

Guidelines for the checking and treatment of sulphur hexafluoride (SF₆) taken from electrical equipment and specification for its re-use

The European Standard EN 60480:2004 has the status of a
British Standard

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee GEL/10, Fluids for electrotechnical applications, which has the responsibility to:

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**Guidelines for the checking and treatment of sulphur hexafluoride (SF₆)
taken from electrical equipment and specification for its re-use
(IEC 60480:2004)**

Lignes directrices relatives au contrôle
et au traitement de l'hexafluorure
de soufre (SF₆) prélevé sur le matériel
électrique et spécification en vue
de sa réutilisation
(CEI 60480:2004)

Richtlinien für die Prüfung und
Aufbereitung von Schwefelhexafluorid
(SF₆) nach Entnahme aus elektrischen
Betriebsmitteln und Spezifikation für
dessen Wiederverwendung
(IEC 60480:2004)

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

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The following dates were fixed:

- | | | |
|--|-------|------------|
| – latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2005-08-01 |
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Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60480:2004 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

ISO 14040	NOTE	Harmonized as EN ISO 14040:1997 (not modified).
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CONTENTS

INTRODUCTION.....	4
1 Scope	5
2 Normative references	5
3 Terms and definitions	6
4 Typical applications of SF ₆	8
5 Impurities and their sources.....	8
6 Environmental aspects	9
7 Health and safety	10
8 Quality specification for re-use of SF ₆ in new or existing switchgear.....	11
9 Analytical methods for SF ₆ and their significance.....	13
10 Handling, storage and transportation	16
Annex A (informative) Derivation of maximum tolerable moisture levels for re-use	19
Annex B (informative) Description of the different methods of analysis (on-site and laboratory)	21
Annex C (informative) Reclaiming recommendations and procedures on-site.....	29
Annex ZA (normative) Normative references to international publications with their corresponding European publications	32
Bibliography	33
Figure 1 – Decision flow chart for the destination of removed SF ₆	12
Figure 2 – Decision flow chart for on-site analysis.....	14
Figure A.1 – Moisture levels (ppmv) as a function of gas pressure <i>p</i>	19
Figure B.1 – SF ₆ gas sampling set-up: evacuation	21
Figure B.2 – SF ₆ gas sampling set-up: purging	22
Figure B.3 – Typical gas chromatogram of decomposed SF ₆	25
(analysis performed with a Porapak Q column).....	25
Figure B.4 – IR spectrum of contaminated SF ₆	28
Table 1 – Origin of SF ₆ impurities	8
Table 2 – Maximum acceptable impurity levels.....	13
Table 3 – On-site methods.....	15
Table 4 – Laboratory methods	15
Table B.1 – Thermal conductivity detector relative response factor.....	26
Table B.2 – Peak absorption of SF ₆ and contaminants	28
Table C.1 – Suggested reclaiming operations	29
Table C.2 – Typical adsorbents for various SF ₆ impurities	30
Table C.3 – Summary of SF ₆ transportation regulations	31

INTRODUCTION

Sulfur hexafluoride, SF₆, is an essential gas for electrical equipment. Influenced by environmental concerns, the international community, and especially the electrical industry, has made and is still making a substantial contribution towards controlling the environmental impact of the product at all stages of its life, from “the cradle to the grave”, as it is defined in ISO 14040 [5]¹.

In line with these efforts and as a complement to them, particular attention has been paid to reclaiming procedures of the SF₆ as used in electrical equipment. These procedures allow the re-use of the gas when equipment is maintained, repaired or reaches the end of its service life. This includes acceptable limits for impurity levels, according to experience gained by main users (manufacturers and electrical utilities).

¹ References in square brackets refer to the bibliography.

GUIDELINES FOR THE CHECKING AND TREATMENT OF SULFUR HEXAFLUORIDE (SF₆) TAKEN FROM ELECTRICAL EQUIPMENT AND SPECIFICATION FOR ITS RE-USE

1 Scope

This International Standard concerns the re-use of sulfur hexafluoride (SF₆) after removal from electrical equipment (for maintenance, or at the end of life).

