On-load tap-changers, types UCC and UCD with motor-drive mechanism, type BUE

Maintenance guide
Recommended Practices

ABF Power Technology Products AB recommends careful consideration of the following factors for maintenance work on on-load tap-changers.

Before you start any work, make sure that the personnel doing the job have read and fully understood the Maintenance documents provided with the unit.

To avoid damaging the unit, never exceed the operating 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.

WARNING, CAUTION and NOTE

-------------------------- WARNING --------------------------

A WARNING provides information which, if disregarded, could cause injury or death.

-------------------------- CAUTION --------------------------

A CAUTION provides information which, if disregarded, could cause damage to the equipment.

NOTE: A NOTE provides additional information to assist in carrying out the work described.

Safety Precautions

-------------------------- WARNING --------------------------

The Maintenance Guide should be read and understood before any work is started, and the procedures in this document should be followed at all times.

-------------------------- WARNING --------------------------

Before any work is carried out on the on-load tap-changer:
Make sure that the transformer is disconnected and that earthing is properly carried out. Obtain a signed certificate from the engineer in charge.
WARNING
Before carrying out work on the on-load tap-changer, put the LOCAL/REMOTE switch in the motor-drive mechanism to position 0. It is also recommended to shut the door of the motor-drive mechanism and pad lock it when work is carried out on the on-load tap-changer. The key should be kept by the operator. This is done to avoid unexpected start of the motor-drive mechanism.

WARNING
Before starting any work inside the motor-drive mechanism, the auxiliary power must be switched off.

N.B. The motor, contactors and heating element may be energized from separate sources.

WARNING
In no case should any person go down into the diverter switch housing. The cleaning of the diverter switch housing should be carried out by using brushes and rags and by flushing with oil.

CAUTION
Approval should be given for inspection as well as for operating the on-load tap-changer.

CAUTION
ABB recommends that only maintenance engineers trained by ABB carry out contact replacement.

During Service

WARNING
Small amounts of explosive gases will always come out from the breathing devices (dehydrating breather or one-way breather). Make sure that no open fire, hot surfaces or sparks occurs in the immediate surroundings of the breathing devices.

WARNING
If a failure in power supply occurs during operation, the operation will be completed when the power returns.

WARNING
The hand crank must not be inserted during electrical operation.
**WARNING**

If the on-load tap-changer is not in its exact position and the hand crank is pulled out, the motor-drive mechanism will start and go to the exact position if the power supply is on.

---

**CAUTION**

*After a pressure relay trip, follow the instructions in the chapter "Pressure Relay" in the Repair Guide.*

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**During Oil Handling**

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**WARNING**

Unused transformer oil is slightly harmful. Fumes from unused warm oil may irritate the respiratory organs and the eyes. After long and repeated contact with transformer oil skin becomes very dry.

*Used* on-load tap-changer oil from diverter switch housings and selector switch housings contains harmful substances. Fumes are irritating to the respiratory organs and the eyes and are very easily set on fire. Used transformer oil may well be carcinogenic.

Avoid contact with the oil as much as possible and use oiltight protective gloves when handling the oil.

First aid:

- **Skin contact:** Wash the hands. Use skin cream to counteract drying.
- **In the eyes:** Rinse the eyes in clean water.
- **Swallowing:** Drink water or milk. Avoid vomiting. Call a doctor.

Collect used oil in oil drums.

Waste and cleaning up: Should be absorbed by an absorber. Treat it as hazardous to the environment.

Upon fire: The fire should be extinguished by using powder, foam or carbon acid.

---

**WARNING**

When oil that has been used in a diverter switch compartment is pumped out, conducting tubes and hoses that are earthed should be used to avoid the risk of explosion due to the gases produced by the arcs during service.

---

**WARNING**

The oil in the diverter switch compartment may be hot. Be cautious!

---

**WARNING**

There is always a cushion of explosive gases in the top of the diverter switch housing. No open fire, hot surfaces or sparks may be present during opening of the housing or draining from the valve. After the cover is removed let the gas vent away approximately 15 min before any work is started.
WARNING
Be aware of the risk for slipperiness caused by oil spillage for instance when working on the transformer cover.

CAUTION
Take care to avoid ingestion of moist air when oil is drained. If the ambient air is moist, let incoming air pass through a dehydrating breather with slow air flow to obtain proper dehydration.

CAUTION
Do not fill oil into the on-load tap-changer if the transformer tank is under vacuum and the on-load tap-changer is not.

CAUTION
Do not fill oil into the transformer tank if the on-load tap-changer is under vacuum and the transformer tank is not.

CAUTION
Leave a gas cushion on top of the oil in the diverter switch housing.

After Oil Filling

CAUTION
Do not energize the transformer earlier than three hours after oil filling in atmospheric pressure. This waiting period is needed to allow airbubbles to disappear.

Mounting of Gaskets

CAUTION
Sealing surfaces and gaskets must be clean and undamaged. Diametrically opposed bolts in sealing joints must be tightened alternately several times, beginning with a low tightening torque and finally with the recommended tightening torque as described in section 1.3 Tightening Torque, in this guide.
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1 Introduction

1.1 General

The UC range of on-load tap-changers manufactured by ABB has been developed over many years to provide maximum reliability. The simple and rugged design gives a service life equal to the service life of the transformer. Minimum maintenance is required for trouble-free operation. The only parts requiring maintenance are contacts that might need replacement during the service life, the insulating oil and the motor-drive mechanism.

The design allows excellent access to all parts, making inspection and maintenance quick and simple.

The on-load tap-changer, type UCC/UCD, is housed in the transformer tank. The motor-drive mechanism BUE is attached to the transformer tank and connected to the on-load tap-changer by means of drive-shafts and a bevel gear, see Fig. 1.

Fig. 1. On-load tap-changer and motor-drive mechanism
Fig. 2 shows the general arrangement of an on-load tap-changer type UC. The main components are the spring-operated diverter switch and the tap selector with sliding contacts. For maintenance the diverter switch is lifted. The contacts are then immediately accessible and can be inspected for wear. The drive-shafts should not be dismantled when lifting the diverter switch.

Maintenance is normally not required on the parts operating in the oil of the transformer tank. However, when the on-load tap-changer has made one million operations a check of the tap selector is recommended.

The diverter switch has its own housing separate from the transformer oil. This is to prevent contamination of the transformer oil since the diverter switch oil deteriorates due to the switching operations. The oil needs to be checked and filtered at regular intervals to maintain adequate dielectric strength as well as to prevent mechanical wear.

It is necessary to inspect the contacts and clean the insulation parts of the diverter switch as well as to clean the housing inside at regular intervals.

The main components of the diverter switch are:

- Fixed main contacts
- Moving main contacts
- Fixed transition contacts
- Moving transition contacts
- Transition resistors
- Spring-driven polygon link system.

Besides the maintenance of the diverter switch and cleaning of the oil, the motor-drive mechanism should be checked and lubricated.

The pressure relay, the device that protects the transformer from damages due to excessive pressure in the diverter switch housing, should also be checked.

