Gas insulated wall bushing, type GGFL
Installation and maintenance guide

Applicable for wall bushings:
1ZSC0002776-AAA, GGFL 400  1ZSC0002640-AAB, GGFL 420
1ZSC0003517-AAA, GGFL 600  1ZSC0002777-AAA, GGFL 800
The information provided in this document is intended to be general and does not cover all possible applications. Any specific application not covered should be referred directly to ABB, or its authorized representative.

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Safety information
Keep this instruction available to those responsible for the installation, maintenance, and operation of the bushing.

The installation, operation, and maintenance of a bushing present numerous potential unsafe conditions, including, but not limited to, the following:

- High pressures
- Lethal voltages
- Moving machinery
- Heavy components
- Slip, stumble or fall

Specialized procedures and instructions are required and must be adhered to when working on such apparatus. Failure to follow the instructions could result in severe personal injury, death, and/or product or property damage.

Additionally, all applicable safety procedures such as regional or local safety rules and regulations, safe working practices, and good judgement must be used by the personnel when installing, operating, maintaining and/or disposing such equipment.

Safety, as defined in this instruction, involves two conditions:

1. Personal injury or death.
2. Product or property damage (includes damage to the bushing or other property, and reduced bushing life).

Safety notations are intended to alert personnel of possible personal injury, death or property damage. They have been inserted in the instructional text prior to the step in which the condition is cited.

The safety conditions are headed by one of the three hazard intensity levels which are defined as follows:

**WARNING**

WARNING indicates an imminently hazardous situation, which if not avoided will result in death or serious injury. This signal word is to be limited to the most extreme situations.

WARNING also indicates a potentially hazardous situation, which if not avoided could result in death or serious injury.

**CAUTION**

CAUTION indicates a potentially hazardous situation, which if not avoided may result in minor or moderate injury. It may also be used to alert of unsafe practices.

CAUTION may also indicate property-damage-only hazards.

**INFO**

INFO provides additional information to assist in carrying out the work described and to provide trouble-free operation.
Recommended practices

ABB recommends careful consideration of the following factors when installing bushings:

- Before you install or commission a unit, make sure that the personnel doing the job have read and fully understood the Installation Guide provided with this unit.
- To avoid damaging the unit, never exceed the operation limits stated in delivery documents and on rating plates.
- Do not alter or modify a unit without first consulting ABB.
- Follow local and international wiring regulations at all times.
- Use only factory authorized replacement parts and procedures.

Warnings and cautions in this guide

**WARNING**

Keep the components clean, dry and undamaged during installation.

**WARNING**

Lifting and handling of heavy components.

**WARNING**

Do not energize the bushing before all preparations in this guide are done.

**WARNING**

Damaging the silicone insulator may lead to partial discharge during operation.

**WARNING**

Make sure that both sealing O-rings are undamaged, clean and correctly positioned if their respective grooves.

**WARNING**

Make sure that no insects, water, dirt or any other particle can come through open holes during this operation.

**WARNING**

The bushing is provided with a bursting disc as protection against over-pressure. Do not in any circumstances exceed maximum service pressure, MSP = 0.60 MPa over-pressure.

**WARNING**

Energizing the bushing without the appropriate corona shield may lead to flash over and serious damage to the equipment.

**WARNING**

The bushing should always be earthed and de-energized when being worked on.

**WARNING**

SF6 gas is more dense than air, it is invisible and does not smell. If gas is released it will settle in low areas, and there is a significant risk of asphyxiation and death if entering the area.

**WARNING**

Before starting the gas filling procedure, go to a protected area and a safe distance from the bushing. An explosion can cause death or injury to personnel and/or damage equipment.

**CAUTION**

The bushing can operate without any restrictions down to the lowest alarm density corresponding to a pressure of 0.5 MPa (20°C, abs.). By monitoring all alarm levels planned, counter measures can be made before damaging the equipment.

**CAUTION**

The transport box is not designed for long term storage in high humidity and at varying temperatures. For long term storage in the transport box, keep it indoors with controlled temperature and low humidity.
CAUTION

Make sure that the supports do not damage the insulator. The bushing should be handled with care.

CAUTION

The density guard is a calibrated monitoring instrument. It must be handled with care and protected against carless handling or any kind of mechanical damage. Do not open the package of the density guard until the guard is needed.