This standard recommends procedures for reclaiming used SF₆ and for restoring its quality to an acceptable level, which would allow the filling of new or existing electrical equipment.

This standard provides guidance to operational and maintenance personnel for the testing and safe handling of used SF₆.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050(191):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 191: Dependability and quality of service*

IEC 60050(212):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 212: Insulating solids, liquids, gases*

IEC 60050(441):1984, *International Electrotechnical Vocabulary (IEV) – Chapter 441: Switchgear, controlgear and fuses*

IEC 60050(826):1982, *International Electrotechnical Vocabulary (IEV) – Chapter 826: Electrical installations of buildings*

IEC 60376:1971, *Specification and acceptance of new sulfur hexafluoride*

IEC 60376A:1973, First supplement, *Specification and acceptance of new sulfur hexafluoride – Section Thirteen: Mineral oil content*

IEC 60376B:1974, Second supplement, *Specification and acceptance of new sulfur hexafluoride – Clause 26*

IEC 60694:1996, *Common specifications for high-voltage switchgear and controlgear standards*

IEC 61634:1995, *High-voltage switchgear and controlgear – Use and handling of sulfur hexafluoride (SF₆) in high-voltage switchgear and controlgear*

3 Terms and definitions

For the purposes of this document, the terms and definitions contained in IEC 60050(191) IEC 60050(212), IEC 60050(441) and IEC 60050(826), as well as the following, apply.

3.1 General terms

3.1.1

electrical equipment

any item used for such purposes as generation, conversion, transmission, distribution or utilization of electrical energy, such as machines, transformers, apparatus, measuring instruments, protective devices, wiring materials, appliances

[IEV 826-07-01]

3.1.2

enclosure

part providing protection of equipment against certain external influences and, in any direction, against direct contact

[IEV 826-03-12]

3.1.3

maintenance

combination of all technical and administrative actions, including supervision actions, intended to retain an item in, or restore it to, a state in which it can perform a required function

[IEV 191-07-01]

3.2 Material aspects

3.2.1

insulating material

solid with negligible low electric conductivity, used to separate conducting parts of different electrical potentials

[IEV 212-01-01]

3.2.2

insulating gas

gas with negligible low electric conductivity, used to separate conducting parts of different electrical potentials

[IEV 212-01-03]

3.2.3

electrode

conducting part intended as a conducting interface with a medium of different conductivity

3.2.4

reservoir

storage container

3.3 Environmental aspects

3.3.1

new sulfur hexafluoride

SF₆ complying with IEC 60376, and never used previously

3.3.2

used sulfur hexafluoride

SF₆ introduced into electrical equipment

3.3.3

unused sulfur hexafluoride

SF₆ never been introduced into electrical equipment (e.g. gas having been transferred into a storage tank)

3.3.4

recycling

operation to pass through a series of changes or treatment so as to return to a previous stage in a cyclic process

3.3.5

reclaiming

elimination of soluble and insoluble contaminants from an insulating liquid or gas by chemical adsorption means, in addition to mechanical means, in order to restore properties as close as possible to the original values or to the levels proposed in this standard

[IEV 212-09-05, modified]

3.3.6

solid adsorbent

solid substances that can be used for adsorbing impurities

3.3.7

reclaimer

device for the purification of used gas for the purpose of re-use on-site [1]

3.3.8

re-use

use of reclaimed gas for filling new or existing electrical equipment

3.3.9

reclaimed gas

gas that has been processed by a reclaimer [1]

3.3.10

recovery

transfer of gas from electrical power equipment into a reclaimer or storage container [1]

3.3.11

final disposal

transformation of gas into substances which can either be used for other purposes or which can be disposed of in an environmentally compatible way [1]

4 Typical applications of SF₆

The typical applications of SF₆ are described in IEC 60376 and IEC 61634.