**NOTE:** One on-load tap-changer of UCD type may in rare cases consist of two units driven by a common motor-drive mechanism. The instructions in this guide deals with one unit. If there is two units, all work described should be carried on all units unless otherwise is stated. If more than one diverter switch is lifted out at the same time, make sure the right diverter switch is lowered into the right housing (compare with the serial numbers, see Fig. 2).

### 1.2 Maintenance Schedule

Maintenance of the on-load tap-changer consists of three major steps:

- Inspection
- Overhaul
- Contact replacement.
**Diverter switch housing**

- Bevel gear
- Position indicator
- Serial No.
- Earthing terminal
- Connection flange for gas operated relay
- Insulating shaft
- Shielding-ring
- Transition resistors
- Fixed and moving contacts
- Serial No.
- Guide-pins
- Driving disc for the diverter switch
- Bottom valve for drying process
- Intermediate gear

**Tap selector**

- Geneva gear
- Change-over selector
- Moving fine-selector contacts
- Fixed fine-selector contacts
- Conductors to diverter switch housing
- Current collectors

---

1) Only at impulse withstand voltage to earth of 650 kV and 1050 kV

---

Fig. 2. General arrangement of on-load tap-changer, type UC. (UCC/UCD have a completely horizontal flange, but all equipments are the same).
1.2.1 Inspection

On the rating plate, “inspection once a year” is recommended. This principally concerns the motor-drive mechanism and refers to a visual inspection inside the motor-drive cabinet to check that nothing is loose and the heater is functioning.

In the motor-drive mechanism a counter registers every tap-changer operation. During inspection the counter is read. If possible, motor and counter are tested by operating one step and then back.

If the on-load tap-changer has its own oil conservator, the breather and the oil level indicator are checked according to the instructions from the transformer manufacturer.

The inspection is carried out while the transformer is in service.

If the on-load tap-changer is equipped with an oil filter unit from ABB, it should be inspected once a year according to the "Oil filter unit for on-load tap-changers, manual”.

1.2.2 Overhaul

The contact life and the frequency of operations or the time in service determine the interval between overhauls.

The number of operations run by the on-load tap-changer is recorded by a counter, housed in the motor-drive mechanism cabinet. The registered number of operations should be noted at every inspection and overhaul.

The on-load tap-changer should normally be overhauled regularly at intervals of 1/5 of the estimated contact life. The relevant information is stated on the rating plate. Hereby, the contact wear can be followed and necessary preparations can be made for replacing the contacts.

If the tap-change operations occur infrequently and a very long time elapses until the number of operations amounts to 1/5 of the contact life, the interval between overhauls should be limited to the time stated on the rating plate (normally 7 years).

1.2.3 Contact Replacement

On the rating plate of the on-load tap-changer the estimated contact life of the breaking contacts in the diverter switch at rated load is stated.

The contacts will withstand a very large number of switching operations. For normal power transformers the number of operations of the diverter switch is approximately 20 per day, which means that replacement of the contacts is not normally necessary during the life of the transformer. (In case of on-load tap-changers on furnace transformers, the frequency of operations may be considerably higher).

---

**CAUTION**

*The number of operations must in no case exceed 500 000, due to weakening spring tension of the contacts.*
1.3 Tightening Torque

The following tightening torques are recommended for metallic screw joints:

- M6, 10 Nm ±10 %
- M8, 24.5 Nm ±10 %
- M10, 49 Nm ±10 %
- M12, 84 Nm ±10 %

for non-metallic screw joints:

- M10, 9 Nm ±10 %
- M12, 13 Nm ±10 %
- M16, 22 Nm ±10 %

if not otherwise is stated in this guide.
2 Inspection

The inspection mainly consists of a visual check of the motor-drive mechanism and the conservator once a year while the transformer is in service.

In the motor-drive mechanism the following points are to be checked:

■ Motor and counter
■ Heater
■ The counter’s value.

On the conservator the following are to be checked:

■ Oil level
■ Breather

2.1 Required Tools and Materials

The following equipment is required for the inspection:

■ Set of screwdrivers
■ Pen and note pad.

2.2 Procedure

--- CAUTION ---
Approval should be given for inspection as well as for operating the on-load tap-changer.

--- WARNING ---
This work must be carried out from ground level since the transformer is energized!

1. Check the breathers according to the instructions for the transformer.

--- WARNING ---
The breathers and the tube from the conservator contains explosive gases. No open fire, hot surfaces or sparks may be present when loosening the breather.

2. Check the oil level in the conservator for the on-load tap-changer. The oil level should be according to the transformer documentation.

See Fig. 3
3. Open the cabinet door of the motor-drive mechanism and turn the selector-switch to the LOCAL position. Then turn the control switch to the RAISE (LOWER) position.

4. Check that the motor works properly, the position indicator increases (decreases) one step and the counter advances one step for each operation. Record the counter’s value. The counter shows the number of operations run by the on-load tap-changer (the overhaul-schedule can be determined with the help of this information).

5. Turn the control switch to the LOWER (RAISE) position for 1-2 seconds. Check that the motor also works properly in that direction, the position indicator decreases (increases) one step and the counter advances one step more. Reset the draghands.

6. Check the emergency stop.
   Give a RAISE or LOWER impulse and after about one second press the emergency stop. The operation should be interrupted. Reset the emergency stop by turning the knob clockwise and by switching on the protective motor switch. The started operation should now be completed. Operate back to service position.

7. Check the earth fault protector (option).
   If the motor-drive mechanism is equipped with an outlet, the earth fault protector should be tested by pressing the test knob on the outlet.

8. Disconnect the incoming auxiliary power.

---

**WARNING**

Before starting any work inside the motor-drive mechanism the auxiliary power must be switched off.

N. B. The motor, contactors and heating element may be energized from separate sources.

---

9. Open the control panel

10. Check by feeling with a finger on the protection plate that the heater has been functioning.

11. Close the control panel and reconnect the incoming auxiliary power.

12. Complete the inspection by turning the switch to the REMOTE position and closing the cabinet door.
Layout of Motor-Drive Mechanism, type BUE

1. Locking device prepared for padlock
2. Emergency stop
3. (Option) Switch for extra heater
4. Air vent
5. LOCAL/REMOTE switch
6. RAISE/LOWER switch
7. Outgoing shaft
8. Lamp (40 W socket E27)
9. Lifting eye
10. Counter
11. Tap-change in progress indicator
12. Position indicator with draghands for max. and min. position
13. Shaft for handcrank
14. Heater 50 W + optional 100 W (behind the panel)
15. (Option) Outlet with earth fault protector
16. Terminal blocks (behind the panel)
17. Protective motor switch
18. (Option) Thermostat or hygrostat for extra heater 100 W
19. Door-operated switch for lamp
20. Handcrank
21. User's manual and circuit diagram
3 Overhaul

--- WARNING ---
Before any work is carried out on the on-load tap-changer:
Make sure that the transformer is disconnected and that earthing is properly carried out. Obtain a signed certificate from the engineer in charge.

--- CAUTION ---
Some UCC are of the reinforced type to withstand higher short circuit currents. Those diverter switches are equipped with magnetic yokes on the current contacts.

Overhaul on those UCC:s must not be carried out by others than engineers from ABB.