CAUTION

Check during gas filling that all alarm levels works and are correctly connected to the control system.

CAUTION

Dirt or damages on the corona shield may lead to partial discharge in the air. Be careful during assembly and clean away all dirt.

CAUTION

To avoid external heating of the bushing, the connection of the external bus must be assembled and connected according to the instruction from the supplier.

CAUTION

Install the gas valve and the bursting disc after maximum three hours. Moisture that enters the center housing can cause damage to the bushing.

CAUTION

SF6 gas must be recycled and not released into the atmosphere.
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1. Description

1.1 Design

This wall bushing is a gas-insulated bushing intended for use in HVDC valve halls. The main insulation consists of compressed SF₆ gas (sulphur hexafluoride). The bushing consists of an aluminium intermediate flange fitted with two insulators, one of them for indoor use and the other for outdoor use.

The insulators consist of a glass fibre reinforced epoxy tube fitted with silicone rubber sheds. The respective connections to the intermediate flange and the cover are of aluminium and are fastened with screws and nuts and provided with O-ring seals. Current passes from the outdoor end connection through the cover to a tubular aluminium conductor. There is a corresponding arrangement at the indoor end to carry the current to the indoor end connection. Thermal movement is compensated by a flexible bellow. During transport, the conductor is supported by nylon supports. These have to be removed before the bushing is put in service. See chapter 2.5.4 and Fig. 10.

Both ends of the bushing must have prescribed corona shields to function according to the specification. See chapter 2.9.

The intermediate flange has gas connections and a bursting disc unit.

Fig. 1. Bushing design.
1.2 Operating conditions
The table below shows the standard technical specifications for the GGFL wall bushing. For conditions exceeding the below values, please contact ABB.

<table>
<thead>
<tr>
<th>General specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
</tr>
<tr>
<td>Classification</td>
</tr>
<tr>
<td>Ambient temperature</td>
</tr>
<tr>
<td>Altitude of site</td>
</tr>
<tr>
<td>Type of insulating media</td>
</tr>
<tr>
<td>Markings</td>
</tr>
</tbody>
</table>

1.3 Spare parts
In the event of major damage to the bushing, we recommend sending it back to ABB for repair and electrical testing. For certain parts that can be damaged or lost during transportation, spare parts can be ordered from ABB.

1.4 Mechanical loading
Maximum permissible static load on the bushing according to Fig. 2.

![Fig. 2. Mechanical loading.](image-url)
1.5 Gas density

**WARNING**

The bushing is equipped with supports for the conductor tube during transport, which must be removed prior to gas handling. See Fig. 10. A vacuum/gas filling process must then be done. See chapter 2.8.

The two purposes of the compressed SF\textsubscript{6} gas are to cool the tubular conductor and insulate it from earth. Its capacity for doing so depends on the density of the gas. The bushing is filled for operation with gas at a pressure of 570 kPa (5.7 bar) abs. at 20 °C. The gas density is monitored by a density guard equipped with three switches, one for each alarm level, see Fig. 3. The first is activated at a pressure of 530 kPa (5.3 bar) abs. at 20 °C to indicate a low gas density. The second signal level is activated at 520 kPa (5.2 bar) abs. at 20 °C to indicate decreased gas density. The third level gives an alarm at 500 kPa (5 bar) abs. at 20 °C, which is the dimensioning density for the bushing. In order to increase the redundancies, an extra density guard is intended to be installed in the second gas valve. Fig. 4 shows an example of a circuit diagram for connections to the density guard.

- Alarm level 1 (530 kPa): Switch number D1 is activated, circuit 11-13 is opened and 11-12 is closed.
- Alarm level 2 (520 kPa): Switch number D2 is activated, circuit 21-23 is opened and 21-22 is closed.
- Alarm level 3 (500 kPa): Switch number D3 is activated, circuit 31-33 is opened and 31-32 is closed. At gas densities below 500 kPa the type test levels for dielectric strength do not apply.

**CAUTION**

The bushing can operate without any restrictions down to the lowest alarm density corresponding to a pressure of 0.5 MPa (20°C, abs.). By monitoring all alarm levels planned, counter measures can be made before damaging the equipment.

