SF6 insulated Ring Main Units and Compact Switchgear - SafeRing and SafePlus

Instruction for Installation, Operating and Maintenance
Ensure compliance of local legal and safety norms

We recommend that installation and commissioning should be carried out by qualified and authorised personnel.

Check that the personnel operating the apparatus have this instruction manual with them.
1. GENERAL DESCRIPTION

SafeRing / SafePlus with vacuum circuit-breaker in compliance with IEC 60056. With this unit the transformer will be protected by a vacuum circuit breaker combined with relays and current transformers.

The standard relays are based on digital technology and do not require an auxiliary power supply. SafeRing is a SF6 insulated ring main unit and SafePlus is a compact switchgear for applications in medium voltage distribution networks. SafeRing can be supplied as a 2, 3 or 4-way standard configurations with additional equipment according to customer specification, DF, CCF, CCC, CCCF, CCFF, DV, CCV, CCCV, CCVV.

SafePlus has a unique flexibility due to its extendibility and the possible combination of fully modular and semi modular configurations.

Be - SL - Sv - M - C - De - D - F - V.

SafeRing and SafePlus offers a sealed stainless steel tank which contains all the live components and switching functions. The transformer is protected either by a switch fuse combination or a vacuum circuit-breaker.

The units/modules are delivered from the factory ready for installation.

Routine tests are carried out on all units/modules before dispatch.

No special tools are required for installing the equipment.

Available modules are:
- C - Cable switch
- F - Switch fuse disconnector
- D - Direct cable connection
- De - Direct cable connection with earthing
- V - Vacuum circuit breaker
- SL - Busbar sectionalizer, load break switch Busrise needed when SL on right side of SF6 tank
- Sv - Busbar sectionalizer, vacuum circuit breaker Sv always together with busrise (total width=650 mm)
- M - Metering cubicle

SafeRing / SafePlus with switch fuse combination in compliance with IEC 60420.

With this unit the transformer will be protected by current-limiting HV fuses in combination with a load break switch. The load break switch is equipped with a stored spring energy mechanism which can be tripped by the fuse striker pin.

SafeRing / SafePlus with vacuum circuit-breaker in compliance with IEC 60056

With this unit the transformer will be protected by a vacuum circuit breaker combined with relays and current transformers. The standard relays are based on digital technology and do not require an external power supply.
### 1.1 TABLE OF LOCATIONS

1. Lifting Hooks  
2. Capacitive voltage indication  
3. Short circuit indicator  
4. Pressure indicator  
5. Legend plate with serial number  
6. Mimic diagram  
7. Relay protection  
8. Blown fuse indicator  
9. Padlock device  
10. Cable compartment  
11. Test bushings (optional)  
12. Ronis key interlock  
13. Circuit breaker  
14. Fuse switch disconnector  
15. Earthing switch  
16. Isolator  
17. Circuit breaker open/close emergency stop  
18. Circuit breaker  
19. Fuses
1.2 DIMENSIONAL DRAWINGS

<table>
<thead>
<tr>
<th>Unit</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-way</td>
<td>371</td>
</tr>
<tr>
<td>2-way</td>
<td>696</td>
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<tr>
<td>3-way</td>
<td>1021</td>
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<td>4-way</td>
<td>1346</td>
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<tr>
<td>5-way</td>
<td>1671</td>
</tr>
</tbody>
</table>

ABB
2. TRANSPORT AND HANDLING

The units are delivered from the factory ready for installation.

Weight table for standard SafeRing
- 2-way DV 252 kg 2-way DF 260 kg
- 3-way CCV 313 kg 3-way CCF 320 kg
- 4-way CCCV 403 kg 4-way CCCF 410 kg
- 4-way CCVV 411 kg 4-way CCFF 430 kg
- 3-way CCC 300 kg
- 4-way CCCC 390 kg

SafePlus
- Standard 1-way 130 kg
- 2-3 and 4-way as for SafeRing
- 5-way approx. between 480-600 kg
- M-metering cubicle approx. 250 kg

The weights is without additional equipment

SafeRing / SafePlus is fitted with lifting lugs, but can also be moved on pallets with a forklift truck.

