Transformer bushing, type GSBK
Installation and maintenance guide
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1 Safety

1.1 Levels of safety risks

Throughout the manual, various types of safety risks are indicated. The most serious level on this scale provides a warning about serious personal injury or possible death, or major damage to a product, if the instructions are not observed.

Symbols and their meanings

The following describes the symbols that appear in the manual, along with their meaning.

**DANGER!**

The yellow, filled warning triangle warns that an accident will occur if the instructions are not complied with and that it will result in serious personal injury or death and/or major damage to the product.

It is used, for example, to warn of such dangers as: contact with high voltage, explosion or fire risk, risk for toxic gases, risk of crushing, impacts, falls from high places, etc.

**CAUTION!**

The round warning symbol warns that an accident could occur if the instructions are not observed, and that this could result in personal injury and/or damage to the product.

It is also used to warn of risks that entail burns, eye or skin injuries, impaired hearing, crushing or slipping injuries, tripping, impacts, falls from high places, etc.

In addition, it is used to warn of functional requirements when assembling or removing equipment where there is a risk of damage to the product or downtime.

**NOTE!**

The comment symbol identifies important information and conditions. Also used to indicate any danger that could lead to property damage.

**Torque**

The torque symbol indicates tightening torque.
## 1.2 Hazardous working situations

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working close to high voltage.</td>
<td>Disconnect all plant power. Ground all objects at the workplace.</td>
</tr>
<tr>
<td></td>
<td>If work must be done close to live plant components, make sure that the safety distance is in compliance with the applicable safety regulations.</td>
</tr>
<tr>
<td>Working on ladders and platforms.</td>
<td>Work must be done in accordance with the applicable safety regulations.</td>
</tr>
<tr>
<td></td>
<td>Do not use ladders or platforms in poor weather conditions.</td>
</tr>
<tr>
<td>Working with heavy objects.</td>
<td>Do not walk under lifted objects.</td>
</tr>
<tr>
<td></td>
<td>Make sure that heavy objects are stable before starting work.</td>
</tr>
</tbody>
</table>

## 1.3 Safety precautions

<table>
<thead>
<tr>
<th>Precaution</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformer oil</td>
<td>Collect used transformer oil in drums.</td>
</tr>
<tr>
<td></td>
<td>Transformer oil is dangerous. Fumes from hot oil can cause irritation to the respiratory organs and the eyes. Long and repeated contact with transformer oil can cause damage to your skin.</td>
</tr>
<tr>
<td>Waste and cleaning up</td>
<td>Clean up liquid waste with an adsorbent. Treat waste as hazardous to the environment.</td>
</tr>
<tr>
<td>Fire</td>
<td>Extinguish fires with powder, foam or carbon dioxide.</td>
</tr>
</tbody>
</table>
2 Product description

2.1 Design

Overview

The GSBK type is a transformer bushing. It is made for immersed oil to SF₆ service. The bushing is of the dry, gas-free type, with a resin impregnated paper RIP condenser core as the primary insulation. Bushings of this design can be installed at any angle from vertical to horizontal.

General schematics

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Outer terminal</td>
</tr>
<tr>
<td>2</td>
<td>RIP condenser core</td>
</tr>
<tr>
<td>3</td>
<td>Mounting flange</td>
</tr>
<tr>
<td>4</td>
<td>RIP condenser core</td>
</tr>
<tr>
<td>5</td>
<td>End shield</td>
</tr>
<tr>
<td>6</td>
<td>Test/voltage tap</td>
</tr>
</tbody>
</table>
Terminal system

The bushing can be configured with one of two terminal systems: the fixed bottom contact system, or the draw-rod system.

1 Draw rod
2 Fixed bottom contact
Test tap

The bushing has a test tap that is connected to the outermost conductive layer of the condenser core. The test tap is used to measure the bushing insulation by capacitance and dissipation factor. The cover connects the outermost conductive layer to ground, and must always be installed when the bushing is energized.

The maximum one minute test voltage for this test tap is $2 \text{ kV}_{\text{rms}}$. The test tap can be used as a power source, if it is connected to an external capacitance. The operating voltage is limited to 600 V.

CAUTION!

Do not energize the bushing without a test adapter or the cover installed. The bushing is grounded through the cover to prevent damage to the bushing.
**Voltage tap**

The voltage tap is available as an option, instead of the test tap.

The bushing has a voltage tap that is connected to the second outermost conductive layer of the condenser core. The voltage tap is used to measure the bushing insulation by capacitance and dissipation factor. The cover connects the outermost conductive layer to ground, and must always be installed when the bushing is energized.

The maximum one minute test voltage for this voltage tap is 20 \( \text{kV}_{\text{rms}} \). The voltage tap can be used as a power source, if it is connected to an external capacitance. The operating voltage is limited to 6 kV.

![CAUTION!]

Do not energize the bushing without a test adapter or the cover installed. The cover connects the outermost conductive layer to ground and will prevent damage to the bushing.

---

**2.2 Transformer testing**

To simplify the transformer testing, several alternatives are available instead of using the GIS-system.

- The GSBK bushing can be used as an oil-to-oil bushing.
- The GSBK bushing can be replaced by an oil-to-air bushing, in the combinations listed in the table.

<table>
<thead>
<tr>
<th>Type</th>
<th>Alternative bushing</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSBK 245</td>
<td>GSB 245 or GOE(2) 1175-850</td>
<td>-</td>
</tr>
<tr>
<td>GSBK 362</td>
<td>GSB 362 or GOE(2) 1175-850</td>
<td>GOE(2) 1175-850 has an oil-side that is 110 mm shorter than GSBK 362.</td>
</tr>
<tr>
<td>GSBK 420</td>
<td>GSB 420 or GOE(2) 1425-1050</td>
<td>-</td>
</tr>
<tr>
<td>GSBK 550</td>
<td>GSB 550</td>
<td>-</td>
</tr>
</tbody>
</table>

**NOTE!**

The GSBK draw-rod system is not compatible with the GOE draw-rod system.
2.3 Technical specifications

2.3.1 General specifications

Refer to the table for the standard technical specifications of the bushing. For conditions exceeding the specifications, please contact ABB.