![Fig. 3. Density guard.](image)

![Fig. 4. Circuit diagram example.](image)
2. Assembly instructions

**WARNING**

Keep the components clean, dry and undamaged during installation.

**WARNING**

Lifting and handling of heavy components.

**WARNING**

Do not energize the bushing before all preparations in this guide are done.

### 2.1 Recommended fitting sequence, alternative 1

1. Check that all necessary tools, accessories and equipment are at hand. See chapters 2.3 and 2.4.
2. Check the packaging for damages.
3. Unpack. See chapter 2.5.
4. Lift the bushing out and place it on ground. Use the supports that come with the box. Carry out visual inspection of the bushing. See chapter 2.5.2.
5. Lift and screw firmly into the wall. See chapter 2.5.3.
6. Fit the corona shields. See chapter 2.9.
7. Preferably, after the corona shields have been fitted, connect the bushing to the main circuit via the end connections. See chapter 2.10.
8. Remove the supports used during transport and mount the gas valve and rupture disc unit. See chapter 2.5.4 and Fig. 10.
10. Check the insulation and the through resistance. See chapter 2.6.1 and 2.6.2.
11. Mount the density guards on the bushing. See chapter 2.7.
12. Connect the signal cables to the density guards.
13. Check the density guards. See chapter 2.7.
14. Earth the bushing. See chapter 2.11.

### 2.2 Recommended fitting sequence, alternative 2

1. Check that all necessary tools, accessories and equipment are at hand. See chapters 2.3 and 2.4.
2. Check the packaging for damages.
3. Unpack. See chapter 2.5.
4. Lift the bushing out and place it on supports on the ground, high enough for removing the transport supports, see Fig. 10. Secure the bushing, so that it can not fall down from the supports. Carry out visual inspection on the bushing. See chapter 2.5.2.
5. Remove the supports used during transport and mount the gas valve and rupture disc unit. See chapter 2.5.4 and Fig. 10.
6. Vacuum and gas filling process. See chapter 2.8. Fill SF₆ gas to transport pressure, 125 kPa (1.25 bar) abs. at 20 °C.
7. Lift and screw firmly into the wall. See chapter 2.5.3.
8. Fit the corona shields. See chapter 2.9.
9. Preferably, after the corona shields have been fitted, connect the bushing to the main circuit via the end connections. See chapter 2.10.
10. Fill the rest of the SF₆ gas, see chapter 2.8, Table 3.
11. Check the insulation and the through resistance. See chapter 2.6.1 and 2.6.2.
12. Mount the density guards on the bushing. See chapter 2.7.
13. Connect the signal cables to the density guards.
14. Check the density guards. See chapter 2.7.
15. Earth the bushing. See chapter 2.11.

### 2.3 Special tools and material required

- Soft slings, minimum 4000 kg, length according to Fig. 8, and crane for sufficient lifting height and weight.
- If needed: counter weight with adjustable load up to 250 kg and fixation device.
- Working platform for sufficient height and weight.
- Clean, stiff paper sheets for protecting of the silicone sheds during installation in the wall.
- Gas of correct kind in sufficient quantity.
- Thermometer to measure ambient temperature, filling device appropriate to bushing filling valve, and precision manometer with range covering at least 100 - 600 kPa abs.
- Torque wrench with grip 13 to 36 mm.
- Torque wrench key for hexagon socket head cap screw, socket width from 5 mm (M6) to 10 mm (M12).
- Open end wrench 13 to 24 mm.
- Gas filling equipment.
- Vacuum pump for emptying.
Table 1. Tightening torques for screw joints.

<table>
<thead>
<tr>
<th>Screw Diameter</th>
<th>Torque (Nm)</th>
<th>±10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>M6</td>
<td>10</td>
<td>±10%</td>
</tr>
<tr>
<td>M8</td>
<td>24.5</td>
<td>±10%</td>
</tr>
<tr>
<td>M10</td>
<td>49</td>
<td>±10%</td>
</tr>
<tr>
<td>M12</td>
<td>84</td>
<td>±10%</td>
</tr>
<tr>
<td>M16</td>
<td>203</td>
<td>±10%</td>
</tr>
<tr>
<td>M20</td>
<td>396</td>
<td>±10%</td>
</tr>
<tr>
<td>M24</td>
<td>685</td>
<td>±10%</td>
</tr>
</tbody>
</table>

2.4 Required consumable
Fomblin OT20, 1171 4016-616, to grease screws and sealings.

2.5 Transport, unpacking and lifting

2.5.1 Transport
The bushing should be transported horizontally in its box with the support and cover intended for this purpose. The transport box should only be lifted with a fork lift at desired locations or with slings in loop eyes if present on box.

