SF$_6$ & ALTERNATIVES COALITION

SF$_6$ and Alternatives
Global Standards and Technical Activity

Institute of Electrical and Electronic Engineers (IEEE)

- **Technical Report PES-TR64** - Impact of Alternate Gases on Existing IEEE Standards (2018)
  Scope: This document summarizes the state of the art in 2018 including technical considerations, toxicity, cost and availability of SF$_6$ alternatives and the contemporary environmental / regulatory situation. IEEE switchgear and substation standards are reviewed in the context of SF$_6$ alternatives.
- **PC37.100.7** - Guide for the evaluation of performance characteristics of non-Sulfur Hexafluoride insulation and arc quenching media for switchgear rated above 1000 V (2022, estimated).
  Scope: The guide reviews existing standards and performance criteria for switchgear rated above 1000 V. Each aspect of performance is discussed within the context of Sulfur Hexafluoride alternatives, how their behavior may differ from existing technologies and how this behavior may lead to changes in the qualification process.
- **PC37.122.10** - Guide for Handling Non-Sulphur Hexafluoride (SF$_6$) Gas Mixtures for High Voltage Equipment (2023, estimated).
  Scope: This guide describes the on-site handling of non-SF$_6$ gases and their gas mixtures used in electric power equipment. This includes gas mixing, filling, analysis, recovery, reclamation, and recycling.
- **C37.122.3** - Guide for Sulphur Hexafluoride (SF$_6$) Gas Handling for High-Voltage (over 1000VAC) Equipment (2011). Estimated updated in 2022.
  Scope: The purpose of this guide is to provide state-of-the-art technologies and procedures to minimize SF$_6$ gas emission to a minimum functional level for the electric power equipment to preserve the environment.
- **C37.122.5** - Guide for Moisture Measurement and Control in SF$_6$ Gas-Insulated Equipment (2013).
  Scope: This guide describes generally accepted processes for moisture level measurement, moisture data interpretation, and moisture control in gas-insulated switchgear

International Electrotechnical Commission (IEC)

- **60376** - Specification of Technical Grade Sulphur Hexafluoride (SF$_6$) and Complementary Gases to Be Used in Its Mixtures For Use In Electrical Equipment (2018).
  Scope: This Standard defines the quality for technical grade SF$_6$ and complementary gases such as nitrogen and carbon tetra-fluoride for use in electrical equipment.
- **60480** - Specifications for the re-use of sulphur hexafluoride (SF$_6$) and its mixtures in electrical equipment (2019).

Scope: This Standard provides criteria for the re-use of SF6 and its mixtures after recovery and reclaiming from electrical equipment (e.g. for maintenance, at the end-of-life).

- **62271-4 (revision)** - Handling Procedures for Gases and Gas Mixtures for Insulation and/or Switching (2020).
  Scope: This part of IEC 62271 applies to the procedures for handling of gases and gas mixtures for insulation and/or switching during installation, commissioning, repair, overhaul, normal and abnormal operations and disposal at the end-of-life of high-voltage switchgear and controlgear.

International Council on Large Electric Systems (CIGRE)

- **Technical Brochure 589** - The Impact of the Application of Vacuum Switchgear at Transmission Voltages (2014). An analysis of the viability of vacuum technology in high-voltage applications.
  Technical Brochure 730 - Dry Air, N2, CO2 and N2/SF_6 Mixtures for Gas Insulated Systems (2018). Provides the latest information on basic and practical properties of the potential gas-insulated systems using dry air, N2, CO2 and N2/SF_6 mixtures.
- **Technical Brochure 802** - Application of Non-SF_6 Gases or Gas Mixtures in Medium and High Voltage Gas Insulated Switchgear (2020). Describes the needs for adaptations or new requirements for the safe, reliable and sustainable application of non-SF_6 gases and gas mixtures in gas-insulated switchgear.
- **Working Group D1.67** - Dielectric Performance of New Non-SF_6 Gases and Gas Mixtures for Gas Insulated Systems (2021, estimated).
- **Working Group A3.41** - Interrupting and Switching Performance with SF_6 Free Switching Equipment (2021, estimated).
- **Working Group B3-A3.59** - Guidelines for SF_6 End-of-Life Treatment for T&D Equipment in Substations (2024, estimated).

SF_6 & Alternatives Coalition

- **Considerations for Planning an SF_6 Phase-Out** (2020). Recommendations for decision-makers on how to plan for a system-wide or market-wide phase-out of SF_6.
- **Alternative Insulation Technologies** (2019). An overview of the alternative insulating gases on the market and how they compare with SF_6 in certain performance criteria.
- **Advantages of Shipping Gas-Insulated Equipment with Dry Air** (2019). A best practices guide for OEMs to reduce cost and facilitate customer tracking/reporting of SF_6 emissions.
- **SF_6 Reporting Challenges** (2016). An explanation of how use of GIE nameplate for emissions tracking can lead to erroneous calculations.
- **Nameplate Adjustment** (2016). Recommended processes to support accurate reporting of SF_6 emissions.

Other Associations

- **ASTM International**
  - D1933-03 Standard Specification for Nitrogen Gas as an Electrical Insulating Material (2017)
  - D2472-15 Standard Specification for Sulfur Hexafluoride
- **T&D Europe Manufacturing Association - WG Gases for Switchgear**
  - Technical Report on Alternative to SF_6 Gas in Medium Voltage & High Voltage Electrical Equipment (2020). An overview of the European region, covering present and emerging technologies by applications, as well as opportunities, limitations and drawbacks.
  - Technical Guide to Validate Alternative Gas For SF_6 In Electrical Equipment (2017). A guide to provide manufacturers of electrical equipment with a method to validate a new alternative gas to SF_6.
  - T&D Europe Position Paper on SF_6 and SF_6 Alternative Technologies (2020). T&D Europe supports a clear regulatory framework at European level enabling a reliable long-term planning basis for all stakeholders.
- **German ZVEI - WG SF_6 & Alternative Gases**
  - Scenario for Reducing SF_6 Operating Emissions from Electrical Equipment through the Sse of Alternative Insulating Gases (2020). An anaysis of the effects of sticking with SF_6 technology and introducing alternative technologies in medium and high voltage.
  - SF_6 in der Energietechnik (2020). Explores the use of SF_6 in energy technologies (available only in German).
- **Fraunhofer Institute for Energy Economics and Energy System Technology**
  - Project Impact Assessment of F-gas Free Medium Voltage GIS Applications (2020). A study that analyzes the use of the potent greenhouse gas SF_6 and of F-gas free alternatives in medium voltage grids.
- **University of Antwerp**
  - Replacing SF_6 in Electrical Gas-Insulated Switchgear: Technological Alternatives and Potential Life Cycle Greenhouse Gas Savings in an EU-28 Perspective (2020). Projects a carbon footprint reduction of (median) 14 Mt of CO2e across the EU-28 over 50 years based on a phase-out starting from 2020.