



Sustainable Reduction of SF₆ Emission – OEMs, Users, new EU-F-Gas Regulation 2017 Workshop for SF₆ Emission Reduction Strategies Peter Glaubitz, Siemens AG

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San Francisco, California - January 24-25,2017

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Agenda

- Fluorinated greenhouse gases and the EU*-F-Gas-regulation
- SF₆ in CIGRÉ
- SF₆ in the IEC
- SF₆-Emission reduction
- Installed Base and the application of SF₆ in the manufacturing process
- Alternative solutions
- Conclusion



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The Kyoto Protocol of the UNFCCC was the start of the EU-F-Gas-regulation and has the target to reduce greenhouse gas emissions into the atmosphere

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SF₆ emission reduction is the focus of every (F-Gas-) regulation



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2017 Workshop for SF₆ Emission Reduction Strategies

EU-F-Gas-regulation (EG) 517/2014 involves 28 member states



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- Complex, because 28 "man-made-substances" (all F-gases) are considered
- No restrictions on the application of SF₆ in electrical power equipment and SF₆ switchgear
- Contains requirements for producers and operators of SF₆ electrical power equipment and implementation dates
- The new F-Gas-regulation has to be transferred into national regulations <u>until January 1st, 2017 (</u>Article 25)
- <u>Until July 1st, 2020</u>, the Commission shall publish a report assessing if reliable alternatives exist, which will allow the replacement of F-Gases in new MV secondary switchgear (Article 21)
- Further report on the effects of the regulation to be published <u>in 2022</u> (Article 21)

Link for all regulations: www.eur-lex.europa.eu

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Implementing Regulations for SF₆ electrical power equipment derived from the EU-F-Gas-regulation 517/2014



EU-F-Gas-r	Implementing					
	517/2014	Regulations				
Training and Certification	Article 10	(EU) 2015/2066 (17. Nov 2015)				
Labelling	Article 12	(EU) 2015/2068 (17. Nov 2015)				
Reporting	Article 19	(EU) 1191/2014 (30. Oct 2014)				



Important articles of the EU-F-Gas-regulation 517/2014 have been detailed in implementing regulations for easier application

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EU-F-Gas-regulation 517/2014 – Prevention of emissions, leak checks and leakage detection systems

Article

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- Intentional release shall be prohibited
- Leakages have to be minimized, detected leakages have to be repaired without undue delay, verify effective repair (< 1 Month)
- Leak checks → SF₆ electric power equipment is not affected provided they comply with one of the following conditions
 - Tested leakrate of less than 0.1% per year
 - Equipped with a pressure or density monitoring device
 - Or it contains less than 6kg of fluorinated greenhouse gases (per compartment)
- Leakage detection systems have to be installed <u>from 1st January 2017</u> for functionality reasons, in most of the cases, already implemented in the past
- Leakage detection systems shall be checked at least once every 6 years
- SF₆ electric power equipment containing less than 500ton CO₂e (approx. 22kg SF₆) do not need a leakage detection system

* Type tested

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Art. 3 – 5

EU-F-Gas-regulation 517/2014 – Recovery, Training and Certification

Article

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- Operators shall ensure that the recovery of fluorinated gases is carried out by natural persons that hold the relevant certificates provided for by Article 10
- As per <u>1st July 2017</u> the persons carrying out the tasks below shall be trained and hold a certificate provided for by Article 10 Installation, servicing, maintenance, repair and decommissioning of SF₆ electric power equipment + recovery of fluorinated greenhouse gases
- Only for on-site works \rightarrow No certification in the factory as processes are automated (attention: maintenance of SF₆-handling equipment in factory)
- Existing certificates issued in accordance with regulation (EC) no. 842/2006 remain valid
- Member States shall recognize certificates issued in another Member State (attention: language)

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Art. 10

EU-F-Gas-regulation 517/2014 – Labelling

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- Products and equipment must be labelled
 - Reference to fluorinated greenhouse gases (A) and