3.1 Required Tools and Materials

Necessary for the overhaul is the following equipment:

- Normal hand tools (keywidth up to 19 mm)
- Normal set of combination spanners
- Thickness gauges (0.40; 0.50; 1.20 mm)
- Small hammer
- Sliding caliper
- Spring balance (10 N)
- Watch (with hand for seconds)
- Oil can
- Ohmmeter (1-30 Ohm)
- Air pump with pressure gauge (0-200 kPa) and connection to R 1/8” male thread
- Telpher (at least 300 kg lifting force)
- Empty and clean barrels for transformer oil (approximately 1000 l)
- Oil draining and filtering equipment with connections
- Test equipment according to IEC 156
- Bucket (approximately 10 l)
- Rags (non-fuzzing)
- 50 l of new transformer oil (class II according to IEC 296)
- Grease (GULF-718 EP synthetic grease, Mobilgrease 28, Shell-Aero Shell grease 22 or similar)
- Oil (for plain ball and roller bearings)
- Degreasing agent
Protective gloves, oil proof
Dimension drawing for the on-load tap-changer
Pen and note pad
Set of spare contacts (see ”Spare parts list for UC”)
New O-ring for the cover (806x10).

When restoring the gas cushion. (section 3.18.5):
Small oil pump with connection to the oil valve
Empty and clean barrel for transformer oil (~ 50 l)
Box wrench 6 mm.

When measuring contact timing, add this equipment:
See section 3.19.

When replacing contacts (chapter 4), add this equipment:
Small crowbar
Large adjustable wrench
Allen keys
L-shaped Allen keys
Spacer sleeves (see Fig. 28)
Vice
Steel ruler.

3.2 Procedure
The overhaul procedure includes the following points:
Oil testing and oil draining
Lifting and cleaning the diverter switch
Cleaning the diverter switch housing and the oil filter (if any)
Oil filtration
Checking the breathers
Checking the contact positions
Checking the contact wear
Checking the transition resistors
Checking before lowering the diverter switch
Lowering the diverter switch
3.3 Preparations

NOTE: If the on-load tap-changer is oil filled under atmospheric pressure, a waiting period of three hours is needed before energizing. To save outage time of the transformer, carry out all work on the on-load tap-changer and the oil filling before the maintenance of the motor-drive mechanism is started.

3.3.1 On-Load Tap-Changer Position

Note the position of the on-load tap-changer to enable restart of the transformer in the right tap position.

3.3.2 Disconnection and Earthing of the Transformer

WARNING
Before starting any work in the on-load tap-changer the protective motor switch and the LOCAL/REMOTE switch must be set at 0.

WARNING
Before any work is carried out on the on-load tap-changer: Make sure that the transformer is disconnected and that earthing is properly carried out. Obtain a signed certificate from the engineer in charge.

3.3.3 Oil Volumes and Lifting Heights

The necessary number of empty drums for collecting and filtering of the oil in the diverter switch housing should be kept ready. The drums must be carefully cleaned and free from water. New oil needed should be of class II according to IEC 296.

| Quantity of oil in the diverter switch housing and lifting height for the diverter switch |
|---------------------------------|----------|--------------------------------|
| UCC/UCD. 380/... | Approx. 770 litres (lifting height 1.7 m) |
| UCC/UCD. 650/... | Approx. 840 litres (lifting height 1.9 m) |
| UCC/UCD. 1050/... | Approx. 950 litres (lifting height 2.2 m) |
NOTE: The volume of the oil conservator is not included.

Alternatively, the oil may be replaced by new oil and the used oil filtered at some later occasion. A certain quantity of new oil, at least 50 litres, should be kept ready to replace waste oil and for cleaning.

CAUTION

Do not energize the transformer until oil has been filled as per section 3.18 "Oil Filling" in this guide.

3.3.4 Recommended Set of Spare Parts

It is recommended to have a set of contacts for the diverter switch available during the overhaul, see Spare Parts List for ordering.

3.4 Oil Testing and Oil Draining

The diverter switch housing is equipped with an oil valve placed on the top section. For connection dimensions, see the dimension drawing for the on-load tap-changer.

WARNING

The oil in the diverter switch housing may be hot. Be cautious!

Take an oil-sample from the oil valve and carry out the dielectric strength test according to IEC 156 (between spherical calottes, distance 2.5 mm). This test is carried out for deciding whether the oil can be filtered or must be exchanged.

The dielectric strength of the oil should not be allowed to be less than 120 kV/cm for an on-load tap-changer in service.

NOTE: When taking the oil-sample, first drain some oil into a bucket to clean the valve.

If the oil conservator of the on-load tap-changer is common with the oil conservator of the transformer tank, close the valve in the pipe connection to the oil conservator and open the oil valve. After a while, open the air release valve. See Fig. 16.

NOTE: If the on-load tap-changer is equipped with an oil filter unit for continuous oil filtration from ABB and it is maintained and operated according to our instructions, oil draining and filtering is not needed, provided that the dielectric strength is at least 160kV/cm (IEC 156).

Use the filtering equipment or the pump to drain oil from the on-load tap-changer into carefully cleaned oil drums. Connect the pump to the oil valve and drain the oil from the diverter switch housing and the conservator. Draining can be effected quickly if filtering equipment is used and at the same time the whole oil quantity will be filtered once. Remove the cover of the diverter switch housing while draining.
**WARNING**

There is always a cushion of explosive gases in the top of the diverter switch housing. No open fire, hot surfaces or sparks may be present during opening of the housing or draining from the valve. After the cover is removed let the gas vent away approximately 15 min before any work is started.

---

**WARNING**

When oil that has been used in a diverter switch housing is pumped out, conducting tubes and hoses that are earthed should be used to avoid the risk of explosion due to the gases produced by the arcs during service.

---

![Fig. 4. Diverter switch, general arrangement](image-url)
3.5 Lifting and Cleaning the Diverter Switch

The weight of the diverter switch is approximately 250 kg.

Lift the diverter switch partly so you can flush it with oil. After careful flushing, lift the diverter switch from the housing and wipe it with rags.

Lift according to Fig. 6.

**NOTE:** If the on-load tap-changer is equipped with an oil filter unit for continuous oil filtration from ABB and it is maintained and operated according to our instructions, the flushing and wiping of the diverter switch is not necessary.

---

**CAUTION**

When lifting the diverter switch, use a manually operated telpher to avoid damages on the diverter switch. Make sure that the end of the tie-rod or its coupling is kept clear of the inner edge of the flange.

---

**WARNING**

Make sure that all lifting equipments are dimensioned and used properly.

---

3.5.1 Lifting Rig

The diverter switch (mass approx. 250 kg) can be lifted out of the housing by means of a telpher. As a holder for the telpher, it is recommended to use a rig similar to the one shown in Fig. 5. Install the supports on the flange of the top-section after the cover is removed (Fig. 6).
**WARNING**

Make sure the rig is properly fixed to the cover flange before the diverter switch is lifted.
3.6 Cleaning

3.6.1 Cleaning the Diverter Switch Housing

Clean the inner walls of the housing by means of a nylon brush, then flush with oil. Drain the oil. Wipe the bottom and inner walls with rags.