2.1 RECEIVING INSPECTION

Upon receiving the SafeRing / SafePlus please check that the delivered equipment has not been damaged during transport. If any such damage has occurred, a claim must be submitted to the carrier immediately.

After unpacking, the following must be checked:

1. Operating handle 1 piece should be included.
2. Check that the pointer on the pressure indicator is in the green area.
3. Carry out a function test on the mechanical parts.

Any faults or omissions must be reported immediately to the supplier.

2.2 STORAGE

SafeRing / SafePlus must be stored under cover in a dry and well-ventilated area until it is installed and put into operation.
### 3. TECHNICAL DATA

#### 3.1 ELECTRICAL DATA

<table>
<thead>
<tr>
<th>SafeRing</th>
<th>C-module</th>
<th>F-module</th>
<th>V-module</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Switch</td>
<td>Switch</td>
<td>Vacuum</td>
</tr>
<tr>
<td>Rated voltage</td>
<td>disconnector</td>
<td>fuse</td>
<td>circuit</td>
</tr>
<tr>
<td>Power frequency withstand voltage</td>
<td>28/38/50</td>
<td>28/38/50</td>
<td>28/38/50</td>
</tr>
<tr>
<td>Impuls withstand voltage</td>
<td>95/95/125</td>
<td>95/95/125</td>
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<tr>
<td>Rated current</td>
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<td>see(^2)</td>
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<td>Breaking capacities:</td>
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<tr>
<td>active load</td>
<td>A</td>
<td>630/630/630</td>
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<tr>
<td>closed loop</td>
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<tr>
<td>earth fault</td>
<td>A</td>
<td>200/150/150</td>
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<tr>
<td>earth fault cable charging</td>
<td>A</td>
<td>115/87/87</td>
<td></td>
</tr>
<tr>
<td>Short circuit breaking current</td>
<td>kA</td>
<td>see(^3)</td>
<td>21/16/16</td>
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<tr>
<td>Making capacity</td>
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<td>Short time current 1 sec.</td>
<td>kA</td>
<td>5/5/5</td>
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<tr>
<td>Short time current 3 sec.</td>
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<table>
<thead>
<tr>
<th>SafePlus</th>
<th>C-module</th>
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<tr>
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<td>Making capacity</td>
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<tr>
<td>Short time current 3 sec.</td>
<td>kA</td>
<td>21/21/21</td>
<td>21/21/21</td>
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</tbody>
</table>

1) 38 kV on request  
2) Depending on the current rating of the fuse  
3) Limited by High Voltage fuse links

Safering RMU/SafePlus CSG is tested according to IEC publications IEC 60056, IEC 60129, IEC 60265, IEC 60298, IEC 60420 and IEC 60694
### 3.2 FUSE TABLE FOR MODULES

#### 100% Normal operating conditions with no overload

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<th>160</th>
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#### 120% Normal operating conditions with 20% overload

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<th>125</th>
<th>160</th>
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</tbody>
</table>

The table is based on using fuses type ABB CEF

Normal operating conditions with no overload

Ambient temperature -25 °C + 40 °C
4. INSTALLATION

The base must be flat and fitted with anchor bolts in accordance with the dimensional drawing for the number of modules or units as appropriate.

<table>
<thead>
<tr>
<th>Unit</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
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<td>1-way</td>
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<td>5-way</td>
<td>1671</td>
<td>1597</td>
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<td>1671</td>
</tr>
</tbody>
</table>
4.1 CABLE COMPARTMENT

Opening of cable door:

NB!
The cable door are supplied with interlocking to earthing switches. When interlocking is fitted, the cable cabinet can only be accessed when the earthing switch is in the closed position. For opening the door, press the lever at the bottom and pull the door.