(B) amount in kg SF₆ \rightarrow 2015;

and

(B) CO_2e and $GWP^* \rightarrow 2017$

- Labels shall be placed on the equipment
 Information shall
- Information shall be included in instruction manuals and in descriptions used for advertising

* Global Warming Potential Unrestricted © Siemens AG 2017

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Art. 12 (A) Example of EU-label -GWP SF_: 22800 LT: Sudėtyje yra fluoruotų šiltnamio efektą sukeliančių dujų DE: Enthält fluoriertes Treibhausgas LV: Satur fluorētas siltumnīcefekta gāzes EN: Contains fluorinated greenhouse gas MT: Kontenut gas tat tip "flourinated greenhouse" BG: Съдържа флуорирани парникови газове **GWP SF₆: 22800 EN:** Contains fluorinated greenhouse gases RU: Содержит фторированный парниковый газ Sisältää fluorattuja kasvihuonekaasuja 479 SK: Obsahuje fluórovaný skleníkový plyn Contient du gaz à effet de serre fluoré SL: Vsebuje fluorirane toplogredne pline Ina bhfuil gáis cheaptha teasa fhluairínithe SV: Innehåller fluorerade växthuscaser Codrži fluorizono etokloničko plinova Example of SE₂ quantity label

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ik-Nr.	(D)	LS	I I			Anl	age	
il no.	12 345 678 CB			Switchgear				
Gasraum	Gas compartment	00	01	02	03	04	05	06
SF6-Überdruck	Fülldruck bei Filling pressure at	20°C 5.6	4.5	4.5	4.5	4.5	4.5	4.5
Gauge pressure	GWP SF ₆ : 22800				4.0	4.0	4.0	4.0
[bar]	Banked Mass of Co	O ₂ equiva	ale	nt	6.0	6.0	6.0	6.0
[kg]	SF6-Füllmenge Banked mass of SF6							
Treibhauspotenzial	Global warming potential					22,800		
[4]	CO2e-Füllmenge Banked mass of CO2e							

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EU-F-Gas-regulation 517/2014 – Record keeping and Reporting

Article

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Art. 6 and 19

- Record keeping (installed amount, leaking quantities) for equipment containing SF₆ is <u>not</u> required as a leakage detection system (pressure or density monitoring device with remote signalling function) is installed according to Article 4
 - However operators of SF_6 electric power equipment should continue with their established internal documentation processes as agreed upon national self commitments
- On 31 March of each year (introduced in 2015), the amount of bulk SF₆ imported into or exported from the EU has to be reported, with reference to the previous year
 - This is valid for manufacturers and operators In addition operators have to report the amount of SF_6 contained in equipment imported into the EU

CIGRÉ brochures give guidance for the environmental friendly handling of SF₆

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CIGRÉ SF₆-brochures

Concepts

- Keep SF₆ in a closed cycle
- Avoid any deliberate release
- Allow SF₆ re-use on-site

Sustainable application of SF₆

- State-of-the-art handling-equipment \rightarrow recover all SF₆ (0 mbar/psig*)
- State-of-the-art SF₆ quality checks
- State-of-the-art measurement
- State-of-the-art equipment
- Best available processes

What shall be done?

- → tightness of equipment but also of reclaimers, pipes etc.
- \rightarrow repair of leaks without undue delay
- \rightarrow long SF₆ life time

- \rightarrow gas collecting capability
- \rightarrow clear parameters
- \rightarrow extended maintenance intervals
- → trained and certified service staff for SF₆ handling
- Many CIGRÉ brochures have been transferred into Standards and regulations
 → CIGRÉ "SF₆ Green Book" planned
- * 1 mbar = 0.0145 psig

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The CIGRÉ ELECTRA* Position Paper...