NOTE: If the on-load tap-changer is equipped with an oil filter unit for continuous oil filtration from ABB and it is maintained and operated according to our instructions, the cleaning of the diverter switch housing is not necessary.

WARNING
In no case should any person go down into the diverter switch housing. The cleaning of the diverter switch housing should be carried out by using brushes and rags and by flushing with oil.

3.6.2 Cleaning the Oil Filter in the Conservator Pipe (if any)

The diverter switch housing and the oil conservator are connected by a pipe. The diverter switch oil is contaminated due to the arcing that occurs when the contacts operate. In case of a common conservator with the transformer the impure oil in the diverter switch housing must be prevented from entering the oil conservator. An oil filter is therefore mounted in the pipe.
The filter, which is mounted in a flange pipe on the top of the diverter switch housing, is screwed from the inside. It can easily be screwed out for inspection and cleaning. The oil filter does not need to be replaced nor cleaned in any other way than by washing with oil.

![Diagram of Oil Filter](image)

**Fig. 7. Oil filter details**

### 3.7 Oil Filtration

The drained oil should be filtered until it is cleaned and has regained the high dielectric strength required. The break-down value for purified oil should be at least 160 kV/cm according to IEC 156.

To check the result of the filtering, take test sample during the oil filtration and after the oil has been filled into the on-load tap-changer.

**NOTE:** If the on-load tap-changer is equipped with an oil filter unit for continuous oil filtration from ABB and it is maintained and operated according to our instructions, no further oil filtration is necessary. Only take a sample and measure the dielectric strength of the oil, see section “Oil Testing and Oil Draining” in this guide.

### 3.8 Checking of the Breathing Device

Check the breathing device according to the instructions from the transformer manufacturer.

---

**WARNING**

The breathers and the tube from the conservator contains explosive gases. No open fire, hot surfaces or sparks may be present when loosening the breather.
3.9 Checking the Contact Positions

Those parts of the fixed contacts and the moving contacts which are exposed to arcing during an operation are tipped by copper-tungsten.

In a tap position, the moving main switching contacts and the fixed main switching contacts should have a clearance of min. 0.5 mm as shown in Fig. 8.

For checking the clearance on both sides of the diverter switch it has to be operated. Operate it by turning the key grip, see Fig. 26. Note the position of the diverter switch before operation.

**WARNING**

Take care to avoid finger injuries when operating the diverter switch. Oil splash occurs during operation, especially in the moving direction.

If the clearance is too small on most of or all of the contacts, contact ABB for advisory. If the clearance is too small on a few contacts, they might be adjusted in this way:

Break up the polygon link device with a crowbar as shown in Fig. 25 until the moving main contact to be adjusted has broken from the fixed main contact, see Fig. 8. The main switching contacts should still be making.

Put a mandrel on the back of the moving main contact, halfway between the end of the lining and the bearing hole. Punch slightly on the mandrel. Force the diverter switch back to its service position by using an adjustable wrench as shown if Fig. 26. Measure the clearance again.

This procedure needs normally to be repeated several times before the clearances are right.

Proceed with the other side of the diverter switch. When finished, operate the diverter switch to the position it had before the first operation.

Fig. 8 shows the current path through the fixed main contact in a tap position. The figure also shows the copper part of the moving contact.
Make sure that all flexible connections, operating springs, contact springs and all plug-in contacts are in good condition. Make sure that no bolts have worked loose.

### 3.10 Checking the Contact Wear

The contact system consists of fixed and moving contacts.

Check the degree of contact burning of the breaking contacts.

![Image](image)

*Fig. 9. Tolerance limits for contact burning*  

For a new contact with tips of copper-tungsten (Fig. 9), the thickness at (A) and (B) is 5.5 mm in the upper end of the contact. In the lower end, the thickness is 3 mm.

Estimate the degree of contact burning and record this to enable comparison with the condition at the next overhaul. Do not file or smooth the burned and pitted contact surfaces.

A contact with a tip of copper-tungsten (Fig. 9) should be replaced when the thickness at (A) and (B) in the upper end of the contact is approximately 0.5 mm. (The thickness in the upper and the lower end of the tip will be approximately the same when close to the limit for replacement).

Also replace contacts which are assumed to wear out before the next overhaul.

The dimensions above are valid for both main contacts and transition contacts. For contact replacement, see chapter 4 “Contact Replacement”.

### 3.11 Checking the Transition Resistors

Measurement is carried out on the side with open contacts. Connect one cable from the ohmmeter to a fixed main contact and the other cable to a fixed transition contact. Measure the resistance.

Measure the resistance of each resistor branch across the open switch.

Operate the diverter switch to the other side as described in section 3.9 and measure the resistance with open contacts.

Check that the resistors are undamaged and compare with the value given on the rating plate. The value must not differ by more than 10 %.
Check that nothing has worked loose. Operate the diverter switch back to its previous position.

### 3.12 Checking before Closing

Before installing the diverter switch, make sure that no foreign objects, tools, wires, rags etc. are left in the diverter switch housing.

### 3.13 Installation of the Diverter Switch

---

**CAUTION**

*Check the serial numbers to make sure that the diverter switch is mounted in the correct housing, see Fig. 2.*

---

**CAUTION**

*Make sure that the diverter switch housing is clean and free from water and that no foreign objects (tools etc.) are left in the housing.*

---

**CAUTION**

*Lower the diverter switch into its housing carefully so that neither the diverter switch nor the housing is damaged.*

---

The diverter switch is provided with two guiding slots that fit the guide bars in the diverter switch housing, see Fig. 10.

Rotate the diverter switch so the widest slot is aligned with the widest guiding bar, see Fig. 10.

When the diverter switch is lowered, check visually that its plug-in contacts are aligned with the contacts in the cylinder wall.

The top part of the diverter switch lifting device should be at least 1 mm under the level of the machined surface of the upper flange, see Fig. 10, when lowered to its final position. If not, push the diverter switch down to its final position.

In order to ensure that the diverter switch pin has engaged the driving disc, carry out at least **three** tap change operations in **one** direction. A distinct sound can be heard when the diverter switch operates which indicates that the driving pin of the diverter switch has been connected.

If check of contact timing should be carried out, proceed with that according, to section 3.19 before mounting the cover.

Insert a new O-ring for the cover in the upper flange. Mount the on-load tap-changer cover. Turn the cover so the guiding pin in the housing is facing the guiding hole in the cover. (The cover must be pressed down in order to overcome the spring force of the springs which hold the diverter switch in place.) Insert screws and washers and tighten them.
Fig. 10.

Lifting eye
Lifting device
Shielding-ring
(not on 380 kV withstand voltage to earth and lower)
Plug-in contacts
Guiding slot
Tie-rod
Driving pin
Serial number

Fig. 10a.

Notch for the driving-pin
Holes for guiding pins
Upper part of the diverter switch
Guide bars
Min. 1 mm

Fig. 10b.
3.14 Checking the Pressure Relay

3.14.1 Functional Check of the Pressure Relay

Fig. 11. Pressure relay

1. Set the valve handle to the test position as shown on the information plate.

2. Connect the air pump and the pressure gauge to the test tap on the pressure relay. (Thread R 1/8”).

3. Raise the pressure until the pressure relay trips the circuit breakers of the transformer.

4. Read the pressure on the manometer and check against the pressure stated on the information plate. Max. permitted deviation is ±10 %. If the deviation is greater, the pressure relay should be replaced.