1. Press the interlocking lever up to open the door.

2. Removal of front section.

3. Front section removed.

4. The panel can be removed by unscrewing A and B.

Interlocking Lever
4.2 CABLE CONNECTION

SafeRing/ SafePlus is equipped with external bushings which comply with DIN47636T1 & T2/EDF HN 525-61 for termination of cables.

All bushings are situated in the same height from the floor and are protected by the cable cover.

SafeRing / SafePlus is supplied with 400 series bolted type bushing

For cable termination kits please refer supplier documentation for details.

The manufacturer installation instructions must be followed. Be sure to lubricate the bushings thoroughly with the silicone supplied.

NB!
Where cables are not connected, the earthing switch must be locked in closed position or the bushings must be fitted with deadend recepticals before the unit is put into operation.
4.3 CURRENT TRANSFORMERS FOR RELAY PROTECTION

Installing current transformers. The cable shielding is led back through the centre hole and earthed.

A protection relay is installed in each vacuum circuit breaker module. The cables from the protection relay to the current transformers are placed in the cable compartment, ready for connection to the three current transformers supplied.

Before installation:
- Check that the three current transformers have been delivered and that they are all of the same type.
- Check that the current transformers are of the correct type, with the correctly rated transformer ratio, for the distribution transformer rated current and for the adjustment range on the protection relay (see protection relay manual).

Each current transformer must be mounted onto its high voltage cable before the cable termination is fitted.

The earth shield on the cable must be led back through the centre hole in the current transformer (see figure on left) and earthed on the earthing bar in the cable compartment. A mounting plate for the current transformers is fitted in the cable compartment.

After the current transformers have been installed in the unit, the cables from the protection relay are connected. Refer the manual supplied with the protection relay for a description of the connections.

SafeRing with vacuum circuit breakers are suitable for three different types of protection relays: SACE PR521/512, SEG WIC/WIP. All these types are designed so that there is no need for external auxiliary voltage for correct functioning.

Separate manuals have been supplied for each of these protection relay, with examples of adjustments.

SACE PR 521/512
This relay offers advanced protection with facilities for constant-time, normal inverse, very inverse and extremely inverse characteristics as well as simple earth fault protection in accordance with IEC 60255-3.

It is essential for correct functioning that the current transformers are properly connected and that the protection relay is properly adjusted.

SafePlus can be delivered with advanced protection relays. As option SPAJ140 can be delivered and also other ABB relays like REJ and REF54 can be fitted. This will require additional low voltage compartment.

See separate documentation for these relays.
5. OPERATION

5.1 OPERATING CONDITIONS

Normal ambient conditions
SafeRing / SafePlus is generally equipped for operation/service in normal indoor conditions in accordance with IEC 60694. The following limitations apply:

- Ambient temperature:
  - Max. temperature +40°C
  - Max. temperature (24-hour average) +35°C
  - Min. temperature -25°C

- Humidity:
  - Max. average relative humidity measured over 24 hours 95%
  - Max. average relative humidity measured over 1 month 90%

Installation without reducing gas pressure 1,000 metres

Special conditions
In accordance with IEC 60694, the manufacturer and end-user must agree about special operating conditions which deviate from operation under normal conditions. The manufacturer/supplier must be consulted in advance if especially difficult operating conditions are involved. When electrical equipment is installed at more than 1,000 metres above sea level, for example, the atmospheric pressure will be lower and the overpressure in the tank will have to be reduced.

Airfreight
Units / modules delivered with reduced overpressure - see procedure for refilling.

---

4.4 GAS PRESSURE

SafeRing / SafePlus contains SF6 gas with a nominal pressure of 1.4 bar at 20°C.

SafeRing / SafePlus is sealed for life and is fitted with a temperature-compensated pressure indicator.

