are possible in case of smaller damages with special measures according to the instructions of HSP or carried out by HSP.

In case of internal failures the inner construction parts are accessible only after damaging the composite or the porcelain insulator. We recommend returning the bushings to the manufacturer who has suitable means and measures and professional investigation methods.

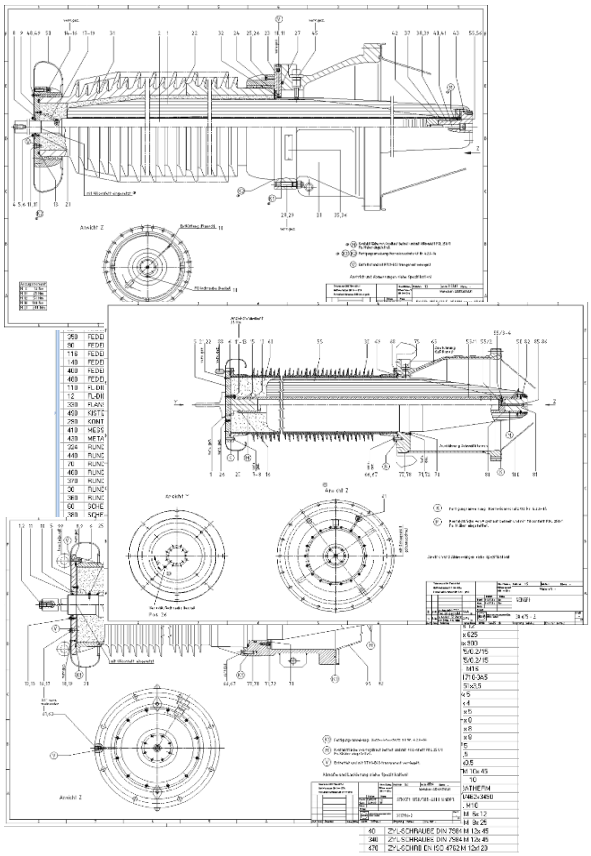


Fig.30

5 Storage

In its original packing the bushing can be stored in dry rooms protected from rain up to 12 months.
If the bushing is packed in aluminum coated foil with inlaid dehydrating bags, storage time is 24 months.

For long-term storage, e.g. for spare parts, the hermetic protection cover (Fig. 31) is obligatory. The material RIP is hygroscope and can absorb moisture, especially in case of long storage time. The protection cover has to be made of metal, is equipped with sealings and has to be fixed to the bushing flange by screws.

Fig.31

The procedure of long-term storage is described in item 2.1. It is recommended to store the bushings in their transport crates in a dry environment to prevent the crate from decomposing.

6 Disposal after End of Operation

The bushing does not contain any liquids, the parts are neither toxic, self-inflammable nor physically burdening. All parts can be disposed of as industrial waste.

It includes following components

- Silicone elastomere (SEKGFt)
- Fiber-glass re-enforced epoxy resin (SEKGFt)
- Porcelain (ceramics) (EKGFt)
- Portland cement (EKGFt)
- Polyurethane elastomere (dry filling)
- Epoxy resin impregnated special paper with aluminum foil as layers
- Armatures made of aluminium alloys
- Conductor bolt made of E-Cu
- Fastening materials, test tap, screws etc. made of non-corrosive steel, aluminum alloy or brass

As the insulating body is undetectably fixed to the porcelain or composite housing by dry filler it is recommended to cut the bushing above and underneath the flange and the head in the area of the composite housing for easier disposal.
In case of porcelain housing the housing must be destroyed (Caution, danger of splitter!)