5. Check that the signal disappears when the pressure is released.

6. After finishing the check, turn back the valve handle to service position.

3.14.2 Replacing the Pressure Relay

If replacement of the pressure relay is necessary, it is carried out according to the instruction in IZSE 5492-129, Repair Guide for On-Load Tap-Changers types UCG, UCL, UCC, UCD.
3.15  **Lubrication of the On-Load Tap-Changer and the Drive Shaft System**

The bevel gears are greased at delivery and the same type of grease is used for the couplings of the outer shaft system.

For access to the couplings, loosen the hose-clips and push the protective tubes together. For access to the bevel gears, dismount the covers.

---

**WARNING**

The bevel gear contains moving gears. Be cautious!

---

**WARNING**

Rotating shafts. Be cautious!

---

Check and lubricate with grease if necessary. Recommended types of grease are GULF-718 EP Synthetic Grease, Mobilgrease 28, Shell-Aero Shell Grease 22 or similar.

Remount covers (make sure the gaskets are properly in place).

3.16  **Checking of Motor-Drive Mechanism**

The motor-drive mechanism should be checked and lubricated at the same time as the on-load tap-changer.

The overhaul includes the following points:

**Before disconnecting the power supply:**

- Motor protection function
- Earth fault protection (option)
- Counter function

**After disconnecting the power supply:**

- Heater function
- Toothed belt
- Cable connections
- Disc brake function
- Position transmitter and other position switches
- Lubrication

Reconnect the power supply and make operation tests according to section 3.17.
Fig. 12. Motor-drive mechanism, type BUE
3.16.1 Motor Protection

Open the motor-drive cabinet door and turn the selector-switch to the LOCAL position. The function of the protective motor switch is checked. For three-phase AC motors, one of the phase fuses is removed and the function time of the protective motor switch is checked by a RAISE or LOWER operation. The protective motor switch shall release within 60 seconds at a current setting equal to the rated current of the motor at actual voltage.

---

**WARNING**

The motor power voltage is dangerous.

---

If the protective motor switch do not trip within 60 seconds, switch off the power and adjust the current setting. Repeat the test when the motor is cold.

Protective motor switches for DC motors and for single-phase AC motors are not tested.

3.16.2 Earth Fault Protection (option)

If the motor-drive mechanism is equipped with an outlet, the earth fault protector should be tested by pressing the test knob on the outlet.

3.16.3 Counter

Check that the counter is functioning at RAISE and LOWER operations. Check that the position indicator increases (decreases) one step and the counter advances one step for each operation. Record the counter’s value. The counter shows the number of operations run by the on-load tap-changer.

3.16.4 Heater

---

**WARNING**

Before starting any work inside the motor-drive mechanism, the auxiliary power must be switched off.

N.B. The motor, contactors and heating element may be energized from separate sources.

---

Check by feeling with a finger that the heating element has been functioning.

3.16.5 Toothed Belt

Check that the toothed belt is sufficiently tight. If tightening is required, adjust the motor support. The tightness of the belt can be checked by a spring balance attached to the belt halfway between the pulleys. At a 10 N load the belt should yield about 5 mm.
3.16.6 **Cable Connections**

Check that all cable connections within reach are secure.

3.16.7 **Disc Brake**

Wipe the brake disc free from grease.

The kinetic energy in the motor and the toothed wheels should be absorbed by the brake, and the motor-drive mechanism should stop, as shown in Fig. 13, with a tolerance of ± 25 degrees as measured on the brake disc (± 125 degrees measured on the hand crank), see Fig. 13.

This can be adjusted by tightening both of the spring bolts on the brake. Using the hand crank, operate the motor-drive mechanism until the brake is fully open. At this point the length of the springs must not be less than 35 mm. If the brake still does not function with that spring length, oil or grease has entered the brake linings, which will then need cleaning.

Clean as follows:

Using a pair of tongs, remove the roll pins that hold the supporting shafts on the brake blocks, see Fig. 12. Then remove the shaft and the brake blocks. Clean the brake linings on the two brake blocks with degreasing agent.

When refitting the brake, check that the brake disc is completely free from grease. Adjust the spring force of the brake until the motor-drive mechanism stops within the tolerances given above.

---

**CAUTION**

*If the motor-drive still not stops when the brake is adjusted to a spring length of 35 mm when the brake is fully open, please contact ABB for advice.*

---

![Fig. 13. Brake adjustment](image)
3.16.8 Brake for the Maintaining Contact

Check that the brake for the maintaining contact prevents the arm system on the maintaining contact shaft from swinging beyond its normal position when the roller on the driving arm moves free from the cam disc, see Fig. 12. At the end of the operation, contacts for operation in the opposite direction shall not move when the arm system swings back towards its normal position.

Unpermitted swinging should be prevented by raising the braking force, i. e. tightening the spring bolt.

An adjusted increasing spring force on the disc brake makes the maintaining contact arm swing back with a different speed, and the brake for the maintaining contact must be adjusted.

3.16.9 Position Transmitter and other Position Switches

Clean the contact plates and arms (Fig. 14) from dust and dirt with a dry cloth.

Check and adjust the resilience of the moving contacts in the multi-position switches. The moving contact shall, in all positions, have a clearance between the nut and the contact arm of 0.4–1.2 mm. Adjustment is made with the nuts on the contact (Fig. 14).

![Fig. 14. Contact arm play](image-url)
3.16.10  **Lubrication**

See Fig. 15.

The bearing points of the brake blocks and the links should be sparingly lubricated with oil. (Use oil for bearings.)

The spur gears, the geneva wheel with the limit stop, the cam discs and the cam bar are sparingly lubricated with the same type of grease as for the shaft system when necessary.

Other bearing points do not need lubrication.

*NOTE:* *Protect the brake disc and the brake linings against lubricants. Wipe of excess lubricant.*

Reconnect the power supplies.
NOTE: The small bevel gear for the position indicator shaft shall be greased.

Fig. 15. Lubrication points
3.17 Operation Test

Operate the motor-drive mechanism, first by manual operation and then electrically between the limit positions. Check the limit stops by operating the on-load tap-changer to one of the end positions. When trying to operate it electrically beyond the end position, the motor should not start. Check the mechanical end stop by trying to hand crank it beyond the end position. After a couple of turns on the hand crank it should be mechanically stopped. Handcrank back to the end position (where the indicator flag is positioned in the middle). Operate the on-load tap-changer electrically to the other end position and carry out the same test procedure as above.

Check the emergency stop by giving a RAISE or LOWER impulse and after about one second press the emergency stop. The operation should be interrupted. Reset the emergency stop by turning the knob clockwise and switch on the protective motor switch. The started operation should now be completed.