- Pointer in green area - unit has correct pressure
- Pointer in red area - pressure is too low

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Refilling of SF6 gas in SafeRing/SafePlus

Following equipment is needed:
- Gas bottle with manometer and reduction valve adapter
- Pressure measuring device

1. Remove front cover and unscrew manometer as shown.
2. Screw (tightening the torque 45 Nm) the adapter to the valve.
3. Before connecting the hose from the gas bottle to the adapter, the air in the hose must be removed by running SF6 gas through the hose.
4. When gas is flowing into the RMU/switchgear, the manometer on the gas bottle has to be observed. When it shows 0.4 bar at ambient temperature 20 Celsius, (14 bar absolute) the gas filling must be stopped. See table for filling pressure above.
5. Remove the filling hose and connect the pressure device to check the pressure inside the RMU/switchgear.
6. When the correct pressure of 0.4 bar (14 bar absolute) is obtained, remove the adapter and screw with tightening torque 45 Nm the manometer to the RMU/switchgear as shown above. Observe that the sealing between the manometer and the valve is smooth and clean.
5.2 OPERATION

All switches can be operated with the included operating handle. Internal mechanical interlocking between the switch disconnector/circuit breaker and the associated earthing switches prevents incorrect operation. The operation of the switch disconnector/circuit breaker and earthing switches can be further interlocked by means of a padlock. The earthing switches are operated by a snap action mechanism, which ensures fast closing.

The earthing switch is closed by turning the operating handle clockwise. Turning the operating handle anti-clockwise opens the switch.

For closing the transformer switch the spring mechanism must be charged. Turning the operating handle clockwise does this. Then the green ‘on’ button must be pressed to close the switch/breaker.

An anti-reflex system, standard on all operating handles, prevents the immediate re-operation of switches.

Switch disconnector:
Close: Turn the operating handle clockwise.
Open: Turn the operating handle anti-clockwise.

Earthing switch:
Close: Turn the operating handle clockwise.
Open: Turn the operating handle anti-clockwise.

Fuse switch disconnector.
Close: Turn the operating handle clockwise to charge the close/open spring. Then push the green button. (A)
Open: Push the red button. (B)

In circuit breaker configurations, the transformer circuit breaker can be tripped by the protection relay, while in switch fuse configurations fuse switch disconnector can be triggered by the fuse striker pin if an over current or short-circuit occurs.

Mechanical position indicators:
C: Transformer breaker open
D: Earthing switch closed
5.3 INSTALLATION AND REPLACEMENT OF FUSES

A red indicator below the fuse symbol on the lower front panel indicates a fuse trip. Fuses are replaced as shown in the sequence of illustrations. Switch fuse configurations are supplied without fuses installed. When installing fuses for the first time, follow the sequence of illustrations 1-9.

1. Fuse trip indicator.

2. Close earthing switch by turning operating handle clockwise.

3. Unscrew fuse cover.

4. Tilt out the fusepanel to gain access to fuse canisters.

5. Applying the operating handle and turning anti-clockwise opens the fuse canisters.
6. Pull out the fuse handle. The fuses are firmly fixed in the fuse cover.

7. Fix the fuses to the fuse cover using the contact screw. The striker must point out from the fuse canister for the fuse to function properly.

8. Turn the handle on the fuse cover clockwise to close and seal the fuse canister. Use the operating handle.

9. Close the fuse panel. The switches are ready for operation.
5.4 RELAYS

SafeRing / SafePlus with vacuum circuit breakers are suitable for following different types of protection relays: SACE PR521/512 and SEG WIC/WIP. All these types are designed so that there is no need for external auxiliary voltage for correct functioning.

Separate manuals are available for each of these protection relay, with examples of adjustments.

SafePlus can be delivered with advanced protection relays. As option SPAJ140 can be delivered and also other ABB relays like REJ and REF can be fitted. This will require additional low voltage compartment.

Refer separate documentation for these relays.

6. ADDITIONAL EQUIPMENT

6.1 LOW-VOLTAGE CONNECTIONS

AUXILIARY CONTACTS
(2NO+2NC) can be supplied to indicate switch positions on all switches/breakers. Access to the low-voltage connections is obtained by removing the top front panel. A shunt trip coil (AC or DC) can be fitted on the transformer switch/breaker.