<table>
<thead>
<tr>
<th>Application:</th>
<th>Transformers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classification:</td>
<td>Transformer bushing</td>
</tr>
<tr>
<td>•</td>
<td>Resin impregnated paper, capacitance graded, oil immersed.</td>
</tr>
<tr>
<td>•</td>
<td>Temperature class E (120 °C) according to IEC 60137.</td>
</tr>
<tr>
<td>Ambient temperature limits:</td>
<td>-40 °C to +40 °C.</td>
</tr>
<tr>
<td>Immersion medium on switchgear side:</td>
<td>SF$_6$ gas.</td>
</tr>
<tr>
<td>•</td>
<td>Maximum daily mean temperature: +75 °C.</td>
</tr>
<tr>
<td>•</td>
<td>Maximum pressure: 850 kPa (abs).</td>
</tr>
<tr>
<td>•</td>
<td>Minimum pressure: 350 kPa (abs).</td>
</tr>
<tr>
<td>Immersion medium:</td>
<td>Transformer oil.</td>
</tr>
<tr>
<td>•</td>
<td>Maximum daily mean oil temperature: +90 °C.</td>
</tr>
<tr>
<td>•</td>
<td>Maximum temporary oil temperature, at normal load: +100 °C.</td>
</tr>
<tr>
<td>•</td>
<td>Maximum temporary oil temperature, at short time overload: +115 °C.</td>
</tr>
<tr>
<td>Oil-level in transformer:</td>
<td>Not lower than 30 mm from the bushing flange.</td>
</tr>
<tr>
<td>Maximum pressure of medium:</td>
<td>$p_g$ 100 kPa ($p_g$ = relative to ambient pressure).</td>
</tr>
<tr>
<td>Angle of installation:</td>
<td>From horizontal to vertical.</td>
</tr>
<tr>
<td>Test tap:</td>
<td>According to IEEE potential tap type A. $U_t = 600$ V.</td>
</tr>
<tr>
<td>Voltage tap:</td>
<td>According to IEEE potential tap type A. $U_t = 6$ kV.</td>
</tr>
<tr>
<td>Capacitance $C_2$ of test tap:</td>
<td>&lt;5000 pF</td>
</tr>
<tr>
<td>Arcing horns:</td>
<td>N/A</td>
</tr>
<tr>
<td>Conductor:</td>
<td>Center-tube conductor.</td>
</tr>
<tr>
<td>Markings:</td>
<td>Conforming to IEC/IEEE.</td>
</tr>
</tbody>
</table>
List of bushings applicable to this installation guide

<table>
<thead>
<tr>
<th>Type</th>
<th>Article number</th>
<th>Test tap 2 kV</th>
<th>Voltage tap 6 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSBK 170</td>
<td>1ZSC900170-AAA</td>
<td>1ZSC900170-ABA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1ZSC900170-AAB</td>
<td>1ZSC900170-ABB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1ZSC900170-ACA</td>
<td>1ZSC900170-ADA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1ZSC900170-ACB</td>
<td>1ZSC900170-ADB</td>
<td></td>
</tr>
<tr>
<td>GSBK 245</td>
<td>1ZSC900245-AAA</td>
<td>1ZSC900245-ABA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1ZSC900245-AAB</td>
<td>1ZSC900245-ABB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1ZSC900245-ACA</td>
<td>1ZSC900245-ADA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1ZSC900245-ACB</td>
<td>1ZSC900245-ADB</td>
<td></td>
</tr>
<tr>
<td>GSBK 362</td>
<td>1ZSC900362-AAA</td>
<td>1ZSC900362-ABA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1ZSC900362-AAB</td>
<td>1ZSC900362-ABB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1ZSC900362-ACA</td>
<td>1ZSC900362-ADA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1ZSC900362-ACB</td>
<td>1ZSC900362-ADB</td>
<td></td>
</tr>
<tr>
<td>GSBK 420</td>
<td>1ZSC900420-AAA</td>
<td>1ZSC900420-ABA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1ZSC900420-AAB</td>
<td>1ZSC900420-ABB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1ZSC900420-ACA</td>
<td>1ZSC900420-ADA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1ZSC900420-ACB</td>
<td>1ZSC900420-ADB</td>
<td></td>
</tr>
<tr>
<td>GSBK 550</td>
<td>1ZSC900550-AAA</td>
<td>1ZSC900550-ABA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1ZSC900550-AAB</td>
<td>1ZSC900550-ABB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1ZSC900550-ACA</td>
<td>1ZSC900550-ADA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1ZSC900550-ACB</td>
<td>1ZSC900550-ADB</td>
<td></td>
</tr>
</tbody>
</table>

2.3.2 Mechanical loading

Maximum permitted static load on the outer terminal

The load must be applied at the midpoint (2) of the outer terminal. The total cantilever load must be perpendicular to the bushing axis. The bushing can be installed in all positions from horizontal to vertical.

**NOTE!**
The loads described in this section are static loads, for dynamic loads such as earthquakes and extreme weather conditions, please contact your ABB sales representative.
### Load on the outer terminal

<table>
<thead>
<tr>
<th>Type</th>
<th>Cantilever load</th>
<th>Outer terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSBK 170</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>GSBK 245</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>GSBK 362</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>GSBK 420</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>GSBK 550</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

#### Maximum cantilever load on the outer terminal:
- **Type test load, 1 minute (kN)**
- **Maximum service load (kN)**

1. Cantilever load
2. Outer terminal
Load on the bushing flange

1 Bending moment
2 Compressive or tensile load
3 Shearing load
4 Bushing flange

<table>
<thead>
<tr>
<th>Type</th>
<th>Maximum bending moment on the bushing flange:</th>
<th>Maximum load on the bushing flange in service:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test load (kNm)</td>
<td>In operation (kNm)</td>
</tr>
<tr>
<td>GSBK 170</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>GSBK 245</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>GSBK 362</td>
<td>80</td>
<td>40</td>
</tr>
<tr>
<td>GSBK 420</td>
<td>80</td>
<td>40</td>
</tr>
<tr>
<td>GSBK 550</td>
<td>80</td>
<td>40</td>
</tr>
</tbody>
</table>

GIS pressure

The limit SF₆ gas pressures for the GIS side of the bushing.

<table>
<thead>
<tr>
<th>Type</th>
<th>Type test pressure 1 minute MPaₐ₁</th>
<th>Routine test pressure 1 minute MPaₐ₁</th>
<th>Maximum service pressure MPaₐ₁</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSBK 170</td>
<td>2.55</td>
<td>1.25</td>
<td>0.85</td>
</tr>
<tr>
<td>GSBK 245</td>
<td>2.55</td>
<td>1.25</td>
<td>0.85</td>
</tr>
<tr>
<td>GSBK 362</td>
<td>2.55</td>
<td>1.25</td>
<td>0.85</td>
</tr>
<tr>
<td>GSBK 420</td>
<td>2.55</td>
<td>1.25</td>
<td>0.85</td>
</tr>
<tr>
<td>GSBK 550</td>
<td>2.55</td>
<td>1.25</td>
<td>0.85</td>
</tr>
</tbody>
</table>
3 Delivery

3.1 Incoming inspection

- Make sure that all items have been delivered, refer to the packing list.
- Carefully inspect the bushings for shipping damage.

