



Edition 3.0 2019-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE



Specifications for the re-use of suppur hexafluoride (SF6) and its mixtures in electrical equipment (standards.iteh.ai)

Spécifications pour la réutilisation de l'hexafluorure de soufre (SF₆) et des mélanges contenant du SF₆ dans le matériel électrique 8-

8a441433eca4/iec-60480-2019





THIS PUBLICATION IS COPYRIGHT PROTECTED Copyright © 2019 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office 3, rue de Varembé CH-1211 Geneva 20 Switzerland

Tel.: +41 22 919 02 11 info@iec.ch www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22,000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (EV) online. 21

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online (and) 48(67(000 electrotechnical terminology entries in English and once a month by email. https://standards.iteh.ai/catalog/standard

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Glossary - std.iec.ch/glossary

French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been IEC Customer Service Centre - webstore.iec.chi/csc/33eca4/ieccofiletted from earlier publications of IEC TC 37, 77, 86 and CISPR.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary

67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.





Edition 3.0 2019-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE



Specifications for there-use of support nexafuoride (SF₆) and its mixtures in electrical equipment (standards.iteh.ai)

Spécifications pour la réutilisation de l'hexafluorure de soufre (SF₆) et des mélanges contenant du SF₆ dans le matériel électrique 8-

8a441433eca4/iec-60480-2019

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 29.040.20; 29.130.01

ISBN 978-2-8322-6697-7

Warning! Make sure that you obtained this publication from an authorized distributor. Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

 Registered trademark of the International Electrotechnical Commission Marque déposée de la Commission Electrotechnique Internationale

CONTENTS

FC	FOREWORD					
1	Scop	e	7			
2	2 Normative references					
3	Term	is and definitions	8			
4	Cont	aminants and their sources	9			
	4.1	General	9			
	4.2	Contaminants from handling and use				
	4.3	SF ₆ by-products in equipment that only have an insulating function				
	4.4	SF ₆ by-products in switching equipment				
	4.5	SF ₆ by-products from internal arcs				
	4.6	SF ₆ mixtures specific by-products				
5	Spec	ifications for re-use of SF ₆				
6	Spec	ifications for re-use of SF ₆ mixtures	11			
7	Recla	aiming of SF ₆ and SF ₆ mixtures	11			
	7.1	Feasibility and process				
	7.2	Detection techniques for checking the quality of the gases	14			
	7.2.1	General On-site analysis	. 14			
	7.2.2					
	7.2.3	Laboratory analysistandards.iteh.ai)	. 15			
8	Hand	lling, storage and transportation (informative)	16			
9	Safe	ty and first aid <u>IEC.60480:2019</u>	. 16			
	9.1	General safety rules	. 16			
	9.1.1	General	. 16			
	9.1.2					
	9.1.3	Handling of contaminated safety equipment and tools	18			
	9.1.4	Pressurized equipment and tools or measuring devices	19			
	9.1.5	Personal safety and protective equipment	19			
	9.1.6	Facilities and services	20			
	9.2	Additional safety measures in case of abnormal release of SF ₆ due to external fire or internal arc fault	20			
	9.3	First aid equipment and treatment	21			
	9.3.1	General	21			
	9.3.2	Irritation of the skin	21			
	9.3.3	Irritation of the eyes	22			
	9.3.4	Breathing difficulty	22			
10	Envii	onmental aspects	22			
Ar	nex A (informative) Description of methods of analysis (on-site and laboratory)	23			
	A.1	Sampling	23			
	A.1.1	General	23			
	A.1.2	On-site sampling connection	23			
	A.1.3					
	A.1.4					
	A.2	On-site analysis				
	A.2.1					
	A.2.2	SF ₆ concentration meter	25			

