

ESI-102

# Handling the SF<sub>6</sub> switchgear

15-04-2020

This safety instruction is part of the activities in the technical work instructions.

## Purpose

This electrical safety instruction has two functions 1) Dealing with SF<sub>6</sub> switchgear (GIS) and 2) measures for employees and organisation against exposure to SF<sub>6</sub> gas.

### 1. Handling the SF<sub>6</sub> switchgear

## Purpose

Reducing the risk of voltage transfer in the installation and unnecessary ageing of the insulation material.

### 1.1 Earthing of the rail-system in GIS prior to commissioning

## Working method

Before re-energizing a switched-off rail in the GIS installation, the rail must first be grounded before re-energizing.

### Explanation of the reason for grounding the rail in the GIS installations, before re-energizing.

Interference voltages due to switching operations due to:

1. Switching with circuit breakers
  - Short-circuit currents
  - Load currents
  - Small inductive currents (switch off of an idle transformer)
  - Small capacitive currents (switch off rail of an idle rail)
2. Switching with disconnectors

The interference voltages that can occur from switching with disconnectors are usually bigger than those caused by switching with circuit breakers, because the speed at which the contacts in a circuit breaker move is much higher. This is why we will only describe the switching with disconnectors. When closing a disconnector, the capacitance formed by the unloaded part of the station (the rail) must follow the mains voltage. When opening a disconnector, this capacity (the rail) must be released from the voltage. Because the contacts of a disconnector move slowly, switching it on and off can be accompanied by capacitive pre- or re-ignitions over the separator contacts. When switching off, the result of these re-ignitions is that electrical charge (DC voltage) remains on the rail. Leaving electrical charge is undesirable for two reasons:

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### Reason 1:

The electrical charge from the rails flows very slowly through the insulators of the rail (the spacers) or over the surface of those spacers. The free electrical charge carriers that adhere to the surface of the spacers or penetrate the spacers can lead to partial discharges and sometimes to insulator penetration when the rail is re-started. By grounding the rail before it is put back into operation after it has been switched off, the above mentioned free electrical charge carriers are largely removed. This greatly reduces the risk of partial discharges (which in the long run affect the insulation medium of the spacers under the influence of the electric field) or breakthrough along the insulator surface.

### Reason 2:

The rail assumes a potential in relation to the enclosure. When the operating voltage is switched on, the mains voltage may be in counter-phase with the voltage remaining on the rail. The field change in the spacers, but also along the spacer surface, is then higher compared to the field change when switching on a rail that is (almost) zero voltage. This means that the insulation of the spacers is more heavily charged.

**In summary: grounding the rail before commissioning reduces the electrical charge on spacers, thus preventing unnecessary ageing of the insulation material. The risk of voltage transfer on the spacing is reduced.**

## ***2. measures for employee and organisation against exposure to SF<sub>6</sub>***

The text below is copied from the arbo-catalogus netwerkbedrijven

### **Purpose**

Prevention of poisoning, skin and eye damage, shortness of breath due to lack of oxygen and suffocation due to excessive concentration of SF<sub>6</sub>.

### **2.1 Organisational measures against exposure to contaminated SF<sub>6</sub> during maintenance activities**

#### **2.1.1 Risks**

Poisoning, skin and eye damage, respiratory distress due to lack of oxygen and suffocation due to excessive concentration of SF<sub>6</sub>.

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### 2.1.2 Measures

- Provide information and instruction on working with SF<sub>6</sub>.
- Make sure that employees who recover SF<sub>6</sub> from high voltage switchgear (from 1000 Volt alternating current) have a certification in handling SF<sub>6</sub> gas in HV installations.
- Provide storage for hazardous waste disposal.
- Provide orange coloured bottles (or orange banner) with a sticker (UN 3308) for the removal of the contaminated gas to the supplier.
- Use calibrated measuring equipment.
- Make sure that the measuring equipment is periodically checked and calibrated.

### 2.2 Employee and organisation measures against exposure to contaminated SF<sub>6</sub> in case of malfunction

#### 2.2.1 Risks

Poisoning, skin and eye damage, respiratory distress due to lack of oxygen and suffocation due to excessive concentration of SF<sub>6</sub>.