The box should be transported and stored with support over at least 75% of its length. For convenience the box is marked “Top end”.

Care must be taken when storing the bushing so that the silicone rubber sheds are not damaged. For instance, rodents, insects or birds can destroy the sheds.

CAUTION
The transport box is not designed for long term storage in high humidity and at varying temperatures. For long term storage in the transport box, keep it indoor with controlled temperature and low humidity.

The bushing shall also be protected from penetrating water if stored outdoors. This means that it shall not be stored in areas where it can be foreseen that the ground will be wet and muddy during heavy rain. Shelter the bushing from rain and snow with a tarpaulin or roofing.

The bushing is supplied with the gas volume filled with nitrogen gas ($N_2$) at a pressure of 25 kPa gauge. This pressure should be maintained during shipping and storage.

The bushings should under long term storage be filled with sufficient amount of dry clean nitrogen, $N_2$, at a positive relative pressure. The purpose is to maintain a positive inner pressure to reduce the risk against moisture and contaminants entering the bushing.

For shorter periods and during shipping a relative pressure of 25 kPa, at 20°C, is considered sufficient. But for longer periods of storage the pressure could be increased according to the guideline below. Factors affecting the pressure to take into consideration are temperature and storage time, together with verified rate of leakage.

Fig. 5. Lifting points for soft slings and forklift.
The pressure versus temperature of the gas may be estimated by using the common law of gas:

\[ p = \frac{nRT}{V} \]

where \( V \) = volume, \( n \) = amount of substance (in moles) and \( R \) = universal gas constant all can be considered constant for this evaluation.

\[ T = \text{absolute temperature in Kelvin, where } +20°C = 293 K \]

Thus, the remaining parameters, pressure and temperature, can be approximated as linear and the following relation is found:

\[ \frac{P_1}{T_1} = \frac{p_2}{T_2} = \frac{nR}{V} \]

or

\[ P_1 = \frac{T_1}{T_2} \cdot p_2 \]

**Pressure as function of temperature**

Using recommended pressure 25 kPa_{rel} = 125 kPa_{abs} as pressure \( P_2 \) at temperature \( T_2, 293 K \) in order to calculate the pressure needed to assure 25 kPa also at other temperatures, use the relation to calculate \( P_1 \) at the relevant temperature \( T_1 \).

Example, ambient temperature -20°C = 253 K, gives:

\[ P_1 = \frac{253}{293} \cdot 125 \text{ kPa} = 108 \text{ kPa} \]

The pressure has dropped 125/108 = 16%, thus increase the pressure at filling with:

Filling pressure at 20°C = 1.16 \cdot 125 \text{ kPa} = 145 \text{ kPa}

**Pressure as function of verified maximum leakage rate**

The long term leakage is verified through routine test at operating pressure being less than 0.5% per year of the enclosed gas.

Assuming a period of 30 years, the maximum amount of gas and decreased pressure thus affected is:

\[ 0.995^{30} = 0.86 \text{ or 86%} \]

Increase the above filling pressure with 1/0.86 = 16% compensates for the theoretical max leakage.

This gives a total pressure at +20°C of 145 \cdot 1.16 \text{ kPa} = 165 \text{ kPa}, or 65 kPa_{rel} (gauge).

(Note that the referenced +20°C is the temperature of the gas. The temperature of the gas may be estimated as the ambient air temperature at steady-state, not directly after filling.)

**Summary**

The procedure and example above shows a filling of 65 kPa gauge \( N_2 \) should maintain a sufficient margin for storage during 30 years with a minimum ambient temperature of -20°C.

The actual pressure is recommended to be verified during periodical maintenance, such as every 5 or 10 years.

The bushings are normally delivered from ABB in boxes with the busing supported by blocks and fibre boards. The boxed are marked with “Top end”. This information can be important and shows how the bushing is oriented inside the box.
2.5.2 Unpacking

Before unpacking, inspect the packaging for transport damage.

