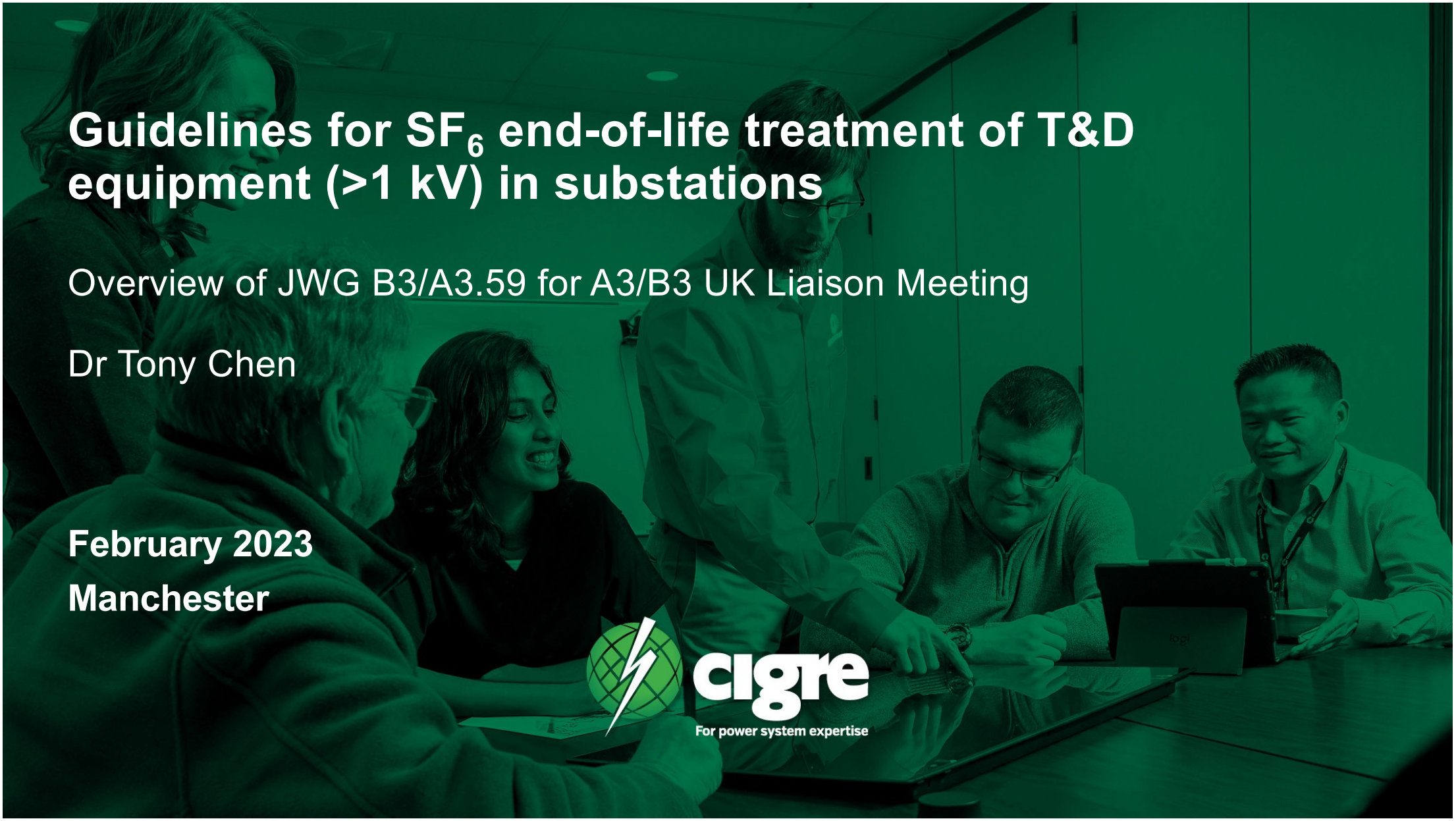


Guidelines for SF_6 end-of-life treatment of T&D equipment (>1 kV) in substations

Overview of JWG B3/A3.59 for A3/B3 UK Liaison Meeting

Dr Tony Chen

February 2023

Manchester

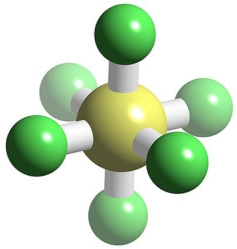
cigre

For power system expertise

Guidelines for SF_6 end-of-life treatment of T&D equipment (>1 kV) in substations

Motivation

- SF_6 is the strongest greenhouse gas with GWP_{100} of 24300* and a lifetime of >1000 years
- Professional and environmentally friendly disposal of SF_6 from electrical equipment acc. IEC 62271-4:2022
  ➔ important contribution to environmental protection!
- Required in the current version of the EU F-Gas Regulation (2014).
- Stricter measures in the event of infringement announced in the new version (2024)!
- HV > 52 kV: few users, high level of experience, high level of expertise.
- MV ≤ 52 kV: very many users (including industry), little experience,
  so far only few equipment has been dismantled.
- Publications [1] give cause for concern that there is a risk of high SF_6 emissions, particularly in medium voltage.