3.2 Transportation

- The bushing must be transported in the transport box.
- Make sure that the bushing is wrapped in the original (or equivalent) moisture proof wrapping. If the drying agent inside the wrapping has been exposed to the atmosphere, replace it.
- The bushing must be transported in the horizontal position.
- Carefully inspect the bushing for damage after transportation.

3.3 Storage

Short term storage, less than 6 months

- Make sure that the bushing is wrapped in the original (or equivalent) moisture-proof wrapping. If the drying agent inside the wrapping has been exposed to the atmosphere, replace it.
- The bushing can be stored outdoors, if it is in the transport box. Keep the transport box protected from water, when the bushing is stored outdoors.
- Keep the bushing dry, clean and protected against mechanical damage.
- The bushing can be stored in both the vertical, and horizontal positions.
Long term storage, more than 6 months

- Use transport containers on both sides of the bushing, they have to be ordered separately. Put drying agent in both transport containers.
- The bushing can be stored outdoors, if it is in the transport box. Keep the transport box protected from water, when the bushing is stored outdoors.
- Keep the bushing dry, clean and protected against mechanical damage.
- The bushing can be stored in both the vertical, and horizontal positions.

The bushing is delivered from ABB in a transport box, and the bushing is held in place by support blocks and fiberboard in the box.

3.4 Lifting

3.4.1 Lifting the transport box

Overview

1 Center of gravity
2 Soft lifting slings
3
Procedure

1. Make sure that the crane and the soft lifting slings are approved for the total weight of the transport box and bushing. Refer to the weight in the packing list.

2. Attach soft lifting slings (2).

3. Make sure that the angle of the soft lifting sling is not more than 20°.

4. Carefully lift the transport box.

5. Set down the transport box on a flat surface.

End of instruction

3.4.2 Lifting the bushing out of the transport box

Overview

Procedure

1. Make sure that the crane is approved for lifting the weight of the bushing. Refer to the weight on the rating plate.

2. Open the transport box.

NOTE!
The cover is attached with bolts.
3. Attach a soft lifting sling to the condenser core (1) and then to the crane hook.

4. Attach a soft lifting sling to the condenser core (1) and then to the crane hook.

5. Carefully lift the bushing.

6. Lower the bushing onto soft bedding.

End of instruction
4 Installation

4.1 Tools

<table>
<thead>
<tr>
<th>Tool</th>
<th>Part number</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifting tool</td>
<td>9ADA338</td>
<td>-</td>
</tr>
<tr>
<td>Soft bedding</td>
<td>-</td>
<td>E.g. rubber mat or wood board</td>
</tr>
<tr>
<td>Soft lifting slings</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Pull-through cord</td>
<td>9760 669-A</td>
<td>With M8 terminal. For assembly and disassembly of the draw rod.</td>
</tr>
<tr>
<td>Torque wrench key for hex socket</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>screws, 10 mm (M12), torque 20 to 40 Nm.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wrench for hex socket screws 30 mm or adjustable wrench for 30 mm bolts or larger.</td>
<td>-</td>
<td>For the test tap cover.</td>
</tr>
<tr>
<td>Shackles</td>
<td>-</td>
<td>To fit Ø 25 mm holes, for connection of the soft lifting slings to the bushing flange.</td>
</tr>
<tr>
<td>Hydraulic jack</td>
<td>2769 897-A</td>
<td>For removal, and installation of the bottom contact. Draw-rod system.</td>
</tr>
<tr>
<td>Box spanner</td>
<td>9760 669-B</td>
<td>For removal, and installation of the bottom contact. Draw-rod system.</td>
</tr>
<tr>
<td>Tackle</td>
<td>-</td>
<td>For installation of the bushing at a specific angle.</td>
</tr>
</tbody>
</table>

4.2 Consumables

<table>
<thead>
<tr>
<th>Item</th>
<th>Brand</th>
<th>ABB part number</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil based Vaseline</td>
<td>Fuchs</td>
<td>1171 5011-102</td>
<td>For treatment of contact surfaces. Does not react with transformer oil.</td>
</tr>
<tr>
<td>Mobilgrease 28</td>
<td>MOBIL</td>
<td>1171 4014-407</td>
<td>Lubricates and protects metals against corrosion. Protects rubber. Does not react with transformer oil.</td>
</tr>
<tr>
<td>Molykote 1000</td>
<td>Dow Corning</td>
<td>1171 2016-618</td>
<td>For the sealing and lubrication of the contact on the outer terminal.</td>
</tr>
</tbody>
</table>
4.3 Installation with fixed bottom contact

4.3.1 Installation of lifting tools

Overview

![Diagram of installation process]

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Soft bedding, i.e. rubber mat or woodboard</td>
</tr>
<tr>
<td>2</td>
<td>Lifting eye</td>
</tr>
</tbody>
</table>

Procedure

1. Install the lifting eyes (1) in the top end and intermediate flange.
2. Attach soft lifting slings (8) from the lifting eye to the crane hook.

3. For installation at a specific angle: attach soft lifting slings with a schackle (9) from the intermediate flange to the crane hook.
4.3.2 Installation with fixed bottom contact

**Diagram**

1. Bottom contact
2. Bushing
3. Pulling ring

**Procedure**

1. If the bushing has the optional transport container installed, remove it.

   **CAUTION!**
   
   Do not cause damage to the RIP-core when removing the transport container.
2. Make sure that there is a distance of $7 \pm 0.5$ mm between the pressing ring (17) and the pulling ring (3).

3. Make sure with a torque wrench that the six bolts are tightened with a torque of 40 Nm.

4. Make sure that the gasket is installed in the turret flange.

   NOTE!
   The gasket is supplied by the transformer manufacturer.
5. Lower the bushing onto the transformer.

6. When installing the bushing at the transformer factory:
   1. Make sure that the bushing is installed in the correct orientation.
   2. Make permanent markings (16) on the bushing flange and the transformer turret.

7. Install the bolts and washers. Tighten the bolts in a crosswise sequence.
   - When installing the bushing at site, make sure that the marking (16) on the bushing flange lines up with the marking on the transformer turret.