The screws for the framework cover should be loosened first. Be aware of only loosening screws for the cover, see Fig. 6.

First, lift the framework piece by piece. If a lifting yoke is used, the framework cover may be disassembled at once. Proceed with removing wooden cover, in the same manner, after ensuring all screws or nails are removed.

If needed, use stairway to enter the box. Never enter the box climbing on the bushing itself, use stairway or likewise, inside the box as well if needed.

Remove plastic wrapping as late as possible prior to installing the bushing in the wall, or even after assembly, to avoid damages and dirt on the bushing during handling.

Installation guide and other related documents are placed in a sealed plastic bag inside the transportation box.

![Diagram of bushing and cover](image)

**WARNING**

Damaging the silicone insulator may lead to partial discharge during operation.

After unpacking, check the bushing and its accessories for transport damage, with particular attention to the following: end connections, all joints between flanges and their screw connections, gas valves, density guards, bursting disc and corona shields.

If transport damage is found and it is judged that correct operation of the bushing is not possible, a damage report should be sent to the insurance company. It is also recommended that photographs are taken of the damaged details. Mark the photos with ABB’s reference number and the serial number of the bushing. Send them to ABB for comments.
Check that the parts delivered, type designations and the serial number agrees with the delivery documents, e.g. the packing list or ABB’s order acknowledgement. The serial numbers to be checked are those on the rating plate, see Fig. 1.

The internal pressure of the bushing may be measured by precision manometer covering at least 0 - 50 kPa (0 - 0.5 bar) gauge pressure to see if it is still transport pressure. The ambient temperature should be taken into account in interpreting the resulting measurement.

⚠️ CAUTION

Make sure that the supports do not damage the insulator. The bushing shall be handled with care.
2.5.3 Lifting
During manufacture at ABB, the bushing is filled with pure SF₆ gas for testing. For shipping, supports for the conductor are mounted and the bushing is filled with nitrogen gas to a transport pressure of 125 kPa (1.25 bar) abs. at 20 °C. The bushing should be lifted and handled at transport pressure.

**WARNING**

In view of the risks involved in lifting pressurized items, no lifting should take place at pressure higher than transport pressure.

Use clean, soft slings around the intermediate flange and the outdoor top end. Secure that the silver plating or paint does not get damaged during lifting.

To achieve the correct mounting angle, a counter weight can be applied to compensate the different centers of gravity. Adjust the counter weight so the bushing is horizontal, before inserting it into the wall, see Fig. 8. The maximum load on the counter weight is 250 kg.

Mount the bushing in the wall, see Fig. 9.

**CAUTION**

Be careful not to damage the silver plated contact surface when attaching the slings.

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**Fig. 8. Lifting and inserting the bushing into the wall.**

**Fig. 9. Mounting the bushing in the wall.**
2.5.4 Shipping supports, gas valve and rupture disc unit

Two nylon supports internally secure the conductor during transport. The supports are attached in the gas-tight covers, which are placed on the outdoor side of the intermediate flange, see Fig. 10. When the supports are mounted, the bushing is filled with nitrogen to transport pressure 125 kPa (1.25 bar) absolute at 20 °C. The supports shall be removed, the gas valve and the rupture disc mounted and the bushing filled with SF₆ gas according to the following sequence:

- Clean the intermediate flange properly from dust and dirt. This is to make sure no particles can fall down into the opened holes during assembly.
- Reduce the pressure of nitrogen through the gas valve on the intermediate flange
- Remove the nylon supports carefully.
- Slightly moisten the O-rings with fomblin.
- Mount the gas valve and the bursting disc unit, see Fig. 10.

**WARNING**

Make sure that both sealing O-rings are undamaged, clean and correctly positioned in their respective grooves.

**WARNING**

Make sure no insects, water, dirt or any other particle enters the bushing through the open holes during this operation.

**CAUTION**

Install the gas valve and the bursting disc after maximum three hours. Moisture that enters the center housing can cause damage to the bushing.

- Evacuate the bushing down to a pressure below 2 mbar and re-fill with pure SF₆ gas. See chapter 2.8.
- Store the supporting devices if they should be needed in the future.

---

Fig. 10. Supports for conductor during transport, rupture disc unit and gas valve.
2.6 Check before installation
The bushing may be checked on a number of points before being put into operation or fitted in the wall. The most important characteristics that may be checked are insulation, through resistance and density guard.