Check the running-through protection with the step-by-step function disengaged. This is done by first removing the connection between terminals X4:1 and X4:2 and then keep the RAISE/LOWER switch engaged. The motor-drive mechanism should stop before the fourth operation is completed. This checking must be done at least five steps from the end position. After the test reset the time relay by putting the LOCAL/REMOTE switch to 0 and then back. Reset the protective motor switch to ON. Remount the connection between X4:1 and X4:2.

Check the step-by-step relay by keeping the RAISE/LOWER switch engaged in RAISE. The on-load tap-changer shall make only one step. Repeat the check in LOWER.

Check the function of the position transmitter and other multi position switches in all positions.

3.18 Oil Filling

If check of contact timing is to be carried out, see section 3.19, fill the diverter switch housing with oil up to the level of the fixed main breaking contacts by easiest possible method before checking. Oil fill completely according to the instructions below after check of contact timing.
3.18.1 Filling Methods and Restrictions

Oil filling can be carried out at atmospheric pressure or under vacuum. The wall between the diverter switch housing and the transformer tank is designed to withstand vacuum on one side and atmospheric pressure on the other side. It is not allowed to have vacuum on one side and the pressure of an oil column on the other side.

After maintenance oil is normally filled at atmospheric pressure. This procedure is described in section 3.18.3. If filling is to be carried out under vacuum, see IZSE 5492-117 Installation and Commissioning Guide for UCC and UCD.

After oil filling, a gas cushion should remain on the top of the oil in the diverter switch housing.

The connection to the oil conservator is designed to automatically give a gas cushion when filling at atmospheric pressure.

NOTE: If the new oil, especially degassed oil, is filled into the diverter switch housing and the number of operations is low, the gas cushion may be dissolved in the oil. The oil level in the oil conservator should then be checked after a month in service and if the oil level is lower than after the oil filling, (corrected for temperature differences), the gas cushion should be restored according to section 3.18.5 “Restoring the Gas Cushion” in this guide.

3.18.2 Before Filling

NOTE: Oil filling may be carried out in different ways depending on what is convenient as long as the rules above are fulfilled and the on-load tap-changer is filled with oil to the correct level with a gas cushion on the top. The method below is recommended and if it is followed in detail no pressure limits are exceeded and oil levels and gas cushion will be correct.

3.18.3 Filling at Atmospheric Pressure

See Fig. 16.

1. Close the air release valve
2. Open the conservator valve, if any.
3. Dismantle the breathing device on the conservator for the on-load tap-changer.
4. Pump oil into the diverter switch housing via the oil valve (connection dimensions, see the dimension drawing for the on-load tap-changer). Continue until the conservator is filled to the correct level at the actual temperature. See even section 3.18.4.

5. Shut the oil valve and disconnect the pump.

6. Remount the breathing device. Make sure the connection to the breathing device is properly sealed.

3.18.4 Oil Level
For correct oil level in the oil conservator, see the transformer documentation.

3.18.5 Restoring the Gas Cushion
Check the oil level in the oil conservator one month after oil filling. If the oil level is lower now than when the oil filling was finished (correct for temperature differences!) and no leakages are observed, the gas cushion has been solved in the oil and has to be restored.

The procedure below is used for on-load tap-changers without oil filter unit for continuous oil filtration. In case the on-load tap-changer is equipped with an oil filter unit for continuous oil filtration from ABB, and it is installed according to our recommendations, follow the instructions in "Oil filter unit for on-load tap-changers, manual" for restoring the gas cushion.

CAUTION
To operate the on-load tap-changer with a too small or no gas cushion means a risk for a trip of the pressure relay.

WARNING
The oil in the diverter switch housing may be hot. Be cautious!

WARNING
Before any work is carried out on the on-load tap-changer:
Make sure that the transformer is disconnected and that earthing is properly carried out. Obtain a signed certificate from the engineer in charge.
### 3.18.5.1 Procedure

1. Close the valve in the tube to the conservator.
2. Connect the oil pump to the oil valve. (For connection dimensions, see the dimension drawing for the on-load tap-changer), see Fig. 16.
3. Open the oil valve and the air release valve.
4. Start the oil pump and drain approximately 45 litres of oil into a clean and dry container.
5. Close the air release valve.
6. Close the oil valve and disconnect the pump.
7. Connect the output side of the pump to the oil valve.
8. Open the oil valve.
9. **Open the valve in the tube to the conservator!**
10. Pump the earlier drained 45 litres of oil back into the diverter switch housing.
11. Close the oil valve and disconnect the pump.
12. The level in the oil conservator and the gas cushion are now restored.

---

**CAUTION**

*Avoid to do the restoring in damp weather since moisture will get into the diverter switch housing. If the restoring has to be done in such weather, the incoming air has to be dehydrated and the drained oil protected from water.*
3.18.6 Waiting Period

CAUTION

Do not energize the transformer earlier than three hours after oil filling in atmospheric pressure. This waiting period is needed to allow air bubbles to disappear.

3.19 Check of Contact Timing

Checking the contact timing is a good check of the condition of the on-load tap-changer, but it is not necessary to check contact timing at every overhaul. It is recommended to be carried out after every 500 000 operations.

The test requires:

- Two indicator lamps (glow discharge lamps for the minimum possible magnetisation of the transformer)
- Necessary leads
- Two stiff insulated leads or bars.

WARNING

Never force DC current through the transformer windings.

The insulated leads (or bars) are used for connection to the moving contact arms of the tap selector via the plug-in contacts of the diverter switch (They can be made of an insulating tube with a lead inside.)

Connect the lamps as shown in Fig. 17.

The diverter switch contacts are designated as shown in Fig. 18.

Determine if x or v contacts are closed, see Fig. 18. In the contact-timing diagram for the on-load tap-changer you can find out the corresponding position. See Fig. 19.

The diverter switch housing shall be filled with transformer oil up to the fixed main contacts to secure the correct function of the dash pots during operation of the diverter switch, see section 3.18.

At repeated operations in the same direction the selector arms V and H operate every second time. When the direction of operation is reversed, the contact arms will be at rest during the first operation. The operation is then performed by means of the diverter switch only.

NOTE: When testing, the operation must be carried out in the same direction as the previous operation.
Fig. 17. Indicator lamp connection during contact timing test

Fig. 18. The diverter switch outlet marking

The test is to be made on all three-phases and carried out as follows:

Find the exact position of the on-load tap-changer by adjusting the disc brake as shown in Fig. 13.

1. Note the number of whole turns and parts of turns on the hand crank, during a slow manual operation.

2. Note when each tap-selector arm breaks and makes (the corresponding lamp goes out or lights).

3. Note when the diverter switch flicks over (a distinct sound is heard).
After this, compare the operations with the contact-timing diagram in Fig. 19.

One operation corresponds to 25 turns of the hand crank on the motor-drive mechanism.

Remove the equipment for contact-time measuring.

Mount the cover of the diverter switch housing according to section 3.13.

Complete the oil filling.

---

**CAUTION**

*If the result is beyond the limits given here, please contact ABB.*

---

*Fig. 19. Example of contact-timing diagram*

**NOTE:** The diverter switch must have switched over before the 21st turn with the hand crank is finished.

### 3.20 Putting into Operation

Operate the on-load tap-changer to the position noted in section 3.3.1. Put the LOCAL/REMOTE switch to REMOTE. Reset the drag hands. Make sure that no tools or foreign objects are left in the motor-drive mechanism cabinet. Close the door. Make sure that nothing is left on the transformer cover.