Torque

Refer to the transformer manufacturers documentation.
8. Remove the lifting eyes (1).

9. Put the winding cables through the end-shield.

10. Install the winding cables to the bottom contact.

**CAUTION!**
Make sure that there is no tension in the winding cables. Tension in the winding cables will cause damage to the bottom contact.

- **Torque**: 68 ± 6 Nm
11. Install the end shield:
   1. Push the end shield carefully against the pressing ring (17).
   2. Turn the end shield approximately 20°, to its locked position.

12. If the transformer will be oil-filled with the atmospheric process:
   1. Remove the hex screws (6).
   2. Put the blades of two screwdrivers in the recesses (19) in the outer terminal (5), and carefully push them down to lift the outer terminal (5) straight up.

   **CAUTION!**
   Do not cause damage to the shield (18).

13. The bushing is ready for oil-filling of the transformer, refer to *Oil-filling*, page 39.

End of instruction
4.4 Preparations with draw rod

4.4.1 Removal of the outer terminal

Procedure

1. If the bushing has the optional transport container installed, remove it.

   **CAUTION!**
   Do not cause damage to the RIP-core when removing the transport container.

2. Remove the hex screws (6).

3. Put the blades of two screwdrivers in the recesses (19) in the outer terminal (5), and carefully push them down to lift the outer terminal (5) straight up.

   **CAUTION!**
   Do not cause damage to the shield (18).
4. Install the lifting eye (1).

4.4.2 Removal of the lower draw rod with bottom contact from the bushing

Overview

The bottom contact is usually installed in the bushing when it is delivered from ABB, the first step at the transformer factory is thus to remove it.

1 Upper draw rod
2 Lower draw rod with bottom contact
3 Bottom contact
4 Bushing
Procedure

1. If the bushing has the optional transport container installed, remove it.

   **CAUTION!**
   Do not cause damage to the RIP-core when removing the transport container.

2. Put the pull-through cord (12) through the box-spanner (13).

   **NOTE!**
   The terminal on the pull-through cord (12) has M8 threads.

3. Apply Vaseline to the threads on the pull-through cord (12), then connect it to the upper draw rod.

   **NOTE!**
   Or use a lubricant with equal properties to Vaseline.
4. Remove the M16 nut (10) and washer (11), on the draw rod with the box spanner.

**CAUTION!**
Do not remove the compensation device.

**NOTE!**
Keep the draw-rod nut (10) and washer (11), they will be used again.

5. Pull down the draw rod from the bottom end of the bushing, and disassemble it at the lower joint (8).

**CAUTION!**
Do not disassemble the joint (7), this increases the risk of incorrect assembly.

The joint (7) is locked with high strength tread-locking fluid grade 42.

6. Carefully clean the bottom end of the bushing, and the inside of the center hole. Look for damage.

End of instruction

### 4.4.3 Installation of the large bottom contact in the transformer

**Overview**

1 Bottom contact
Procedure

1. Remove the transformer cover (13) from the transformer turret (11).

2. Install the winding cables to the bottom contact.

   **CAUTION!**
   Make sure that there is no tension in the winding cables. Tension in the winding cables will cause damage to the bottom contact.

3. Install the end shield:
   1. Push the end shield carefully against the pressing ring (17), until the springs are fully compressed.
   2. Turn the end shield approximately 20°, to its locked position.

End of instruction
4.4.4 Lifting the bushing for installation on the transformer

Procedure

1. Make sure that the crane can lift the bushing. Refer to the net weight in the packing list.

2. Align the crane hook with the lifting tool on the bushing.

3. Attach soft lifting slings (8) to the lifting tool and to the crane hook.

   **CAUTION!**
   Put soft bedding (2) under the bottom contact. The bottom contact is made of soft metal, and contact with the floor can cause damage.

4. For installation of the bushing at a specific angle:

   1. Attach soft lifting slings with a shackle (9) on the flange and to the crane hook.

5. Carefully lift the bushing from the floor.

   **CAUTION!**
   Make sure that the bushing does not rotate.

6. Adjust the shackle (9) until the bushing flange has the same angle as the transformer flange.

7. Lift the bushing to a position above the transformer.

   **CAUTION!**
   Make sure that the bushing does not rotate.
8. Align the bushing with the hole in the transformer turret.

4.5 Installation with draw rod

4.5.1 Installation of the bushing on the transformer

Overview

1 Draw-rod
12 Pull-through cord
Procedure

1. Connect the upper draw-rod (1) to the lower draw-rod (4).

2. Hold the pull-through cord (12) in tension, while lowering the bushing onto the transformer.

   **CAUTION!**
   Do not damage the stud bolts. There is a risk of metal falling into the transformer.

   **NOTE!**
   Plastic sleeves put on two or three of the stud bolts will help to guide the flange, and will prevent damage to the stud bolts.

3. When installing the bushing at the transformer factory:
   1. Make sure that the bushing is installed in the correct orientation.
   2. Make permanent markings (16) on the bushing flange and the transformer turret.
4. Install the bolts and washers. Tighten the bolts in a crosswise sequence.
   - When installing the bushing at site, make sure that the marking (16) on the bushing flange lines up with the marking on the transformer turret.

5. Install the draw-rod nut (10):
   1. Apply a generous quantity of Molykote to the nut (10), and the threads of the draw rod.
   2. Install the washer (11) and nut (10) on the draw rod, tighten with your fingers.
   3. Remove excess Molykote with a rag.

   **CAUTION!**
   If the nut (10) is not lubricated correctly, it will not be tightened to the correct torque. This can cause the bushing to fail.

6. Tighten the draw-rod nut (10).

   **Torque**
   10 Nm

7. Remove the pull-through cord (12).
8. Remove the lifting eyes (1).

9. Tighten the draw-rod nut, refer to Hydraulic tightening of the draw-rod nut, page 38, or Manual tightening of the draw-rod nut, page 36.

End of instruction

4.5.2 Manual tightening of the draw-rod nut

Overview

This procedure requires the draw-rod nut, washer and threads of the draw rod to be correctly lubricated. The draw rod will not get the correct tension if the fasteners are not correctly lubricated, this can cause the bushing to fail.

Procedure

1. Make sure that the draw-rod nut, and threads of the draw rod are correctly lubricaded, and that the draw-rod nut is tightened to 10 Nm.

2. Measure the distance (a).

**NOTE!**
The bushing is delivered with an information sheet that specifies the measurement (b-a). These values are measured when the bushing is manufactured, and are unique to every unit.
3. Turn the nut clockwise until you get the correct extension (b).