2.6.1 Insulation
The resistance is measured between end connection and ground. The value should exceed 1000 MΩ. This may be checked before filling with gas. It may also be checked by a Doble-test of capacitance and loss factor. The maximum voltage is 10 kV between end connection and ground at transport pressure.

These measurements should be done before connection to the main circuit, otherwise the results may be highly misleading.

2.6.2 Through-resistance
Measurement of resistance between the bushing end connections. The normal value is in the region of 50 - 500 $\mu$Ω depending on rated current and bushing length. If such a measurement has been performed during the routine test, the value can be compared to the test record. The ambient temperature at the time should be taken into account in interpreting measurement results.

2.7 Density guards
The density guards are delivered separately from the bushing and are installed as follows:

Unscrew the protective cap from the valve. Check that the valve and the density guard orifice are clean. Insert the density guard orifice into the valve and screw down the clamping nut. Torque at 20 Nm.

All switches of the density guard may be checked by removing the guard from the bushing. All three levels should then indicate low pressure. When re-installing the switch, all levels should indicate proper gas pressure.

CAUTION
The density guard is a calibrated monitoring instrument. It must be handled with care and protected against careless handling or any kind of mechanical damage. Do not open the package of the density guard until the guard is needed.

Check during gas filling that all alarm levels works and are correctly connected to the control system.

2.8 Gas filling and emptying

WARNING
The bushing is provided with a bursting disc as protection against over-pressure. Do not in any circumstances exceed maximum service pressure, MSP = 0.60 MPa over-pressure.

A special gas filling equipment with a vacuum pump is required. The bushing should be evacuated down to a pressure below 2 mbar before SF$_6$ gas is filled up to the specified pressure. If there are any questions about this, please contact ABB.

2.8.1 Description of SF$_6$ gas
Sulfur hexafluoride (SF$_6$) is a synthetic gas, it is colorless, does not smell and does not burn. The gas is chemically very stable, and it does not react with any other substance at room temperature. The stability of the gas is the reason for being used in electrical equipment, because it provides very high electrical insulation. These properties of SF$_6$ gas makes possible the construction of devices and equipment with small dimensions, using less material, that are safe and have long service-lives. For electrical equipment, the SF6 gas is only used in closed and sealed systems, e.g. as insulation gas in substations.

Chemical name: Sulfur hexafluoride
Colorless, odorless, non-toxic, non-flammable, chemically inert
High dielectric strength, almost 3 times higher than air or N$_2$
Climate-effecting CO$_2$ equivalent: 22,800
Lifetime in the atmosphere: 3,200 years

2.8.2 Quantity of pure SF$_6$ gas for filling of bushing
The filling to operational pressure requires gas with approximate weight according to Table 2.

<table>
<thead>
<tr>
<th>Bushing</th>
<th>Catalog number</th>
<th>Amount of SF$_6$</th>
<th>CO$_2$ gas equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>GGFL 400</td>
<td>1ZSC002776-AAA</td>
<td>51 kg</td>
<td>1162.8 tonne</td>
</tr>
<tr>
<td>GGFL 420</td>
<td>1ZSC002640-AAB</td>
<td>52 kg</td>
<td>1185.6 tonne</td>
</tr>
<tr>
<td>GGFL 600</td>
<td>1ZSC003517-AAA</td>
<td>112 kg</td>
<td>2553.6 tonne</td>
</tr>
<tr>
<td>GGFL 800</td>
<td>1ZSC002777-AAA</td>
<td>200 kg</td>
<td>4560 tonne</td>
</tr>
<tr>
<td>GGFL 1100</td>
<td>1ZSC005399-AAA</td>
<td>370 kg</td>
<td>8436 tonne</td>
</tr>
</tbody>
</table>
2.8.3 Quality and type of gas
The quality of the SF₆ gas should adhere to standards IEC 60376 and 60796b.

2.8.4 Gas handling and filling
Any commercial equipment for handling of SF₆ gas may be used.

The steps for filling are:

- Drain the bushing to a pressure below 2 mbar with a vacuum pump.
- Add SF₆ gas to a nominal pressure of 570 kPa abs. at 20 °C.