[1] https://www.iee.fraunhofer.de/content/dam/iee/energiesystemtechnik/de/Dokumente/Projekte/f-gas-free/SF6_study-public_report-Fraunhofer_IEE-final2.pdf

* according last IPCC AR6 report

CIGRE has therefore decided to create a guide with hints for planning and implementing professional disposal.

Guidelines for SF_6 end-of-life treatment of T&D equipment (>1 kV) in substations

JWG B3/A3.59

- Working group started in August 2020
- 43 members
- 10 meetings done (9 online, 1 hybrid, due to COVID)
- Very effective work and contribution from
  - manufacturer of equipment,
  - manufacturer of gas handling equipment,
  - TSO/DSO and also
  - recyclers
- Valid input from German ZVEI running a work on it´s own guide with reduced scope in parallel
- Brochure has been published 25.08.23
- Ready for tutorials

Guidelines for SF_6 end-of-life treatment of T&D equipment (>1 kV) in substations

Covered electrical equipment

Not just the classic GIS, but about all(!) electrical equipment, that contain SF_6. From several 100 kg per housing to << 1 kg.

Typically, the amount of SF_6 and the number of units installed are inversely proportional!

High voltage (>52 kV)

- Gas-insulated switchgear GIS
- SF_6 circuit breakers (dead tank or life tank)
- Gas-insulated transducer
- Gas-insulated transmission lines GIL/GIB
- Gas-insulated busbars (generator bars)

Medium voltage (>1 kV…52 kV)

- Primary switchgear GIS
- Secondary switchgear GIS, Ring Main Units RMU
- SF_6 circuit breakers
- SF_6 switch-disconnector
- Gas-insulated busbars

Guidelines for SF_6 end-of-life treatment of T&D equipment (>1 kV) in substations

Preparation and planning of the work steps

Before starting to work a robust planning can give a clear overview about how and who. It helps to avoid that something is fogotten and will create issues when the work is ongoing. Detailed questions and checklists have been developed, covering:

- Defining the scope of work: ➔ Who does what? Determination by owner!
- Acquisition of the available data of the equipment: ➔ Manufacturer, size, amount of gas
- Condition of the equipment and the gas: ➔ Defects, leaks, special conditions?
- Preparation of the documentation: ➔ What does the disposal company or forwarder need?
- Requirements for the staff: ➔ Knowledge of product, equipment, safety
- Equipment required: ➔ Gas handling, dismantling, loading, transport
- Preparations of the storage and shipping area: ➔ eg temporary interim storage

The checklists developed in the appendix to the guidelines provide support during planning and ensure that everything is thought of.

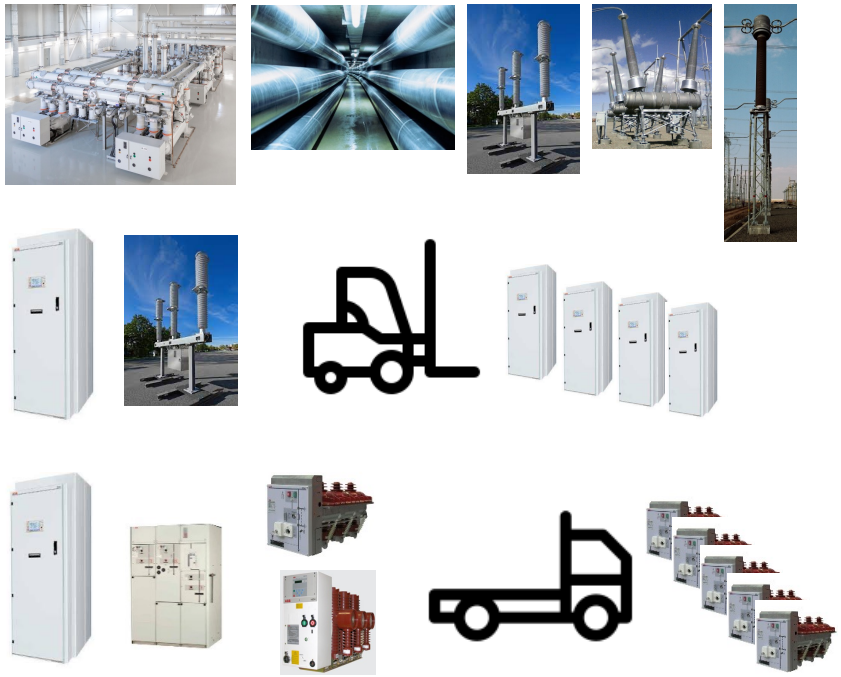
Guidelines for SF_6 end-of-life treatment of T&D equipment (>1 kV) in substations