Distance (b) = (a) + extension, refer to the table.

**CAUTION!**
Make sure that you do not overtighten the nut. Use a torque wrench set to 140 Nm.

**NOTE!**
One turn of the nut corresponds to a 2 mm extension of the draw rod.

<table>
<thead>
<tr>
<th>Type</th>
<th>Extension CT 300 mm</th>
<th>Extension CT 300 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSBK 170</td>
<td>24.0 mm</td>
<td>24.5 mm</td>
</tr>
<tr>
<td>GSBK 245</td>
<td>24.5 mm</td>
<td>25.0 mm</td>
</tr>
<tr>
<td>GSBK 362</td>
<td>25.0 mm</td>
<td>25.5 mm</td>
</tr>
<tr>
<td>GSBK 420</td>
<td>25.0 mm</td>
<td>25.5 mm</td>
</tr>
<tr>
<td>GSBK 550</td>
<td>25.5 mm</td>
<td>26.0 mm</td>
</tr>
</tbody>
</table>

4. Make sure with a torque wrench that the nut is tightened with a torque of more than 70 Nm and less than 140 Nm.

5. Continue with *Installation of the outer terminal*, page 40.
4.5.3 Hydraulic tightening of the draw-rod nut

Overview

![Diagram showing hydraulic jack and draw-rod nut](image)

<table>
<thead>
<tr>
<th>8</th>
<th>Hydraulic jack</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Draw-rod nut</td>
</tr>
</tbody>
</table>

Procedure

1. Install the hydraulic jack (8).

2. Pull the draw rod with a force according to the table.

<table>
<thead>
<tr>
<th>Type</th>
<th>Force</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CT 300 mm</td>
</tr>
<tr>
<td>GSBK 170</td>
<td>39.5 kN</td>
</tr>
<tr>
<td>GSBK 245</td>
<td>39.1 kN</td>
</tr>
<tr>
<td>GSBK 362</td>
<td>39.1 kN</td>
</tr>
<tr>
<td>GSBK 420</td>
<td>39.0 kN</td>
</tr>
<tr>
<td>GSBK 550</td>
<td>39.4 kN</td>
</tr>
</tbody>
</table>

3. Tighten the nut on the draw rod with your hand.

4. Remove the hydraulic jack (8).

End of instruction
4.6 Oil-filling

Overview

Start this procedure when the transformer oil has reached the bottom of the bushing.

- This procedure is NOT applicable if the transformer is oil-filled with the vacuum process.

The purpose of this procedure is to remove as much air as possible from the center tube of the bushing. Because air is soluble in transformer oil, air will go into the transformer oil and will cause its performance to deteriorate. The amount of air that can be removed depends on the bushings position in relation to the transformers oil-conservator.

Oil spillage

Oil spillages that are not removed can be mistaken for oil-leakage at a later time, it is thus important to remove them.

Procedure

1. Make sure that the transformer oil-level is less than 30 mm from the flange.
2. Wait until the oil-level (h) in the center-tube has risen to the same height as the oil-level in the transformers oil-conservator.

   • If the top of the bushing is lower than the transformers oil-conservator, wait until oil flows out from top of the bushing.

   **NOTE!**
   Air is soluble in transformer oil, thus as much as possible must be released from the bushing center-tube.

3. Install the outer terminal, refer to *Installation of the outer terminal, page 40.*

   End of instruction

### 4.7 Installation of the outer terminal

**Procedure**

1. Carefully clean the contact and gasket surfaces with a soft cloth, and then apply Mobilgrease 28.

   **CAUTION!**
   Do not use a wire brush on aluminium surfaces, or silver coated surfaces. A wire brush can make scratches in the surfaces.
2. Carefully clean the contact and gasket surfaces with a soft cloth, and then apply Mobilgrease 28 to the contact surfaces and the O-rings (3).

**CAUTION!**
Do not use a wire brush on aluminium outer terminals. A wire brush can make scratches in the silver coating.

**NOTE!**
Or use a lubricant with equal properties to Mobilgrease 28.

**NOTE!**
When the outer terminal (5) is installed at site for grid operation, replace the used O-rings (3) with new O-rings. New O-rings are supplied with the bushing.

3. Put the O-rings (3) on the outer terminal (5).

**CAUTION!**
Make sure that the guide-ring (7) is in position.

4. Put the outer terminal (5) on the bushing.
5. Apply Mobilgrease 28 to the M10 hex screws (6).

**NOTE!**
Or use Molykote 1000 as an alternative.

6. Install the M10 hex screws (6).

7. Tighten the M10 hex screws (6) in a crosswise sequence.

**CAUTION!**
Make sure that the outer terminal moves straight down. Turn each bolt a little, and then the next bolt, until all bolts can be tightened to the correct torque.

8. Make sure that there is a distance of 2-3 mm between the outer terminal (5) and the pulling ring (8).

**NOTE!**
The current is conducted through the center-tube conductor and the outer terminal, thus it is important that there is good contact between the mating surfaces (9).
9. Prepare the contact surface of the outer terminal for the external connection. Refer to the documentation from the supplier of the external connection.

10. Install the external connections. Refer to the documentation from the supplier of the external connection.

End of instruction
4.8 Grounding of the bushing flange

Overview

The bushing flange must be grounded to the transformer tank. This prevents electrical discharge between the bushing flange and the transformer tank under normal service conditions.

There are two alternatives.

**DANGER!**

Make sure that the grounding is correct. An unsatisfactory grounding can cause damage to equipment, or death to personnel.

Procedure with a cone point set screw

1. Apply a large quantity of Mobilgrease 28 to the cone point set screw (13).
   
   **CAUTION!**
   
   The quality of the cone point set screw is important, stainless steel of A4-80 quality is recommended.
   
   **NOTE!**
   
   Or use a lubricant similar to Mobilgrease 28.

2. Install the cone point set screw (13).
   
   **NOTE!**
   
   The cone point of the set screw penetrates the paint. This makes an electrical connection between the bushing and the keeping them at the same potential.