2.8.5 Connection to the bushing gas valves
The gas valves are made of a spring loaded closing device, see Fig. 11. A nozzle made according to the dimensions in Fig. 12, held to the nozzle by the clamping nut, opens the valve. EPDM rubber gaskets, dimension 15.3 x 2.4 mm, are recommended for the two O-ring grooves.

Table 3. Filling pressure.

<table>
<thead>
<tr>
<th>Filling pressure in MPa (abs) shown on data plate</th>
<th>Ambient temperature in °C</th>
<th>Filling pressure in MPa (over-pressure) indicated on pressure gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.57</td>
<td>-30°C</td>
<td>0.36</td>
</tr>
<tr>
<td>0.36</td>
<td>-20°C</td>
<td>0.38</td>
</tr>
<tr>
<td>0.38</td>
<td>-10°C</td>
<td>0.40</td>
</tr>
<tr>
<td>0.40</td>
<td>±0°C</td>
<td>0.43</td>
</tr>
<tr>
<td>0.43</td>
<td>+10°C</td>
<td>0.45</td>
</tr>
<tr>
<td>0.45</td>
<td>+20°C</td>
<td>0.47</td>
</tr>
<tr>
<td>0.47</td>
<td>+30°C</td>
<td>0.50</td>
</tr>
<tr>
<td>0.50</td>
<td>+40°C</td>
<td>0.52</td>
</tr>
</tbody>
</table>

When correct gas pressure has been set, remove the filling hose and fit the airtight bonnet to the gas valve.

![Gas valve on the bushing flange](image1)

Fig. 11. Gas valve.

![Nozzle for connection to gas valve](image2)

Fig. 12. Nozzle for connection to gas valve.
2.8.6 Removal of SF₆ gas for transportation
The bushing must not contain SF₆ gas during transport. Before dismounting or other handling of the bushing, the gas needs to be removed into a bottle or other gas container suitable for SF₆ gas. Fill the bushing with nitrogen (N₂) at a transport pressure of P₉₅⁰125 kPa.

WARNING
SF₆ gas is more dense than air, it is invisible and does not smell. If gas is released it will settle in low areas, and there is a significant risk of asphyxiation and death if entering the area.

WARNING
Before starting the gas filling procedure, go to a protected area and a safe distance from the bushing. An explosion can cause death or injury to personnel and/or damage equipment.

CAUTION
SF₆ gas must be recycled and not released into the atmosphere.

The steps for removing gas, if the bushing is subject for opening or transport, are:

1. Connect the SF₆ gas to a service unit.
2. Remove all SF₆ gas to a vacuum of P₉₅⁰20 Pa.

   The SF₆ gas must be recovered for reuse or destruction.

   The permitted quality of the SF₆ gas is specified in the standard IEC 60376.

3. Fill the bushing with dry nitrogen (N₂) to a pressure of P₉₅⁰100 kPa.
4. Install the transport supports.
5. Remove again all the nitrogen (N₂) to a vacuum of P₉₅⁰20 Pa.
6. Fill the bushing again with dry nitrogen (N₂) to a transport pressure of P₉₅⁰125 kPa.
2.9 Corona shields

The corona shields, if ordered from ABB, are delivered in separate boxes. However, due to design aspects the appropriate corona ring, according to Table 4, has to be included in the bushing setup. The Electrical data on dimension drawing is not valid with any other corona shield.

### Table 4. Corona shield

<table>
<thead>
<tr>
<th>Bushing</th>
<th>Dimension drawing</th>
<th>Corona shield outdoor</th>
<th>Corona shield indoor</th>
</tr>
</thead>
<tbody>
<tr>
<td>GGFL (kV)</td>
<td>Article numbers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>1ZSC002641-AAA</td>
<td>1ZSC001635-AAG</td>
<td>1ZSC001635-AAH</td>
</tr>
<tr>
<td>420</td>
<td>1ZSC002641-AAB</td>
<td>2748 530-DB</td>
<td>1ZSC001635-AAL</td>
</tr>
<tr>
<td>600</td>
<td>1ZSC003272-AAA</td>
<td>1ZSC001635-AAK</td>
<td>1ZSC001635-AAK</td>
</tr>
<tr>
<td>800</td>
<td>1ZSC001668-AAB</td>
<td>1ZSC001635-AAJ</td>
<td>1ZSC001635-AAB</td>
</tr>
<tr>
<td>1100</td>
<td>1ZSC004616-AAA</td>
<td>1ZSC001635-AAN</td>
<td>1ZSC001635-AAB</td>
</tr>
</tbody>
</table>

**WARNING**

Energizing the bushing without the appropriate corona shields may lead to flashover and serious damage to the equipment.