#### 2.2.2 Employee measures

##### Before you start

- Use the following personal protection equipment
  - Disposable overall
  - Rubber or neoprene gloves
  - Rubber or neoprene boots
  - Full face mask with B2 P3 filter or fresh air hood
- Before entering the room, measure the SF<sub>6</sub> concentration. If it is higher than 1200 mg/m<sup>3</sup> (200 ppm), do not enter the room.
- Ventilate the area before entering. If mechanical ventilation is present, turn it on.
- Clear the location and set up safety zones.

##### During work

- Measure continuously the SF<sub>6</sub> concentration, it must be less than 1200 mg/m<sup>3</sup> (200 ppm). Otherwise leave the room.
- Remove loose dust with a vacuum cleaner with an micro (HEPA)-filter on the outlet of the vacuum cleaner.
- Remove adherent dust with non-abrasive dry material.

After cleaning, you can continue working in the compartment without the use of personal protection equipment.

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### When the work is done

- Clean tools and personal protection equipment with a vacuum cleaner or with non-abrasive dry cloths or a 10% soda solution.
- Clean the vacuum cleaner compartment with a cloth soaked in 10% soda and place the micro-filter and vacuum cleaner bag in a 10% soda mixture for 24 hours.
- Dispose the waste as hazardous waste.
- Wash hands and face with soap and water after finishing or when work is interrupted.

### 2.2.3 Organisational measures

- Provide information and instruction on working with SF<sub>6</sub>.
- Make sure that employees who recover SF<sub>6</sub> from high voltage switchgear (from 1000 Volt alternating current) have a certificate in handling SF<sub>6</sub> gas in HV installations.
- Provide storage for hazardous waste disposal.
- Where decomposition products can occur, one can place bags with activated aluminium (lami pouch). These bags can bind gaseous decomposition products and water. This reduces the amount of decomposition products by 75-90%.
- Use calibrated measuring equipment that complies with NEN-EN-IEC 60480.
- Make sure that the measuring equipment is periodically checked and calibrated.

## 2.3 Employee and organisation measures against exposure to clean SF<sub>6</sub>

### 2.3.1 Risks

Poisoning, skin and eye damage, respiratory distress due to lack of oxygen and suffocation due to excessive concentration of SF<sub>6</sub>.

### 2.3.2 Employee measures

NOTE: No safety measures are required for outdoor installations.

#### Before you start

- Ventilate the area before you enter. If mechanical ventilation is present, turn it on.
- Measure the SF<sub>6</sub> concentration in the high-voltage areas (equal to or greater than 50kV) or if the work plan indicates this. Carry out the measurements low near the floor surface.
- If you are in a room for a short time, for example to place measuring equipment, the concentration of clean SF<sub>6</sub> should not exceed 6000 mg/m<sup>3</sup> (1000 ppm).
- When entering a room where any leaked SF<sub>6</sub> may be present, the concentration should not exceed 1200 mg/m<sup>3</sup> (200 ppm).
- If you stay longer in a room and work on the SF<sub>6</sub> equipment in that room, the concentration must not exceed 60 mg/m<sup>3</sup> (10 ppm).

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### During work

- Do not smoke or use an open flame in a room with SF<sub>6</sub> installations or in open spaces connected to rooms containing SF<sub>6</sub> installations.
- Do not eat or drink in a room with SF<sub>6</sub> installations or in open spaces connected to rooms with SF<sub>6</sub> installations.
- Continuously measure the concentration of SF<sub>6</sub> during welding or soldering or other work where temperatures above 150°C can occur. If you measure 10 ppm or more of SF<sub>6</sub>, stop the work immediately and leave the room.

### 2.3.3 Organisational measures

- Provide information and instruction on working with SF<sub>6</sub>.
- Make sure that employees who recover SF<sub>6</sub> from high voltage switchgear (from 1000 Volt alternating current) have a certificate in handling SF<sub>6</sub> gas in HV installations.
- Provide storage for hazardous waste disposal.
- Define the situations in which the employee must perform measurements.
- Use calibrated measuring equipment that complies with NEN-EN-IEC 60480.
- Make sure that the measuring equipment is periodically checked and calibrated.