Sign the revision protocol and give it to the engineer in charge and inform that the on-load tap-changer is ready for energizing.
4 Contact Replacement

**CAUTION**

ABB recommends that only authorized personnel from ABB carry out contact replacement.

**CAUTION**

Some UCC are of the reinforced type to withstand higher short circuit currents. These diverter switches are equipped with magnetic yokes. Contact replacement on these diverter switches must not be carried out by others than engineers from ABB.

Replace worn-out main switching contacts and transition contacts as required. (It is not necessary to replace both main switching contacts and transition contacts if, for instance, only the main switching contacts are worn out.)

**CAUTION**

Fixed contacts and their corresponding moving contacts should always be replaced at the same time.

Also replace contacts which are assumed to wear out before the next overhaul.

*Fig. 20. Diverter switch, contact design*
Fig. 21. Removing the lifting yoke

Before replacing contacts, it is necessary to dismount the lifting yoke, the lifting bars, and the resistors in order to make all the contacts easily accessible (see Fig. 21). Put all fasteners in order to simplify remounting. Note in which position the diverter switch is.

1. Remove the screws holding the lifting bars of the lifting yoke to their brackets.
2. Remove the screw for the connection to the shielding ring (only for 380 kV impulse withstand voltage to earth and higher).
3. Remove the lifting bars with the lifting yoke.
4. Remove the screws holding the connections to the transition resistors on the fixed main switching contact brackets of the outer phases. Note where locking washers were mounted.

5. Remove the fastening screws holding the insulating brackets for the transition resistors and the insulating cross bars on the outer phases.

6. Remove the insulating cross bars and turn down the resistors of the outer phases at the side of the diverter switch as shown in Fig. 22.

7. Remove the screws holding the connection to the transition resistors on both the fixed transition contact holders and on the fixed main switching contact brackets on the middle phase. Note where locking washers were mounted.

8. Remove the fastening screws holding the insulating brackets for the transition resistors and the insulating cross bars of the middle phase.

9. Remove the transition resistors and the insulating cross bars of the middle phase.

*Fig. 22. Contact replacement, dismantling resistors*
4.1 Replacement of Moving Transition Contacts

The whole fastening bar is removed with the moving transition contacts. The contact replacement is carried out on that side of the diverter switch which has open contacts.

1. Loosen the fastening screws of the bar as shown in Fig. 23.

2. Remove the fastening bar by lifting it aside.

3. Clamp the bar in a vice and remove the contacts by unscrewing the Allen screws that hold them. The springs can be pushed aside for better access to the screws.

4. Mount the new contacts in all phases but tighten the screws only slightly.

5. Put the fastening bar back in place and tighten the screws.

6. Set the diverter switch in unlocked position by bending up the link, marked with an arrow in Fig. 24, with a small crowbar applied as shown in Fig. 25. Apply the crowbar from the side with open contacts.

7. Using an adjustable wrench, set the diverter switch as far as possible to the side where the moving transition contacts have been replaced, see Fig. 26.

---

**CAUTION**

*Avoid operating the diverter switch with the cross bars removed!*

---
WARNING

Be aware of the risk for jamming injuries when operating the diverter switch.

Replace the moving transition contacts on the other side as described above.

Fig. 24. The link

Cross bar (mounted in section 4.5)

Fig. 25. Breaking up the link of the polygon device
4.2 Replacement of Fixed Transition Contacts

Operate the diverter switch as far as possible to one side as described in section 4.1 and replace the contacts on the other side.

1. Remove the screws and washers holding the contacts and remove the contacts.
2. Put new contacts in place and mount the screws and washers.
3. Clearances in the holes for the screw make adjustments possible. Push the contacts against their brackets. Move the contacts to the centre of their lateral tolerance range and tighten the screws slightly.
4. Check that the moving transition contacts are aligned laterally with the fixed transition contacts by operating the diverter switch until the moving contacts touch the fixed contacts. If not, adjust the moving contacts to its best position by loosening the holding screws a little and pushing the contacts to the best position.
5. Tighten the screws for the moving contacts, with a tightening torque of approximately 24 Nm (no torque wrench is required).

6. Adjust the lateral alignment accurately by loosening the screws for the fixed contacts slightly and pushing them carefully to the correctly aligned position.

7. Tighten the screws, with a tightening torque of approximately 24 Nm (no torque wrench is required).

Operate the diverter switch as far as possible against the other side and replace and adjust the contacts on the first side as described above.

### 4.3 Replacement of Moving Main Switching Contacts

Operate the diverter switch as far as possible to one side by means of the adjustable wrench as earlier described and replace contacts on the other side.

1. Remove the screws that hold the flexible connections.

2. Remove the screws that hold the moving main contact units. Use a L-shaped Allen key. The springs can be pushed to the side to give better access to the screws.

3. Remove the moving main contact units.

4. Mount new moving contact units but tighten their fastening screws only slightly. The flexible connections is not mounted at this stage.

5. Operate the diverter switch as far as possible to the other side by means of an adjustable wrench as earlier described.

6. Replace the moving main contacts on this side as described for the first side.

7. Mount the flexible connections, the washers and the copper spacer (not on the later version) as shown in Fig. 27, according to the appropriate figure. Tighten the screws for the flexible connections. Lock with new locking washers on the early version (not needed on the later version).

![Fig. 27. Mounting the flexible connections](image-url)
4.4 Replacement of Fixed Main Switching Contacts

Operate the diverter switch as far as possible to one side and replace the contacts on the other side.

1. Remove the screws and washers that hold the contacts and remove the contacts.

2. Put new contacts in place and mount the screws and washers. Put new locking washers on if such were mounted before, otherwise not.

3. Clearances in the holes for the screws make adjustments possible. Put the contact against its brackets. Move the contacts to the centre of their lateral tolerance range and tighten the screw slightly. Proceed with all contacts on this side.

4. Check that the moving contacts are aligned laterally with the fixed contacts by operating the diverter switch until the moving contact touch the fixed contacts. If not, adjust the moving contacts by loosening the holding screws a little and pushing the contacts to the best position.

5. Tighten the screws for the moving contacts with a tightening torque of approximately 24 Nm (no torque wrench is required).

6. Adjust the lateral alignment accurately by loosening the screws for the fixed contacts slightly and pushing them carefully to the correctly aligned position.

7. Put the contacts against their brackets, then tighten and lock the screws, (see point 2), with a tightening torque of 18 Nm.

Operate the diverter switch as far as possible to the other side and replace the contacts on that side in the same way.

4.5 Alignment of Contacts

Mount the insulating cross bars with one spacer sleeve (see Fig. 28) at each end of the cross bar.

Push the diverter switch towards one side as earlier described and stop when the first moving main switching contacts has made on the fixed contact. Make sure that the clearance of any of the other contact does not exceed 0.5 mm.

If adjustment is necessary, bend the contact somewhat. This is easily done due to the soft material.