A.2.3	B Hygrometers	25
A.3	Laboratory analysis	26
A.3.1	Gas chromatography	26
A.3.2	Infrared spectroscopy	28
Annex B (informative) By-products of SF6 and its mixtures	31
B.1	Decomposition of SF ₆ and its mixtures	31
B.1.1	General	31
B.1.2	Behaviour of SF ₆ in an electric arc	31
B.1.3		
B.1.4	Catalytic decomposition of SF ₆ (high-temperature behaviour)	33
B.2	Corrosion behaviour of SF ₆ and its by-products	
B.3	Measures for the removal of by-products	
B.4	Physiological characteristics of by-products	34
	(informative) Procedures for evaluating the potential effects on health from ets of SF ₆ and its mixtures	35
C.1	General	35
C.2	Formation and health effects of SF ₆ by-products	35
C.2.1		
C.2.2	·	
C.2.3		
C.2.4	Procedures for health risk evaluation PREVIEW	38
C.3	Conclusion	40
Annex D (Conclusion	42
D.1	General	42
D.2	Filtering recommendations atalog/standards/sist/74c9c6d3-8dda-4b43-bb18	42
D.3	Transport of used SF6 in gas cylinders and containers by road	
Annex E (informative) Cryogenic reclaiming of SF ₆	43
E.1	General	43
E.2	Applications	43
E.3	Physical background	43
E.4	Cryogenic processes	44
E.5	Description of a cryogenic reclaimer	44
Bibliograp	hy	47
Figure 1 -	- Decision flow chart for recovered SF ₆	13
Figure A.	1 – One-sampling cylinder method set-up	24
-	2 – Two-sampling cylinder method set-up	
Figure A.3	 B – Example of a gas chromatogram in one print out showing the different by-products after decomposition 	
•		
	4 – Typical GCMS chromatogram of decomposed SF ₆ /CF ₄ mixture	
-	5 – IR spectrum of contaminated SF ₆	30
	1 – Procedure for the evaluation of the potential effects on health due	39
	2 – Procedure for the evaluation of the potential effects on health due to low	
	scharges	
-	1 – Saturated vapour pressure of various gases as a function of temperature	
Figure D.2	2 – Typical cryogenic reclaimer for SF ₆ recovery on site	45
Figure D.3	3 – Typical cryogenic reclaimer for removing contaminants	45

Table 1 – SF ₆ contaminants	9
Table 2 – Specifications for re-use of SF ₆	10
Table 3 – Specifications for re-use of SF ₆ /N ₂ mixtures	11
Table 4 – Specifications for re-use of SF ₆ /CF ₄ mixtures	11
Table 5 – General contaminants and methods for their removal	12
Table 6 – Typical adsorbents for various SF ₆ contaminants	12
Table 7 – On-site methods	15
Table 8 – Laboratory methods	16
Table 9 – Measures when working with SF ₆ electric power equipment	17
Table 10 – Safety measures when opening or accessing gas compartments	
Table 11 – Neutralizing solutions	19
Table 12 – Additional safety measures	21
Table A.1 – Peak absorption of SF ₆ and contaminants	29
Table C.1 – OELs for SO2, HF, and S2F10	
Table C.2 – SOF ₂ production rate	

iTeh STANDARD PREVIEW (standards.iteh.ai)

<u>IEC 60480:2019</u> https://standards.iteh.ai/catalog/standards/sist/74c9c6d3-8dda-4b43-bb18-8a441433eca4/iec-60480-2019

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SPECIFICATIONS FOR THE RE-USE OF SULPHUR HEXAFLUORIDE (SF₆) AND ITS MIXTURES IN ELECTRICAL EQUIPMENT

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committee; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies sist/74c9c6d3-8dda-4b43-bb18-
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60480 has been prepared by IEC technical committee 10: Fluids for electrotechnical applications.

This third edition cancels and replaces the second edition, published in 2004. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- specifications for the re-use of SF₆ have been confirmed;
- specifications for the re-use of SF₆ mixtures, namely SF₆/N₂ and SF₆/CF₄ mixtures are included;
- as a result of a new repartition of annexes in IEC 60376, IEC 60480 and IEC 62271-4, this new edition now contains the following five annexes:
 - Annex A: Description of methods of analysis (on-site and laboratory);
 - Annex B: By-products of SF₆ and its mixtures;

- Annex C: Procedure for evaluating the potential effects on health from by-products of SF₆ and its mixtures;
- Annex D: Reclaiming recommendations.
- Annex E: Cryogenic reclaiming of SF₆;

The text of this International Standard is based on the following documents:

FDIS	Report on voting
10/1075/FDIS	10/1080/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed, •
- withdrawn, •
- replaced by a revised edition, or

(standards.iteh.ai)

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

SPECIFICATIONS FOR THE RE-USE OF SULPHUR HEXAFLUORIDE (SF₆) AND ITS MIXTURES IN ELECTRICAL EQUIPMENT

1 Scope

This document provides criteria for the re-use of sulphur hexafluoride (SF_6) and its mixtures after recovery and reclaiming from electrical equipment (e.g. for maintenance, at the end-of-life).

Sulphur hexafluoride (SF₆), nitrogen (N₂) and carbon tetrafluoride (CF₄), are gases commonly used for electrical equipment. Taking into account environmental concerns, particular attention is paid to re-use criteria for SF₆ and its mixtures with N₂ and CF₄ for its use in electrical equipment. Procedures for recovering and reclaiming used SF₆ and its mixtures are outside the scope of this document and are described in IEC 62271-4.

