

## SF6 end-of-life treatment of T&D equipment (>1kV) in Substations

## **Background**

 $SF_6$  has proven its excellent dielectric properties for the safe and secure operation of electrical equipment. Its only drawback is the very high global warming potential which casts a serious cloud over this substance when released into the atmosphere. In the electric power industry, large numbers of  $SF_6$ -containing transmission and distribution equipment are operating in Substations and other similar installations such as Power Plants and Gas Insulated Lines.  $SF_6$  emissions from this equipment could occur during production, commissioning, operation and servicing and in the case of end-of-life handling. While  $SF_6$  emissions from state-of-the-art electrical equipment during normal operation are negligible, a recent study by the well-accepted Fraunhofer Institute of Energy Economics and Energy System Technology (IEE) claims that end-of-life treatment is by far the dominant source of  $SF_6$  emissions.

## Present challenges

The installation of SF<sub>6</sub>-containing electrical transmission and distribution equipment started in the 1970s for high-voltage equipment and extended down to medium-voltage in the 1980s. There is an increasing number of installations coming to their end-of-life in the coming years.

Although the use and handling of  $SF_6$  is regulated for this equipment, regulations (e.g. the European F-Gas regulation) have not given clear requirements on end-of-life treatment of  $SF_6$  and do not rigorously sanction improper  $SF_6$  end-of-life handling or stimulate re-use or recycling of  $SF_6$ .

Policymakers in some regions in the world are engaged in reducing  $CO_2$  equivalent emissions and also  $SF_6$  due to its high global warming potential. However, the majority of the  $SF_6$  efforts focus on new installations of electrical transmission and distribution equipment where  $SF_6$  might be replaced by more environmentally friendly candidates. This approach may limit the amount of banked  $SF_6$  in the future but still does not address the predominant emission potential from the installed base.

In addition, there is a high number of  $SF_6$ -based technical solutions from many manufacturers in very different market segments, operated by TSO, DSO and industry. Unfortunately, no clear instructions available at present on how this equipment can be treated at end-of-life in a responsible way with minimal impact on the environment. Without guidance, mishandling actions from non-experts in this area might lead to higher  $SF_6$  emissions.

## The Joint Working Group's task

The scope of the Joint Working Group B3/A3.59 entitled "Guidelines for  $SF_6$  end-of-life treatment of T&D equipment (>1kV) in Substations " is to give practical guidelines for appropriate  $SF_6$  end-of-life treatment contained in transmission and distribution equipment as a blueprint for environmentally responsible end-of-life handling of  $SF_6$  in the electric power industry, which bears the risk to become the main source of  $SF_6$  emission during equipment's life cycle.

A technical brochure shall:

- 1. Give an overview of existing SF<sub>6</sub> end-of-life techniques and practices;
- 2. Collect and analyse existing SF<sub>6</sub> end-of-life recommendations, specifications, standards and regulations;
- 3. Conduct a gap analysis where SF<sub>6</sub> end-of-life practices or recommendations, specifications, standards or regulations are missing;
- 4. Establish guidelines for appropriate and practical  $SF_6$  end-of-life treatment (i.e. removal, storage, transport, final disposal and possible re-use/recycling) while minimizing the end-of-life emissions and ensure safe end-of-life handling;
- 5. Provide advice for future regulation(s) addressing the safeguard of appropriate SF<sub>6</sub> end-of-life treatment and ensuring minimal SF<sub>6</sub> end-of-life emissions.

The Joint Working Group consists of members with a wide variety of experience from all over the world, dealing with SF<sub>6</sub>-containing transmission and distribution equipment in all phases of its lifetime: From the equipment design, manufacturing and testing, commissioning at the installation site, operation, servicing, and decommissioning until the final (used) SF<sub>6</sub> gas treatment.

The Joint Working Group will discuss and record practical guidelines for SF<sub>6</sub> end-of-life treatment in relevant stages:

- 1. Preparation of the equipment for decommissioning, by establishing a checklist for preparatory work that has to be done before the physical decommissioning;
- 2. Equipment decommissioning procedures, including the recovery of SF6, based on best available practices;
- 3. Formulate handling procedures for decommissioned equipment following SF<sub>6</sub> recovery to not simply treat the equipment as waste, but as reusable material depending on its contamination level. Procedures will vary for equipment containing non-arced gases, sightly arced gases or heavily arced gases as well as for failed equipment;

- 4. On-site storage of retrieved (used) SF<sub>6</sub>, supplying information on how the gas may be temporarily stored on-site before being transferred to its final treatment;
- 5. Transport of retrieved (used) SF<sub>6</sub> in accordance with relevant legislative requirements and appropriative labelling;
- 6. SF<sub>6</sub> quality evaluation procedures that shall determine if the retrieved (used) SF<sub>6</sub> is ready for re-use after reconditioning or must be treated as waste;
- 7. Reconditioning of SF<sub>6</sub> for re-use, detailing its preconditions and available processes;
- 8. Final disposal procedures for non-reusable SF<sub>6</sub> which cannot be put back into any lifecycle and must be incinerated;
- 9. Recommendations to existing or new regulation(s) to safeguard appropriate SF<sub>6</sub> end-of-life treatment which will be based on a gap and best practice analysis. This will enable the regulators to review the local regulations and adapt accordingly.