Selection of the location for the recovery of SF_6

- **Gas recovery at the installation site:**
  For HV and older MV products that cannot be dismantled or transported without gas works

- **Gas recovery on site, close to the original installation:**
  For medium-sized, gas-filled transportable units on one owner's collection point

- **External, central gas recovery:**
  At medium, small and micro units, collected at the disposal company



Guidelines for SF_6 end-of-life treatment of T&D equipment (>1 kV) in substations

Preparation for gas recovery

- **Access to the gas:**
  Is there a filling valve and the corresponding adapter or is there a need to be drilled gas-tight?

or

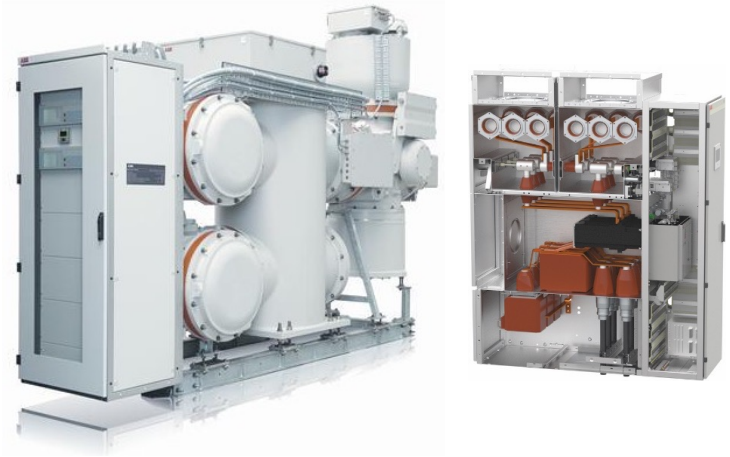
- **Evaluation of the toxicity of the SF_6:**
  - Is the used SF_6 classified as toxic?
  - Is a gas analysis necessary and possible?
  - Can this be denied due to the design and application?

Guidelines for SF_6 end-of-life treatment of T&D equipment (>1 kV) in substations

Procedure for gas recovery

Evacuable electrical equipment:

- Gas recovery by evacuation.
- Standard on HS and some MV assets that can be evacuated

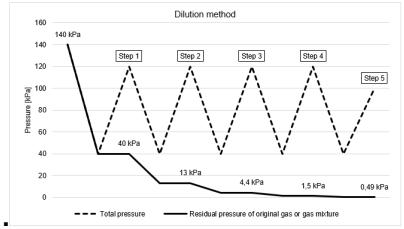


Electrical equipment that cannot be evacuated:

- Gas recovery by evacuation. Deformation with gas tightness is accepted

- Gas recovery using an evacuation chamber (only at the disposal company)

- Gas recovery with the dilution method. High quantities of SF_6 diluted with air. The only option for leaking HV containers.