This document provides several annexes on the description of the different methods of analysis, on by-products, on the procedure for evaluating the potential health effects from by-products, on cryogenic reclaiming of SF_6 , and on reclaiming recommendations.

Storage, transportation and disposal of SF₆ and its mixtures are outside the scope of this document and are covered by IEC 62271-4. Procedures to determine SF₆ leakages are described in IEC 60068-2-17 [4]¹.

(standards.iteh.ai)

For the purposes of this document, the complementary gases used in SF_6 mixtures will be limited to N_2 or CF_4 . IEC 60480:2019

> https://standards.iteh.ai/catalog/standards/sist/74c9c6d3-8dda-4b43-bb18-8a441433eca4/iec-60480-2019

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60050-192, International Electrotechnical Vocabulary – Part 192: Dependability (available at http://www.electropedia.org)

IEC 60050-212, International Electrotechnical Vocabulary – Part 212: Electrical insulating solids, liquids and gases (available at http://www.electropedia.org)

IEC 60050-441, International Electrotechnical Vocabulary – Part 441: Switchgear, controlgear and fuses (available at http://www.electropedia.org)

IEC 60050-826, International Electrotechnical Vocabulary – Part 826: Electrical installations (available at http://www.electropedia.org)

IEC 62271-4:2013, High-voltage switchgear and controlgear – Part 4: Handling procedures for sulphur hexafluoride (SF₆) and its mixtures

¹ Numbers in square brackets refer to the bibliography.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-192, IEC 60050-212, IEC 60050-441 and IEC 60050-826, and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1

electrical equipment

item used for such purposes as generation, conversion, transmission, distribution or utilization of electrical energy, such as electric machines, transformers, switchgear and controlgear, measuring instruments, protective devices, wiring systems, current-using equipment, insulated bushings, surge arresters

[SOURCE: IEC 60050-826:2004, 826-16-01, modified – "insulated bushings, surge arresters" has been added.]

3.2

container

vessel (cylinder) suitable for the containment of pressurized gases either in gaseous or liquid phase, according to local and/or international safety and transportation regulations

3.3

(standards.iteh.ai)

used sulphur hexafluoride

SF₆ which has been introduced into electrical equipment

https://standards.iteh.ai/catalog/standards/sist/74c9c6d3-8dda-4b43-bb18-

8a441433eca4/iec-60480-2019

3.4 reclaiming

process of contaminants removal from an insulating liquid or gas

3.5

recovery

process of transferring gas from electrical equipment to an alternate container

3.6

SF₆ mixture

gas mixture formed by SF_6 and a complementary gas, typically N_2 or CF_4

3.7

contaminant

foreign substance or material in an insulating liquid or gas which usually has a deleterious effect on one or more properties

[SOURCE: IEC 60050-212:2010, 212-17-27, modified - "or solid" has been deleted.]

3.8

by-products

contaminants which are formed by the degradation of ${\rm SF}_6$ and its mixtures by electrical arcs or sparks

3.9

ambient air

normal atmosphere surrounding the equipment

[SOURCE: IEC 60079-29-2:2015, 3.1.1]

4 Contaminants and their sources

4.1 General

 SF_6 recovered from electrical equipment in operation contains several kinds of contaminants. Contaminants in recovered SF_6 come both from gas handling and from use.

Table 1 summarizes the main contaminants and their sources. Additional information is available in Annex B.

SF ₆ situation and use	Origin	Possible contaminant
Llandling and in convice	Leaks and incomplete evacuation	For pure SF ₆ : Air, oil, H ₂ O
Handling and in service	Desorption	For SF ₆ mixtures: Air, oil, H_2O , N_{2} , CF_4
Insulating function	Partial discharges (e.g. corona) and low	Gaseous by-products: HF, SO ₂ , SOF ₂ , SOF ₄ , SO ₂ F ₂
Insulating function	energy flashovers and sparkovers	For SF ₆ mixtures: HF, SO ₂ , SOF ₂ , SOF ₄ , SO ₂ F ₂ , NO _x , NF _X
Switching equipment	iTeh STANDARD PR Switching arc erosion (standards.iteh.	Gaseous by-products: HF, SO ₂ , SOF ₂ , SOF ₄ , SO ₂ F ₂ , SF ₄ , CF ₄ , WF ₆ Solid by-products: Metal dusts, particles, AF ₃ , FeF ₃ , WO ₃ , CuF ₂ For SF ₆ mixtures: HF, SO ₂ , SOF ₂ , SOF ₄ , SO ₂ F ₂ NO _x , NF _x
http:	<u>IEC 60480:2019</u> Mechanical terosion Systematical terosion	Metal dusts, particles
		Gaseous by-products: HF, SO ₂ , SOF ₂ , SOF ₄ , SO ₂ F ₂ , SF ₄ , CF ₄ , WF ₆
Internal arc	Melting and decomposition of materials	Solid by-products: Metal dusts, particles, AIF_3 , FeF_3 , WO_3 , CuF_2
		For SF ₆ mixtures: HF, SO ₂ , SOF ₂ , SOF ₄ , SO ₂ F ₂ , NO _x , NF _X

Table 1 – SF₆ contaminants

4.2 Contaminants from handling and use

Filling and recovering gas leads to the additional contamination with ambient air and water (humidity).