CIGRE Position Paper on the Application of SF₆ in Transmission and Distribution Networks Preve Glaubitz, Silvio Stangherlin, Jean-Marc Blasse, Fallo Meyer, Mathieu Dallet, L. Mynast, A. Jenssen, R. Sneets, D. Oufournet

Published in the ELECTRA magazine no. 274, in June 2014

... gives a general overview of SF_6 and its application in the electrical industry

* Monthly magazine of CIGRÉ

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IEC and the application and handling of sulfur hexafluoride (SF₆) in high-voltage switchgear and controlgear

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Which Measures have been implemented by Operators in order to reduce emissions?

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What is SF₆ emission?

Leakage losses



Handling losses



SF₆-Emission

handling losses can be avoided by...

- Trained personal
- State-of-the-art handling- and measurement equipment
- Long maintenance intervals to reduce openings

leakage losses can be avoided by...

- Gas-tight equipment
- SF₆ leak detection systems
- Immediate repair of leaks
- Replacement of electric power equipment, even before end of lifetime

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Installed base and emission of SF₆ in electric power equipment in Switzerland





- The finally achieved emission rate for Switzerland of 0.12% seems to be very close to the possible optimum
- All known measures have been implemented including the replacement of leaking equipment and controlled pressure systems

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Installed base and emission of SF₆ in electric power equipment in Germany





SF₆ - inventory and emission rate of electric power equipment Ur \ge 52kV in operation from 2003 – 2015 in Germany (Data of FNN, VIK, ZVEI and Solvay)

- Compared to Switzerland the SF₆-emission can still be reduced
- The biggest lever seems to be the replacement of 1st generation controlled pressure systems (high leakage rates)

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Development of arc quenching technologies



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Gas Insulated Switchgear: Significant reduction of Global Warming Potential with SF₆-Technology, further reduction with Vacuum-Technology achieved

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Boundary conditions:

145 kV GIS "Old" : lifetime 40 years; SF $_6$: 180kg, 3% leakage rate in operation, maintenance not included

145 kV GIS "state-of-the-art": Lifetime 50 years; SF_6 83 kg, 0,1% leakage rate in operation;

145 kV GIS "Alternative": 15 kg CleanAir, one maintenance interval after 25years

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94% GWP-reduction with SF₆:

- Very low leakage rate
- Reduction of gas volume
- Shorter sealing length
- Design optimization

97% GWP-reduction with alternative gas solutions

- No emissions of F-gas
- High recycling rates
- Maintenance-free
 operation

How can an alternative solution look like?

Peter Glaubitz

Switching-Technology – Which benefit offers the Vacuum Switching-Technology?

- Excellent arc quenching capability and proven technology in Medium-Voltage for many decades
- Excellent at low ambient temperature
- High number of C-O operations



Insulating Medium 100% N₂

5 Vacuum Live-Tank Circuit Breaker 72.5 kV in operation since 2010

Vacuum-Circuit Breakers show no discrepancies in their performance in relation to SF_6 -Circuit Breakers

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72,5 kV	145 kV
31,5 kA	40 kA
2500 A	3150 A

Alternative Gas Solution Clean-Air Switchgear





72.5 kV Clean-Air application for Windtower



145 kV Clean-Air GIS

- Vacuum tubes for Circuit Breaker switching
- Clean-Air insulation \rightarrow 80% N₂ and 20% O₂
- No Global Warming Potential (GWP) = 0
- Low boiling point and no liquidation at low temperatures
- Known and proven material compatibility
- Low requirements for transportation, installation, operation, documentation and recycling
- C-Gas-free → without risk of Carbon by-products in switching and insulating gas compartments
- The F-Gas-regulation does not apply to vacuum/Clean-Air electric power equipment, which reduces extensive requirements



To avoid SF₆ emission ...

- All known sustainable measures have to be implemented, especially
 - Replacement of equipment and controlled pressure systems which cannot be tightened
 - Gas handling only by certified staff
- SF_6 emission can be reduced to 0.1% based on the installed SF_6 inventory, further reduction is utmost challenging
- SF₆ respectively F-Gas replacement solutions are under investigation – first pilot projects in place

Contact



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