   **Torque**
   
   M12: 40 Nm

End of instruction
Procedure with a flexible cable

1. Clean the contact surfaces.

2. Put a flexible cable (14) between the grounding hole in the bushing flange and a grounding point on the transformer.

3. Apply a large quantity of Mobilgrease 28 to the bolt (13).

   **CAUTION!**
   The quality of the bolt is important, stainless steel of A4-80 quality is recommended.

   **NOTE!**
   Or use a lubricant similar to Mobilgrease 28.

4. Install the bolt (13).

   Torque
   M12: 40 Nm

5. Connect the other end of the flexible cable (14) to the transformer.

   **NOTE!**
   This makes an electrical connection between the bushing and keeping them at the same potential.

End of instruction
5 Commissioning

5.1 Waiting time before energization

Waiting times after oil-filling of the transformer

Some waiting time is necessary after the transformer has been oil-filled, before the bushing is energized. The reason for this is that air bubbles stick to the bushings surface when the transformer is filled with oil, and flashovers and partial discharges can form in the bubbles. Thus, it is important to let the necessary waiting time pass, to make sure that all the air bubbles have risen to the surface of the oil before the bushing is energized. Refer to the table.

<table>
<thead>
<tr>
<th>The transformer is oil-filled with</th>
<th>Necessary waiting time</th>
</tr>
</thead>
<tbody>
<tr>
<td>The vacuum process</td>
<td>No waiting time is necessary, air bubbles does not form in vacuum. Refer to the transformer manufacturers instructions.</td>
</tr>
<tr>
<td>Gas-saturated transformer oil</td>
<td>After the oil-filling process has been completed, wait for 24 hours before energizing the transformer.</td>
</tr>
<tr>
<td>De-gassed transformer oil</td>
<td>After the oil-filling process has been completed, wait for 6 hours before energizing the transformer.</td>
</tr>
<tr>
<td>A reduced oil-level</td>
<td>After the oil-level has been restored, wait 24 hours before energizing the transformer.</td>
</tr>
</tbody>
</table>

5.2 Recommended tests before energization

5.2.1 Overview

The tests should be done to check the insulation, sealing and current path of the bushing.

NOTE!
The tests should be done after installation, but before connecting the outer terminal of the bushing to the power circuit.

5.2.2 Tightness test between transformer and bushing flange

Many different methods can be used, and we thus refer to the instructions given by the company responsible for field erection.

For example, the tightness of the seal between the transformer and the bushing flange can be examined when the transformer is oil-filled, with chalk or paper strips.
5.2.3 Measurement of capacitance and dissipation factor

Overview

After installation of the bushing, it is recommended to measure the capacitance values for future reference, such as repairs, service etc. This can be done on an installed bushing because it has an insulated test/voltage tap. Refer to 2750 515-142, “Bushing diagnostics and conditioning”.

- $C_1$ is the capacitance between the test/voltage tap and the outer terminal.
- $C_2$ is the capacitance between the test/voltage tap and ground.

**NOTE!**
The transport container must be removed before measuring the capacitance and dissipation factor (tan $\delta$).

Nominal capacitance

The capacitance ($C_2$) depends on the transformer, and it is not possible to give a nominal value that is valid for all service conditions. Thus, it is important to measure and record the capacitance ($C_2$) for future reference, such as repairs, service etc.

<table>
<thead>
<tr>
<th>Type</th>
<th>Space for CT = 300 mm</th>
<th>Space for CT = 600 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$C_1$</td>
<td>$C_1$</td>
</tr>
<tr>
<td>GSBK 170</td>
<td>496</td>
<td>656</td>
</tr>
<tr>
<td>GSBK 245</td>
<td>500</td>
<td>622</td>
</tr>
<tr>
<td>GSBK 362</td>
<td>405</td>
<td>494</td>
</tr>
<tr>
<td>GSBK 420</td>
<td>346</td>
<td>424</td>
</tr>
<tr>
<td>GSBK 550</td>
<td>286</td>
<td>353</td>
</tr>
</tbody>
</table>
Dissipation factor, tan $\delta$

The dissipation factor varies with the temperature of the bushing core, and thus the measured dissipation factor must be multiplied with the correction factor given below.

<table>
<thead>
<tr>
<th>Bushing core temperature °C</th>
<th>Correction factor to 20 °C (IEC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2</td>
<td>0.76</td>
</tr>
<tr>
<td>3-7</td>
<td>0.81</td>
</tr>
<tr>
<td>8-12</td>
<td>0.87</td>
</tr>
<tr>
<td>13-17</td>
<td>0.93</td>
</tr>
<tr>
<td>18-22</td>
<td>1.00</td>
</tr>
<tr>
<td>23-27</td>
<td>1.07</td>
</tr>
<tr>
<td>28-32</td>
<td>1.14</td>
</tr>
<tr>
<td>33-37</td>
<td>1.21</td>
</tr>
<tr>
<td>38-42</td>
<td>1.27</td>
</tr>
<tr>
<td>43-47</td>
<td>1.33</td>
</tr>
<tr>
<td>48-52</td>
<td>1.37</td>
</tr>
<tr>
<td>53-57</td>
<td>1.41</td>
</tr>
<tr>
<td>58-62</td>
<td>1.73</td>
</tr>
<tr>
<td>63-67</td>
<td>1.43</td>
</tr>
<tr>
<td>68-72</td>
<td>1.42</td>
</tr>
<tr>
<td>73-77</td>
<td>1.39</td>
</tr>
<tr>
<td>78-82</td>
<td>1.35</td>
</tr>
<tr>
<td>83-87</td>
<td>1.29</td>
</tr>
</tbody>
</table>

Procedure

1. De-energize the transformer.
2. Disconnect the external connections from the outer terminal of the bushing.
3. Remove the cover (2).
4. Connect the measuring equipment.
   1. Connect the low voltage cable to the stud (1).
   2. Connect the high voltage cable to the outer terminal.
   3. Connect the ground cable to the bushing flange (3).

5. Measure the capacitance ($C_1$) between the outer terminal and the stud (1).
   • Record the capacitance ($C_1$) for future reference.

   **NOTE!**
   Refer to the table for the nominal capacitance ($C_1$), *Nominal capacitance*, page 48.

6. Measure the capacitance ($C_2$) between the stud (1) and the flange.
   • Record the capacitance ($C_2$) for future reference.

7. Measure the dissipation factor:
   1. Start the measurements with a low sensitivity setting on the measuring bridge.
   2. Gradually increased the sensitivity setting on the measuring bridge to the highest possible.
   3. Calculate the dissipation factor with the correction factor, refer to *Dissipation factor, tan δ*, page 49.

   **NOTE!**
   In some cases, external interference can make it difficult to set the measuring bridge to zero.

8. Install the cover (2).

   **CAUTION!**
   The voltage tap is not self-grounding!
   The bushing can be destroyed if the voltage tap is not grounded. Because the capacitance ($C_2$) is usually relatively small, the voltage tap must never be open-circuited when applying a voltage to the bushing. It must always be grounded or connected to an external impedance.