6.2 REMOTE CONTROL AND MONITORING UNIT

SafeRing can be equipped with an integrated remote control and monitoring unit (see picture left). This unit is preengineered and can be delivered and installed as a retrofit solution or complete from factory. SafePlus can have the same equipment but need an additional low voltage compartment on top of the switchgear.
6.2 CAPACITIVE VOLTAGE INDICATION

Capacitive voltage indication system.

Plugin type
Voltage indicator

Wim 1

Wim 3

Voltage presence indication system
(VPIS)

Phase balance check

6.3 SHORT CIRCUIT INDICATOR

Three types can be supplied:
Horstman ALPHA-M
Horstman ALPHA-E
Horstman GAMMA
6.4 MOTOR OPERATION

Cable switches, vacuum circuit-breakers and earthing switches are operated by mechanisms located behind the front panel.
The mechanisms for all the switches and breakers are operated manually with the operating level (standard), or are fitted with motor operation (additional equipment).
The earthing switch can only be operated manually and is fitted with mechanisms to achieve fault making capabilities.

Motor operation can be easily retrofitted.

6.5 CABLE TESTING

Voltage testing and locating cable faults can be performed in two ways:

1. Directly at the testing points (A) if they are fitted on the unit. Proceed as follows: engage the earthing switch. Connect the testing equipment on top of the testing points which hold the earth bar (B). Remove the earth bar and perform the test. Refit the earth strip before the testing equipment is disconnected.

2. Directly at the cable connectors which are designed for testing the voltage of the cable. Follow the suppliers instructions.

2.1. Cable connector connected

2.2. Cable connector dismounted
6.6 EXTERNAL BUSBAR
SafeRing and SafePlus can be equipped with an external busbar.

6.7 PRESSURE INDICATOR
SafeRing / SafePlus is always supplied with a pressure indicator in the form of a manometer.

6.8 BASE FRAME
SafeRing/SafePlus can be installed on a separate base frame. The base frame is designed for cable entry from both sides or from the back. Two different heights 290 mm and 450 mm.

6.9 TOP ENTRY BOX FOR LOW VOLTAGE CABLES
SafeRing/SafePlus can be supplied with top entry box for low voltage cables.

6.10 LOW VOLTAGE COMPARTMENT
SafePlus can be supplied with low voltage compartment for protection relays, metering and other secondary equipment.

6.11 FLAG INDICATOR
SafeRing/SafePlus can be supplied with flag indicator for breaker with protection relay type WIC of AVK SEG make.
7. Maintenance

All components in the SF₆ tank are maintenance-free for the declared life expectancy of the product. The tank is made of stainless steel.

If the panels sustain any scratches or damage, these must be repaired with paint to prevent corrosion.

Mechanical parts are positioned outside the tank and behind the front panel. This enables easy access and replacement if required.

Mechanical parts are surface-treated to prevent corrosion. Moving parts are lubricated at the factory for the product life expectancy. In extreme conditions (dust, sand and pollution), inspection and maintenance will be imperative, and in some cases replacements will be necessary. Check that the lubricant is not washed or wiped away from the mechanical moving parts.

7.1 Control And Monitoring The Gas

SafeRing / SafePlus is a pressure-sealed system that normally does not require special inspections. However, the gas pressure on the manometer should always be checked prior to operation.
### 7.2 ENVIRONMENTAL CERTIFICATION

#### 1. LIFE EXPECTANCY OF PRODUCT

The product is developed in compliance with the requirements denoted by IEC 298. The design incorporates a life span under indoor service conditions exceeding 30 years (IEC 298 annex GG).

The switchgear is gas-tight with an expected diffusion rate of less than 0.1 % per annum. Referring to the reference-pressure of 1.4 bar, the switchgear will maintain gas-tightness and a gas-pressure better than 1.3 bar* throughout its designed life span. *) at 20°C.