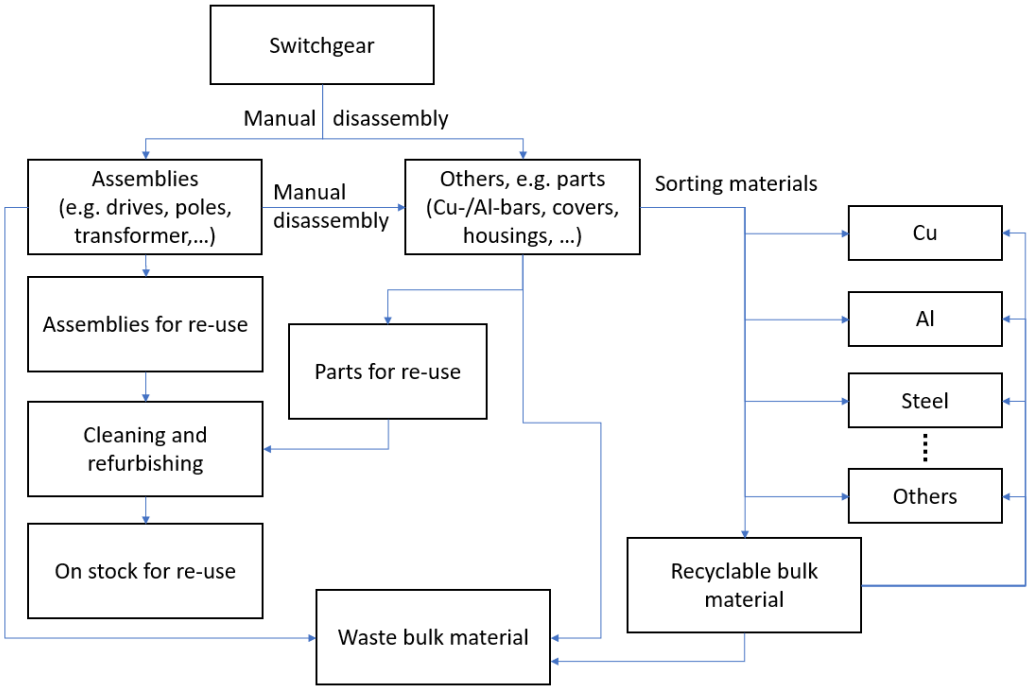


Guidelines for SF_6 end-of-life treatment of T&D equipment (>1 kV) in substations

Treatment of the emptied equipment

- In particular, gas compartments in which switching operations have taken place must be decontaminated first
- Loose dust is extracted
- Surfaces are decontaminated with lye
- **Observe personal protection!!!**

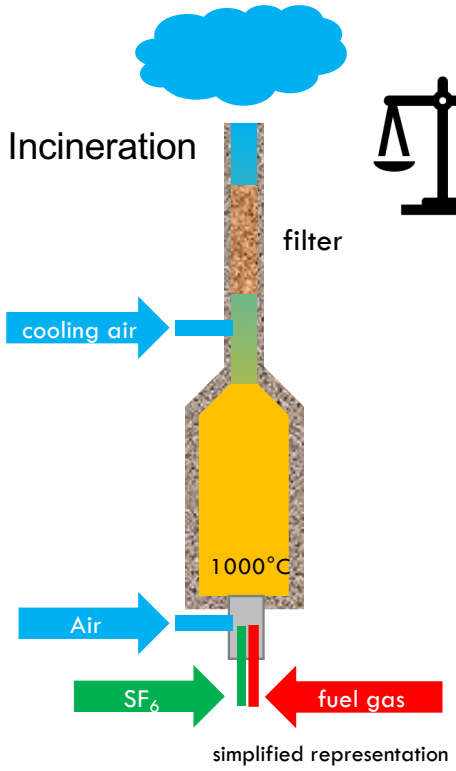
- The materials are then dismantled and sorted for reuse or recycling
- This can be done manually or by shredder (especially for small or embedded parts)



Guidelines for SF_6 end-of-life treatment of T&D equipment (>1 kV) in substations

Disposal of SF_6

- More SF_6 is currently required than is being returned
- The majority is recycled by filtering and purification through multiple cycles with a combination of increased pressure and reduced temperature to the desired quality
- Only a very small proportion of SF_6 that is usually too heavily contaminated is destroyed
- This is currently done by incineration at >1000°C
- However, this will change due to increasing SF_6 bans and the use of alternative insulating gases
- Then the amount of SF_6 becomes too large for admixture in incinerators
- New concepts for destroying SF_6 must be developed
- The brochure shows some possibilities

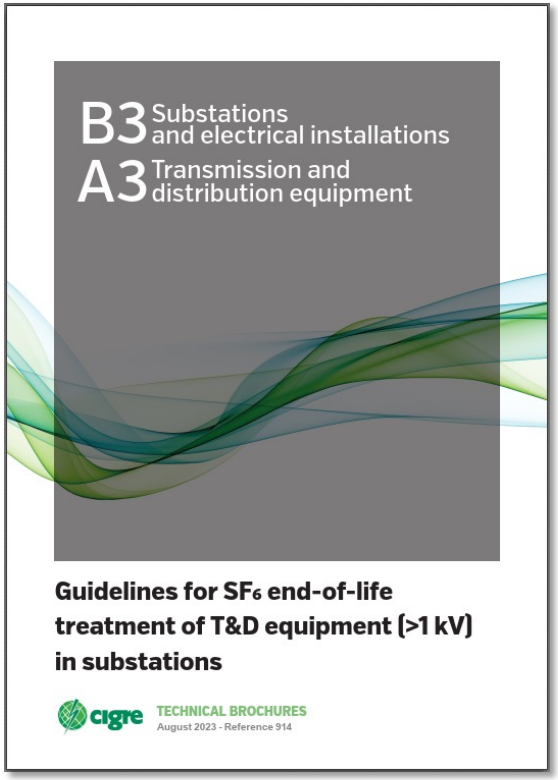


Recycling

Guidelines for SF_6 end-of-life treatment of T&D equipment (>1 kV) in substations

Guide availability

- The CIGRE brochure has been published 25.08.2023 as number 914
- It is available for download (free for CIGRE members): https://e-cigre.org/publication/914-guidelines-for-sf6-end-of-life-treatment-of-td-equipment-1-kv-in-substations




Thank You!
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cigre
For power system expertise