   **CAUTION!**
   Do not energize the bushing without the cover or a test adapter installed. The cover connects the outermost conductive foil to ground and will prevent damage to the bushing.

   **CAUTION!**
   Make sure that the cover is correctly installed with the O-ring in place, when the bushing is not in use. The purpose is to prevent dust and water from entering the tap.
9. Connect the outer terminal of the bushing to the external connections.

End of instruction

5.2.4 Measurement of through-resistance

Overview

The method to use for measuring the through-resistance depends on the design of the transformer. In general, a current is applied from bushing to bushing. The voltage drop from the outer terminal to outer terminal is measured. The resistance is calculated with Ohm's law, $R=U/I$.

(R: total circuit resistance, U: measured voltage drop, I: through-current).

The total through-resistance is the sum of the transformer winding, lead resistance, the bushing conductor, and contact resistance. The additional resistance from the bushing conductor should not be more than 150 μΩ. Because the through-resistance of the HV winding of a typical power transformer is in the order of 0.1 to 1 Ω, this is a very rough method that can only be used to detect very large faults in the current path, such as open circuits.

Small faults in the current path can only be detected by making sensitive measurements across each connection point, or by measuring the temperature increase during operation with an infrared sensitive camera (thermovision).

The through-resistance of an installed bushing can only be measured from the outer terminal of one bushing, to the outer terminal of the other bushing on the same transformer winding. The through-resistance will include the resistance of both bushings, all connections and the transformer winding.

Procedure

1. Record the temperature of the transformer winding.

   NOTE!
   The resistance of metals depends on their temperature. Because the transformer winding usually dominates the total resistance, the average winding temperature at the time of measurement must be recorded.

2. Measure the through-resistance from outer terminal to outer terminal.

3. Calculate the measured resistance to the reference temperature. Then compare the calculated resistance to the reference resistance.

   A difference of less than 2% is acceptable.

   NOTE!
   The transformer manufacturer gives the reference temperature for through-resistance measurements.

4. If the calculated difference of resistance is more than 2% from the reference resistance:
   1. Make sure that the external connections have low resistance, and make sure that the outer terminal and the internal connections are correctly installed.
   2. Measure the through-resistance again.

5. If the calculated difference of resistance again is more than 2%:
   - Wait 24 hours and do steps 1 through 5 again.

End of instruction
6 Maintenance

6.1 Recommended maintenance

General

The bushings are maintenance free, no regular maintenance is necessary.

**DANGER!**

Risk of electrocution!

Do not go near the bushing while it is energized, or ungrounded. High voltages can kill you.

Make sure that the bushing is de-energized, and grounded before you do work on it.

Measurement of capacitance and dissipation factor

Please refer to *Measurement of capacitance and dissipation factor*, page 48.

Thermovision (infrared camera) check for local overheating on connectors

At the maximum rated current, the bushing outer terminal normally operates at a temperature of about +35 °C to +45 °C above the ambient temperature. Significantly higher temperatures can be a sign of bad connections, especially at lower current loading.

Checking of oil leakage

Make a visual inspection for oil leakage during regular station supervision.

After repairs

ABB recommends that the capacitance is measured after repairs have been done, after maintenance of connected equipment, or after work near the bushing is completed.

It is important to compare the capacitance before energization with the capacitance that was measured at commissioning. A change in capacitance gives indication of a fault. Refer to *Measurement of capacitance and dissipation factor*, page 48.
7 Re-packing

7.1 Removal of the bushing from the transformer, fixed bottom contact

Procedure

1. Install the lifting tool, refer to *Installation of lifting tools*, page 20.

2. Remove the end shield:
   1. Push the end shield carefully against the pressing ring (17).
   2. Turn the end shield approximately 20°, and lower it.

3. Remove the winding cables from the bottom contact.
4. Remove the bolts and washers.

5. Carefully lift the bushing from the transformer.

⚠️ CAUTION!
Do not cause damage to the stud bolts, there is a risk of metal falling into the transformer.

6. Install the transport cover (13) on the transformer turret (11).

7. Lower the bushing to the floor.

⚠️ CAUTION!
Make sure that there is soft bedding, or support blocks on the floor.

---

### 7.2 Removal of the bushing from the transformer, draw rod

#### Procedure

1. Install the lifting tool, refer to *Installation of lifting tools, page 20.*
2. Put the pull-through cord (12) through the box-spanner (13).

**NOTE!**
The terminal on the pull-through cord (12) has M8 threads.

3. Apply Vaseline to the thread on the pull-through cord (12), then connect it to the draw rod.

**NOTE!**
Or use a lubricant with equal properties to Vaseline.

4. Remove the M16 nut (10) on the draw rod with the box spanner (13).
5. Remove the bolts and washers.

6. Hold the pull-through cord (12) in tension, while lifting the bushing from the transformer.

   **CAUTION!**
   Do not damage the stud bolts, there is a risk of metal falling into the transformer.

7. Disassemble the draw rod at the lower joint (8). Use the key grip on the lower draw rod.

   **DANGER!**
   Make sure that the upper draw rod does not fall down when the lower joint (8) is disassembled.

   **CAUTION!**
   Do not disassemble the joint (7), this increases the risk of incorrect assembly.

   The joint (7) is locked with tread-locking fluid grade 42.
8. Pull up the draw rod, and install the washer (11) and nut (10).

⚠️ **CAUTION!**
Make sure that the centering ring (28) is in position, it is necessary for the correct installation of the draw rod.

9. Remove the pull-through cord.

10. Lower the bushing to the floor.

⚠️ **CAUTION!**
Make sure that there is soft bedding, or support blocks on the floor.

11. Install the lower draw rod (4) in the transport cover (13).

12. Install the transport cover (13) on the transformer turret (11).

End of instruction
7.3 Re-packing of the bushing

Overview

![Image of bushing re-packing](image1)

Procedure

1. For storage <6 months: wrap the bushing in the original protective wrapping, and replace the drying agent.

2. For storage >6 months: install the transport container (1):
   1. Replace the drying agent in the transport container (1).
   2. Install the gasket (2).
   3. Carefully put the transport container on the bushing, and install the bolts.

   **CAUTION!**
   Make sure that the transport container does not cause damage to the condenser core.

   **NOTE!**
   The transport container has to be ordered separately.

3. Lift the bushing. Refer to *Lifting the bushing out of the transport box, page 17.*
4. Lower the bushing into the transport box.