#### 2. RECYCLING CAPABILITY

<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Amount</th>
<th>% of total weight</th>
<th>Recycle</th>
<th>Environmental effects &amp; recycle/reuse processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>132.80 kg</td>
<td>42.53%</td>
<td>Yes</td>
<td>Separate, utilise in favour of new source (ore)</td>
</tr>
<tr>
<td>Stainless steel</td>
<td>83.20 kg</td>
<td>24.93%</td>
<td>Yes</td>
<td>Separate, utilise in favour of new source (ore)</td>
</tr>
<tr>
<td>Copper</td>
<td>43.98 kg</td>
<td>14.09%</td>
<td>Yes</td>
<td>Separate, utilise in favour of new source (ore)</td>
</tr>
<tr>
<td>Brass</td>
<td>2.30 kg</td>
<td>0.74%</td>
<td>Yes</td>
<td>Separate, utilise in favour of new source (ore)</td>
</tr>
<tr>
<td>Aluminium</td>
<td>8.55 kg</td>
<td>2.74%</td>
<td>Yes</td>
<td>Separate, utilise in favour of new source (ore)</td>
</tr>
<tr>
<td>Zinc</td>
<td>3.90 kg</td>
<td>1.25%</td>
<td>Yes</td>
<td>Separate, utilise in favour of new source (ore)</td>
</tr>
<tr>
<td>Silver</td>
<td>0.075 kg</td>
<td>0.024</td>
<td>Yes</td>
<td>Electrolysis, utilise in favour of new source</td>
</tr>
<tr>
<td>Thermoplastic</td>
<td>5.07 kg</td>
<td>1.63%</td>
<td>Yes</td>
<td>Make granulate, re-use or apply as energy superior additive in refuse incineration</td>
</tr>
<tr>
<td>Epoxy incl. 60% quartz</td>
<td>26.75 kg</td>
<td>8.35%</td>
<td>Yes</td>
<td>Grind to powder and use as high-grade energy additive in cement mill</td>
</tr>
<tr>
<td>Rubber</td>
<td>1.35 kg</td>
<td>0.42%</td>
<td>Yes</td>
<td>High-grade energy additive in refuse incineration</td>
</tr>
<tr>
<td>Dielectric oil</td>
<td>0.21 kg</td>
<td>0.066%</td>
<td>Yes</td>
<td>Reclaim or use as High-grade energy additive in refuse incineration</td>
</tr>
<tr>
<td>SF₆ gas</td>
<td>3.24 kg</td>
<td>1.04%</td>
<td>Yes</td>
<td>ABB reclaims used SF₆ gas.</td>
</tr>
<tr>
<td>Total for recycling</td>
<td>311.44 kg</td>
<td>97.25%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not specified *</td>
<td>9.00 kg</td>
<td></td>
<td></td>
<td>*Stickers, Film-foils, powder coating, screws, nuts, tiny components, grease E.</td>
</tr>
<tr>
<td>Total weight **</td>
<td>320.00 kg</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packing foil</td>
<td>0.2 kg</td>
<td></td>
<td>Yes</td>
<td>High-grade energy additive in refuse incineration</td>
</tr>
<tr>
<td>Wooden pallet</td>
<td>21.5 kg</td>
<td></td>
<td>Yes</td>
<td>Re-use or use as energy additive in refuse incineration</td>
</tr>
</tbody>
</table>

*) All figures are collected from CCF 3-way unit with arc suppresser.

#### 3. END-OF-LIFE

ABB is committed to the protection of the environment and adhere to ISO 14001 standards. It is our obligation to facilitate end-of-life recycling for our products.

There exist no explicit requirements for how to handle discarded switchgears at end-of-life. ABB's recycling service is according to IEC 1634 edition 1995 section 6: End of life of SF₆ filled equipment and in particular 6.5.2.a: Low decomposition: No special action is required; nonrecoverable parts can be disposed of normally according to local regulations.

We also recommend ABB's website: http://www.abb.com/sf6.
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