5 Impurities and their sources

5.1 Introductory remark

SF₆ taken from electrical equipment in operation contains several kinds of impurities. Some of them are already present in the new gas, as a result of the manufacturing process. The nature of these impurities and the quantities admissible are reported in IEC 60376 and IEC 61634. The expected additional impurities in SF₆ taken from equipment come from both gas handling and the operation of the equipment. Table 1 summarizes the main impurities and their sources [1][2].

Table 1 – Origin of SF₆ impurities

SF ₆ situation and use	Sources of impurities	Possible impurities
During handling and in service	Leaks and incomplete evacuation Desorption	Air, Oil, H ₂ O
Insulating function	Partial discharges: Corona and sparking	HF, SO ₂ , SOF ₂ , SOF ₄ , SO ₂ F ₂
Switching equipment	Switching arc erosion	H ₂ O, HF, SO ₂ , SOF ₂ , SOF ₄ , SO ₂ F ₂ , CuF ₂ , SF ₄ , WO ₃ , CF ₄ , AlF ₃
	Mechanical erosion	Metal dusts, particles
Internal arc	Melting and decomposition of materials	Air, H ₂ O, HF, SO ₂ , SOF ₂ , SOF ₄ , SO ₂ F ₂ , SF ₄ , CF ₄ Metal dusts, particles, AlF ₃ , FeF ₃ , WO ₃ , CuF ₂

5.2 Impurities from handling and in service

Filling and emptying equipment may lead to the addition of air and water vapour.

Moisture can also be desorbed from internal surfaces of the equipment and from polymeric parts. Oil from handling equipment (pumps and compressors) may also be inadvertently introduced to SF₆.

5.3 Impurities in equipment having only an insulating function

The essential process is the decomposition of SF₆ by partial discharges (corona and sparking). The immediate products are fragments of SF₆, such as SF₅, SF₄ and F, that combine with O₂ and H₂O to form compounds, mainly HF, SO₂, SOF₂, SOF₄ and SO₂F₂. Due to low energy of the partial discharges, the accumulated quantities of these compounds are usually negligible.

5.4 Impurities in switching equipment

During current interruption, the existence of high temperature arcs leads to the formation of decomposition products of SF₆, vaporized electrode metal, plastics and impurities. In addition, chemical reactions take place between the products formed (see Table 1).

The quantity of these by-products is controlled by the number of operations, the design of equipment and the use of adsorbers (solid adsorbents).

Switching equipment may also contain particles and metal dust coming from the rubbing of contacts.

5.5 Impurities from internal arcs

The occurrence of an internal arc is extremely rare. The expected impurities in SF₆ in faulted equipment are similar to those normally found in switching equipment. The difference lies in the quantity of compounds, which becomes high enough to create a potential toxic risk (see IEC 61634). In addition, significant vaporization of metallic material occurs and creates additional reaction products.

6 Environmental aspects

6.1 Introductory remark

Human activities have an effect on the environment. The impact of a given activity depends on its scale and on the materials involved. It is therefore necessary to consider the possible influence of SF₆ on the environment.

6.2 Impact on the ecosystem

SF₆ is an inert gas [3]. As its solubility in water is very low [3], it presents no danger to surface and ground water or the soil. A biological accumulation in the nutrition cycle does not occur. Therefore, SF₆ does not harm the ecosystem.

6.3 Ozone depletion

SF₆ does not contribute to the destruction of stratospheric ozone [3].

6.4 Greenhouse effect

SF₆ contributes to the greenhouse effect. However, the relative amounts used are such that its contribution is less than 1 to 1 000 in comparison with other agents. Its effect is very small. Good handling practices such as those defined in this standard contribute to ensuring that a very small impact is effectively maintained over a long period of time [3].

6.5 Decomposition products

Decomposition products of SF₆ are not released into the atmosphere in significant quantities [2]. At the end of the service life of an item of equipment, they can be converted into naturally occurring neutral products with no adverse impact on the local environment.

6.6 Conclusion

The use of SF₆ in electrical equipment has a negligible impact on the global environment and ecosystem. However, this will only remain so provided that due regard is paid by users to the containment and management of SF₆ when used in electrical equipment.