**CAUTION!**
Make sure that the support blocks are in the correct positions in the transport box.
Make sure that there is soft bedding in the transport box.

**CAUTION!**
Make sure that the test/voltage tap does not make contact with the transport box, or other objects.

5. Attach the bushing to the transport box in the same way as when it was delivered.

**CAUTION!**
Make sure that the bushing cannot move or rotate in the transport box.

6. Close the transport box.

**NOTE!**
Refer to *Lifting the transport box*, page 16 and *Transportation*, page 15.
### 8.1 Summary

If the bushing is damaged, we recommend that it is returned to ABB for repairs and re-testing. Some parts that are damaged or lost during transportation or installation can be ordered from ABB.

### 8.2 Spare parts

#### Cover

For the test/voltage tap.

<table>
<thead>
<tr>
<th>Position</th>
<th>Part</th>
<th>Article number</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cover</td>
<td>1ZSC00442-CAK</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>O-ring</td>
<td>2769 522-M</td>
<td>-</td>
</tr>
</tbody>
</table>

![Diagram of Cover](image-url)
### 8.3 Special tools

#### Lifting tool

<table>
<thead>
<tr>
<th>Part</th>
<th>Article number</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifting eye</td>
<td>9ADA338</td>
<td>2 pcs.</td>
</tr>
</tbody>
</table>

![Lifting tool diagram]

#### Pull-through cord

<table>
<thead>
<tr>
<th>Part</th>
<th>Article number</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pull-through cord</td>
<td>9760 669-A</td>
<td>With M8-terminal.</td>
</tr>
</tbody>
</table>

![Pull-through cord diagram]
## Hydraulic jack

<table>
<thead>
<tr>
<th>Part</th>
<th>Article number</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydraulic jack</td>
<td>2769 897-A</td>
<td>For removal, and installation of the bottom contact. Draw-rod system.</td>
</tr>
</tbody>
</table>

![Diagram of Hydraulic Jack](image1)

## Box-spanner

<table>
<thead>
<tr>
<th>Part</th>
<th>Article number</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box-spanner</td>
<td>9760 669-B</td>
<td>-</td>
</tr>
</tbody>
</table>

![Diagram of Box-spanner](image2)
9 Disposal and environmental information

9.1 Overview

This chapter specifies the materials used in the bushing. Comply with local environmental regulations on disposal of this product, the materials used are specified for this purpose.

9.2 Disposal and recycling

ABB strives to minimize the product's impact on the environment throughout its entire life cycle. Technical and product development focuses on environmental aspects. The ecocycle approach is striven for, and consideration is taken to the materials' environmental impact and recycling alternatives. The manufacturing processes are selected to be as safe for the environment as possible.

Disposal of worn-out equipment

Worn-out equipment must be disposed of in an environmentally sound manner. Much of the material, or the energy content in the material, can be recycled if it is sorted and cleaned. The quantity of material that can be recycled varies depending on the technical resources and capabilities in each country. Non-recyclable components should be sent to an approved environmental waste treatment plant for destruction or disposal.

The bushing has these parts and materials

- The conductor is made of low-alloy aluminum or copper.
- The outer terminal is made of silver plated aluminum, the pulling ring and bolts are made from stainless steel.
- The bottom contact is made of copper. The pulling ring and bolts are made of stainless steel.
- The bushing flange, outdoor housing, tap cover, and end-shield are made of aluminum. The fixed corona shield is made of aluminum.
- The test/voltage tap body is made of epoxy with a core of brass, cover of aluminum, cable and contacts of brass.
- The voltage tap option is filled with 200 cc of silicone gel.
- O-rings are made of rubber.
- The condenser core is made of paper, 1 % aluminum foil (by weight), 2 g of carbon and 1 g of lead. It also has small quantities of rubber bonded cork, rubber seals, braided copper wire (tinned), braided copper strap, silver glue and lead.

Gas

The SF$_6$ gas must be removed before disposal of the bushing. All handling of SF$_6$ gas must be done with care and according to the applicable regulations, to make sure that gas does not leak into the environment. Used gas can be:

- Regenerated on-site, and reused in other equipment.
- Sent to the gas supplier for regeneration.
- Sent for destruction at a special waste treatment plant.
If the bushing is filled with mixed gas, the SF$_6$ gas can be separated from the mixture for regeneration. As an alternative, the gas mixture can be sent for destruction without being separated. Upon request, ABB can provide a quote for final disposal of used gas in connection with the disposal of a bushing.

**DANGER!**

SF$_6$ gas must be recycled and not released into the atmosphere.

Porcelain

After cleaning, the porcelain can be sent for disposal or used for other purposes, such as for use as filling material.

Electronics

Electronics equipment should be sent to an approved recycling plant, or sorted into different component materials for correct processing.

Metals

Metals should be sorted according to type and surface coating, and sent to an approved recycling plant. After the removal of paint or other surface coatings, clean metal can usually be melted down and used in new products. Many metal components of iron, steel and aluminum are large and easy to identify, e.g. support structures. ABB strives to reduce the use of precious metals and the release of environmentally hazardous metals.

The recycling of precious metals is particularly important. Metals such as copper and silver are expensive, and are only present in small quantities in the earth's crust. Copper is primarily used in current conductors, contacts and cables. Some contacts are silver plated. Fumes from some metals can cause environmental damage, this applies to zinc and nickel, which are used sparingly as surface coatings.

Plastics

The different types of plastic should be separated and sent to an approved environmental waste treatment plant or recycling plant. The energy content in thermoplastics and thermosetting plastics can often be recovered through combustion at a plant built for the purpose. Thermoplastics can usually be melted down and reused without significant loss of quality. Composites can be fractioned and used as filling materials in other materials, or be disposed of.

Oils and greases

Before disposal of the bushing, oil, grease and similar products must be removed and sent to an approved environmental waste treatment plant or recycling plant. By utilizing gravimetric forces, oil waste can be separated into oil, water and a range of contaminants. In many cases, the oil can then be reused. As an alternative, the energy content in oil can be recovered through combustion at a plant designed for the purpose.

Rubber

Send rubber to an approved environmental waste treatment plant, either for disposal or reuse for different purposes.

Rubber is used in seals and gaskets.

Other materials

Sort other materials and send them to an approved environmental waste treatment plant.
10 Reference

10.1 Summary

- Markings: Conforming to IEC/IEEE.
- Bushing diagnostics and conditioning, 2750 515-142.
- The quality of the SF$_6$ gas must comply with standard IEC 60376.