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

When using gas mixtures, the possibility of cross contamination shall be considered (contaminating one gas mixture by another).

4.3 SF₆ by-products in equipment that only have an insulating function

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

4.4 SF₆ by-products in switching equipment

During current interruption, the existence of high temperature arcs leads to the formation of by-products of SF_6 , vaporized electrode metal, polymeric materials and contaminants. In addition, chemical reactions take place among the products formed (see Table 1).

The quantity of these by-products depends on the number of operations, the cumulative short circuit current, 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.

4.5 SF₆ by-products from internal arcs

The occurrence of an internal arc is extremely rare. The expected contaminants in SF_6 in faulted equipment are similar to those normally found in switching equipment. The difference lies in the quantity of compounds, which create a potential toxic risk (see Clause 9). In addition, significant vaporization of metallic material occurs and creates additional reaction products such as dust.

4.6 SF₆ mixtures specific by-products

For SF₆ mixtures, the usual SF₆ by-products mentioned in Table 1 and specific mixture byproducts, such as nitrogen oxide(s) and nitrogen fluoride(s) for SF₆/N₂ and fluorocarbon(s) for SF₆/CF₄, are produced. The quantities depend on the mixture composition, contaminants and energy introduced. For typical SF₆ mixtures, the gas decomposition rates are not expected to exceed those for SF₆. (standards.iteh.ai)

Within the by-products generated in mixtures, SF₆ by-products are generally predominant in terms of quantity and toxicity. Safety procedures related to the presence of the usual SF₆ by-products shall also apply in applications with SF₆ mixtures.

5 Specifications for re-use of SF₆

Substance ^a	Concentration		
SF ₆ > 97 % volume			
Air and/or CF ₄	< 30 000 µl/l (i.e. 3 % volume)		
H ₂ O	< 200 µl/l (i.e. 200 ppmv)		
Mineral oil	< 10 mg/kg ^b (i.e. 10 ppmw)		
Acidity	< 50 µl/l total (i.e. 50 ppmv) or 12 µl/l (i.e. 12 ppmv) for (SO_2+SOF_2) or 25 µl/l (i.e. 25 ppmv) HF		

Table 2 – S	pecifications	for	re-use	of SF ₆	
-------------	---------------	-----	--------	--------------------	--

Key

ppmv = part per million by volume

ppmw = part per million by weight

- ^a H_2S and CO have been considered irrelevant due to lack of valuable data.
- ^b If gas handling equipment (pump, compressor) containing oil is used, it may be necessary to measure the oil content of the SF₆. If all equipment in contact with the SF₆ is oil-free, then it is not necessary to measure the oil content.

For the determination of total acidity, the sum of all acidic compounds is reported as one value. Alternatively, total acidity can be measured in terms of $(SO_2 + SOF_2)$ or in terms of HF with a limit value of 12 μ l/l and 25 μ l/l respectively.

6 Specifications for re-use of SF₆ mixtures

Table 3 – Specifications for re-use of SF₆/N₂ mixtures

Substance	Concentration		
N ₂	As per OEM specifications		
SF ₆ percentage	±5 % volume of the specified percentage ^a		
Air and CF ₄	< 30 000 µl/l (i.e. 3 % volume) ª		
H ₂ O	< 200 µI/I (.i.e. 200 ppmv)		
Mineral oil	< 10 mg/kg ^b (i.e. 10 ppmw)		
Total acidity	< 50 µl/l total (i.e. 50 ppmv) or 12 µl/l (i.e. 12 ppmv) for (SO ₂ +SOF ₂) or 25 µl/l (i.e. 25 ppmv) HF		
	Storage conditions		
Shall comply with IEC 62271-4:2013, CI	ause J.7 in order to prevent liquefaction of SF_{e} .		

Key

ppmv = part per million by volume

ppmw = part per million by weight

- ^a Or unless otherwise specified by the original equipment manufacturer (OEM).
- ^b If gas handling equipment (pump, compressor) containing oil is used, it may be necessary to measure the oil content of the SF₆. If all equipment in contact with the SF₆ is oil-free, then it is not necessary to measure the oil content.