**CAUTION**

Dirt or damages to the corona shield may lead to partial discharge in air. Be careful during assembly and clean away all dirt.

The outdoor and indoor corona shield are attached with supports at both ends of the bushing. The fitting of the corona shields should be carried out with the bushing filled to no more than transport pressure.

2.9.1 Outdoor corona shield
See Fig. 13.

2.9.2 Indoor corona shield
See Fig. 14.
2.10 Terminals

CAUTION

Before connection of untreated aluminium clamps, the outer terminals should always be cleaned with Scotch-Brite or similar product and lubricated with a suitable contact paste or a suitable grease before connection to the main circuit.

The terminals are normally supplied already mounted on the bushing. If they are to be replaced, the following applies: The contact surfaces on the bushing cap and the internal contact surface of the terminal have been surface-treated and should not be brushed before mounting, but they should be cleaned. Contact paste or grease should not be used between the terminal and the cap.

The O-ring and the terminal should be assembled according to Fig. 15.

Tighten the screws that press the connection against the cap (M10) and compresses the O-ring. It is important that tightening is done in stages crosswise so that the end connection is not tightened unevenly.

2.11 Earthing

The bushing flange must be earthed in order to prevent electrical discharges between the bushing flange and the wall to which the bushing is installed. Applying a flexible cable between one of the M12 threaded holes in the flange and the mounting plate in the wall is recommended to assure proper grounding, see Fig. 16.

2.12 Connection to the external bus

CAUTION

To avoid external heating of the bushing, the connection of the external bus must be assembled and connected according to the instruction from the supplier.

Fig. 16. Holes for flange earthing.

![Fig. 15. Left: terminal GGFL 400, 600 and 800. Right: terminal GGFL 420.](image)
WARNING

The bushing should always be earthed and de-energized when being worked on.

GGFL bushings normally require no maintenance. The suggestions given below cover aspects of bushing supervision to be carried out, for example, on the occasion of station overhauls or normal scheduled maintenance.

3.1 Handling and cleaning of composite insulators
The weather sheds do not normally require any cleaning during their lifetime. The surface may appear to be dirty, but this has no significance to its function. If the insulators have been exposed to extreme pollution under installation or during service, it can be cleaned according to SEPTPT/PL/T/MB 2193.

Should, for any reason, the insulator be subjected to live washing with water, care should be taken so that the sheds are not exposed to excessive forces (e.g. do not use high pressure nozzlers directly on the sheds).

For more information about handling and cleaning, please refer to SEPTPT/PL/T/MB 2193.

3.2 Gas
The gas density should not be allowed to fall below the nominal insulating density. Checking that the density guards are operating as intended may be carried out according to chapter 2.5. Gas moisture content may be checked according to IEC 60376 B. Checking of gas characteristics may be carried out according to IEC 60480.

3.3 Electrical conduction
The temperature in the bushing may be checked using Termovision infrared-sensitive equipment during operation. The normal temperature rise at rated current is 20 - 40 K above ambient.

3.4 Hydrofobicity check
The hydrophobicity of the silicone rubber may be checked as directed in product information 2750 515-53.
4. Disposal after end of service life

The approximate material composition is as follows:

- 40 % aluminium of various compositions
- 30 % glass fiber reinforced epoxy
- 23 % silicone rubber
- 5 % stainless steel
- 2 % copper

The epoxy tube and the silicone rubber contains no poison or heavy metals and may be burnt or deposited without harmful environmental effects.

SF₆ gas is handled according to chapter 2.6.
5. References

- IEC 60376 and 60796 B "Specifications and acceptance of new sulphur hexafluoride"
- IEC 60376 B "Specification of Dew Point Measuring"
- IEC 60480 "Guide for checking SF6 taken from electrical equipment"
- SEPTPT/PL/T/MB 2193 “Handling and cleaning of composite insulators"
- 2750 515-53 “Determination of the hydrophobic characteristics of a surface"