--- CAUTION ---

*Only adjust those contacts which are too much out of alignment.*

- To increase the clearance, pull the moving contact backwards and hit the part of the contact where the spring is fastened (A in Fig. 8) with a hammer while holding the contact with your hand.

- To decrease the clearance, pull the contact backwards and release it. It will bend a little when it hits the stop pin.
Repeat the above alignment procedure for the other side of the diverter switch.

Now operate the diverter switch to the position where the transition contacts on one side is just about to break. Make sure that no contact has a clearance of more than 1.0 mm when the "last" contact is about to break. Adjust the moving contact as described above for the moving main contact.

Repeat the procedure described in the previous paragraph for the transition contacts on the other side of the switch.

### 4.6 Remount the Diverter Switch

Operate the diverter switch back in service position by turning the key grip (see Fig. 26) with a 19 mm socket and handle. A click is heard when the diverter switch goes into the locked service position again.

Check the clearance and adjust if necessary as described in section 3.9.

---

**CAUTION**

*If an adjustment of more than 0.5 mm is required, repeat the contact alignment of the main switching contacts as described in section 4.5.*

---

Operate the diverter switch a couple of times in both directions. It should switch over rapidly with a distinct sound and stop in the locked service position.

---

**WARNING**

*Take care to avoid finger injuries when operating the diverter switch. Oil splash occurs during operation, especially in the moving direction.*

---

*Fig. 28. Spacer sleeve, dimensions in mm*
Remove the spacer sleeves and insulating cross bars.

Put the transition resistors and the insulating cross bars for the middle phase back in position and mount the screws and washers. Fit the plain washer closest to the insulating bar, then the conical spring washer, locking washer and screw.

Remount the connections to the transition resistors on both the main contact bracket and the transition contact bracket. Place washers and connections as shown in Fig. 29. Use new locking washers where such were mounted before, otherwise not, see section 4, point 7.

Lift up the transition resistors of the outer phases and mount the resistors and insulating cross bars. Fit the washers in the same order as for the middle phase.

Mount all the connections to the main switching contact brackets. Place the washers and connection as shown in Fig. 29. Use new locking washers where such were mounted before otherwise not, see section 4, point 4.

Fit the yoke with lifting bars in place and tighten the screws. Lock with new locking washers.

For 380 kV and higher, mount the connection for the shielding ring to the bracket. Operate the diverter switch back to the position it had before starting the contact replacement, see section 4.

Proceed according to section 3.13.

Fig. 29. Washers and connections
5 Specification of Materials

5.1 General
On disposal of this product, it is recommended that local environmental regulations in each country are met. For environmental reasons, materials used are specified.

5.2 Diverter Switch Housing

<table>
<thead>
<tr>
<th>Material</th>
<th>Approx. amount</th>
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</thead>
<tbody>
<tr>
<td>Steel</td>
<td>50 kg</td>
</tr>
<tr>
<td>Aluminium</td>
<td>180 kg</td>
</tr>
<tr>
<td>Copper and alloys</td>
<td>25 kg</td>
</tr>
<tr>
<td>Epoxy resin</td>
<td>80 kg</td>
</tr>
<tr>
<td>Transformer oil</td>
<td>800 kg</td>
</tr>
</tbody>
</table>

5.3 Diverter Switch

<table>
<thead>
<tr>
<th>Material</th>
<th>Approx. amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
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<td>Copper and alloys</td>
<td>50 kg</td>
</tr>
<tr>
<td>Silver</td>
<td>150 g</td>
</tr>
<tr>
<td>Tungsten</td>
<td>1 kg</td>
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<tr>
<td>Polyester resin</td>
<td>35 kg</td>
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<tr>
<td>Phenol resin laminate</td>
<td>15 kg</td>
</tr>
<tr>
<td>Resistor wire (mainly copper and nickel alloys with small amounts of aluminium and manganese)</td>
<td>10–100 kg</td>
</tr>
</tbody>
</table>
5.4 Tap Selectors

**Tap selector IV:**

<table>
<thead>
<tr>
<th>Material</th>
<th>Approx. Amount</th>
<th>Material</th>
<th>Approx. Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>110 kg</td>
<td>Steel</td>
<td>25 kg</td>
</tr>
<tr>
<td>Copper and alloys</td>
<td>100 kg</td>
<td>Aluminium</td>
<td>50 kg</td>
</tr>
<tr>
<td>Silver</td>
<td>0–100 g</td>
<td>Copper and alloys</td>
<td>80 kg</td>
</tr>
<tr>
<td>Phenol resin laminate</td>
<td>2 kg</td>
<td>Silver</td>
<td>70 g</td>
</tr>
<tr>
<td>Polyester resin</td>
<td>120 kg</td>
<td>Epoxy resin</td>
<td>35 kg</td>
</tr>
</tbody>
</table>

**Tap selector III:**

<table>
<thead>
<tr>
<th>Material</th>
<th>Approx. amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>10 kg</td>
</tr>
<tr>
<td>Aluminium</td>
<td>40 kg</td>
</tr>
<tr>
<td>Copper and alloys</td>
<td>50 kg</td>
</tr>
<tr>
<td>Silver</td>
<td>10 g</td>
</tr>
<tr>
<td>Polyester resin</td>
<td>10 kg</td>
</tr>
<tr>
<td>Epoxy resin</td>
<td>30 kg</td>
</tr>
</tbody>
</table>

5.5 Conductors

<table>
<thead>
<tr>
<th>Material</th>
<th>Approx. amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>35 kg</td>
</tr>
<tr>
<td>Cellulose</td>
<td></td>
</tr>
</tbody>
</table>

5.6 Shaft System

<table>
<thead>
<tr>
<th>Material</th>
<th>Approx. amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>8 kg</td>
</tr>
<tr>
<td>Aluminium</td>
<td>2 kg</td>
</tr>
<tr>
<td>Copper and alloys</td>
<td>2 kg</td>
</tr>
<tr>
<td>Polyethylene</td>
<td>2 kg</td>
</tr>
</tbody>
</table>
5.7 Motor-Drive Mechanism

<table>
<thead>
<tr>
<th>Material</th>
<th>Approx. amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>100–120 kg</td>
</tr>
<tr>
<td>Copper and alloys</td>
<td>5–10 kg</td>
</tr>
<tr>
<td>Silver</td>
<td>10 g</td>
</tr>
<tr>
<td>Plastics:</td>
<td></td>
</tr>
<tr>
<td>chlorsulphonated polyethylene</td>
<td></td>
</tr>
<tr>
<td>polyamide</td>
<td></td>
</tr>
<tr>
<td>phenol resin laminate</td>
<td></td>
</tr>
<tr>
<td>polyester</td>
<td></td>
</tr>
<tr>
<td>PVC</td>
<td></td>
</tr>
<tr>
<td>carbonate plastic</td>
<td></td>
</tr>
<tr>
<td>Rubbers:</td>
<td></td>
</tr>
<tr>
<td>nitrile rubber</td>
<td></td>
</tr>
<tr>
<td>fluorine rubber</td>
<td></td>
</tr>
</tbody>
</table>

**CAUTION**

Materials listed in the table above without any specification of amount are included because they may cause pollution problems during de-commissioning, even in the small quantities used.