Table 4 – Specifications for re-use of SF_6/CF_4 mixtures

Substance	IEC 60480:2019 Concentration
CF ₄	lards.iten.a/catalogistandards/ski/74c9cod3-8dda-4043-0018- As per OEM specifications 8a441431eca40rec-01480-7119
SF ₆ percentage	±5 % volume of the specified percentage ^a
Air and N ₂	< 30 000 µl/l (i.e. 3% volume) ^a
H ₂ O	< 200 µl/l (.i.e. 200 ppmv)
Mineral oil	< 10 mg/kg ^b (i.e. 10 ppmw)
Total acidity	< 50 µl/l total (i.e. 50 ppmv) or 12 µl/l (i.e. 12 ppmv) for (SO ₂ +SOF ₂) or 25 µl/l (i.e. 25 ppmv) HF
	Storage conditions
Shall comply with IEC 62271-4:	2013, Clause J.7 in order to prevent liquefaction of SF ₆ .
14	· · · · · ·

Key

ppmv = part per million by volume

ppmw = par per million by weight

^a Or unless otherwise specified by the original equipment manufacturer (OEM).

^b If gas handling equipment (pump, compressor) containing oil is used, it may be necessary to measure the oil content of the SF₆. If all equipment in contact with the SF₆ is oil-free, then it is not necessary to measure the oil content.

7 Reclaiming of SF₆ and SF₆ mixtures

7.1 Feasibility and process

The quality of reclaimed ${\rm SF}_6$ shall meet the requirements of this document.

All occurring contaminants are formed in normal operation and can generally be eliminated on-site. Table 5 lists methods recommended for removing the contaminants as given in Table 1.

Contaminant	Humidity (water vapour)	Gaseous by- products	Solid by- products	Air, N ₂ , CF ₄	Mineral oil
Removal method	Adsorption with molecular sieve	Adsorption with activated aluminium oxide	Retaining with solid filters	Separation by cryogenic process or membrane filtration	Adsorption with activated charcoal filter
For SF ₆ and its mixtures, these gaseous contaminants cannot be removed easily on-site. In each situation, an					

 Table 5 – General contaminants and methods for their removal

For SF₆ and its mixtures, these gaseous contaminants cannot be removed easily on-site. In each situation, an evaluation of the reclaiming options should be done to determine if the SF₆ and its mixture could be reclaimed on-site.

Various types of adsorbent materials are available to remove contaminants from SF_6 gas (see Table 6).

Table 6 – Typical adsorbents for various SF₆ contaminants

Adsorbent	Contaminants removed
Molecular sieve 4A SIANDAR	Water, SO ₂ , SOF ₂ , SF ₄
Molecular sieve 13X (standard	Water, SO ₂ , SOF ₂ , SF ₄
	(also adsorbs some SF ₆)
Activated aluminium oxide IEC 6048	Mater, SO ₂ , SOF ₂ , SF ₄ , HF
https://standards.iteh.ai/catalog/standard Soda lime (CaO-NaOH)	s/sist//4c9c6d3-8dda-4b43-bb18- Water, SO ₂ F ₂ , HF
Activated charcoal	Oil vapour

If the results of the gas analysis exceed the specifications for re-use of SF_6 and its mixtures given in Table 2, Table 3 or Table 4, a decision regarding the reclaiming method has to be made depending on the level and type of contamination. In general, re-purifying the gas on-site with a service device plus a separation device will be the most favourable way. However, if re-use is not possible, reclaiming by the gas manufacturer or disposal will be necessary. In this case, the gas shall be sent to the SF_6 manufacturer or reclaimer.

Figure 1 defines the selection procedure to determine the best use of SF_6 after recovery for potential treatment.



Figure 1 – Decision flow chart for recovered SF₆

- For contaminants of water or by-products, the question of whether the SF₆ is reclaimable on-site depends only on the performance of the filters available. The addition of external pre-filters may be required to increase the efficiency of the reclaiming process. If the SF₆ is not reclaimable on-site, then it shall be returned to the SF₆ manufacturer or sent to a reclaiming or disposal company.
- The case of contamination with air, N_2 and/or CF_4 shall be considered separately.
- For non-mixed SF₆, if the concentration of air and/or CF₄ exceeds the maximum acceptable contaminant level as given in Table 2, and if the container from which the sample has been taken contains liquid SF₆, then transfer SF₆ from the gas phase into a second container. The transfer should be continued until a sample from the first reservoir satisfies the maximum acceptable level. The contents of the second container cannot be